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268
Nature,
August 2, 1930]

Nature

A WEEKLY

JOURNAL OF SCIENCE

VOLUME CXXV

JANUARY, 1930, to JUNE, 1930

*"To the solid ground
Of Nature trusts the mind that builds for aye."*—WORDSWORTH.



London

MACMILLAN AND CO., LIMITED

NEW YORK: MACMILLAN COMPANY

1930.439



INDEX

NAME INDEX

- Abbe (the late Ernst), connexion with the firm of Zeiss, 211
Abetti (G.), and B. Nováková, Structure of the line *Ha* and period of rotation of the Solar Chromosphere, 34
Ablett (R.), A Course in Physics : for Medical and Dental Students, 812
Achard (C.), and M. Enachesco, The Variations, Spontaneous or Provoked, of the Distribution of Chlorine between the Serum and the Blood Corpuscles in Disease, 958
Acharya (Prof. D. P.), Spectrum of Trebly Ionised Krypton, 204
Ackermann (A. S. E.), Three Waterspouts in Rapid Succession, 829
Adams, Joy, Sanford, and Strömberg, Radial Velocities of 741 Stars, 649
Adler (A.), with a prefatory essay by Dr. F. G. Crookshank. Edited by P. Mairet, Problems of Neurosis : a book of Case-Histories, 162
Adler, (Dr. S.), appointed professor of parasitology and director of the department of parasitology at the Hebrew University, Jerusalem, 112
Aikawa (H.), On Larval Forms of some Brachyura, 395
Alexander (F. H.), Bird-flotation, 902
Algar (J.), and A. V. Flaegel, The Action of Grignard Reagents on Phthalide, 478; and Mary Boylan, Azo Dyes derived from Diacetoresorcinol, 478
Allan (Miss F. E.), The General Form of the Orthogonal Polynomials for Simple Series with Proofs of their Elementary Properties, 878
Allen (Prof. H. S.), Group Velocity and Wave Mechanics, 561; Haas's Introduction to Theoretical Physics, 559
Allen (N. P.), Experiments on the Influence of Gases on the Soundness of Copper Ingots, 477
Allen (W. H.), Sons, and Co., Ltd., Engineering and Training, 900
Allison (F. E.), Nitrogen Fixation by Bacteria, 578
Allmand and Style, Photolysis of Aqueous Hydrogen Peroxide, 952
Alpatov (W. W.), Duration of Life in *Drosophila*, 508
Alquier (J.), Mlle. L. Asselin, Mme. M. Kogane, and Mlle. G. Silvestre and de Sacy, The Variations of the Mineral Composition of the Bone Tissue in the Normal Rat, etc., 434
Alston (A. H. G.), appointed assistant-keeper in the department of botany, British Museum (Natural History), 213
Alter (Prof. D.), Prediction of the Sunspot Curve, 251
Amagat (Mlle.), Action of Sodium Amide on some Alkyl Bromides, 959
Ambarzumian (V.), and D. Iwanenko, Unobservable Electrons and the β -rays, 586
Anderson (Prof. J. Wemyss), [death], 715
Andrade (Prof. E. N. da C.), The Viscosity of Liquids, 309, 582
Andress (W. R.), awarded a Rayleigh prize of Cambridge University, 547
Andrew (R. L.), Determination of Minute Amounts of Iodine in Soils and Waters, 433
Andrew-Marshall (G.), Water Supply of London, 147
Andrieux (L.), The Preparation and Properties of the Borides of Tantalum and Columbium, 222; The Preparation of Thallium by the Electrolysis of its Oxides, 842
Angeli (A.), and Z. Jolles, Certain Oxidation Processes determined by Normal Diazo-hydrates, 338
Annand (Dr. P. N.), Adelginæ (Phylloxeridæ) of North America, 722
Annenkova (N. P.), A Supplement to the Polychæt Fauna of the Black Sea (1), 586
Anschütz (Prof. R.), August Kekulé. 2 Band, 807
Antoniadi (E. M.), Saturn, 425
Appleton (Dr. A. B.), elected a fellow of Downing College, Cambridge, 219; Laboratory Guide to Vertebrate Dissection : for Students of Anatomy, 739
Appleton (Prof. E. V.), Ionised Layers in the Upper Atmosphere, 579; Wireless Methods of Investigating the Electrical Structure of the Upper Atmosphere (2), 958
Appleton (Dr. J. H.), [death], 679
Appleyard (R.), Pioneers of Electrical Communication, 300
Arcay (G. P.), The Deformation of the Flat Spiral, 73
Arciszewski (W.), and W. Kopaczewski, The Buffer Power of Serum, 75
Armellini (Prof. G.), Distance of the Trans-Neptunian Planet, 613; The Modern Theory of the Evolution of the Stars, 842
Armstrong (Prof. H. E.), Anent Metameric Hydrogens, 46; awarded the Albert Medal of the Royal Society of Arts, 903; Book Prices and Reading, 234; Edward Clodd, 535; Organic Chemistry in Peril, 344; Our Present Course of Education, 341; School Science and Educational Values, 560; The Barcelona Meeting of the French Society of Chemical Industry, 62; The Doctrine of Atomic Valency, 807
Arnall (Dr. F.), [death], 324
Arnold (Prof. J. O.), [death], 537; [obituary article], 641
Arnold (Sir Thomas Walker), [death], 944
Ashbrook (F. G.), and K. B. Hanson, Delayed Development of Embryonic Young in Martens, 834
Askania-Werke, A.-G., Rauschelbach Current Meter, 652
Aston (Dr. F. W.), Mass-Spectra of Mercury, Krypton, and Xenon, 332; The Photometry of Mass-Spectra and the Atomic Weights of Krypton, Xenon, and Mercury, 186
Astruc (A.), M. Mousseron, and Mlle. N. Bouissou, A New Method for the Micro-estimation of the Calcium Ion, 478
Atkins (Dr. W. R. G.), and Dr. H. H. Poole, The Photoelectric Recording of Daylight, 305
Atkinson (Sir William), [death], 324
Aurino (S.), The Photometric System of Naples, 338
Austen (Major E. E.), Dr. James Waterston, 786
Austin (A. O.), High Tension Testing, 836
Austin (J. B.), Raman Effect in Liquefied Gases, 464
Avery, Ltd. (W. and T.), A 100-ton Testing Machine, 686
Ayyar (Rao Bahadur L. K. Ananta Krishna), Anthropology of the Syrian Christians, 852
Azéma (M.), and H. Pied, Vanadium in the Blood of Acidians, 338
Baade (Dr. W.), Comet Schwassmann-Wachmann (1), 103
Backer (C. A.), The Problem of Krakatao as seen by a Botanist, 627
Bäcklin (E.), X-ray Measurements with a Plane Diffraction Grating, 239
Bagnall (R. S.), and W. Hall, External Parasites of British Birds, 871
Bailey (Prof. E. B.), awarded the Neill prize of the Royal Society of Edinburgh, 756

- Bailey (V.), and C. C. Sperry, Food of Grasshopper Mice, 330
- Baily, Grundy and Barrett, Ltd., An Automatic Thermostat, 651
- Baker (F. C.), Fresh-Water Mollusca of Wisconsin, 104
- Baker (Prof. H. B.), Intensive Drying of Gases and Liquids, 229
- Balavoine (P.), The Luminosity of some Colouring Matters in Ultra-Violet Light, 915
- Balcom (Dr. R. W.), [death], 61
- Baldet (F.), Observations, with the large Meudon Telescope, of the Celestial Body discovered at the Lowell Observatory, 766; The New Planet, 672
- Baldwin (Mr. Stanley), elected Chancellor of Cambridge University, 799; installed as Chancellor of Cambridge University, 911
- Balfour (Earl of), [death], 465; [obituary articles], 497-502
- Balfour (H.), How Fire became Known, 920
- Ballantyne (Miss Frances M.), Development of *Callichthys*, 905
- Ballay, Electrolytic Deposits on Aluminium and its Alloys, 434
- Bamberger (L.), and Mrs. Felix Fuld, gift for the establishment of an institute for advanced study, at Newark, New Jersey, or its vicinity, 912
- Band (W.), A New Relativity Theory of the Unified Physical Field, 130
- Banerjee (Dr. K.), Structure of Naphthalene and Anthracene, 456
- Banerji (Prof. A. C.), Scattering of α -Particles by Light Atoms, 167
- Banerji (S. K.), The Electric Field of Overhead Thunderclouds, 729
- Banister (H.), and others. Edited by C. Murchison, The Foundations of Experimental Psychology, 376
- Bär (Dr. R.), Raman Effects in Liquids, 332
- Barbulescu (Dr. N.), Surface Tension and Temperature, 393
- Bardet (J.), and A. Tehakirian, Some Combinations of Germanium Oxide and Oxalic Acid, 74
- Barfield (R. H.), Direction Finding by Radio, 907
- Barnes (A. H.), Capture of Electrons by α -Particles, 509
- Barnett (Prof. S. J.), The Green Flash in Southern California, 446
- Barns (T. A.), [death], 465
- Barovskii (V. V.), A New Species of the Genus *Malthodes* Kies. (Coleoptera, Cantharididae) of Central Asia, 586
- Barrett (Sir James W.), Research and the State, 310
- Barrie (Sir James), elected Chancellor of Edinburgh University, 876
- Barritt (N. W.), Cotton Yield and the Flowering Curve, 872
- Bartlett, Jr. (J. H.), Electron Affinities of the Elements, 459
- Bartram (E. B.), Taxonomy of Bryophyta, 473
- Bary (P.), The Study of Solutions of Colouring Matters for Petrography, 550
- Basta (J.), The Mechanical Theory of the Solidification and Hardening of Cements and Concrete, 915
- Battye (A. E.), and H. M. Dawson, Nature of the Reaction between Phorone and Iodine, etc., 34
- Bauer (G. N.), Mathematics Preparatory to Statistics and Finance, 379
- Bauer (Dr. L. A.), retirement of, 176
- Baylis (Dr. H. A.), Nematode Infection of a Young Dolphin, 578
- Bayliss (L. E.), E. Boyland, and A. D. Ritchie, The Adductor Mechanism of *Pecten*, 841
- Beattie (Prof. J. M.), Bacteriology in Medicine and Public Health, 80; Bacteriology in Medicine, 359, 522
- Beattie and Lawrence, Properties of Ammonia, 290
- Beaven (Dr. E. S.), Cereal Breeding, 544
- Bechhold (Prof. H.), Die Kolloide in Biologie und Medizin. Fünfte Auflage, 771
- Beck (Dr. G.), Scattering of Electrons and α -Particles, 458
- Becke (F.), The Systematics and Nomenclature of the 32 Symmetry Classes of Crystals, 398
- Becker (J. A.), Oxide-coated Filaments, 68
- Beckett (H. E.), Coloured Glass as a Deterrent to House Flies, 780
- Becquerel (P.), The Latent Life of Fern Spores in a Vacuum at the Temperature of Liquid Helium, 995
- Bedel (C.), Compact Fused Silicon and the Density of this Element, 514
- Bedford (L. H.), The 'Wave-band' Theory of Wireless Transmission, 198
- Bedford (T. G.), reappointed university lecturer in physics in Cambridge University, 839
- de Beer (G. R.), Embryology and Evolution, 883
- Begg (D.), elected vice-president of the Royal Philosophical Society of Glasgow, 541
- Beier (M.), Zoological Expedition to the Ionian Islands (10), 767
- Beliainkin (D.), Titanium Oxide in the Dinas, 586
- Beliainkin (Dr.), Petrographic Nomenclature, 28
- Bell (R. M.), and W. R. Fredrickson, Raman Effect of Sulphuric Acid, 892
- Belling (Dr. J.), The Secondary Split in the Maturation Divisions of Liliaceous Plants, 52
- Bellingham (L.), The Neon Lamp as a Glow Relay, 928
- Bender (Dr. M.), Measurement of Ultra-Violet Radiation, 987
- Benham (Dr. W. B.), Pelagic Polychaetes of the *Terra Nova* Expedition, 252
- Bennet-Clark (T. A.), A Method of Investigating Gas Exchanges of Living Tissues, 492
- Bensted (H. J.), and others, A System of Bacteriology in relation to Medicine. Vol. 4, 359
- Berg (Prof. G.), Vorkommen und Geochemie der mineralischen Rohstoffe, 596
- Bergstrand (Prof.), Periodic Changes in the Solar Corona, 649
- Berkeley (L.), and Major Raven-Hart, Broadcasting and the Development of Music, 790
- Berman (L.), Spectroscopic Study of ξ Ursae Majoris, 904
- Bernal (J. D.), reappointed university lecturer in structural crystallography in Cambridge University, 839
- Bernard (R.), and P. Job, The Oxidation of Cobalt Salts in Alkaline Media, 337
- Bernatzik (Dr. H. A.), Mit Beiträgen von Prof. O. Reche, Prof. B. Struck und Dr. H. Antonius, Zwischen Weissem Nil und Belgisch-Kongo, 301
- Berry (A. J.), F. W. Dootson, 323
- Berthois (L.), The Heavy Minerals of the Granite Massif of Fougères (Ille-et-Vilaine), 730
- Bertrand (G.), and L. Silberstein, Estimation of Sulphur and Phosphorus in Plants, 73; The Relative Importance of Sulphur and Phosphorus in the Nutrition of Plants, 113; and M. Mokragatz, Distribution of Nickel and Cobalt in Plants, 257; and Mme. M. Rosenblatt, The Proportion of Potassium and Sodium contained in Plants which grow in Brackish Water or on the Sea-Coast, 914; and Mlle. Y. Beauzemont, The Variations of the Content in Zinc of Animals with Age, 995
- Besicovitch (A. S.), reappointed a university lecturer in mathematics in Cambridge University, 839
- Best (A. C.), Instruments for Obtaining Dry and Wet Temperatures, 841
- Betrem (J. G.), Elm Disease, 252
- Bewley (Dr. W. F.), and B. J. Bolas, Aucuba or Yellow Mosaic of the Tomato Plant: Reaction of Infected Juice, 130
- Bews (Prof. J. W.), The World's Grasses: their Differentiation, Distribution, Economics, and Ecology, 119
- Beyschlag (Prof. F.), Geologische Karte der Erde. Lief. 1, enthaltend die Blätter 1, 2, 3, 4, 488
- Bhagavantam (S.), and S. Venkateswaran, Raman Effect with Optically Active Substances, 237
- Bidder (Dr. G. P.): On the Attitude of a Hexactinellid at the Bottom of the Sea, etc., 913; The Importance of Cataclasm in Evolution, 783
- Biedermann (Dr. W.), [death], 537
- Bigler (Dr. W.), Myriopoda of the Swiss National Park, 871
- Bigney (Prof. A. J.), [death], 174
- Bigourdan, The Instruments and Obscurities of P. J. de Beauchamp, 729
- Billy (J. S.), A Steel Triangulation Tower, 795
- Billiter (Prof.), New Developments in Technical Electrolytic Processes, 724
- Bingham (Dr. H. C.), Work of Gorilla Expedition in Central Africa, 646

- Birge (Prof. R. T.), and C. R. Jeppesen, Moment of Inertia of Hydrogen from Raman Effect, 463
- Bishop (W. B. S.), Metallic Elements in Animal and Plant Tissues, 648
- Biswas (K.), Freshwater Biological Research in the Indian Empire, 670
- Black (Prof. Davidson), Pleistocene Man in China, 22
- Black (Dr. D. H.), The Viscosity of Liquids, 581
- Black (Dr. I. A.), The Tesla-Luminescent Spectrum of Benzene, 274
- Black (M.), Formation of Limestone, 509
- Blackburn (Dr. Kathleen Bever), awarded the Trail award and medal of the Linnean Society, 719
- Blackett (P. M. S.), and Dr. E. K. Rideal, Measurement of Relative Specific Heats of Gases at High Temperatures, 816
- Blacklock (Prof. B.), Health in West Africa, 286
- Blakely (W. F.), A Further Contribution to our Knowledge of the Flora of New South Wales, 114
- Bliss (E. W.), A Study of Rainfall in the West Indies, 113
- Bocking and Bailey, The Yield of Coal Seams, 697
- Bodenheimer (Dr. F. S.), Materialien zur Geschichte der Entomologie bis Linné. Band 2, 483
- Bohr (Prof. Niels): awarded the James Scott prize of the Royal Society of Edinburgh, 756; Chemistry and the Quantum Theory (Faraday Lecture), 788; Philosophical Aspects of Atomic Theory, 958; presented with the Faraday Medal of the Chemical Society, 788
- Bolitho (H.), with certain chapters edited by M. Burton, The Glorious Oyster, 406
- Bolton (E. R.), and K. A. Williams, Composition and Polymerisation of Chinese Wood (Tung) Oil, 802
- Bomford (Capt. G.), Errors in Precise Levelling, 181
- Bompiani (E.), Projective Interpretation of Certain Ordinary Differential Equations of the Second Order, 730
- Bond (G.), Cell Division in the Endodermis, 221
- von Bonde (Dr. C.), Methods of Tagging Fishes and Crustacea, 426
- Bone (Prof. W. A.): Gaseous Combustion, 274; Dr. D. M. Newitt, and Dr. D. T. A. Townend, Gaseous Combustion at High Pressures: being mainly an Account of the Researches carried out in the High Pressure Gas Research Laboratories of the Imperial College of Science and Technology, London, together with the Equipment and Experimental Methods Employed, 302; L. Horton, and S. H. Ward, Researches on the Chemistry of Coal (6), 801
- Boone (L.), Crabs from Panama, 181
- Borchgrevink (C. E.), awarded the Patron's Medal of the Royal Geographical Society, 467
- Bordas (F.), and E. Roelens, Alcoholometric Corrections for Temperatures below 0° C., 841
- Borodin (Prof. I. P.), [obituary article], 678
- van den Bos (W. H.), Double Star Measures at Johannesburg, 684
- Bose (Prof. D. M.), A Diamagnetic Simple Salt of Nickel, 708
- Bose (Sir Jagadis Chunder), Growth and Tropic Movements of Plants, 438; made an honorary member of the Academia Scientiarum Fennica, Helsingfors, 424; The Advance of Plant Physiology, 25
- Bose (Dr. N. K.), Flow of Underground Water, 723
- Boswell (Prof. P. G. H.), appointed professor of geology at the Imperial College of Science, 840
- Bothe (Dr. W.), Enumeration of Coincidences, 105
- Bourdillon (R. B.), R. G. C. Jenkins, and T. A. Webster, The Absorption Spectrum of Vitamin D, 635
- Bourguel (M.), and R. Truchet, Action of the Chlorides of the Aromatic Sulphonic Acids on the Sodium Derivatives of Acetylene Hydrocarbons, 730; and Mlle. V. Gredy, The Mechanism of Catalytic Hydrogenation, 74
- Boutaric (A.), and Mlle. Madeleine Roy, The Radioactivity of Various Metals obtained from Old Roofs, 550
- Bowen and Tietz, Oxidation of Acetaldehyde, 579
- Brabrook (Sir Edward), [death], 537; [obituary article], 642
- Bradbury (Prof. J. B.), [death], 944
- Bradford (B. W.), awarded the Sir Edward Frankland medal and prize of the Institute of Chemistry, 421
- Bradford (Sir John Rose), appeal for funds for the restoration of the tower of Hempstead Church, 680
- Bradford (Dr. S. C.), The diffraction of X-rays by Vitreous Solids and its bearing on their Constitution, 975
- Bradley (W. H.), Duration of Eocene Time, 835
- Brady (F. L.), Prevention of Corrosion in Lead Buildings, 509
- Bragg (Sir William), awarded the Franklin medal of the Franklin Institute, 286; Cellulose in the light of the X-rays, 176, 315, 324; elected a corresponding member of the Vienna Academy of Sciences, 948; New Data on Cellulose Space Lattice, 634
- Bragg (Prof. W. L.), The Structure of Silicates, 510
- Brain (Dr. C. K.), Insect Pests and their Control in South Africa, 378
- Brambell (Dr. R.), Differentiation of Sex, 905
- Brauer (Prof. B.), the work of, 466
- Brdička (R.), and M. Pavlik, Automatic registration of Extinction Curves of Absorption Spectra, 915
- Breder, Jr. (C. M.), Field Book of Marine Fishes of the Atlantic Coast from Labrador to Texas, 969
- Bressler (S.), and V. Kondratjew, The Heat of Dissociation of the Molecule O₄ and Sutherland's Constant for Oxygen, 164
- Breuil (Abbé H.), and M. C. Burkitt; with the collaboration of Sir Montagu Pollock, Rock Paintings of Southern Andalusia: a Description of a Neolithic and Copper Age Art Group, 157
- Bridel (M.), and C. Charaux, Oroboiside, a New Glucoside Hydrolysed by Emulsion, 478; and J. Rabaté, Distribution of Piceoside (Ch. Tanret's Piceine) in the Vegetable Kingdom, 222
- Bridgman (Prof. P. W.), Elastic and Electric Properties under Pressure, 290; on the application of Thermodynamics to the Thermo-electric Circuit, 114; on the Nature of the Transverse Thermo-magnetic Effect, etc., 114
- Briggs (E. A.), Gonophores of *Myriothele*, 27
- Brimble (L. J. F.), Problems of Plant Physiology, 438
- Brindley (G. W.), The Dielectric Constants of Helium and Argon, 33
- Briner (E.), and A. Rivier, The Chemical Action of Electric Discharges, 186; and H. Kuhn, Some new Ammonia Addition Compounds of Phenols, 258; J. P. Luginr, and R. Monnier, Action of Nitrogen Peroxide and of Sulphur Dioxide on Lime Calcium Carbonate and Calcium Phosphate, 693
- Brioux (C.), and E. Jouis, The Correlation between the Fineness and the Solubility in Carbonic Acid of Powdered Limestones, and their Neutralising Action on Acid Soils, 397
- Briquet (J.), Number of Carpels in the Flowers of *Campanula*; The Carpology of the Genus *Mantisalca* Cass, 693; The Glochide Trichomes of Helminthia, 914
- Bristol (Prof. W. A.), [death], 982
- Britten (F. W.), Horological Hints and Helps, 969
- Britton (Dr. H. T. S.), Hydrogen Ions: their Determination and Importance in Pure and Industrial Chemistry, 369
- Broadhead (C. F.), The Production of Bitural, 909
- Broch (Dr. H.), The Musk-rat a Pest, 98
- Brocklehurst (Dr. R. J.), appointed professor of Physiology in Bristol University, 112
- de Broglie (M.), The Use of Gratings at Grazing Incidence for Spectrophotography of the Extreme Ultra-violet, 294
- Brooks (C. C.), Recovery from Parasitism, 14
- Brooks (Dr. C. E. P.), The Climate of the First Half of the Eighteenth Century, 995; and S. T. A. Mirrlees, Irregularities in the Annual Variation of Temperature in London, 995
- Brooks (C. M.), Studies on *Pectinatella*, 181
- Brooks (Dr. Matilda Moldenhauer), Penetration of Methylene Blue into Living Cells, 599
- Broom (Dr. R.), On some Recent New Light on the Origin of the Mammals, 114; The Age of *Australopithecus*, 814
- Brown (Prof. Baldwin), impending resignation of, 431
- Brown (C. B.), Geology of North-Eastern British Somaliland, 877
- Brown (Prof. E. W.), Occultations of Stars by the Moon, 986

- Brown (G. B.), The 'Wave-band' Theory of Wireless Transmission, 272
- Brown and Sons, Ltd., 'Sanbro' Laboratory Hot-Water Ovens, 253
- Browne (Bishop G. F.), [death], 944
- Bruce (J. H.), Ionisation in Nitrogen, 780
- de Bruin (Dr. T. L.), The Moment of the Bromine Nucleus, 414
- Brun (P.), The Boiling-Points of Aqueous Alcoholic Liquid Mixtures, 294
- Brunhes (Prof. J.), awarded the Cullum geographical medal of the American Geographical Society, 648
- Brunton (G.), The Earliest Civilisation of Egypt, 27
- Brus (G.), and G. Peyresblanques, The Fixation of Ozone by Benzene Linkages and by Acetylene Linkages, 657; The Fixation of Ozone by Unsaturated Compounds, 550
- Brustier (V.), The Ultra-Violet Absorption Spectrum of Chelidonine, 550
- Buchanan-Riddell (Sir Walter), appointed Chairman of the University Grants Committee, 800
- Buchanan-Wollaston (H. J.), and W. C. Hodgson, New Method of Treating Frequency Curves, 143
- Buckman (late S. S.), Type Ammonites, Parts 71-72, 101; with Editorial Note, Chronological and other Tables and Index, by Dr. A. Morley Davies: Type Ammonites-VII., Parts 71-72 (combined), 773
- Buisson (H.), G. Jausseran, and P. Rouard, The Transparency of the Lower Atmosphere, 766
- Bulkeley (G.), Railway and Seaport Freight Movement: with examples of British and American Practice, 488
- Bull (H. O.), Nature of Purposive Movement in Fishes, 794
- Bulloch (Prof. W.), and others, A System of Bacteriology in Relation to Medicine. Vol. 3, 80
- Burchell (J. P. T.), Flint Implements of Lower Palaeolithic Age from the Mammaliferous Gravels of Yorkshire, 858; Flint Implements of Upper Palaeolithic Types from Glacial Deposits in Norfolk and Yorkshire, 235
- Burgatti (P.), The Transformations of Lorentz, 587
- Burgess (A. F.), and S. S. Crossman, Biological Control of the Gipsy Moth, 392
- Burkitt (M. C.), Petroglyphs of California and Adjoining States, 361
- Burnett (Major J. C.), Magic Square of Fifth Order, 17
- Burns (Dr. C. Delisle), Rationalisation, 117
- Burt (D. R. R.), A Case of Intersexuality in *Bos indicus*, with a Theory of the Significance of the Genetic Male Intersex, 221
- Burton (H.), Mobile Anion Tautomerism (Part 5), 662
- Burton (M.), Glass-sponges, 913
- Bury (H.), The Classification of the Primates, 311
- Butcher (R. W.), Preparations of Protozoa and Algae, 276
- Butler (Dr. J. A. V.), and C. Ockrent, Adsorption from Solutions containing two Solutes, 853
- Butterfield (Prof. T. E.), Steam and Gas Engineering, 851
- Buxton (Earl), awarded the African Society's gold medal, 902
- Buxton (L. H. Dudley), Latin Oration at Oxford, 512
- Buxton (Dr. P. A.), Measurement of Animal Environment, 158
- Cabanac (Mlle. M.), The Catalytic Decomposition of some Acetals of the Fatty Series by Metallic Oxides, 803
- Cabannes (J.), avec la collaboration d'Yves Rocard, La diffusion moléculaire de la lumière, 740
- Caccioppoli (R.), Laplace's Series, 879
- y Cajal (Prof. S. Ramón), translated and edited by Dr. R. M. May, Degeneration and Regeneration of the Nervous System. 2 vols., 230
- Cajori (Prof. F.), A History of Mathematical Notations. Vol. 2: Notations mainly in Higher Mathematics, 78; A History of Physics in its Elementary Branches: including the Evolution of Physical Laboratories. Revised and enlarged edition, 77; Kepler's Work, 833
- Calkins (Prof. Mary Whiton), [death], 715
- Callendar (Prof. H. L.), Critical Relations between Water and Steam (Thomas Hawksley Lecture), 71; [death], 136; [obituary article], 173
- Calvert (P. P.) Growth in Insects, 288
- Calvert (W. J. R.), Physics. Parts 2, 3 and 4, 886
- Cambi (L.), and A. Cagnasso, The Reactions between Ferrous Compounds and Nitric Oxide (2), 766
- Cammerloher (the late Dr. H.), Studies on Tetrarhynchids, 216
- Campbell (Col. R. B.), appointed director under the scheme of Edinburgh University for promoting physical welfare and athletics, 219
- Campbell (W. B.), and O. Maas, Equilibria in Sulphur Dioxide Solutions, 545
- Cannata (C.), The Ballistic Hypothesis and the Verification of the Law of Areas in the Orbits of Telescopic Stars, 338
- Cannon, The Sympathetic System as an Agent of Stability of the Organism, 514
- Cantoni (O.), The Supposed Existence of Pulmonary Lipodieresis, 398
- Capell (R.), Opera, 969
- Carl (J.), The Relief of Southern India, 915
- de Carli (F.), Viscosity Isotherms of Binary Mixtures (4), 34, (5), 339
- Carpenter (Sir Harold): The Metal Crystal, 867; and Dr. J. M. Robertson, The Metallography of some Ancient Egyptian Implements, 859
- Carpenter (Kathleen E.), Life in Inland Waters: with especial reference to Animals, 774
- Carr (Emma P.), A Relation between Ultra-Violet Absorption Spectra and Heats of Combustion, 237
- Carr (Prof. H. Wildon), Leibniz, 264
- Carrelli (Prof. A.), Raman Effect in the X-ray Region, 201
- Cartellieri (Prof. O.), translated by M. Letts, The Court of Burgundy: Studies in the History of Civilisation, 12
- Cass (W. G. L.), International Trade, 735; Political Science, 663; Unemployment and Hope, 225, 346
- Castellani (Sir Aldo), Fungi and Fungus Diseases, 631
- Castle (E. S.), The Light-sensitive System as the Basis of the Photic Responses of *Phycomyces*, 842
- Catcheside (D. G.), Chromosome Linkage and Syndesis in *Eriothera*, 221; Chromosome Linkage in *Eriothera*, 906
- Caton-Thompson (Gertrude), Early Rhodesian Gold, 163; The Great Zimbabwe and other Ruins in Rhodesia, 912
- Catterson-Smith (Prof. J. K.), appointed professor of electrical engineering at King's College, London, 993
- Cavara and Chistoni, Opium in the Poppy, 330
- Cavinato (A.), Euclase from Valle Aurina, 694
- Cawadias (Dr. A. P.), From Epidaurus to Galen, 291
- Cayeux (L.), Existence of Two Groups of Algae with the Structure preserved in the Schisto-limestone System of the French Congo, 397
- Cayley (D. M.), Sex in Fungi, 527
- Cellerier (J. F.), The Scientific Analysis of Musical Sounds, 258
- Challansonnet (J.), The Dilatometric Analysis of some Synthetic Cast Irons with Nickel, Vanadium, and Nickel-vanadium, 842
- Chalmers (Miss J.), and J. C. Earl, The Hydrolysis of Cellulose (1), 659
- Champion (H. G.), Sylvicultural Research in India, 331
- Champy (C.), and M. Heitz-Boyer, The Mechanism of the Action of the High Frequency Electric Cautery, 222
- Chang (Y. C.), Orientation of the Planes of Binary Stars, 103
- Chapman (D. L.), and Grigg, Union of Hydrogen and Chlorine, 29
- Chapman (F.), Open-Air Studies in Australia, 379
- Chapman (Prof. S.), The Application of Spherical Harmonic Functions to Mathematical Physics, 109
- Charles II., Three hundredth anniversary of the birth of, 828
- Charlesworth (Prof. J. K.), Some Geological Observations on the Origin of the Irish Fauna and Flora, 337
- Charonnat (R.), and R. Delaby, The Constitution of Dioxypyramidon, 222
- Chatelet (M.), Mixtures of Vapours of Iodine and of Various Solvents, 842
- Cherbuliez (E.), and St. Ansbacher, The Physiological presence of Copper in certain Organs in the Higher Animals, 186
- Cherry (R. O.), Field Intensity Measurements around some Australian Broadcast Stations, 513
- Chevalier (M.), Les paysages catalans: leurs aspects, leur structure et leur évolution, 232

- Chevey (P.), The Value of the Method of Examination of the Scales applied to Fishes of the Intertropical Zone, 338
- Childe (Prof. V. Gordon), The Danube in Prehistory, 591
- Childs (Dr. W. H. J.), and Prof. R. Mecke, Intensities in the Atmospheric Oxygen (Intercombination) Bands, 599
- Chilowsky, A New Method of Gasifying Heavy Oils, 550
- Chipp (Dr. T. F.), Vegetation of the Anglo-Egyptian Sudan, 210
- Chisholm (A. H.), Birds and Green Places: a Book of Australasian Nature Gossip, 367
- Chisholm (Dr. G. G.), [death], 324; [obituary article], 419
- Chodat (F.), A New Demonstration of the Traube Cell, 294; A New Method for the Determination of the Iso-electric Point by Ferments, 730
- Christy (Major C.), Nature Unadorned in Tropical Africa, 301
- Church (Major A. G.), Education for Environment, 261
- des Cilleuls (J.), The Phytoplankton of the Loire in the course of the Summers of 1928 and 1929, 766
- Claisen (Prof. L.), [death], 136
- Clark (F. N.), The California Jack Smelt, 104
- Clark (G. H.), Californian Salmon, 252
- Clark (G. L.), and Lucy W. Pickett, Crystal Structures of some Derivatives of Diphenyl, 843
- Clark (J. E.), and I. D. Margary, Floral Isophenes and Isakairs, 113
- Clark (R. Moir), [death], 465
- Clark (Prof. W. E. Le Gros), The Classification of the Primates, 236
- Clark and Pickett, Chemical Effects of X-rays, 760
- Clay (Prof. H.), Unemployment, 946
- Clayton (Dr. G. C.), elected president of the Institute of Chemistry, 421
- Cleland (Prof. J. B.), Wild Birds and Butterflies, 276
- Clodd (Edward), [death], 465; [obituary articles], 535, 536
- Clogne (R.), Mlle. A. Courtois, and Cazala, The Proportion of Arsenic in the Wells of Choussy de La Bourboule and the Fixation of this Arsenic in the Organism, 995
- Clowes (E. S.), Shipways to the Sea: our Inland and Coastal Waterways, 379
- Clusius (Dr. K.), and C. N. Hinshelwood, Homogeneous Catalysis of Gaseous Reactions, 311
- Cobb (Prof. J. N.), [death], 787
- Cobb (Prof. J. W.), Relations between the Institution of Gas Engineers and Leeds University, 909
- Coble (Prof. A. B.), Algebraic Geometry and Theta Functions, 775
- Coblentz and Stair, Transparent Window Glasses, 332
- Cochran-Patrick (Col.), Air Survey, 110
- Cockayne (Dr. L.), appointed honorary botanist to the Wellington City Council, N.Z., 541; Hybridism in the Forests of New Zealand, 473; presented with the Darwin medal of the Royal Society; the work of, 100
- Cockcroft (Dr. J. D.), appointed University demonstrator in physics in Cambridge University, 431
- Cockerell (Prof. T. D. A.), Matthew Island, 414; Siliceous Shells of Protozoa, 975; The Oldest Record of a Slug, 745; Width of Head and Pelvis in *Homo*, 131
- Cockerham (E.), Cambial Activity and Seasonal Changes in Starch Content of Sycamore (*Acer Pseudoplatanus*), 622
- Coker (Prof. E. G.), A New Lateral Extensometer, 723
- Colebrook (F. M.), The Physical Reality of 'Side-bands', 726
- Coleman (Prof. A. P.), Age of the Earth, 668
- Coles (Dr. Fay-Cooper), The Educational System for Natives in Tanganyika, 753
- Colin (H.), and E. Guéguen, The Sugar of the Floridae, 622
- Collard (J.), The Articulation of a Telephone Circuit, 475
- Collet (L. W.), Structure of the Canadian Rockies, 729
- Collier (A. J.), Kevin-Sunburst Oilfield, Montana, 727
- Collin (Ella M.), The Rapid Determination of Bismuth and Copper in Lead Bullion by Internal Electrolysis, 433; The Separation of Cadmium and Copper in Spelter and Zinc Ores by Internal Electrolysis, 621
- Collins, Jr. (H. B.), Prehistory of the Eskimo, 66
- Collip (Prof. J. B.), The Ovary Stimulating Hormone of the Placenta, 444
- Comel (M.), Can Strontium be Fixed by the Tissues? 842
- Compton (Prof. R. H.), Work at the Kirstenbosch Gardens, South Africa, 755
- Condon (E. U.), and J. E. Mack, A Cosmological Conjecture, 455
- Connolly (Gertrude), Vegetation of Southern Connemara, 33
- Conrady (Prof. A. E.), Applied Optics and Optical Design, part 1, 372
- Cook (S.), The Value of High Pressure Steam for Marine Work, 247
- Cooksey (Prof. C. D.), and D. Cooksey, Glancing Angle of Reflection from Calcite for Silver ($K\alpha_1$) X-rays, 461
- Cooper (C. Forster), elected to a non-stipendiary fellowship at Trinity Hall, Cambridge, 993
- Cooper-Key (Major Sir Aston), [death], 944
- Copson (Dr. E. T.), appointed lecturer in mathematics and applied mathematics in St. Andrews University, 72
- Cornish (Dr. Vaughan), Coast National Parks, 574; Landscape at the Royal Academy, 712; Preservation of Scenery in the Thames Valley, 737
- Cornubert (R.), and R. Humeau, An Ultimate Property of the Carbonyl Group, 622
- Costantin (J.), Mountain Plants and Lamarekism, 586
- Coste (J. H.), Water-Meadows and River-flow, 858
- Coster (Prof. D.), K-Absorption Edge of Zinc, 509
- Cotton (A.), Asymmetric Synthesis and the Existence of Racemic Compounds in Solution, 221; and G. Dupouy, The Magnetic Fields given by the large Bellevue Electro-Magnet, 586; and M. Scherer, The Magnetic Double Refraction of Specimens of Petroleum from various sources, 729
- Cotton (A. D.), Giant Senecios on Kilimanjaro, 951
- Courty (A.), Tests of Casting, under Constant Pressure, of Aluminium and Alpac, 842
- Cousin (Mlle. G.), The Diapause of *Lucilia sericata*, 622
- Coustal (R.), and F. Prevet, The Optimum Concentration for the Phosphorogen and Flux in Zinc Sulphide, Copper, etc., 729
- Coventry (B. O.), Denudation of the Punjab Hills, 170
- Cowan (J. M.), Botanical Exploration through North-West Persia, 693
- Coward and Gleadall, Extinction of Methane Flames by Water Vapour, 579
- Cox (Dr. H. J.), [death], 643
- Craigie (Major P. G.), [death], 97; [obituary article], 135
- Crawford (O. G. S.), What is Archaeology? 908
- Creager (W. P.), Engineering for Masonry Dams. Second edition, 45
- Creed (R. S.), Crossed Connexion of the Cerebral Hemispheres with the Muscles and Sense Organs, 307
- Cressy (E.), Discoveries and Inventions of the Twentieth Century. Third edition, 740
- Crew (Prof. F. A. E.); Mendelism and Anthropology, 191; and L. Miskaia, Mating during Pregnancy in the Mouse, 564; and L. Miskaia, Maturity in the Female Mouse, 257
- Crew (Prof. H.), The Rise of Modern Physics: a Popular Sketch, 84
- Cridde (N.), Fluctuations of Manitoban Grouse, 685
- Crofts (Doris R.), Haliotis, 304
- de la Croix (P. Mayne), The Gaits of Quadrupeds, 215
- Crommelin (Dr. A. C. D.), appointed president of the Royal Astronomical Society, 286; Discovery of a Trans-Neptunian Planet, 450; Stellar Velocities and Stellar Physics, 333; Visitation of the Royal Observatory, Greenwich, 909
- Crookall (Dr. R.), Coal Measure Plants, 159; Some Curious Fossils from the Downtonian and Lower Old Red Sandstone of Scotland, 878
- Crowther (Prof. J. A.), Ions, Electrons and Ionizing Radiations. Fifth edition, 887
- Cruikshank (Dr. J. N.), The Causes of Neo-natal Death, 903
- Cunningham (A.), The Life-Cycle of *Bac. saccharobutyricus* v. Klecki, 168
- Cunningham (Dr. Brysson), Canadian Hydro-Electric Power Development during 1929, 824; River Flow Records in the Ness Basin, Scotland, 334
- Cunningham (J. T.), Evolution of the Hive-Bee, 857; The Origin of Adaptations, 221

- Curie (Mlle. Irène), and F. Joliot, The Nature of the Absorbable Radiation which accompanies the α -rays of Radium, 222
- Curie (Mme. P.), Radioactive Constants, 182
- Currie (B. W.), Atmospheric Light Columns from Artificial Lights, 526
- Curtiss (Prof. R. H.), [death], 174
- Curwen (E. C.), Neolithic Camps, 614
- Curzi (M.), A New and Serious Disease of Maize, 35
- Cushman (Dr. A. S.), [death], 982
- Cuthbertson and Maas, Dielectric Constants of Water and Hydrogen Peroxide, 724
- Cutler (Dr. D. Ward), Nitrifying Bacteria, 168
- Dadiou (A.), and K. W. F. Kohlrausch, Raman Effect and Chemical Structure, 796; The Raman Spectrum of Organic Substances, 398
- Dalsace (J.), M. Gory, and Nemours-Auguste, An Attempt on the Radiographic Visibility of the Kidney, 397
- Dammerman (Dr. K. W.), Mammals of Buru, Moluccas, 472
- Dampier-Whetham (W. C. D.), A History of Science and its Relations with Philosophy and Religion, 4
- Dangeard (P.), The Influence of Oxygen in Iodo-volatilisation, 294
- Daniell (G. F.), The New Planet, 746
- Daniels (E. J.), Unsoundness in Bronze Castings, 477
- Daniels (Prof. F.), Prof. J. H. Mathews, and Prof. J. W. Williams, Experimental Physical Chemistry, 596
- Danjon (A.), Results obtained during the Eclipse of May 9, 1929, 150
- Darling (Prof. C. R.), A Simple Method of showing the Modes of Vibration of a Wire, 958
- Darlington (C. D.), Telosynapsis or Structural Hybridity in *Oenothera*? 743; The Hybridity of *Drosophila melanogaster*, 600; Chromosomes of *Prunus*, 988
- Darmois (E.), The Action of Boric Acid and Borates on the Rotatory Power of Tartaric Acid, 478; and J. Martin, The Influences of Alkaline Molybdates on the Rotatory Power of Glucose, 434
- Darney (M.), Photograph of a Lunar Landscape, 793
- Darwin (Major L.), Evolution and Evidence, 126
- Dauvillier (Dr. A.), Visible Electron Diffraction, 50
- Dauzère (C.), The Formation of Electrical Charges in Storms, 114
- David (Prof. W. T.): Gaseous Combustion, 409; and W. Davies, Gaseous Combustion, 127
- Davies (A. C.), Prof. F. Horton, and E. Blundell, Critical Potentials for the Excitation of Soft X-rays from Iron, 336
- Davies (Dr. F.), appointed reader in anatomy at King's College, London, 396
- Davies (L.), and L. Wright, Protective Value of some Electro-deposited Coatings, 513
- Davies (Lt.-Col. L. M.), The Genus *Dictyoconus* and its Allies, 549
- Davies (Dr. W. M.), Parasitism in Relation to Pupation in *Lucilia sericata* Meig., 779
- Davis (Dr. A. H.), Measurements of Noise by means of a Tuning-fork, 48; and E. J. Evans, Absorption of Sound, 759; Measurement of Absorbing Power of Materials by the Stationary Wave Method, 256
- Davis (Dr. J. J.), Viruses and Life, 351
- Dawson (Sir Douglas), The Occurrence of Potassium Nitrate near Goyder's Pass, M'Donnell Ranges, Central Australia, 149
- Dawson of Penn (Lord), Henry Hill Hickman, 572
- Deaglis (R.), The Action of Light on Thermionic Phenomena, 434
- Dean (Capt. F. W.), A Sea-creature of Unknown Species, 469
- Dean (W. R.), appointed university lecturer in mathematics in Cambridge University, 292
- De Beer, Chondrocranium of the Lizard, 987
- Debye (Prof. P.), Polar Molecules; Polare Molekeln, 9; the Guthrie Lecture of the Physical Society, 645
- Décombe (J.), The Passage from the β -Ketonic Esters to the β -Amino Esters, 397
- Décombe (L.), The Undulatory Theory and Black Body Radiation, 549
- De Filippi (Cav. Filippo), awarded the Charles P. Daly gold medal of the American Geographical Society, 648
- Dehalu (M.), and P. Swings, A Method of Star Photography based on the Measurement of the Opacities of Photographic Tracks, 658
- Déjardin (G.), A Second Spectrum of Xenon in the Interval 9000 Å.-6000 Å., 586
- Defafeld (M. L.), [death], 209
- Delf (E. M.), Release of Oogonia in the Fucaceæ, 957
- Deluchat, A Class of Benzene Glycols, 514
- Demerec (M.), Changes in the Rate of Mutability of the Mutable Miniature Gene of *Drosophila virilis*, 623
- Demolon (A.), and G. Barbier, The Valuation of the Phosphoric Acid Deficiency of Soils, 730
- Dempster (Prof. A. J.), awarded the American Association prize, 64; Reflection of Positive Ions by Crystals, 741; Reflection of Protons from Calcite, 51
- Denham (Prof. H. G.), An Inorganic Chemistry. Second edition, 888
- Denizot (A.), Relation between Specific Heat and Temperature, 182
- Denning (W. F.), Remarkable Meteors, 986
- Denny (L.), America Conquers Britain: a Record of Economic War, 965
- Deodhar (G. B.), Fine Structure of *K*-Absorption Limit of Silicon Oxide, 777
- Desbleds (L. B.), Exact Colour Matching and Specifying, 12
- Desmaroux and Mathieu, The Solutions of Diphenylurea in Nitrocellulose, 730
- Dhavale (D. G.), A Probable Band Spectrum of Neon, 276
- Dickson (Dr. B. T.), Report on the Division of Economic Botany of the Australian Council for Scientific and Industrial Research, 900
- Dieke (Dr. G. H.), and W. L. Holtgreven, Some Bands of the Carbon Molecule, 51
- Dillinger (M.), The Maximum of Current occurring in the Electrolysis of Mercuric Cyanide Solutions with the Dropping Mercury Cathode, 586
- Dimmock (Dr. G.), [death], 982
- Dinulescu (G.), The Presence in France of *Gastrophilus inermis*, 434
- Diplock (W. J. K.), Isis: or the Future of Oxford, 382
- Dirac (Dr. P. A. M.), A Theory of Electrons and Protons, 186; Electrons and Protons, 182; The Annihilation of Electrons and Protons; Exchange Phenomena in the Thomas Atom, 914
- Ditchburn (R. W.), Notes on Resolving Power, 958
- Dix (Emily), The Flora of the Upper Portion of the Coal Measures of North Staffordshire, 802; and A. E. Trueman, Some Non-marine Lamellibranchs from the Upper Part of the Coal Measures, 802
- Dixon (Prof. H. H.), The Mechanism of Variation, 992; and T. A. Bennet-Clark, Electrical Properties of Emulsions, 434; Responses of Plant Tissues to Electric Currents, 434
- Dixon (Eng.-Vice-Admiral Sir Robert), elected a member of the Athenæum Club, 470
- Dixon (Dr. W. E.), reappointed reader in pharmacology in Cambridge University, 764
- Dobbie (J. C.), appointed first junior observer at the Solar Physics Observatory, Cambridge, 219
- Dodd (A. P.), The Biological Control of Prickly-Pear in Australia, 691
- Doljanski (L.), J. J. Trillat, and Lecomte du Noüy, The Action of the X-rays on Cultures of Tissues *in vitro*, 996
- Domin (Prof. K.), *Draba fladnizensis* Wulf, a New Species for Czechoslovakia, 915; The Geology and Natural History of the Primeval Woodlands of Boubin, 946
- Dondona (Lieut.-Col. F.), awarded the premium of the Institution of Naval Architects, 213
- Donnan (Prof. F. G.), Foundation of a fellowship in honour of, at Johns Hopkins University, 612; Science and Philosophy: a proposed International Conference, 857
- Doodson (Dr. A. T.), awarded the Thomas Gray prize of the Royal Society of Arts, 541
- Dootson (F. W.), [obituary article], 323
- Dorabalska (Mlle.), The Heat Evolved by Polonium, 74
- Dotterer (Prof. R. H.), Philosophy by way of the Sciences: an Introductory Textbook, 521

- Douglas (C. K. M.), The Cyclonic Depressions of Nov. 16 and 23, 1928, 336
- Douglas (Rear-Admiral), Echo Sounding and Depths, 893; Undercurrents in the Strait of Gibraltar, 780
- Douvillé (H.), *Cardita beaumonti* Beds of Sind, 28
- Draper (Dr. D.), [obituary article], 714
- Driberg (J. H.), People of the Small Arrow, 375
- Druce (Dr. G. C.), The eightieth birthday and work of, 752
- Drummond (Prof. J. M. F.), appointed Harrison professor of botany in Manchester University, 840
- Duane (W.), The Polarisation of X-radiation, 150
- Dubois (E.), The Volta Effect, 222
- Dudgeon (G. C.), [death], 787
- Dudley (Surgeon-Capt. S. F.), awarded the Chadwick gold medal and Naval prize, 250
- Dufay (J.), and Mlle. R. Schwéglér, The Visual Measurement of very small Luminosities, 222
- Dufton (A. F.), Integration of Sunlight, 635
- Dunn (Dr. J. T.), elected president of the Society of Public Analysts, 470
- Duparc (L.), An Anorthose Trachyte from Gambeila (Abyssinia), 914; and C. Wakker, The Auriferous Layers of St. Yrieix, 694; and L. Galopin, The Phenocrystals and Microlites of the Plagioclases of the Abyssinian Basalts, 694
- Dupin (P.), and M. Teissié-Solier, The Distribution of the Pressure around an Immersed Cylinder, 622
- Dupont (G.), and J. Lévy, The Autoxidation of Abietic Acid, 74
- Dupont (L.), Action of Caustic Alkalis at High Temperatures on Albumenoids, 74
- Durning-Lawrence (Lady), bequest by, to University College, London, 292
- Dusseau (Mlle. A.), The Chlorophyll of the Leaves of Wheat, 258
- Dutoit (P.), and C. Zbinden, The Spectrographic Analysis of Organs, 337
- Dybowski (B.), Polychæta of Lake Baikal, 615
- Dyson (Sir Frank), Everyday Astronomy, 507
- Eales (Dr. N. B.), A Method of obtaining Stages in the Life-history of the Liver Fluke for Class Purposes, 779
- Eastham (L. E. S.), reappointed university lecturer in advanced and economic entomology in Cambridge University, 993
- Eberle (H. R.), appointed assistant curator of mining at the Chicago Museum of Science and Industry, 648
- Eccles (Dr. W. H.), Physics in relation to Wireless, 894; Presidential address to the Institute of Physics; re-elected president of the Institute of Physics, 868
- Eckersley (Capt. P. P.), and N. Ashbridge, The Choice of Sites for British Broadcasting Stations, 754
- Eckersley (T. L.), Recombination of Electrons and Positive Ions in the Upper Atmosphere, 669
- Eddington (Sir A. S.), elected president of the Physical Society, 576; Space and its Properties, 849; The Charge of an Electron, 474; The Problem of Stellar Luminosity, 489; The Rotation of the Galaxy (Halley Lecture), 866
- Eddy (C. E.), and Prof. T. H. Laby, Quantitative Analysis by X-rays, 686
- Edinger (Dr. Tilly), Die fossilen Gehirne, 738
- Edlén (B.), and A. Ericson, Hydrogen-like Spectra of Lithium and Beryllium in the Extreme Ultra-violet, 233; Extreme Ultra-violet Spectra, 427
- Edmonson (C. H.), Growth of Hawaiian Corals, 66
- Edwards (W.) and Co., New Type of Epidiascope, 105
- Egedal (Dr. J.), Tides of the Upper Atmosphere and the Heights of Meteors, 202
- Ehrenfeld (Dr. L.), appointed curator of organic and industrial chemistry at the Chicago Museum of Science and Industry, 648
- Ehrenhaft (F.), Magnetophotophoresis and Electrophotophoresis, 397
- Eielson (Lieut. C. B.), [obituary article], 465
- Einstein (Prof. A.), History of the Concept of Space, 897
- Eipper (P.), translated by P. Kirwan, Animals Looking at You, 378
- Ekhart (Dr. E.), Rainfall of the World, 795
- Ekman (Dr. G.), [obituary article], 827
- Ekstrom (Dr.), Cost of Underground Electrical Mains, 796
- Elam (Dr. C. F.), The Diffusion of Zinc in Copper Crystals, 513
- Elford (W. J.), Structure in very Permeable Collodion Gel Films and its Significance in Filtration Problems, 432
- Eliashevich (M.), and A. Terenin, Fluorescence of Mercury Vapour in the Far Ultra-Violet, 856
- Elles (Gertrude Lilian), and C. E. Tilley, Metamorphism in Relation to Structure in the Scottish Highlands, 514
- Elliot (H. S. R.), [obituary article], 786
- Elliott (A.), Band Spectrum of Chlorine, 989
- Elliott-Cooper (Sir Robert), eighty-fifth birthday of, 136
- Ellis (Dr. O. C. de C.), The Fallacious Determination of the Specific Heats of Gases by the Explosion Method, 165
- Ells (S. C.), Core Drilling Bituminous Sands, 795
- Emanuel (Dr. J. G.), invited to be joint professor of medicine in Birmingham University, 395
- Emeléus (Dr. K. G.), The Conduction of Electricity through Gases, 740; Velocities of Ions in the Cathode Dark Space, 337
- Emir (Fahir), Surface Solutions on Mercury, 337
- Emschwiler (G.), The Photolysis of the Organic Iodides: the Influence of Temperature, 803; The Utilisation of the Light, 729
- Encyclopædia Britannica Co., Ltd., (The W. H. Franks, Manager), 'Encyclopædia Britannica', 311
- Engledow (F. L.), elected Drapers professor of agriculture in Cambridge University, 148
- English (Dr. S.), Loss of Ultra-Violet Transparency in Glasses, 85
- Epstein (P. S.), Geometrical Optics in Absorbing Media, 843
- Erikson (P. E.), The Growth of Telephone Services, 99
- Eriksson (J. V.), Chemical Denudation, 253
- Eropkin (D. I.), Determination of the Absorption in the Atmosphere of Planets, 586
- Esclançon (E.), Determination of the Position and of the Elements of a Planet or Distant Comet, 914; Determination of the Position and Elements of an Object (Planet or Comet) by Three Observations corresponding to a Small Arc of the Orbit, 995; Position of the Celestial Body supposed to be a trans-Neptunian Planet, 878
- Evans (S. F.), The Absorption Spectrum of Selenium Dioxide, 528
- Eve (Prof. A. S.), The Growing Importance of Frequency, 454; The Universe as a Whole, 865; and Prof. D. A. Keys, Applied Geophysics in the Search for Minerals, 267
- Evelyn (John), Fumifugium, 368
- Ewing (Sir Alfred), The Earl of Balfour, 500
- Ewing (Dr. A. C.) The Morality of Punishment: with some Suggestions for a General Theory of Ethics, 376
- Ewing (Dr. H. E.), A Manual of External Parasites, 377
- Ewles (J.), Water as an Activator of Luminescence, 706; and J. B. Speakman, Examination of the Fine Structure of Wool by X-ray Analysis, 149
- Exner (Prof. F. M.), [death], 324; [obituary article], 419
- Eynon (L.), The World's Sugar Industry (Streatfeild Memorial Lecture), 255
- Eyring and Daniels, The Decomposition of Nitrogen Pentoxide, 907
- Fabry (C.), A New Method for the Experimental Study of Elastic Pressures, 549; and E. Dubreuil, A Supposed Transformation of Lead by the Effect of Solar Radiation, 294
- Fagerberg (S.), Grating Errors and Electronic Charge, 13
- Fajans (Prof. K.), and Dr. J. Wüst, Physikalisch-chemisches Praktikum, 380
- Farmer (E.), Vocational Psychology, 831
- Farmer (Sir John), elected an honorary fellow of the Royal Microscopical Society, 719
- Faulds (Dr. H.), [death], 571
- Faulkner (Miss G. H.), Living Chromosomes in *Obelia*, 67
- Fawcuz (Lieut.-Genl.), The Health of the Army for the Year 1928, 576
- de Fazi (R.), and F. Monforte, New Reaction of Aldehydes (4), 694; and F. Pirrone, Studies on Indones; New Reactions of α -ethyl- β -phenylindone and of α -methyl- β -phenylindone (10), 731

- Fee (Dr. A. R.), [obituary article], 571
 van der Feen, Jr. (Dr. P. J.), Fossil Brains, 738
 Felete (Dr. M.), appointed associate professor of Mathematics in the Hebrew University, Jerusalem, 112
 Fenoglio (M.) Presence of Nesquehonite in the Serpentine of Viù in Val di Lanzo, 842
 Ferguson (Dr. A.), Photo-Electric Cells, 953; Prof. K. J. P. Orton, 898; The Parachor and Molecular Volume, 597; The Physical Society's Discussion on Magnetism, 874
 Fermi (Prof. E.), Magnetic Moments of Atomic Nuclei, 16
 de Ferranti (Dr. S. Z.), [death], 97; [obituary article], 172
 Ferrari (A.), and A. Inganni, Importance of the Crystalline Form in the Formation of Solid Solutions (6), 34; and C. Colla, Crystalline Structure of Neutral Carbonates of Cobalt and Nickel, 658; and F. Giorgi, Crystalline Structure of Anhydrous Iodides of Divalent Metals (1), 587
 Filele (E. A.), Salaries of Educationists in America, 828
 Finch (R. H.), Rainfall accompanying Volcanic Explosions, 651
 Finnemore (H.), and C. B. Cox, Cyanogenetic Glucosides in Australian Plants (2), 659
 Finzel (T. G.), Pyrophoric Iron, 616
 Finzi (B.), Dynamic Actions Relative to Plane Irrotational Currents of Viscous Liquids, 730; 766
 Firth (Dr. J. B.), Chemistry in the Home, 269; Physical Chemistry, 84
 Fishenden (Dr. Margaret), Methods for Handling Heat Transmission Calculations, 909
 Fisher (J. W.), and Dr. H. T. Flint, The Equations of the Quantum Theory, 256
 Fisher (Dr. R. A.), Bauer's Mathematics Preparatory to Statistics and Finance, 379; Distribution of Gene Ratios for Rare Mutations, 878; Mortality amongst Plants and its bearing on Natural Selection, 972
 Fisher (R. C.), and E. A. Parkin, Presence of a Yeast in the Death Watch Beetle (*Xestobium rufo-villosum* De G.), 892
 Fleming (Sir Ambrose), elected president of the Television Society, 541; The Viscosity of Liquids, 580; The 'Wave Band' Theory of Wireless Transmission, 92; 198; 307
 Fleming (J. A.), appointed acting director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, 176
 Flerov (K. K.), Some New Data on *Capreolus* of Eastern Asia, 34
 Fleure (Prof. H. J.), appointed professor of geography in the University of Manchester, 31
 Florence (Prof. P. S.), The Statistical Method in Economics and Political Science: a Treatise on the Quantitative and Institutional Approach to Social and Industrial Problems, 39
 Flower (H. W.), Japanese and Chinese Fishes, 508
 Flux (A. W.), The Food Supply of the United Kingdom, 984
 Flynn (Prof. T.), Pycnogonida of South Africa, 426
 Fodor (Prof. A.), Das Fermentproblem (zugleich Einführung in die Chemie der Lebenserscheinungen). Zweite Auflage, 381
 Foëx (G.), The Diamagnetism of the Halogen Ions, 549
 Forbes (Prof. G.), the 81st birthday of, 537
 Forbes (Dr. H. O.), seventy-ninth birthday of, 136
 Forbes (Prof. S. A.), [death], 787
 Forde (Dr. C. D.), appointed professor of geography and anthropology at the University College of Wales, Aberystwyth, 1911
 Fort (R.), and C. N. Hinshelwood, The Kinetics of the Oxidation of Gaseous Benzene, 433
 Fortescue (Prof. C. L.), An Ammeter for High Frequency Currents, 253; The 'Wave-band' Theory of Wireless Transmission, 198, 272
 Fosse (R.), A. Brunel, and P. de Graeve, A New Fermentation of Uric Acid produced by the Liver of Various Animals, 258
 Foster (Dr. D.), and Dr. R. M. Bozorth, Nature of the Magnetisation Curve of Single Iron Crystals, 525
 Foster (G. A. R.), A Grating Periodograph, 544
 Fourier (Jean Baptiste Joseph), Centenary of the death of, 723
 Fournier (L.), French Floods of 1930, 723
 Fowler (Prof. A.), The Radcliffe Observatory, 776
 Fox (Dr. F.), The Waters and Coasts of Britain, 506
 Fraenkel (Dr. A.), appointed professor of mathematics in the Einstein Institute of Mathematics at the Hebrew University, Jerusalem, 112
 Di Franco (S.), The Lava from the Eruption of Etna in 1928, 767
 François (F.), Action of Selenoxanthidrol on Ureas and Carbamic Esters, 766; The Selenoxanthidrols, 337
 Franz (L.), Vorgeschiehtliches Leben in den Alpen, 775
 Fraser (Mrs. Kennedy), gift to Edinburgh University, 431
 Fraser-Harris (Prof. D. F.), The Muscular Sense, 204
 Frazer (Sir James George), Myths of the Origin of Fire: an Essay, 920
 Freeman (L. J.), The Spectra of Trebly-Ionised Oxygen (O IV) and Trebly-Ionised Nitrogen (N IV), 802
 Fremont (C.), Shearing and Punching Metals, 29
 French (C. N.), A Countryman's Day Book: an Anthology of Countryside Lore, 304
 French (H. J.), and T. G. Digges, Tests of Tool Steels, 651
 Frenkel (Prof. J.), On the Correct Formulation of Pauli's Exclusion Principle, 235; The Viscosity of Liquids, 581
 Friedel (G.), and V. Maikowsky, Temperature Measurements in Boring, 73
 Friedmann (Dr. H.), The Cowbirds: a Study in the Biology of Social Parasitism, 367
 Fritsch (Prof. F. E.), Research in Freshwater Biology and the Functions of a Freshwater Biological Station, 241
 Frost (A. V.), and O. Frost, The Product of the Radioactive Disintegration of Potassium, 48
 Fry (Dr. H. J. B.), [death], 715; [obituary article], 827
 Fry (Dr. T. C.), Elementary Differential Equations, 380
 Fukumako (S.), Electric Power Stations in Japan, 579
 Furuichi (Baron Koi), elected an honorary member of the Institution of Civil Engineers, 328
 v. Gaertner (H. R.), Geology of the Central Carnic Alps, 398
 Gairdner (Alice E.), and C. D. Darlington, Structural Variation in the Chromosomes of *Campanula persicifolia*, 87
 Galadzhiev (M.), and E. Malm, Influence of some Physico-chemical Factors on Marine Water Protozoa, 34
 Galle (J. B.), and G. Talon, Researches relating to the Propagation of Radio-electric Waves carried out on the occasion of the Eclipse of May 9, 1929, 258
 Garçon (M.), and J. Vinchon, translated by S. Haden Guest, The Devil: an Historical, Critical and Medical Study, 371
 Gardiner (Prof. J. Stanley), *Terra Nova* Madreporaria, 143
 Gardner (R.), A Method of Setting Out the Classification of the Elements, 146
 Garrelon (L.), D. Santenoise, H. Verdier, and M. Vidacovitch, The Pancreas and Pneumogastric Excitability, 338
 Garrod (Miss D. A. E.), Cave Art in Palestine, 794
 Garstang (Prof. J.), The Historicity of the Books of Joshua and Judges, 764
 Garstang (Prof. W.), Frank Buckland and Fish Culture, 653; Buckland Course of Fisheries Lectures, 645
 Garwood (Prof. E. J.), elected president of the Geological Society of London, 328; The Tuedian Beds of Northern Cumberland and Roxburghshire east of the Liddelwater, 477
 Gatenby (Prof. J. B.), appointed Theresa Seessel fellow of Yale University, 719; and Dr. S. D. King, Nutrition of the *Grantia* Amphiblastula, 614
 Gates (Prof. G. E.), Loose References to Earthworms, 680
 Gates (Prof. R. R.), elected president of the Royal Microscopical Society, 140; Heredity in Man, 191; Synapsis and Chromosome Rings in *Enothera*, 854; and D. V. Daran, Zygosporangium Formation in *Mucors*, 309
 Gaunt (J. A.), Continuous Absorption, 257
 Gaurier (L.), The Change of the Alluvium in Lakes converted into Reservoirs, 549
 Gautier (Prof. É. F.), awarded the Charles P. Daly gold medal of the American Geographical Society, 648
 Geary (A. R.), Woodhouse and Kilgour's "Jute and Jute Spinning," 124

- Gee (N. G.), Chinese Mammals, 871; and Alice M. Boring, Chinese Amphibia, 650
- Genders (R.), Macrostructure of Cast Alloys, 477; The Aluminium-brasses, 513
- George (T. N.), *Ambocelia* Hall and certain similar British Spiriferidae, 693
- George (Dr. W. H.), Physiological Mechanics of Piano-playing, 43; The Gramophone, 520
- Georgii (Prof. W.), and F. Stamer, Ten Years' Gliding and Soaring in Germany; The Flying School at Wasseruppe, 325
- Gerlach (Prof. W.), Raman Spectra of Crystalline Nitrates, 819
- Georghiu (T. D.), The Absorption of Dextro- and Lævo-rotatory Copper Tartrates and of their Mixture, 222
- Ghosh (J. C.), The Determination of Titanium as Phosphate, 621
- Giaque and Johnston, Isotopes of Oxygen, 145
- Gibbs (R. W. M.), The Adjustment of Errors in Practical Science, 380
- Gibson (Prof. C. S.), A Chemical Dictionary, 593
- Gibson (Prof. G. A.), [death], 608; Memorial Service for, 576; [obituary article], 713
- Gibson (J. W.), Chimney Dust Problems, 574
- Gide (A.), translated by Dorothy Bussy, Travels in the Congo, 596
- Giffen (E.), and C. M. White, A Simple Transmission Dynamometer, 907
- Gilard (P.), and P. Swings, A Simple Method of Determination of the Absorption of Glasses in the Ultra-Violet Region of the Spectrum, 658
- Gilbert-Carter (H.), appointed University lecturer in botany in Cambridge University, 547
- Gillespie (J.), The Engineer and the Petroleum Industry, 212
- Gilmore (M. R.), (Pahok), Prairie Smoke, 554
- Gilmour (J. S. L.), appointed curator of the Herbarium and Botanical Museum of Cambridge University, 876
- Gimson (B. L.), Arithmetic of Citizenship, 109
- Ginsberg (Dr. M.), appointed Martin White professor of sociology at the London School of Economics, 547
- Giordani and Mattias, Oxides of Nickel, 427
- Girard (P.), and J. Parrod, The Formation of Hydroxymethyl-4-imidazol, at Low Temperatures, etc., 434
- Giřavicius, (J. O.), Methyl Glyoxal as an Intermediary in Fermentation, 817
- Glazebrook (Sir Richard), elected an honorary member of the Institution of Electrical Engineers, 101; Dr. Sebastian Z. de Ferranti, 239; The 'Wave-Band' Theory of Wireless Transmission, 272
- Glegg (W. E.), A History of the Birds of Essex, 197
- Glennie (Agnes Elisabeth), Index to the Literature of Food Investigation, Vol. 1, No. 2, 754
- Godbert (A. L.), and Prof. R. V. Wheeler, Measurement of Coal Dust Inflammability, 332
- Godchet (M.), and Mlle. G. Cauquil, The Methylcycloheptanols, 622; and M. Mouseron, New Methods of Formation of 2:5-Dimethylpiperazine, 766
- Goddard (T. R.), History of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, 1829-1929, 487
- Gogate (D. V.), and Y. G. Naik, Effect of Direct Current on the Frequency of Sonometer Wire, 819
- Goldie, (A. H. R.), Atmospheric Light Columns from Artificial Lights, 743
- Goodey (T.), *Tylenchinema oscinellæ* gen. et sp. n., Parasite in the Frit-fly *Oscinella frit* L., attacking Oats, 293
- Goodings (Dr. A. C.), appointed to a position under the Ontario Research Foundation, 505
- Gordon (G. S.), elected a member of the Athenæum Club, 213
- Gordon (Seton), Sea Birds and Seals, 504
- Gosman (B.), Reduction of Sulphurous Acid at the Dropping Mercury Cathode, 959
- Gosney (E. S.), and Dr. P. Popenoe, Sterilisation for Human Betterment: a Summary of Results of 6000 Operations in California, 1909-1929, 40
- Goudsmit (S.), and L. A. Young, The Nuclear Moment of Lithium, 461
- Gould (Lieut.-Comdr. R. T.), Enigmas: Another Book of Unexplained Facts, 269
- Govaert (F.), The Nitration of *o*-fluorbenzoic Acid, 658
- Grabau (Dr. A. W.), Origin of Graptolitic Shales, 67
- Grabham (G. W.), Native Policy in South Africa, 131
- Grainger (J.), The Appearance of Bean Mozaic in England; an Attempt to Cultivate the Virus of Tobacco Mozaic *in vitro*, 34
- Grant (L. C.), Quenched Arc Switches, 216
- Grard (J.), Bromomalonic Dialdehyde, 337
- Gray (L. M. T.), and D. W. G. Style, The Absorption of Light by Chlorine, Bromine, and their Gaseous Mixtures, 336
- Gray (R. W.), The Integuments of Whales, 744
- Grégoire (J. A.), A New Mode of Transmission of Rotations with Conservation of the Velocity between Two Shafts with Variable Angle, 337
- Gregory (Prof. J. W.): Australian Origin of Red Rain in New Zealand, 410; Early Rhodesian Gold, 47; Earthquakes and Volcanoes, 11; Geology of Albania, 8; The Geological History of the Pacific Ocean, 750; Ethel Dobbie Currie, J. Weir, S. Williams, and G. W. Tyrrell on the Geological Collection from the South Central Sahara made by Mr. Francis Rodd, 293
- Gregory (Sir Richard), Weather Recurrences and Weather Cycles, 132
- Green (H. E. H. H.), reappointed demonstrator in anatomy in Cambridge University, 993
- Green (W. J.), Stability in Soap Films, 815
- Greenwood (A. W.), and J. S. S. Blyth, The Results of Testicular Transplantation in Brown Leghorn Hens, 293
- Grey of Fallodon (Viscount), Natural History, the Pleasure and Purpose of Observation, 328
- Grier (J.), and H. Brindle, Institution of silver medals in pharmaceuticals in Manchester University, 764
- Grieve (S.), Transport of Stones by Attached Seaweed, 217
- Griffith (Dr. R. O.), and Dr. A. McKeown, Photo-Processes in Gaseous and Liquid Systems, 405
- Grignard (Prof. V.), elected an associate of the Royal Academy of Sciences, Letters and Art of Belgium, 141
- Grimpe (G.), und E. Wagler, Die Tierwelt der Nord- und Ostsee. Lief. 14, Teil 10f: Amphipoda, Dr. K. Stephenson, 303
- Gross (P.), and A. Goldstern, Optical Determination of Electrolytic Dissociation in very Dilute Alcoholic Solution, 767
- Grundström (R.), and Prof. E. Hulthén, Pressure Effects in the Band Spectrum of Calcium Hydride, 634
- Gruning (Capt. E. L.), Leading an Expedition in British Honduras, 175
- Gravel (A.), and W. Besnard, A New Oceanographic Apparatus, 586
- Gudger (Dr. E. W.), Falling Fish Records, 248; Teleostean Fishes of Tortugas, 27
- Guérin (P.), Hydrocyanic Acid in the Vetches, 550; The Proportion of Hydrocyanic Acid in the genus *Lotus*, 75
- Guggisberg (Sir Gordon), [death], 643
- Guichard, Clausmann, and Billon, Influence of the Initial State of certain Metals and Alloys on the Variation of Hardness as a Function of Cold Hardening, 549
- Guillot (M.), An Attempt to Prove the Existence of a Non-electrolytic Complex of Polonium, 294; The Carrying Down of Polonium, a Chloropoloniate, by Ammonium Chloroplumbate, 586
- Guinness (Lieut.-Col. W. E.), elected president of the Marine Biological Association, 213
- Gulati (A. N.), Do Cockroaches Eat Bed Bugs? 858
- Gunther (Dr. R. A.), Early Science in Oxford, Vol. 5: Chaucer and Messahalla on the Astrolabe, 556; Vol. 6: The Life and Work of Robert Hooke (part 1); Vol. 7: The Life and Work of Robert Hooke (part 2), 629; Thames Floods and Pollution, 49
- Gupta (D. N. Sen), Dipole Moment of some Organic Halides, 600
- Gurney (Dr. R.), Fresh-water Crustacea of Norfolk, 543
- Güssow (Margarete), Photo-electric Observations at Neubabelsberg, 613
- Gutenberg (B.), Earth Evolution, 426
- Gutton (C.), Properties of Ionised Gases in Electromagnetic Fields of High Frequency, 803
- Guyer (Dr. M. F.), Acquired Characters, 722; The Marine Biological Stations of Japan, 25

- Guyot (A.), and M. Fournier, A New General Method for the Preparation of Primary and Secondary Amines, 74
- Gwynne-Vaughan (Dame Helen), and Mrs. H. S. Williamson, Nutritive Heterothallism, 113
- Haas (Prof. A.), translated by Dr. T. Verschoyle, Introduction to Theoretical Physics. Vol. 2. Second edition, 559
- de Haas, van Aubel, and Voogd, Superconductors, 952
- Hackh (Prof. I. W. D.), A Chemical Dictionary, 593
- Haddon (Dr. A. C.), Edward Clodd, 536
- Haddon (Kathleen), (Mrs. O. H. T. Rishbeth), Artists in String: String Figures, their Regional Distribution and Social Significance, 888
- Hadfield, Bart. (Sir Robert), Speech to Hadfields, Ltd., 791; The Development of the Resources of the British Empire, 468; T. G. Elliott, and R. J. Sargant, Recent Developments in Corrosion and Heat-resisting Steels, 247
- Hadley (Dr. A. T.), [death], 465
- Hagen (Prof. G.), Dark Objects in Barnard's Photographic Atlas, 391
- Haigh (B. P.), and B. Jones, Atmospheric Action in relation to Fatigue in Lead, 514
- Hake (Dr. H. W.), [death], 174
- Haldane (J. B. S.), elected Fullerian professor of physiology at the Royal Institution, 390; Principles of Plant Breeding, 326
- Haldane (T. G. N.), Production of Low Grade Heat from Electricity, 23
- Hale (Lieut. P. G.), Meteorological Conditions accompanying a Waterspout, 292
- Hall (Dr. A.), [death], 679
- Hall (E. H.), Recent Progress in the Dual Theory of Metallic Conduction, 843
- Hall (F. G.), and Dr. E. K. Rideal, Cambridge Five-Figure Tables, 968
- Hall (M. C.), Arthropods as Intermediate Hosts of Helminthes, 144
- Hanson (D.), S. L. Archbutt, and Grace W. Ford, Investigation of the Effects of Impurities on Copper. Part 6, 513
- Harden (Prof. A.), The Function of Phosphate in Alcoholic Fermentation, 277, 313
- Hardy (Sir William B.), The Physical Basis of Life (Huxley Lecture), 422
- Harger (H. S.), Dr. D. Draper, 714
- Hargreaves (J.), The Effect of Nuclear Spin on the Optical Spectra (2), 256, (3), 802
- Harkins (Prof. W. D.): Effect of Collisions between α -particles and Nitrogen Atoms, 611; D. M. Gans, and H. E. Bowers, Raman Effect for Solutions of Sulphur Dioxide, 464
- Harmer (Sir Sidney), Polyzoa, 543
- Harper (Dr. R. M.), A Statistical Measure of Civilisation, 330
- Harris (G. T.), Diatoms: *Satis superque*! 922
- Harris (Dr. H. A.), appointed president of the Microscopical Society of Wales, 903; awarded the William Julius Mickle fellowship of London University, 396
- Harris (Dr. J. A.), [death], 982
- Harris (Dr. L. J.), An Apparent Rôle for the Thymus (in Calcium Metabolism), 346
- Harris (Dr. T. M.), reappointed demonstrator in botany in Cambridge University, 993
- Harrison (H. H.), Machine Telegraph Systems, 760
- Harrison (J. V.), The Geology of some Salt-plugs in Laristan (Southern Persia), 294
- Harrison (Dr. T. H.), Photoelectric Recording of Daylight, 704
- Hartinger (Dr. H.), the late Ernst Abbe and his connexion with the firm of Zeiss, 211
- Hartley (Sir Harold), appointed a vice-president of the L.M. and S. R. Coy. and director of scientific research to the company, 213; elected a member of the Athenæum Club, 576
- Hartmann (Prof. J.), Jet-Wave Rectifiers, 760
- Hartshorn (L.), Surface Resistivity Measurements of Solid Dielectrics, 765
- Harvey (A.), The Zeeman Effect in the Band Spectrum of Helium (2), 186
- Harvey-Gibson (Prof. R. J.), Two Thousand Years of Science: the Wonders of Nature and their Discoveries, 404
- Haslam (Dr. J. F. C.), Recent Advances in Preventive Medicine. With a chapter on the Vitamins by Prof. S. J. Cowell, 968
- Hatfield (Dr. H. S.), The Conquest of Thought by Invention in the Mechanical State of the Future, 370
- Hausman (L. A.), Hair of the Fossil Ground-Sloth (Nototherium), 951
- Havliček (F. J.), Recombination of Atomic Hydrogen, 989
- Haward (Sir Harry), Recent Developments in the Electricity Supply of Great Britain, 468
- Hawkes (O. A. M.), Danish-Carib Crosses, 143
- Hawkins (Prof. H. L.), The Restless Earth: An Introduction to the History of the Rocks, 11
- Hawks (E.), The Book of Electrical Wonders, 923
- Haworth, Hirst, and Webb, Glycogen, 29
- Hay (O. G.), The Ross Modification of the Hilger Interferometer, 257
- Hayes (Prof. M. R. J.), [death], 65
- Heath (Sir Frank), The Earl of Balfour, 501
- Hearsey (Lt.-Col. H. H. Y.), [death], 715
- Hecht (J. S.), Unsolved Problems: National and International, 735
- Hellings (H.), Dr. S. Pexton, and Dr. Chaplin, presented with the Moulton medal of the Institution of Chemical Engineers, 574
- Henderson (Dr. J.), Geological Structure of New Zealand, 289
- Hendry (Prof. G. W.), Plant Remains in Sun-dried Bricks, 215
- Henking (Dr. H.), Species and Races in the Salmonidæ, 951
- Henri (Prof. V.), Existence of Two Limits of Predissociation in the Nitrogen Peroxide Molecule and the Heat of Dissociation of Oxygen, 202; Dissociation Energy of Oxygen determined from the Pre-Dissociation of Sulphur Dioxide, 275; The Heat of Dissociation of the Molecule of Oxygen and the Energy of Activation of the Oxygen Atom, 337
- Henry (Prof. A.), [death], 571; [obituary article], 606
- Hepburn (Major P. H.), [death], 26; [obituary article], 60
- Hermann (H.), F. Caujolle, and F. Jourdan, Elimination of some Alkaloids and some Genalkaloids by the Bile Ducts, 258
- Heron-Allen (E.), Preparations of Protozoa and Algæ, 91
- Herrington (W. C.), Life History of the Pismo Clam, 987
- Herskovits (Dr. M. J.), Cultural Areas in Africa, 426
- Herzog (E.), and G. Chaudron, The Alteration of the Mechanical Properties of Sheets of Duralumin after Corrosion by Sea Water, 114
- Hess (F. L.), and R. C. Wells, Samarskite from New Mexico, 393
- Hettner (Prof. A.), awarded the Cullum geographical medal of the American Geographical Society, 648
- Hevesy (Prof. G.), Quantitative Analysis by X-Rays, 776; The Chemistry and Geochemistry of the Titanium Group of Elements (Hugo Müller lecture), 539; and A. Guenther, Search for an Inactive Isotope of the Element 84 (Polonium), 744; and O. H. Wagner, The Therapeutic Use of Metals, 868
- Hewer (H. R.), Colour-Changes in Fish (Pt. 5), 957
- Hewlett (Dr. C. W.), A Film Phonograph, 285
- Hewlett (Prof. R. T.), Dr. F. R. Blaxall, 944
- Hey (M. H.), On Face- and Zone-symbols referred to Hexagonal Axes, 958; On Pink Epsomites and Fauserite, 958
- Hickman (Henry Hill), centenary of the death of, 572
- Hicks (Prof. G. Dawes), The Philosophy of Spinoza and Leibniz, 264; The Earl of Balfour, 497; Hugh S. R. Elliot, 786
- Hill (Prof. A. V.), Vapour Pressure of Solutions, 724
- Hill (Dr. A. W.), Scientific and Industrial Research in the British Empire, 386
- Hill (late C.), Origin of the Caste System in India, 685
- Hill (Prof. J. P.), awarded the Linnean gold medal for 1930, 719
- Hill (Sir Leonard), The Kata-Thermometer, 836; Nutritive Value of Elm Tree Bark, 780; Diving, 249, 415
- Hill (Dr. W. C. O.), resignation of lectureship of anatomy in Birmingham University, 395

- Hill (Engr. Rear-Admiral W. S.), Powdered Coal for Ship Propulsion, 326
- Hillebrand (Dr. W. F.), and Dr. G. E. F. Lundell, Applied Inorganic Analysis: with special reference to the Analysis of Metals, Minerals, and Rocks, 852
- Hinchley (Prof. J. W.), presented with the Osborne Reynolds medal of the Institution of Chemical Engineers, 574
- Hind (S. R.), Josiah Wedgwood and his Influence on the English Pottery Industry, 781
- Hindle (Prof. E.), Recent Work on Yellow Fever, 19; Yellow Fever Vaccine, 27
- Hingston (Major R. W. G.), In the Canopy of the Forest (British Guiana), 548
- Hino (T.), Research on Earthworms, 871
- Hinshelwood (C. N.): The Kinetics of Chemical Change in Gaseous Systems. Second edition, 703; and R. Fort, Oxidation of Benzene, 724
- Hirschi (Dr. H.), Radioactivity of Granites and Graptolites, 686
- Hirst (A. S.), [obituary article], 899
- Hoare (Sir Samuel), nominated as president of the British Science Guild, 612
- Hobson (A. D.), Regeneration of the Spines in Sea-Urchins, 168
- van Hoepen (Dr. E. C. N.), Cretaceous Mollusca of South Africa, 906
- Hoffert (W. H.), and G. Claxton, Benzole Recovery in Gasworks Practice, 909
- Hoffmann (P.), et J. Deboffe, Cinquante ans de travaux sur l'agriculture et sur l'horticulture, 979
- Hoffmann and Lenher, Precipitated Selenium Dioxide, 29
- von Hoffmann (Capt. C.), Edited by E. Löhrike, Jungle Gods, 375
- Hoffmeister (J. E.), H. S. Ladd, and H. L. Alling, Falcon Island: a Pyroclastic Cone, 252
- Hofmeyer (Dr. J. H.), Scientific Work in South Africa, 617
- Hogben (Prof. L. T.), appointed professor of social biology at the London School of Economics, 396
- Holdaway (F. G.), and A. C. Evans, Parasitism a Stimulus to Pupation: *Alysia manducator* in relation to the Host *Lucilia sericata*, 598
- Holden (H. S.), Some Wound Reactions in *Ankyropteris corrugata*, 693
- Holland (Sir Thomas H.), awarded the gold medal of the Institution of Mining and Metallurgy, 390
- Hollingworth (S. E.), The Glaciation of Western Edenside and adjoining Areas, etc., 513
- Holmes (Prof. A.), and Dr. R. W. Lawson, The Product of the Radioactive Disintegration of Potassium, 48
- Holmes (P. F.), and D. M. Henshaw, Endowment of the William Cartwright Holmes Scholarship in Leeds University, 72
- Holmes (Prof. S. J.), Inheritance in Man (Galton Lecture), 987
- Holtum (R. E.), Periodicity of Leaf-fall in Singapore, 129
- Hönigschmid (Prof. O.), The Product of the Radiographic Disintegration of Potassium, 91
- Hooker (Prof. H. D.), [death], 97
- Hoover (President), a tribute to men of science and their work, 139
- Hope-Jones (W.), Annual Meeting of the Mathematical Association, 109
- Hopfield (Dr. J. J.), New Spectrum of the Hydrogen Molecule, 927
- Hopkins (E. W.), Nitrogen Fixation by Bacteria, 579
- Hora (Dr. S. L.), Value of Field Studies in Zoology, 650
- Hori (Prof. T.), Spectrum of Ionised Mercury Hydride, 131; Spectrum of Sodium Hydride, 615
- Horn (C. O.), Effect of Electric Tramways on Reception in Broadcasting Receiving Sets, 424
- Hornblower (G. D.), Sacred Trees in Egypt, 392
- Hornshaw (B. E.), Australian Petroglyphs, 650
- Hough (H. W.), Soil Corrosion, 835
- Houllevigue (Prof. L.), La vie du globe et la science moderne, 304
- Houstoun (Dr. R. A.), and J. F. Shearer, Fechner's Law, 891
- Howard (A.), awarded the Barclay memorial medal of the Asiatic Society of Bengal, 612
- Howarth (M. G. B.), appointed chief chemist to the Newcastle-upon-Tyne and Gateshead Gas Company, 184
- Howell (A. H.), American Chipmunks, 181
- Howitt (F. O.), Starch Envelopes of Pyrenoids, 412
- Hubbard (M. K.), appointed research associate in geology and geophysics at the Chicago Museum of Science and Industry, 648
- Hudson (Henry), the explorer, unveiling of a memorial window to, 899
- Hudson (Miss Hilda P.), The Mathematician in Ordinary Intercourse, 110
- Hudson (R. G. S.), The Age of the *Lithostrotion arachnoideum* Fauna of the Craven Lowlands, 622
- Hudson (W. H.), The Purple Land: being the Narrative of one Richard Lamb's Adventures in the Banda Oriental, in South America, as told by Himself, 45
- Huffman, Parkes, and Daniels, Thermal Data on Organic Compounds, 907
- Hughes (A. A.), History of Bell-founding, 145
- Hukumoto (Y.), A Relation between the Continuous and the Many-lined Spectra of Hydrogen, 975
- Humphrey (H. A.), D. M. Buist, and J. W. Bansall, The New Industrial Power Plant of Imperial Chemical Industries, Ltd., at Billingham-on-Tees, 511
- Hurd and Puterbaugh, Concentration of Hydrogen Peroxide, 796
- Hurry (Dr. J. B.), [death], 465
- Hutchinson (Dr. D. H. A.), [obituary article], 324
- Hutchinson (H. P.), and H. G. H. Kearns, Insect Pests of Willows, 201
- Hutchisson (E.), Intensities in Band Spectra, 746
- Hutton (J. H.), awarded the Rivers memorial medal of the Royal Anthropological Institute, 177; Skull Ornamentation in the Naga Hills, 66
- Huxley (Prof. J. S.), The Aims of School Biology, 283; The Maladaptation of Trout Spermatozoa to Fresh Water, 494
- Hybl (J.), The Heat of Evaporation of Liquids, 915
- Hyman (Dr. H. H.), and C. R. Jeppesen, Moment of Inertia of Hydrogen from Band Spectra, 462
- von Ihering (Prof. H.): [death], 537; [obituary article], 678; Atlantic and Pacific Land-Bridges, 954
- Imamura (Prof. A.), Multiple Origin of the Japanese Earthquake of 1923, 289; and T. Kodaira, Earth-Tiltings before Earthquakes, 544
- Imanishi (S.), Electronic Fine Structure in Helium Bands, 529
- Ingham (A. E.), elected a fellow of King's College, Cambridge, 476; appointed a university lecturer in mathematics in Cambridge University, 839
- Inglis (R. A.), Botanical Nomenclature, 204
- Inoué (W.), and T. Sugiyama, Earth-Tiltings before Earthquakes, 544
- Inwards (R.), Ninetieth birthday of; work of, 608
- Isaacs (Mrs.), The Biological Interests of Young Children, 961
- Ishida (Prof. Y.), Stark Effect in the Ultra-Violet Spectrum of Neon, 970
- Ivens (W.), White Immigrants in Polynesian Tradition, 614
- Ives (H. C.), Seven Place Natural Trigonometrical Functions, etc., 968
- Jackling (D. C.), Establishment of the Jackling Foundation at the Missouri School of Mines and Metallurgy, 692
- Jacks (G. V.), Soil Science in Sweden, 289
- Jackson (Sir Henry), [obituary article], 59
- Jackson (Dr. J.): Lowell's Prediction of a Trans-Neptunian Planet, 451; The Planet discovered at Lowell Observatory, 491
- Jackson (Dr. L. C.), The Stern-Gerlach Experiment with Active Nitrogen, 131
- Jacob (C. T.), The Zodiacal Light, 471
- James (Col. S. P.), Report on a Visit to Kenya and Uganda to advise on Antimalarial Measures, 208
- Jameson (Prof. A. H.), and Prof. M. T. M. Ormsby, Mathematical Geography. Vol. 2, 923
- Jamotte (A.), A *Glossopteris* Flora in the Lukuga Valley in the neighbourhood of Greinerville (Belgian Congo), 338

- Janet (Prof. M.), Leçons sur les systèmes d'équations aux dérivées partielles, 443
- Javillier (M.), and Mlle. L. Emerique, The Vitamin Activity of Carotene, 622
- Jeffrey (Prof. E. C.), The Present Status of *Drosophila melanogaster*, 411
- Jeffreys (Dr. H.), 'Digging' in Rowing, 928; The Future of the Earth, 11
- Jelley (E. E.), Mounting Medium for Film Sections, 276; For Microscopic Work, 672
- Jenkin (G. F.), and G. D. Lehmann, High Frequency Fatigue, 617
- Jog (Dattatraya Shridhar), New Bands in the Molecular Spectrum of Hydrogen, 709
- Johnson (J.), awarded the gold medal of the Institution of Naval Architects, 213
- Johnson (M. C.), A Method of calculating the Numerical Equation of State for Helium below 6° abs. and of estimating the relative importance of Gas Degeneracy and Interatomic Forces, 433
- Johnson (Dr. R. C.), Some Bands of the Carbon Molecule, 89
- Johnston (J. H.), Light in Four Dimensional Space, 199; 709
- Joliot (F.), The Electrical Properties and the Structure of the Metallic Films obtained by Thermal and Cathodic Projection, 622
- Jolles (Z.), and J. Krugliakoff, Investigations on Diazo-hydrates, Azoxy-compounds, and Nitrones, 767
- Jolly (Dr. W. A.), elected president of the Royal Society of South Africa, 755
- Joly (Prof. J.), Application of Gamma Radiation to Deep-seated Tumours, 693
- Jones (Prof. F. Wood), Man's Place among the Mammals, 6; Polynesian Anthropometry, 685
- Jones (Dr. H. Spencer), Revision of Newcomb's Occultation Memoir, 142
- Jones (Prof. J. H.), The Present Position of the British Coal Trade, 343
- Jones (R. D. H.), awarded the Sheepshanks Exhibition of Cambridge University, 728
- Jones (W. R. D.), Metallic Magnesium, 514
- Joukowsky (Dr. E.), Floods of the Seine, 508
- Julin (Prof. C.), [death], 246
- Kahn (R. F.), elected a fellow of King's College, Cambridge, 476
- Kamienski (Prof. M.), An Ice-Telemeter, 835
- Karandikar (S. V.), Hindu Exogamy, 407
- Kari (A.), The Design of Merchant Ships and Cost Estimating. Second edition, 921
- Kashyap (Shiv Ram), Indian Liverworts, 331
- Kassel (L. S.), The Binding Energy of some Organic Compounds, 926
- Katz (Dr. S. H.), and C. S. W. Grice, Mine Rescue Apparatus, 509
- Kawamoto (N.), Blood of the Eel, 905
- Kawata (S.), K-absorption Edge of Zinc, 509
- Kearns (H. G. H.), Insect Pests of Willows, 276
- Kearton (C.), In the Land of the Lion, 12
- Keeble (Sir Frederick), M. G. Nelson, and R. Snow, The Integration of Plant Behaviour (1), 149; (2), 293
- Keesom (Prof. W. H.), and H. H. Mooy, The Crystal Structure of Krypton, 889
- Keilin (D.), Cytochrome and Intracellular Oxidase, 841
- Keith (Sir Arthur), Man's Ancestry, 6; Recent Discoveries of Fossil Man, 935, 944
- Keller (Prof. C.), [death], 679
- Kemp (C. N.), X-rays in the Examination of Coal, 68
- Kendall (Dr. E. C.), Thyroxine, 161
- Kendall (Prof. J.), At Home among the Atoms: a First Book of Congenial Chemistry, 155
- Kendrick (T. D.), 'Bar-lip' Pottery from Essex and Alderney, 950
- Kennaway (E. L.), and I. Hieger, Tar Cancer, 932
- Kent-Jones (D. W.), and A. J. Amos, The Bacteriology of Wheat and Flour, 433
- Kenwick (Evelyn and Miriam), The Child from Five to Ten: Interests and Problems of Early Childhood, 161
- Kenyon (Sir Frederic), Librarians and Museums, 969
- Keys (Dr. D. A.), and J. F. Heard, The Striated Discharge, 971
- Kidavu (M. G.), and P. A. Venkateswaran, Pepper Cultivation, 794
- Kidd (F.), and C. West, Physiology of Fruit (1), 221
- Kidson (Dr. E.), Australian Origin of Red Rain in New Zealand, 410
- King (H.), and W. K. Anslow, Synthesis of Glycine, 68
- Kipping (Dr. F. H.), appointed University demonstrator in chemistry in Cambridge University, 431
- Kirk (E.), A New Ordovician Gastropod, 759
- Kirkpatrick (T. W.), Leaf-Curl in Cotton, 672
- Kirrmann (A.), and J. Grard, An Abnormal Reaction of the Dihalogen Propylenes, 803
- Kittenberger (K.), translated from the Hungarian, Big Game Hunting and Collecting in East Africa, 1903-1926, 373
- Klauber (L. M.), Rattlesnakes of the Western United States, 758
- Klemperer (O.), Properties of β -Particles, 182
- Klumak (R.), and F. Hecht, Absolute Motions of Stars, 904
- Knight (B. C. J. G.), Monomolecular Films of Batyl Alcohol, 351
- Knudson (Prof.), and Dr. Rayner, Mycorrhiza in the Ericaceae, 508
- Kober (L.), Distribution of Masses on the Earth's Surface, 694
- Kodama (S.), Reduction of Carbon Monoxide, 386
- Koehler (O.), Heredity of Polydactyly in Man, 834
- Koetschau (Dr. R.), Einführung in die theoretische Wirtschaftsschemie, 964
- Kohn-Abrest (E.), Mlle. Hélène Villard, and L. Capus, The Presence of Thiocyanates in the Human Organism, 397
- Koller (P.), Genetic Studies of the A and B Races of *D. obscura*, 257
- Kopaczewski (W.), Traité de biocolloïdologie. Tome 1: Pratique des colloïdes. Deux. édition. Fasc. 1, 813
- Kordylewski (K.), The Variable Star Tauri. 41. 1929, 150
- Koto (Prof.), Multiple Origin of the Japanese Earthquake of 1923, 289
- Kozelka (A. W.), Inheritance of Natural Immunity, 472
- Krabbe (Dr. T. N.), translated by Annie I. Fausbøll, Greenland: its Nature, Inhabitants and History, 379
- Krepelka (J. H.), The Atomic Weight of Arsenic (1), 959
- Krishnamurti (Dr. K.), The Identity of Colloidal Particles in Soap Sols and Gels, 746
- Krishnamurti (P.), Raman Effect in Metallic Halides, 892; Raman Spectra of Crystalline Powders, 463
- Kroeber (A. L.), The Nisenan, 722
- Kuboto and Yamanaka, Promoter Action, 216
- Küstner (Dr. F.), elected an honorary member of the American Astronomical Society, 177
- van Laar (Prof. J. J.), awarded the Roozeboom gold medal; the work of, 423
- Labouret (Prof. H.), et Prof. P. Rivet, Le royaume d'Arda et son évangélisation au XVII^e siècle, 376
- Laby (Prof. T. H.): Quantitative Analysis by X-rays, 818; and C. E. Eddy, Quantitative Analysis by X-rays, 524
- Lacassagne (A.), The Difference in the Biological Action caused in Yeasts by Various Radiations, 550
- Ladame (G.), The Metalliferous Deposits of Mt. Chemin, Valais, 694
- Ladd-Franklin (Dr. Christine), [death], 787
- Lamarek, Projected Memorial to, 97
- Lamb (Prof. H.), Hydrodynamics, 402
- Lamb (H. C.), The Manchester System of Electricity Supply, 790
- Lambrey (M.), The Two Normal States of the NO Molecule, 657
- Lampitt (L. H.), E. B. Hughes, and H. S. Rooke, The Diastatic Activity of Honey, 802
- Lancaster (R.), and J. G. Berry, Zinc-base Die-casting Alloys, 514
- Lancum (F. H.), The Eviction-method of the Cuckoo, 113
- Lander (Dr. C. H.), Physics in Fuel Research, 989
- Lane (Prof. A. C.), Geological Climates, 830
- Langmuir (Dr. I.), awarded the Willard Gibbs gold medal of the Chicago section of the American Chemical Society, 470

- Lapworth (Dr. H.), Meteorology and Water Supply (Symons Memorial Lecture), 504
- Laquer (Prof. E.), E. Dingemans, and S. Kober, Crystalline 'Menformon', 90
- Larmor (Sir Joseph), The Connexion of Mass with Luminosity for Stars, 273; The Scientific Principle of Uncertainty, 345
- Lartz (L.), The Soluble Ferments Secreted by the Hymenomyces, 338
- La Souef (A. S.), Rapid Changes in Mammals caused by Climate, 578
- Latifi (Dr. A.), A National Script for India, 575
- Laude (G.), New Syntheses of Cyanic Acid and Urea by Oxidation of Carbon and its Derivatives in the Presence of Ammonia, 514
- Laurie (Prof. A. P.), de Wild's The Scientific Examination of Pictures, 382
- Lavin (G. I.): and F. B. Stewart, Production of Hydroxyl by the Water Vapour Discharge, 150; and J. R. Bates, The Exit Gas from an Ammonia Discharge Tube, 709
- Lawrence (A. S. C.), Stability in Soap Films, 970
- Lazarev (P.): and L. Teile, The Action of Blood-vessel Dilators on the Sensitiveness of the Eye in Peripheral Vision, 258; and N. I. Kolesnikova, The Staining of Boric Glass by the Action of Radium Rays, 258; and N. Rodzevitch, The Phenomena of Ionisation of a Gas during the Discoloration of Colouring Substances in Visible and in Ultra-Violet Light, 258
- Leach (Dr. J. A.), Australian Nature Studies: a Book of Reference for those interested in Nature-Study. Second edition, 123
- Le Bel (J. A.), The Sparks which are emitted by Stalactites when violently struck with a Steel Tool, 73
- von Le Coq (Dr. A.), [obituary article], 714
- Leeper (G. W.), The Thiocyanate Method of Determining Iron, 433
- Lefèvre (J.), and A. Auguet, The Influence of the Hygro-metric State of the Air on Metabolism, 434
- Leggett (Dr.), Electro-medical Apparatus and Medical Research, 505
- Leigh (Dr. R. W.), Dental Morphology of Prehistoric Guam, 905
- Lelli (M.), W. Thomson's Minimum Heat Theorem, 338
- Lempfert (R. G. K.), elected president of the Royal Meteorological Society, 141
- Lenard (P.), Grosse Naturforscher: eine Geschichte der Naturforschung in Lebensbeschreibung, 812
- von Lengerken (H.), Die Salzkäfer der Nord- und Ostseeküste: mit Berücksichtigung der angrenzenden Meere sowie des Mittelmeeres, des Schwarzen und des Kas-pischen Meeres; eine ökologisch-biologisch-geographische Studie, 558
- Lenglen and Durier, Appreciation of the Value of Powdered Limestones used in Agriculture, 478
- Lennard-Jones (Prof. J. E.), The Polarity of Molecules, 9
- Lepape (A.), and M. Geslin, The Radioactivity acquired by Materials Exposed to the Action of Atmospheric Agents, 657
- Lerrigo (A. F.), Routine Detection of Nitrates in Milk, 621
- Leskov (A. I.), Occurrence of *Buxus sempervirens* L. in the Northern Caucasus, 259
- Lespiau: Phenyltrimethylene, 995; and Bourguet, A New Ethylenic Erythrite, 478
- Levaditi (C.), and F. R. Selbie, The Mode of Transmission of Acute Epidemic Polymorphous Erythema, 223
- Levaillant (R.), Some Reactions of Sulphurous and Carbonic Esters, 258
- Levi-Civita (Prof. T.): Characteristics and Bicharacteristics of Einstein's Gravitational Equations, 730; translated by Dr. J. Dougall, A Simplified Presentation of Einstein's Unified Field Equations, 813
- Levinstein (Dr. H.), Chemical Warfare, 254
- Levy (Prof. H.), World Power and the Power of Man, 810
- Lewis (Dr. B.), and Dr. H.-J. Schumacher, A First Order Solid Phase Reaction, 129
- Lewis (J. S.), Ignition of Hydrocarbons in Oxygen, 474
- Lewis (S. Judd), The Spectroscopic Investigation of Jams; A Simple Polarimetric Test for Sugars in Jams, 548
- Leyshon (Miss A. W.), Characteristics of Discharge Tubes under 'Flashing' Conditions, etc., 336
- Li (Ju-chi), Variation in Chinese Students, 834
- Lichtenstein (Prof. L.), Grundlagen der Hydromechanik, 402
- Lienhart (R.), The Genetics of the Castorrex Rabbit, 550
- Lien-Teh (Dr. Wu), Manchurian Rodents and Disease, 685
- Lightfoot (B.), Wankie Coalfield and its Fossil Flora, 722
- Linfort (E. H.), The 'Wave Band' Theory of Wireless Transmission, 306
- Linnik (W.), Single Mirror Interference Fringes with X-rays, 836
- Linstead (Dr. R. P.), awarded the Harrison memorial prize for 1929, 100; presented with the Harrison memorial plaque and prize, 538
- Lions (F.), Researches on Indoles (I), 659; Some Trimethoxy-quinoline Derivatives, 659
- Lister (H.), The Comparative Morphology of the Protozoan Fauna found in the Paunch and Reticulum of Ruminants, 693
- Lloyd (Dr. Ll.), Preparations of Protozoa and Algæ, 91
- Lock (C. N. H.), The Equations of Motion of a Viscous Fluid in Tensor Notation, 513
- Lockley (R. M.), Habits of the Manx Shearwater, 215
- Lodge (Sir Oliver), Legitimate Uncertainty, 17; Test of a Relativity Postulate, 632; The 'Wave-Band' Theory of Wireless Transmission, 271
- Loeper, A. Mougeot, R. Degos, and S. de Seze, The Glycogen of the Heart and Cardiac Medicines, 878
- Löhnis (M. E.), Nitrogen Fixation by Bacteria, 579
- Longo (B.), and C. Paderi, The Biological Significance of Alkaloids on Plants, 338
- Lopes (G. de Arroyave), Bequest to the Zoological Society of London, 179
- Lowie (R. H.), Are we Civilized? Human Culture in Perspective, 383
- Lowry (Prof. T. M.): Optical Rotatory Power, 762; The Parachor, 364; and C. B. Allsopp, Measurement of Refractive Indices, 28
- Lowry and Jessop, Chlorides of Sulphur, 873
- Loyd (L. R. W.), The Birds of South-east Devon, 367
- Lübecke (Dr. E.), Technical Sound Problems, 616
- Lubimenco (V. N.), and Mme. Rauser-Cernousova, The Fossil Remains of Chlorophyll in Marine Mud Deposits, 766
- Lucas (R.), and Mlle. D. Biquard, The Influence of Temperature and of Solvents on the Rotatory Powers of Active Substances, 114
- Lugeon (M.), The Origin of Granite, 995
- Lundquist (Dr. O.), Researches on the X-ray Spectrum of Sulphur, 925
- Lupton (the late A. G.), tribute to, 396
- Luyten (Dr. W. J.), The Grootfontein Meteor, 214
- Lyell (Sir Charles), Centenary of the Publication of "Principles of Geology", 466
- Lyman (Prof. T.), The Distribution of Light Intensity in a Fresnel Diffraction Pattern from a Straight Edge, 843
- Lynch (Col. A.), The Muscular Sense, 52
- Lyons (C. G.): awarded the Gordon Wigan prize of Cambridge University, 184; and Dr. E. K. Rideal, Unimolecular Films, 455
- Lyons (Sir Henry), Co-operation between the Geographer and Surveyor, 110; reappointed director and secretary of the Science Museum, 902
- Macalister (Prof. R. A. S.), and Prof. J. K. Charlesworth, The Archæological Finds at Rosses Point, Sligo, 248
- Macallum (Prof. A. B.), and R. C. Bradley, Horse and Fowl Hæmoglobin, 494
- Macaulay (W. H.), and Brig.-Genl. G. E. Smith, Curling, 408
- McBain (Dr. M. E. L.), and Prof. J. W. McBain, The Identity of the Colloidal Particles in Soap Sols and Jellies, 125
- McBain and Du Bois, Gibbs's Absorption Equation, 182
- MacBride (Prof. E. W.), Embryology and Recapitulation, 883; Mortality amongst Plants and its Bearing on Natural Selection, 973; Reversibility of Evolution, 166; Sterilisation as a Practical Eugenic Policy, 40; The Acquired Characters of *Alytes*, 670
- McCallien (W. J.): The Geology of North-eastern Antrim, 549; and R. B. Anderson, The Carboniferous Sediments of Kintyre, 549

- McClellan (Capt. W. N.), River Flows of the Ness Basin, 514; River Flow Records, Ness Basin: River Moriston and River Garry, 334
- McCormick (Sir William), [death], 537; [obituary article], 569
- McCrea (Dr. W. H.), appointed lecturer in mathematics in the University of Edinburgh, 31
- MacCurdy (J. T.), Mechanism in Nerve Centres, 632
- MacDonald (Mr. Ramsay), recommended for election into the Royal Society, 864
- Macfadyen (W. A.), Solution of Coral Reef Limestone, 215
- MacGregor (M. E.), The Mechanism of Electrolytic Rectification, 128
- Mache (H.), und S. Meyer, Physikalische Beiträge zur Radium-emanations-therapie, 407
- MacInnes and Dole, The Glass Electrode, 652
- M'Intosh (Prof. W. C.), re-elected president of the Ray Society, 541
- Mackay (Principal J. Y.), [death], 571; [obituary article], 679
- McKenna (Dr. C. F.), [death], 982
- McKeon (Dr. R.), The Philosophy of Spinoza: The Unity of his Thought, 264
- McKinney (Dr. T. E.), [death], 982
- McLaughlin (D. B.), Relation of Light Changes to Velocity Changes in Variable Stars, 65
- McLennan (Prof. J. C.): A Superconducting Alloy with Resistance Temperature Hysteresis, 447; Ruthenium a Superconductor, 168; Allen and Wilhelm, Superconductors, 952; and H. J. C. Ireton, Spectroscopy of the Night Sky, 952
- Macleod (Prof. J. J. R.), Prof. G. N. Stewart, 980
- MacMahon (Major P. A.), [death], 26; [obituary article], 243
- Madge (E. W.), The Viscosity of Liquids, 580
- Mahanti (P. C.), Band Spectra of Copper Oxide, 819
- Mahr (A.), The Viking Sword from Ballinderry, Co. Westmeath, 337
- Majumdar (R. C.), and D. S. Kothari, The Common Third Level in the Raman Effect, 165
- Malinowski (Prof. B.), Is Humanism Dead? 847
- Malloch (E. S.), and C. E. Baltzer, Fuel Tests, 29
- de Man (H.), translated by Eden and Cedar Paul, Joy in Work, 667
- de Man (Dr. J. G.), [obituary article], 465
- Mann (Dr. F. G.), appointed University lecturer in chemistry in Cambridge University, 431
- Mannaberg (M.), [death], 97
- Manneback (Prof. C.), Optical Anisotropy and Theoretical Intensities of Raman Lines in Diatomic Gases, 88
- Manson (J. L.), and F. E. Drury, Experimental Building Science. Vol. 2, 44
- Manton (Dr. S. M.), reapointed demonstrator in comparative anatomy in Cambridge University, 993; The Segmental Excretory Organs of Crustacea (5), 548
- Marcelet (H.), The Spectrographic Analysis of the Fluorescences of some Vegetable Oils observed under the Ultra-Violet Rays, 995
- Marchand, Salinity Investigations in the South African Seas, 473
- Marchant (Prof. E. W.), Globular Lightning, 128
- Marchlewski (L.): Phyllyerthrin, 75, 150; and A. Boryniec, The Absorption of Ultra-Violet Radiations by the Methoxybenzoic Acids, 478
- Marcolongo (R.), The Dynamics of Leonardo da Vinci, 139
- de Margerie (E.), awarded the Victoria medal of the Royal Geographical Society, 467
- Marie (C.), and Gérard, The Electrolytic Deposit of Copper in the Presence of Amino Acids, 803
- Marini (Prof. L.), [death], 61
- Mark (H.), and R. Wierl, Electron Diffraction Rings, 723
- Markley (Dr. J. L.), [death], 827
- Marrack (J. R.), and F. C. Smith, The Composition of Diphtheria Toxin—Anti-toxin Floccules, 149
- Marrian (G. F.), Preparation of Œstrin, 90
- Marsden-Jones (E. M.), and W. B. Turrill, Hybridisation in the British Flora, 759
- Marshall (Prof. H. T.), [death], 136
- Marshall (W.), Mounting Media for Microscopic Work, 563
- Martin (A. J.), Sewage and Sewage Disposal, 541
- Martin (Dr. L. C.), A Point in the Theory of 'Critical Illumination' in the Microscope, 741
- Martindale (Dr. W. H.), The Extra Pharmacopœia of Martindale and Westcott. Nineteenth edition. In 2 vols. Vol. 2, 366
- Martyn (D. F.), A New Method of Measurement of Minute Alternating Currents, 549
- Marvin (Prof. F. S.), Renan's Recollections of My Youth, 851; Trade Rivalry and World Peace, 965
- Mascarelli (L.), and D. Gatti, Diphenyl and its Derivatives, (5), 398
- Masefield (G. H.), The Use of Rubber in Recent Years, 646
- Massee (A. M.), Dr. A. N. A. Nalepa, 96
- Massy (Anne L.), Marine Mollusca off the West Coast of Ireland, 651
- Mather (the late S. T.), presented with the Public Welfare medal of the U.S. National Academy of Sciences, 791
- Matheson (N.), Rotary Oil-Well Drilling Plant, 906
- Mathias (E.), Study of Fulminating Matter, 114; The Conception of Stephen Gray on the Identity of Lightning and the Sparks of Electric Machines, 803
- Matthes (Prof. M.), [death], 787
- Matthews (Sir Thomas), [death], 97
- Matthey (R.), The Chromosomes of Saurians, 186
- Matuzawa (T.), Seismic Waves and the Sedimentary Layer, 615
- Maurer (Dr. H.), Echo Sounding and Depths, 473
- Mawer (A.), elected a member of the Athenæum Club, 576
- Mawson (Sir Douglas): Discoveries in the Antarctic, 212; and C. T. Madigan, Pre-Ordovician Rocks of the McDonnell Ranges (Central Australia), 477
- Maybach (Dr. W.), [obituary article], 96
- Mayo (Earl of), S. D. Adshead, and P. Abercrombie, with the assistance of W. H. Thompson, The Thames Valley from Cricklade to Staines: a Survey of its Existing State and some Suggestions for its Future Preservation, 737
- Maziarski (S.), Striated Muscle in Liver of Spider, 288
- Mazzone-Sangiorgi (G.), The First Elements of a New General Theory for the Motion of Waters and other Fluids (2), 694
- Mecke (Prof. R.), Bandenspektra und ihre Bedeutung für die Chemie, 380; The Heat of Dissociation of Oxygen and of the C-H Bond, 526
- Meesmaecker (R.), A New Colour Reaction of Ergosterol, 338
- Mehta (Prof. K. C.), Rust Recurrence on Indian Wheat, 289
- Meinesz (Dr. V.), Pendulum Observations at Sea, 104
- Mellanby (Mrs. May), Diet and the Teeth, an Experimental Study. Part 1: Dental Structure in Dogs, 604
- Melsom (S. W.), A. N. Arman, and W. Bibby, Failure of Insulators due to Deposition of Sea Salt, 989
- Menzies (Dr. A. C.), The Raman Effect, 205
- Menzies (Prof. A. W. C.), Contamination by Dust Particles and Intensive Desiccation, 445
- Mercanton (P. L.), The True Height of the Beerenberg of Jan Mayen, 114
- Merola (M.), *R Scuti*, 34; The Variable SX Herculis, 338
- Merriam (J. C.), The Living Past, 888
- Messier (C.), bicentenary of the birth of, 945
- Meta (J.), The Oldest Known Star Catalogue, 870
- Metropolitan-Vickers Electrical Co., Ltd., Research Activities in 1929, 146
- Metz (C. W.), and M. Louise Schmuck, Unisexual Progenies and the Sex Chromosome Mechanism in *Sciara*, 623
- Metzelaar (Dr. J.), [death], 61
- Meunier (L.), and K. Le Viet, The Hydrophil Properties of Collagen, 74
- Mezzadrola (G.), and E. Varetton, Action Exerted by Ultra-short Electromagnetic Waves on the Catalasic Power of Seeds, 879; Action of Ultra-Violet Rays on the Germination of Seeds and on the Growth of Plants, 842; Action of Wood's Light on the Germination of Seeds and on the Growth of Plants, 35; Comparison between the Actions Exerted by Ultra-short Electromagnetic Waves ($\lambda 2.3$ mm.) and by the Lakhovsky Oscillating Circuit, 35; The Action Exerted by a Radio-oscillator for Ultra-short Waves of 2.3 Metres Wave-length on the Germination of Seeds, etc. (1), 731, (2), 767

- Michal (O.), The K-absorption and the Satellites of the Ferromagnetic Elements, 623
- Michel-Durand (E.), Influence of Treatment with Alcohol on the Extraction of Tannin from Plants, 222
- Michel-Lévy (A.), and H. Muraour, The Microscopic Examination of Colloidal Powders in Polarised Light, 150
- Michelson (Prof. A. A.), awarded the Duddell medal of the Physical Society of London, 470; resignation of position in Chicago University; to take up work at Pasadena, 97; the work of, 538
- Middleton (A. D.), Vole Cycles in Great Britain, 950
- Miers (Sir Henry A.), Mineralogy: an Introduction to the Scientific Study of Minerals. Second edition, revised by Dr. H. L. Bowman, 887
- Milbauer (J.), The Preparation of Vegetable Charcoal (1), 622
- Mill (Dr. H. R.), awarded the Cullum Geographical medal of the American Geographical Society, 648; Dr. F. Nansen, 933
- Miller (Dr. Christina C.), awarded the Keith prize of the Royal Society of Edinburgh, 756
- Miller (G. S.), Mammals formerly Eaten in the Dominican Republic, 543; Systematic Studies of Mammals, 508
- Miller (H. G.), The Future of British Agriculture, 725
- Millikan (Prof. R. A.), Alleged Sins of Science, 388; re-elected foreign secretary of the U.S. National Academy of Sciences, 791
- Mills (Dr. W. H.), awarded the Longstaff medal of the Chemical Society, 250; presented with the Longstaff medal of the Chemical Society, 538
- Milne (Prof. E. A.), The Problem of Stellar Luminosity, 453, 708
- Miner (J. R.), The Cost of Biological Books, 682
- Minot (Dr. G. R.), and Dr. W. P. Murphy, awarded the Cameron prize of Edinburgh University, 476
- Mitchell (Sir Peter Chalmers), Defence of Materialistic Monism (Herbert Spencer Lecture), 912
- Moir (J. Reid), Flint Implements of Upper Palæolithic Types from Glacial Deposits in Norfolk and Yorkshire, 234; Tertiary Man, 167
- Møller (C.), Scattering of α -Particles by Light Atoms, 459
- Mondain-Monval (P.), The Spontaneous Inflammation of Mixtures of Air and Hydrocarbons, 150; and P. Galet, The Anomalies of the Physical Properties of the Vitreous State, 294; and R. Quanquin, The Temperature of Spontaneous Inflammation of Gaseous Mixtures of Air and Saturated Hydrocarbons, 74
- Monkhouse (Col.), and L. C. Grant, The Heating of Buildings Electrically by Thermal Storage, 63
- Monterosso (B.), Structure and Function of the Middle Intestine of *Perodermis cylindricum*, 879
- Moore (Prof. C. A.), Lime Requirement of Soil, 691
- Moon (C.), Calibration of Tuning-forks, 795
- Moon (P. H.), and A. S. Norcross, Electrical Breakdown in a Solid Dielectric, 217
- Moore (H. B.), A Deep Sea Echinoid in British Waters, 351
- Morgan (Prof. G. T.): and G. R. Davies, Antimony Analogues of the Carbazole Series, 433; and R. Taylor, Ethyl Alcohol: a Product of High Pressure Syntheses, 889
- Morgan (H. R.), The Constant of Aberration, 251
- Morgan (Prof. T. H.), elected president of the American Association, 141
- Morton (F.), Measurements of Brightness with Grey-wedge Photometers on a Sea-voyage from Europe to Guatemala and in Guatemala, 1928-29, 398
- Morton (Dr. R. A.), awarded the Meldola medal of the Institute of Chemistry, 421
- Moser (L.), K. Neumayer, and K. Winter, Determination and Separation of Rare Metals from other Metals (19), 398
- Mott (N. F.), Wave-Mechanics of α -Ray Tracks, 28
- Mottram (J. C.), Non-Disjunction produced by Carbon Dioxide, 275
- Moureu (C.), C. Dufraisse, and N. Drisch, The Mechanism of the Formation of Rubrene: a New Synthesis, 586; and P. Lotte, The Phenomena of Luminescence in the Satellites of Rubrene, 337
- Mouriquand (G.), A. Leulier, and P. Sedallian, The Arrest of the Diphtheric Intoxication by the Placenta, 514
- Mozley (A.), Reports of the Jasper Park Lakes Investigations, 1925-26, 257
- Mrozowski (S.), Dissociation Energy of Zn₂ Molecules, 528
- Mukerji (S.), Taxonomic Importance of the Terminal Segments of Psychodid Larvæ, 446
- Müller (Dr. A.), Crystal Structure of Normal Paraffins, 952
- Muller (G. S.), Human 'Missing Links', 758
- Müller (R.), Changes in the Period of the Variable Star R Hydra, 142
- Mumford (E. P.), and D. H. Hey, The Water Balance of Plants as a Factor in their Resistance to Insect Pests, 411
- Munn (Capt. L.), The Golconda Diamond Mines, 686
- Munro (Air Vice-Marshal D.), appointed secretary of the Industrial Health Research Board, 286
- Munro (Dr. J. W.), appointed professor of entomology at the Imperial College of Science, 839
- Munro (Prof. J. W.), and W. S. Thomson, Report on Insect Infestation of Stored Cacao, 183
- Munsterhjelm (L.), Advocacy of the Musk-rat, 98
- Murray (Miss M. A.), Slug or Horned Viper? 975
- Musgrave (Dr. A.), Zoological Nomenclature: Acarine or Insect? 414
- Mushketov (D. I.), and P. M. Nikiforov, A Gravimetric and Seismic Expedition to Central Asia, 586
- Mutel (H.), Measurement of the Effective Intensity of High Frequency Currents, 803
- Myers (Dr. G. J.), Insect Singers: a Natural History of the Cicadas, 122
- Myers (Dr. J. G.), Wild Cacao, 289
- Myres (Prof. J. L.), An Anthropological Congress, 494, 672; Anthropology, National and International, 212, 297; elected president of the Royal Anthropological Institute, 179
- Nakamura (Dr. K.), [death], 944
- Nakamura (Prof. S.), The Tango (Japan) Earthquake of Mar. 7, 1927, 759
- Nalepa (Dr. A. N. A.), [obituary article], 96
- Nall (G. H.), Sea Trout from the Moray Firth, 218; Sea Trout of South Uist, 834
- Nansen (Dr. F.), A Self-operating Meteorological Observatory, 64; [death], 756; [obituary article], 933
- Nash (Prof. A. W.), and Dr. A. R. Bowen, The Principles and Practice of Lubrication: A Manual for Petroleum Technologists, Students, Engineers, Oil Salesmen, etc., 193
- Nasonov (N. N.), The Freshwater Fauna of *Turbellaria rhabdocelida* of Japan, 34
- Nasu (N.), After-shocks of the Tango (Japan) Earthquake of Mar. 7, 1927, 392
- Natta (Prof. G.): and Prof. A. G. Nasini, The Crystal Structure of Krypton, 889; The Crystal Structure of Xenon, 457; and L. Passerini, The Crystal Structure of White Phosphorus, 707
- Naudé (S. M.), Isotopes of Nitrogen, 253
- Naylor (T. M.), and A. G. Abel, An Analysis of the Link-gear of an Old Beam Engine, 34
- Needham (Dr. J.), Biochemical Aspect of the Recapitulation Theory, 950; Prof. E. Rignano, 642; The Sceptical Biologist (Ten Essays), 374
- Needham (Prof. J. G.), and Hortense Butler Heywood, and others, A Handbook of the Dragonflies of North America, 811
- Neher (Prof. F.), [death], 174
- Nehrling (H.), [death], 97
- Nel (L. T.), A New Occurrence of Zunyite near Postmasburg, South Africa, 150
- Nelson (Dr. A.), appointed lecturer in botany in the University of Edinburgh, 31
- Newall (Prof. H. F.), a portrait of, presented to Cambridge University, 756
- Newbold (A. A.), The 'Wave-Band' Theory of Wireless Transmission, 306
- Newby (H. L.), and Dr. W. H. Pearsall, Nitrogen Metabolism in the Leaves of *Vitis* and *Rheum*, 622
- Newman (Prof. H. H.), Effects of Environment on Twins, 104
- Newman (M. H. A.), reappointed a University lecturer in mathematics in Cambridge University, 839

- Newton (E. T.), [death], 209; [obituary article], 280
 Newton (R. F.), and M. G. Bolinger, Dissociation Constant of Water, 836
 Nicholls (L.), Snakes of Ceylon, 27
 Nichols (E. L.), and Frances G. Wick, Ozone in Luminescence, 843
 Nichols (Dr. W. H.), [death], 827
 Nicol (E. A. T.), The Feeding Mechanism, Formation of the Tube and Physiology of Digestion in *Sabella Pavonina*, 878
 Nicol (H.), Atmospheric Light Columns from Artificial Lights, 671; Early Chinese Rice, 819
 Nicolle (C.), P. Durand, and E. Conseil, Preventive Vaccination against Plague Pneumonia by the Respiratory Tract, 397
 Nicols (J. B.), Comparison of the Ultracentrifuge Method for Molecular Weight Determination with the Classical Methods, 814
 Nierenstein (Dr. M.), Galls, 348
 Nodon (Dr. A.), The Nature and Origin of the Cosmic Rays, 683
 Noguchi (Y.), Development of the Inflorescence in Cereals, 473
 Nolan (Prof. J. J.), and J. G. O'Keeffe, The Ions produced by Discharges at Liquid Surfaces, 893
 Nopcsa (Baron Fr.), Geographie und Geologie Nordalbanians; mit einem Anhang von H. v. Mžik: Beiträge zur Kartographie Albanians nach orientalischen Quellen, 8
 Nordenskiöld (Baron Erland), Modifications in Indian Culture through Inventions and Loans, 968
 Norinder (Dr. H.), Transmission Line Surges, 68
 Norman (H. A.), Presidential Address to the Conference of Teachers in Technical Institutions, 955
 Northcott (Dr. C. H.), Personnel Policy and Procedure, 682
 Northrop (F. S. C.), Two Contradictions in Current Physical Theory and their Resolution, 843
 Northumberland (Duke of), elected president of the Royal Institution, 717
 Nottage (M.), Passive Copper, 579
 du Nouÿ (Dr. P. Lecomte), Équilibres superficiels des solutions colloïdales: études de biophysique moléculaire, 771
 Noyes (Prof. W. A.), Salaries of Professors in American Colleges and Universities, 828
 Nuttall (J. M.), and E. J. Williams, A Method of Examining Stereoscopic Photographs, 336
 Oakden (Ellen C.), and Mary Sturt, Growing Up: How one did it in Different Times and Places, 888
 O'Brien (Maureen), and Prof. J. B. Gatenby, The Oogenesis of *Lumbricus*, 891
 Ofverholm (I.), The Electrification of the Swedish State Railways, 682
 Ogilvie (Sir F. G.), The 1851 Exhibition Commissioners and their Work, 929, 976
 Oishi (J.), and K. Yosiaka, Anode Spots, 723
 Oldham (R. D.), Earth Movements in the Delta of the Rhone, 601
 Olenev (N.), Classification and Geographical Distribution of Ixodidæ (4), 586
 Oliphant (M. L. E.), Liberation of Electrons by Positive Ions, 872; and G. B. Moon, The Liberation of Electrons from Metal Surfaces by Positive Ions, 801
 Oliver (Prof. D.), centenary of the birth of, 213
 Olson (R. L.), Chumash Prehistory, 758
 Onslow (Lord), The Preservation of the Native Fauna, 866
 Oppenheimer (J. R.), The Nature of Positive Electricity, 616
 Orékhoff (A.), The Alkaloids of *Anabasis aphylla*, 74
 Ormsby-Gore (Hon. W. G. A.), Report on Visit to West Africa during 1926, 208
 Ornstein (Prof.), and J. Rekveld, Dependence of Raman Scattering on Frequency, 835
 Ortmann (O.), The Physiological Mechanics of Piano Technique: an Experimental Study of the Nature of Muscular Action as used in Piano-playing, and of the Effects thereof upon the Piano Key and the Piano Tone, 43
 Orton (Prof. K. J. P.), [death], 465; [obituary article], 898
 Orton (Dr. W. A.), [death], 679
 Osborn (Prof. H. F.), The Ancestry of Man, 745; The Discovery of Tertiary Man, 53, 61
 Osborne (G. D.), and H. G. Raggatt, Some Interesting Geological Faults in the Vicinity of Branxton, N.S.W., 659
 Osterberg (H.), An Interferometer Method of Observing the Vibrations of an Oscillating Quartz Plate, 623
 Paget, Bart. (Sir Richard), Human Speech: some Observations, Experiments and Conclusions as to the Nature, Origin, Purpose and Possible Improvement of Human Speech, 966
 Paine (W. W.), Banking, 969
 Paley (R. E. A. C.), awarded a Smith's prize of Cambridge University, 547
 Palmer (Prof. L. S.), Correlations between the Pre-history of Hampshire and Africa, 908
 Paneth (Prof. F.): and W. Lautsch, Isolation of the Radical Ethyl, 564; W. D. Urry and W. Koeck, The Age of Iron Meteorites, 490
 Panteleymonoff (Prof. B.), Utilisation of Salt Lake Deposits, 687
 Parejas (E.), Would the Geneva Basin lend itself to a Study of Glacial Varves? 294
 Park (R. E.), and others, edited, with an introduction, by W. Gee, Research in the Social Sciences: its Fundamental Methods and Objectives, 663
 Parker (E.), English Wild Life, 378
 Parker (Prof. G. H.), The Ciliation of the Fallopian Tubes, 841; The Basis of Colour Changes in Animals, 758
 Parker (Dr. R. L.), Kristallzeichnen, 851
 Parkes (Dr. A. S.), appointed to a Foulerton Research Studentship, 141; The Internal Secretions of the Ovary, 629
 Parkinson (Dr. J.), The Platinum Group Metals in South Africa, 662
 Parravano (N.), and E. Onorata, 'Blanc' Alumina, 587
 Partington (Prof. J. R.), Fluorescent and Phosphorescent Substances, 636
 Pascal (P.), Amides and Ionides derived from Vanadium, 257
 Pascher (A.), New Species of *Amœba* with a Stigma, 650
 Passerini (N.), Minimum Temperatures at Different Small Heights above the Ground, 658
 Patel (J. S.), Presence of a Kuogenic Substance in the Corpus Luteum of the Cow, 257
 Paterson (C. C.), nominated for election as president of the Institution of Electrical Engineers, 869
 Paton (E. R.), and O. G. Pike, The Birds of Ayrshire, 367
 Patterson (Dr. A. L.), The Gibbs-Ewald Reciprocal Lattice, 238, 447
 Patton (Prof. W. S.), and Dr. A. M. Evans, Insects, Ticks, Mites, and Venomous Animals of Medical and Veterinary Importance. Part 1: Medical, 698
 Pauli (Prof. W.), und Dr. E. Valkó, Elektrochemie der Kolloide, 771
 Peake (H.), The Flood: New Light on an Old Story, 923; and Prof. H. J. Fleure, The Corridors of Time. Vol. 5: The Steppe and the Sown; Vol. 6: The Way of the Sea, 375
 Pearce (Dr. R. M.), [death], 643
 Pearsall (Dr. W. H.), and Alice Wright, The Proportions of Soluble and Insoluble Nitrogenous Materials in Fresh and Dried Plant Tissues, 34
 Pei (W. C.), and others, *Sinanthropus*, 715
 Pélabon (H.), The Copper Oxide Rectifier, 622
 Peltier (J.), The Search for Defects in Ferromagnetic Test-pieces, 959
 Pelton (M. O.), Lustre of Textile Fibres due to a Geometrical Property of Transparent Cylindrical Filaments with Polished Surfaces, 693
 Penfold (A. R.): and F. R. Morison, The Essential Oils *Melaleuca decora* (Salisbury) Druce and *M. nodosa* var. *Tennifolia* (de Candolle), 35; and J. L. Simonsen, The Leaf Oil from *Caecyrium Franklinii* Hooker, 35
 Pérard (C.), The Caoutchouc Conger, 75
 Percy (Lord Eustace), Education at the Crossroads, 701

- Perrier (G.), The Rohan-Chabot Expedition (Angola, Zambezi), 958
- Perrine (Prof. C. D.), Radial Motions of the O-type Stars, 180
- Petch (T.), Buttress Roots, 722
- Petri (L.), Experimental Reproduction of *mal del secco* of Lemons, 766
- Petrie (Sir W. M. Flinders), dinner in honour of fifty years of exploration and research in Egyptian Archaeology, 982; Egyptian Chronology, 650; The Accuracy of a Moth, 928
- Pfücke (Dr. M.), The Early History and Development of *Das chemische Zentralblatt*, 98
- Phelps (H. J.), appointed assistant lecturer and demonstrator in physiology at Cardiff University College, 476
- Phisalix (Mme.), Natural Immunity against Snake Poison and the Virus of Rabies of the Common Dormouse, *Eliomys nitela*, 294
- Piaggio (Prof. H. T. H.), Geometry of *N* Dimensions, 266; The Concept of Space, 897
- Piccardi (G.), Spectrographic Detection of Bismuth in the Ashes of Animal Organisms, 34
- Pickering (Prof. W. A.), Mars in 1926, 471
- Piéron (Prof. H.), translated by Prof. J. B. Miner, Principles of Experimental Psychology, 268
- Piettre (M.), Influence of Neutral Salts on the Separation of Proteins by the Acetone Method, 75; The Function of the Non-electrolytes in the Stability of Biological Media, 914
- Pilkington Bros., Ltd., Coloured Glass as a Deterrent to House Flies, 529
- Pinchin (E. A.), [death], 97
- Pistolesi (E.), A Rapid Method for the Calculation of the Dynamic Effect of a Translatory Current on a Cylinder in the Neighbourhood of an Indefinite Plane-wall, 879
- Pittard (E.), Bushman Craniology, 143; The Coronal Angle of the Skulls of Bushmen, Hottentots, and Griquas, 914
- Pittard (M.), Statistics of Cancer in England and Wales, 469
- Plaskett (Dr. J. S.): presented with the Rumford premium of the American Academy of Arts and Sciences, 755; Rotation of the Galaxy; awarded the gold medal of the Royal Astronomical Society, 103; and J. A. Pearce, Distribution of Matter in Interstellar Space, 542
- Pocock (R. W.), The Age of the Midland Basalts, 657
- Poley (A. F. E.), with introduction by Sir Reginald Blomfield, St. Paul's Cathedral, 228
- Policard (A.): and M. Boucharlat, Pulmonary Anthracosis, 258; and J. Devuns, Histo-chemical Researches on the Mineral Particles contained in the Lungs of Miners, 878
- Pollacci (G.), and Maria Bergamaschi, The Formation of Formaldehyde in Living Plants during Chlorophylllic Photosynthesis, 694
- Pollard (Prof. A. F. C.), The Kinematical Design of Couplings in Instrument Mechanisms, 160
- Ponder (Prof. E.), Essentials of General Physiology, 232
- Poole (Dr. J. H. J.), A New Form of Recording Galvanometer, 802
- Pope (Sir W. J.), Organic Chemistry at University College, London, 238
- Portier (P.), and Mlle. de Rorthays, The Mode of Flight of Insects and the Wing Load per unit of Surface, 478
- Posselt (F.), Fables of the Veld, 123
- Powell (A. R.), and W. R. Schoeller, A New Method for the Separation of Titanium from Zirconium and Hafnium, 802
- Powell (A. W. B.), and J. A. Bartram, Tertiary Molluscan Fauna of Waiheke Island, New Zealand, 834
- de Pradennes (Vayson), L'affaire Glozel, 983
- Prandtl (Dr. L.), awarded the Daniel Guggenheim gold medal, 869
- Pratt (J. D.), Rationalisation, 246
- Prentice (F.), Experience with a Waterless Gasholder, 909
- Preston (J. M.), Mounting Media for Microscopic Work, 563
- Preston (J. S.), The Reflection Factor of Magnesium Oxide, 257
- Prettre (M.), and P. Laffitte, The Inflammation and Combustion of Carbon Disulphide, 766
- Pringle (J.), The Geology of Great Britain, 362
- Pringle-Pattison (Prof. A. S.), Kant's "Critique of Pure Reason", 557
- Proudman (Prof. J.), "Encyclopædia Britannica", 239
- Prytherch (W. E.), Gases in Copper and their Removal, 477
- Przibram (Prof. H.), The Acquired Characters of *Alytes*, 856
- Przibram (K.), Natural Blue Rock-salt, 398
- Pschorr (Prof. R. F.), [obituary], 608
- Punnnett and Pease, Polyductility in Fowls, 543
- Purves (Sir Thomas), Inductive Interference in Telephone Circuits, 873; Ship-shore Telephony, 790.
- Quilico (A.), and M. Freri, A New Method of Formation of Pyrrole Blacks, 842
- Quintin (Mlle. Marguerite), The Influence of the Medium on the Photovoltaic Effect of Iodide of Copper, 222
- Rabaté (E.), and J. Fleckinger, A Colour Reaction for the Proteids of the Wheat Seed, 730
- Rac (F.), Studies in the Rhamnose Series, 959
- Radcliffe-Brown (Prof.), Totemism in Eastern Australia, 950
- Raffles (Sir Stamford), Memorial to, 24
- Ralli (P. A.), [death], 643
- Ramart-Lucas (Mme.), and F. Salmon-Legagneur, The Configuration of Molecules in Space, 550
- Ramaswamy (C.), Raman Effect in Diamond, 704
- Ramsauer (C.), and R. Kollath, Collisions between very slow Electrons and Molecules, 427
- Ramsbottom (J.), elected president of the Quekett Microscopical Club, 328
- Ramsey (F. P.), [death], 136; [obituary article], 245
- Ramsperger (H. C.), and R. C. Tolman, The Rate of Decomposition of Nitrogen Pentoxide at very low Pressures, 843
- Randall (J. T.), H. P. Rooksby, and B. S. Cooper, The Diffraction of X-rays by Vitreous Solids and its Bearing on their Constitution, 458
- Ranzi (Dr. S.), Axial Gradients, 834
- Rao (Dr. I. R.), Investigation of Electrolytic Dissociation by the Raman Effect, 872; Raman Effect in Water, 600; Study of Electrolytic Dissociation by the Raman Effect (1), 433; Total Secondary Electron Emission from a Single Crystal Face of Nickel, 801; Total Secondary Electron Emission from Polycrystalline Nickel, 801
- Rao (M. Ganesha), and V. Subrahmanyan, Standardisation of a Plate Method of counting Soil Actinomyces, 871
- Raoult (F. M.), centenary of the birth of, 679
- Ratcliffe (J. A.): The 'Wave-Band' Theory of Wireless Transmission, 272; and F. W. G. White, Negative Attenuation of Wireless Waves, 926
- Rateau (Prof. A.), [obituary article], 209
- Rawlings (Dr. A. L.), The Theory of the Gyroscopic Compass and its Deviations, 11
- Ray (Prof. B. B.), Scattering of X-rays by Bound Electrons, 746, 856
- Ray (Satyendra), Interpretation of the Raman Effect, 647
- Raybaud (L.), Action of Germinated Seeds in Feeding, 75
- Rayleigh (Lord), Do Glass Tubes or Rods Bend under their own Weight? 311; Iridescent Colours in Nature, 211, 474; Partial Destruction of the Laboratory of, 420; The 'Green Flash' at Sunset, 144
- Raymond-Hamet, The Action of Ouabaine on the Intestine *in situ*, 294
- Rayner (Dr. E. H.), W. G. Standing, and R. Davis, Measurements at High Voltages, 687
- Raynes (H. E.), The Mortality of Europeans in Equatorial Africa, 110
- Read (A. B.), Tubular Forms of Lighting, 63
- Read (Prof. J.): Brighter Chemistry, 155; Tanning Materials of the British Empire, 240; and Ishbel G. M. Campbell, Optically Active Diphenylethylene Oxide, 16; and R. A. Storey, Optical Superposition among Menthylamines and Menthols, 86
- Reavell (J. A.), Science and Industry, 574
- Reboul (G.), A Method of Activation of Matter, 478
- Regan (Dr. C. Tate), A New Ceratoid Fish (*Caulophryne* sp.), Female with Male, from off Madeira, 621; Angler Fishes, 422, 747; presented with the Isidore Geoffroy Saint-Hilaire medal of the Société Nationale d'Acclimatation de France, 612; the Classification of the Primates, 125

- Reilly (Prof. J.), Allen's Commercial Organic Analysis. Vol. 7. Fifth edition, 231
- Reisner (Dr. G. A.), Harvard-Boston Expedition's Excavations in the Sudan, 987
- Renan (Ernest), translated by C. B. Pitman, Recollections of my Youth, 851
- Renard (Prof. G.), translated by R. T. Clark, Life and Work in Prehistoric Times, 45
- Renkema (H. W.), and J. Ardagh, Aylmer Bourke Lambert and his Description of the genus *Pinus*, 336
- Rennell (Major J.), centenary of the death of, 467
- Rennie (J. V. L.), The Cretaceous Fossils from Angola, 906
- Rey (C. F.), The Romance of the Portuguese in Abyssinia, 631
- Reyner (J. H.), Field Strength in Broadcasting and Receiver Efficiency, 183
- Reynolds (Dr. W. C.), Globular Lightning, 413
- Reyrolle (A.), and Co., New Short Circuit Testing Plant, 875
- van Rhijn (Prof. P. J.), A New Determination of the Galactic Pole, 684
- Ribaud (G.), The Calculation of the Temperature of Flames and their Proportion of Atomic Hydrogen, 478
- Rice (Prof. J.), Introduction to Statistical Mechanics: for Students of Physics and Physical Chemistry, 700
- Richards (F. J.), Indian Chronology, 543
- Richards (I. A.), Practical Criticism: a Study of Literary Judgment, 304
- Richardson (C. W.), Curling, 494
- Richardson (Dr. J. H.), elected Montague Burton professor of industrial relations in Leeds University, 148
- Richardson (Prof. O. W.): elected a member of the Athenæum Club, 213; Emission of Secondary Electrons and the Excitation of Soft X-rays, 801; and U. Andrewes, A Comparative Study of the Excitation of Soft X-rays from Single Crystal Surfaces and from Polycrystalline Surfaces of Graphite and Aluminium, 801; and S. Ramachandra Ras, The Excitation of Soft X-rays from a Single Crystal Face of Nickel, 801; The Excitation of Soft X-rays from some Polycrystalline Metal Surfaces, 801
- Richet (C.), and M. Faguet, Action of Irradiated Sea-Water on Lactic Fermentation, 802
- Rickard (Dr. T. A.), Early Rhodesian Gold, 47; The Early Use of the Metals, 477
- Ricketson (O. J.), and Dr. A. V. Kidder, Archaeology from the Air in Central America, 655
- Rideal (Dr. E. K.), Catalytic Reactions at High Pressures, 584; Photochemistry, 405; recommended as temporary professor of colloidal physics in Cambridge University, 799
- Rideal (Dr. S.): [obituary article], 96
- Rignano (Prof. E.), [death], 420; [obituary article], 642
- Rigotard (L.), The Rôle of Sulphur in the Formation of Plant Soil, 337
- Rinck (E.), The Equilibrium in the Fused State between Potassium, Sodium, and their Iodides, 222; The Equilibrium, in the Fused State, between Sodium, Potassium, and their Fluorides, 959
- Ritchev (Dr. G. W.), Astro-photography of the Future, 180, 329; The Development of Astro-photography and the Great Telescopes of the Future, 169
- Ritchie (A. D.), History of Science, 4
- Ritchie (Dr. J.), Spread of the Mountain Hare, 143
- Ritter (Prof. W. E.), Food-storing by Californian Woodpeckers, 578
- Roaf (Prof. H. E.), Crossed Connexion of the Cerebral Hemispheres with the Muscles and Sense Organs, 203, 493; Visual Acuity in Light of Different Colours, 841
- Roberts (A. W. R.), Larvæ of the Coleoptera, 988
- Roberts (E.), Zebra-Horse Crosses, 508
- Roberts (J. E.): The Critical Potentials of the Hydrogen Molecule, 621; and Prof. R. Whiddington, Inelastic Electron Collisions in Oxygen at Low Pressures, 33; The Passage of Electrons through Argon, 621
- Roberts (Prof. W. M.), Gunnery and some of its Mathematical Problems, 109
- Robertson (H. P.), On the Foundations of Relativistic Cosmology, 150
- Robertson (J. M.), Structure of Naphthalene and Anthracene, 456
- Robertson (Dr. J. W.), [death], 571
- Robertson (Sir Robert), and Dr. J. J. Fox, Infra-red Spectrum of Diamond by Infra-red Spectrometer and Raman Methods, 704
- Robertson (T.), The Origin of the Etruria Marl, 657
- Robertson (Prof. T. B.), [death], 174; [obituary article], 245
- Robinson (E. A. G.), appointed University lecturer in economics and politics in Cambridge University, 799
- Robinson (Prof. H. R.), appointed professor of physics at East London College, 839, 868
- Robinson (H. R.), and C. L. Young, The Magnetic Spectroscopy of X-ray Electrons, 995
- Robinson (P.), Mechanism of Reactions, 836
- Robinson (Prof. R.), Structure of Strychnine and Brucine (Bakerian Lecture), 873
- Robinson (Prof. W.), [death], 537; [obituary article], 571
- Robson (G. C.), A Monograph of the Recent Cephalopoda: based on the Collections in the British Museum (Natural History). Part 1: Octopodinae, 850; A Rare Cephalopod, 330; Slug or Horned Viper? 893
- Rod (E.), Tables of the Coefficients of the Instrumental Errors, in Mayer's Formula, for the Latitude of Geneva, 914
- Rodd (F. Rennell), Weather and Climate of the Sahara, 619
- Rodebush (Prof. W. H.), The Vapour Density of Sodium, 130
- Rodés (L.), The Diurnal and Annual Periods in the Distribution of 1944 Earthquakes recorded by the same Seismograph, 514
- Roe, Jr. (Dr. E. D.), [death], 246
- Rogers (A. F.), Silica Glass at Meteor Crater, 686
- Roginsky (S.), and L. Rosenkewitsch, The Quantum Theory of the Kinetics of Homogeneous and Heterogeneous Reactions, 347
- Rolla (L.), and L. Mazza, Systems of Telegraphy and Telephony by means of Pencils of Infra-red Radiations, 730
- Rolleston (Dr. J. D.), Alcoholism, 950; Recent Literature on the Tobacco Problem, 648
- Rolt (F. H.), edited by Sir R. T. Glazebrook, Gauges and Fine Measurements. Vols. 1 and 2, 81
- Rose (D. C.), Energy Losses of Electrons in Mercury Vapour, 460
- Rosenbach (Prof. J. B.), and Prof. C. A. Whitman, Plane Trigonometry, 443
- Rosenblum (S.), The Fine Structure of the Magnetic Spectrum of the α -rays, 995
- Rosenhead (L.), The Spread of Vortices in the Wake behind a Cylinder, 801
- Ross (I. C.), Bionomics of the Liver Fluke, 66
- Ross (Sir Ronald), and Sir Malcolm Watson, A Summary of Facts regarding Malaria, 648
- Ross (T. W.), and H. G. Bell, Protective Devices on Electric Supply Networks, 144
- Rossi (B.), Method of Registering Multiple Simultaneous Impulses of several Geiger's Counters, 636
- Roth (Prof. L.), Spinoza, 264
- Roughton (Dr. F. J. W.), Rapid Chemical Changes, 393
- Rowan (Prof. W.), Migration of Birds and Sex Cycles, 252
- Rudberg (E.), Characteristic Energy Losses of Electrons scattered from Incandescent Solids, 256
- Ruedy (Dr. R.), Bandenspektren auf experimenteller Grundlage, 407
- Rupp (Dr. E.), Electron Diffraction by Mica, 88
- Russell (Dr. A.), Dr. S. Z. de Ferranti, 172
- Russell (Dr. A. S.), Intermetallic Compounds in Mercury, 89
- Russell (Dr. F. S.): Do Oceanic Plankton Animals lose themselves? 17; and G. A. Steven, The Swimming of Cuttlefish, 893; and Dr. C. M. Yonge, The Sea: our Knowledge of Life in the Sea and how it is gained, 666
- Russo (A.), Nuclear Dualism and Sexuality in *Chrysothilum echini* Maupas, 878
- Rutherford (Sir Ernest), A Wireless Talk to the Royal Society of Canada, 985; appointed chairman of the Advisory Council of the Department of Scientific and Industrial Research, 719; awarded the Faraday medal of the Institution of Electrical Engineers, 176; The Transmutation of Matter, 539

- Rutgers (J. J.), The Micro-estimation of Mercury in Organic Compounds, 730
Ruttan (Dr. R. F.), [death], 679
- Saha (M. N.), Colours of Inorganic Salts, 163
St. John (C. E.), Elements in the Sun, 115
Salaman (R. N.): Crinkle 'A', an Infectious Disease of the Potato, 220; and R. H. Le Pelley, Para-crinkle, a Potato Disease of the Virus Group, 220
Salceanu (C.), The Magnetic Double Refraction of Organic Substances in the Fused State, 729
Salisbury (Prof. E. J.), Mortality amongst Plants and its Bearing on Natural Selection, 817
Salisbury (Lord), centenary of the birth of, 209
Salmon (C. E.), [obituary], 643
Salt (Dr. G.), Natural Control of *Lucilia sericata*, 203
Sampson (Prof. R. A.), Indeterminacy in Physics, 493; The New Equipment at the Royal Observatory, Edinburgh, 467
Samuel (G.), Nature of Disease-producing Viruses, 51
Sanborn (C. C.), Mammals of Uruguay, 614
Sand (H. J. S.), The Separation of Metals by 'Internal Electrolysis', 433
Sandford (Dr. K. S.), Ice of North-east Land, 67
Saunders (V. T.), Range of Electromagnetic Waves, 393
Sax (K.), Chromosome Behaviour in *Sorbopyrus* and *Sorbaronia*, 150
Sayce (R. U.), reappointed university lecturer in material culture and physical anthropology in Cambridge University, 728
Scagliarini (G.): and G. Tartarini, Additive Compounds of Halides of Bivalent Metals with Organic Bases (7), 35; and P. Pratesi, Potentiometric Determination of Alkaline Sulphides, 766; and P. Pratesi, The Colour Reaction between Nitroprusside and Creatinine, 35
Schafer (Sir Edward Sharpey), gift to Edinburgh University, 431
Schaffer (J.), Change of Function in Gland Organs of the Skin, 398
Schenck (W. E.), and E. J. Dawson, Archaeology of the San Joaquin Valley, California, 104
Schmidt (Dr. J.), presented with the Agassiz medal of the U.S. National Academy of Sciences, 791
Schoch (C.), [obituary article], 136
de Schokalsky (Prof. J.), awarded the Cullum geographical medal of the American Geographical Society, 648
Schomberg (Lt.-Col. R. C. F.), Climatic Changes in Central Asia, 759
Schottky (Prof. W.), Thermodynamik, 406
Schryver (late Prof. S. B.), Proteins in Brewing, 105
Schuchert (Prof. C.): Continental Connexions in the Cretaceous, 331; and C. M. Le Vene, Fossil Brachiopods, 67
Schück (Prof. H.), and R. Sohlman, translated by Brian and Beatrix Lunn, The Life of Alfred Nobel, 495
Scott (Prof. C. F.), awarded the Edison medal by the American Institute of Electrical Engineers, 213
Scott (Prof. J. M. D.), [death], 209; [obituary article], 323
Scott (Prof. W. B.), presented with the Mary Clark Thompson medal of the U.S. National Academy of Sciences, 791
Seeley (Miss Sylvia), and Count Begouën, Prehistoric Art, 99
Seemann (H.), O. Kantorowicz, and Dr. K. F. Schotzky, Complete Spectral Diagrams of Crystals, 853
Segre (B.), Existence of Distinct Continuous Systems of Plane Algebraic Curves with given Plueckerian Numbers, 658
Seki (Dr. H.), A New Japanese Oyster, 473
Seligman (Dr. R.), inducted as president of the Institute of Metals; the work of, 467
Selivanova (E.), *Coelanthus subtilis* (Tratt.) Seidel, 186
Semple (J. G.), appointed professor of mathematics in Queen's University, Belfast, 993
Senderens (J. B.), and J. Aboulenc, The Catalytic Dehydration of the Fatty Alcohols by Alkaline Bisulphates, 337
Serebrovsky, Genetics of Interspecific Hybrid Birds, 614
Setna, Neuro-muscular Mechanism of the Gill of *Pecten*, 794
Seton (E. Thompson), presented with the Daniel Giraud Elliot medal and honorarium of the U.S. National Academy of Sciences, 791
- Sévault (A.), The Special Aluminium Bronzes with Zinc Silicon and Antimony, 514
Sevin (E.), and R. Deaglio, The Action of Light on Thermionic Phenomena, 434
Seward (Prof. A. C.), elected an associate of the Royal Academy of Sciences, Letters, and Art of Belgium, 141
Seydl (Dr. O.), Distribution of Stars of Different Spectral Types, 391
Seyler (C. A.), Microscopic Examination of Coal, 988
Shah (M. S.), Combustion of Charcoal, 290
Sharp (Sir Henry), The Growth of Education in India, 93
Sharp (H. A.), An Historical Catalogue of Surrey Maps, 161
Shaw (Prof. A. M.), Variations in the Skeletal Structure of the Pig, 254
Shearcraft (W. F. F.), and D. Larrett, Science and Mathematical Tables: for use in Schools, 968
Sheffield (F. M. L.), and J. Henderson Smith, Intracellular Bodies in Plant Virus Diseases, 200
Shelford (Prof. V. E.), Laboratory and Field Ecology: the Responses of Animals as Indicators of Correct Working Methods, 158
Sheppard (Dr. S. E.), The Relation of Fluidity of Liquids to Temperature, 489, 709
Sheppard (T.), Hull Museum Treasures, 574; The Alleged Maglemose Harpoons, 902
Sheppard (Dr. W. F.), Mathematics for Study of Frequency Statistics, 109
Sherrington (Sir Charles), and J. C. Eccles, Numbers and Contraction-values of Individual Motor-units examined in some Muscles of the Limb, 841
Shotter (G. F.); R. S. J. Spilsbury; Dr. Arnold, Power Measurement in an Alternating Current Circuit, 290
Shoulejkin (Prof. W. W.), New Recording Anemometers, 954
Sidhanta (Prof. N. K.), The Heroic Age of India: a Comparative Study, 375
Siegbahn (Prof. M.), Dr. Nobel and the Royal Institution of London, 648
Silberstein (Dr. L.), The Size of the Universe: Attempts at a Determination of the Curvature Radius of Space-time, 849
Sillinger (P.), The Vegetation of the Limestone Hills of Tematinské Kopce (Western Slovakia), 915
Simanin (P. I.), The Culicid Fauna of Fergana, 586
Simeon (E.), The Generation of Sound by the Siren Principle, 765
Simon (Prof. F.), Interpretation of Infra-red Frequencies of the Diamond, 855
Simonnet (H.), and G. Tanret, The Toxicity for Laboratory Animals of Large Doses of Irradiated Ergosterol, 478
Simonson (Dr. E.), Respiration Apparatus, 427
Simpson (Dr. G. C.): presented with the Symons Memorial medal of the Royal Meteorological Society; the work of, 137; The Climate of the Pleistocene Period, 992; The Distribution of Terrestrial Radiation, 336; and others, Geological Climates, 546
Simpson (Prof. J. Y.), Nature, Cosmic, Human and Divine, 382
Siracusans (N.), New Phenomena observed in the Annular Discharge, 730
Skrabal (A.), The Development of Chemical Mechanics, 767
Sladden (D. E.), Distortion of Development in Amphibia caused by Lack of Oxygen in Very Early Stages in Development, 293
Slater (G.), Studies on the Rhone Glacier, 1927, 293
Sledge (W. A.), Rooting of Woody Cuttings, 686
Smallwood (Prof. W. M.), and Mary M. Smallwood, The 'German' Carp, 66
Smart (W. M.), appointed a university lecturer in mathematics in Cambridge University, 839
Smith (A. D. Buchanan), Coloured Glass as a Deterrent to House Flies, 780
Smith (Engr. Capt. E. C.), Pioneer Ships of the Atlantic Ferry, 387; Progress in Naval Engineering, 134
Smith (E. C.), and T. Moran, The Formation of Lactic Acid in Desiccated Amphibian Muscles, 220
Smith (Dr. E. W.), Dehydrating Coal Gas before Distribution, 909
Smith (F. D.), The Magnetostriction Constant for Alternating Magnetic Fields, 433

- Smith (Prof. G. Elliot), Early Man in China, 448; New Light on Vision, 820; The Classification of the Primates, 270
- Smith (H.), presented with the junior Moulton medal of the Institution of Chemical Engineers, 574
- Smith (Dr. J. W.), The Effects of Moisture on Chemical and Physical Changes, 229
- Smith (Prof. Parker), Electrical Applications in Motor-cars, 651
- Smith (P. I.), Glue and Gelatine, 162
- Smith (Prof. P. T.), and Prof. W. R. Longley, Mathematical Tables and Formulas, 379
- Smith (Stanley), The Carboniferous Inliers at Codrington and Wick (Gloucestershire), 221; Some Valentinian Corals from Shropshire and Montgomeryshire; with a Note on a New Stromatopora, 221
- Smith (T.), Charts for Simple Two and Three Thin Lens Problems, 693; Imagery around a Skew Ray, 549
- Smith (Dr. T. B.), Analytical Processes: a Physico-chemical Interpretation, 381
- Smith (W. Campbell), Classification of some Rhyolites, Trachytes, and Phonolites from part of Kenya Colony, 693
- Smithells (Prof. A.): Chemical Training, 421; Outlook for Higher Education, 701; presidential address to the Institute of Chemistry, 644; Whitaker, and Holmes, Ignition of Carbon Monoxide, 545
- Smith-Rose (Dr. R. L.): Radio Direction-finding by Transmission and Reception, 530, 568
- Smuts (Gen. J. C.), recommended for election into the Royal Society, 864; to be nominated as president of the British Association; the work of, 466
- Snow (C. P.), and F. I. G. Rawlins, Colours of Inorganic Salts, 349
- Soar (C. D.), and W. Williamson, The British Hydracarina. Vol. 3, 559
- Soddy (Prof. F.), Unemployment and Hope, 345
- Solway (A.), [death], 608
- Somigliana (C.), The External Gravitational Field of the Ellipsoidal Geoid, 842
- Sommerville (Prof. D. M. Y.), An Introduction to the Geometry of N Dimensions, 266
- Soper (J. D.), Breeding Grounds of Blue Goose, 288
- Southwell (Prof. R. V.): Aeronautical Progress, 1914 to 1930 (James Forrest Lecture), 753; and L. Chitty, The Problem of Hydro-dynamic Stability (1), 186
- Soyer (B.), The Variation of the Permeability of the Cells in the course of Growth in a Ligneous Plant, 338
- Spear (F. G.), The Delayed Lethal Effect of Radium on Tissue Cultures *in vitro*, 149
- Spence (Dr. J. W. L.), [death], 608
- Spencer (C. D.), Do Glass Tubes or Rods bend under their own weight? 707
- Spencer (Dr. L. J.), A New Meteoric Iron from Piedade do Bagre, Minas Geraes, Brazil, 957; Biographical Notices of Mineralogists recently Deceased (Fourth Series), 958
- Sperry (E. A.), [death], 944
- Sponsler (Prof. O. L.), New Data on Cellulose Space Lattice, 633
- Sprague (T. A.), Botanical Nomenclature, 310
- Spriggs (G. W.), Problems of Individual Education, with special reference to Mathematics, 109
- Sraffa (P.), reappointed university lecturer in economics in Cambridge University, 547
- Sreenivasaya (M.), and B. N. Sastri, The Spike Disease of Sandal, 911
- Stadler (L. J.), Chromosome Number and the Mutation Rate in *Avena* and *Triticum*, 623
- Stahel (Prof. G.), Wild Cacao, 289
- Stamp (Dr. L. Dudley), Annual Conference of the Geographical Association, 110
- Staniland (L. N.), Presence of a Yeast in the Death Watch Beetle (*Xestrobium rufo-villosum* de G.), 635
- Stanley (G. H.), Primitive Metallurgy in South Africa, 799
- Stapf (Dr. O.), Index Londinensis to Illustrations of Flowering Plants, Ferns and Fern Allies: being an emended and enlarged edition continued up to the end of the Year 1920 of Pritzels's Alphabetical Register of Representations of Flowering Plants and Ferns compiled from Botanical and Horticultural Publications of the XVIIIth and XIXth Centuries. Vol. 1, 42; vol. 2, 523
- Stapledon (Prof.), Cocksfoot Grass, 951
- Stark (Prof. J.), Polarisierte und gerichtete Röntgenstrahlung aus einem Kristall, 745
- Stebbing (Prof. E. P.), Prof. A. Henry, 606; Sir George Watt, 677
- Steers (J. A.), An Introduction to the Study of Map Projections. Second and revised edition, 197; reappointed university lecturer in geography in Cambridge University, 876
- von den Steinen (Prof. K.), [obituary article], 208
- Stempell (Prof. W.), Repetitorium der allgemeinen Zoologie (Morphologie, Physiologie, Ökologie, Abstammungslehre), 303
- Stenhouse (Surgeon Rear-Admiral J. H.), Birds of the *Adventure* and *Beagle*, 181
- Stephen (A. C.), Scottish Marine Fauna, 878
- Stephenson (Lt.-Col. J.), An Oligochaete Worm Parasitic in Frogs of the genus *Phrynomerus*, 621; The Oligochaeta, 594
- Stephenson (L. W.), New Cretaceous Ostreidae from Texas, 331
- Stern (T. E.), Conduction of Electricity in Metals, 545; The Conduction of Electricity in Metals and Allied Phenomena, 186
- Steven (Dr. H. M.), Afforestation in South Africa, 252
- Stevenson (Dr. A. W.), election as future principal of the Scottish Woolen Technical College, Galashiels, 424
- Steward (J. H.), Petroglyphs of California and Adjoining States, 361
- Stewart (D. S.), Practical Design of Simple Steel Structures. 2 vols., 196
- Stewart (E. G.), Functions of Coke Ovens, 909
- Stewart (Prof. G. N.), [death], 944; [obituary article], 980
- Stewart (Dr. R. W.), and Prof. J. Satterly, A Textbook of Light. Sixth edition, 523
- Stockdale (D.), The Composition of Eutectics, 477
- Stoner (Dr. E. C.), Free Electrons and Ferromagnetism, 621 The Interchange Interaction Theory of Ferromagnetism, 621; The Thermo-electric Properties of Ferromagnetics, 973
- Stopes (Dr. Marie C.), Sterilisation as a Practical Policy, 204
- Störmer (Prof. C.), Do the Wireless Echoes of Long Delay come from Space outside the Moon's Orbit? 326; Spectrum of the Sunlit Auroral Rays, 305; Twenty-five Years Study of the Polar Aurora, 422; Visit to Great Britain; the work of, 282
- Storror (B.), Herring Researches at Cullercoats, 794
- Stoughton (R. H.), Angular Leaf-spot Disease of Cotton, 350
- Stower (Rev. B.), The Breeding of *Pterophyllum scalare*, 506
- Strachan (J.), Adsorption on the Crystal Lattice of Cellulose, 671
- Stracke (Dr. G.), A New Trojan Minor Planet, 577; Bahnbestimmung der Planeten und Kometen, 84
- Stratton (Prof. F. J. M.), Some Solar Eclipse Expeditions of 1930 and 1932, 673
- Strömgen (E.), The Restricted Problem of Three Bodies, 397
- Strutt (Hon. E. G.), [death], 420
- Struve (Dr. O.), and C. T. Elvey, Stellar Absorption Lines, 308
- Study (Prof. E.), [death], 246
- Sugden (Dr. S.), The Parachor and Molecular Volume, 778; The Parachor and Valency, 364
- Summerhayes (W. E.), The Diffusion Constant of Water Vapour, 433
- Summers (Dr. M.), The Vampire in Europe, 371
- Supino (G.), Certain Integral Properties of Cubic Expansion, 398; The Choice between Elastic Solutions with Equal Resultants, 879
- Susz (B.), and E. Briner, The True Energy Yields in the Production of Ozone by the Silent Discharge and their Improvement, 258
- Sutermeister (E.), Chemistry of Pulp and Paper Making. Second edition, 197
- Svedberg, L. M. Carpenter, and D. C. Carpenter, Molecular Weight of Casein, 652; and Sjögren, Molecular Weights of Amandin and Excelsin, 652
- Sweet (Miss Jessie M.), British Barytes, 958
- Swietoslowski (W.), The Heat of Combustion of Camphor, Azobenzene, and Hydrazobenzene, 150

- Swingle (H. S.), Lead Arsenate Sprays, 105
 Swinnerton (Prof. H. H.), The Post-glacial Deposits of the Lincolnshire Coast, 957
 Swinton (A. A. Campbell), [death], 324; [obituary article], 356
- Tait (W. A.), bequest to Edinburgh University, 431
 Taliaferro (Prof. W. H.), The Immunology of Parasitic Infections, 703
 Tandy (G.), Sundry Observations on *Caulerpa*, 336
 Tánning (Dr. A. V.), Plaiçe Investigations in Icelandic Waters, 184
 Tartar and Hoard, Formation of Nitric Oxide, 332
 Tawada (K.), Effect of Hydrogen and Water on Radiation from Cyanogen-oxygen Flame, 705
 Taylor (Miss E. G. R.), New Light on Drake's Voyage, 181
 Taylor (F. B.), Notes on Diatoms: an Introduction to the Study of the Diatomaceæ, 922
 Taylor (F. J.), A New School Chemistry, 303
 Taylor (Prof. G. L.), Tour in the East Indies, 389; Vibrations in the Atmosphere, 67
 Taylor (Prof. H. S.), and J. R. Bates, Photo-Decomposition of Molecules having Diffuse Band Spectra, 599
 Taylor (R.), Production of Helium from Monazite, 145
 Taylor (T. H.), The Blowfly's Mouth, 238
 Taylor (T. W. J.), and Sally Marks, The Conversion of a Benzilmonoxime into the β Oxime by Animal Charcoal, 636
 Taylor (W.), Curling, 576
 Teale (Dr. E. O.), Soil Erosion in Tanganyika Territory, 615
 Teegan (J. A. C.), and G. R. Rendall, Integration of Sunlight in the Tropics, 447
 Temple (Archbishop), The Peril of a purely Scientific Education, 387
 Temple (G.), The Group Properties of Dirac's Matrices; The Operational Wave Equation and the Energy Levels of the Hydrogen Atom, 802
 Terada (Prof. T.): Form of Volcanoes, 67; Projection of Long Spark upon the Yellow Spot of the Retina, 528; and Yamamoto, Ignition of Gases by Electric Spark, 332
 Termier (H.), The Vertical Extension of the Genus *Spiriferina* in Morocco, 478
 Thane (Sir George), [death], 136; [obituary article], 281
 Theobald (Prof. F. V.), [obituary article], 607
 Thibaud (J.): and F. Dupré la Tour, The Polymorphism of the Crystals and the Orientations of the Fatty Acids as a Function of the Temperature, 842; and J. J. Trillat, Effects of Filtration of the General Radiation on the X-ray Diagrams of Liquids, 74
 Thomas (A.), Relations between the Soviet Union and the International Institutions of the League of Nations, 983
 Thompson (Dr. H.), Biology of the Haddock in Icelandic Waters, 184
 Thompson (Dr. W. R.), Entomophagous Parasites and Phagocytes, 167; Reaction of the Phagocytes of Arthropods to their Internal Insect Parasites, 565
 Thomson (Dr. Elihu), Plans for the 200-inch Telescope, 425
 Thomson (Prof. G. P.), The Atom, 667
 Thomson (Prof. J. A.), impending resignation of; the work of, 572; Outlines of Zoology. Eighth edition, 269
 Thomson (Sir J. J.), The Earl of Balfour, 499
 Thorndike (Prof. L.), Science and Thought in the Fifteenth Century, 441
 Thornton (H. G.), The Influence of the Host Plant in inducing Parasitism in Lucerne and Clover Nodules, 221
 Thorpe (Prof. J. F.), Organic Chemistry at University College, London, 239
 Thorpe (W. H.), Further Notes on Biological Races in *Hyponomeuta padella* (Linn.), 221
 Tiercy (G.), A Formula giving the Value of the Colour Index of a Star, 914; Generalisation of the Plantamour Method for the Measurement of the Error of Compensation of Chronometers, 186; On four 'Mean' Curves relative to the Cepheids, 294; The New Refrigerating Installation of the Chronometric Department of the Observatory at Geneva, 258
- Tietjens (Dr. O.), Hydro- und Aeromechanik nach Vorlesungen von L. Prandtl. Band 1, 402
 Tietze (Dr. C.), Birth- and Death-rates, 288
 Tiffeneau (M.), Mlle. Jeanne Lévy, and E. Ditz, Some Pairs of Amino Alcohols, 258
 Tilby (A. W.), The Origin of Right, 139
 Timmins (L. P.), resignation of lectureship of oil engineering in Birmingham University, 395
 Tirelli (Dr. M.), Irreversible Change in the Viscosity of the Eggs of *Bombyx mori* L., 731; Physico-chemical Phenomena in the Silkworm's Egg, 215
 Tizard (H. T.), elected a member of the Athenæum Club, 213; elected president of the Association of Special Libraries and Information Bureaux, 832; The Earl of Balfour, 502
 Tizzoni (G.), and G. De Angelis, Certain Causes which may Weaken or Destroy the Immunising Power of our Phenolated Anti-cancer Vaccine, 730
 Todd (C.), Cellular Individuality in the Higher Animals, 149
 Todd (J. A.), awarded a Smith's prize of Cambridge University, 547
 Tombrock (Dr. W.), Atomic Structure, 796
 Tommasina (T.), Experimental Proof, in the Heat Radiation, of Dynamic Ultra-red Rays, 186
 Tonnoir (A. L.), Australian Mycetophilidae, 114
 Tonolo (A.), Integration of the Maxwell-Hertz Electromagnetic Equation, 694
 Topley (B.), The Homogeneous Isothermal Reaction $2CO + O_2 = 2CO_2$ in the presence of Water Vapour, 560
 Topley (Prof. W. W. C.), and Dr. G. S. Wilson, The Principles of Bacteriology and Immunology. 2 vols., 522
 Toporescu (E.), The Potentials of Metals in Pure Liquids, 434
 Tordorf (Prof. F. A.), [death], 174
 Toutain (J.), translated by M. R. Dobie, The Economic Life of the Ancient World, 558
 Touton (K.), Special Skin Affections due to Common Plants, 758
 Townsend (C. H.), Colour Change in Fishes, 988; The Public Aquarium: its Construction, Equipment, and Management, 505
 Trägårdh (L.), The Pine-Sawyer Pest in Sweden, 546
 Travers (A.), and Avenet, Estimation of the Total Cyanogen in Effluents from Coke Ovens, 914
 Trillat (J. J.), The Internal and Superficial Structure of Organic Liquids with Long Chains, 803
 Trotter (H.), Common Commercial Timbers of India and their Uses, 394
 Trotter (W.), Science and Philosophy, 924
 Truffaut (G.), and I. Pastac, The Chemotherapy of Plant Diseases by Organic Colouring Matters, 75
 Tsuya (H.), Petrology of the Izu Islands, Japan, 795
 Tsvetkov (A. N.), The Theory of Physiological Units, 258
 Tuge (H.), Research on Earthworms, 871
 Tupper-Carey (Rosa M.), The Anatomical Changes in Tissue Bridges across Rings through the Phloem in Trees, 622
 Turnbull (Prof. H. W.), The Great Mathematicians, 523
 Turner (Prof. H. H.), The Radcliffe Observatory, 656
 Turner (T. H.), resignation of lectureship in metallurgy in Birmingham University, 395
 Tuzi (Z.), Photoelasticity, 28
 Twitchin (H.), bequest to the Eugenics Society, 610
 Twort (Dr. C. C.), appointed director of the department of cancer research of Manchester University, 512
 Twyman (F.), Optics in Radio Transmission and other Fresh Fields, 284; The Practice of Spectrum Analysis with Hilger Instruments: including a Note on the various Types of Emission Spectra. Fourth edition, 45
- Unmack (A.), D. M. Murray-Rust, and Sir Harold Hartley, The Conductivity of Thiocyanates in Methyl Alcohol, 433
 Urbain (P.), A Quantitative Method of Spectrographic Analysis, 842
 Urbanek (J.), Diffusion of Light by Polished Surfaces, 803
 Urwick (L.), Rational Organisation, 682

- Vaidyanathan (V. I.), Influence of Chemical Colloidisation on the Anomalous Diamagnetism of Bismuth and Antimony, 672
- Vaillant (P.), The Absorption of Cobalt Salts in Concentrated Solutions, 337
- Vallaux (M.), The Length of a Nautical Mile, 144
- Vallentin (R.), Occurrence of *Craspedacusta (Limnocoedium) Sowerbii* in the Exeter Ship Canal, 15
- Van Iddekinge (H. H.), Band Spectrum of Sulphur, 858
- Van Riel (Commdr. P. M.), The *Snellius* Expedition, 761
- Vasiliev (Prof. A. V.), [death], 246
- Vaufrey (Dr. R.), Les éléphants nains des îles méditerranéennes et la question des isthmes pléistocènes, 82
- Vaughan (Dr. V. C.), [death], 136
- Vaux (P.), A Communal House on Little Andaman, 330
- Vegard (Prof. L.), New Types of Emission Spectra, 14
- Velluz (L.), Action of Soaps on the Toxicity of certain Alkaloids (Cryptoalkaloids), 222
- Verblumsky (S.), awarded the Allen scholarship of Cambridge University, 431
- Verigo (A. B.), An Apparatus for the Determination of the Electrostatic Capacity of Electroscopes, 34
- Vialleton (Prof. L.), [death], 679
- Villat (Prof. H.), Leçons sur la théorie des tourbillons, 969; Leçons sur l'hydrodynamique, 402
- de Villiers (C. G. S.); V. Fitzsimons; G. van Dam, Breeding Habits of South African Frogs and Toads, 252
- Vines (Prof. S. H.), Proteolysis in Plants, 906
- Viola (G.), The System of *U Cephei*, 587
- Vlès (F.), A. de Coulon, and J. Nicod, The Action of the Amino Acids towards Tar Tumours in Mice, 150
- Volkringer (H.), The Band Spectra of Zinc Vapour, 222
- Votoček (E.), and V. Kučerko, The Series of Fucose (*l*-galacto-methyllose), 623
- Waddell (Dr. L. A.), Pictographs on European Prehistoric Pottery, 392
- Waddington (C. H.), Developmental Mechanics of Chicken and Duck Embryos, 924
- Wagner (Dr. P. A.), The Platinum Deposits and Mines of South Africa. With a chapter on the Mineragraphy and Spectrography of the Sulphidic Platinum Ores of the Bushveld Complex, by Prof. D. H. Schneiderhöhn, 662; and H. S. Gordon, Material from Ancient Smelters in the Transvaal, 799; [obituary article], 787
- Wagner-Jauregg (T.), Autoracemisation, 145
- Waldschmidt-Leitz (Prof. E.), translated and extended by R. P. Walton, Enzyme Actions and Properties, 124
- Walker (A.), and G. P. McNicol, A School Geometry, 443
- Walker (Dr. C.), The Acquired Characters of *Alytes*, 562, 889
- Walker (F.), A Tholeiitic Phase of the Quartz-dolerite Magma of Central Scotland, 958; Geology of the Shiant Isles, 33; The Doleritic Isles of the North Minch, 549
- Walker (Sir Gilbert T.), On the Mechanism of Tornadoes, 113; Seasonal Foreshadowing, 841
- Walker (J. C.), K. P. Link, and H. R. Angell, Chemical Aspects of Disease Resistance in the Onion, 150
- Walker (W. C.), The Original Mode of Constructing a Voltaic Pile, 349
- Wallace (T.), Manurial Experiments on Fruit Trees, 615
- Wallas (Prof. Graham), Physical and Social Science (Huxley Memorial Lecture), 881
- Walton (A.), The Maladaptation of Trout Spermatozoa to Fresh Water, 564
- Walton (Dr. J.), appointed a senior lecturer in botany in Manchester University, 840; Improvements in the Peel-Method of preparing Sections of Fossil Plants, 413; Wankie Coalfield and its Fossil Flora, 722
- Wansborough-Jones (Dr. O. H.), elected a research fellow of Trinity Hall, Cambridge, 993
- Ward (A. F. H.), A Microcalorimeter, 397
- Ward (F. Kingdon), awarded the Founder's medal of the Royal Geographical Society, 467
- Wardlaw (Dr. H. S. H.), Presidential address to the Linnean Society of New South Wales, 900
- v. Warmele (Dr. N. J.), The Earliest Bantu, 472
- Warner (Sir Francis), [death], 174
- Warren (Dr. E.), An Exceptional Whirlwind in Natal, 890; Multiple Spermatozoa and the Chromosome Hypothesis of Heredity, 973
- Wataghin (G.), An Application of Relativity to Quantum Mechanics, 398
- Waterhouse (L. L.), and W. R. Browne, Quartzite containing Common Opal and Chalcedony at Tallong, N.S.W., 658
- Waterhouse (W. L.), Australian Rust Studies (Pt. 1), 114
- Waterman (Miss H. C.), Evolution of the Pelvis of Primates, 215
- Waters (Prof. E. G. R.), [death], 571
- Waterson (K. W.), Interruptions on Telephone Conversations, 24
- Waterston (Dr. J.), [obituary article], 786
- Watson (D. J.), reappointed Frank Smart university student in botany in Cambridge University, 876
- Watt (Sir George), [obituary article], 677
- Watt (R. A. Watson), Halo Phenomena, 755; Wireless Defects, 616
- Watton (W. L.), A New Type of Dewar Flask, for use as a Calorimeter, 513
- Wavre (R.), A Possible Agreement between Geodesy and the Theory of the Precession of the Equinoxes, 258; Complement to the Theory of Planetary Figures, 186; The Force which, at Earlier Periods, tended to draw a Continent to the Equator, 914; The Method of the Cavity and the Internal Movements of the Planets, 730; The Planetary Stratifications, 915
- Weatherburn (Prof. C. E.), Differential Geometry of Three Dimensions. Vol. 2, 813
- Weber (Prof. Max), awarded the Joy Gobind Law memorial medal of the Asiatic Society of Bengal, 612
- Wedgwood (Josiah), forthcoming bicentenary celebrations, 503
- Weigner (G.), Base Exchange, 914
- Weill (R. F.), New Results from the Study of Cœlenterate Nematocysts, 623
- Welch (M. B.), Some Mechanical Properties of Australian Grown *Pinus insignis* (2); Some Properties of Red Satinay, *Syncarpia Hillei*, 658
- Welch (Dr. W. H.), the eightieth birthday of, 537
- Weld (Dr. H. J.), elected a member of the Athenæum Club, 470
- West (A. P.), and H. Taguibao, Philippine Camphor, 758
- Wheeler (Prof. Olive A.), Youth: the Psychology of Adolescence and its Bearing on the Reorganisation of Adolescent Education, 161
- Wheeler (Prof. R. V.), Explosion Researches, 302
- Whiddington (Prof. R.), The Electron Gun, 33
- Whipple (Dr. F. J. W.), Atmospheric Light Columns from Artificial Lights, 526, 743; The Great Siberian Meteor and the Waves, Seismic and Aerial, which it produced, 729
- Whipple (R. S.), Some Scientific Instrument Makers of the Eighteenth Century, 829
- White (H. E.), Hyperfine Structure in Line Spectra, 216
- White (Prof. P. J.), [death], 61
- Whitehead (G. O.), Change in an African Society, 27
- Whitehead (Dr. T.), Transmission of Potato Leaf-Roll, 974
- Whitelaw, Jun. (J.), Eighth edition, revised and enlarged by Col. Sir Gordon Risley Hearn, Surveying: as Practised by Civil Engineers and Surveyors, 83
- Whitley (Mr. J. H.), nominated as chairman of the British Broadcasting Corporation, 902
- Wibberley (T.), The Future of British Agriculture, 725
- Wigglesworth (V. B.), A Theory of Tracheal Respiration in Insects, 477
- de Wild (Dr. A. M.), The Scientific Examination of Pictures, 382
- Wildish (J. E.), Origin of Protoactinium, 474
- Wilkins (Dr. F. J.), Rate of Vaporisation and Vapour Pressure: a Method of Measuring the Specific Area of a Surface, 236
- Wilkins (Sir Hubert), Antarctic Flight, 100, 388; Discoveries in Antarctica, 63
- Willcox (Sir William), Secret Poisoning, 291
- Willey (E. J. B.), Active Nitrogen, 724
- Williams (E. J.), The Induction of Electromotive Forces in a Moving Liquid by a Magnetic Field, and their Application to the Investigation of the Flow of Liquids; The Motion of a Liquid in an Enclosed Space, 765, 958

- Williams (J.), and F. R. Terroux, Properties of β -Particles, 182
- Williams (S.), Morphology of *Trichomanes aphlebioides* Christ, with special reference to the Aphlebioid Leaves, 257
- Williamson (Isobel J. F.), Bacterial Infection in Fish and certain other Lower Vertebrates; Furunculosis of the Salmonidae, 255
- Williamson (Dr. R.), appointed university demonstrator in pathology in Cambridge University, 431
- Wilsdon (Prof. B. H.), Problems of Irrigation, 674
- Wilson, Bart. (Sir David), [death], 608
- Wilson (Prof. E. B.), elected an honorary fellow of the Royal Microscopical Society, 719
- Wilson (P.), and G. W. Webb, Modern Gramophones and Electrical Reproducers, 520
- Wilson (W. C.), The Tannic Acid Treatment of Burns, 58
- Wimperis (H. E.), The Phenomenon of Spin in Aeroplanes, 717
- Winge (O.), Sex-determination in the Cyprinodont *Lebistes reticulatus*, 398
- Wingfield-Stratford (Dr. E.), The History of British Civilization. Second edition, 407
- Winogradsky (S.), The Synthesis of Ammonia by the Soil *Azotobacter*, 657
- Witherby (H. F.), British Bird Ringing, 650
- Wittich (E.), Gipsy Exorcism, 578
- Wollaston (A. F. R.), [death], 944; [obituary article], 981
- Womersley (H.), Collembola of Ireland, 508
- Wood (A. R.), and M. N. Leathwood, Glasses Transparent to Ultra-violet Radiation, 351
- Wood (D. R.), Examination of Milk for Tubercle Bacilli, 802
- Wood (Prof. R. W.), Raman Lines of Mercury in Arc improbable, 464
- Wood (W. A.): Silicon Transformer Steel Residue, 974; and J. Thewlis, Behaviour of Electrons in a Gas Tube, 457
- Woodhouse (T.), and P. Kilgour, Jute and Jute Spinning, Part 1. Second edition; Part 2, 124
- Woodruff (L. L.), and others, edited by Prof. G. A. Baitsell, The Evolution of Earth and Man, 382
- Woolley (C. L.), Ur of the Chaldees: a Record of Seven Years of Excavation, 84
- Woolley (S. W.), and G. F. Forrester, Pharmaceutical Formulas. P.F. Tenth edition, 366
- Wordie (J. M.), Greenland, 442
- Wormell (Dr. T. W.), Electric Currents to the Ground, 989; Vertical Electric Currents below Thunderstorms and Showers, 432
- Worrall (R. L.), Association of Stimuli in the Development and Function of the Nervous System, 927
- Worthington (E. B.), elected Balfour student in Cambridge University, 839; Vertical Movements of Fresh-water Macroplankton, 913
- Wright (F. J.), The New Nature Study, 268
- Wright (S. J.), The Elasticity of Pintsch Crystals of Tungsten, 433
- Wright (W. D.), A Redetermination of the Mixture Curves of the Spectrum, 693
- Wright (W. R.), Occurrence of *Cepedea* in Frogs, 52
- Wrigley (R. W.), Changes of Rock Temperatures and Irregularities of the Earth's Rotation, 257
- Wulf (Prof. T. L.), High Voltage Electrometer, 906
- Wyatt, Fraser, and Stock, Boredom in Industry, 288
- Wynne-Edwards (V. C.), Behaviour of Starlings in Winter, 143
- Yakimach (A.), Complexes of Quadrivalent Manganese Cyanide, 657
- Yamagiwa (Prof. K.), [death], 827
- Yamamoto (I.), The Zodiacal Light, 471
- Yarrow (Sir Alfred), elected an honorary member of the Institution of Civil Engineers, 179
- Yehara (S.), Japanese Tectonics, 872
- Yerkes (Prof. R. M.), and Ada W. Yerkes, The Great Apes: a Study of Anthropoid Life, 485
- Yokoyama (Prof. M.), Pliocene and Pleistocene Fossils from Sakhalin, 392
- Yonge (Dr. C. M.), The Crystalline Style of the Mollusca and a Carnivorous Habit cannot normally Co-exist, 444; The Great Barrier Reef, 789
- York (Archbishop of), The Distinctive Excellencies of Greek and Latin, 608
- Young (L. C.), awarded a Rayleigh prize of Cambridge University, 547
- Zadoc-Kahn (Mlle. Jacqueline), The Magnetic Double Refraction of Para-azoxyanisole, 657
- Zagami (V.), Muscular Phosphogen in Fish, 658
- Zanon (Dr. D. Vito), Arctic Diatoms, 288
- Zeleny (Prof. J.), A Singular Behaviour of Striae in the Positive Column of an Electrical Discharge through Hydrogen, 562; The Ions produced by Discharges at Liquid Surfaces, 706
- Zmaczynski (A.), and A. Bonhoure, The Boiling Point of Water as a Function of the Pressure, 114
- Zwicky (F.), On Mosaic Crystals, 150; On the Red Shift of Spectral Lines through Interstellar Space, 114

TITLE INDEX

- a* Benzilmonoxime, The Conversion of, into the β Oxime by Animal Charcoal, T. W. J. Taylor and Sally Marks, 636
- Aberation, The Constant of, H. R. Morgan, 251
- Aberystwyth, University College of Wales, Dr. C. D. Forde appointed professor of geography and anthropology, 911
- Abietic Acid, The Autoxidation of, G. Dupont and J. Lévy, 74
- Absorbing Power of Materials, Measurement of, by the Stationary Wave Method, A. H. Davis and E. J. Davis, 256
- Absorption, Continuous, J. A. Gaunt, 257; Spectra, Extinction Curves of, Automatic Registration of, R. Brdička and M. Pavlik, 915
- Abyssinian Basalts, The Phenocrystals and Microlites of the Plagioclases of the, L. Duparc and L. Galopin, 694
- Academia Scientiarum Fennica, Helsingfors, The honorary membership of the, conferred on Sir J. C. Bose, 424
- Acetaldehyde, Oxidation of, Bowen and Tietz, 579
- Acetals of the Fatty Series, Catalytic Decomposition of some, by Metallic Oxides, Mlle. M. Cabanac, 803
- Achema*, The Sixth, 984
- Acoustic Analyses, Gramophone Records of, Dr. W. H. George, 394
- Acquired Characters, Dr. M. F. Guyer, 722
- Activation of Matter, A Method of, G. Reboul, 478
- Adaptations, The Origin of, J. T. Cunningham, 221
- Adelginæ* (*Phylloxeridæ*) of North America, Dr. P. N. Annand, 722
- Administration, Science and, 1
- Adventure and Beagle*, Birds of the, Surgeon Rear-Admiral J. H. Stenhouse, 181
- Aerial Surveys in East Africa, 645
- Aeronautical Progress, 1914 to 1930, Prof. R. V. Southwell, 753
- Aeroplane Survey in Canada, 835
- Aeroplanes, Spin in, H. E. Wimperis, 717
- Afforestation in South Africa, Dr. H. M. Steven, 252
- African Society, Change in an, G. O. Whitehead, 27; Society's gold medal, Award of the, to Earl Buxton, 902
- Agricultural Science and Grassland, 119
- Agriculture, British, The Future of, T. Wibberley; H. G. Miller, 725; Progressive, 979
- Air-craft, U.S. Quarantine Officers to inspect, 98; Survey, Col. Cochran-Patrick, 110
- Albumenoids, Action of Caustic Alkalis at High Temperatures on, L. Dupont, 74
- Alcoholic Fermentation, The Function of Phosphate in, Prof. A. Harden, 277, 313
- Alcoholism, Dr. J. D. Rolleston, 950
- Alcoholometric Corrections for Temperatures below 0° C., F. Bordas and E. Roelens, 841
- Aldehydes, New Reaction of (4), R. de Fazi and F. Monforte, 694
- Algæ, Two Groups of, with the Structure preserved in the 'Schisto-limestone System' of the French Congo, L. Cayeux, 397
- Algebraic Geometry and Theta Functions, Prof. A. B. Coble, 775
- Alkaline Sulphides, Potentiometric Determination of, G. Scagliarini and P. Pratesi, 766
- Alkalis on Plants, The Biological Significance of, B. Longo and C. Paderi, 338
- Allen's Commercial Organic Analysis. Vol. 7. Editor, C. Ainsworth Mitchell. Fifth edition, 231
- Allgemeinen Elektrizitäts-Gesellschaft, Jahrbuch des Forschungs-Instituts der, Band 1, 703
- Alloys, Cast, Macrostructure of, R. Genders, 477
- Alluvium in Lakes converted into Reservoirs, The Change of the, L. Gaurier, 549
- Alpen, Vorgeschichtliches Leben in den, L. Franz, 775
- Alternating: Current Circuit, Power Measurement in an, G. F. Shotton; R. S. J. Spilsbury and Dr. Arnold, 290; Currents, Minute, A New Method of Measurement of, D. F. Martyn, 549; Magnetic Fields, The Magnetostriction Constant for, F. D. Smith, 433
- Aluminium: and Alpac, Tests of Casting, under constant Pressure, of, A. Courty, 842; and its Alloys, Electrolytic Deposits on, Ballay, 434; -Brasses, The, R. Genders, 513; Bronzes, The Special, with Zinc, Silicon, and Antimony, A. Sévaut, 514
- Alytes*, The Acquired Characters of, Dr. C. Walker, 562, 889; Prof. E. W. MacBride, 670; Prof. H. Przibram, 856
- Ambocoelia* Hall and certain similar British Spiriferidæ, T. N. George, 693
- America Conquers Britain: a Record of Economic War, L. Denny, 965
- American: Association: Award of the prize of the, to Prof. A. J. Dempster, 64; Prof. T. H. Morgan elected president of the, 141; Astronomical Society, Dr. F. Küstner elected an honorary member of the, 177; Geographical Society, Award of the Cullum geographical medal to Dr. H. R. Mill, Prof. J. Brunhes, Prof. A. Hettner, and Prof. J. de Schokalsky; the Charles P. Daly gold medal to Cav. E. De Filippi and Prof. E. F. Gautier, 648; Society of Mechanical Engineers, The Fiftieth anniversary of the, 177
- Amines, Primary and Secondary, A New General Method for the Preparation of, A. Guyot and M. Fournier, 74
- Amino Alcohols, Some Pairs of, M. Tiffeneau, Mlle. Jeanne Lévy, and E. Ditz, 258
- Ammeter for High Frequency Currents, An, Prof. C. L. Fortescue, 253
- Ammonia: addition compounds of Phenols, Some New, E. Briner and H. Kuhn, 258; Discharge Tube, The Exit Gas from an, G. I. Lavin and J. R. Bates, 709; Properties of, Beattie and Lawrence, 290; The Production of, 575
- Ammonites-VII., Type, The late S. S. Buckman: with Editorial Note, Chronological and other Tables, and Index, by Dr. A. Morley Davies, 773; Parts 71-72, 101
- Amœba* with a Stigma, New Species of, A. Pascher, 650
- Amphibia: Distortion of Development in, caused by Lack of Oxygen in Very Early Stages in Development, D. E. Sladden, 293; Eggs of, Radio-sensitiveness in the Development of the, (1), P. Pasquini and G. Meldolesi, 35
- Anabasis aphylla*, The Alkaloids of, A. Orékhoff, 74
- Analytical Processes: a Physico-Chemical Interpretation, Dr. T. B. Smith, 381
- Ancient Egyptian Implements, The Metallography of some, Sir Harold Carpenter and Dr. J. M. Robertson, 859
- Andaman, Little, A Communal House on, P. Vaux, 330
- Anemometers, New Recording, Prof. W. W. Shoulejkin, 954
- Angler Fishes, Dr. C. Tate Regan, 422, 747
- Anglo-Egyptian Sudan, Vegetation of the, Dr. T. F. Chipp, 210
- Anhydrous Iodides of Divalent Metals, Crystalline Structure of, (1), A. Ferrari and F. Georgi, 587
- Animal: Breeding Research Department of the University of Edinburgh, Ninth Annual Report of the, 178; Environment, Measurement of, Dr. P. A. Buxton, 158
- Animals looking at you, P. Eipper. Translated by P. Kirwan, 378
- Anion Tautomerism, Mobile, H. Burton (Part 5), 622
- Ankyropterus corrugata*, Some Wound Reactions in, H. J. Holden, 693
- Annuaire astronomique et météorologique Camille Flammarion pour 1930, 613
- Annual Register, The, 1929, edited by Dr. M. Epstein, 813
- Annular Discharge, New Phenomena observed in the, N. Siracusano, 730
- Anode Spots, J. Oishi and K. Yosiaka, 723

Anorthose Trachyte from Gambaella (Abyssinia), An, L. Duparc, 914
 Antarctic : Discoveries in : Sir Hubert Wilkins, 63 ; Sir Douglas Mawson, 212 ; Expedition, The Mawson, 248 ; Flight, Sir Hubert Wilkins's, 388
 Anthropological Congress, An, Prof. J. L. Myres, 494, 672
 Anthropology, National and International, Prof. J. L. Myres, 212, 297
 Antimony Analogues of the Carbazole Series, Prof. G. T. Morgan and G. R. Davies, 433
Antiquity, June, 983
 Antrim, North-eastern, The Geology of, W. J. McCallien, 549
 α -Particles : and Nitrogen Atoms, Effect of Collisions between, Prof. W. D. Harkins, 611 ; Scattering of, by Light Atoms, Prof. A. C. Banerji, 167 ; C. Møller, 459
 Apes : The Great, a Study of Anthropoid Life, Prof. R. M. Yerkes and Ada W. Yerkes, 485
 Aquarium : The Public, its Construction, Equipment, and Management, C. H. Townsend, 505
 Aqueous Alcoholic Liquid Mixtures, The Boiling Points of, P. Brun, 294
 α -Rays of Radium, Nature of the Absorbable Radiation which accompanies the, Mlle. Irène Curie and F. Joliot, 222 ; The Fine Structure of the Magnetic Spectrum of the, S. Rosenblum, 995
 Arc Switches, Quenched, L. C. Grant, 216
 Archæological Finds at Rosses Point, Sligo, The, Prof. R. A. S. Macalister and Prof. J. K. Charlesworth, 248
 Archæology : and Anthropology, International Congress of, Portugal, 1930, 690 ; and Bible History, 764 ; from the Air in Central America, O. J. Ricketson and Dr. A. V. Kidder, 655 ; What is, O. G. S. Crawford, 908
 Arctic : Diatoms, Dr. D. Vito Zanon, 288 ; Ice in 1929, 615
 d'Arda, Le royaume, et son évangélisation au XVII^e siècle, Prof. H. Labouret et Prof. P. Rivet, 376
 Arithmetic of Citizenship, B. L. Gimson, 109
 Army, Health of the, Report for 1928, 576
 Arsenic : in the Wells of Choussy de La Bourboule, etc., The proportion of, R. Clogne, Mlle. A. Courtois, and Cazala, 995 ; The Atomic Weight of (1), J. H. Krepelka, 959
 Arthropods as Intermediate Hosts of Helminthes, M. C. Hall, 144
 Astrolabe, The, 556

ASTRONOMICAL NOTES.

Comets :
 Comets, 26 ; Wilk's Comet, 65 ; Comet Schwassmann-Wachmann, Dr. W. Baade, 103 ; Wilk's Comet, 142 ; Comets, 214 ; New Comet, 1930a, 329 ; Comets, 425 ; New Comet, 1930b, 471 ; Comets, 507 ; The New Comet Wilk, 1930c, 542 ; New Comet, 1930d, 721 ; Comet, 1927d, 757, 870
 Instruments :
 Plans for the 200-inch Telescope, Dr. Elihu Thomson, 425
 Meteors :
 The Grootfontein Meteor, Dr. W. J. Luyten, 214 ; Large Fireball, 833 ; The Large Fireball of May 16, 870 ; Remarkable Meteors, W. F. Denning, 986
 Observatories :
 Report of Washington Naval Observatory for 1929, 180 ; Report of the Paris Observatory for 1928, 391 ; Observatory at Bedford College, London, 507 ; Handbook of Cracow Observatory for 1930, 649 ; Zi-Ka-Wei Observatory, 793 ; Work of the Washington Naval Observatory, 904
 Planets :
 Minor Planets, 65 ; Saturn, E. M. Antoniadi, 425 ; Mars in 1926, Prof. W. H. Pickering, 471 ; The Trans-Neptunian Planet, 507, 542 ; A New Trojan Minor Planet, 577 ; The New Planet, 577 ; Distance of the Trans-Neptunian Planet, Prof. G. Armellini, 613 ; The Lowell Object, 649 ; The Lowell Planet, 721 ; Conjunction of the Planets Venus and Jupiter, 757 ; The Lowell Planet, 757 ; Photograph of a Lunar Landscape, M. Darney, 793 ; The Lowell Planet, 833 ; Occultations of Stars by the Moon, Prof. E. W. Brown, 986

Stars :
 Relation of Light Changes to Velocity Changes in Variable Stars, D. B. McLaughlin, 65 ; Rotation of the Galaxy, Dr. J. S. Plaskett, 103 ; Orientation of the Planes of Binary Stars, Y. C. Chang, 103 ; Changes in the Period of the Variable Star R Hydra, R. Müller, 142 ; Radial Motion of the O-type Stars, Prof. C. D. Perrine, 180 ; The Constant of Aberration, H. R. Morgan, 251 ; Distribution of Stars of different Spectral Types, Dr. O. Seydl, 391 ; Distribution of Matter in Interstellar Space, Dr. J. S. Plaskett and J. A. Pearce, 542 ; Radial Velocities of 741 Stars, Adams, Joy, Sanford, and Strömberg, 649 ; Double Star Measures at Johannesburg, W. H. van den Bos, 684 ; A New Determination of the Galactic Pole, Prof. P. J. van Rhijn, 684 ; Melbourne Astrographic Catalogue, vol. 3, 684 ; New Constellation Boundaries, 721 ; The Companion of Mira Ceti, 793 ; The oldest known Star Catalogue, J. Meta, 870 ; Absolute Motions of Stars, R. Klumak and F. Hecht, 904 ; Spectroscopic Study of ξ Ursae Majoris, L. Berman, 904
 Sun :
 An Active Region on the Sun, 26 ; The Central Solar Eclipse of April 28 next, 214 ; Prediction of the Sun-spot Curve, Prof. D. Alter, 251 ; Periodic Changes in the Solar Corona, Prof. Bergstrand, 649 ; The Total Solar Eclipse of April 28 in California, 721 ; 'Wolf's Numbers' for 1929, 757
 Miscellaneous :
 Revision of Newcomb's Occultation Memoir, Dr. H. Spencer Jones, 142 ; Astro-Photography of the Future, Dr. G. W. Ritchey, 180, 329 ; Observers' Handbook, 251 ; Dark Objects in Barnard's Photographic Atlas, Prof. G. Hagen, 391 ; The Zodiacal Light, I. Yamamoto ; C. T. Jacob, 471 ; Recent Magnetic Disturbances, 613 ; Photo-electric Observations at Neubabelsberg, 613 ; Annuaire astronomique et météorologique Camille Flammarion pour 1930, 613 ; Tercentenary of Kepler's Death, Prof. F. Cajori, 833
 Astronomy, Everyday, Sir Frank Dyson, 507
 Astro-Photography : of the Future, Dr. G. W. Ritchey, 180, 329 ; The Development of, and the Great Telescopes of the Future, Dr. G. W. Ritchey, 169
 Asymmetric Synthesis and the Existence of Racemic Compounds in Solution, A. Cotton, 221
 Athenæum Club, Election : of Brig.-Gen. Sir Harold Hartley and A. Mawer, 576 ; of Engr.-Vice-Admiral Sir Robert Dixon and Dr. H. J. Weld, 470 ; of G. S. Gordon, Prof. O. W. Richardson, and H. T. Tizard, 213
 Atlantic and Pacific Land-Bridges, the late Dr. von Ihering, 954
 Atmosphere : Lower, Transparency of the, H. Buisson, G. Jausseran, and P. Rouard, 766 ; Vibrations in the, Prof. G. I. Taylor, 67
 Atmospheric : Corrosion of Metals : Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association), 739 ; Light Columns from Artificial Lights, B. W. Currie ; Dr. F. J. W. Whipple, 526 ; H. Nicol, 671 ; A. H. R. Goldie ; Dr. F. J. W. Whipple, 743 ; Oxygen (Intercombination) Bands, Intensities in the, Dr. W. H. J. Childs and Prof. R. Mecke, 599 ; Pollution, Report for Year ending March 1928, 871
 Atom, The, Prof. G. P. Thomson, 667
 Atomic : Hydrogen, Recombination of, F. J. Havlicek, 989 ; Nuclei, Magnetic Moments of, Prof. E. Fermi, 16 ; Physics and Related Subjects, 453-464 ; Structure, Dr. W. Tombrock, 796 ; Theory, Philosophical Aspects of, Prof. N. Bohr, 958 ; Valency, The Doctrine of, Prof. H. E. Armstrong, 807
 Atoms : At Home among the, a First Book of Congenial Chemistry, Prof. J. Kendall, 155
 Aucuba or Yellow Mosaic of the Tomato Plant : Reaction of Infected Juice, Dr. W. F. Bewley and B. J. Bolas, 130
 Auroral Rays, Sunlit, Spectrum of the, Prof. C. Størmer, 305

- Australia : Council for Scientific and Industrial Research, Activities of the, 867 ; Imperial Geophysical Experimental Survey, The, 388
- Australian : Council for Scientific and Industrial Research, Division of Economic Botany, Report by Dr. B. T. Dickson, 900 ; Fisheries, Map of the, 871 ; Mycetophilidæ, A. L. Tonnoir, 114 ; Nature Studies : a Book of Reference for those interested in Nature-Study, Dr. J. A. Leach. Second edition, 123 ; Petroglyphs, B. E. Hornshaw, 650 ; Plants, Cyanogenetic Glucosides in, H. Finnemore and C. B. Cox (2), 659 ; Rust Studies (Part 1), W. L. Waterhouse, 114
- Australopithecus*, The Age of, Dr. R. Broom, 814
- Autoraemisation, T. Wagner-Jauregg, 145
- Avena* and *Triticum*, Chromosome Number and the Mutation Rate in, L. J. Stadler, 623
- Aviation, British, 661
- Axial Gradients, Dr. S. Ranzi, 834
- Azotobacter, The Synthesis of Ammonia by the Soil, S. Winogradsky, 657
- Azo Dyes derived from Diacetoresorcinol, J. Algar and Mary Boylan, 478
- Bac. saccharobutyricus* v. Klecki, The Life-Cycle of, A. Cunningham, 168
- Bacteria, Nitrifying, Dr. D. Ward Cutler, 168
- Bacterial Infection in Fish, 255
- Bacteriology : in Medicine : Prof. J. M. Beattie, 359, 522 ; and Public Health, Prof. J. M. Beattie, 80 ; in Relation to Medicine, A System of. Vol. 3, Prof. W. Bulloch, and others, 80 ; Vol. 4, H. J. Bensted, and others, 359 ; and Immunology, The Principles of, Prof. W. W. C. Topley and Dr. G. S. Wilson. 2 vols., 522
- Badger, The, and its Reputation, 139
- Bakerian Lecture, The, Prof. R. Robinson, 873
- Ballistic Hypothesis, The, and the Verification of the Law of Areas in the Orbits of Telescopic Stars, C. Cannata, 338
- Bananas, Artificial Ripening of, 426
- Bandenspektren und ihre Bedeutung für die Chemie, Prof. R. Mecke, 380
- Bandenspektren auf experimenteller Grundlage, Dr. R. Ruedy, 407
- Band Spectra, Intensities in, E. Hutchisson, 746
- Banking, W. W. Paine, 969
- Bantu, The Earliest, Dr. N. J. v. Warmele, 472
- Barclay Memorial Medal of the Asiatic Society of Bengal, awarded to A. Howard, 612
- 'Bar-lip' Pottery from Essex and Alderney, T. D. Kendrick, 950
- Barnard's Photographic Atlas, Dark Objects in, Prof. G. Hagen, 391
- Barton : Dr., The Time-Journey of, an Engineering and Sociological Forecast based on Present Possibilities, edited by J. Hodgson, 810
- Base Exchange, G. Weigner, 914
- Batyl Alcohol, Monomolecular Films of, B. C. J. G. Knight, 351
- Bavarian Zugspitze Mountain Railway, The, 139
- Bavenda, The, H. A. Stuyt, 789
- Bean Mosaic in England, Appearance of, J. Grainger, 34
- de Beauchamp, P. J., The Instruments and Observations of, Bigourdan, 729
- Bedford College, London, Observatory at, 507
- Behm Limno-Sounder, The, 393
- Belfast, Queen's University, J. G. Semple appointed professor of mathematics, 993
- Bell-founding, History of, A. A. Hughes, 145
- Benzene : Glycols, A Class of, Deluchat, 514 ; Oxidation of, C. N. Hinshelwood and R. Fort, 724 ; The Tesla-Luminescent Spectrum of, Dr. I. A. Black, 274
- Benzole : and Allied Products, Standard Specifications for, 1929, 740 ; Producers, Second International Conference of, 869 ; Recovery in Gasworks Practice, W. H. Hoffer and G. Claxton, 909
- Big Game Hunting and Collecting in East Africa, 1903-1926, K. Kittenberger. Translated from Hungarian, 373
- Binary Mixtures, Viscosity Isotherms of, (4), F. de Carli, 34, (5), 339
- Binnengewässer : Die Einzeldarstellungen aus der Limnologie und ihren Nachbargebieten. Unter Mitwirkung von Dr. E. Naumann und anderen Fachgenossen herausgegeben von Prof. A. Thienemann. Band 7 : Die Biologie der Moore. Von Dr. O. Harnisch. Band 8 : Der Hochgebirgsee der Alpen (Versuch einer limnologischen Charakteristik). Von Dr. O. Pesta, 377
- Biocolloidologie, Traité de, W. Kopaczewski. Tome 1, Fasc. 1, 813
- Biological : Books, The Cost of, J. R. Miner, 682 ; Interests of Young Children, The, Mrs. Isaacs, 961 ; Media, Function of the Non-electrolytes in the Stability of, M. Piettre, 914
- Biologischen Arbeitsmethoden, Handbuch der. Herausgegeben von Prof. E. Abderhalden : Lief. 293. Abt. 9 : Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 4, Heft 3. Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Methoden und Technik der Nerven- und Muskelphysiologie bei wirbellosen Tieren. Von H. J. Jordan und P. J. van der Feen, 378 ; Lief. 307. Abt. 9 : Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 6, Heft 1. Methoden der Meeresfischereibiologie. Die Methodik fischereibiologischer Untersuchungen an Meerestischen. Von A. Büchmann, 523
- Biology : for Young Children, 961 ; Fresh-water, 774 ; School Certificate, 37
- Bird -flotation, A Problem of, F. H. Alexander, 902 ; Ringing, British, H. F. Witherby, 650
- Birds : and Green Places : a Book of Australian Nature Gossip, A. H. Chisholm, 367 ; Migration of, and Sex Cycles, Prof. W. Rowan, 252 ; and their Ways, 367 ; of Ayrshire, The, E. R. Paton and O. G. Pike, 367 ; of Essex, A History of the, W. E. Glegg, 197 ; of South-East Devon, The, L. R. W. Loyd, 367
- Birmingham University : Reports of Vice-Chancellor and Council, 292 ; Dr. J. G. Emanuel invited to the joint professorship of medicine ; gift to ; resignation of T. H. Turner, L. P. Timmins, and Dr. W. C. O. Hill, 395 ; Radium lent to the, and to the General Hospital, 764
- Birth- : and Death-rates : Dr. C. Tietze, 288 ; and Infant Mortality, Provisional Figures of the, for 1929, 213 ; Control and Racial Progress, Data from a Mother's Clinic of the Society for Constructive, 902
- Bismuth : and Antimony, Anomalous Diamagnetism of, Influence of Chemical Colloidisation on the, V. I. Vaidyanathan, 672 ; and Copper in Lead Bullion, The Rapid Determination of, by Internal Electrolysis, Ella M. Collin, 433 ; in the Ashes of Animal Organisms, Spectrographic Detection of, G. Piccardi, 34
- Bisons d'Argilé', 'Les, Two Replicas of, for Canada, 98
- Bitural, The Production of, C. F. Broadhead, 909
- Bivalent Metals with Organic Bases, Additive Compounds of Halides of, G. Scagliarini and G. Tartarini, 35
- β -ketonic Esters to the β -amino Esters, The Passage from the, J. Décombe, 397
- Black Sea, A Supplement to the Polychæet Fauna of the, (1), N. P. Annenkova, 586
- 'Blanc' Alumina, N. Parravano and E. Onorata, 587
- Blind, Welfare of the, Advisory Committee on the, Eighth Report of the, 903
- Blowfly's Mouth, The, T. H. Taylor, 238
- Blue : Goose, Breeding Grounds of, J. D. Soper, 288 ; Rock-salt, Natural, K. Przißram, 398
- Bombyx mori* L., Irreversible Change in the Viscosity of the Eggs of, M. Tirelli, 731
- Bone Tissue in the Normal Rat, Rachitic Rat, and the Rat Cured of Experimental Rickets, Variations of the Mineral Composition of the, J. Alquier, Mlle. L. Asselin, Mme. M. Kogane, and Mlle. G. Silvestre de Sacy, 434
- Book Prices and Reading, Prof. H. E. Armstrong, 234
- Boredom in Industry, Wyatt, Fraser, and Stock, 288
- Boric Glass, The Staining of, by the Action of Radium Rays, P. Lazarev and N. I. Kolesnikova, 258
- Borough Polytechnic, Opening of New Buildings, 335
- Bos indicus*, Intersexuality in, D. R. R. Burt, 221
- Botanical : Exploration of Krakatao, 627 ; Nomenclature, R. A. Inglis, 204 ; T. A. Sprague, 310

- Boubin, Šumava, The Geology and Natural History of the Primeval Woodlands of, Prof. K. Domin, 946
- β -Particles, Properties of, O. Klemperer; E. J. Williams and F. R. Terroux, 182
- Brachiopods, Fossil, Prof. C. Schuchert and C. M. Le Vene, 67
- Brachyura, On Larval Forms of some, H. Aikawa, 395
- Bremen, The Propelling Machinery of the, 945
- Brewing, Institute of, The Research Scheme of the, 839
- Brighter Biochemistry, 423
- Brightness, Measurements of, with Grey-wedge Photometers, F. Morton, 398
- Bristol University, Dr. R. J. Brocklehurst appointed professor of physiology, 112
- Britain's Coal Resources, Prof. J. H. Jones, 343
- Britannica, The New, 357
- British: Agriculture, The Future of, T. Wibberley; H. G. Miller, 725; Aviation, 661; Association: Centenary Meeting of the, Genl. Smuts to be nominated as president of the, 466; Meeting at Bristol, Presidents and Recorders of the, 101; Barytes, Notes on, Miss Jessie M. Sweet, 958; Broadcasting Corporation, Mr. J. H. Whitley nominated as chairman of the, 902; Birds, External Parasites of, R. S. Bagnall and W. Hall, 871; Civilization, The History of, Dr. E. Wingfield-Stratford. Second edition, 407; Coal Trade, The Present Position of the, Prof. J. H. Jones, 343; Disinfectant Manufacturers' Association, Formation of the, 25; Electrical and Allied Industries Research Association, Report of the, 176; Empire, Universities of the, 885; Gliding Association, Establishment of the, 573; Guiana, In the Canopy of the Forest, Major R. W. G. Hingston, 548; Honduras, The British Museum Expedition to, 175; Hydracarina, The, C. D. Soar and W. Williamson. Vol. 3, 559; Industries Fair, The, 282, 312; Journal Photographic Almanac and Photographer's Daily Companion, 1930. Edited by G. E. Brown, 232; Medical Association, forthcoming annual meeting of the, 140; Museum: (Natural History), Acquisitions of the, 178; A. H. G. Alston appointed assistant-keeper in the department of Botany, 213; Accessions to the, 328, 505, 830; Patent System, Memorandum on, by a joint chemical committee, 610; Photographic Research Association, Report of the, 178; Polar Exhibition, a forthcoming, 573; Post-graduate Hospital and Medical School, a proposed, 610; Science Guild: Annual Report of the, 865; Sir Samuel Hoare nominated as president, 612; Somaliland, North-eastern, Geology of, C. B. Brown, 877; Zoologists, Annual Meeting of, 100
- Broadcast Licences, The Postal Regulations respecting, 211
- Broadcasting: and Music, L. Berkeley and Major Ravenhart, 790; and Receiver Efficiency, Field Strength in, J. H. Reyner; H. A. Thomas, 183; in Switzerland, 423; Receiving Sets, Electric Tramways and, C. O. Horn, 424; Stations, Sites for, P. P. Eckersley and N. Ashbridge, 754
- Bromine Nucleus, The Moment of the, Dr. T. L. de Bruin, 414
- Bromomalonic Dialdehyde, J. Grard, 337
- Bronns, Dr. H. G., Klassen und Ordnungen des Tierreichs wissenschaftlich dargestellt in Wort und Bild. Band 5, Abteilung 4, Buch 3: Tardigrada. Bearbeitet von E. Marcus, 702
- Bronze Castings, Unsoundness in, E. J. Daniels, 477
- Brown Leghorn Hens, Results of Testicular Transplantation in, A. W. Greenwood and J. S. S. Blyth, 293
- Bryophyta, Taxonomy, E. B. Bartram, 473
- Buckland: Foundation Lectures, Prof. W. Garstang, 644; Frank, and Fish Culture, Prof. W. Garstang, 653
- Buckman's Type Ammonites, 773
- Building: Material and Heat Insulation, 616; Science, Experimental, J. L. Manson and F. E. Drury. Vol. 2, 44
- Bureau International des Poids et Mesures, Travaux et mémoires. Vol. 18, 948
- Burgundy: The Court of, Studies in the History of Civilisation, Prof. O. Cartellieri. Translated by M. Letts, 12
- Buru, Moluccas, Mammals of, Dr. K. W. Dammerman, 472
- Bushman Craniology, E. Pittard, 143
- Butterflies, Wild Birds and, Prof. J. B. Cleland, 276
- Buttress Roots, T. Petch, 722
- Buxus sempervirens* L. in the Northern Caucasus, A. I. Leskov, 259
- Byrd Antarctic Expedition, The, 178
- Cacao: Insect Infestation of, Prof. J. W. Munro and W. S. Thomson, 183; Wild, Prof. G. Stahel; Dr. J. G. Myers, 289
- Cadmium and Copper in Spelter and Zinc Ores, The Separation of, by Internal Electrolysis, Ella M. Collin, 621
- Calcium: Hydride, Band Spectrum of, Pressure Effects in the, B. Grundström and Prof. E. Hulthén, 634; Ion, The Micro-estimation of the, A. Astruc, M. Mousseron, and Mlle. N. Bouissou, 478
- California Jack Smelt, The, F. N. Clark, 104
- Californian: Salmon, G. H. Clark, 252; Woodpeckers, Food Storing by, Prof. W. E. Ritter, 578
- Callichthys*, Development of, Miss Frances M. Ballantyne, 905
- Cambridge: Five-figure Tables, F. G. Hall and Dr. E. K. Rideal, 968; Mineralogy at, 418; University: F. L. Engledow elected Drapers professor of agriculture; the Smithsonian Research Fund, 148; C. G. Lyons awarded the Gordon Wigan prize, 184; Dr. A. B. Appleton elected a fellow of Downing College; J. C. Dobbie appointed first junior observer at the Solar Physics Observatory, 219; W. R. Dean appointed University lecturer in mathematics, 292; Dr. R. Williamson appointed University demonstrator in pathology; award of the Allen scholarship to S. Verblumsky; Dr. F. G. Mann appointed University lecturer in chemistry, Dr. J. D. Cockcroft University demonstrator in physics, Dr. F. B. Kipping University demonstrator in chemistry, 431; A. E. Ingham and R. F. Kahn elected fellows of King's College, 476; P. Sraffa reappointed University lecturer in economics; H. Gilbert-Carter appointed University lecturer in botany; award of Smith's prizes to R. E. A. C. Paley and J. A. Todd; award of Rayleigh prizes to W. R. Andress and L. C. Young, 547; award of the Sheepshanks Exhibition to R. D. H. Jones; R. U. Sayce reappointed University lecturer in material culture and physical anthropology, 728; Dr. W. E. Dixon reappointed reader in pharmacology, 764; E. A. G. Robinson appointed University lecturer in economics and politics; Dr. E. K. Rideal recommended as professor of colloidal physics; Mr. Stanley Baldwin elected Chancellor, 799; M. H. A. Newman and A. S. Besicovitch reappointed University lecturers in mathematics; W. M. Smart and A. E. Ingham appointed University lecturers in mathematics; T. G. Bedford reappointed University lecturer in physics, and J. D. Bernal University lecturer in structural crystallography, 839; E. B. Worthington elected Balfour student; grants for a post-graduate course or research work in Heidelberg University; new regulations for the Economics Tripos, 839; J. A. Steers reappointed University lecturer in geography; J. S. L. Gilmour appointed curator of the Herbarium and Botanical Museum; D. J. Watson reappointed Frank Smart University student in botany, 876; proposed establishment of a University demonstratorship in pharmacology in the faculty of medicine; Mr. Stanley Baldwin installed as Chancellor; conferment of honorary degrees, 911; C. Forster Cooper elected a non-stipendiary fellow of Trinity Hall and Dr. O. H. Wansborough-Jones a research fellow, 993; L. E. S. Eastham reappointed University lecturer in advanced and economic entomology; Dr. T. M. Harris demonstrator in botany; H. L. H. H. Green demonstrator in anatomy; Dr. S. M. Manton demonstrator in comparative anatomy, 993
- Campanula persicifolia*: Structural Variation in the Chromosomes of, Alice E. Gairdner and C. D. Darlington, 87; The Number of Carpels in the Flowers of, J. Briquet, 693
- Canada: Anthropological Discoveries in, 755; National Museum of, Second Annual Report of the, 946; North-West Territories of, Survey Work in the, 24; Population of, Composition of the, 147

- Canadian: Hydro-electric Power Development during 1929, Dr. Brysson Cunningham, 824; National Research Laboratories, 31; Rockies, Structure of the, L. W. Collet, 729
- Cancer: in England and Wales, M. Pittard, 469; Tar, Drs. E. L. Kennaway and I. Hieger, 932
- Candies and Chocolate, Micro-organisms in, 104
- Caoutchouc Conger, The, C. Pérard, 75
- Capreolus* of Eastern Asia, Some New Data on, K. K. Flerov, 34
- Carbon: Dioxide, Non-disjunction produced by, J. C. Mottram, 275; Disulphide, The Inflammation and Combustion of, M. Prettre and P. Laffitte, 766; Molecule, Some Bands of the, Dr. G. H. Dieke and W. L. Holtgreven, 51; Dr. R. C. Johnson, 89; Monoxide, Ignition of, Smithells, Whitaker, and Holmes, 545; Reduction of, S. Kodama, 836
- Carbonic Acid of Powdered Limestones, Correlation between the Fineness and the Solubility in, and their Neutralising Action on Acid Soils, C. Brioux and E. Jouis, 397
- Carboniferous Inliers at Codrington and Wick (Gloucestershire), The, Stanley Smith, 221
- Carbonisation Tests, 687
- Carbonyl Group, An Ultimate Property of the, R. Cornubert and R. Humeau, 622
- Cardiff University College: H. J. Phelps appointed assistant lecturer and demonstrator in physiology, 476; The Tatem Laboratories at, 837
- Cardita beaumonti* Beds of Sind, H. Douvillé, 28
- Carnegie: Foundation for the Advancement of Teaching, Annual Report, 31; Institution of Washington, Department of Terrestrial Magnetism, Retirement of Dr. L. A. Bauer; J. A. Fleming to be acting director, 176; Trust for the Universities of Scotland, Report for 1928-1929, 431
- Carotene, The Vitamin Activity of, M. Javillier and Mlle. L. Emerique, 622
- Carp, The 'German', Prof. W. M. Smallwood and Mary M. Smallwood, 66
- Casein, Molecular Weight of, Svedberg, L. M. Carpenter and D. C. Carpenter, 652
- Cast Irons, The Dilatometric Analysis of Some Synthetic, with Nickel, Vanadium, and Nickel-vanadium, J. Challansonnet, 842
- Caste System in India, Origin of the, the late C. Hill, 685
- Castor Oil Plant, Cultivation of the, 872
- Cataclasmis in Evolution, The Importance of, Dr. G. P. Bidder, 783
- Catalans: Les paysages, leurs aspects, leur structure et leur évolution, M. Chevalier, 232
- Catalytic Hydrogenation: The Mechanism of M. Bourguel and Mlle. V. Gredy, 74; Reactions at High Pressures, Dr. E. K. Rideal, 584
- Catgut, Sterilised Surgical, 506
- Caulerpa*, Sundry Observations on, G. Tandy, 336
- Cellular Individuality in the Higher Animals, C. Todd, 149
- Cellulose: Crystal Lattice of, Adsorption on the, J. Strachan, 671; in the Light of the X-rays, Sir William Bragg, 176, 315, 324; Space Lattice, New Data on, Prof. O. L. Sponser, 633; Sir W. Bragg, 634; The Hydrolysis of, Miss J. Chalmers and J. C. Earl, (1), 659
- Cements and Concretes, The Mechanical Theory of the Solidification and Hardening of, J. Basta, 915
- Centenaries, Scientific, in 1930, 21
- Central: Asia, A Gravimetric and Seismic Expedition to, D. I. Musketov and P. M. Nikiforov, 586; Carnic Alps, Geology of the, H. R. v. Gaertner, 398
- Cepedea* in Frogs, Occurrence of, W. R. Wright, 52
- Cephalopod, A Rare, G. C. Robson, 330
- Cephalopoda: A Monograph of the Recent, based on the Collections in the British Museum (Natural History). Part 1: Octopodinae, G. C. Robson, 850
- Cepheids, On Four 'Mean' Curves Relative to the, G. Tiercy, 294
- Ceratioid Fish, A New (*Caulophryne* sp.), Female with Male, from off Madeira, Dr. C. Tate Regan, 621
- Cereal: Breeding, Dr. E. S. Beaven, 544; Synonyms, Conference on, 100
- Cereals, Transplanting, 651
- Cerebral Hemispheres, Crossed Connexion of the, with the Muscles and Sense Organs, Prof. H. E. Roaf, 203, 493; R. S. Creed, 307
- Chadwick gold medal and Naval prize, award of the, to Surg.-Capt. S. F. Dudley, 250
- Channel Tunnel, Report of a Sub-committee of the Committee of Civil Research on the Proposed, 467
- Charcoal: Combustion of, M. S. Shah, 290; Vegetable, The Preparation of (1), J. Milbauer, 622
- Charles II., Three-hundredth Anniversary of the Birth of, 828
- Chelidone, The Ultra-Violet Absorption Spectrum of, V. Brustier, 550
- Chemical: and Physical Changes, The Effects of Moisture on, Dr. J. W. Smith, 229; Change in Gaseous Systems, The Kinetics of, C. N. Hinshelwood. Second edition, 703; Changes, Rapid, Dr. F. J. W. Roughton, 393; Denudation, J. V. Eriksson, 253; Dictionary, A, Prof. I. W. D. Haack, 593; Prof. C. S. Gibson, 593; *Education, Journal of*, 333; Engineering Economics, 964; Industries, Proposed Standardising Body for the, 945; Mechanics, The Development of, A. Skrabal, 767; Training, Prof. A. Smithells, 421; Warfare, Dr. H. Levinstein, 254
- Chemische Zentrablatt*, Das, Dr. M. Pflücke on, 98
- 'Chemist', Use of the Word, 644
- Chemistry: A New School, F. S. Taylor, 303; An Inorganic, Prof. H. G. Denham. Second edition, 888; and Chemical Industry, Proposed Building for Principal Societies and Institutions concerned with, 390; and the Quantum Theory, Prof. N. Bohr, 788; Applied, Reports on the Progress of, Vol. 14, 1929, 739; Brighter, Prof. J. Read, 155; in the Home, Dr. J. B. Firth, 269; Institute of, Presidential Address to the, Prof. A. Smithells, 644; Physical, Dr. J. B. Firth, 84; Experimental, Prof. F. Daniels, Prof. J. Mathews, and Prof. J. W. Williams, 596; Progressive, 333; Theoretical and Applied Colloid, 771
- Chemists, The Rationalisation of, 517
- Chicago Museum of Science and Industry, Appointments at the, 648
- Chicken and Duck Embryos, Developmental Mechanics of, C. H. Waddington, 924
- Child from Five to Ten, The, Interests and Problems of Early Childhood, Evelyn and Miriam Kenwick, 161
- Chimiques des Pays-Bas, Recueil des travaux*, No. 9, 179
- Chimney Dust Problems, J. W. Gibson, 574
- China: Early Man in, Prof. G. Elliot Smith, 448; *Geological Society of, Bulletin of the*, Vol. 8, No. 3, 715; Pleistocene Man in, Prof. Davidson Black, 22
- Chinese: Amphibia, H. G. Gee and Alice M. Boring, 650; and Malayan Medicine, 862; Mammals, N. G. Gee, 871; Students, Variation in, Ju-chi Li, 834; Wood (Tung) Oil, Composition and Polymerisation of, E. R. Bolton and K. A. Williams, 802
- Chipmunks, American, A. H. Howell, 181
- Chlorides of the Aromatic Sulphonic Acids, The Action of the, on the Sodium Derivatives of Acetylene Hydrocarbons, M. Bourguel and R. Truchet, 730
- Chlorine: Band Spectrum of, A. Elliott, 989; Distribution of, between the Serum and the Blood Corpuscles in Disease, C. Achard and M. Enachesco, 958
- Chlorophyll, The Fossil Remains of, in Marine Mud Deposits, V. N. Lubimenko and Mme. Rauser-Cernousova, 766
- Chrysochilum echini* Maupas, Nuclear Dualism and Sexuality in, A. Russo, 878
- Chumash Prehistory, R. L. Olson, 758
- Cicadas, 122
- Civil Engineers: Institution of, awards of the, 869; Baron K. Furiuchi elected an honorary member of the, 328; Service Estimates, Education and Science in the, 430
- Civilized? Are we, Human Culture in Perspective, Prof. R. H. Lowrie, 383
- Clean Air*, 64
- Climate: of the First Half of the Eighteenth Century, The, Dr. C. E. P. Brooks, 995; of the Pleistocene Period, The, Dr. G. C. Simpson, 992
- Climatic Changes in Central Asia, Lt.-Col. R. C. F. Schomburg, 759

- Coal : Chemistry of, Researches on the, (6), Prof. W. A. Bone, L. Horton, and S. H. Ward, 801 ; Dust Inflammability, Measurement of, A. S. Godbert and Prof. R. V. Wheeler, 332 ; Gas, Dehydrating, before Distribution, Dr. E. W. Smith, 909 ; Measure Plants, Dr. R. Crookall, 159 ; Measures of North Staffordshire, The Flora of the Upper Portion of the, Emily Dix, 802 ; Microscopic Examination of, C. A. Seyler, 988 ; Seams, The Yield of, Bocking and Bailey, 697
- Cobalt : and Nickel, Crystalline Structure of Neutral Carbonates of, A. Ferrari and C. Colla, 658 ; Salts : in Alkaline Media, The Oxidation of, R. Bernard and P. Job, 337 ; in Concentrated Solutions, The Absorption of, P. Vaillant, 337
- Cockroaches eat Bed Bugs ? Do, A. N. Gulati, 858
- Cocksfoot Grass, Prof. Stapledon, 951
- Cœlenterate Nematocysts, New Results from the Study of, R. F. Weill, 623
- Coincidences, Enumeration of, Dr. W. Bothe, 105
- Coke Ovens, Functions of, E. G. Stewart, 909
- Cold-rolling Mill, Experimental, 29
- Coleoptera, Larvæ of the, A. W. A. Roberts, 988
- Collagen, The Hydrophil Properties of, L. Meunier and K. Le Viet, 74
- Collembola of Ireland, H. Womersley, 508
- Collodion Gel Films, Structure in very Permeable, and its Significance in Filtration Problems, W. J. Elford, 432
- Colloidal : Particles in Soap Sols and Gels, The Identity of, Dr. K. Krishnamurti, 746 ; Powders, The Microscopic Examination of, in Polarised Light, A. Michel-Lévy and H. Muraour, 150
- Colonial : Official Appointments, 102, 328, 424, 576, 755, 903 ; Services, Recruitment in the, 917
- Colour : Changes in Animals, The Basis of, Prof. G. H. Parker, 758 ; Matching and Specifying, Exact, L. B. Desbleds, 12
- Coloured : Glass as a Deterrent to House Flies, Pilkington Bros., Ltd., 529 ; A. D. Buchanan Smith ; H. E. Beckett, 780
- Colouring Matters, The Luminosity of some, in Ultra-Violet Light, P. Balavoine, 915
- Colston Research Society, The, 752
- Comenius and the Indians of New England, R. F. Young, 680
- Comet : New, 1930a, 329 ; 1930b, 471 ; 1930d, 721 ; 1927d, 757 ; Schwassmann-Wachmann (1), Dr. W. Baade, 103 ; Wilk, The New, 1930c, 542
- Comets, 26, 214, 425, 507, 870
- Commonwealth Fund Fellowships, 72, 912
- Congo, Travels in the, A. Gide, translated by Dorothy Bussy, 596
- Connemara, Southern, The Vegetation of, Gertrude Conolly, 33
- Constellation Boundaries, New, 721
- Continent to the Equator, The Force which, at Earlier Periods, tended to draw a, R. Wavre, 914
- Continental Connexions in the Cretaceous, Prof. C. Schuchert, 331
- Copper : and Bronze in South Africa, Early, late Dr. P. A. Wagner ; G. H. Stanley, 799 ; Effects of Impurities on, Part 6, D. Hanson, S. L. Archbutt, and Grace W. Ford, 513 ; Gases in, and their Removal, W. E. Prytherch, 477 ; Ingots, Soundness of, Influence of Gases on the, N. P. Allen, 477 ; in Certain Organs in the Higher Animals, The Physiological Presence of, E. Cherbuliez and St. Ansbacher, 186 ; Oxide, Band Spectra of, P. C. Mahanti, 819 ; Rectifier, The, H. Pélabon, 622 ; Passive, M. Nottage, 579 ; The Electrolytic Deposit of, in the Presence of Amino Acids, C. Marie and Gérard, 803
- Coral Reef Limestone, Solution of, W. A. Macfadyen, 215
- Core Drilling Bituminous Sands, S. C. Ells, 795
- Corpus Luteum of the Cow, Presence of a Kuogenic Substance in the, J. S. Patel, 257
- Alytes*, The Acquired Characters of, Dr. C. Walker, 562, 889 ; Prof. E. W. MacBride, 670 ; Prof. H. Przibram, 856
- Ammonia Discharge Tube, The Exit Gas from an, G. I. Lavin and J. R. Bates, 709
- Anthropological Congress, An, Prof. J. L. Myres, 494, 672
- Atmospheric : Light Columns from Artificial Lights, B. W. Currie ; Dr. F. J. W. Whipple, 526, 743 ; H. Nicol, 671 ; A. H. R. Goldie, 743 ; Oxygen (Intercombination) Bands, Intensities in the, Dr. W. H. J. Childs and Prof. R. Mecke, 599
- Atomic Nuclei, Magnetic Moments of, Prof. E. Fermi, 16
- Aucuba or Yellow Mosaic of the Tomato Plant : Reaction of Infected Juice, Dr. W. F. Bewley and B. J. Bolas, 130
- Auroral Rays, Sunlit, Spectrum of, Prof. C. Stormer, 305
- Australian Origin of Red Rain in New Zealand, Dr. E. Kidson ; Prof. J. W. Gregory, 410
- Australopithecus*, The Age of, Dr. R. Broom, 814
- Bac. saccharobutyricus* v. Klecki, The Life-Cycle of, A. Cunningham, 168
- Band Spectra, Intensities in, E. Hutchisson, 746
- Batyl Alcohol, Monomolecular Films of, B. C. J. G. Knight, 351
- Bed Bugs ? Do Cockroaches eat, A. N. Gulati, 858
- Benzene, The Tesla-Luminescent Spectrum of, Dr. I. A. Black, 274
- Bismuth and Antimony, Influence of Chemical Colloidisation on the Anomalous Diamagnetism of, V. I. Vaidyanathan, 672
- Blowfly's Mouth, The, T. H. Taylor, 238
- Book Prices and Reading, Prof. H. E. Armstrong, 234
- Botanical Nomenclature, R. A. Inglis, 204 ; T. A. Sprague, 310
- Bromine Nucleus, The Moment of the, Dr. T. L. de Bruin, 414
- Calcite, Reflections of Protons from, Prof. A. J. Dempster, 51
- Calcium Hydride, Pressure Effects in the Band Spectrum of, B. Grundström and Prof. E. Hulthén, 634
- Campanula persicifolia*, Structural Variation in the Chromosomes of, Alice E. Gairdner and C. D. Darlington, 87
- Carbon : Dioxide, Non-Disjunction produced by, J. C. Mottram, 275 ; Molecule, Some Bands of the, Dr. G. H. Dieke and W. Lochte Holtgreven, 51 ; Dr. R. C. Johnson, 89
- Cellulose : Crystal Lattice of, Adsorption on the, J. Strachan, 671 ; Space Lattice, New Data on, Prof. O. L. Sponser, 633 ; Sir W. H. Bragg, 634
- Cepedea* in Frogs, Occurrence of, W. Rees Wright, 52
- Cerebral Hemispheres, Crossed Connexion of the, with the Muscles and Sense Organs, Prof. H. E. Roaf, 203, 493 ; R. S. Creed, 307
- Chemistry, Organic, at University College, London, Sir W. J. Pope, 238 ; Prof. J. Thorpe, 239
- Chicken and Duck Embryos, Developmental Mechanics of, C. H. Waddington, 924
- Chinese Rice, Early, H. Nicol, 819
- Coloured Glass as a Deterrent to House Flies, Pilkington Bros., Ltd., 529 ; A. D. Buchanan Smith ; H. E. Beckett, 780
- Copper Oxide, Band Spectra of, P. C. Mahanti, 819
- Cosmological Conjecture, A, E. U. Condon and J. E. Mack, 455
- Cotton : Angular Leaf-spot Disease of, R. H. Stoughton, 350 ; Leaf-Curl in, T. W. Kirkpatrick, 672
- Craspedacusta (Limnocodium) Sowerbii* in the Exeter Ship Canal, Occurrence of, R. Vallentin, 15
- 'Critical Illumination' in the Microscope, A Point in the History of, Dr. L. C. Martin, 741
- Crystalline : Nitrates, Raman Spectra of, Prof. W. Gerlach, 819 ; Style of the Mollusca, The, and a Carnivorous Habit cannot normally Co-exist, Dr. C. M. Yonge, 444
- Crystals : Complete Spectral Diagrams of, H. Seemann, O. Kantorowicz and Dr. K. F. Schotzky, 853 ; Reflection of Positive Ions by, Prof. A. J. Dempster, 741
- Curling, W. H. Macaulay and Brig.-Genl. G. E. Smith, 408 ; C. W. Richardson, 494
- Cuttlefish, The Swimming of, F. S. Russell and G. A. Steven, 893
- Cyanogen-Oxygen Flame, Radiation from, Effect of Hydrogen and Water on, K. Tawada, 705

CORRESPONDENCE.

- α Benzilmonoxime, The Conversion of, in the β Oxime by Animal Charcoal, T. W. J. Taylor and Sally Marks, 636
- α -Particles, Scattering of, by Light Atoms, Prof. A. C. Banerji, 167 ; C. Møller, 459

- Daylight, The Photo-electric Recording of, Dr. W. R. G. Atkins and Dr. H. H. Poole, 305; Dr. T. H. Harrison, 704
- Death Watch Beetle (*Xestobium rufo-villosum* De G.), Presence of a Yeast in the, L. N. Staniland, 635; R. C. Fisher and E. A. Parkin, 892
- Diamond: Infra-red: Frequencies of the, Interpretation of, Prof. F. Simon, 855; Spectrum of, by Infra-red Spectrometer and Raman Methods, Sir Robert Robertson and Dr. J. J. Fox, 704; Raman Effect in, C. Ramaswamy, 704
- Diphenylethylene Oxide, Optically Active, Prof. J. Read and Ishbel G. M. Campbell, 16
- Dipole Moment of some Organic Halides, D. N. Sen Gupta, 600
- Discharges at Liquid Surfaces, The Ions produced by, Prof. J. Zeleny, 706
- Disease-producing Viruses, Nature of, G. Samuel, 51
- Drosophila melanogaster*: The Hybridity of, C. D. Darlington, 600; The Present Status of, Prof. E. C. Jeffrey, 411
- Dust Particles and Intensive Desiccation, Contamination by, Prof. A. W. C. Menzies, 445
- Earth, Age of the, Prof. A. P. Coleman, 668
- Echinoid, A Deep Sea, in British Waters, H. B. Moore, 351
- Echo Sounding and Depths, Rear-Admiral H. P. Douglas, 893
- Electrical Discharge through Hydrogen, A Singular Behaviour of Striæ in the Positive Column of an, Prof. J. Zeleny, 562
- Electrolytic Rectification, The Mechanism of, M. E. MacGregor, 128
- Electron: Affinities of the Elements, J. H. Bartlett, Jun., 459; Diffraction, Visible, Dr. A. Dauvillier, 50
- Electrons: and α -Particles, Scattering of, Dr. G. Beck, 458; and Positive Ions in the Upper Atmosphere, Recombination of, T. L. Eckersley, 679; in a Gas Tube, Behaviour of, W. A. Wood and J. Thewlis, 457; in Mercury Vapour, Energy Losses of, D. C. Rose, 460
- Elm-Tree Bark, Nutritive Value of, Sir L. Hill, 780
- Emission Spectra, New Types of, Prof. L. Vegard, 14
- "Encyclopædia Britannica", Prof. J. Proudman, 239; Encyclopædia Britannica Co., Ltd., 311
- Ethyl Alcohol: a Product of High Pressure Syntheses, Prof. G. T. Morgan and R. Taylor, 889
- Evolution: and Evidence, Major L. Darwin, 126; Reversibility of, Prof. E. W. MacBride, 166
- Fechner's Law, Dr. R. A. Houstoun and J. F. Shearer, 891
- de Ferranti, Dr. Sebastian Z., Sir R. T. Glazebrook, 239
- Ferromagnetics, The Thermo-electric Properties of, Dr. E. C. Stoner, 973
- Flint Implements: of Lower Palæolithic Age from the Mammaliferous Gravels of Yorkshire, J. P. T. Burchell, 858; of Upper Palæolithic Types from Glacial Deposits in Norfolk and Yorkshire, J. Reid Moir, 234; J. P. T. Burchell, 235
- Fluidity of Liquids, The Relation of, to Temperature, Dr. S. E. Sheppard, 489, 709
- Fluorescent and Phosphorescent Substances, Prof. J. R. Partington, 636
- Fossil-Plants, Improvements in the Peel-method of Preparing Sections of, Dr. J. Walton, 413
- Frequency, The Growing Importance of, Prof. A. S. Eve, 454
- Freshwater Biological Research in the Indian Empire, K. Biswas, 670
- Fungi, Sex in, D. M. Cayley, 527
- Galls, Dr. M. Nierenstein, 348
- Gaseous: Combustion, Prof. W. T. David and W. Davies, 127; Prof. W. A. Bone, 274; Prof. W. T. David, 409; Reactions, Homogeneous Catalysis of, Dr. K. Clusius and C. N. Hinshelwood, 311
- Gases: Measurement of Relative Heats of, at High Temperatures, P. M. S. Blackett and Dr. E. K. Rideal, 816; Specific Heats of, The Fallacious Determination of the, by the Explosion Method, Dr. O. C. de C. Ellis, 165
- Gas Exchanges of Living Tissues, A Method of Investigating, T. A. Bennet-Clark, 492
- Geiger's Counters, Several, Method of Registering Multiple Simultaneous Impulses of, B. Rossi, 636
- Gibbs-Ewald Reciprocal Lattice, The, Dr. A. L. Patterson, 238, 447
- Gibraltar, Strait of, Undercurrents in the, Rear-Admiral H. P. Douglas, 780
- Glancing Angle of Reflection from Calcite for Silver (Ka_1) X-Rays, Prof. C. D. Cooksey and D. Cooksey, 461
- Glasses: Loss of Ultra-Violet Transparency in, Dr. S. English, 85; Transparent to Ultra-Violet Radiation, A. R. Wood and M. N. Leathwood, 351
- Glass Tubes or Rods bend under their own Weight? Do, Lord Rayleigh, 311; C. D. Spencer, 707
- Globular Lightning, Prof. E. W. Marchant, 128; Dr. W. C. Reynolds, 413
- Grating Errors and Electronic Charge, S. Fagerberg, 13
- Green Flash in Southern California, The, Prof. S. J. Barnett, 446
- Group Velocity and Wave Mechanics, Prof. H. S. Allen, 561
- Helium Bands, Electronic Fine Structure in, S. Imanishi, 529
- Hive-Bee, Evolution of the, J. T. Cunningham, 857
- Homo, Width of Head and Pelvis in, Prof. T. D. A. Cockerell, 131
- Horse and Fowl Hæmoglobin, Prof. A. B. Macallum and R. C. Bradley, 494
- Hydrogen: Molecule, New Spectrum of the, Dr. J. J. Hopfield, 927; Molecular Spectrum of, New Bands in the, Dattatraya Shridhar Jog, 709; Moment of Inertia of: from Band Spectra, Dr. H. H. Hyman and C. R. Jeppesen, 462; from Raman Effect, Prof. R. T. Birge and C. R. Jeppesen, 463; Spectra of, A Relation between the Continuous and the Many-lined, Y. Hukumoto, 975
- Indeterminacy in Physics, Prof. R. A. Sampson, 493
- Inorganic Salts, Colours of, Prof. M. N. Saha, 163; C. P. Snow and F. I. G. Rawlins, 349
- Insect Pests of Willows, H. P. Hutchinson and H. G. H. Kearns, 201
- Ions produced by Discharges at Liquid Surfaces, The, Prof. J. J. Nolan and J. G. O'Keeffe, 893
- Iron: Crystals, Single, Nature of the Magnetisation Curve of, Dr. D. Foster and Dr. R. M. Bozorth, 525; Meteorites, The Age of, Prof. F. Paneth, W. D. Urry and W. Koeck, 490
- Isolation of the Radical Ethyl, Prof. F. Paneth and W. Lautsch, 564
- Isothermal Reaction $2CO + O_2 = 2CO_2$, The Homogeneous, in the Presence of Water Vapour, B. Topley, 560
- Kristall, Polarisierte und gerichtete Röntgenstrahlung aus einem, Prof. J. Stark, 745
- Krypton: The Crystal Structure of, Prof. W. H. Keesom and H. H. Mooy; Profs. Natta and A. G. Nasini, 889; Treble Ionised, Spectrum of, Prof. D. P. Acharya, 204
- Leaf-fall in Singapore, Periodicity of, R. E. Holtum, 129
- Light in Four Dimensional Space, J. H. Johnston, 199, 709
- Lightning, Globular, Prof. E. W. Marchant, 128; Dr. W. C. Reynolds, 413
- Liliaceous Plants, The Secondary Split in the Maturation Divisions of, Dr. J. Belling, 52
- Liquids, The Viscosity of, Prof. E. N. da C. Andrade, 309
- Lithium: and Beryllium, Hydrogen-like Spectra of, in the Extreme Ultra-Violet, B. Edlén and A. Ericson, 233; The Nuclear Moment of, S. Goudsmit and L. A. Young, 461
- Liver Fluke for Class Purposes, A Method of obtaining Stages in the Life History of the, Dr. N. B. Eales, 779
- Lucilia sericata*, Natural Control of, Dr. G. Salt, 203
- Lumbricus*, The Oogenesis of, Maureen O'Brien and Prof. J. B. Gatenby, 891
- Luminescence, Water as an Activator of, J. Ewles, 706
- Luminosity, The Connexion of Mass with, for Stars, Sir Joseph Larmor, 273
- Magic Square of Fifth Order, Major J. C. Burnett, 17
- Man, The Ancestry of, Prof. H. F. Osborn, 745
- Mass, The Connexion of, with Luminosity for Stars, Sir Joseph Larmor, 273
- Matthew Island, Prof. T. D. A. Cockerell, 414
- Menformon, Crystalline, Prof. E. Laqueur, E. Dingemanse, and S. Kober, 90
- Menthylamines and Menthols, Optical Superposition among, Prof. J. Read and R. A. Storey, 86
- Mercury: Hydride, Ionised, The Spectrum of, Prof. T. Hori, 131; Intermetallic Compounds in, Dr. A. S. Russell, 89; Vapour in the Far Ultra-Violet, Fluorescence of, M. Eliashevich and A. Terenin, 856

- Metameric Hydrogens, Anent, Prof. H. E. Armstrong, 46
Methylene Blue, Penetration of, into Living Cells, Dr. Matilda Moldenhauer Brooks, 599
Methyl Glyoxal as an Intermediary in Fermentation, J. O. Giršavičius, 817
Molecular Weight Determination, Comparison of the Ultracentrifuge Method for, with the Classical Methods, J. B. Nichols, 814
Molecule O₂, The Heat of Dissociation of the, and Sutherland's Constant for Oxygen, S. Bressler and V. Kondratjew, 164
Molecules, Photo-Decomposition of, having Diffuse Band Spectra, Prof. H. S. Taylor and J. R. Bates, 599
Moth, The Accuracy of a, Sir Flinders Petrie, 928
Mounting Medium for Film Sections, E. E. Jelley, 276, 672; W. Marshall, 563; J. M. Preston, 563
Mouse, Pregnancy in the, Mating during, Prof. F. A. E. Crew and L. Miskaia, 564
Multiple Spermatozoa and the Chromosome Hypothesis of Heredity, Dr. E. Warren, 973
Muscular Sense, The, Col. A. Lynch, 52; Prof. D. F. Fraser-Harris, 204
Naphthalene and Anthracene, Structure of, Dr. K. Banerjee; J. M. Robertson, 456
Native Policy in South Africa, G. W. Grabham, 131
Neon: A probable Band Spectrum of, D. G. Dharvale, 276; Lamp as a Glow Relay, The, L. Bellingham, 928
Nerve Centres, Mechanism in, J. T. MacCurdy, 632
Nervous System, Association of Stimuli in the Development and Function of the, R. S. Worrall, 927
Nickel, A Diamagnetic Simple Salt of, Prof. D. M. Bose, 708
Nitrifying Bacteria, Dr. D. W. Cutler, 168
Nitrogen: Active, The Stern-Gerlach Experiment with, Dr. L. C. Jackson, 131; Ionisation in, J. H. Bruce, 780; Peroxide Molecule and the Heat of Dissociation of Oxygen, Existence of Two Limits of Predissociation in the, Prof. V. Henri, 202
Noise, Measurements of, by means of a Tuning-fork, Dr. A. H. Davis, 48
Oceanic Plankton Animals lose themselves? Do, F. S. Russell, 17
Oenothera? Telosynapsis or Structural Hybridity in, C. D. Darlington, 743; Prof. R. R. Gates, 854
Oestrin, Preparation of, G. F. Marrian, 90
Organic Chemistry: at University College, London, Sir W. J. Pope, 238; Prof. J. Thorpe, 239; in Peril, Prof. H. E. Armstrong, 344; Compounds, The Binding Energy of some, L. S. Kassel, 926
Oxygen, Dissociation Energy of, determined from the Predissociation of Sulphur Dioxide, Prof. V. Henri, 275; The Heat of Dissociation of, and of the C-H Bond, Prof. R. Mecke, 526
Parachor, The, and Molecular Volume, Dr. A. Ferguson, 597; Dr. S. Sugden, 778
Parasites and Phagocytes, Entomophagous, Dr. W. R. Thompson, 167
Parasitism: a Stimulus to Pupation: *Alysia manducator* in relation to the Host *Lucilia sericata*, F. G. Holdaway and A. C. Evans, 598; in relation to Pupation in *Lucilia sericata* Meig., Dr. W. M. Davies, 779; Recovery from, C. C. Brooks, 14
Pauli's Exclusion Principle, On the Correct Formulation of, Prof. J. Frenkel, 235
Philosophy: Science and, A proposed International Conference, Prof. F. G. Donnan, 857; W. Trotter, 924
Phosphorus, White, The Crystal Structure of, Prof. G. Natta and L. Passerini, 707
Placenta, The Ovary Stimulating Hormone of the, Prof. J. B. Collip, 444
Planet discovered at Lowell Observatory, The, Dr. J. Jackson, 491; The New, F. Baldet, 672; G. F. Daniell, 746
Plants, Mortality amongst, and its Bearing on Natural Selection, Prof. E. J. Salisbury, 817; Dr. R. A. Fisher, 972; Prof. E. W. MacBride, 973
Plant Virus Diseases, Intracellular Bodies in, F. M. L. Sheffield and J. Henderson Smith, 200
(Polonium), Element 84, Search for an Inactive Isotope of the, Prof. G. Hevesy and A. Guenther, 744
Potassium, Radioactive Disintegration of, The Product of the, A. V. Frost and O. Frost; Prof. A. Holmes and Dr. R. W. Lawson, 48; Prof. O. Hönigschmid, 91
Potato Leaf-Roll, Transmission of, Dr. T. Whitehead, 974
Primates, The Classification of the, Dr. C. Tate Regan, 125; Prof. W. E. Le Gros Clarke, 236; Prof. G. Elliot Smith, 270; H. Bury, 311
Protozoa and Algæ, Preparations of, Dr. Ll. Lloyd; E. Heron-Allen, 91; R. W. Butcher, 276
Pyrenoids, Starch Envelopes of, F. O. Howitt, 412
Quantitative Analysis by X-rays, Prof. T. H. Laby and C. E. Eddy, 524; Prof. G. Hevesy, 776; Prof. T. H. Laby, 818
Quantum Theory of the Kinetics of Homogeneous and Heterogeneous Reactions, The, S. Roginsky and L. Rosenkewitsch, 347
Radcliffe Observatory, The, Prof. A. Fowler, 776
Raman Effect: for Solutions of Sulphur Dioxide, Prof. W. D. Harkins, D. M. Gans, and H. E. Bowers, 464; in Diamond, C. Ramaswamy, 704; in Liquefied Gases, J. B. Austin, 464; in Metallic Halides, P. Krishnamurti, 892; in the X-ray Region, Prof. A. Carrelli, 201; in Water, I. Ramakrishna Rao, 600; of Sulphuric Acid, R. M. Bell and W. R. Fredrickson, 892; The 'Common Third Level' in the, R. C. Majumdar and D. S. Kothari, 165; with Optically Active Substances, S. Bhagavantam and S. Venkateswaran, 237; Lines in Diatomic Gases, Optical Anisotropy and Theoretical Intensities of, Prof. G. Manneback, 88; Lines of Mercury in Arc improbable, Prof. R. W. Wood, 464; Spectra of Crystalline Powders, P. Krishnamurti, 463
Red Rain in New Zealand, Australian Origin of, Dr. E. Kidson; Prof. J. W. Gregory, 410
Relativity Postulate, Test of a, Sir Oliver Lodge, 632
Research and the State, Sir James W. Barrett, 310
Rhodesian Gold, Early, Dr. T. A. Rickard; Prof. J. W. Gregory, 47; Miss Gertrude Caton-Thompson, 163
Rowing, 'Digging' in, Dr. H. Jeffreys, 928
Ruthenium a Superconductor, Prof. J. C. McLennan, 168
School Science and Educational Values, Prof. H. E. Armstrong; A. A. E., 560
Science and Philosophy: a proposed International Conference, Prof. F. G. Donnan, 857; W. Trotter, 924
Sea-Urchins, Spines in, Regeneration of the, A. D. Hobson, 168
Selenium Dioxide, The Absorption Spectrum of, S. F. Evans, 528
Siliceous Shells of Protozoa, Prof. T. D. A. Cockerell, 975
Silicon Oxide: Fine Structure of K-Absorption Limit of, G. B. Deodhar, 777; Transformer Steel Residue, W. A. Wood, 974
Slug or Horned Viper? Miss M. A. Murray, 975; The Oldest Record of a, Prof. T. D. A. Cockerell, 745; G. C. Robson, 893
Soap Films, Stability in, W. J. Green, 815; A. S. C. Lawrence, 970; Sols and Gels, The Identity of Colloidal Particles in, Dr. K. Krishnamurti, 746; Sols and Jellies, The Identity of the Colloidal Particles in, Dr. M. E. L. McBain and Prof. J. W. McBain, 125
Sodium, The Vapour Density of, Prof. W. H. Rodebush, 130
Solid Phase Reaction, A First Order, Dr. B. Lewis and Dr. Hans-Joachim Schumacher, 129
Solutions containing Two Solutes, Adsorption from, Dr. J. A. V. Butler and C. Ockrent, 853
Sonometer Wire, Frequency of, Effect of Direct Current on the, D. V. Gogate and Y. G. Naik, 819
South Africa, Native Policy in, G. W. Grabham, 131
Stark Effect in the Ultra-Violet Spectrum of Neon, Prof. Y. Ishida, 970
Stars, The Connexion of Mass with Luminosity for Stars, Sir Joseph Larmor, 273
Stellar: Absorption Lines, Dr. O. Struve and C. T. Elvey, 308; Luminosity, The Problem of, Prof. E. A. Milne, 453, 708; Prof. A. S. Eddington, 489
Sterilisation as a Practical Policy, Dr. Marie C. Stopes, 204
Stern-Gerlach Experiment with Active Nitrogen, The, Dr. L. C. Jackson, 131
Striated Discharge, The, Dr. D. A. Keys and J. F. Heard, 971
Sulphur: Band Spectrum of, H. H. Van Iddekinge, 858; X-ray Spectrum of, Researches on the, Dr. O. Lundquist, 925
Sunlight: in the Tropics: Integration of, J. A. C. Teegan and G. R. Rendall, 447; Integration of, A. F. Dufton, 635

- Superconducting Alloy, A, with Resistance Temperature Hysteresis, Prof. J. C. McLennan, 447
- Sutherland's Constant for Oxygen, The Heat of Dissociation of the Molecule O_4 and, S. Bressler and V. Kondratjew, 164
- Terminal Segments of Psychodid Larvæ, Taxonomic, Importance of the, S. Mukerji, 446
- Tertiary Man, J. Reid Moir, 167
- Thames Floods and Pollution, Dr. R. T. Gunther, 49
- Thymus (in Calcium Metabolism), An Apparent Rôle for the, Dr. L. J. Harris, 346
- Tides of the Upper Atmosphere and the Heights of Meteors, Dr. J. Egedal, 202
- Tomato Plant: Aucuba or Yellow Mosaic of the, Reaction of Infected Juice, Dr. W. F. Bewley and B. J. Bolas, 130
- Trout Spermatozoa, The Maladaptation of, to Fresh Water, Prof. J. S. Huxley, 494; A. Walton, 564
- Ultra-Violet: Absorption Spectra and Heats of Combustion, A Relation between, Emma P. Carr, 237; Transparency in Glasses, Loss of, Dr. S. English, 85
- Uncertainty, Legitimate, Sir Oliver Lodge, 17; The Scientific Principle of, Sir Joseph Larmor, 345
- Unemployment and Hope, Prof. F. Soddy, 345; W. G. Linn Cass, 346
- Unified Physical Field, A New Relativity Theory of the, W. Band, 130
- Unimolecular Films, C. G. Lyons and Dr. E. K. Rideal, 455
- Vaporisation and Vapour Pressure: Rate of, a Method of Measuring the Specific Area of a Surface, Dr. F. J. Wilkins, 236
- Viruses and Life, Dr. J. J. Davis, 351
- Vitamin D, The Absorption Spectrum of, R. B. Bourdillon, R. G. C. Jenkins, and T. A. Webster, 635
- Voltaic Pile, The Original Mode of Constructing a, W. C. Walker, 349
- Water Balance of Plants, The, as a Factor in their Resistance to Insect Pests, E. P. Mumford and D. H. Hey, 411
- Water-meadows and River-flow, J. H. Coste, 858
- 'Wave-band': Theory of Wireless Transmission, The, Prof. C. L. Fortescue; L. H. Bedford; Sir Ambrose Fleming, 198, 307; Sir Oliver Lodge, 271; Sir R. T. Glazebrook, 272; Prof. C. L. Fortescue, 272; J. A. Ratcliffe, 272; G. B. Brown, 272; E. H. Linfoot, 306; A. A. Newbold, 306; Wave Mechanics, Group Velocity and, Prof. H. S. Allen, 561
- Whales, The Integuments of, R. W. Gray, 744
- Whirlwind in Natal, An Exceptional, Dr. E. Warren, 890
- Wild Birds and Butterflies, Prof. J. B. Cleland, 276
- Willows, Insect Pests of, H. P. Hutchinson and H. G. H. Kearns, 201; H. G. H. Kearns, 276
- Wireless Transmission: The 'Wave-band' Theory of, Prof. C. L. Fortescue; L. H. Bedford; Sir Oliver Lodge, 271; Sir R. T. Glazebrook, 272; Sir Ambrose Fleming, 198, 307; Prof. C. L. Fortescue, 272; J. A. Ratcliffe, 272; G. B. Brown, 272; E. H. Linfoot, 306; A. A. Newbold, 306; Waves, Negative Attenuation of, J. A. Ratcliffe and F. W. G. White, 926
- Xenon, The Crystal Structure of, Prof. G. Natta and Prof. A. G. Nasini, 457
- X-ray Measurements with a Plane Diffraction Grating, E. Bäcklin, 239
- X-rays: Scattering of, by Bound Electrons, Prof. B. B. Ray, 746, 856; The Diffraction of, by Vitreous Solids and its Bearing on their Constitution, J. T. Randall, H. P. Rooksby and B. S. Cooper, 458; Dr. S. C. Bradford, 975
- Yellow Spot of the Retina, Projection of Long Spark upon the, T. Terada, 528
- Zn_2 Molecules, Dissociation Energy of, S. Mrozowski, 528
- Zoological Nomenclature: Acarine or Insect? Dr. A. M. Musgrave, 414
- Zygosporium Formation in Mucors, Prof. R. R. Gates and D. V. Daran, 309
- Corrosion: and Heat-resisting Steels, Recent Developments in, Sir Robert Hadfield, Bart., T. G. Elliott, and R. J. Sargant, 247; in Lead Buildings, Prevention of, F. L. Brady, 509
- Cosmic Rays, Nature and Origin of the, Dr. A. Nodon, 683
- Cosmological Conjecture, A, E. U. Condon and J. E. Mack, 455
- Cotton: Angular Leaf-spot Disease of, R. H. Stoughton, 350; Growing, Experimental Work in, 553; in Africa, 291; Leaf-curl in, T. W. Kirkpatrick, 672; Yield and the Flowering Curve, N. W. Barritt, 872
- Countryman's Day Book, A, an Anthology of Countryside Lore, compiled and arranged by C. N. French, 304
- Cow Birds, The, a Study in the Biology of Social Parasitism, Dr. H. Friedmann, 367
- Crabs from Panama, L. Boone, 181
- Cracow Observatory, Handbook of, for 1930, 649
- Craspedacusta (Limnocoedium) Soverbii* in the Exeter Ship Canal, Occurrence of, R. Vallentin, 15
- Creation by Evolution: a Consensus of Present-day Knowledge as set forth by Leading Authorities in Non-technical Language that all may Understand, edited by Frances Mason, 162
- Cretaceous Mollusca of South Africa, Dr. E. C. N. van Hoepen; J. V. L. Rennie, 906
- Crinkle 'A', an Infectious Disease of the Potato, R. N. Salaman, 220
- 'Critical Illumination' in the Microscope, A Point in the Theory of, Dr. L. C. Martin, 741
- Criticism, Practical, a Study of Literary Judgment, J. A. Richards, 304
- Crustacea, The Segmental Excretory Organs of, S. M. Manton, 548
- Cryptoalkaloids, Action of Soaps on the Toxicity of Certain Alkaloids, L. Velluz, 222
- Crystal: Models, Stereoscopic Photographs of, edited by Sir William and Prof. W. L. Bragg. Second series: The Silicates, 381; Structures of Some Derivatives of Diphenyl, G. L. Clark and Lucy W. Pickett, 843
- Crystalline Style of the Mollusca, The, and a Carnivorous Habit cannot Normally Co-exist, Dr. C. M. Yonge, 444
- Crystals: Complete Spectral Diagrams of, H. Seemann, O. Kantorowicz, and Dr. K. F. Schotzky, 853; 32 Symmetry Classes of, The, Systematics and Nomenclature of the, F. Becke, 398
- Cubic Expansion, Certain Integral Properties of, G. Supino, 398
- Cuckoo, The Eviction-method of the, F. H. Lancum, 113
- Culicid Fauna of Fergana, The, P. I. Simanin, 586
- Cultural Areas in Africa, Dr. M. J. Hirskovits, 426
- Curling: W. H. Macaulay and Brig.-Genl. G. E. Smith, 408; C. W. Richardson, 494; W. Taylor, 576
- Cuttlefish, The Swimming of, F. S. Russell and G. A. Steven, 893
- Cyanic Acid and Urea by Oxidation of Carbon, etc., New Syntheses of, G. Laude, 514
- Cyanogen: in Effluents from Coke Ovens, Estimation of the Total, A. Travers and Avenet, 914; -Oxygen Flame, Radiation from, Effect of Hydrogen and Water on, K. Tawada, 705
- Cycles in Natural Phenomena, 18
- Cyclonic Depressions of Nov. 16 and 23, 1928, The, C. K. M. Douglas, 336
- Cytochrome and Intracellular Oxidase, D. Keilin, 841
- Czechoslovak Chemical Communications, Collections of*, 287
- Dacrydium Franklinii* Hooker, The Leaf Oil from, A. R. Penfold and J. L. Simonsen, 35
- Dairy Research, Journal of*, No. 1, 287
- Danish-Caribb Crosses, O. A. M. Hawkes, 143
- Danube in Prehistory, The, Prof. V. Gordon Childe, 591
- Darwin: and Goethe, Proposal for an Exhibition in Commemoration of, 470; Medal of the Royal Society presented to Dr. L. Cockayne, 100; Really said: What, connected Extracts from the "Origin of Species". With an Introduction by Prof. J. Huxley, 378; to Owen, An Early Letter from, 910
- Day, Will, Historical Collection of Kinematography, etc., The, 539
- Daylight, The Photoelectric Recording of, Dr. W. R. G. Atkins and Dr. H. H. Poole, 305; Dr. T. H. Harrison, 704
- Death Watch Beetle (*Xestobium rufo-villosum* De G.), Presence of a Yeast in the, R. C. Fisher and E. A. Parkin, 892

DEATHS.

Anderson (Prof. J. Wemyss), 715
 Appleton (Dr. J. H.), 679
 Arnall (Dr. F.), 324
 Arnold (Prof. J. O.), 537, 641
 Arnold (Sir Thomas Walker), 944
 Atkinson (Sir William), 324
 Balcom (Dr. R. W.), 61
 Balfour (Earl of), 465, 497, 499, 500, 501, 502
 Barns (T. A.), 465
 Biedermann (Dr. W.), 537
 Bigney (Prof. A. J.), 174
 Blaxall (Dr. F. R.), 944
 Borodin (Prof. I. P.), 678
 Brabrook (Sir Edward), 537, 642
 Bradbury (Prof. J. B.), 944
 Bristol (Prof. W. H.), 982
 Browne (Bishop G. F.), 944
 Calkins (Prof. Mary Whiton), 715
 Callendar (Prof. H. L.), 136, 173
 Chisholm (Dr. G. G.), 324, 419
 Claisen (Prof. L.), 136
 Clark (R. Moir), 465
 Clodd (E.), 465, 535, 536
 Cobb (Prof. J. N.), 787
 Cooper-Key (Major Sir Aston), 944
 Cox (Dr. H. J.), 643
 Craigie (Major P. G.), 97, 135
 Curtiss (Prof. R. H.), 174
 Cushman (Dr. A. S.), 982
 Delafield (M. L.), 209
 Dimmock (Dr. G.), 982
 Dootson (F. W.), 323
 Draper (Dr. D.), 714
 Dudgeon (G. C.), 787
 Eielson (Lieut. C. B.), 465
 Ekman (Dr. G.), 827
 Elliot (H. S. R.), 786
 Exner (Prof. F. M.), 324, 419
 Faulds (Dr. H.), 571
 Fee (Dr. A. R.), 571
 de Ferranti (Dr. S. Z.), 97, 172
 Forbes (Prof. S. A.), 787
 Fry (Dr. H. J. B.), 715, 827
 Gibson (Prof. G. A.), 608, 713
 Guggisberg (Sir Gordon), 643
 Hadley (Dr. A. T.), 465
 Hake (Dr. H. W.), 174
 Hall (Dr. A.), 679
 Harris (Dr. J. A.), 982
 Hayes (Prof. M. R. J.), 465
 Hearsey (Lt.-Col. H. H. Y.), 715
 Henry (Prof. A.), 571, 606
 Hepburn (Major P. H.), 26, 60
 Hirst (A. S.), 899
 Hooker (Prof. H. D.), 97
 Hurry (Dr. J. B.), 465
 Hutchinson (Dr. D. H. A.), 324
 von Ihering (Prof. H.), 537, 678
 Jackson (Sir Henry), 59
 Julin (Prof. C.), 246
 Keller (Prof. C.), 679
 Ladd-Franklin (Dr. Christine), 787
 von Le Coq (Dr. A.), 714
 McCormick (Sir William), 537, 569
 Mackay (Principal J. Y.), 571, 679
 McKenna (Dr. C. F.), 982
 McKinney (Dr. T. E.), 982
 MacMahon (Major P. A.), 26, 243
 de Man (Dr. J. G.), 465
 Mannaberg (M.), 97
 Marini (Prof. L.), 61
 Markley (Dr. J. L.), 827
 Marshall (Prof. H. T.), 136
 Matthes (Prof. M.), 787
 Matthews (Sir Thomas), 97
 Maybach (Dr. W.), 96
 Metzelaar (Dr. J.), 61
 Nakamura (Dr. K.), 944
 Nalepa (Dr. A. N. A.), 96

Nansen (Dr. F.), 756, 933
 Neher (Prof. F.), 174
 Nehrling (H.), 97
 Newton (E. T.), 209, 280
 Nichols (Dr. W. H.), 827
 Orton (Prof. K. J. P.), 465, 898
 Orton (Dr. W. A.), 679
 Pearce (Dr. R. M.), 643
 Pinchin (E. A.), 97
 Pschorr (Prof. R. F.), 608
 Ralli (P. A.), 643
 Ramsey (F. P.), 136, 245
 Rateau (Prof. A.), 209
 Rideal (Dr. S.), 96
 Rignano (Prof. E.), 420, 642
 Robertson (Dr. J. W.), 571
 Robertson (Prof. T. Brailsford), 174, 245
 Robinson (Prof. W.), 537, 571
 Roe, Jr. (Dr. E. D.), 246
 Ruttan (Dr. R. F.), 679
 Salmon (C. E.), 643
 Schoch (C.), 136
 Scott (Prof. J. M. D.), 209, 323
 Solvay (A.), 608
 Spence (Dr. J. W. L.), 608
 Sperry (E. A.), 944
 von den Steinen (Prof. K.), 208
 Stewart (Prof. G. N.), 944, 980
 Strutt (Hon. Edward Gerald), 420
 Study (Prof. E.), 246
 Swinton (A. A. Campbell), 324, 356
 Thane (Sir George), 136, 281
 Theobald (Prof. F. V.), 607
 Tondorf (Rev. F. A.), 174
 Vasiliev (Prof. A. V.), 246
 Vaughan (Dr. V. C.), 136
 Vialleton (Prof. L.), 679
 Wagner (Dr. P. A.), 787
 Warner (Sir Frank), 174
 Waters (Prof. E. G. R.), 571
 Waterston (Dr. J.), 786
 Watt (Sir George), 677
 White (Prof. P. J.), 61
 Wilson, Bart. (Sir David), 608
 Wollaston (A. F. R.), 944, 981
 Yamagiwa (Prof. K.), 827

Deep Sea Echinoid in British Waters, A. H. B. Moore, 351
 Delphinapteridæ, A Characteristic of the, Sir Sidney F. Harmer, 286
 Denudation of the Punjab Hills, B. O. Coventry, 170
 d'équations aux dérivées partielles, Leçons sur les systèmes, Prof. M. Janet, 443
 "Deutsche Forschung", 831
 Deutsches Museum, Munich, The, 638
 Development Commissioners, Nineteenth Report of the, 424
 Devil: The, an Historical, Critical and Medical Study, M. Garçon and J. Vinchon. Translated by S. Haden Guest, 371
 Dewar Flask, a New Type of, for Use as a Calorimeter, W. L. Watton, 513
 Dextro- and Lævorotatory Copper Tartrates, The Absorption of, and of their Mixture, T. D. Gheorghiu, 222
 Diamond: Infra-red Frequencies of the, Interpretation of, Prof. F. Simon, 855; Infra-red Spectrum of, by Infra-red Spectrometer and Raman Methods, Sir Robert Robertson and Dr. J. J. Fox, 704; Raman Effect in, C. Ramaswamy, 704
 Diatoms: Notes on, an Introduction to the Study of the Diatomaceæ, Compiled by F. B. Taylor, 922; Satis superque! G. T. Harris, 922
 Diazohydrates, Azoxy-compounds, and Nitrones, Investigations on, Z. Jolles and J. Krugliakoff, 767
Dictyoconus, The Genus, and its Allies, Lt.-Col. L. M. Davies, 549
 Dielectric Constants of Water and Hydrogen Peroxide, Cuthbertson and Maas, 724
 Diet and the Teeth, an Experimental Study. Part 1: Dental Structure in Dogs, May Mellanby, 604

- Differential: Equations: Elementary, Dr. T. C. Fry, 380; of the Second Order, Projective Interpretation of Certain Ordinary, E. Bompiani, 730; Geometry of Three Dimensions, Prof. C. E. Weatherburn. Vol. 2, 813
- 'Digging' in Rowing, Dr. H. Jeffreys, 928
- Dihalogen Propylenes, An Abnormal Reaction of the, A. Kirmann and J. Grard, 803
- 2: 5-dimethyl-piperazine, New Methods of Formation of, M. Godchot and M. Mousseron, 766
- Dioxyppyrarnidone, The Constitution of, R. Charonnat and R. Delaby, 222
- Diphenyl and its Derivatives (5), L. Mascarelli and D. Gatti, 398
- Diphenylethylene Oxide, Optically Active, Prof. J. Read and Ishbel G. M. Campbell, 16
- Diphenylurea in Nitrocellulose, The Solutions of, Desmaroux and Mathieu, 730
- Diphtheria Toxin-Antitoxin Floccules, The Composition of, J. R. Marrack and F. C. Smith, 149
- Diphtheria Intoxication, The Arrest of the, by the Placenta, G. Mouriquand, A. Leulier, and P. Sedallian, 514
- Dipole Moment of Some Organic Halides, D. N. Sen Gupta, 600
- Dipolmoment und chemische Struktur, herausgegeben von Prof. P. Debye, 775
- Dirac's Matrices, The Group Properties of, G. Temple, 802
- Direction Finding by Radio, R. H. Barfield, 907
- Discharge Tubes under 'Flashing' Conditions, Characteristics of, as Determined by the Use of a Cathode Ray Oscillograph, Miss A. W. Leyshon, 336
- Discoveries and Inventions of the Twentieth Century, E. Cressy. Third edition, 740
- Discovery Expedition, The, 178
- Disease-producing Viruses, Nature of, G. Samuel, 51
- Distillation under Low Pressure, 509
- Diving, Prof. L. Hill, 249, 415
- D. obscura*, A and B races of, Genetic Studies on the, P. Koller, 257
- Downtonian and Lower Old Red Sandstone of Scotland, Some Curious Fossils from the, R. Crookall, 878
- Draba fadnisensis* Wulf, A New Species for Czechoslovakia, K. Domin, 915
- Dragon-flies: of North America, A Handbook of the, Prof. J. G. Needham and Hortense Butler Heywood, and others, 811; of the Family Cordulegasteridae, 614
- Drake's Voyage, New Light on, Miss E. G. R. Taylor, 181
- Drosophila*: Duration of Life in, W. W. Alpatov, 508; *melanogaster*: The Hybridity of, C. D. Darlington, 600; The Present Status of, Prof. E. C. Jeffrey, 411; *virilis*, Changes in the Rate of Mutability of the Mutable Miniature Gene of, M. Demerec, 623
- Duddell Medal: award of the, to Prof. A. A. Michelson, 470; presentation of the, to Prof. A. A. Michelson, 537
- Duralumin, The Alteration of the Mechanical Properties of Sheets of, after Corrosion by Sea-water, E. Herzog and G. Chaudron, 114
- Dust Particles, Contamination by, and Intensive Desiccation, Prof. A. W. C. Menzies, 445
- Dynamic: Effect of a Translatory Current on a Cylinder in the Neighbourhood of an Indefinite Plane-wall, A Rapid Method for the Calculation of the, E. Pistolesi, 879; Ultra-red Rays, Experimental Proof, in the Heat Radiation, of, T. Tommasina, 186
- Early Man in China, Prof. G. Elliot Smith, 448
- Earth: and Man, The Evolution of, L. L. Woodruff, and others. Edited, with a preface, by Prof. G. A. Baitsell, 382; Evolution, B. Gutenberg, 426; Movements in the Delta of the Rhone, R. D. Oldham, 601; -Tiltings before Earthquakes, W. Inouye and T. Sugiyama; Prof. A. Imamura and T. Kodaira, 544; The Age of the, Prof. A. P. Coleman, 668; The Future of the, Dr. H. Jeffreys, 11; The Restless, an Introduction to the History of the Rocks, Prof. H. L. Hawkins, 11
- Earth's Surface, Distribution of Masses on the, L. Kober, 694
- Earthquake: in North-western Persia, 832; Recorded at Kew, 102, 328, 541, 752
- Earthquakes: and Volcanoes, Prof. J. W. Gregory, 11; Recorded by the same Seismograph, The Diurnal and Annual Periods in the Distribution of 1944, L. Rodés, 514
- Earthworms: Loose References to Species of, Prof. G. E. Gates, 680; Researches on, H. Tuge; T. Hino, 871
- East: Indies, A Tour in the, Prof. G. I. Taylor, 389; London College, Prof. H. R. Robinson appointed professor of physics at, 868
- Echo Sounding and Depths, Dr. H. Maurer, 473; Rear-Admiral H. P. Douglas, 893
- Eclipse of May 9, 1929, Results obtained during the, A. Danjon, 150
- Economic: Advisory Council, The Composition of the, 283; Life of the Ancient World, The, J. Toutain. Translated by M. R. Dobie, 558
- Economics and Political Science: The Statistical Method in, a Treatise on the Quantitative and Institutional Approach to Social and Industrial Problems, Prof. P. S. Florence, 39
- Edinburgh University: Dr. A. Nelson appointed lecturer in botany, and Dr. W. H. McCrea lecturer in mathematics, 31; Col. R. B. Campbell appointed director under the scheme of physical welfare of students, etc., 219; to subscribe to the Students' Hostel, Benmore, 395; impending retirement of Prof. Baldwin Brown; gifts by Sir Edward Sharpey Schafer, and Mrs. Kennedy Fraser, and a bequest by W. A. Tait, 431; award of the Cameron prize to Dr. G. R. Minot and Dr. W. P. Murphy; forthcoming conferment of honorary doctorates, 476; Sir James Barrie elected Chancellor, 876
- Edison medal of the American Institute of Electrical Engineers, Conferment of the, upon Prof. C. F. Scott, 213
- Education: and Science in the Civil Service Estimates, 430; at the Crossroads, Lord Eustace Percy, 701; for Environment, Major A. G. Church, 261; Higher, Outlook of, Prof. A. Smithells, 701; Individual, Problems of, with special reference to Mathematics, G. W. Spriggs, 109; in India, The Growth of, Sir H. Sharp, 93; Our Present Curse of, Prof. H. E. Armstrong, 341
- Educational: System for Natives in Tanganyika, The, Dr. Fay-Cooper Coles, 753; Values, School Science and, 341
- Eel, Blood of the, N. Kawamoto, 905
- Egypt: Sacred Trees in, G. D. Hornblower, 392; The Earliest Civilisation of, G. Brunton, 27
- Egyptian: Chronology, Sir Flinders Petrie, 650; Mathematics, 962
- Einstein's: Gravitational Equations, Characteristics and Bicharacteristics of, Prof. T. Levi-Civita, 730; Unified Field Equations, A Simplified Presentation of, Prof. T. Levi-Civita. Translated by Dr. J. Dougall, 813
- Elastic: and Electric Properties under Pressure, Prof. P. W. Bridgman, 290; Pressures, A New Method for the Experimental Study of, C. Fabry, 549; Solutions, Choice between, with Equal Resultants, G. Supino, 879
- Electric: Cautery, High Frequency, Mechanism of the Action of the, C. Champy and M. Heitz-Boyer, 222; Currents: to the Ground, Dr. T. W. Wormell, 989; Vertical, below Thunderstorms and Showers, Dr. T. W. Wormell, 432; Discharges, The Chemical Action of, E. Briner and A. Rivier, 186; Power Stations in Japan, S. Fukumaka, 579; Supply Networks, Protective Devices on, T. W. Ross and H. G. Bell, 144
- Electrical: Applications in Motor-Cars, Prof. Parker Smith, 651; Breakdown in a Solid Dielectric, P. H. Moon and A. S. Norcross, 217; Charges in Storms, The Formation of, C. Dauzère, 114; Communication: between Madrid and Buenos Aires, 681; Pioneers of, R. Appleyard, 300; Engineers, Institution of, Awards of Premiums of the, 792; C. C. Paterson nominated as president of the, 869; Sir Richard Glazebrook elected an honorary member of the, 101; The Revised Wiring Regulations of the, 946; Progress, Pioneers of, 300; Research in Industry, Metropolitan-Vickers Electrical Co., Ltd., 146;

- Structure of the Upper Atmosphere, Wireless Methods of Investigating the (2), Prof. E. V. Appleton, 958; Wonders, The Book of, E. Hawks, 923
- Electricity: in Metals, Conduction of, T. E. Stern, 545; Supply of Great Britain, Recent Developments in the, Sir Harry Haward, 468; The Conduction of, in Metals and upon Allied Phenomena, T. E. Stern, 186; through Gases, The Conduction of, Dr. K. G. Emeléus, 740
- Electrification and the Protection of Beauty, 327
- Electrode, The Glass, MacInnes and Dole, 652
- Electro-deposited Coatings, Protective Value of some, L. Davies and L. Wright, 513
- Electrodeposition, Developments of, 218
- Electrolysis of Mercuric Cyanide Solutions with the Dropping Mercury Kathode, The Maximum of Current occurring in the, M. Dillinger, 586
- Electrolytic: Dissociation in very Dilute Alcoholic Solution, Optical Determination of, P. Gross and A. Goldstern, 767; Processes, Technical, New Developments in, Prof. Billiter, 724; Rectification, The Mechanism of, M. E. MacGregor, 128
- Electromagnetic Waves, Range of, V. T. Saunders, 393
- Electro-medical Apparatus, Dr. Leggett, 505
- Electrometer, High Voltage, Prof. T. L. Wulf, 906
- Electromotive Forces in a Moving Liquid by a Magnetic Field, etc., Induction of, E. J. Williams, 765, 958
- Electron: Affinities of the Elements, J. H. Bartlett, Jun., 459; Diffraction: by Mica, Dr. E. Rupp, 68; Rings, H. Mark and R. Wierl, 723; Visible, Dr. A. Dauvillier, 50; Emission, Total Secondary: from a Single Crystal Face of Nickel, S. Ramachandra Rao, 801; from Polycrystalline Nickel, S. Ramachandra Rao, 801; Gun, The, Prof. R. Whiddington, 33; The Charge of an, Sir A. S. Eddington, 474
- Electronic Configurations of the Elements, A Table of, 146
- Electrons: and α -Particles, Scattering of, Dr. G. Beck, 458; and Molecules, Collisions between very Slow, C. Ramsauer and R. Kollath, 427; and Positive Ions in the Upper Atmosphere, Recombination of, T. L. Eckersley, 669; and Protons: Dr. P. A. M. Dirac, 182; A Theory of, 186; The Annihilation of, Dr. P. A. M. Dirac, 914; Capture of, by α -Particles, A. H. Barnes, 509; Free, and Ferromagnetism, Dr. E. C. Stoner, 621; in a Gas Tube, Behaviour of, W. A. Wood and J. Thewlis, 457; in Mercury Vapour, Energy Losses of, D. C. Rose, 460; Liberation of, by Positive Ions, M. L. E. Oliphant, 872; Scattered from Incandescent Solids, Characteristic Energy Losses of, E. Rudberg, 256; The Emission of Secondary, and the Excitation of Soft X-rays, Prof. O. W. Richardson, 801; The Liberation of, from Metal Surfaces by Positive Ions, M. L. E. Oliphant and P. B. Moon, 801; through Argon, The Passage of, J. E. Roberts and Prof. R. Whiddington, 621; Unobservable, and the β -rays, V. Ambarzumian and D. Iwanenko, 586
- Electroscopes, Electrostatic Capacity of, An Apparatus for the Determination of the, A. B. Verigo, 34
- Elements, Classification of the, A Method of Setting Out the, R. Gardner, 146
- Elephants, The Extinct Dwarf, of Sicily and Malta, 82
- Éléphants nains des îles méditerranéennes et la question des isthmes pléistocènes, Dr. R. Vaufrey, 82
- Eliomys nitela*, Natural Immunity against Snake Poison and the Virus of Rabies of the Common Dormouse, Mme. Phisalix, 294
- Ellipsoidal Geoid, The External Gravitational Field of the, C. Somigliana, 842
- Elm: Disease, J. G. Betrem, 252; Tree Bark, Nutritive Value of, Sir Leonard Hill, 780
- Embryology: and Evolution, G. R. de Beer, 883; and Recapitulation, Prof. E. W. MacBride, 883
- Emission Spectra, New Types of, Prof. L. Vegard, 14
- Empire: Cotton Growing Corporation: Report for 1930, 947; Reports received from Experimental Stations, 1928-1929, 553; Development, Sir Robert A. Hadfield, Bart., 468; Geography in Schools, Report on, 611; Meteorologists, Publications relating to the Conference of, 177
- Emulsions, Electrical Properties of, Prof. H. H. Dixon and T. A. Bennet-Clark, 434
- "Encyclopædia Britannica": Prof. J. Proudman, 239; Physics and Chemistry in the, 990; A New Survey of Universal Knowledge, Fourteenth edition. In 24 vols., 357; The Encyclopædia Britannica Co., Ltd., W. H. Franks (Manager), 311
- Endodermis, Cell Division in the, G. Bond, 221
- Engineering: for Masonry Dams, W. P. Creager, Second edition, 45; Museum in Newcastle-upon-Tyne, A Proposed, 284; Training: W. H. Allen, Sons and Co., Ltd., 900; for Officer's Rank, 681
- English Wild Life, E. Parker, 378
- Enigmas: Another Book of Unexplained Facts, Lieut.-Comdr. R. T. Gould, 269
- Entomologie bis Linné, Materialien zur Geschichte der, Dr. F. S. Bodenheimer, Band 2, 483
- Entomology, The Beginnings of, 483
- Enzyme Actions and Properties, Prof. E. Waldschmidt-Leitz. Translated and extended by R. P. Walton, 124
- Eocene Time, Duration of, W. H. Bradley, 835
- Epidaurus to Galen, From, Dr. A. P. Cawadias, 291
- Epidiascope, New Type of, W. Edwards and Co., 105
- Ergosterol: A New Colour Reaction of, R. Meesmaecker, 338; Irradiated, The Toxicity for Laboratory Animals of Large Doses of, H. Simonnet and G. Tanret, 478
- Errors in Practical Science, The Adjustment of, R. W. M. Gibbs, 380
- Erythrite, A New Ethylenic, Lespiau and Bourguel, 478
- Eskimo, Prehistory of the, H. B. Collins, Jr., 66
- Essex Field Club, Fiftieth anniversary of the, 325
- Ethyl: Alcohol: a Product of High Pressure Syntheses, Prof. G. T. Morgan and R. Taylor, 889; Petrol, Final Report of the Departmental Committee on, 574, 710
- Etna, Eruption of, in 1928, The Lava from the, S. Di Franco, 767
- Etruria Marl, The Origin of the, T. Robertson, 657
- Euclase from Valle Aurina, A. Cavinato, 694
- Eugenics Society, bequest to the, by H. Twitchin, 610
- European Prehistoric Pottery, Pictographs on, Dr. L. A. Waddell, 392
- Europeans in Equatorial Africa, The Mortality of, H. E. Raynes, 110
- Eutectics, The Composition of, D. Stockdale, 477
- Evelyn's "Fumifugium", 368
- Everflowing Stream, An, 591
- Evolution: and Evidence, Major L. Darwin, 126; Cataclams in, The Importance of, Dr. G. P. Bidder, 783; Reversibility of, Prof. E. W. MacBride, 166
- Exhibition: Commissioners, 1851, The, and their Work, Sir F. G. Ogilvie, 929, 976; appointments to Senior Studentships, 876
- Experimental Biology, Society for, Conference of the, 64
- Explosion Researches, Prof. R. V. Wheeler, 302
- Extensometer, A New Lateral, Prof. E. G. Coker, 723
- Fables of the Veld, F. Posselt, 123
- Fabrics Research, 907
- Falcon Island: a Pyroclastic Cone, J. E. Hoffmeister, H. S. Ladd, and H. L. Alling, 252
- Fallopian Tubes, The Ciliation of the, G. H. Parker, 841
- Far Eastern Association of Tropical Medicine, The Seventh Congress of the, 327
- Faraday Medal of the Institution of Electrical Engineers, award of the, to Sir Ernest Rutherford, 176
- Fatty: Acids, the Polymorphism of the Crystals and the Orientations of the, as a Function of the Temperature, J. Thibaud and F. Dupré la Tour, 842; Alcohols, The Catalytic Dehydration of the, by Alkaline Bisulphates, J. B. Senderens and J. Aboulenc, 337
- Fechner's Law, Dr. R. A. Houstoun and J. F. Shearer, 891
- Feeding, Action of Germinated Seeds in, L. Raybaud, 75
- Fermente, Die Technologie der, herausgegeben von Prof. C. Oppenheimer. Halbband 2, 596
- Fermentproblem, Das (zugleich Einführung in die Chemie der Lebenserscheinungen), Prof. A. Fodor. Zweite Auflage, 381
- Fern Spores, The Latent Life of, in a Vacuum at the Temperature of Liquid Helium, P. Becquerel, 995
- Ferromagnetic: Elements, The K-absorption and the Satellites of the, O. Michal, 623; Test-pieces, The Search for Defects in, J. Peltier, 959

- Ferromagnetics, The Thermo-Electric Properties of, Dr. E. C. Stoner, 973
- Ferromagnetism, The Interchange Interaction Theory of, Dr. E. C. Stoner, 621
- Ferrous Compounds and Nitric Oxide, The Reactions between, (2), L. Cambi and A. Cagnasso, 766
- Fibre Production, Hybrid Vigour and, 279
- Field Intensity Measurements, around some Australian Broadcast Stations, R. O. Cherry, 513
- Filaments, Oxide-coated, J. A. Becker, 68
- Film : Phonograph, A, Dr. C. W. Hewlett, 285 ; Sections, Mounting Medium for, E. E. Jelley, 276
- Fire : became known, How, H. Balfour, 920 ; Myths of the Origin of, an Essay, Sir James George Frazer, 920
- Fireball : of May 16, The Large, 870 ; Large, 833
- Fires in Bunkers and Cargo Coal, 687
- Fish : Bacterial Infection in, 255 ; Colour-changes in (Part 5), H. R. Hewer, 957 ; Poisons, Native, as Insecticides, 218
- Fishery Investigations off Iceland, Dr. H. Thompson ; Dr. A. V. Tåning, 184
- Fishes : and Crustacea, Methods of Tagging, Dr. C. von Bonde, 426 ; Colour Change in, C. H. Townsend, 988 ; from the Sky, Dr. E. W. Gudger, 248 ; of the Inter-tropical Zone, The Value of the Method of Examination of the Scales applied to, P. Chevey, 338 ; of the North Atlantic, 472 ; Purposive Movement in, Nature of, H. O. Bull, 794
- Flames, The Temperature of, and their Proportion of Atomic Hydrogen, G. Ribaud, 478
- Flat Spiral, The Deformation of the, G. P. Arcay, 73
- Flight of Insects, Mode of, and the Wing Load per Unit of Surface, P. Portier and Mlle. de Rorthays, 478
- Flint Implements : of Lower Palæolithic Age from the Mammaliferous Gravels of Yorkshire, J. P. T. Burchell, 858 ; of Upper Palæolithic Types from Glacial Deposits in Norfolk and Yorkshire, J. Reid Moir, 234 ; J. P. T. Burchell, 235
- Flood : The, New Light on an Old Story, H. Peake, 923
- Floods : Disastrous, in Southern France, 421 ; in the Seine, Dr. E. Joukowsky, 508
- Floral Isophenes and Isakairs, J. E. Clark and I. D. Margary, 113
- Floride, The Sugar of the, H. Colin and E. Guéguen, 622
- Fluidity of Liquids to Temperature, The Relation of, Dr. S. E. Sheppard, 489
- Fluorescent and Phosphorescent Substances, Prof. J. R. Partington, 636
- Flying School at Wasserkuppe, The, Prof. W. Georgii and F. Stamer, 325
- Folk-lore of the North American Indians, 554
- Food : Investigation, Index to the Literature of. Vol. 1, No. 2, Agnes Elisabeth Glennie, 754 ; Supply of the United Kingdom, The, A. W. Flux, 984
- Forest : Officers in the Government Service, Appointment of a Committee on the Training of, 949 ; Research Institute at Dehra Dun, India, Opening of the, 654
- Forestry Research, An Advisory Committee on, 64
- Formaldehyde in Living Plants, Formation of, during Chlorophyllic Photosynthesis, G. Pollacci and Maria Bergamaschi, 694
- Forrest, James, Lecture, The, Prof. R. V. Southwell, 753
- Forthcoming Books of Science, 383
- Fossil : Brains, Dr. P. J. van der Feen, Jr., 738 ; Ground-Sloth (*Nototherium*), Hair of the, L. A. Hausman, 951 ; Man, Recent Discoveries of, Sir Arthur Keith, 935, 944 ; Plants : from the Coal Measures, 159 ; Improvements in the Peel-Method of preparing Sections of, Dr. J. Walton, 413
- Foulerton Research Studentship, Dr. A. S. Parkes appointed to the, 141
- Fourier, Jean Baptiste Joseph, 1768-1830, 710
- Fowl Typhoid, Leaflet on, 648
- Fox Farming, Hygiene in, 141
- Franklin Medal of the Franklin Institute, Award of the, to Sir William Bragg, 286
- Frazer Lecture, The, to be delivered by Dr. P. Rivet, 177
- French : Floods of 1930, L. Fournier, 723 ; Society of Chemical Industry, on the Congress of the, in Barcelona, Prof. H. E. Armstrong, 62
- Frequency: Curves, New Method of Treating, H. J. Buchanan-Wollaston and W. C. Hodgson, 143 ; The Growing Importance of, Prof. A. S. Eve, 454
- Freshwater : Biological Research in the Indian Empire, K. Biswas, 670 ; Biology, Research in, and the Functions of a Freshwater Biological Station, Prof. F. E. Fritsch, 241 ; Crustacea of Norfolk, Dr. R. Gurney, 543 ; Macroplankton, Vertical Movements of, E. B. Worthington, 913 ; Mollusca of Wisconsin, F. C. Baker, 104
- Fruit, Physiology of, (1), F. Kidd and C. West, 221
- Fruits and Vegetables, Preservation of, 426
- Fucose (*l*-galacto-methylose), Studies in the Series of, E. Votoček and V. Kučerenko, 623
- Fuel : Research, Physics in, Dr. C. H. Lander, 989 ; Testing in Canada, 145 ; Tests, E. S. Malloch and C. E. Baltzer, 29
- Fulminating Matter, E. Mathias, 114
- Fumifugium, J. Evelyn, 368
- Fungi : and Fungous Diseases, Sir Aldo Castellani, 631 ; Sex in, D. M. Cayley, 527
- Galactic Pole, A New Determination of the, Prof. P. J. van Rhijn, 684
- Galaxy : Rotation of the, Sir A. S. Eddington, 866 ; Dr. J. S. Plaskett, 103
- Galls, Dr. M. Nierenstein, 348
- Galvanometer, A New Form of Recording, Dr. J. H. J. Poole, 802
- Game Birds Suitable for Naturalising in the United States, 540
- Gamma Radiation, Application of, to Deep-seated Tumours, Prof. J. Joly, 693
- Gas : Engineers, Institution of, and Leeds University, Relations between the, Prof. J. W. Cobb, 909 ; Engineers, Institution of, Leeds Meeting of the, 909 ; Exchanges of Living Tissues, A Method of Investigating, T. A. Bennet-Clark, 492
- Gaseous : Benzene, The Kinetics of the Oxidation of, R. Fort and C. N. Hinshelwood, 433 ; Combustion, Prof. W. A. Bone, 274 ; Prof. W. T. David, 409 ; Prof. W. T. David and W. Davies, 127 ; at High Pressures, Prof. W. A. Bone, Dr. D. M. Newitt, and Dr. D. T. A. Townend, 302 ; Mixtures of Air and Saturated Hydrocarbons, The Temperature of Spontaneous Inflammation of, P. Mondain-Nonval and R. Quanquin, 74 ; Reactions, Homogeneous Catalysis of, Dr. K. Clusius and C. N. Hinshelwood, 311
- Gases : and Liquids, Intensive Drying of, Prof. H. B. Baker, 229 ; Ignition of, by Electric Spark, Terada, Tumoto, and Yamamoto, 332 ; The Fallacious Determination of the Specific Heats of, by the Explosion Method, Dr. O. C. de C. Ellis, 165
- Gasholder, Waterless, Experience with a, F. Prentice, 909
- Gastrophilus inermis*, Presence in France of, G. Dinulescu, 434
- Gauges and Fine Measurements, F. H. Rolt. Edited by Sir R. T. Glazebrook. Vols. 1 and 2, 81
- Gehirne, Die fossilen, Dr. Tilly Edinger, 738
- Geiger's Counters, Method of Registering Multiple Simultaneous Impulses of, B. Rossi, 636
- General Electric Co., Ltd., Journal of the, 901
- Gene Ratios for Rare Mutations, Distributions of, Dr. R. A. Fisher, 878
- Genetics of Interspecific Hybrid Birds, Serebróvsky, 614
- Geneva Observatory, The New Refrigerating Installation of the Chronometric Department of, G. Tiercy, 258
- Geodesy and the Theory of the Precession of the Equinoxes, A Possible Agreement between, R. Wavre, 258
- Geographer and Surveyor, Co-operation between the, Sir Henry Lyons, 110
- Geographical Association, Annual Conference of the, Dr. L. Dudley Stamp, 110
- Geography, Mathematical, Prof. A. H. Jameson and Prof. M. T. M. Ormsby. Vol. 2, 923
- Geologica Hungarica. Series Geologica, Tomus 3. Baron Fr. Nopcsa ; mit einem Anhang von H. v. Mžik, 8
- Geological : Climates, Prof. A. C. Lane, 830 ; Dr. G. C. Simpson, and others, 546 ; Congress, The Fifteenth International, South Africa, 1929, 69 ; Faults in the

- Vicinity of Branxton, N.S.W., Some Interesting, G. D. Osborne and H. G. Raggatt, 659; Society, Election of Officers, 328; of America, Addition of Consultants to the Library Services, 753; of London, Awards of the, 100
- Geologische Karte der Erde, Prof. F. Beyschlag, Lief. 1, enthaltend die Blätter 1, 2, 3, 4, 488
- Geology: of Albania, Prof. J. W. Gregory, 8; of Great Britain, Handbook of the, a Compilative Work, Edited by Dr. J. W. Evans and Dr. C. J. Stubblefield; J. Pringle, 362
- Geometrical Optics in Absorbing Media, P. S. Epstein, 843
- Geometry: A School, A. Walker and G. P. McNicol, 443; of *N* Dimensions, Prof. H. T. H. Piaggio, 266
- Geophysics, Applied, in the Search for Minerals, Prof. A. S. Evet and Prof. D. A. Keys, 267
- Geophysik, Lehrbuch der, herausgegeben von Prof. B. Gutenberg, Lief. 5 (Schluss), 162
- Germanium Oxide and Oxalic Acid, Some Combinations of, J. Bardet and A. Tehakirian, 74
- Gibbs, Willard, gold medal, award of the, to Dr. I. Langmuir, 470
- Gibbs-Ewald Reciprocal Lattice, The, Dr. A. L. Patterson, 238, 447
- Gibbs's Absorption Equation, McBain and Du Bois, 182
- Gibraltar, Strait of, Undercurrents in the, Rear-Admiral H. P. Douglas, 780
- Gipsy: Exorcism, E. Wittich, 578; Moth, Biological Control of the, A. F. Burgess and S. S. Crossman, 392
- Glacial Varves? Would the Geneva Basin lend itself to a Study of, E. Parejas, 294
- Glaciation of Western Edenside and Adjoining Areas, etc., S. E. Hollingworth, 513
- Gland Organs of the Skin, Change of Function in, J. Schaffer, 398
- Glass: Sponges, M. Burton, 913; Tubes or Rods Bend under their own Weight? Do, Lord Rayleigh, 311; C. D. Spencer, 707
- Glasses: Determination of the Absorption of, in the Ultra-Violet Region of the Spectrum, P. Gilard and P. Swings, 658; Loss of Ultra-Violet Transparency in, Dr. S. English, 85; Transparent to Ultra-Violet Radiation, A. R. Wood and M. N. Leathwood, 351
- Gliding: 285; and Soaring in Germany, Ten Years', Prof. W. Georgii and F. Stamer, 325
- Globular Lightening, Prof. E. W. Marchant, 128
- Glossopteris* Flora in the Lukuga Valley, in the Neighbourhood of Greinerville (Belgian Congo), A. Jamotte, 338
- Glazel, L'affaire, Vayson de Pradennes, 983
- Glucose, the Rotatory Power of, Influence of Alkaline Molybdates on, E. Darmon and J. Martin, 434
- Glue and Gelatine, P. I. Smith, 162
- Glycine, Synthesis of, H. King and W. K. Anslow, 68
- Glycogen: Haworth, Hirst, and Webb, 29; of the Heart, The, and Cardiac Medicines, Loeper, A. Mougeot, R. Degos, and S. de Seze, 878
- Gmelin's Handbuch der anorganischen Chemie. Achte Auflage. System-Nummer 59: Eisen. Teil A, Lief. 1, 667
- Golconda Diamond Mines, The, Capt. L. Munn, 686
- Golden Arrow*, Nickel Steel in the, 30
- Gorilla: Expedition to Central Africa, Work of the, Dr. H. C. Bingham, 646; Sanctuary in Uganda, A, 390
- Gramophone: Records of Acoustic Analyses, Dr. W. H. George, 394; The, Dr. W. H. George, 520
- Gramophones, Modern, and Electrical Reproducers, P. Wilson and G. W. Webb, 520
- Granite: Massif of Fougères (Ille-et-Vilaine), The Heavy Minerals of the, L. Berthois, 730; The Origin of, M. Lugeon, 995
- Granites and Granodiorites, Radioactivity of, Dr. H. Hirschi, 686
- Grantia* Amphiblastula, Nutrition of the, Prof. J. B. Gatenby and Dr. S. D. King, 614
- Graptolitic Shales, Origin of, Dr. A. W. Grabau, 67
- Grasses, The World's, their Differentiation, Distribution, Economics and Ecology, Prof. J. W. Bews, 119
- Grasshopper Mice, Food of, V. Bailey and C. C. Sperry, 330
- Grating Errors and Electronic Charge, S. Fagerberg, 13
- Gray, Thomas, Memorial Trust, award of the prize to Dr. A. T. Doodson, 541
- Great Barrier Reef of Australia, The, Dr. C. M. Yonge, 789
- Greek and Latin, The Distinctive Excellencies of, Archbishop of York, 608
- 'Green Flash': at Sunset, The, Lord Rayleigh, 144; in Southern California, The, Prof. S. J. Barnett, 446
- Greenhouse Red Spider, Control of, 951
- Greenkeeping: Problems, Investigations in, 30; *Research, Journal of the Board of*, 947
- Greenland, Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. A. S. Jensen, Vol. 2; J. M. Wordie, 442; Vol. 3: The Colonisation of Greenland and its History until 1929, 559; its Nature, Inhabitants and History, Dr. T. N. Krabbe, translated by Annie I. Fausbøll, 379
- Greenwich, Royal Observatory, Visitation of the, Dr. A. C. D. Crommelin, 909
- Grid System, Progress with the, 247
- Grootfontein Meteor, The, Dr. W. J. Luyten, 214
- Group Velocity and Wave Mechanics, Prof. H. S. Allen, 561
- Growing Up: How one did it in Different Times and Places, Ellen C. Oakden and Mary Sturt, 888
- Guam, Prehistoric, Dental Morphology of, Dr. R. W. Leigh, 905
- Guggenheim, Daniel, gold medal awarded to Dr. L. Prandtl, 869
- Gunnery and some of its Mathematical Problems, Prof. W. M. Roberts, 109
- Guthrie Lecture, The, Prof. P. Debye, 645
- Gyroscopic Compass, The Theory of the, and its Deviations, Dr. A. L. Rawlings, 11
- Hadfields, Ltd., Address to, Sir Robert Hadfield, Bart., 791
- Hadrian's Wall, Menace to the Neighbourhood of, 609
- Haffkine Institute, Bombay, Report for 1928, 470
- Haliotis*, Doris R. Crofts, 304
- Halley Lecture, The, Sir A. S. Eddington, 866
- Halo Phenomena, R. A. Watson Watt, 755
- Halogen Ions, The Diamagnetism of the, G. Foëx, 549
- Hardness, Variation of, as a Function of Cold Hardening, Influence of the Initial State of certain Metals and Alloys on the, Guichard, Clausmann, and Billon, 549
- Hare, Mountain, Spread of the, Dr. J. Ritchie, 143
- Harrison Memorial Plaque and Prize, award of the, to Dr. R. P. Linstead, 100, 538
- Harvard-Boston Expedition's Excavations in the Sudan, Dr. G. A. Reisner, 987
- Hawaiian Corals, Growth of, C. H. Edmondson, 66
- Hawksley, Thomas, Lecture, Prof. H. L. Callendar, 71
- Health, Ministry of, Publications of the, 470
- Heat: from Electricity, Production of Low Grade, T. G. N. Haldane, 23; of Combustion of Camphor, Azobenzene, and Hydrazobenzene, W. Swietoslawski, 150; Transmission Calculations, Methods for Handling, Dr. Margaret Fishenden, 909
- Heating Buildings Electrically by Means of Thermal Storage, Col. Monkhouse and L. C. Grant, 63
- Hebrew University, Jerusalem, Appointments in the, 112
- Helium: and Argon, on the Dielectric Constants of, G. W. Brindley, 33; Bands, Electronic Fine Structure in, S. Imanishi, 529; below 6° abs., etc., a Method of Calculating the Numerical Equation of State for, M. C. Johnson, 433; from Monazite, Production of, R. Taylor, 145
- Helminthia, The Glochide Trichomes of, J. Briquet, 914
- Hempstead Church Tower, appeal for funds for the restoration of, Sir John Rose Bradford, 680
- Heredity in Man, Prof. R. R. Gates, 191
- Herring Researches at Cullercoats, B. Storrow, 794
- Heterothallism, Nutritive, Dame Helen Gwynne-Vaughan and Mrs. H. S. Williamson, 113
- Hexactinellid at the Bottom of the Sea, etc., The Attitude of a, Dr. G. P. Bidder, 913
- Hexagonal Axes, on Face- and Zone-symbols referred to, M. H. Hey, 958

- High : Frequency : Currents, Measurement of the Effective Intensity of, H. Mutel, 803; Fatigue, G. F. Jenkin and G. D. Lehmann, 617; Pressure Steam for Marine Work, The Value of, S. Cook, 247; Tension Testing, A. O. Austin, 836; Voltage Research Laboratory, A New, 353; Voltages, Measurements at, Dr. E. H. Rayner, W. G. Standing, and R. Davis, 687
- Hilger : Instruments : The Practice of Spectrum Analysis with, including a Note on the various Types of Emission Spectra, compiled by F. Twyman. Fourth edition, 45; Interferometer, The Ross Modification of the, O. G. Hay, 257
- Hindu Exogamy, S. V. Karandikar, 407
- Historic Natural Events, 32, 73, 112, 149, 185, 220, 256, 293, 335, 396, 432, 476, 512, 548, 585, 620, 656, 692, 728, 765, 800, 840, 877, 913, 956, 994
- History, Science and, 77
- Hive-bee, Evolution of the, J. T. Cunningham, 857
- Holland, Land Reclamation Work in, 249
- Home and School, International Federation of, 184
- Homo, Width of Head and Pelvis in, Prof. T. D. A. Cockerell, 131
- Homogeneous : and Heterogeneous Reactions, The Quantum Theory of the Kinetics of, S. Roginsky and L. Rosenkewitsch, 347; Isothermal Reaction $2CO + O_2 = 2CO_2$ in the Presence of Water Vapour, B. Topley, 561
- Honey, The Diastatic Activity of, L. H. Lampitt, E. B. Hughes, and H. S. Rooke, 802
- Hong Kong Naturalist, No. 1, 718
- Hooke, Robert, 629
- Horological Hints and Helps, F. W. Britten, 969
- Horse and Fowl Hæmoglobin, Prof. A. B. Macallum and R. C. Bradley, 494
- Hull Museum Treasures, T. Sheppard, 575
- Humanism Dead ? Is, Prof. B. Malinowski, 847
- Human 'Missing Links', G. S. Muller, 758
- Human Speech : Some Observations, Experiments and Conclusions as to the Nature, Origin, Purpose, and possible Improvement of Human Speech, Sir Richard Paget, Bart., 966
- Huxley : Lecture of the University of Birmingham, The, Sir William B. Hardy, 422; Memorial Lecture of the Imperial College of Science and Technology, Prof. Graham Wallis, 881; for 1931, to be delivered by Sir A. Smith Woodward, 903
- Hybrid Vigour and Fibre Production, 279
- Hybridisation in the British Flora, E. M. Marsden-Jones and W. B. Turrill, 759
- Hydrobiological Investigation of High-Alpine Swiss Lakes, 179
- Hydrocarbons in Oxygen, Ignition of, J. S. Lewis, 474
- Hydrocyanic Acid in the Vetches, P. Guérin, 550
- Hydro-dynamic Stability, The Problem of, (1), Prof. R. V. Southwell and L. Chitty, 186
- Hydrodynamics, Prof. H. Lamb, 402
- l'Hydrodynamique, Leçons sur, Prof. H. Villat, 402
- Hydrogen : and Chlorine, Union of, D. L. Chapman and Grigg, 29; Atom, The Operational Wave Equation and the Energy Levels of the, G. Temple, 802; from Band Spectra Moment of Inertia of, Dr. H. H. Hyman and C. R. Jeppesen, 462; from Raman Effect, Moment of Inertia of, Prof. R. T. Birge and C. R. Jeppesen, 463; Ion : Concentration, 369; Measurements, Electrometric, 873; Ions : their Determination and Importance in Pure and Industrial Chemistry, Dr. H. T. S. Britton, 369; -like Spectra of Lithium and Beryllium in the Extreme Ultra-Violet, B. Edlén and A. Ericson, 233; Molecule : New Spectrum of the, Dr. J. J. Hopfield, 927; The Critical Potentials of the, J. E. Roberts, 621; Molecular Spectrum of, New Bands in the, Dattatraya Shridhar Jog, 709; Peroxide : Aqueous, Photolysis of, Allmand and Style, 952; Concentration of, Hurd and Puterbaugh, 796; Spectra of, A Relation between the Continuous and the Many-lined, Y. Hukamoto, 975
- Hydrogens, Anent Metameric, Prof. H. E. Armstrong, 46
- Hydromechanik, Grundlagen der, Prof. L. Lichtenstein, 402
- Hydroxyl, Production of, by the Water Vapour Discharge, G. I. Lavin and F. B. Stewart, 150
- Hydroxymethyl-4-unidazol, The Formation of, P. Girard and J. Parrod, 434
- Hymenocetes, The Soluble Ferments secreted by the, L. Lutz, 338
- Hyponomeuta padella* (Linn.), Biological Races in, W. H. Thorpe, 221
- Ice-Telemeter, An, Prof. M. Kamienski, 835
- Illumination : Congress, Forthcoming International, 23; Internal, Papers on, 755; Requirements, 544
- Imagery around a Skew Ray, T. Smith, 549
- Immunity, Natural, Inheritance of, A. W. Kozelka, 472
- Imperial : College of Tropical Agriculture, Prospectus of the, 956; Entomological Conference, The Third, 949
- Indeterminacy in Physics, Prof. R. A. Sampson, 493
- Index Londinensis to Illustrations of Flowering Plants, Ferns and Fern Allies. Being an emended and enlarged edition continued up to the end of the year 1920 of Pritzel's Alphabetical Register of Representations of Flowering Plants and Ferns, compiled from Botanical and Horticultural Publications of the XVIIIth and XIXth Centuries. Prepared under the Auspices of the Royal Horticultural Society of London at the Royal Botanic Gardens, Kew, by Dr. O. Stapf. Vol. 1, 42; Vol. 2, 523
- India : A National Script for, Dr. A. Latifi, 575; Common Commercial Timbers of, and their Uses, H. Trotter, 394; Education in, The Growth of, Sir H. Sharp, 93; Latitude Variations in, 105; Meteorological Department of the Government of, Report, 1928-29, 23; Southern, The Relief of, J. Carl, 915; The Heroic Age of, a Comparative Study, Prof. N. K. Sidhanta, 375; The Medical Profession in, 625
- Indian : Central Cotton Committee, Report of the Twentieth Meeting of the, 137; Chronology, F. J. Richards, 543; Culture, Modifications in, through Inventions and Loans, Baron Erland Nordenskiöld, 968; Statutory Commission. Interim Report of the Indian Statutory Commission (Review of Growth of Education in British India), 93; Wheat, Rust Recurrence in, Prof. K. C. Mehta, 289
- Indones, Studies on, (10), R. de Fazi and F. Pirrone, 731
- Industrial : Administration, Institute of, 137; Health Research Board, Air Vice-Marshal D. Munro, appointed secretary of the, 286
- Industry, Psychology and, 481
- Inelastic Electron Collisions in Oxygen at Low Pressures, J. E. Roberts and Prof. R. Whiddington, 33
- Inflorescence in Cereals, Development of the, Y. Noguchi, 473
- Inheritance in Man (Galton Lecture), Prof. H. J. Holmes, 987
- Inorganic : Analysis : Applied, with special reference to the Analysis of Metals, Minerals and Rocks, Dr. W. F. Hillebrand and Dr. G. E. F. Lundell, 852; Salts : Colours of, C. P. Snow and F. I. G. Rawlins, 350; Prof. M. N. Saha, 163
- Insect : Pests : and their Control in South Africa, Dr. C. K. Brain, 378; of Willows, H. G. H. Kearns, 276; H. P. Hutchinsonson and H. G. H. Kearns, 201; Singers : a Natural History of the Cicadas, Dr. J. G. Myers, 122
- Insects : Growth in, P. P. Calvert, 288; infesting Stored Cacao, 183; Ticks, Mites, and Venomous Animals of Medical and Veterinary Importance. Part 1 : Medical, Prof. W. S. Patton and Dr. A. M. Evans, 698
- Institute of Physical and Chemical Research, Tokyo, The, 179
- Institution of Civil Engineers, Sir Alfred Yarrow elected an honorary member of the, 179
- Instrument Mechanisms, The Kinematical Design of Couplings in, Prof. A. F. C. Pollard, 160
- Insulators, Failure of, due to Deposition of Sea Salt, S. W. Melsom, A. N. Arman, and W. Bibby, 989
- Interference Fringes, Single Mirror, with X-Rays, W. Linnik, 836

- International: Astronomical Union (Union Astronomique Internationale). Transactions of the International Astronomical Union. Vol. 3: Third General Assembly held at Leiden, July 5 to July 13, 1928. Edited by Prof. F. J. M. Stratton, 196; Botanical Congress, Arrangements for the Fifth, 138, 504; Congresses, 297; Congress: of Americanists, the Forthcoming, 506; of Archaeology and Anthropology, Portugal, 1930, 690; Geological Congress, The Fifteenth, South Africa, 1929, 69; Horticultural Congress, The Forthcoming, 506; Research Council, The, 176; Union: for Geodesy and Geophysics, Forthcoming General Assembly of the, 64; for Pure and Applied Chemistry, Reconstitution of the, 176
- Invention in the Mechanical State of the Future, The Conquest of Thought by, Dr. H. S. Hatfield, 370
- Iodide of Copper, The Photovoltaic Effect of, Influence of the Medium on, Mlle. Marguerite Quintin, 222
- Iodides, Organic, The Photolysis of, G. Einschwiler, 729, 803
- Iodine: in Soils and Waters, Minute Amounts of, Determination of, R. L. Andrew, 433; Mixtures of Vapours of, and of Various Solvents, M. Chatelet, 842
- Ionian Islands, Zoological Expedition to the, (10), M. Beier, 767
- Ionisation of a Gas during the Discoloration of Colouring Substances in Visible and in Ultra-violet Light, P. Lazarev and H. Rodzevitch, 258
- Ionised: Gases in Electromagnetic Fields of High Frequency, Properties of, C. Gutton, 803; Layers in the Upper Atmosphere, Prof. E. V. Appleton, 579
- Ions: Electrons, and Ionizing Radiations, Prof. J. A. Crowther, Fifth Edition, 887; in the Cathode Dark Space, Velocities of, Dr. K. G. Emeléus, 337; produced by Discharges at Liquid Surfaces, The, Prof. J. J. Nolan and J. G. O'Keeffe, 893
- Iridescent Colours in Nature, Lord Rayleigh, 211, 474
- Irish Fauna and Flora, The Origin of the, Prof. J. K. Charlesworth, 337
- Iron: Crystals, Single, Nature of the Magnetisation Curve of, Dr. D. Foster and Dr. R. M. Bozorth, 525; determining, The Thiocyanate Method of, G. W. Leeper, 433; Meteorites, The Age of, Prof. F. Paneth, W. D. Urry, and W. Koeck, 490; Pentacarbonyl, Formation of, 873
- Irrigation: in India, 289; Problems of, Prof. B. H. Wildon, 674
- Isis: or The Future of Oxford, W. J. K. Diplock, 382
- Iso-electric point, Determination of the, by Ferments, P. Chodat, 730
- Ixodidæ, Classification and Geographical Distribution of, (4), N. Olenov, 586
- Izu Islands, Japan, Petrology of the, H. Tsuya, 795
- Jams: Sugar in, A Simple Polarimetric Test for, S. Judd Lewis, 548; The Spectroscopic Investigation of, S. Judd Lewis, 548
- Jan Mayen, 331; the Beerenberg of, The True Height of, P. L. Mercanton, 114
- Japan, The Marine Biological Stations of, Prof. M. F. Guyer, 25
- Japanese: and Chinese Fishes, H. W. Flower, 508; Earthquake: of 1923, Multiple Origin of the, Prof. A. Imamura, Prof. Koto, 289; Research Institute, *Bulletin* of the, 868; Oyster, A New, Dr. H. Seki, 473; Tectonics, S. Yehara, 872
- Jasper Park Lakes Investigations, 1925-26, Reports of the, A. Mozley, 257
- Jet-Wave Rectifiers, Prof. J. Hartmann, 760
- Johns Hopkins University, Foundation of a Frederick G. Donnan fellowship in chemistry, 612
- Joshua and Judges, The Historicity of the Books of, Prof. J. Garstang, 764
- Jungle Gods, C. von Hoffman. Edited by E. Löhrke, 375
- Jute and Jute Spinning, T. Woodhouse and P. Kilgour, Part 1. Second edition; Part 2, 124
- Kant's "Critique of Pure Reason", Prof. A. S. Pringle-Pattison, 557; Translated by Prof. N. Kemp Smith, 557
- Kata-Thermometer, The, Sir Leonard Hill, 836
- Kekulé, August, Prof. R. Anschütz, 2 Band, 807
- Kennelly-Heaviside Layer, The, 545
- Kenya: and Uganda, Report on a Visit to, to Advise on Antimalarial Measures, Col. S. P. James, 208; Settlement in, 835
- Kepler's: Death, Tercentenary of, 833; Work, Prof. F. Cajori, 833
- Kevin-Sunburst Oilfield, Montana, A. J. Collier, 727
- Kew, Royal Botanic Gardens, Work of the, 1929, 679
- Kidney, An Attempt on the Radiographic Visibility of the, J. Dalsace, M. Gory, and Nemours-Auguste, 397
- Kikuya Movement, The Young, in Kenya, 386
- Kilimanjaro, Giant Senecios on, A. D. Cotton, 951
- King's Birthday Honours, 864
- Kintyre, The Carboniferous Sediments of, W. J. McCallien and R. B. Anderson, 549
- Kirstenbosch Gardens, The, Prof. R. H. Compton, 755
- Kolloide: Elektrochemie der, Prof. W. Pauli und Dr. E. Valkó, 771; in Biologie und Medizin, Die, Prof. H. H. Bechhold. Fünfte Auflage, 771
- Krakatao, The Problem of, as seen by a Botanist, C. A. Backer, 627
- Kristallzeichnen, Dr. R. L. Parker, 851
- Krypton: The Crystal Structure of, Prof. W. H. Keesom and H. H. Mooy; Prof. G. Natta and A. G. Nasini, 889; Trebly Ionised, Spectrum of, Prof. D. P. Acharya, 204
- Laboratory: and Field Ecology: the Responses of Animals as Indicators of Correct Working Methods, Prof. V. E. Shelford, 158; Hot-Water Ovens, Brown and Sons, Ltd., 253
- Lactic: Acid in Desiccated Amphibian Muscles, The Formation of, E. C. Smith and T. Moran, 220; Fermentation, Action of Irradiated Sea Water on, C. Richet and M. Faguet, 802
- l'Agriculture, Cinquante ans de travaux sur, et sur l'horticulture, P. Hoffmann et J. Deboffe, 979
- Lambert, Aylmer Bourke, and his 'Description of the Genus *Pinus*', H. W. Renkema and J. Ardagh, 336
- Lamellibranchs from the Upper Part of the Coal Measures, Some Non-marine, Emily Dix and A. E. Trueman, 802
- Lamp, A New, 474
- Land of the Lion, In the, C. Kearton, 12
- Landscape at the Royal Academy, Dr. Vaughan Cornish, 712
- Laplace's Series, R. Caccioppoli, 879
- Larval Crabs, 395
- Law, Joy Gobind, Memorial medal of the Asiatic Society of Bengal awarded to Prof. Max Weber, 612
- Lead: A Supposed Transformation of by the Effect of Solar Radiations, C. Fabry and E. Dubreuil, 294; Arsenate Sprays, H. S. Swingle, 105; Fatigue in, Atmospheric Action in Relation to, B. P. Haigh and B. Jones, 514
- Leaf-fall in Singapore, Periodicity of, R. E. Holtum, 129
- League of Nations, Education and the, 32
- Lebistes reticulatus*, Sex-determination in, O. Winge, 398
- Leeds University: Endowment by P. F. Holmes and D. M. Henshaw of a William Cartwright Holmes scholarship, 72; Plans for new buildings for the department of chemistry, 112; Dr. J. H. Richardson elected Montague Burton professor of industrial relations, 148; M. G. B. Howarth appointed chief chemist to the Newcastle-upon-Tyne and Gateshead Gas Company, 184; appreciation of the late A. G. Lupton, 396; Report for 1928-29, 547; laying the foundation stone of the new library building, 993
- Leibniz, Prof. H. Wildon Carr, 264
- Lemons, *mal del secco* of, Experimental Reproduction of, L. Petri, 766
- Leningrad Academy of Sciences, M. Volgin appointed secretary of the, 540
- Lens Problems, Charts for Simple Two or Three Thin, T. Smith, 693
- Leonardo da Vinci, The Dynamics of, R. Marcolongo, 139
- Levelling, Precise, Errors in, Capt. G. Bomford, 181
- Libraries and Museums, Sir Frederic Kenyon, 969

- Life: and Mechanism, 374; in Inland Waters: with especial reference to Animals, Dr. Kathleen E. Carpenter, 774; The Physical Basis of, Sir William B. Hardy, 422
- Light: A Textbook of, Dr. R. W. Stewart and Prof. J. Satterly. Sixth edition, 523; Diffusion of, by Polished Surfaces, J. Urbanek, 803; in Four Dimensional Space, J. H. Johnston, 199, 709; Intensity in a Fresnel Diffraction Pattern from a Straight Edge, The Distribution of, Prof. T. Lyman, 843; Modern, 195; The Absorption of, by Chlorine, Bromine, and their Gaseous Mixtures, L. M. T. Gray and D. W. G. Style, 336
- Lighting, Tubular Forms of, A. B. Read, 63
- Lightning: Globular, Prof. E. W. Marchant, 128; Dr. W. C. Reynolds, 413; The Conception of Stephen Gray on the Identity of, and the Sparks of Electric Machines, E. Mathias, 803
- Ligneous Plant, The Variation of the Permeability of the Cells in the Course of Growth in a, B. Soyer, 338
- Liliaceous Plants, The Secondary Split in the Maturation Divisions of, Dr. J. Belling, 52
- Lime: Calcium Carbonate and Calcium Phosphate, Action of Nitrogen Peroxide and of Sulphur Dioxide on, E. Briner, J. P. Lugrin, and R. Monnier, 693; Requirement of Soil, Prof. C. A. Mooers, 691
- Limestone, Formation of, M. Black, 509
- Limestones, Powdered, used in Agriculture, The Value of, Lenglen and Durier, 478
- Lincolnshire Coast, The Post-glacial Deposits of the, Prof. H. H. Swinnerton, 957
- Line Spectra, Hyperfine Structure in, H. E. White, 216
- Link Gear of an Old Beam Engine, An Analysis of the, T. M. Naylor and A. G. Abel, 34
- Linnean Society of London, award of the Linnean gold medal to Prof. J. P. Hill and of the Trail award and medal to Dr. Kathleen Bever Blackburn, 719
- Liquid: in an Enclosed Space, The Motion of a, E. J. Williams, 765, 958; Surfaces, Discharges at, The Ions produced by, Prof. J. Zeleny, 706
- Liquids: Evaporation of, The Heat of, J. Hybl, 915; The Viscosity of, Prof. E. N. da C. Andrade, 309; Sir Ambrose Fleming; E. W. Madge, 580; Dr. D. H. Black; Prof. J. Frenkel, 581; Prof. E. N. da C. Andrade, 582; to Temperature, Relation of Fluidity of, Dr. S. E. Sheppard, 709
- Lithium, The Nuclear Moment of, S. Goudsmit and L. A. Young, 461
- Lithostrotion arachnoideum* Fauna of the Craven Lowlands, The Age of the, R. G. S. Hudson, 622
- Liver Fluke: Bionomics of the, I. C. Ross, 66; for Class Purposes, A Method of obtaining Stages in the Life-history of the, Dr. N. B. Eales, 779
- Liverpool University, Conferment of honorary degrees, 911
- Liverworts, Indian, Shiv Ram Kashyap, 331
- Living Past, The, J. C. Merriam, 888
- Livingstone College, Annual Report of, 102
- Lizard, Chondrocranium of the, De Beer, 987
- L.M. and S. Ry. Co., Sir Harold Hartley appointed a vice-president of the, and director of scientific research to the company, 213, 283
- London Hospital, Researches at the, 756*
- 'London House', proposed hall of residence for British male students, Site for, 912
- London University: conferment of doctorates, 219; Dr. H. A. Harris awarded the William Julius Mickle fellowship; Dr. F. Davies appointed reader in anatomy at King's College; Prof. L. T. Hogben appointed professor of social biology at the London School of Economics, 396; conferment of doctorates, 431; Dr. M. Ginsberg appointed Martin White professor of sociology at the London School of Economics; conferment of the title of professor in the University of London; impending institution of a chair of physics at the Imperial College—Royal College of Science, 547; Presentation Day, 799; Prof. H. R. Robinson appointed professor of physics at East London College; Dr. J. W. Munro professor of entomology at the Imperial College of Science, 839; and Prof. P. G. H. Boswell professor of geology at the Imperial College of Science; conferment of doctorates, 840, 993; appointment of Prof. J. K. Catterson-Smith to the chair of electrical engineering at King's College, 993; College, bequest by Lady Durning-Lawrence, 292
- London, Water Supply of, G. Andrew-Marshall, 147
- Longstaff medal: of the Chemical Society, award of the, to Dr. W. H. Mills, 250; presentation of the, to Dr. W. H. Mills, 538
- Lorentz, The Transformations of, P. Burgatti, 587
- Lotus*, The Proportion of Hydrocyanic Acid in the Genus, P. Guérin, 75
- Lowell: Object, The, 649; Observatory, Celestial Body discovered at the, Observations of the, F. Baldet, 766; Planet, The, 721, 757, 833
- Lowell's Prediction of a Trans-Neptunian Planet, Dr. J. Jackson, 461
- Low Temperature Carbonisation Plant, Test of, 652
- Lubrication: The Principles and Practice of, a Manual for Petroleum Technologists, Students, Engineers, Oil Salesmen, etc., Prof. A. W. Nash and Dr. A. R. Bowen, 193
- Lucilia sericata*: Meig., Parasitism in relation to Pupation in, Dr. W. M. Davies, 779; Natural Control of, Dr. G. Salt, 203; The Diapause of, Mlle. G. Cousin, 622
- Lumbricus*, The Oogenesis of, Maureen O'Brien and Prof. J. B. Gatenby, 891
- Luminescence in the Satellites of Rubrene, The Phenomena of, C. Moureu, C. Dufraisse, and P. Lotte, 337
- Luminosities, very small, The Visual Measurement of, J. Dufay and Mlle. R. Schwégler, 222
- Lunar Landscape, Photograph of a, M. M. Darney, 793
- M'Donnell Ranges (Central Australia), Pre-Ordovician Rocks of the, Sir Douglas Mawson and C. T. Madigan, 477
- Machine Telegraph Systems, H. H. Harrison, 760
- Magic Square of Fifth Order, Major J. C. Burnett, 17
- Maglemose Harpoons, The Alleged, T. Sheppard, 902
- Magnesium: Metallic, W. R. D. Jones, 514; Oxide, The Reflection Factor of, J. S. Preston, 257
- Magnetic: Charts, New, for France, 795; Disturbance, Recent, 613; Fields given by the Large Bellevue Electro-magnet, The, A. Cotton and G. Dupouy, 586
- Magnetism, The Physical Society's Discussion on, Dr. A. Ferguson, 874
- Magnetophoresis and Electrophoresis, F. Ehrenhaft, 397
- Maize, A New and Serious Disease of, M. Curzi, 35
- Malaria: A Summary of Facts Regarding, Sir Ronald Ross and Sir Malcolm Watson, 648; Prophylaxis in Kenya, 208
- Malayan, Chinese and, Medicine, 862
- Malthodes* Kies (Coleoptera, Cantharididae) of Central Asia, A New Species of the Genus, V. V. Barovskii, 586
- Mammals: formerly eaten in the Dominion Republic, G. S. Miller, 543; Origin of the, Some Recent New Light on the, Dr. R. Broom, 114; Rapid Changes in, caused by Climate, A. S. La Souef, 578; Systematic Studies of, G. S. Miller, 508
- Man and His Past, Research and Finance in the Study of, 189; Fossil, Recent Discoveries of, Sir Arthur Keith, 935, 944; The Ancestry of, Prof. H. F. Osborn, 745
- Man's: Ancestry, Sir Arthur Keith, 6; Place among the Mammals, Prof. F. Wood Jones, 6
- Manchester: Electricity Supply, The, H. C. Lamb, 790; Microscopical Society, Jubilee Reunion of the, 390; University, Prof. H. J. Fleure appointed professor of geography, 31; Dr. C. C. Twort appointed director of the department of Cancer Research, 512; Institution by J. Grier and H. Brindle of silver medals in pharmaceuticals, 764; Prof. J. M. F. Drummond appointed Harrison professor of botany, and Dr. J. Walton a senior lecturer in botany; gift of the Medical Library of the Manchester Medical Society; conferment of honorary doctorates, 840
- Manchurian Rodents and Disease, Dr. Wu Lien-Teh, 685
- Manganese Cyanide, Complexes of Quadrivalent, A. Yakimach, 657
- Manitoba Grouse, Fluctuations of, N. Criddle, 685
- Mantisalca* Cass., The Carpology of the Genus, J. Briquet, 693

- Manurial Experiments on Fruit Trees, T. Wallace, 615
Manx Shearwater, Habits of the, R. M. Lockley, 215
Map Projections, An Introduction to the Study of, J. A. Steers. Second and revised edition, 197
Maps, Early Manuscript, Reproductions of, 1: The Portolan Chart of Angellino de Dalorto, MCCCXXV., in the Collection of Prince Corsini at Florence, with a note on the surviving Charts and Atlases of the Fourteenth Century, by A. R. Hinks, 486
Marine: Biological Association, Lt.-Col. W. E. Guinness elected president of the, 213; Fishes of the Atlantic Coast from Labrador to Texas, Field Book of, C. M. Breder, Jr., 969; Mollusca off the West Coast of Ireland, Anne L. Massy, 651; Water Protozoa, Influence of some Physico-chemical Factors on, M. Galadzhiev and E. Malm, 34
Marlborough College Natural History Society, Report of the, 647
Mars in 1926, Prof. W. H. Pickering, 471
Martens, Embryonic Young in, Delayed Development of, F. G. Ashbrook and K. B. Hanson, 834
Mass-spectra, The Photometry of, and the Atomic Weights of Krypton, Xenon, and Mercury, Dr. F. W. Aston, 186
Mathematical: Association, Annual Meeting of the, W. Hope-Jones, 109; Notation, 78; Notations, A History of, Prof. F. Cajori. Vol. 2: Notations mainly in Higher Mathematics, 78; Tables and Formulas, Prof. P. F. Smith and Prof. W. R. Longley, 379
Mathematician, The, in Ordinary Intercourse, Miss Hilda P. Hudson, 110
Mathematicians, The Great, Prof. H. W. Turnbull, 523
Mathematics: for Study of Frequency Statistics, Dr. W. F. Sheppard, 109; Preparatory to Statistics and Finance, G. N. Bauer, 379
Matter in Interstellar Space, Distribution of, Dr. J. S. Plaskett and J. A. Pearce, 542
Matthew Island, Prof. T. D. A. Cockerell, 414
Maxwell: Clerk, and the Michelson Experiment, 566; -Hertz, Electro-magnetic Equations, Integration of the, A. Tonols, 694
Mechanical Engineers, Institution of, Report for 1929, 387; State of the Future, The, 370
Medical: Education, Methods and Problems of, 15th Series, 102; Entomology, A Textbook of, 698; Profession in India, The, 625; Research Council, The, 637
Medicine: History of, 291; Preventive, Recent Advances in, Dr. J. F. C. Haslam, with a chapter on the Vitamins by Prof. S. J. Cowell, 968
Medieval Maps, 486
Melaleuca decora (Salisbury) Druca and *M. nodosa* var. *Tennifolia* (de Candolle) from the Port Jackson District, The Essential Oils (1), A. R. Penfold and F. R. Morison, 35
Melbourne Astrographic Catalogue, Vol. 3, 684
Mendelism and Anthropology, Prof. F. A. E. Crew, 191
'Menformon,' Crystalline, Prof. E. Laqueur, E. Dingemans, and S. Kober, 90
Merchant Ships, The Design of, and Cost Estimating, A. Kari. Second edition, 921
Mercury: Hydride, Ionised, The Spectrum of, Prof. T. Hori, 131; in Organic Compounds, The Micro-estimation of, J. J. Rutgers, 730; Intermetallic Compounds in, Dr. A. S. Russell, 89; Krypton, and Xenon, Mass-spectra of, Dr. F. W. Aston, 332; Surface Solutions on, Fahir Emir, 337; Vapour in the Far Ultra-Violet, Fluorescence of, M. Eliashevich and A. Terenin, 856
Metabolism, Influence of the Hygrometric State of the Air on, J. Lefèvre and A. Auguet, 434
Metal Crystal, The, Sir Harold Carpenter, 867
Metallic: Conduction, Recent Progress in the Dual Theory of, E. H. Hall, 843; Elements in Animal and Plant Tissues, W. B. S. Bishop, 648; Films obtained by Thermal and Cathodic Projection, The Electrical Properties and the Structure of the, F. Joliot, 622
Metallography of some Ancient Egyptian Implements, The, Sir Harold Carpenter and Dr. J. M. Robertson, 859
Metals: in Pure Liquids, The Potentials of, E. Toporescu, 434; Institute of, Dr. R. Seligman inducted as president, 467; Journal of the, Vol. 42. Edited by G. Shaw Scott, 852; Rare, Determination and Separation of, from other Metals (19), L. Moser, K. Neumayer, and K. Winter, 398; Shearing and Punching, C. Fremont, 29; The Early Use of the, T. A. Rickard, 477; The Separation of, by 'Internal Electrolysis,' H. J. S. Sand, 433; The Therapeutic Use of, Prof. G. Hevesy and O. H. Wagner, 868
Meteoric Iron, A New, from Piedade do Bagre, Minas Geraes, Brazil, Dr. L. J. Spencer, 957
Meteorological: Conditions accompanying a Waterspout, Lieut. P. G. Hale, 292; Observatory, A Self-operating, Dr. F. Nansen, 64
Meteorology and Water Supply (Symons Memorial Lecture), Dr. H. Lapworth, 504
Meteors: Heights of, Tides of the Upper Atmosphere and the, Dr. J. Egedal, 202; Remarkable, W. F. Denning, 986
Methane Flames, Extinction of, by Water Vapour, Coward and Gleadall, 579
Methyl: Alcohol, The Conductivity of Thiocyanates in, A. Unmack, D. M. Murray-Rust, and Sir Harold Hartley, 433; Glyoxal as an Intermediary in Fermentation, J. O. Giršavičius, 817
Menthylamines and Menthols, Optical Superposition among, Prof. J. Read and R. A. Storey, 86
Methylcycloheptanols, The, M. Godchot and Mlle. G. Cauquil, 622
Methylene Blue, Penetration of, into Living Cells, Dr. Matilda Moldenhauer Brooks, 599
Michelson Experiment, Clerk Maxwell and the, 566
Microcalorimeter, A, A. F. H. Ward, 397
Microscopical Society of Wales, Inception of a, 832
Midland Basalts, The Age of the, R. W. Pocock, 657
Miers' Mineralogy, 887
Milk, An Experiment with Children on, 282; Examination of, for Tubercle Bacilli, D. R. Wood, 802; Studies Concerning the Handling of, 287
Mine Rescue Apparatus, Dr. S. H. Katz and C. S. W. Grice, 509
Mineral Particles contained in the Lungs of Miners, Histochemical Researches on the, A. Policard and J. Devuns, 878
Mineralischen Rohstoffe, Vorkommen und Geochemie der, Prof. G. Berg, 596
Mineralogists Recently Deceased, Biographical Notices of (fourth series), Dr. L. J. Spencer, 958
Mineralogy: An Introduction to the Scientific Study of Minerals, Sir Henry A. Miers. Second edition, revised by Dr. H. L. Bowman, 887; at Cambridge, 418
Minimum Temperatures at Different Small Heights above the Ground, N. Passerini, 658
Mining: and Metallurgy, Institution of, Sir Thomas H. Holland awarded the gold medal of the, 390; "Man should know, What Every", 23
Mira Ceti, The Companion of, 793
Missouri School of Mines and Metallurgy, Establishment of a Jacking Foundation by D. J. Jackling, 692
Moléculaire de la lumière, La diffusion, J. Cabannes, avec la collaboration d'Yves Roizard, 740
Molecular: Spectra and Molecular Structure, a General Discussion held by the Faraday Society, Sept. 1929, 380; Weights Determination, Comparison of the Ultracentrifuge Method for, with the Classical Methods, J. B. Nichols, 814
Molecule O₂, The Heat of Dissociation of the, and Sutherland's Constant for Oxygen, S. Brassler and V. Kondratjew, 164
Molecules: having Diffuse Band Spectra, Photo-decomposition of, Prof. H. S. Taylor and J. R. Bates, 599; in Space, Configuration of, Mme. Ramart-Lucas and F. Salmon-Legagneur, 550; The Polarity of, Prof. J. E. Lennard-Jones, 9
Mosaic Crystals, F. Zwicky, 150
Moth, The Accuracy of a, Sir Flinders Petrie, 928
Motion: of a Viscous Fluid, The Equations of, in Tensor Notation, C. N. H. Lock, 513; of Waters and other Fluids, a New General Theory for the, (2), G. Mazzone-Sangiorgi, 694
Motor-units, Numbers and Contraction-values of Individual, Examined in some Muscles of the Limb, Sir Charles Sherrington and J. C. Eccles, 841

- Mt. Chemin, Valais, The Metalliferous Deposits of, G. Ladame, 694
- Mountain Plants and Lamarckism, J. Costantin, 586
- Mounting: Medium for Film Sections, E. E. Jelley, 276, 672; J. M. Preston; W. Marshall, 563
- Mouse: Female, Maturity in the, Prof. F. A. E. Crew and L. Mirskaia, 257; Pregnancy in the, Mating during, Prof. F. A. E. Crew and L. Mirskaia, 564
- Müller, Hugo, lecture, The, Prof. G. Hevesy, 539
- Müller-Pouillet's Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer und E. Waetzmann. In fünf Bänden. Band 2: Lehre von der strahlenden Energie (Optik). Herausgegeben von K. W. Meissner. Zweite Hälfte, Erster Teil. Zweite Hälfte, Zweiter Teil, 195
- Multiple Spermatozoa and the Chromosome Hypothesis of Heredity, Dr. E. Warren, 973
- Murray River, Centenary of the Discovery of the, 22
- Muscular: Phosphogen in Fish, V. Zagami, 658; Sense, The, Col. A. Lynch, 52; Prof. D. F. Fraser-Harris, 204
- Museums Movement, Monetary Help for the, 647
- Musical Sounds, The Scientific Analysis of, J. F. Cellier, 258
- Musk-rat, The, Dr. H. Broch; L. Munsterhjelm, 98
- Mycorrhiza in the Ericaceae, Prof. Knudson, 508
- Myriopoda of the Swiss National Park, Dr. W. Bigler, 871
- Myriothela*, Gonophores of, E. A. Briggs, 27
- Naphthalene and Anthracene, Structure of, Dr. K. Banerjee; J. M. Robertson, 456
- National: Coal Resources, Physical and Chemical Survey of the Appointment of a Committee for the West Yorkshire Coal Area, 423; Illumination Committee, Report on the Work of the, 719; Institute of Industrial Psychology, Annual Report of the, 481; Museums and Galleries, Royal Commission on, Final Report, Part II., 153; Parks, the Coasts of Great Britain and, Dr. Vaughan Cornish, 574; Physical Laboratory: Collected Researches of the, Vol. 21, 576; Report for 1929, 947
- Native: Fish-poisons as Insecticides, 218; Fauna, Preservation of the, in the British Empire, Lord Onslow, 866; Policy in South Africa, G. W. Grabham, 131
- Natural History*, 1929, 469; January, 286
- Natural: History: Society of Northumberland, Durham, and Newcastle-upon-Tyne, History of the, 1829-1929, T. R. Goddard, 487; the Pleasure and Purpose of Observation, Viscount Grey of Fallodon, 328; Phenomena, Cycles in, 18
- Nature: Cosmic, Human, and Divine, Prof. J. Y. Simpson, 382; Study, The New, F. J. Wright, 268; Unadorned in Tropical Africa, Major C. Christy, 301
- Naturforscher: Grosse, eine Geschichte der Naturforschung in Lebensbeschreibung, 812
- Nauka Polska*, Vol. II., 250
- Nautical Mile, The Length of a, M. Vallaux, 144
- Naval: Architects, Institution of the, award of the Gold Medal to J. Johnson, and of the Premium to Lieut.-Col. F. Dondona, 213; Engineering, Progress in, Eng.-Capt. E. C. Smith, 134; Observatory, Washington, Work of the, 904
- Navy, Health of the, Report of the, for 1928, 720
- N Dimensions, Geometry of, An Introduction to the, Prof. D. M. Y. Sommerville, 266
- Nematode Infection of a Young Dolphin, Dr. H. A. Baylis, 578
- Neolithic Camps, E. C. Curwen, 614
- Neon: A Probable Band Spectrum of, D. G. Dhavale, 276; Lamp, The, as a Glow Relay, L. Bellingham, 928; Stark Effect in the Ultra-Violet Spectrum of, Prof. Y. Ishida, 970
- Neo-Natal Death, Causes of, Dr. J. N. Cruickshank, 903
- Nerve: Cell, Reactions of the, to Injury, 230; Centres, Mechanism in, J. T. MacCurdy, 632
- Nervous System, Degeneration and Regeneration of the, Prof. S. Ramón y Cajal. Translated and edited by Dr. R. M. May. 2 Vols., 230
- Neurosis: Problems of, a Book of Case-histories, A. Adler. With a Prefatory Essay by Dr. F. G. Crookshank. Edited by P. Mairet, 162
- Neutral Salts, Influence of, on the Separation of Proteins by the Acetone Method, M. Piettre, 75
- Newcomb's Occultation Memoir, Revision of, Dr. H. Spencer Jones, 142
- N.S.W.: Flora of, W. F. Blakely, 114; Linnean Society of, Presidential Address to the, Dr. H. S. H. Wardlaw, 900; Report of the Director-General of Public Health, for 1928, 792
- New Year Honours, 62
- New Zealand: Department of Scientific and Industrial Research, Grant to the, by the Empire Marketing Board, 390; Geological Structure of, Dr. J. Henderson, 289; Hybridisation in the Forests of, Dr. Cockayne, 473; Problem of Deer in, 830
- Nickel: and Cobalt in Plants, Distribution of, G. Bertrand and N. Mokragnatz, 257; -Oxides of, Giordani and Mattias, 427; Salt of, A Diamagnetic Simple, Prof. D. M. Bose, 708; Steel in the *Golden Arrow*, 30
- Night Sky, Spectroscopy of the, Prof. J. C. McLennan and H. J. C. Ireton, 952
- Nisenan, The, A. L. Kroeber, 722
- Nitrates in Milk, Routine Detection of, A. F. Lerrigo, 621
- Nitric Oxide, Formation of, Tartar and Hoard, 332
- Nitrogen: Active, E. J. B. Willey, 724; Fixation by Bacteria, F. E. Allison, E. W. Hopkins; M. E. Löhms, 578; Ionisation in, J. Bruce, 780; Isotopes of, S. M. Naudé, 253; Pentoxide, The Rate of Decomposition of, at very Low Pressures, H. C. Ramsperger and R. C. Tolman, 843; Peroxide: Decomposition of, Eyring and Daniels, 907; Molecule, Existence of Two Limits of Predissociation in the, and the Heat of Dissociation of Oxygen, Prof. V. Henri, 202
- Nitrogenous Materials in Fresh and Dried Plant Tissues, The Proportions of Soluble and Insoluble, W. H. Pearsall and Alice Wright, 34
- Nobel: Laureates in Medicine and Chemistry, Banquet in Honour of the, 210; Prize Awards, 532; Prof. M. W. Beyerinck; Dr. von Auwers, 612; Prizes for Research Work in Science, The, 495; The Life of Alfred, Prof. H. Schück and R. Sohlman. Translated from the German of Dr. W. H. v. d. Muelbe by Brian and Beatrix Lunn, 495
- Noise, Measurements of, by Means of a Tuning-fork, Dr. A. H. Davis, 48
- NO Molecule, The Two Normal States of the, M. Lambrey, 657
- Non-Disjunction produced by Carbon Dioxide, J. C. Mottram, 275
- North: American: Dragon-flies, 811; Indians, Tales of the, Selected and Annotated by Prof. S. Thompson, 554; Minch, The Doleritic Isles of the, F. Walker, 549; -East: Coast Institution of Engineers and Shipbuilders and the Institution of Engineers and Shipbuilders in Scotland, joint meeting in Holland, 985; -East Land, Ice of, Dr. K. S. Sandford, 67; -West Persia, Botanical Exploration through, J. M. Cowan, 693
- Norvegia*, Expedition, The, 178, 326
- Nuzhatu-l-Qulub of Hamdulāh al-Musta'fi-al-Quazwīni, The Zoological Section of the, Edited, translated, and annotated by Lieut.-Col. J. Stephenson, 124
- Obelia*, Living Chromosomes in, Miss G. H. Faulkner, 67
- Observers' Handbook, 251
- Oceanic Plankton Animals Lose Themselves? Do, Dr. F. S. Russell, 17
- Oceanographic Apparatus, A New, A. Gruvel and W. Besnard, 586
- Octopoda, Classification of the, 850
- Enothera*, Chromosome Linkage and Syndesis in, D. G. Catcheside, 221, 906; Synapsis and Chromosome Rings in, Prof. R. R. Gates, 854; Telosynapsis or Structural Hybridity in, C. D. Darlington, 743
- Oestrin, Preparation of, G. F. Marrian, 90
- o*-fluorbenzoic Acid, The Nitration of, F. Govaert, 658
- Oil-Well Drilling Plant, Rotary, N. Matheson, 906
- Oils, Heavy, A New Method of Gasifying, Chilowsky, 550
- Oligochaeta, The, Dr. J. Stephenson, 594
- Oligochaete Worm Parasitic in Frogs of the Genus *Phrynomeris*, On an, Dr. J. Stephenson, 621

- Onion, Disease resistance in the, Chemical Aspects of, J. C. Walker, K. P. Link and H. R. Angell, 150
- Ontario Research Foundation, Dr. A. C. Goodings appointed to a post under the, 505
- Oogonia in the Fucaceae, Release of, E. M. Delf, 957
- Open-air Studies in Australia, F. Chapman, 379
- Opera, R. Capell, 909
- Opium in the Poppy, Cavara and Chistoni, 330
- Optical: Dispersion Formula, The Accuracy of Constants in an, G. W. Brindley, 33; Rotatory Power (Faraday Society Discussion), Prof. T. M. Lowry, 762; Spectra, Effect of Nuclear Spin on the, (2), J. Hargreaves, 256, (3), 802
- Optics: Applied: and Optical Design, Prof. A. E. Conrady. Part 1, 372; The Trend of, 372; in Radio Transmission and other Fresh Fields, F. Twyman, 283
- Orang-utans, Protection of, 61
- Ordnance Survey Maps on Waterproof Paper, 647
- Ordovician Gastropod, A New, E. Kirk, 759
- Organic: Chemistry: at University College, London, Sir W. J. Pope, 238; Prof. J. F. Thorpe, 239; in Peril, Prof. H. E. Armstrong, 344; Compounds: The Binding Energy of some, L. S. Kassel, 926; Thermal Data on, Huffman, Parkes, and Daniels, 907; Liquids with Long Chains, The Internal and Superficial Structure of, J. J. Trillat, 803; Substances in the Fused State, The Magnetic Double Refraction of, C. Salceanu, 729
- Organs, The Spectrographic Analysis of, P. Dutoit and C. Zbinden, 337
- Oroboside, A New Glucoside Hydrolysed by Emulsion, M. Bridel and C. Charaux, 478
- Orthogonal Polynomials for Simple Series with Proofs of their Elementary Properties, The General Form of the, Miss F. E. Allan, 878
- Osram Lamps, Materials used for, 754
- Ostreidae, New Cretaceous, from Texas, L. W. Stephenson, 331
- O-type Stars, Radial Motions of the, Prof. C. D. Perrine, 180
- Ouabaine, The Action of, on the Intestine *in situ*, Raymond-Hamet, 294
- Ovarian Secretions, 629
- Ovary: Stimulating Hormone of the Placenta, The, Prof. J. B. Collip, 444; The Internal Secretions of the, Dr. A. S. Parkes, 629
- Ovidii Nasonis Fastorum Libri Sex: Publii, The "Fasti" of Ovid, Edited with a Translation and Commentary by Sir James George Frazer. 5 vols., 847
- Oxford: Annual Report on the Bodleian Library, 431; Early Science in: Vol. 5: Chaucer and Messahalla on the Astrolabe, Dr. R. T. Gunther, 556; Vol. 6: The Life and Work of Robert Hooke (Part 1). Vol. 7: (Part 2), Dr. R. T. Gunther, 629; University: Library affairs: Report on Observatory, 335; Latin Oration of, L. H. Dudley Buxton, 512; The proposed removal of the Radcliffe Observatory, Prof. H. H. Turner, 656; The Radcliffe Trust, 691; Annual Report of the Lewis Evans Collection; grant towards an expedition to Lapland and Western Norway, 764; The Radcliffe Observatory; delivery by Sir Peter Chalmers Mitchell of the Herbert Spencer Lecture; delivery by Miss Caton-Thompson of a lecture on the Great Zimbabwe and other ruins in Rhodesia, 912; The Radcliffe Observatory site and buildings; Reports of University Museum and various scientific departments, 956
- Oxidation Processes, Certain, determined by normal diazo-hydrates, A. Angeli and Z. Jolles, 338
- Oxygen: Dissociation Energy of, Determined from the Pre-dissociation of Sulphur Dioxide, Prof. V. Henri, 275; in Iodo-volatilisation, Influence of, P. Dangeard, 294; Isotopes of, Giaque and Johnston, 145; (O IV), The Spectra of Trebly-ionised, and Trebly-ionised Nitrogen (N IV), L. J. Freeman, 802; The Heat of Dissociation: of, and of the C-H Bond, Prof. R. Mecke, 526; The Molecule of, and the Energy of Activation of the Oxygen Atom, Prof. V. Henri, 337
- Oyster, The Glorious, H. Bolitho, with certain chapters edited by M. Burton, 406
- Ozone: in Luminescence, E. L. Nichols and Frances G. Wick, 843; The Fixation of: by Benzene Linkages and by Acetylene Linkages, G. Brus and G. Peyresblanques, 657; by Unsaturated Compounds, G. Brus and G. Peyresblanques, 550; True Energy Yields in the production of, by the Silent Discharge and their Improvement, B. Susz and E. Briner, 258
- Pacific Ocean, The Geological History of the, Prof. J. W. Gregory, 750
- Palestine: Archæological Expeditions in, Facilities for, 715; Cave Art in, Miss D. A. E. Garrod, 794
- Pancreas, The, and Pneumogastric Excitability, L. Garrelon, D. Santenoise, H. Verdier, and M. Vidacovitch, 338
- Pangani Falls, Power from the, 901
- Para: -azoxyanisol, The Magnetic Double Refraction of, Mlle. Jacqueline Zadoc-Kahn, 657; -crinkle, a Potato Disease of the Virus Group, R. N. Salaman and R. H. Le Pelley, 220
- Parachor, The: Prof. T. M. Lowry, 364; and Molecular Volume, Dr. A. Ferguson, 597; Dr. S. Sugden, 778; and Valency, Dr. S. Sugden, 364
- Paraffins, Normal, Crystal Structure of, Dr. A. Müller, 952
- Parasites: and Phagocytes, Entomophagous, Dr. W. R. Thompson, 167; External, A Manual of, Dr. H. E. Ewing, 377
- Parasitic Infections, The Immunology of, Prof. W. H. Taliasfero, 703
- Parasitism: a Stimulus to Pupation: *Alysia Manducator* in relation to the Host *Lucilia sericata*, F. G. Holdaway and A. C. Evans, 598; in Lucerne and Clover Nodules, Influence of the Host Plant in inducing, H. G. Thornton, 221; Recovery from, C. C. Brooks, 14
- Paris: Academy of Sciences, Prize awards of the, 107; Observatory, Report of the, for 1928, 391
- Parrots, Importation of, Order prohibiting the, 720
- Pathology: Selected Readings in, from Hippocrates to Virchow, edited by Prof. E. R. Long, 488
- Pauli's Exclusion Principle, On the Correct Formulation of, Prof. J. Frenkel, 235
- Pecten: Neuro-muscular Mechanism of the Gill of, Setna, 794; The Adductor Mechanism of, L. E. Bayliss, E. Boyland, and A. D. Ritchie, 841
- Pectinatella, Studies on, C. M. Brooks, 181
- Peel-method of Preparing Sections of Fossil Plants, Improvements in the, Dr. J. Walton, 413
- Peking: Man, Photograph of the Skull of, 179; *Society of Natural History Bulletin*, June, 250
- Pendulum Observations at Sea, Dr. V. Meinesz, 104
- Pepper Cultivation, M. G. Kidavu and P. A. Venkateswaran, 794
- Periodograph, A Grating, G. A. R. Foster, 544
- Peripheral Vision, Action of Blood-vessel Dilators on the Sensitiveness of the Eye in, P. Lazarev and L. Teile, 258
- Peroderma cylindricum*, Structure and Function of the Middle Intestine of, B. Monterosso, 879
- Personnel Policy and Procedure, Dr. C. H. Northcott, 682
- Peter I. Island, Capt. W. Sachse, 144
- Petroglyphs of California and Adjoining States, J. H. Steward; M. C. Burkitt, 361
- Petrographic Nomenclature, Dr. Beliankin, 28
- Petroleum: from Various Sources, The Magnetic Double Refraction of Specimens of, A. Cotton and M. Scherer, 729; The Engineer and, J. Gillespie, 212
- Phagocytes of Arthropods, Reaction of the, to their Internal Insect Parasites, Dr. W. R. Thompson, 565
- Pharmaceutical: Formulas, P.F. Vol. 1. Tenth edition, S. W. Woolley and C. P. Forrester, 366; Society, Report of the Pharmacological Laboratories of the, 249
- Pharmacopeias, Unofficial, 366
- Pharmacopœia, The Extra, of Martindale and Westcott. Revised by Dr. W. H. Martindale. Nineteenth edition. In 2 vols. Vol. 2, 366
- Phenolated Anti-cancer Vaccine, Certain Causes which may Weaken or Destroy the Immunising Power of our, G. Tizzoni and G. De Angelis, 730
- Phenyltrimethylene, Lespiau, 995

- Philippine Camphor, A. P. West and H. Taguibao, 758
 Philosophy : by Way of the Sciences : an Introductory Textbook, Prof. R. H. Dotterer, 521 ; of Spinoza and Leibniz, The, Prof. G. Dawes Hicks, 264 ; Science and, 521, 845 ; A Proposed International Conference, Prof. F. G. Donnan, 857 ; W. Trotter, 924
 Phloem in Trees, The Anatomical Changes in Tissue Bridges across Rings through the, Rosa M. Tupper-Carey, 622
 Phorone and Iodine, etc., Nature of the Reaction between, A. E. Battye and H. M. Dawson, 34
 Phosphate in Alcoholic Fermentation, The Function of, Prof. A. Harden, 277, 313
 Phosphoric Acid Deficiency of Soils, Valuation of the, A. Demolon and G. Barbier, 730
 Phosphorogen and Flux in Zinc Sulphide, Copper, etc., The Optimum Concentration for the, R. Coustal and F. Prevet, 729
 Phosphorus, White, The Crystal Structure of, Prof. G. Natta and Dr. L. Passerini, 707
 Photo : -chemistry, Dr. E. K. Rideal, 405 ; -elasticity, Z. Twzi, 28 ; -electric : Cells, Dr. A. Ferguson, 953 ; Observations at Neubabelsberg, Margarete Güssow, 613 ; -metric System of Naples, S. Aurino, 338 ; -processes in Gaseous and Liquid Systems, Dr. R. O. Griffith and Dr. A. McKeown, 405
 Phthalide, Action of Grignard Reagents on, J. Algar and A. V. Flaegel, 478
Phycomyces, The Light-sensitive System as the Basis of the Photic Responses of, E. S. Castle, 842
 Phyllerythrin, L. Marchlewski, 75, 150
 Physical : and Social Science, Prof. Graham Wallis (Huxley Memorial Lecture), 881 ; Society, election of officers, 576 ; Society's Discussion on Magnetism, The, Dr. A. Ferguson, 874 ; Society and the Optical Society, The Twentieth Annual Exhibition of the, 106 ; Theory, Current, Two Contradictions in, and their Resolution, F. S. C. Northrop, 843
 Physics : W. J. R. Calvert. Parts 2, 3, and 4, 886 ; A Course in, for Medical and Dental Students, R. Ablett, 812 ; Elementary, A Logical Course of, 886 ; in its Elementary Branches : A History of, including the Evolution of Physical Laboratories, Prof. F. Cajori. Revised and enlarged edition, 77 ; in relation to Wireless, Dr. W. H. Eccles, 894 ; Institute of, Presidential Address to the, Dr. W. H. Eccles, 868 ; Dr. Eccles re-elected president of the, 868 ; Modern, The Rise of, a Popular Sketch, Prof. H. Crew, 84 ; Progressive, 437 ; Theoretical, Introduction to, Prof. A. Haas. Translated by Dr. T. Verschoyle. Vol. 2. Second edition, 559
 Physikisch-chemisches Praktikum, Prof. K. Fajans and Dr. J. Wüst, 380
 Physiological : Mechanics of Piano Playing, Dr. W. H. George, 43 ; Units, The Theory of, A. N. Tsvetkov, 258
 Physiology, General, Essentials of, Prof. E. Ponder, 232
 Phytoplankton of the Loire in the Course of the Summers of 1928 and 1929, The, J. des Cilleuls, 766
 Piano Technique : The Physiological Mechanics of, an Experimental Study of the Nature of Muscular Action as used in Piano-playing, and of the Effects thereof upon the Piano Key and the Piano Tone, O. Ortmann, 43
 Piceoside (Ch. Tanret's Piceine), The Distribution of, in the Vegetable Kingdom, M. Bridel and J. Rabate, 222
 Pickett-Thomson Research Laboratory, Annals of the. Vol. 5 : The Pathogenic Streptococci, their Rôle in Human and Animal Disease (continued), 703
 Pictures, The Scientific Examination of, Dr. A. M. de Wild. Translated by Dr. L. C. Jackson, 382
 Pig, Skeletal Structure of the, Variations in the, Prof. A. M. Shaw, 254
 Pintsch Crystals of Tungsten, The Elasticity of, S. J. Wright, 433
Pinus insignis, Some Mechanical Properties of Australian Grown, M. B. Welch (2), 658
 Pioneer Ships of the Atlantic Ferry, Engr.-Capt. E. C. Smith, 387
 Pipe Lines and Progress, 589
 Picture Telegraphy Services, 99
 Pilot Balloons, Observations by, 952
 Pine-Sawyer Pest in Sweden, The, I. Trägårdh, 546
 Pink Epsomites and Fauserite, on, M. H. Hey, 958
 Pismo Clam, Life History of the, W. C. Herrington, 987
 Plague Pneumonia, Preventive Vaccination against, by the Respiratory Tract, C. Nicolle, P. Durard, and E. Conseil, 397
 Plane : Algebraic Curves with given Plueckerian Numbers, Distinct Continuous Systems of, B. Segre, 658 ; Irrotational Motions of Viscous Fluids, Dynamic Actions relative to, B. Finzi, 730
 Planet : A New Trojan Minor, Dr. G. Stracke, 577 ; Discovered at Lowell Observatory, The, Dr. J. Jackson, 491 ; or Distant Comet, Determination of the Position and of the Elements of a, E. Esclangon, 914 ; the New, 577 ; F. Baldet ; The Writer of the Note, 672 ; G. F. Daniell, 746
 Planetary : Figures, Complement to the Theory of, R. Wavre, 186 ; Stratifications, The, R. Wavre, 915
 Planeten und Kometen, Bahnbestimmung der, Prof. G. Stracke, 84
 Planets : Atmosphere of, Determination of the Absorption in the, D. I. Eropkin, 586 ; Minor, 65 ; The Method of the Cavity and the Internal Movements of the, R. Wavre, 730
 Plant : Behaviour, The Integration of, Sir Frederick Keeble, M. G. Nelson, and R. Snow (1), 149 ; (2) 293 ; Breeding, Principles of, J. B. S. Haldane, 326 ; Diseases, The Chemotherapy of, by Organic Colouring Matters, G. Truffaut and I. Pastic, 75 ; Physiology : Problems of, L. J. F. Brimble, 438 ; The Advance of, Sir J. C. Bose, 25 ; Remains in Sun-dried Bricks, Prof. G. W. Hendry, 215 ; Tissues, Responses of, to Electric Currents, Prof. H. H. Dixon and T. A. Bennet-Clark, 434 ; Virus Diseases, Intracellular Bodies in, F. M. L. Sheffield and J. Henderson Smith, 200
 Plantamour Method for the Measurement of the Error of Compensation of Chronometers, Generalisation of the, G. Tiercy, 186
 Plants : Growth and Tropic Movements of, Sir Jagadis Chunder Bose, 438 ; Mortality amongst, and its Bearing on Natural Selection, Prof. E. J. Salisbury, 817 ; Dr. R. A. Fisher, 972 ; Prof. E. W. MacBride, 973 ; the Nutrition of, The Relative Importance of Sulphur and Phosphorus in, G. Bertrand and L. Silberstein, 113
 Platinum : Deposits and Mines of South Africa, The, Dr. P. A. Wagner. With a chapter on the Mineralogy and Spectrography of the Sulphidic Platinum Ores of the Bushveld Complex, by Prof. D. H. Schneiderhöhn, 662 ; Group Metals in South Africa, The, Dr. J. Parkinson, 662
 Pleistocene Man in China, Prof. Davidson Black, 22
 Pliny as a Chemist, 121
 Pliny's, The Elder, Chapters on Chemical Subjects. Part 1. Edited, with translation and notes, by Dr. K. C. Bailey, 121
 Poisoning, Secret, Sir William Willcox, 291
 Poland, National Parks in, 866
 Polar : Aurora, Twenty-five Years Study of the, Prof. C. Størmer, 422 ; Molecules, Prof. P. Debye, 9
 Polare Molekeln, Prof. P. Debye, 9
 Polarisierte und gerichtete Röntgenstrahlung aus einem Kristall, Prof. J. Stark, 745
Political : Quarterly, The, No. 1, 247 ; Science, W. G. L. Cass, 663
 (Polonium) : Element 84, Search for an Active Isotope of the, Prof. G. Hevesy and A. Guenther, 744 ; Existence of a Non-electrolytic Complex of, An attempt to prove the, M. Guillot, 294 ; The carrying down of, a Chloropoloniate by Ammonium Chloroplumbate, M. Guillot, 586 ; The Heat Evolved by, Mlle. Dorabalska, 74
 Polychæta of Lake Baikal, B. Dybowski, 615
 Polydactyly : in Fowls, Punnett and Pease, 543 ; in Man, Heredity of, O. Koehler, 834
 Polymorphous Erythema, Acute Epidemic, The Mode of Transmission of Acute Epidemic, C. Levaditi and F. R. Selbie, 223
 Polynesia, Survey Work of the Bernice P. Bishop Museum in, 683

- Polynesian Anthropometry, Prof. Wood Jones, 685
 Polyzoa, Sir Sidney Harmer, 543
 Pontifical Academy of Sciences, The, 140
 Portland Island Museum, The, 754
 Portuguese in Abyssinia, The Romance of the, C. F. Rey, 631
 Position and Elements of an Object (Planet or Comet),
 Determination of the, E. Esclançon, 995
 Positive : Electricity, The Nature of, J. R. Oppenheimer,
 616 ; Ions, Reflection of, by Crystals, Prof. A. J.
 Dempster, 741
 Potassium : and Sodium contained in Plants which Grow
 in Brackish Water or on the Sea Coast, The Proportion
 of, G. Bertrand and Mme. M. Rosenblatt, 914 ; Radio-
 active Disintegration of, The Product of the, A. V.
 Frost and O. Frost ; Prof. A. Holmes and Dr. R. W.
 Lawson, 48 ; Prof. O. Höningsschmid, 91 ; Nitrate
 near Goyder's Pass, M'Donnell Ranges, Sir Douglas
 Mawson, 149 ; Sodium, and their Iodides, The
 Equilibrium in the Fused State between, E. Rinck, 222
 Potato Leaf-Roll, Transmission of, Dr. T. Whitehead, 974
 Potatoes, Utilisation of, 875
 Power Plant, A large, at Billingham-on-Tees, H. A.
 Humphrey, D. M. Buist, and J. W. Bansall, 511
 Prairie Smoke, M. R. Gilmore, 554
 Prehistoric : Art : Miss Sylvia Seeley and Count Begouën,
 99 ; and Symbolism, 157 ; Times, Life and Work in,
 Prof. G. Renard. Translated by R. T. Clark, 45
 Pressures round an Immersed Cylinder, The Distribution
 of the, P. Dupin and M. Teissie-Solier, 622
 Prickly-pear Control in Australia, A. P. Dodd, 691
 Primates : The Classification of the, Dr. C. Tate Regan,
 125 ; Prof. W. E. Le Gros Clark, 236 ; Prof. G. Elliot
 Smith, 270 ; H. Bury, 311 ; Pelvis of, Evolution of
 the, Miss H. C. Waterman, 215
 Problems : Unsolved, National and International, J. S.
 Hecht, 735
 Progressive Physics, 437
 Promoter Action, Kuboto and Yamanaka, 216
 Prospecting, Scientific, 267
 Proteins in Brewing, the late Prof. S. B. Schryver, 105
 Proteolysis in Plants, Prof. S. H. Vines, 906
 Protoactinium, Origin of, J. E. Wildish, 474
 Protons from Calcite, Reflection of, Prof. A. J. Dempster,
 51
 Protozoa and Algæ, Preparations of, Dr. Ll. Lloyd ; E.
 Heron-Allen, 91 ; R. W. Butcher, 276
 Protozoan Fauna found in the Paunch and Reticulum
 of Ruminants, the Comparative Morphology of the,
 H. Lister, 693
Prunus, Chromosomes of, Dr. Darlington, 988
 Psittacosis or Parrot Fever, 212, 287
 Psychodid Larvæ, Taxonomic Importance of the Terminal
 Segements of S. Mukerji, 446
 Psychological Register, The, Edited by Prof. C. Murchison,
 and others, 775
 Psychology : and Industry, 481 ; Experimental : Prin-
 ciples of, Prof. H. Piéron, Translated by Prof. J. B.
 Miner, 268 ; The Foundations of, H. Banister, and
 others. Edited by C. Murchison, 376 ; Vocational,
 E. Farmer, 831
Pterophyllum scalare, the Breeding of, Rev. B. Stower, 506
 Public Analysts, Society of, Election of Officers, 470
 Pulmonary : Anthracosis, A. Policard and M. Boucharlat,
 258 ; Lipo-dieresis, the Supposed Existence of, O.
 Cantoni, 398 ; Silicosis, etc., Appointment of a Com-
 mittee on, 327
 Pulp and Paper Making, Chemistry of, E. Sutermeister.
 Second edition, 197
 Pulverised Coal for Ship Propulsion, Engr. Rear-Admiral
 W. S. Hill, 326
 Punishment : The Morality of, with Some Suggestions for
 a General Theory of Ethics, Dr. A. C. Ewing, 376
 Purple Land : The, being the Narrative of one Richard
 Lamb's Adventures in the Banda Oriental, in South
 America, as told by Himself, W. H. Hudson, 45
 Puy-de-Dôme, Sale of the, 101
 Pycnogonida of South Africa, Prof. T. Flynn, 426
 Pyrenoids, Starch Envelopes of, F. O. Howitt, 412
 Pyrophoric Iron, T. G. Finzel, 616
 Pyrrole Blacks, A New Method of Formation of, A.
 Quilico and M. Freri, 842
 Quadrupeds, The Gaits of, P. Mayne de la Croix, 215
 Quantitative Analysis by X-Rays, Prof. T. H. Laby and
 C. E. Eddy, 524 ; C. E. Eddy and Prof. T. H. Laby,
 686 ; Prof. G. Hevesy, 776
 Quantum : Mechanics, An Application of Relativity to,
 G. Wataghin, 398 ; Theory : Equations of the, J. W.
 Fisher and Dr. H. T. Flint, 256 ; of the Kinetics of
 Homogeneous and Heterogeneous Reactions, The, S.
 Roginsky and L. Rosenkewitsch, 347
 Quartzite containing Common Opal and Chalcedony at
 Tallong, N.S.W., L. L. Waterhouse and W. R. Browne,
 658
 Quekett Microscopical Club, election of officers, 328

 Rabbit, Castorrex, The Genetics of the, R. Lienhart, 550
 Radcliffe Observatory, The : Prof. A. Fowler, 776 ; and
 its proposed removal, 769
 Radical Ethyl, Isolation of the, Prof. F. Paneth and W.
 Lautsch, 564
 Radio : Communication in Egypt, Mobility of, 326 ;
 Direction-finding by Transmission and Reception, Dr.
 R. L. Smith-Rose, 530, 568 ; -electric Waves, The
 Propagation of, J. B. Galle and G. Talon, 258 ;
 -oscillator : The Action Exerted by a, for Ultra-short
 Waves of 2-3 Metres Wave-length on the Germination
 of Seeds and on the Growth of Plants, (1), G. Mezza-
 droli and E. Varetton, 731 ; for Ultra-short Waves
 (2-3 Metres Wave-length) on the Germination of Seeds,
 etc., Action Exerted by a, (2), G. Mezzadroli and E.
 Varetton, 767 ; and Telephony : Beam, 538 ; with the
 Dominions, etc., 386
 Radioactive Constants, Mme. P. Curie, 182
 Radioactivity : acquired by Materials exposed to the
 Action of Atmospheric Agents, A. Lepape and M.
 Geslin, 657 ; of various Metals obtained from Old
 Roofs, The, A. Boutaric and Mlle. Madeleine Roy, 550
 Radium : Commission, Progress of the National Organisa-
 tion, 610 ; -emanations-therapie, Physikalische Bei-
 träge zur, H. Mache und S. Meyer, 407 ; Medical Uses
 of, Summary of Reports from Research Centres for
 1928, 102 ; The delayed Lethal Effect of, on Tissue
 Cultures *in vitro*, F. G. Spear, 149
 Railroad Transit, The Progress of, 138
 Railway : and Seaport Freight Movement : with Examples
 of British and American Practice, G. Bulkeley, 488 ;
 Electrification in Sweden, I. Ofverhohm, 682 ; Level
 Crossings, Automatic Signalling for, E. Schwandt, 718
 Rainfall of the World, Dr. E. Ekhardt, 795
 Rainfalls accompanying Volcanic Explosions, R. H. Finch,
 651
 Raman : Effect : and Chemical Structure, Dadiou and
 Kohlrausch, 796 ; Electrolytic Dissociation by the,
 (1), Ramakrishna Rao, 433, 872 ; for Solutions of
 Sulphur Dioxide, Prof. W. D. Harkins, D. M. Gans,
 and H. E. Bowers, 464 ; in Diamond, C. Ramaswamy,
 704 ; in Metallic Halides, P. Krishnamurti, 892 ; in
 Liquefied Gases, J. B. Austin, 464 ; in Liquids, Dr.
 R. Bär, 332 ; of Sulphuric Acid, R. M. Bell and W. R.
 Fredrickson, 892 ; in the X-Ray Region, Prof. A.
 Carrelli, 201 ; in Water, I. Ramakrishna Rao, 600 ;
 Interpretation of the, Satyendra Ray, 647 ; Dr. A. C.
 Menzies, 205 ; The 'Common Third Level' in the,
 R. C. Majumdar and D. S. Kothari, 165 ; with
 Optically Active Substances, S. Bhagavantam and S.
 Venkateswaran, 337 ; Lines : in Diatomic Gases,
 Optical Anisotropy and Theoretical Intensities of,
 Prof. C. Manneback, 88 ; of Mercury in Arc improb-
 able, Prof. R. W. Wood, 464 ; Scattering on Fre-
 quency, Dependence of, Prof. Ornstein and J. Rekveld,
 835 ; Spectra of Crystalline : Nitrates, Prof. W.
 Gerlach, 819 ; Powders, P. Krishnamurti, 463 ; Spec-
 trum of Organic Substances, The, A. Dadiou and K.
 W. F. Kohlrausch, 398
 Rational Organisation, L. Urwick, 682
 Rationalisation, Dr. C. Deslisle Burns, 117 ; J. D. Pratt,
 246
 Rats, Destruction of, by Red-Squill Powders, 905
 Rattlesnakes of the Western United States, L. M. Klauber,
 758
 Rauschelbach Current Meter, Askania-Werke A. G., 652

- Ray Society, election of officers, 541
 Reactions, Mechanism of, P. Robinson, 836
 Recapitulation Theory, Biochemical Aspect of the, Dr. J. Needham, 950
 Recollections of My Youth, Ernest Renan. Translated by C. B. Pitman, 851
 Red : Rain in New Zealand, Australian Origin of, Dr. E. Kidson ; Prof. J. W. Gregory, 410 ; Shift of Spectral Lines through Interstellar Space, On the, F. Zwicky, 114
 Reflection from Calcite for Silver ($K\alpha_1$) X-Rays, Glancing Angle of, Prof. C. D. Cooksey and D. Cooksey, 461
 Refractive Indices, Measurement of, Prof. T. M. Lowry and C. B. Allsopp, 28
 Relatives, Our Nearest Living, 485
 Relativistic Cosmology, The Foundations of, H. P. Robertson, 150
 Relativity Postulate, Test of a, Sir Oliver Lodge, 632
 Research : and Finance in the Study of Man and his Past, 189 ; and the State, Sir James W. Barrett, 310 ; Fundamental, The Position of, 805
 Resolving Power, Notes on, R. W. Ditchburn, 958
 Respiration Apparatus, Dr. E. Simonson, 427
 Retina, Yellow Spot of the, Projection of Long Spark upon the, T. Terada, 528

REVIEWS AND OUR BOOKSHELF.

Agriculture, Forestry, and Horticulture :

- Agricultural Research in 1928. Royal Agricultural Society of England, 11
 Bews (Prof. J. W.), The World's Grasses : their Differentiation, Distribution, Economics and Ecology, 119
 Index Londinensis to Illustrations of Flowering Plants, Ferns and Fern Allies : being an emended and enlarged edition continued up to the end of the Year 1920 of Pritzel's Alphabetical Register of Representations of Flowering Plants and Ferns compiled from Botanical and Horticultural Publications of the XVIIIth and XIXth Centuries. Prepared under the Auspices of the Royal Horticultural Society of London at the Royal Botanic Gardens, Kew, by Dr. O. Stapf. Vol. 1, 42 ; Vol. 2, 523

Anthropology and Archaeology :

- Ayyar (Rao Bahadur L. K. Ananta Krishna), Anthropology of the Syrian Christians, 852
 Breuil (the Abbé H.), and M. C. Burkitt ; with the collaboration of Sir Montagu Pollock, Rock Paintings of Southern Andalusia : a description of a Neolithic and Copper Age Art Group, 157
 Cartellieri (Prof. O.), translated by M. Letts, The Court of Burgundy : Studies in the History of Civilisation, 12
 Childe (Prof. V. Gordon), The Danube in Prehistory, 591
 Driberg (J. H.), People of the Small Arrow, 375
 Franz (L.), Vorgeschichtliches Leben in den Alpen, 775
 Frazer (Sir James George), Myths of the Origin of Fire : an Essay, 920
 Garçon (M.), and J. Vinchon. Translated by S. Haden Guest, The Devil : an Historical, Critical and Medical Study, 371
 Gilmore (M. R.), (Pahok), Prairie Smoke, 554
 Haddon (Kathleen), (Mrs. O. H. T. Rishbeth), Artists in String : String Figures, their Regional Distribution and Social Significance, 888
 von Hoffman (C.), Edited by E. Löhrlke, Jungle Gods, 375
 Jones (Prof. F. Wood), Man's Place among the Mammals, 6
 Karandikar (S. V.), Hindu Exogamy, 407
 Nordenskiöld (Baron Erland), Modifications in Indian Culture through Inventions and Loans, 968
 North American Indians, Tales of the, Selected and Annotated by Prof. S. Thompson, 554
 Nuzhatu-l-Qulüb of Hamdullāh al-Musta'fi-al-Quazwīni, The Zoological Section of the, Edited, translated, and annotated by Lieut.-Col. J. Stephenson, 124
 Ovidii Nasonis Fastorum Libri Sex : Publii, The "Fasti" of Ovid, Edited with a Translation and Commentary by Sir James George Frazer. 5 vols., 847

- Peake (H.), The Flood : New Light on an Old Story, 923 ; and Prof. H. J. Fleure, The Corridors of Time. Vol. 5 : The Steppe and the Sown ; Vol. 6 : The Way of the Sea, 375
 Posselt (F.), Fables of the Veld, 123
 Renard (Prof. G.), Translated by R. T. Clark, Life and Work in Prehistoric Times, 45
 Sidhanta (Prof. N. K.), The Heroic Age of India : a Comparative Study, 375
 Steward (J. H.), Petroglyphs of California and adjoining States, 361
 Summers (Dr. M.), The Vampire in Europe, 371
 Wingfield-Stratford (Dr. E.), The History of British Civilization. Second Edition, 407
 Witch Hunting and Witch Trials : the Indictments for Witchcraft from the Records of 1373 Assizes held for the Home Circuit A.D. 1559-1736. Collected and edited by C. L'Estrange Ewen, with an Introduction, 371
 Woolley (C. L.), Ur of the Chaldees : a record of Seven Years of Excavation, 84

Biology :

- Backer (C. A.), The Problem of Krakatao as seen by a Botanist, 627
 de Beer (G. R.), Embryology and Evolution, 883
 Binnengewässer, Die, Einzeldarstellungen aus der Limnologie und ihren Nachbargebieten. Unter Mitwirkung von Dr. E. Naumann und anderen Fachgenossen herausgegeben von Prof. A. Thienemann. Band 7 : Die Biologie der Moore. Von Dr. O. Harnisch. Band 8 : Der Hochgebirgsee der Alpen (Versuch einer limnologischen Charakteristik). Von Dr. O. Pesta, 377
 Biologischen Arbeitsmethoden, Handbuch der. Herausgegeben von Prof. E. Abderhalden. Lief. 293. Abt. 9 : Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 4, Heft 3. Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Methoden und Technik der Nerven- und Muskelphysiologie bei wirbellosen Tieren. Von H. J. Jordan und P. J. van der Feen, 378 ; Lief. 307. Abt. 9 : Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 6, Heft 1. Methoden der Meeresfischereibiologie. Die Methodik fischereibiologischer Untersuchungen an Meeresfischen, A. Büchmann, 523
 Bodenheimer (Dr. F. S.), Materialien zur Geschichte der Entomologie bis Linné. Band 2, 483
 Bolitho (H.), with certain chapters edited by M. Burton, The Glorious Oyster, 406
 Bose (Sir J. C.), Growth and Tropic Movements of Plants, 438
 Brain (Dr. C. K.), Insect Pests and their Control in South Africa, 378
 Breder, Jr. (C. M.), Field Book of Marine Fishes of the Atlantic Coast from Labrador to Texas, 969
 Bronns, Dr. H. G., Klassen und Ordnungen des Tierreichs wissenschaftlich dargestellt in Wort und Bild. Band 5, Abt. 4, Buch 3 : Tardigrada. Bearbeitet von E. Marcus, 702
 Carpenter (Kathleen E.), Life in Inland Waters : with especial reference to Animals, 774
 Chisholm (A. H.), Birds and Green Places : a book of Australian Nature Gossip, 367
 Creation by Evolution : a Consensus of Present-day Knowledge as set forth by leading authorities in non-technical language that all may understand, edited by Frances Marsh, 162
 Crofts (Doris R.), *Haliotis*, 304
 Darwin really said : What, connected extracts from the 'Origin of Species,' with an introduction by Prof. J. Huxley, 378
 Eipper (P.), Translated by P. Kirwan, Animals Looking at You, 378
 Friedmann (Dr. H.), The Cowbirds : a Study in the Biology of Social Parasitism, 367
 Gates (Prof. R. R.), Heredity in Man, 191
 Glegg (W. E.), A History of the Birds of Essex, 197

- Kittenberger (K.), Translated from the Hungarian, Big Game Hunting and Collecting in East Africa, 1903-1926, 373
- Leach (Dr. J. A.), Australian Nature Studies: a book of reference for those interested in Nature-Study. Second edition, 123
- von Lengerken (H.), Die Salzkäfer der Nord- und Ostseeküste: mit Berücksichtigung der angrenzenden Meere sowie des Mittelmeeres, des Schwarzen und des Kaspischen Meeres; eine ökologisch-biologisch-geographische Studie, 558
- Loyd (L. R. W.), The Birds of South-East Devon, 367
- Myers (Dr. J. G.), Insect Singers: a Natural History of the Cicadas, 122
- Needham (Dr. J.), The Sceptical Biologist (Ten Essays), 374
- Needham (Prof. J. G.), and Hortense Butler Heywood, and others: A Handbook of the Dragonflies of North America, 811
- Parker (E.), English Wild Life, 378
- Paton (E. R.), and O. G. Pike, The Birds of Ayrshire, 367
- Robson (G. C.), A Monograph of the Recent Cephalopoda: based on the Collections in the British Museum (Natural History). Part 1: Octopodinae, 850
- Russell (Dr. F. S.), and Dr. C. M. Yonge, The Seas: our Knowledge of Life in the Sea and how it is gained, 666
- Shelford (Prof. V. E.), Laboratory and Field Ecology: the Responses of Animals as Indicators of Correct Working Methods, 158
- Soar (C. D.), and W. Williamson, The British Hydra-carina. Vol. 3, 559
- Stempel (Prof. W.), Repetitorium der allgemeinen Zoologie (Morphologie, Physiologie, Ökologie, Abstammungslehre), 303
- Stephenson (Dr. J.), The Oligochæta, 594
- Tabulæ Biologicae. Ed.: W. Junk, herausgegeben von C. Oppenheimer und L. Pincussen. Supplement 1 (Band 5): Botanik; Biologie der Algen; Bakteriologie; Hefen- und Schimmel-Pilze; Geschlechter-Verteilung; Kern-Plasma-Relations; Keimung; Wachstum; Allgemeine Physiologie; Assimilation; Periodizität; Experimentelle Ökologie, 377
- Taylor (F. B.), Notes on Diatoms: an Introduction to the Study of the Diatomaceæ, 922
- Thomson (Prof. J. A.), Outlines of Zoology. Eighth edition, 269
- Tierreichs, Die Rohstoffe des, Herausgegeben von F. Pax und W. Arndt. Lief. 2 und 3, 666
- Tierwelt der Nord- und Ostsee, Der, begründet von G. Grimpe und E. Wagler. Lief. 14, Teil 10 f: Amphipoda, Dr. K. Stephenson, 303; Lief. 15, Teil 9a: Aculifera, von H. J. Nierstrasz und H. Hoffmann; Teil 11 f: Thalassobionte und thalassophile Myriapoda, von O. Schubart; Teil 12h: Pisces, 442
- Wright (F. J.), The New Nature Study, 268
- Yerkes (Prof. R. M.), and Ada W. Yerkes, The Great Apes: a Study of Anthropoid Life, 485

Chemistry:

- Allen's Commercial Organic Analysis: a Treatise on the Properties, Modes of Analysis, and Proximate Analytical Examination of the Various Organic Chemicals and Products Employed in the Arts, Manufactures, Medicine, etc.; with Concise Methods for the Detection and Estimation of their Impurities, Adulterations, and Products of Decomposition. Vol. 7: The Vegetable Alkaloids. Editor: C. Ainsworth Mitchell. Fifth edition, Revised and Partly Rewritten, 231
- Anschütz (Prof. R.), August Kekulé. Band 1 und 2, 807
- Bechhold (Prof. H.), Die Kolloide in Biologie und Medizin. Fünfte Auflage, 771
- Benzole and Allied Products, Standard Specifications for, 1929, 740
- Bone (Prof. W. A.), Dr. D. M. Newitt, and Dr. D. T. A. Townend, Gaseous Combustion at High Pressures: being mainly an Account of the Researches carried out in the High Pressure Gas Research Laboratories of the Imperial College of Science and Technology, London, together with the Equipment and Experimental Methods Employed, 302

- British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1930. Edited by G. E. Brown, 232
- Britton (Dr. H. T. S.), Hydrogen Ions: their Determination and Importance in Pure and Industrial Chemistry, 369
- Chemistry, Applied, Reports of the Progress of. Vol. 14, 1929, 739
- Crystal Models, Stereoscopic Photographs of, edited by Sir William and Prof. W. L. Bragg in order to illustrate the results of X-ray Crystallography. Second series: The Silicates, 381
- Daniels (Prof. F.), Prof. J. H. Mathews, and Prof. J. W. Williams, Experimental Physical Chemistry, 596
- Denham (Prof. H. G.), An Inorganic Chemistry. Second edition, 888
- Dipolmoment und chemische Struktur. Herausgegeben von Prof. P. Debye, 775
- Evelyn (John), Fumifugium. Now reissued as an Old Ashmolean Reprint in the Year of the refacing of the Old Ashmolean Museum, which, like 'Fumifugium', was dedicated to King Charles II., founder of the Royal Society, 368
- Fajans (Prof. K.), and Dr. J. Wüst, Physikalisch-chemisches Praktikum, 380
- Fermente, Die Technologie der. Herausgegeben von Prof. C. Oppenheimer. Halbband 2: Fermente in der Fettindustrie, Milchwirtschaft, Lederindustrie, Gelatine- und Leimindustrie, Pharmaz. Industrie, Malzextraktindustrie, Textilindustrie, Nahrungsmittelindustrie, 596
- Firth (Dr. J. B.), Chemistry in the Home, 269; Physical Chemistry, 84
- Fodor (Prof. A.), Das Fermentproblem (zugleich Einführung in die Chemie der Lebenserscheinungen). Zweite, völlig umgearbeitete Auflage, 381
- Gmelins Handbuch der anorganischen Chemie. Achte Auflage. System-Nummer 59: Eisen. Teil A, Lief. 1, 667
- Griffith (Dr. R. O.), and Dr. A. McKeown, Photo-processes in Gaseous and Liquid Systems, 405
- Hackh (Prof. I. W. D.), A Chemical Dictionary, 593
- Hinshelwood (C. N.), The Kinetics of Chemical Change in Gaseous Systems. Second edition, 703
- Kendall (Dr. E. C.), Thyroxine, 161
- Kendall (Prof. J.), At Home among the Atoms: a first book of Congenial Chemistry, 155
- Koetschau (Dr. R.), Einführung in die theoretische Wirtschaftscheme, 964
- Kopaczewski (W.), Traité de biocolloïdologie. Tome 1. Deux. édition. Fasc. 1, 813
- Mecke (Prof. R.), Bandenspektra und ihre Bedeutung für die Chemie, 380
- Molecular Spectra and Molecular Structure: a General Discussion held by the Faraday Society, September 1929, 380
- Nash (Prof. A. W.), and Dr. A. R. Bowen, The Principles and Practice of Lubrication: a Manual for Petroleum Technologists, Students, Engineers, Oil Salesmen, etc., 193
- du Nouÿ (Dr. P.), Équilibres superficiels des solutions Lecomte colloïdales: études de biophysique moléculaire, 771
- Parker (Dr. R. L.), Kristallzeichnen, 851
- Pauli (Prof. W.), und Dr. E. Valkó, Elektrochemie der Kolloide, 771
- Pliny's, The Elder, Chapters on Chemical Subjects. Part. 1. Edited, with Translation and Notes, by Dr. K. C. Bailey, 121
- Smith (Dr. J. W.), The Effects of Moisture on Chemical and Physical Changes, 229
- Smith (Dr. T. B.), Analytical Processes: a Physico-Chemical Interpretation, 381
- Sugden (Dr. S.), The Parachor and Valency, 364
- Sutermeister (E.), Chemistry of Pulp and Paper Making. Second edition, 197
- Tar and its Products, Standard Methods for Testing, 631
- Taylor (F. S.), A New School Chemistry, 303

Walyschmidt-Leitz (Prof. E.), translated and extended by R. P. Walton, *Enzyme Actions and Properties*, 124

Engineering :

- Appleyard (R.), *Pioneers of Electrical Communication*, 300
 Bulkeley (G.), *Railway and Seaport Freight Movement : with examples of British and American Practice*, 488
 Butterfield (Prof. T. E.), *Steam and Gas Engineering : a text covering Power Generating Apparatus utilising Energy released by the Combustion of Fuels*, 851
 Creager (W. P.), *Engineering for Masonry Dams*. Second edition, 45
 Hawkes (E.), *The Book of Electrical Wonders*, 923
 Kari (A.), *The Design of Merchant Ships and Cost Estimating*. Second edition, 921
 Pollard (Prof. A. F. C.), *The Kinematical Design of Couplings in Instrument Mechanisms*, 160
 Rawlings (Dr. A. L.), *The Theory of the Gyroscopic Compass and its Deviations*, 11
 Rolt (F. H.), edited by Sir R. T. Glazebrook, *Gauges and Fine Measurements*. Vols. 1 and 2, 81
 Stewart (D. S.), *Practical Design of Simple Steel Structures*. 2 vols., 196
 Time-Journey of Dr. Barton : The, an Engineering and Sociological Forecast based on Present Possibilities. Edited by J. Hodgson, 810
 Whitelaw, Jr. (J.), Eighth edition, revised and enlarged by Col. Sir Gordon Risley Hearn, *Surveying : as practised by Civil Engineers and Surveyors*, 83
 Wilson (P.), and G. W. Webb, *Modern Gramophones and Electrical Reproducers*, 520

Geography and Travel :

- Bernatzik (Dr. H. A.), mit Beiträgen von Prof. O. Beche, Prof. B. Struck und Dr. H. Antonius, *Zwischen Weissem Nil und Belgisch-Kongo*, 301
 Chapman (F.), *Open-air Studies in Australia*, 379
 Chevalier (M.), *Les paysages catalans : leurs aspects, leur structure et leur évolution*, 232
 Clowes (E. S.), *Shipways to the Sea : our Inland and Coastal Waterways*, 379
 Gide (A.), translated by Dorothy Bussy, *Travels in the Congo*, 596
 Greenland. Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. A. S. Jensen. Vol. 2 : *The Past and Present Population of Greenland*, 442 ; Vol. 3 : *The Colonization of Greenland and its History until 1929*, 559
 Houlléviqve (Prof. L.), *La vie du globe et la science moderne*, 304
 Hudson (W. H.), *The Purple Land : being the Narrative of one Richard Lamb's Adventures in the Banda Oriental, in South America, as told by Himself*, 45
 Jameson (Prof. A. H.), and Prof. M. T. M. Ormsby, *Mathematical Geography*. Vol. 2, 923
 Kearton (Cherry), *In the Land of the Lion*, 12
 Krabbe (Dr. T. N.), translated by Annie I. Fausbøll, *Greenland : its Nature, Inhabitants and History*, 379
 Maps, Reproductions of Early Manuscript, 1: *The Portolan Chart of Angellino de Dalorto, MCCCXXV., in the Collection of Prince Corsini at Florence*. With a Note on the Surviving Charts and Atlases of the Fourteenth Century, by A. R. Hinks, 486
 Mayo (Earl of), S. D. Adshead, and P. Abercrombie, with the assistance of W. H. Thompson, *The Thames Valley from Cricklade to Staines : a Survey of its Existing State and some Suggestions for its Future Preservation*, 737
 Practical Hints to Scientific Travellers. Edited by Prof. H. A. Brouwer. Vol. 6, 378
 Rey (C. F.), *The Romance of the Portuguese in Abyssinia : an Account of the Adventurous Journeys of the Portuguese to the Empire of Prester John ; their Assistance to Ethiopia in its struggle against Islam, and their Subsequent Efforts to impose their own Influence and Religion, 1490-1633*, 631
 Sharp (H. A.), *An Historical Catalogue of Surrey Maps*, 161

Statesman's Year Book, The, 1930. Edited by Dr. M. Epstein, 852
 Steers (J. A.), *An Introduction to the Study of Map Projections*. Second edition, 197

Geology and Mineralogy :

- Berg (Prof. G.), *Vorkommen und Geochemie der mineralischen Rohstoffe : Einführung in die Geochemie und Lagerstättenlehre ; besonders für Chemiker und Studierende der allgemeinen Naturwissenschaften*, 596
 Beyschlag (Prof. F.), *Geologische Karte der Erde*. Lief. 1, 488
 Buckman (the late S. S.), with Editorial Note, Chronological and other Tables and Index, by Dr. A. Morley Davies, *Type Ammonites-VII*. Parts 71-72 (combined), 773
 Crookall (Dr. R.), *Coal Measure Plants*, 159
 Edinger (Dr. Tilly), *Die fossilen Gehirne*, 738
 Eve (Prof. A. S.), and Prof. D. A. Keys, *Applied Geophysics in the Search for Minerals*, 267
Geologica Hungarica. Fasciculi ad illustrandam notionem Geologicam et Palaeontologicam Regni Hungariae. Series Geologica, Tomus 3 : Geographie und Geologie Nordalbaniens, von Baron Fr. Nopcsa ; mit einem Anhang von H. v. Mžik : Beiträge zur Kartographie Albanien nach orientalischen Quellen, 8
Geology of Great Britain, Handbook of the : a Compilative Work. Edited by Dr. J. W. Evans and Dr. C. J. Stubblefield, 362
 Gregory (Prof. J. W.), *Earthquakes and Volcanoes*, 11
 Hawkins (Prof. H. L.), *The Restless Earth : an Introduction to the History of the Rocks*, 11
 Jeffreys (Dr. H.), *The Future of the Earth*, 11
 Merriam (J. C.), *The Living Past*, 888
 Miers (Sir Henry A.), *Mineralogy : an Introduction to the Scientific Study of Minerals*. Second edition, revised by Dr. H. L. Bowman, 887
 Vaufreyc (Dr. R.), *Les éléphants nains des îles méditerranéennes et la question des isthmes pléistocènes*, 82
 Wagner (Dr. P. A.), *The Platinum Deposits and Mines of South Africa : with a chapter on the Minerography and Spectrography of the Sulphidic Platinum Ores of the Bushveld Complex*, by Prof. D. H. Schneiderhöhn, 662

Mathematical and Physical Science :

- Ablett (R.), *A Course in Physics : for Medical and Dental Students*, 812
 Allgemeinen Elektrizitäts-Gesellschaft, *Jahrbuch des Forschungs-Instituts der*. Band 1 : 1928-1929, 703
 Bauer (G. N.), *Mathematics Preparatory to Statistics and Finance*, 379
 Cabannes (J.), avec la collaboration d'Yves Rocard, *La diffusion moléculaire de la lumière*, 740
 Cajori (Prof. F.), *A History of Mathematical Notations*. Vol. 2 : *Notations mainly in Higher Mathematics*, 78 ; *A History of Physics in its Elementary Branches : including the Evolution of Physical Laboratories*. Revised and enlarged edition, 77
 Calvert (W. J. R.), *Physics*. Part 2 : *Sound* ; Part 3 : *Light* ; Part 4 : *Magnetism and Electricity*, 886
 Coble (Prof. A. B.), *Algebraic Geometry and Theta Functions*, 775
 Conrady (Prof. A. E.), *Applied Optics and Optical Design*. Part 1, 372
 Crew (Prof. H.), *The Rise of Modern Physics : a Popular Sketch*, 84
 Crowther (Prof. J. A.), *Ions, Electrons and Ionizing Radiations*. Fifth edition, 887
 Debye (Prof. P.), *Polar Molecules*, 9 ; *Polare Molekühl*, 9
 Emeléus (Dr. K. G.), *The Conduction of Electricity through Gases*, 740
 Fry (Dr. T. C.), *Elementary Differential Equations*, 380
Geophysik, Lehrbuch der. Herausgegeben von Prof. B. Gutenberg. Lief. 5 (Schluss), 162
 Gibbs (R. W. M.), *The Adjustment of Errors in Practical Science*, 380
 Gunther (Dr. R. T.), *Early Science in Oxford*. Vol. 5 : *Chaucer and Messahalla on the Astrolabe*, 556

Haas (Prof. A.), translated by Dr. T. Verschoyle. Introduction to Theoretical Physics. Vol. 2. Second edition, 559

Hall (F. G.), and Dr. E. K. Rideal, Cambridge Five-Figure Tables, 968

International Astronomical Union (Union Astronomique Internationale). Transactions of the International Astronomical Union. Vol. 3: Third General Assembly held at Leiden, July 5 to July 13, 1928. Edited by Prof. F. J. M. Stratton, 196

Ives (H. C.), Seven Place Natural Trigonometrical Functions: together with many Miscellaneous Tables and Appendices on the Adjustment of the Engineer's Transit and Level, Area Computation, Vertical Curves, Simple Curves, and Determination of Latitude, Longitude, and Azimuth, 968

Janet (Prof. M.), Leçons sur les systèmes d'équations aux dérivées partielles, 443

Levi-Civita (Prof. T.), translated by Dr. J. Dougall, A Simplified Presentation of Einstein's Unified Field Equations, 813

Lichtenstein (Prof. L.), Grundlagen der Hydromechanik, 402

Müller-Pouille's Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer und E. Waetzmann. In fünf Bänden. Band 2: Lehre von der strahlenden Energie (Optik). Herausgegeben von K. W. Meissner. Zweite Hälfte, Erster Teil. Zweite Hälfte, Zweiter Teil, 195

Rhind Mathematical Papyrus, The: British Museum 10057 and 10058. Photographic Facsimile, Hieroglyphic Transcription, Transliteration, Literal Translation, Free Translation, Mathematical Commentary, and Bibliography. In 2 volumes. Vol. 1: Free Translation and Commentary, by A. B. Chace, with the assistance of Prof. H. P. Manning; Bibliography of Egyptian Mathematics, by Prof. R. C. Archibald. Vol. 2: Photographs, Transcription, Transliteration, Literal Translation, by A. B. Chace, L. Bull, and Prof. H. P. Manning; Bibliography of Egyptian and Babylonian Mathematics (Supplement), by Prof. R. C. Archibald; The Mathematical Leather Roll in the British Museum, by S. R. K. Glanville, 962

Rice (Prof. J.), Introduction to Statistical Mechanics: for Students of Physics and Physical Chemistry, 700

Rosenbach (Prof. J. B.), and Prof. E. A. Whitman, Plane Trigonometry, 443

Ruedy (Dr. R.), Bandenspektren auf experimenteller Grundlage, 407

Schottky (Prof. W.), In Gemeinschaft mit Dr. H. Ulich and Dr. C. Wagner, Thermodynamik, 406

Sheareroft (W. F. F.), and D. Larrett, Science and Mathematical Tables: for use in Schools, 968

Silberstein (Dr. L.), The Size of the Universe: Attempts at a Determination of the Curvature Radius of Space-time, 849

Smith (Prof. P. F.), and Prof. W. R. Longley, Mathematical Tables and Formulas, 379

Sommerville (Prof. D. M. Y.), An Introduction to the Geometry of N Dimensions, 266

Spectrum Analysis, The Practice of, with Hilger Instruments: including a Note on the various Types of Emission Spectra. Compiled by F. Twyman. Fourth edition. Contributors: Prof. E. N. da C. Andrade, Dr. S. Judd Lewis, D. M. Smith, S. Barratt, A. A. Fitch, J. W. Ryde, 45

Stewart (Dr. R. W.), and Prof. J. Satterly, A Textbook of Light. Sixth edition, 523

Stracke (Prof. G.), Bahnbestimmung der Planeten und Kometen, 84

Thomson (Prof. G. P.), The Atom, 667

Tietjens (Dr. O.), Hydro- und Aeromechanik nach Vorlesungen von L. Prandtl. Band 1: Gleichgewicht und reibungslose Bewegung, 402

Turnbull (Prof. H. W.), The Great Mathematicians, 523

Villat (Prof. H.), Leçons sur l'hydrodynamique, 402; Leçons sur la théorie des tourbillons, 969

Walker (A.), and G. P. McNicol, A School Geometry. Part 1 (Books I.-III.). Part 2 (Books IV.-VII.). Part 2, Section 1 (Books IV.-V.). Part 2, Section 2 (Books VI.-VII.), 443

Weatherburn (Prof. C. E.), Differential Geometry of Three Dimensions. Vol. 2, 813

Medical Science:

Appleton (Dr. A. B.), Laboratory Guide to Vertebrate Dissection: for Students of Anatomy, 739

Bensted (H. J.), and others, A System of Bacteriology in relation to Medicine. Vol. 4, 359

Bulloch (Dr. W.), and others, A System of Bacteriology in relation to Medicine. Vol. 3, 80

y Cajal (Prof. S. Ramón), Translated and edited by Dr. R. M. May, Degeneration and Regeneration of the Nervous System. 2 vols., 230

Castellani (Sir Aldo), Fungi and Fungous Diseases, 631

Haslam (Dr. J. F. C.), Recent Advances in Preventive Medicine. With a chapter on the Vitamins, by Prof. S. J. Cowell, 968

Mache (H.), and S. Meyer, Physikalische Beiträge zur Radium-emanations-therapie, 407

Parkes (Dr. A. S.), The Internal Secretions of the Ovary, 629

Pathology: Selected Readings in, from Hippocrates to Virchow, edited by Prof. E. R. Long, 488

Patton (Prof. W. S.), and Dr. A. M. Evans, Insects, Ticks, Mites, and Venomous Animals of Medical and Veterinary Importance. Part 1: Medical, 698

Pharmacopœia of Martindale and Westcott, The, revised by Dr. W. H. Martindale. Nineteenth edition. In 2 vols. Vol. 2, 366

Pickett-Thomson Research Laboratory, Annals of the, Vol. 5: The Pathogenic Streptococci, their Rôle in Human and Animal Disease (continued), 703

Ponder (Prof. E.), Essentials of General Physiology, 232

Taliaferro (Prof. W. H.), The Immunology of Parasitic Infections, 703

Topley (Prof. W. W. C.), and Dr. G. S. Wilson, The Principles of Bacteriology and Immunology. 2 vols., 522

Tolley (S. W.), and G. P. Forrester, Pharmaceutical Formulas. Tenth edition, 366

Metallurgy:

Hillebrand (Dr. W. F.), and Dr. G. E. F. Lundell, Applied Inorganic Analysis: with special reference to the Analysis of Metals, Minerals, and Rocks, 852

Metals: Atmospheric Corrosion of, Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association), 739

Metals, Institute of, Journal of the, edited by G. Shaw Scott. Vol. 42, 852

Miscellaneous:

Annual Register, The, edited by Dr. M. Epstein, 1929, 813

Capell (R.), Opera, 969

Countryman's Day Book: A, an Anthology of Country-side Lore, Compiled and Arranged by C. N. French, 304

Cressy (E.), Discoveries and Inventions of the Twentieth Century. Third edition, 740

Dampier-Whetham (W. C. D.), A History of Science and its Relations with Philosophy and Religion, 4

Denny (L.), America Conquers Britain: a Record of Economic War, 965

Diplock (W. J. K.), Isis: or the Future of Oxford, 382

Encyclopædia Britannica: The, A New Survey of Universal Knowledge. Fourteenth edition. In 24 volumes, 357

Florence (Prof. P. S.), The Statistical Method in Economics and Political Science: a Treatise on the Quantitative and Institutional Approach to Social and Industrial Problems, 39

Goddard (T. R.), History of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, 1829-1929, 487

Gosney (E. S.), and Dr. P. Popenoe, Sterilisation for Human Betterment: a Summary of Results of 6000 Operations in California, 1909-1929, 40

- Gould (Lieut.-Comdr. R. T.), *Enigmas: another Book of Unexplained Facts*, 269
- Gunther (Dr. R. T.), *Early Science in Oxford. Vol. 6: The Life and Work of Robert Hooke, Parts 1 and 2*, 629
- Harvey-Gibson (Prof. R. J.), *Two Thousand Years of Science: the Wonders of Nature and their Discoverers*, 404
- Hecht (J. S.), *Unsolved Problems: National and International*, 735
- Kenwick (Evelyn and Miriam), *The Child from Five to Ten: Interests and Problems of Early Childhood*, 161
- Kenyon (Sir Frederic), *Museums*, 969
- Lenard (P.), *Grosse Naturforscher: eine Geschichte der Naturforschung in Lebensbeschreibung*, 812
- Lowie (R. H.), *Are we Civilized? Human Culture in Perspective*, 383
- de Man (H.), translated by Eden and Cedar Paul, *Joy in Work*, 667
- Oakden (Ellen C.), and Mary Sturt, *Growing Up: How one did it in Different Times and Places*, 888
- Ortmann (O.), *The Physiological Mechanics of Piano Technique: an Experimental Study of the Nature of Muscular Action as used in Piano-playing, and of the Effects thereof upon the Piano Key and the Piano-Tone*, 43
- Paget, Bart. (Sir Richard), *Human Speech: some Observations, Experiments and Conclusions as to the Nature, Origin, Purpose and possible Improvement of Human Speech*, 966
- Paine (W. W.), *Banking*, 969
- Park (R. E.), and others, edited by W. Gee, *Research in the Social Sciences: its Fundamental Methods and Objectives*, 663
- Percy (Lord Eustace), *Education at the Crossroads*, 701
- Poley (A. F. E.), with Introduction by Sir Reginald Blomfield, *St. Paul's Cathedral*, 228
- Renan (E.), translated by C. B. Pitman, *Recollections of My Youth*, 851
- Richards (I. A.), *Practical Criticism: a Study of Literary Judgment*, 304
- Scientific and Learned Societies of Great Britain and Ireland, *The Year-Book of the, Forty-sixth Annual issue*, 667
- Simpson (Prof. J. Y.), *Nature: Cosmic, Human and Divine*, 382
- Sociology: Descriptive, or, Groups of Sociological Facts, Classified and Arranged by Herbert Spencer. No. 13: Mesopotamia (The Ancient Inhabitants of the Tigris-Euphrates Lands). Compiled and Abstracted upon the plan organised by Herbert Spencer, by R. Levy, 162
- Thorndike (Prof. L.), *Science and Thought in the Fifteenth Century; Studies in the History of Medicine and Surgery, Natural and Mathematical Science, Philosophy and Politics*, 441
- Toutain (J.), translated by M. R. Dobie, *The Economic Life of the Ancient World*, 558
- Universities of the Empire, *The Yearbook of the, 1930*; edited by Sir H. Frank Heath, 885
- Wallas (Prof. Graham), *Physical and Social Science (Huxley Memorial Lecture)*, 881
- Wheeler (Prof. Olive A.), *Youth: the Psychology of Adolescence and its Bearing on the Reorganisation of Adolescent Education*, 161
- de Wild (Dr. A. M.), translated by Dr. L. C. Jackson, *The Scientific Examination of Pictures: an Investigation of the Pigments used by the Dutch and Flemish Masters from the Brothers Van Eyck to the Middle of the 19th Century*, 382
- Woodruff (L. L.), and others, edited, with a Preface, by Prof. G. A. Baitsell, *The Evolution of Earth and Man*, 382
- Dotterer (Prof. R. H.), *Philosophy by Way of the Sciences: an Introductory Textbook*, 521
- Ewing (Dr. A. C.), *The Morality of Punishment: with some Suggestions for a General Theory of Ethics*, 376
- Hatfield (Dr. H. S.), *The Conquest of Thought by Invention in the Mechanical State of the Future*, 370
- Kant's (Immanuel) *Critique of Pure Reason*, translated by Prof. N. Kemp Smith, 557
- McKeon (R.), *The Philosophy of Spinoza: The Unity of his Thought*, 264
- Piéron (Prof. H.), translated by Prof. J. B. Miner, *Principles of Experimental Psychology*, 268
- Psychological Register, The*, edited by C. Murchison, and others, 775
- Roth (Prof. L.), *Spinoza*, 264
- Technology:**
- Britten (F. W.), *Horological Hints and Helps*, 969
- Desbleds (L. B.), *Exact Colour Matching and Specifying*, 12
- Manson (J. L.), and F. E. Drury, *Experimental Building Science. Vol. 2: Being an Introduction to Mechanics and its Application in the Design and Erection of Buildings*, 44
- Smith (P. I.), *Glue and Gelatine*, 162
- Woodhouse (T.), and P. Kilgour, *Jute and Jute Spinning. Part 1, Second edition, and Part 2, 124*
- Rhamnose Series, *Studies in the*, E. Votoček, F. Valentin, and F. Rac, 959
- Rhind *Mathematical Papyrus, The: British Museum 10057 and 10058. Photographic Facsimile, Hieroglyphic Transcription, Transliteration, Literal Translation, Free Translation, Mathematical Commentary, and Bibliography. In 2 vols. Vol. 1: Free Translation and Commentary, by A. B. Chace, with the assistance of Prof. H. P. Manning; Bibliography of Egyptian Mathematics, by Prof. R. C. Archibald. Vol. 2: Photographs, Transcription, Transliteration, Literal Translation, by A. B. Chace, L. Bull, and Prof. H. P. Manning; Bibliography of Egyptian and Babylonian Mathematics (Supplement), by Prof. R. C. Archibald; The Mathematical Leather Roll in the British Museum, by S. R. K. Glanville*, 962
- Rhodesia, Southern, *Report of the Education Commission*, 261
- Rhodesian Gold, Early, Gertrude Caton-Thompson, 163; Dr. T. A. Richard; Prof. J. W. Gregory, 47
- Rhone Glacier, *Studies on the, 1927*, G. Slater, 293
- Rhyolites, Trachytes, and Phonolites from part of Kenya Colony, *A Classification of some*, W. Campbell Smith, 693
- Right, *The Origin of*, A. W. Tilby, 139
- River Flow Records in the Ness Basin, Scotland: Dr. Brysson Cunningham, 334; River Moriston and River Garry, Capt. W. N. McClean, and others, 334; Capt. W. N. McClean, 514
- Rivers memorial medal of the Royal Anthropological Institute, award of the, to J. H. Hutton, 177
- Road and Rail Construction in British East Africa, 645
- Rock: *Paintings of Southern Andalusia: a Description of a Neolithic and Copper Age Art Group*, Abbé H. Breuil and M. C. Burkitt; with the collaboration of Sir Montagu Pollock, 157; *Temperatures, Changes of, and Irregularities of the Earth's Rotation*, R. W. Wrigley, 257
- Rockefeller Foundation *Travelling Fellowships, awards of*, 949
- Rohan-Chabot Expedition, *The*, G. Perrier, 958
- Romney Marsh: *Bird Sanctuary, Proposed*, 504, 866
- Rozeboom gold medal, award of the, to Prof. J. J. van Laar, 423
- Ross Institute and Hospital for Tropical Diseases, *Annual Report*, 985
- Rotations, *A New Mode of Transmission of, with Conservation of the Velocity between Two Shafts with Variable Angle*, J. A. Grégoire, 337
- Philosophy and Psychology:**
- Adler (A.), with a prefatory essay by Dr. F. G. Crookshank. Edited by P. Mairé, *Problems of Neurosis: a Book of Case-Histories*, 162
- Banister (H.), and others, edited by C. Murchison, *The Foundations of Experimental Psychology*, 376
- Carr (Prof. H. Wildon), *Leibniz*, 264

- Rotatory Powers of Active Substances, The Influence of Temperature and of Solvents on the, R. Lucas and Mlle. D. Biquard, 114
- Rowing, 'Digging' in, Dr. H. Jeffreys, 928
- Royal: Academy: Landscape at the, Dr. Vaughan Cornish, 712; of Sciences, Letters and Arts of Belgium, election as associates of Prof. A. C. Seward and Prof. V. Grignard, 141; Agricultural Society of England, Agricultural Research in 1928, 11; *Air Force Quarterly*, No. 1, 286; Anthropological Institute, election of officers, 179; Astronomical Society, election of officers, 286; Geographical Society, awards of the, 467; Institution: gift from the Rockefeller Foundation for research in the Davy Faraday Laboratory, 756; J. B. S. Haldane elected Fullerian professor of physiology, 390; Report of the; election of officers, 717; Meteorological Society, election of officers, 141; Microscopical Society, election of officers, 140; Sir John Farmer and Prof. E. B. Wilson elected honorary fellows of the, 719; Naval Engineering College, History of the, 983; Observatory: Edinburgh, The New Equipment of the, Prof. R. A. Sampson, 467; Greenwich, Visitation of the, Dr. A. C. D. Crommelin, 909; Philosophical Society of Glasgow, election of officers, 541; Scottish Museum, Report for 1929, 901; Society: *Conversazione*, 797; Mr. Ramsay Macdonald and Genl. J. C. Smuts recommended for election into the, 864; of Arts, award of the Albert medal to Prof. H. E. Armstrong, 903; of Edinburgh: election of officers, 390; prize awards, 756; of South Africa, election of officers, 755; recommended candidates for election, 325; Technical College, Glasgow, Journal of the, January, 468
- R Scuti, M. Merola, 34
- Rubber, The Use of, in Recent Years, G. H. Masefield, 646
- Rubrene, Formation of, the Mechanism of the, C. Moureu, C. Dufraisse, and N. Drisch, 586
- Rugby School Natural History Society, Report of the, 647
- Rumford Premium of the American Academy of Arts and Sciences presented to Dr. J. S. Plaskett, 755
- Russian Alphabet, The Latinisation of the, 138
- Ruthenium a Superconductor, Prof. J. C. McLennan, 168
- Sabella pavanina*, The Feeding Mechanism, Formation of the Tube and Physiology of Digestion in, E. A. T. Nicol, 878
- Sahara, Weather and Climate of the, F. Rennell Rodd, 619
- St. Andrews University: Dr. E. T. Copson appointed lecturer in mathematics and applied mathematics, 72; Lectures under the Adult Education scheme for Fife and Stirlingshire, 99
- Saint-Hilaire, Isidore Geoffroy, medal, presented to Dr. C. Tate Regan, 612
- St. Paul's Cathedral, A. F. E. Poley, with introduction by Sir Reginald Blomfield, 228
- St. Yrieix, The Auriferous Layers of, L. Duparc and C. Wakker, 694
- Sakhalin, Pliocene and Pleistocene Fossils from, Prof. M. Yokoyama, 392
- Salinity Investigations in the South African Seas, Marchand, 473
- Salmonidæ, Species and Races in the, Dr. H. Henking, 951
- Salt: -Lake Deposits, Utilisation of, Prof. B. Panteleymonoff, 687; -plugs in Laristan, Southern Persia, Geology of some, J. V. Harrison, 294
- Salzkäfer der Nord- und Ostseeküste, Die; mit Berücksichtigung der angrenzenden Meere sowie des Mittelmeeres, des Schwarzen und des Kaspischen Meeres; eine ökologisch-biologisch-geographische Studie. Von H. von Lengerken, 558
- Samarските from New Mexico, F. L. Hess and R. C. Wells, 393
- San Joaquin Valley, California, Archæology of the, W. E. Schenck and E. J. Dawson, 104
- Sandal, Spike Disease of, M. Sreenivasaya and B. N. Sastri, 911
- de Saron, Bochart, 1730-1794, 95
- Saturn, E. M. Antoniadi, 425
- Saurians, The Chromosomes of, R. Matthey, 186
- Scenery in the Thames Valley, Preservation of, Dr. Vaughan Cornish, 737
- Sceptical Biologist, The (Ten Essays), J. Needham, 374
- School: Biology, The Aims of, Prof. J. S. Huxley, 283; Certificate Biology, 37; Discussion on, 148; Science and Educational Values, 341; Prof. H. E. Armstrong; A. A. E., 560
- Sciara, Unisexual Progenies and the Sex Chromosome Mechanism in, C. W. Metz and M. Louise Schmuck, 623
- Science: A History of, and its relations with Philosophy and Religion, W. C. D. Dampier-Whetham, 4; Alleged Sins of, Dr. R. A. Millikan, 388; and Administration, 1; and History, 77; and Industry, Relationship between, J. A. Reavell, 574; and Mathematical Tables: for use in Schools, W. F. F. Shearcroft and D. Larrett, 968; and Philosophy, 521, 845; W. Trotter, 924; a proposed International Conference, Prof. F. G. Donnan, 857; and Technology, History of, forthcoming International Congress of the, 646; and Thought in the Fifteenth Century, Prof. F. Thorndike, 441; History of, A. D. Ritchie, 4; Masters' Association, Annual Meeting of the, 111; Men of, and their Work, a Tribute to, President Hoover, 139; moderne, La vie du globe et la, Prof. L. Houlevegue, 304; Museum, Sir Henry G. Lyons reappointed director and secretary of the, 902; Students and the Influence of Scientific Teaching, Archbishop Temple, 387; Two Thousand Years of, the Wonders of Nature and their Discoverers, Prof. R. J. Harvey-Gibson, 404
- Scientific: and Industrial Research: Advisory Council of the Department of, Sir Ernest Rutherford appointed chairman of the, 719; Department of, Report for the year 1928-29, 352; in the British Empire, Dr. A. W. Hill, 386; and Learned Societies of Great Britain and Ireland, Year-Book of the, Forty-sixth Annual Issue, 667; and Technical Books, Recent, Jan. 25, Suppt. vii; Feb. 22, v; Mar. 29, v; April 26, v; May 31, v; June 28, v; Centenaries in 1930, 21; Instrument Makers of the Eighteenth Century, R. S. Whipple, 829; *Instruments: Journal of*, Dec., 140, 867; The Design of, 160; Research and Modern Life, 352; Travellers, Practical Hints to, edited by Prof. H. A. Brouwer. Vol. 6, 378
- Scottish: Woolen Technical College, election of Dr. A. W. Stevenson as colleague and successor to Dr. T. Oliver, 424; Marine Fauna, Studies on the, A. C. Stephen, 878; Highlands, Metamorphism in relation to Structure in the, Gertrude Lilian Elles and C. E. Tilley, 514
- Sea: Birds and Seals, Seton Gordon, 504; -Creature of Unknown Species, A. Capt. F. W. Dean, 469; The, and all that in it is, 666; Trout: from the Moray Firth, G. H. Nall, 218; of South Uist, G. H. Nall, 834; -Urchins, Spines in, Regeneration of the, A. D. Hobson, 168
- Seapro*, a Fish-treating Vessel, The, 682
- Seas: The, our Knowledge of Life in the Sea and how it is Gained, Dr. F. S. Russell and Dr. C. M. Yonge, 666
- Seasonal Foreshadowing, Sir Gilbert T. Walker, 841
- Seeds: Catalasic Power of, Action exerted by Ultra-short Electromagnetic Waves on the, G. Mezzadroli and E. Vareton, 879; Germination of, and on the Growth of Plants, Action of Ultra-Violet Rays on the, G. Mezzadroli and E. Vareton, 842
- Seessel, Theresa, fellow of Yale University, Prof. J. B. Gatenby appointed, 719
- Seismic Waves and the Sedimentary Layer, T. Matuzawa, 615
- Selenium Dioxide: Precipitated, Hoffmann and Lenher, 29; The Absorption Spectrum of, S. F. Evans, 528
- Serum, The Buffer Power of, W. Arciszewski and W. Kopaczewski, 75
- Seven Place Natural Trigonometrical Functions, H. C. Ives, 968
- Sewage and Sewage Disposal, A. J. Martin, 541
- Sex: Differentiation of, Dr. R. Brambell, 905; in Fungi, D. M. Cayley, 527
- Shiant Isles, The Geology of the, F. Walker, 33
- Ship-shore Telephony, Sir Thomas Purves, 790
- Ships, Preparing Estimates for, 921
- Shipways to the Sea: our Inland and Coastal Waterways, E. S. Clowes, 379

- Short-circuit Testing Plant, New, A. Reyrolle and Co., 875
- Siberian Meteor, The Great, and the Waves, Seismic and Aerial, which it produced, Dr. F. J. W. Whipple, 729
- 'Side-bands', The Physical Reality of, F. M. Colebrook, 726
- Silica Glass at Meteor Crater, A. F. Rogers, 686
- Silicates : Analysis of, 989 ; The Structure of, Prof. W. L. Bragg, 510
- Siliceous Shells of Protozoa, Prof. T. D. A. Cockerell, 975
- Silicon : Compact Fused, and the Density of this Element, C. Bedel, 514 ; Oxide, Fine Structure of *K*-Absorption Limit of, G. B. Deodhar, 777 ; Transformed Steel Residue, W. A. Wood, 974
- Silkworm's Egg, Physico-Chemical Phenomena in the, Dr. M. Tirelli, 215
- Sinai, Fauna of, 544
- Sinanthropus*, W. C. Pei, 715
- Skin Affections, Special, due to Common Plants, K. Touton, 758
- Skull Ornamentation in the Naga Hills, J. L. Hutton, 66
- Skulls of Bushmen, Hottentots, and Griquas, The Coronal Angle in the, E. Pittard, 914
- Slug : or Horned Viper ? G. C. Robson, 893 ; Miss M. A. Murray, 975 ; The Oldest Record of a, Prof. T. D. A. Cockerell, 745
- Small Arrow, People of the, J. H. Driberg, 375
- Smithsonian Institution, Annual Report for Year ending June 30, 1928, 947
- Smoke Abatement, Report on, 249
- Snakes of Ceylon, L. Nicholls, 27
- Snellius* Expedition, The, Commdr. P. M. Van Riel, 761
- Soap : Films, Stability in, A. S. C. Lawrence, 970 ; W. J. Green, 815 ; Sols and Jellies, The Identity of the Colloidal Particles in, Dr. M. E. L. McBain and Prof. J. W. McBain, 125
- Social : Science Teaching, 881 ; Sciences : Research in the, its Fundamental Methods and Objections, R. E. Park and others. Edited, with an introduction, by W. Gee, 663
- Sociology : Descriptive, or, Groups of Sociological Facts, Classified and Arranged by Herbert Spencer. No. 13 : Mesopotamia (The Ancient Inhabitants of the Tigris-Euphrates Lands). Compiled and Abstracted upon the plan organised by Herbert Spencer, by R. Levy, 162
- Sodium : Amide, Action of, on some Alkyl Bromides, Mlle. Amagat, 959 ; Hydride, Spectrum of, Prof. T. Hori, 615 ; Nitroprusside and Creatinine, The Colour Reaction between, G. Scagliarini and P. Pratesi, 35 ; Potassium, and their Fluorides, The Equilibrium in the Fused State, between, E. Rinck, 959 ; The Vapour Density of, Prof. W. H. Rodebush, 130
- Soil : Actinomycetes, Counting Soil, Standardisation of a Plate Method of, M. Ganesha Rao and V. Subrahmanyam, 871 ; Corrosion, H. W. Hough, 835 ; Erosion in Tanganyika Territory, Dr. E. O. Teale, 615 ; Science in Sweden, G. V. Jacks, 289
- Solar : Chromosphere, Structure of the Line *H α* and Period of Rotation of the, G. Abetti and B. Nováková, 34 ; Corona, Periodic Changes in the, Prof. Bergstrand, 649 ; Eclipse : Expeditions of 1930 and 1932, Some, Prof. F. J. M. Stratton, 673 ; The Central, of April 28 next, 214
- Solid : Dielectrics, Surface Resistivity Measurements of, L. Hartshorn, 765 ; Phase Reaction, A First Order, Dr. B. Lewis and Dr. Hans-Joachim Schumacher, 129 ; Solutions, Importance of the Crystalline Form in the Formation of, (6), A. Ferrari and A. Inganni, 34
- Solutions : colloïdales : Équilibres superficiels des, Études de biophysique moléculaire, Dr. P. Lecomte du Noüy, 771 ; of Colouring Matters, Study of, by Pectography, P. Bary, 550 ; containing Two Solutes, Adsorption from, Dr. J. A. V. Butler and C. Oakrent, 853
- Sonometer Wire, Effect of Direct Current on the Frequency of, D. V. Gogate and Y. G. Naik, 819
- Sorbopyrus* and *Sorbaronia*, Chromosome Behaviour in, K. Sax, 150
- Sound : Absorption of, A. H. Davis and E. J. Evans, 759 ; The Generation of, by the Siren Principle, E. Simeon, 765
- South : Africa, Early Copper and Bronze in, late Dr. P. A. Wagner ; G. H. Stanley, 799 ; African : Frogs and Toads, Breeding Habits of, C. G. S. de Villiers, 252 ; Institute of Medical Research, Report for 1929, 102 ; Vegetation, Dr. J. H. Hofmeyr and others, 617 ; Central Sahara, On the Geological Collection from the, made by Mr. Francis Rodd, Prof. J. W. Gregory, Ethel Dobbie Currie, J. Weir, S. Williams, and G. W. Tyrrell, 293 ; -Eastern : *Naturalist and Antiquary*, 469 ; Union of Scientific Societies, Congress at Portsmouth, 908
- Soviet Union, The, and the International Institutions of the League of Nations, A. Thomas, 983
- Space : and its Properties, Sir A. S. Eddington, 849 ; The Concept of, Prof. A. Einstein ; Prof. H. T. H. Piaggio, 897
- Special Libraries and Information Bureaux, Association of, H. T. Tizard elected president of the, 832
- Specific : Heat and Temperature, Relation between, A. Denizot, 182 ; Heats of Gases, Relative, Measurement of, at High Temperatures, P. M. S. Blackett and Dr. E. K. Rideal, 816
- Spectrographic Analysis, A Quantitative Method of, P. Urbain, 842
- Spectrophotography of the extreme Ultra-Violet, The use of Gratings at Grazing Incidence for, M. de Broglie, 294
- "Spectroscopic : Outfits for Metallurgical Analysis", 24 ; Researches, Recent, 651
- Spectrum : Analysis, The Practice of, with Hilger Instruments : including a Note on the various Types of Emission Spectra. Compiled by F. Twyman. Fourth edition, 45 ; Mixture Curves of the, A Redetermination of the, W. D. Wright, 693
- Spherical Harmonic Functions and their Application to Mathematical Physics, Prof. S. Chapman, 109
- Spike Disease of Sandal, M. Sreenivasaya and B. N. Sastri, 911
- Spinoza : Prof. L. Roth, 264 ; The Philosophy of, The Unity of his Thought, Dr. R. McKeon, 264
- Spontaneous Inflammation of Mixtures of Air and Hydrocarbons, The, P. Mondain-Monval, 150
- Stalactites, The Sparks which are emitted by, when violently struck with a Steel Tool, J. A. Le Bel, 73
- Star : Catalogue, The Oldest Known, J. Meta, 870 ; Colour Index of a, A Formula giving the Value of the, G. Tiercy, 914 ; Double, Measures at Johannesburg, W. H. van den Bos, 684 ; Photography, A Method of, based on the Measurement of the Opacities of Photographic Tracks, M. Dehalu and P. Swings, 658 ; *R* Hydre, Changes in the Period of the Variable, R. Müller, 142 ; Tauri. 41, 1929, The Variable, K. Kordylewski, 150
- Stark Effect in the Ultra-Violet Spectrum of Neon, Prof. Y. Ishida, 970
- Starlings in Winter, Behaviour of, V. C. Wynne-Edwards, 143
- Stars : Absolute Motions of, R. Klumak and F. Hecht, 904 ; Binary, Orientation of the Planes of, Y. C. Chang, 103 ; Evolution of the, The Modern Theory of the, G. Armellini, 842 ; Occultations of, by the Moon, Prof. W. E. Brown, 986 ; of Different Spectral Types, Distribution of, Dr. O. Seydl, 391 ; 741, Radial Velocities of, Adams, Joy, Sanford, and Strömberg, 649 ; The Connexion of Mass with Luminosity for, Sir Joseph Larmor, 273 ; Variable, Relation of Light Changes to Velocity Changes in, D. B. McLaughlin, 65
- Statesman's Year Book, The, 1930, edited by Dr. M. Epstein, 852
- Statistical : Measure of Civilisation, A, Dr. R. M. Harper, 330 ; Mechanics : Introduction to, for Students of Physics and Physical Chemistry, Prof. J. Rice, 700 ; without Tears, 700 ; Method in the Social Sciences, 39
- Steam : and Gas Engineering, Prof. T. E. Butterfield, 851 ; -nozzles Research Committee, Sixth Report of the, 387
- Steatite and Porcelain Products, Ltd., The Electrical Research Laboratory of, 788
- Steel : Pit Props in Collieries, Report on, 716 ; Structures, Simple, Practical Design of, D. S. Stewart. 2 vols., 196

- Stellar : Absorption Lines, Dr. O. Struve and C. T. Elvey, 308; Luminosity, The Problem of, Prof. A. S. Eddington, 489; Prof. E. A. Milne, 453,708; Velocities and Stellar Physics, Dr. A. C. D. Crommelin, 333
- Stereoscopic Photographs, A Method of Examining, J. M. Nuttall and E. J. Williams, 336
- Sterilisation : as a Practical Eugenic Policy, Prof. E. W. MacBride, 40; Dr. Marie C. Stopes, 204; for Human Betterment : a Summary of Results of 6000 Operations in California, 1909-1929, E. S. Gosney and Dr. P. Popenoe, 40
- Stern-Gerlach Experiment with Active Nitrogen, The, Dr. L. C. Jackson, 131
- Stimula, Association of, in the Development and Function of the Nervous System, R. L. Worrall, 927
- Stored Products, Infestation of, by Insects and Fungi, appointment of a committee on, 63
- Streatfeild Memorial Lecture, The, L. Eynon, 255
- Striae in the Positive Column of an Electrical Discharge through Hydrogen, A Singular Behaviour of, Prof. J. Zeleny, 562
- Striated : Discharge, The, Dr. D. A. Keys and J. F. Heard, 971; Muscle in Liver of Spider, S. Maziariski, 288
- String : Artists in, String Figures, their Regional Distribution and Social Significance, Kathleen Haddon (Mrs. O. H. T. Rishbeth), 888
- Strontium be Fixed by the Tissues? Can, M. Comel, 842
- Structures in Sea Water, the Deterioration of, Tenth Report on, 719
- Strychnine and Brucine, Structure of, Prof. R. Robinson, 873
- Submarine Telephone and Telegraph Cables, Loaded, Siemens Bros. and Co., Ltd., 327
- Subsidiary Crops, The Growing of, 25
- Sugar Industry, The World's, L. Eynon, 255
- Sulphur : and Phosphorus in Plants, Estimation of, G. Bertrand and L. Silberstein, 73; Band Spectrum of, H. H. Van Iddekinge, 858; Chlorides of, Lowry and Jessop, 873; Dioxide : Pre-dissociation of, Dissociation Energy of Oxygen determined from the, Prof. V. Henri, 275; Solutions, Equilibria in, W. B. Campbell and O. Maas, 545; in the Formation of Plant Soil, The Rôle of, L. Rigotard, 337; X-ray Spectrum of, Researches on the, Dr. O. Lundquist, 925
- Sulphurous : Acid, Reduction of, at the Dropping Mercury Cathode, B. Gosman, 959; and Carbonic Esters, Some Reactions of, R. Levaillant, 258
- Sun : An Active Region on the, 26; Elements in the, C. E. St. John, 115
- Sunderland Technical College affiliated to the University of Durham, 148
- Sunlight : Integration of, A. F. Dufton, 635; in the Tropics, Integration of, J. A. C. Teegan and G. R. Rendall, 447
- Suns, Mock, in London and elsewhere, 717
- Sunspot Curve, Prediction of the, Prof. D. Alter, 251
- Superconducting Alloy, A, with Resistance Temperature Hysteresis, Prof. J. C. McLennan, 447
- Superconductors, Profs. de Haas, van Aubel, and Voogd; Prof. J. C. McLennan, and Allen and Wilhelm, 952
- Surface Tension and Temperature, Dr. N. Barbalescu, 393
- Surrey Maps, An Historical Catalogue of, H. A. Sharp, 161
- Survey Vessel for Fishery Research, A Projected, 175
- Surveying : as practised by Civil Engineers and Surveyors, J. Whitelaw, Jun. Eighth edition, thoroughly revised and enlarged by Col. Sir Gordon Risley Hearn, 83
- Sutherland's Constant for Oxygen, The Heat of Dissociation of the Molecule O₂ and, S. Bressler and V. Kondratjew, 164
- SX Hercules, The Variable, M. Merola, 338
- Sycamore (*Acer Pseudoplatanus*), Cambial Activity and Seasonal Changes in Starch Content of, E. Cockerham, 622
- Sydney University, gift to, by the Rockefeller Foundation, 876
- Sylvicultural Research in India, H. G. Champion, 331
- Symons Memorial : Lecture, The, Dr. H. Lapworth, 504; medal of the Royal Meteorological Society, presentation of the, to Dr. G. C. Simpson, 137
- Sympathetic System, The, as an Agent of Stability of the Organism, Cannon, 514
- Syncarpia Hillii*, Some Properties of Red Satinay, M. B. Welch, 658
- Syon : House, 137; Park, The Linnean Society and, 97
- Syrian Christians, Anthropology of the, Rao Bahadur L. K. Ananta Krishna Ayyar, 852
- Tabulæ Biologicae. Ed. : W. Junk, Herausgegeben von C. Oppenheimer und L. Pincussen. Supplement 1 (Band 5) : Botanik; Biologie der Algen; Bakteriologie; Hefen- und Schimmel-Pilze; Geschlechter-Verteilung; Kern-Plasma-Relations; Keimung; Wachstum; Allgemeine Physiologie; Assimilation; Periodizität; Experimentelle Ökologie, 377
- Tango (Japan) Earthquake of Mar. 7, 1927, After-shocks of the, N. Nasu, 392; Prof. S. Nakamura, 759
- Tannic Acid Treatment of Burns, The, W. C. Wilson, 58
- Tannin from Plants, Extraction of Influence of Treatment with Alcohol on the, E. Michel-Durand, 222
- Tanning Materials of the British Empire, Prof. J. Read, 240
- Tantalum and Columbium, Borides of, Preparation and Properties of the, L. Andrieux, 222
- Tar : and its Products, Standard Methods for Testing, 631; Cancer, E. S. Kennaway and I. Hieger, 932; Tumours in Mice, Action of the Amino Acids towards, F. Vlès, A. de Coulon, and J. Nicod, 150
- Tartaric Acid, Action of Boric Acid and Borates on the Rotatory Power of, E. Darmono, 478
- Tatem Laboratories at University College, Cardiff, The, 837
- Technical Instrument Bulletin, 577
- Technical : Sound Problems, Dr. E. Lübecke, 616; Teachers in Conference; Presidential Address by H. A. Norman, 955
- Teeth, Diet and the, an Experimental Study. Part 1 : Dental Structure in Dogs, May Mellanby, 604
- Telegraphy and Telephony, Systems of, by Means of Pencils of Infra-red Radiations, L. Rolla and L. Mazza, 730
- Teleostean Fishes of Tortugas, E. W. Gudger, 27
- Telephone : Conversations, Interruptions on, K. W. Waterston, 24; Circuit, The Articulation of a, J. Collard, 475; Circuits, Inductive Interference in, Sir T. F. Purves, 873; Service between London and Australia, Inauguration of a, 716; Services, P. E. Erikson, 99
- Tele-printer Service, A Projected, 716
- Telescope, 200-inch, Plans for the, Prof. Elihu Thomson, 425
- Telescopes of the Future, The Great, 169
- Television : An Early Projection of, 903; Performance of a Play, 829; Society, election of officers, 541; Two-way, Demonstration of, 829
- Tematinské Kopce (Western Slovakia), The Vegetation of the Limestone Hills of, P. Sillinger, 915
- Temperature : in London, Annual Variation of, Irregularities in the, Dr. C. E. P. Brooks and S. T. A. Mirrlees, 995; Measurements in Borings, G. Friedel and V. Maikowsky, 73
- Terra Nova* : Expedition, Pelagic Polychætes of the, Dr. W. B. Benham, 252; Madreporaria, Prof. J. Stanley Gardiner, 143
- Terrestrial : Magnetic Surveys, 988; *Magnetism and Atmospheric Electricity*, Dec., 506; Radiation, The Distribution of, Dr. G. C. Simpson, 336
- Tertiary Man : J. Reid Moir, 167; The Discovery of, Prof. H. F. Osborn, 53, 61
- Tesla-Luminescent Spectrum of Benzene, The, Dr. I. A. Black, 274
- Testing Machine, A 100-ton, W. and T. Avery, Ltd., 686
- Tetrarhynchids, Studies on, late Dr. H. Cammerloher, 216
- Thales to Einstein, From, 404
- Thallium, The Preparation of, by the Electrolysis of its Oxides, L. Andrieux, 842
- Thames : Floods and Pollution, Dr. R. T. Gunther, 49; Valley, The, from Cricklade to Staines, a Survey of its Existing State and some Suggestions for its Future Preservation, Earl of Mayo, S. D. Adshhead, and P. Abercrombie, with the assistance of W. H. Thompson, 737
- Thermionic Phenomena, The Action of Light on, R. Deaglio, 434

- Thermodynamik, Prof. W. Schottky. In Gemeinschaft mit Dr. H. Ulich und Dr. C. Wagner, 406
- Thermo: -electric Circuit, Application of Thermodynamics to the, Prof. P. W. Bridgman, 114; -magnetic Effect, etc., The Transverse, Prof. P. W. Bridgman, 114
- Thermostat, Automatic, Baily, Grundy and Barrett, Ltd., 651
- Thiocyanates in the Human Organism, E. Kohn-Abrest, Mlle. Hélène Villard, and L. Capus, 397
- Tholeiitic Phase of the Quartz-dolerite Magma of Central Scotland, A. F. Walker, 958
- Thomas Atom, Exchange Phenomena in the, Dr. P. A. M. Dirac, 914
- Thomson's, W., Minimum Heat Theorem, M. Lelli, 338
- Three Bodies, The Restricted Problem of, E. Strömberg, 397
- Thunderclouds, Overhead, The Electric Field of, S. K. Banerji, 729
- Thymus (in Calcium Metabolism), An Apparent Rôle for the, Dr. L. J. Harris, 346
- Thyrite, The Use of, 902
- Thyroxine, Dr. E. C. Kendall, 161
- Tidal Institute of the University of Liverpool, Annual Report, 1929, 423
- Tierreichs, Die Rohstoffe des, Herausgegeben von F. Pax und W. Arndt. Lief. 2 und 3, 666
- Tierwelt der Nord- und Ostsee, Die, Begründet von G. Grimpe und E. Wagler. Lief. 14, Teil 10f: Amphipoda, Dr. K. Stephensen, 303; Lief. 15, Teil 9a: Aculifera, von H. J. Nierstrasz und H. Hoffmann; Teil 11f: Thalassobionte und thalassophile Myriapoda, von O. Schubart; Teil 12h₃: Pisces, 442
- Timbers, Common Commercial, of India and their Uses, H. Trotter, 394
- Time, The Corridors of, H. Peake and Prof. H. J. Fleure. Vol. 5: The Steppe and the Sown; Vol. 6: The Way of the Sea, 375
- Titanium: as Phosphate, The Determination of, J. C. Ghosh, 621; Group of Elements, The Chemistry and Geochemistry of the, Prof. G. Hevesy, 539; Oxide in the Dinas, D. Beliankin, 586; Separation of, from Zirconium and Hafnium, A. R. Powell and W. R. Schoeller, 802
- Tobacco: Mozaic *in vitro*, An Attempt to Cultivate the Virus of, J. Grainger, 34; Problem, Recent Literature on the, Dr. J. D. Rolleston, 648
- Tool Steels, Tests of, H. J. French and T. G. Digges, 651
- Tornadoes, On the Mechanism of, Sir Gilbert T. Walker, 113
- Totemism in Eastern Australia, Prof. Radcliffe-Brown, 950
- Tourbillons, Leçons sur la théorie des, Prof. H. Villat, 969
- Town Gas, Odoration of, 652
- Tracheal Respiration in Insects, A Theory of, Dr. V. B. Wigglesworth, 477
- Trade: International, W. G. L. Cass, 735; Rivalry and World Peace, Prof. F. S. Marvin, 965
- Translators, A Panel of Expert, 984
- Transmission: Dynamometer, A Simple, E. Giffen and C. M. White, 907; Line Surges, Dr. H. Norinder, 68
- Transmutation of Matter, The, Sir Ernest Rutherford, 539
- Trans-Neptunian Planet: Discovery of a, Dr. A. C. D. Crommelin, 450; Distance of the, Prof. G. Armellini, 613; Lowell's Prediction of a, Dr. J. Jackson, 451; Position of the Celestial Body supposed to be a, E. Esclangon, 507, 542, 878
- Transport of Stones by attached Seaweed, S. Grieve, 217
- Traube Cell, A New Demonstration of the, F. Chodat, 294
- Triangulation Tower, A Steel, J. S. Bilby, 795
- Trichomanes aphlebioides* Christ, Morphology of, with Special Reference to the Aphlebioid Leaves, S. Williams, 257
- Trigonometry, Plane, Prof. J. B. Rosenbach and Prof. E. A. Whitman, 443
- Trimethoxy-quinoline Derivatives, Some, F. Lions, 659
- Trout: Spermatozoa, The Maladaptation of, to Fresh Water, Prof. J. S. Huxley, 494; A. Walton, 564
- Tuberculosis: Memorandum on the Treatment of, 329; Residential Institution for the Treatment of, Costs at, 179
- Tuedian Beds of Northern Cumberland and Roxburghshire East of the Liddelwater, Prof. E. J. Garwood, 477
- Tuning-forks, Calibration of, C. Moon, 795
- Turbellaria rhabdocelida* of Japan, The Freshwater Fauna of, N. N. Nasonov, 34
- Turbo-generator at Hell Gate Station, New York, 760
- Twins, Effects of Environment on, Prof. H. H. Newman, 104
- Tylenchinema oscinella* gen. et sp. n., Parasitic in the Frit-fly, *Oscinella frit* L., Attacking Oats, T. Goodey, 293
- U Cephei, The System of, G. Viola, 587
- Ultra-short Electromagnetic Waves (λ 2-3 mm.), Comparison between the Actions exerted by, and by the Lakhovsky Oscillating Circuit on the Germination of Seeds and the Growth of Plants, G. Mezzadrolì and E. Varetto, 35; -violet: Absorption Spectra and Heats of Combustion, A Relation between, Emma P. Carr, 237; Radiation: Effects of, on Fishes, 180; Measurement of, Dr. M. Bender, 987; Radiations, Absorption of, by the Methoxybenzoic Acids, L. Marchlewski and A. Boryniec, 478; Spectra, Extreme, B. Edlén and A. Ericson, 427; Transparency in Glasses, Loss of, Dr. S. English, 85
- Uncertainty: Legitimate, Sir Oliver Lodge, 17; The Scientific Principle of, Sir Joseph Larmor, 345
- Underground: Electrical Mains, Cost of, Dr. Ekstrom, 796; Water, Flow of, Dr. N. K. Bose, 723
- Undulatory Theory, The, and Black Body Radiation, L. Décombe, 549
- Unemployment: Prof. H. Clay, 946; and Hope, W. G. L. Cass, 225, 346; Prof. F. Soddy, 345
- Unified Physical Field, A New Relativity Theory of the, W. Band, 130
- Unimolecular Films, C. G. Lyons and Dr. E. K. Rideal, 455
- U.S.A.: Bureau of Standards, Annual Report for Year ending June 30, 1929, 611; National Academy of Sciences: election of members; Prof. R. A. Millikan re-elected Foreign Secretary, 791; presentation of medals to (the late) S. T. Mather, E. Thompson Seton, Dr. J. Schmidt, and Prof. W. B. Scott, 791; National Broadcasting Company, Programmes of the, 867; Salaries of Professors and Others in the, Prof. W. A. Noyes; E. A. Filene, 828; The Hospital Service in the, 756; National Museum, Annual Report to June 1929, 948
- Universe: as a Whole, The, Prof. A. S. Eve, 865; The Size of the, Attempts at a Determination of the Curvature Radius of Spacetime, Dr. L. Silberstein, 849
- Universities: in Great Britain, State Grants to, 728; of the Empire, The Yearbook of the, 1930, Edited by Sir H. Frank Heath, 885
- University: College: Cardiff, The Prince of Wales to Open the New Laboratories of Physics and Chemistry, 503; London: Report for Year ending February 1930, 620; The Chairs of Chemistry at, 572; Grants Committee, Sir Walter Buchanan-Riddell appointed Chairman of the, 800; Women, International Federation of, 185
- Unsaponifiable Fraction of Certain Oils, The, 688
- Upper Atmosphere, Tides of the, and the Heights of Meteors, Dr. J. Egedal, 202
- Ur, Excavation Work at, C. L. Woolley, 84, 285
- Ureas and Carbamic Esters, Action of Selenoxanthidrol on, F. François, 766
- Uric Acid, A New Fermentation of, produced by the Liver of various Animals, R. Fosse, A. Brunel, and P. de Graeve, 258
- ξ Ursae Majoris, Spectroscopic Study of, L. Berman, 904
- Uruguay, Mammals of, C. C. Sanborn, 614
- Vaccination, 401
- Valentin Corals from Shropshire and Montgomeryshire, Some, with a Note on a New Stromatoporoid, Stanley Smith, 221
- Vampire in Europe, The, Dr. L. Summers, 371
- Vanadium: in the Blood of, Ascidiæ, M. Azéma and H. Pied, 338; Amides and Imides derived from, P. Pascal, 257

- Vaporisation and Vapour Pressure: Rate of, a Method of Measuring the Specific Area of a Surface, Dr. F. J. Wilkins, 236
- Vapour Pressure of Solutions, Prof. A. V. Hill, 724
- Variation, The Mechanism of, Prof. H. H. Dixon, 992
- Vegetable Oils observed under the Ultra-Violet Rays, Spectrographic Analysis of the Fluorescences of some, H. Marcelet, 995
- Venus and Jupiter, Conjunction of the Planets, 757
- Vertebrate Dissection: Laboratory Guide to, for Students of Anatomy, Dr. A. B. Appleton, 739
- Verulamium, Proposed Excavation of, 248
- Veterinary Services, Onderstepoort, Pretoria, Annual Report, 948
- Vibration of a Wire, A Simple Method of Showing the Modes of, Prof. C. R. Darling, 958
- Vienna Academy of Sciences, Sir William Bragg elected a corresponding member of the, 948
- Viking Sword from Ballinderry, Co. Westmeath, The, A. Mahr, 337
- Viruses and Life, Dr. J. J. Davis, 351
- Viscosity of Liquids, The, Sir Ambrose Fleming; E. W. Madge, 580; Dr. D. H. Black; Prof. J. Frenkel, 581; Prof. E. N. da C. Andrade, 309, 582
- Viscous Liquids, Plane Irrotational Currents of, Dynamic Actions relative to, B. Finzi, 766
- Vision, New Light on, Prof. G. Elliot Smith, 820
- Visual Acuity in Light of Different Colours, Prof. H. E. Roaf, 841
- Vitamin: A, Recent Work on, 428; D, The Absorption Spectrum of, R. B. Bourdillon, R. G. C. Jenkins, and T. A. Webster, 635
- Vitis* and *Rheum*, Nitrogen Metabolism in the Leaves of, H. L. Newby and Dr. W. H. Pearsall, 622
- Vitreous State, Physical Properties of the, The Anomalies of the, P. Mondain-Monval and P. Galet, 294
- Vocational Guidance in Schools, 472
- Volcanoes, Form of, Prof. T. Terada, 67
- Vole Cycles in Great Britain, A. D. Middleton, 950
- Volta Effect, The, E. Dubois, 222
- Voltaic Pile, The Original Mode of Constructing a, W. C. Walker, 349
- Vorticity, The Spread of, in the Wake behind a Cylinder, L. Rosenhead, 801
- Waiheke Island, New Zealand, Tertiary Molluscan Fauna of, A. W. B. Powell and J. A. Bartram, 834
- Wales, Microscopical Society of, inception of, 832; appointment of officers, 903
- Wankie Coalfield and its Fossil Flora, B. Lightfoot; Dr. J. Walton, 722
- Washington Naval Observatory, Report of the, 180
- Water: and Steam, Properties of, Prof. H. L. Callendar, 71; as an Activator of Luminescence, J. Ewles, 706; Balance of Plants as a Factor in their Resistance to Insect Pests, The, E. P. Mumford and D. H. Hey, 411; Dissociation Constant of, R. F. Newton and M. G. Bolinger, 836; -meadows and River-flow, J. H. Coste, 858; Pollution: Research Board, Report for Year ending June 30, 1929, 903; Summary of Current Literature on, 287; Softening, a Technical Paper on, 179; Supply of London, G. Andrew-Marshall, 147; The Boiling Point of, as a Function of the Pressure, A. Zmaczynski and A. Bonhoure, 114; Vapour, The Diffusion Constant of, W. E. Summerhays, 433
- Waters and Coasts of Britain, The, Dr. F. Fox, 506
- Waterspout, Meteorological Conditions Accompanying a, Lieut. P. G. Hale, 292
- Waterspouts, Three, in Quick Succession, A. S. E. Ackermann, 829
- 'Wave: Band' Theory of Wireless Transmission, The, Sir Ambrose Fleming, 92, 198, 307; Prof. C. L. Fortescue; L. H. Bedford; Sir Oliver Lodge, 271; Sir R. T. Glazebrook; Prof. C. L. Fortescue; J. A. Ratcliffe; G. B. Brown, 272; E. H. Linfoot; A. A. Newbold, 306; Mechanics of α -Ray Tracks; N. F. Mott, 28
- Weather: and Climate of the Sahara, F. Rennell Rodd, 619; Chart, A New, 389; in February, 389; Recurrences and Weather Cycles, Sir Richard Gregory, 132
- Weather Report, Daily*, new series of the, 389
- Wedgwood, Josiah: bicentenary celebrations of, 503, 788, and his Influence on the English Pottery Industry; S. R. Hind, 781
- Wellington, N.Z., City Council, Dr. L. Cockayne appointed honorary botanist to the, 541
- West: Africa: Health in, Prof. B. Blacklock, 286; Report on Visit to, during 1926, Hon. W. G. A. Ormsby-Gore, 208; Indies, Rainfall in the, E. W. Bliss, 113
- Whales: along the Californian Coast, Shortage of, 248; and Plankton in the North Atlantic, 475; The Integuments of, R. W. Gray, 744
- Whaling and Fishing in the North Atlantic, 475
- Wheat: and Flour, Bacteriology of, D. W. Kent-Jones and A. J. Amos, 433; Leaves of, The Chlorophyll of the, Mlle. A. Dusseau, 258; Seed, A Colour Reaction for the Proteids of the, E. Rabaté and J. Fleckinger, 730
- Whirlwind in Natal, An Exceptional, Dr. E. Warren, 890
- White Immigrants in Polynesian Tradition, W. Ivens, 614
- Wild Birds: and Butterflies, Prof. J. B. Cleland, 276; Protection of, Bill for the, in Scotland, 210
- Wilk's Comet, 65, 142
- Willows, Insect Pests of, H. P. Hutchinson and H. G. A. Kearns, 201
- Window Glasses, Transparent, Coblenz and Stair, 332
- Wireless: Defects, R. A. Watson Watt, 616; Echoes of Long Delay come from Space outside the Moon's Orbit? Do the, Prof. C. Størmer, 326; Physics in relation to; Dr. W. H. Eccles, 894; Station for Meteorological Purposes, A, erected in Franz Josef Land, 178; Telephonic Communication with Japan, 249; Transmission: The 'Wave Band' Theory of, Sir Ambrose Fleming, 92; Prof. C. L. Fortescue; L. H. Bedford; Sir Ambrose Fleming, 198; Sir Oliver Lodge, 271; Sir R. T. Glazebrook; Prof. C. L. Fortescue; J. A. Ratcliffe; G. B. Brown, 272; E. H. Linfoot; A. A. Newbold, 306; Sir Ambrose Fleming, 307; of a Page of a Newspaper, 573; Waves, Negative Attenuation of, J. A. Ratcliffe and F. W. G. White, 926
- Wirtschaftschemie, theoretische, Einführung in die, Dr. R. Koetschau, 964
- Witch Hunting and Witch Trials: the Indictments for Witchcraft from the Records of 1373 Assizes held for the Home Circuit A.D. 1550-1736, Collected and Edited by C. L'Estrange Even, with an Introduction, 371
- Witches, Vampires, and the Devil, 371
- 'Wolf's Numbers' for 1929, 757
- Woods Hole Oceanographical Institution, The new, 646
- Wood's Light, Action of, on the Germination of Seeds and on the Growth of Plants, G. Mezzadrolì and E. Vareton, 35
- Woody Cuttings, Rooting of, Dr. W. A. Sledge, 686
- Wool, Examination of the Fine Structure of, by X-ray Analysis, J. Ewles and J. B. Speakman, 149
- Woollen and Worsted Industries, British Research Association for the, Report for 1929-1930, 420
- Work, Joy in, H. de Man. Translated by Eden and Cedar Paul, 667
- World Power and the Power of Man, Prof. H. Levy, 810
- Xenon: The Crystal Structure of, Prof. G. Natta and Prof. A. G. Nasini, 457; The Second Spectrum of, in the Interval 9000 A.-6000 A., G. Déjardin, 586
- X-radiation, the Polarisation of, W. Duane, 150
- X-ray: Diagrams of Liquids, Effects of Filtration of the General Radiation on the, J. Thibaud and J. J. Trillat, 74; Electrons, Magnetic Spectroscopy of, H. R. Robinson and C. L. Young, 995; Measurements with a Plane Diffraction Grating, E. Bäcklin, 239; Scattering, Prof. P. Debye, 645
- X-rays: Action of the, on Cultures of Tissues *in vitro*, L. Doljanski, J. J. Trillat, and Lecomte du Noüy, 996; Cellulose in the Light of the, Sir William Bragg, 315, 324; Chemical Effects of, Clark and Pickett, 760; in the Examination of Coal, C. N. Kemp, 68; Quantitative Analysis by, Prof. G. Hevesy, 776; Scattering of, by Bound Electrons, Prof. B. B. Ray, 746, 856; Soft: Excitation of: from a Single Crystal Face of Nickel, Prof. O. W. Richardson and

- S. Ramachandra Rao, 801; from Single Crystal Surfaces and from Polycrystalline Surfaces of Graphite and Aluminium, Prof. O. W. Richardson and U. Andrewes, 801; from some Polycrystalline Metal Surfaces, Prof. O. W. Richardson and S. Ramachandra Rao, 801; from Iron, Critical Potentials for the Excitation of, A. C. Davies, Prof. F. Horton, and E. Blundell, 336; The Diffraction of, by Vitreous Solids and its Bearing on their Constitution, Dr. S. C. Bradford, 975; J. T. Randall, H. P. Rooksby, and B. S. Cooper, 458
- Yeast in the Death Watch Beetle (*Xestobium rufo-villosum* De G.), Presence of a, L. N. Staniland, 635
- Yeasts, Difference in the Biological Action caused in, by various Radiations, A. Lacassagne, 550
- Yellow Fever: Recent Work on, Prof. E. Hindle, 19; Vaccine, Prof. E. Hindle, 27
- Youth: the Psychology of Adolescence and its Bearing on the Reorganisation of Adolescent Education, Prof. Oliver A. Wheeler, 161
- Zebra-Horse Crosses, E. Roberts, 508
- Zeeman Effect in the Band Spectrum of Helium, The, (2), A. Harvey, 186
- Zi-Ka-Wei Observatory, The, 793
- Zimbabwe Culture, an Exhibition of, 609
- Zinc: -base Die-casting Alloys, R. Lancaster and J. G. Berry, 514; in Copper Crystals, The Diffusion of, C. F. Elam, 513; *K*-Absorption Edge of, S. Kawata; Prof. Coster, 509; of Animals, Variations of the Content in, with Age, G. Bertrand and Mlle. Y. Beauzement, 995; Vapour, The Band Spectra of, H. Volkringer, 222
- Zn₂ Molecules, Dissociation Energy of, S. Mrozowski, 528
- Zodiacal Light, The, I. Yamamoto; C. T. Jacob, 471
- Zoological: Nomenclature: Acarine or Insect, Dr. A. Musgrave, 414; The Rules of, 733; Society of London: Bequest to the, by G. de Arroyave Lopes, 179; Receipts for 1929, 141; Report for 1929, 683; Survey of India, Work of the, in 1926-29, 683
- Zoologie, Repetitorium der allgemeinen (Morphologie, Physiologie, Ökologie, Abstammungslehre), Prof. W. Stempell, 303
- Zoology: Field Studies in, Value of, Dr. S. L. Hora, 650; Outlines of, Prof. J. A. Thomson. Eighth edition, 269
- Zunyte near Postmasburg, South Africa, L. T. Nel, 150
- Zwischen Weissem Nil und Belgisch-Kongo, Dr. H. A. Bernatzik. Mit Beiträgen von Prof. O. Reche, Prof. B. Struck und Dr. H. Antonius, 301

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A WEEKLY JOURNAL OF SCIENCE

“To the solid ground
Of Nature trusts the mind that builds for aye.”—WORDSWORTH.

SATURDAY, JANUARY 4, 1930.

CONTENTS.

	PAGE
Science and Administration	1
History of Science. By A. D. Ritchie	4
Man's Ancestry. By Sir A. Arthur Keith, F.R.S.	6
Geology of Albania. By Prof. J. W. Gregory, F.R.S.	8
The Polarity of Molecules. By Prof. J. E. Lennard-Jones	9
Our Bookshelf	11
Letters to the Editor :	
Grating Errors and Electronic Charge.—Sven Fagerberg	13
New Types of Emission Spectra.—Prof. L. Vegard	14
Recovery from Parasitism.—C. Crawshaw Brooks	14
Occurrence of <i>Craspedacusta (Limnocolidum) Sowerbii</i> in the Exeter Ship Canal.—Rupert Vallentin	15
Magnetic Moments of Atomic Nuclei.—Prof. E. Fermi	16
Optically Active Diphenylethylene Oxide.—Prof. John Read and Ishbel G. M. Campbell	16
Do Oceanic Plankton Animals Lose Themselves? —Dr. F. S. Russell	17
Magic Square of Fifth Order.—Major J. C. Burnett	17
Legitimate Uncertainty.—Sir Oliver Lodge, F.R.S.	17
Cycles in Natural Phenomena. By C. E. P. B.	18
Recent Work on Yellow Fever	19
Scientific Centenaries in 1930	21
News and Views	22
Our Astronomical Column	26
Research Items	27
Nickel Steel in the <i>Golden Arrow</i>	30
Investigations in Greenkeeping Problems	30
Canadian National Research Laboratories	31
University and Educational Intelligence	31
Historic Natural Events	32
Societies and Academies	33
Official Publications Received	35
Diary of Societies	35

Science and Administration.

IN several recent pronouncements relating to widely different fields which touch administration, the importance of the acquisition of scientific knowledge and of the adoption of scientific methods have been strongly emphasised.

On Nov. 30, in the course of the Sidgwick Memorial Lecture on “Democracy”, delivered by him at Cambridge, General Smuts directed attention to the fact that science is necessary to the modern State and should have its functional relation to the State; he stressed the point that to-day not only is a scientific spirit needed in human affairs, but also that above all it is this spirit which is called for in the administration of human affairs. A few days previously, dealing with matters relating to a narrower field, the Secretary of State for the Colonies sounded a similar note when paying a tribute to the value of anthropology in the administration of the affairs of a backward people; he urged the importance of the acquisition of a knowledge of this branch of science by young men proceeding to British Dependencies to take part in administrative work.

Again, there has just been published the valuable Interim Report of the Committee on Education for Salesmanship (H.M.S.O., price 4*d.*). Salesmanship is, as this Committee understands the term, “a prime function of direction and supreme management” and “embraces the study of the fundamental principles of commerce and the planning of policy based upon them”. Consequently, the matters discussed in this Report cover an important area of the administrative field in commerce; where weakness has been shown to exist in this field it has been traced to “a detached and insular attitude

and unscientific practice" on the part of our business community. Not only does this Committee recommend that a "scientific study" should be undertaken of our commercial problems, but it also states that "the evidence of the Associated Chambers of Commerce emphasises the absolute necessity of expert knowledge by the salesman of goods of a technical description".

However, it is apparent that the views of the Associated Chambers of Commerce are not universally accepted in commercial circles, and that old-time prejudices are still alive therein. In some quarters, the view continues to be held that "too much knowledge may be a dangerous thing"; the expert has not yet come into favour there. Indeed, in such quarters, it is feared that in the field of salesmanship the technical dissertations of the expert may prove wearisome to the customer, and hence do more harm than good. It is perhaps for this reason that another way of meeting the situation has been suggested. It has been proposed to the Committee that where a machine, appliance, or article requiring specialist knowledge is being sold, the maker should attach his own expert to the staff of the agent, "so that the technical advice and service may be available on the spot"; that is to say, it is seriously recommended that our manufacturers should employ two men to sell their products, where the shrewdest and most resolute of their foreign competitors employ but one, and that a highly qualified expert.

In view of the foregoing proposal, it cannot be a matter for surprise that, in the course of the remarks which he recently addressed to business men at a meeting held in London, the president of the Canadian National Railways should have felt himself compelled to point out that if Great Britain is to recover its industrial pre-eminence there must be an entire 'scrapping' of present-day commercial policies, methods, machinery, and appliances with the object of reducing the costs of production—he might very appropriately have added: and *above all of reducing the costs of distribution*.

It is a general question which the foregoing pronouncements raise directly, namely, that relating to efficiency in administration and the best form of staff organisation by which it can be attained under modern conditions, whether in the public services, industry, or commerce. Indirectly, these pronouncements point to the necessity for a thorough investigation into matters affecting the functions which should be assigned to the man of science and the technical expert, so that the boundaries of their spheres of responsibility may be readjusted with

the view of meeting the new conditions which have arisen in all branches of human activity owing to the applications of science on every battle-front.

A study of administrative and management methods is a matter of supreme importance at the moment, because they are vital factors in the progress and welfare of our public services, which are increasing in many directions. It must be remembered that for many decades now a gradual change has been taking place in the character of the ownership of our industrial and commercial undertakings. With the growth in their size and the extension of their activities in relation both to the kind of business for which they are responsible and also the considerable area of the territory in which they often operate, individual and partnership ownership has been giving place to collective and corporate ownership. Where undertakings and enterprises have been incorporated under the provisions of statutes they have, for practical purposes, lost the status of a private business, in the strict sense of the term, and have instead thereof become in effect public services. Questions, therefore, affecting the methods of administration and the type of organisation adopted in them can no longer be considered to be merely matters of their own domestic concern: questions in relation to their control and management possess for the public an importance to-day which is only very slightly less than do questions connected with the similar aspects of administration bearing upon governmental and municipal activities and enterprises. In this connexion it is interesting to note that very careful consideration has been given in Germany to the problems of management and organisation in the case of the State-owned concerns which have been set up in that country since the termination of the War. The significant fact stands out that the directors who have been appointed by the German Government to control and manage these concerns are men who have been selected for these positions from among those possessing *expert and specialised knowledge*, and have full executive authority within the limits of the general policy laid down. The practice referred to provides a useful lesson and might with profit be imitated in Great Britain.

There are signs that there is an awakening in Great Britain, and there exists a readiness on the part of progressively minded men to overhaul our old-fashioned and out-of-date methods and practices. In order to stimulate this feeling into action, it seems to be alone necessary for some authori-

tative body to set the ball rolling by indicating the nature of the reforms which will best suit the new conditions which have come into existence with the invasion of science into every domain of human affairs.

The question which perhaps most immediately requires close and attentive examination is that connected with the proper constitution of the controlling bodies responsible for the management of government departments and of industrial and commercial undertakings and enterprises. These bodies are sometimes appropriately referred to as the 'directive organ', and, as is well known, it is in them that reside the power and authority for deciding not only what shall be the character of the administrative methods and practices to be employed in the organisations for which they are responsible, but they have also the final word on questions of even greater importance, affecting, as they do, the whole well-being and success in every sphere in which combinations of knowledge and effort are required, namely, on questions relating to the recruitment of the staff. On these rests the ultimate responsibility for determining what type of men shall be selected for particular positions, technical as well as administrative, and also what shall be the character of the qualifications which shall be sought for in the various classes of officials.

Non-technical administrators and directors cannot, obviously, be so well equipped for dealing with problems of the kinds referred to above as those who have been 'through the mill', and, owing to their scientific and technical training and practical experience, have therefore acquired an intimate personal knowledge of all the essential factors which are severally involved in the solution of particular problems coming under their jurisdiction, and, what is equally important, as to the nature of the qualifications required in those to whom should be entrusted the duty of providing the most satisfactory solution of any particular problem. Hitherto, a disinclination has existed in Great Britain to give men with scientific and technical qualifications—and also possessing other essential qualifications—seats on boards of directors, or to appoint them to the more important administrative positions.

The crippling influence of the harmful traditions and prejudices associated with a narrow policy of the kind here indicated requires to be got rid of; only if a change of spirit can be brought about in this matter is there any likelihood of effecting a real improvement in matters of the deepest concern

to the nation. Desirable economies and other beneficial results would follow suitable reforms carried out in the administrative sphere; they can alone be secured by widening the scope of responsibility of the man of science and the technologists. It is essential that in the case of every 'directive organ' a due proportion of those forming it shall be men possessing scientific knowledge and technical experience, and further, that men with the qualifications here indicated shall be chosen more frequently than in the past for responsible administrative posts.

It has been suggested that the failure in the past to employ, to a sufficient extent, men of science and technologists in the directive and administrative spheres may have been due to the reluctance that these types of men have shown to undertake work in those spheres, or possibly to the absence of aggressiveness on their part in seeking for positions therein. If this has been the case, it is imperative in the national interest that such reluctance or passivity should be overcome by them; they should pay heed to the exhortation of Sir William Bragg, who, on the occasion of the opening of the new science building of St. Edward's School, Oxford (on Dec. 8), made a pointed reference to the needs of the day in the following terms: "There is a certain type of man who is badly wanted in this country at this moment. It is the scientific man who is also an administrator. We need men to-day who are not merely scientists, but who are also willing to take responsibility, to mix in the affairs of men, and to know something of the world."

There is another and an exceedingly important reason why men of science and technologists should play a larger and more important part than in the past in the directive and administrative spheres of responsibility. It is recognised by many who have studied the problem that one of the most pressing requirements of the day is that of narrowing the zone of separation between the workmen on one hand and those responsible for the directive and administrative aspects of the work on the other. Attempts have been made to secure this end. In the governmental sphere officers of the administrative branch have in some cases established direct contact with the workers, and in some industrial enterprises committees of directors have been appointed to preside over departmental operations.

However, there is evidence that the results in such cases have not been altogether happy. Non-technical administrative officers cannot hope to, and, as a rule, do not, hold their own in arguments

exchanged with workers in a technical field, and in these discussions there is often an unwillingness on their part to admit the errors in their views, and this necessarily still further strains the relations between these two groups instead of improving them; the workers naturally derive small comfort when, having got the best of an argument, they are told: 'But there is no logic in administration'. Similarly, interference with details of departmental operations by directors, particularly on the part of those who have no technical knowledge, can but be, and, indeed, has proved to be, harmful; it leads in the long run to inefficiency and loss. In situations of the kind referred to, experienced technical men would carefully avoid saying or doing anything mischievous.

Obviously, it is practically impossible to secure a proper bond of sympathy between the two groups, the directive and the workers, under modern conditions, where the control and management are vested entirely in the hands of non-technical men who are either ignorant of technical considerations or act without regard to them. On the other hand, there is every reason for supposing that the risks of misunderstandings between the several groups in an organisation would be reduced to vanishing point were technical experts who have prepared themselves for the rôle called upon to play a more prominent part than hitherto in the directive and administrative spheres. It is the development of a policy to secure these ends that will provide what is so essential to-day: a strong and effective link between science and administration.

History of Science.

A History of Science and its Relations with Philosophy and Religion. By William Cecil Dampier Whetham. Pp. xxi + 514. (Cambridge: At the University Press, 1929.) 18s. net.

MR. DAMPIER-WHETHAM, in writing a general history of science, has undertaken what is, strictly, an impossible task. It is therefore very easy for any critic who cares to spend a day or two in a library to that end to pick holes in matters of detail. Taking the book as a whole, as in the first instance it should be, it is a fine and bold piece of work. The narrative is always clear and concise and the sequence orderly; it never degenerates into the dismal catalogue of names and dates which sometimes masquerades as the history of science. The mutual relations between scientific discovery and other phases of contemporary thought

are generally well brought out, particularly the relations between science and philosophy.

For the early history of science Mr. Dampier-Whetham is in a more favourable position than his predecessor Whewell, thanks to the recent labours of scholars who have worked out special developments in special periods. But for the later history the task is much harder than in Whewell's time, when physics seemed to be advancing quietly and steadily on proved foundations and biology scarcely existed. Up to the end of the nineteenth century, discoveries and developments of thought can still be seen in perspective in relation to what came before and has come after; the wood can be distinguished from the trees. It is when the present century comes under review that the historian's task becomes really alarming because of the abundance and confusion of material. Yet the historian cannot stop earlier than the present day without cheating the reader of the most interesting part of the story. It is significant that 105 pages suffice for all the time before the fifteenth century; from the fifteenth to the end of the eighteenth, 111 pages; 130 pages for nineteenth century; while 150 are devoted to the present century. This division not unfairly represents the rate of advance.

Modern developments in physics are well and simply described. The story is of course the most exciting episode in the whole history of science. It seems at the moment as though the three main lines of modern research, field-physics, atomic structure, and cosmogony, are all tending towards a final synthesis which will lay bare the ultimate nature of the physical universe. We can all hear the mathematical hounds in full cry, and even as we run panting far in the rear, can share in the excitement of the chase. But with all the excitement it is hard to suppress a haunting fear that the end of this hunt may be like that of the 'Hunting of the Snark'. However this may be, the history of modern physics can be made intelligible; the task needs knowledge and skill but is not impossible, for certain main lines of advance are clearly marked out. It is when the other sciences come to be considered that the historian's task becomes really impossible. There is at present abundant activity in detail, but there are no clear lines of advance, so that we can only guess which discoveries are the important and fruitful ones and which are destined to be sterile, though at the moment they may loom large. The writer is bound to be guided by his interests and prejudices, and the reader in his turn will approve or disapprove according to

whether his own interests and prejudices coincide or not. A few examples will illustrate the difficulties.

The author does not mention chemistry, apart from its biological applications, in his review of the present century. This omission will undoubtedly offend the chemists, but I believe it to be reasonable. Twentieth century chemistry has been concerned with the use of nineteenth century methods for the application and development of nineteenth century theory. New methods and new theories have been left in the hands of the physicists. On the other hand, I should be inclined to dispute the prominent place given in the section on physiology to the recent work on hormones and vitamins. It is true the results are striking and have caught the public eye; nevertheless, there is reason to think that the ideas involved are too crude to have a permanent place in scientific thought and that existing methods of investigation are also very crude relative to the problems. It is pioneer and not classical work. Future generations will probably extend to present-day notions the same pitying tolerance we extend to the notions of 'caloric' and 'phlogiston'. In contrast with this work, I believe the work of Sherrington and his school, which is no more than mentioned, to be classical. Sherrington's methods are completely adequate for his purpose, and his ideas, though clothed in difficult language, are both simple and subtle. These ideas now dominate the physiology of the central nervous system and are likely to do so for a long time to come; the subject, moreover, is the central or key subject of the whole of physiology. This, of course, is a personal opinion; it is introduced merely to emphasise the extreme difficulty of dealing historically with modern work. Not only is an incredible diligence in accumulating detailed knowledge needed, but also superhuman powers of criticism and prophecy. In parenthesis, it seems necessary to protest against the omission of Sørensen's name from the paragraphs on colloid chemistry and ionic equilibria.

The author is to be congratulated on including a survey of those subjects, embryonic perhaps but still sciences, that lie on the borders of the physical sciences, such as psychology and anthropology. His choice of subjects and the views he expresses on certain controversial topics will be objected to by many, but in these regions controversy cannot be avoided except by silence.

There is one aspect of the history of science which is strangely neglected in this book as in others, but which is not without interest; that is, the effect of practical human needs on the course of scientific

discovery. A few examples will make my meaning clear: first a minor one and then two more speculative but more important cases. It is a commonplace that the progress of physics depends upon the design and use of instruments of precision. But apparently no physicist realised either the possibility or the value of galvanometers for measuring small currents until Kelvin devised his mirror galvanometer in response to a purely practical demand, namely, for use with the trans-Atlantic cable when existing telegraphic methods had failed. Once the instrument was made, it was quickly applied to laboratory purposes, and innumerable discoveries have been made with it and its successors. Of course, the development would ultimately have taken place, as would the theory of gravitation without Newton, but it would have been delayed. Given an instrument or method, scientific men are quick to apply it to existing problems, but the existence of a problem does not always call forth a method for solving it; the method may come from some quite unexpected quarter.

The second example is the peculiar position that medicine occupied in the early stages of scientific discovery. As Mr. Dampier-Whetham points out, the enormous success of geometry, which seemed to provide a means for obtaining genuine knowledge about the external world by *a priori* methods, blinded the Greeks (and many others until recent times) to the necessity of observation and experiment. Even apart from this, it seems that human beings are naturally reluctant to start the labour of accurate and disinterested observation. Once a start has been made, the work may be found interesting for its own sake, but some powerful ulterior motive is generally needed at the beginning. In the ancient world the desire to cure disease, in spite of the hocus-pocus that always surrounds the practice of medicine, seemed to provide one of the few motives for precise observation. The best of the Greek medical workers realised that for their purpose *a priori* reasoning led nowhere and only the slow method of observation was any use. In this way were laid the foundations not only of human anatomy and physiology, but also of zoology and botany (it must be remembered that Aristotle was the son of a physician before he was a pupil of Plato), and in later times of chemistry. It is remarkable that while medicine and the studies underlying it were well launched on their scientific career, agriculture still remained for centuries dependent on tradition and superstition, as though hunger was a less powerful motive for research

than compassion. Perhaps it is nearer the truth to say that the stomachs of the intelligentsia have usually been sufficiently well filled to turn their thoughts away from such gross considerations as food supply. But they could not shut their eyes to disease and death, which might come to anyone at any time.

Lastly, consider the case of astronomical observation. The astronomical observations of the Babylonians and Egyptians were dictated by practical considerations, for determining the seasons and for astrological prediction. Astrology was still a leading motive for astronomical observation almost until modern times. The Greeks, who were free from the superstitious motive, seem to have done little in the way of observation. Their contributions were of unique value but were theoretical—the application of mathematics to astronomy and the rudiments of a ‘*mécanique céleste*’. But from the fifteenth century onwards there was a new stimulus to observation with more exacting requirements: this again was a practical need—the art of navigation. For casting a horoscope it was useful to have numerous observations, but they did not need to be precise; the seaman was not so easily satisfied. What is most characteristic of modern physics is the design and use of instruments of precision and exact numerical calculation for purposes of prediction. These characteristics first appeared in connexion with the compilation of the “*Nautical Almanac*” and map-making. Greenwich Observatory was founded for this purpose. More than two centuries earlier, before western Europe had made any contributions to science, Prince Henry the Navigator had founded at Sagres the very first school of technology.

There is another aspect of the voyages of discovery of the fifteenth and sixteenth centuries, a result this time that seems to deserve more notice than it usually gets from the historian of science. Mr. Dampier-Whetham emphasises the fact that at this period the early men of science had to rid themselves of the incubus of the medieval outlook, an incubus from which the Greeks were mercifully free. He does not, however, mention what was possibly the greatest single factor in the process of liberation, the discovery of the New World and the circumnavigation of the globe. These facts proved, in a way which the most thick-headed were compelled to understand, that the traditional cosmology was not infallible, that ancient authorities could be wrong, and that even the thunders of the Vatican could not put Humpty-Dumpty together again.

A. D. RITCHIE.

Man's Ancestry.

Man's Place among the Mammals. By Prof. Frederic Wood Jones. Pp. xi + 372 + 12 plates. (London: Edward Arnold and Co., 1929.) 21s. net.

EARLY in 1918, Prof. F. Wood Jones gave a popular lecture in King's College, London, on man's origin. This lecture, when published by the Society for Promoting Christian Knowledge under the title “*The Problem of Man's Ancestry*”, met with a mixed reception. Anatomists treated it with neglect or contempt; those of an anti-Darwinian bias hailed it with delight. As the little book of 1918 is really the parent of the large work which has just appeared under the title “*Man's Place among the Mammals*”, it is worth while to seek for an explanation of the diversity of feeling evoked by the original publication. The antagonistic attitude of most anatomists is understandable. They were told that man, far from being as they thought the most changed, the most specialised, the most highly evolved of all primate animals, was, when his structural characters were rightly analysed, essentially a very ancient and primitive type. They learned that they had laboured in vain, because in construing the evidence relating to man's origin they had been dominated by a heresy for which Darwin, Huxley, and Haeckel were conjointly responsible, namely, that there had been an anthropoidal stage in man's evolution. Prof. Wood Jones summarily dismissed the anthropoids living and extinct; at no time had they any lot or part in man's ancestry.

The opposition offered to this thesis by anatomists can be understood; but the welcome extended to it by those of a ‘*fundamentalist*’ turn of mind is less easily accounted for. Prof. Wood Jones is a convinced evolutionist; man, he declares, has been evolved, but not from an anthropoidal form. He contends now, as he did in 1918, that man's independent origin has to be sought for among the small Tarsioids which appeared during the Eocene period of the earth's history. It may seem to the ordinary reader that it matters little whether we include or exclude anthropoids from man's ancestry, but at the conclusion of his original lecture Prof. Wood Jones made clear to his audience that a deep ethical significance was involved. He said:

“Were man to regard himself as being an extremely ancient type, distinguished now, and differentiated in the past, purely by the qualities of his mind, and were he to regard existing Primates as misguided and degenerated failures of this ancient stock, I

think it would be something gained for the ethical outlook of humanity—and it would be a belief consistent with present knowledge.”

Herein I think Prof. Wood Jones reflects unfairly on anthropoid apes. Prof. Elliot Smith is convinced of man's anthropoid ancestry, and yet he finds that natural man is peace-loving and virtuous.

The lecture of 1918 was prepared and delivered in a war atmosphere. No doubt the author suffered unfairly from the fact that he was unable in the course of a brief hour to deal fully with the proofs which his critics expected him to produce. He has now had ample opportunities of meeting the demands of his critics. In a series of forty brief chapters, brilliantly written, illustrated by his own excellent drawings and illuminated by happy touches which reveal the author as naturalist as well as anatomist, he expounds his conception not only of man's place among mammals, but also the places which should be given to Lemurs, the Tarsiers, monkeys of the New World, monkeys of the Old World, and to anthropoid apes, both great and small. It is not until we reach the thirty-eighth chapter that we find what we have been waiting for—the author's conception of the evolutionary changes which converted a primitive small-brained Tarsioid into a human being. We particularly want to know how and when man's body underwent the structural revolution which fits it for an orthograde posture and for bipedal progression.

It is just when he approaches these problems that our author, usually so precise and definite, becomes tantalisingly elusive and non-committal. We are told that the “proto-human” stock was the first to break away from that line of Tarsioids which ultimately became separated into anthropoids and Old-World monkeys. Man's ancestry broke away while the basal phylum still retained all its ‘primitive’ features and was adapted in body and limb for life in the trees. Having broken away, the proto-humanoids took to walking on their hind limbs, and their bodies and feet underwent the structural revolution which fitted them for an upright posture and for bipedal progression. Then the brain began to grow.

“Everything would point to the fact that enlargement of the brain came in the proto-human or progressive stock at a time when that stock was in possession of a very primitive type of cranium, and that enlargement of the brain-case occurred at a stage in which no other evolutionary trends, save those of mere enlargement, had been initiated” (p. 341).

It would be fair to presume from this statement that Prof. Wood Jones attributes man's big brain to the fact that it began to grow when his skull was in

a still plastic state. A paragraph on another page, however (p. 340), makes us hesitate in drawing this inference, for there we are informed that “Man . . . enlarged his primitive chondrocranium by his early phylogenetic development of a large brain”; here the large chondrocranium is attributed to the large brain. Clearly, the explanation given by Prof. Wood Jones of man's structural adaptation to bipedal progression and of his large brain cannot be regarded as satisfactory. No evidence in support of such speculations is afforded by any fossil discovery made hitherto; still, as Prof. Wood Jones rightly maintains, the geological records of man's evolution are still very imperfect.

Having thus postulated an independent origin for man, Prof. Wood Jones has to face a multitude of very difficult problems. How are the long list of intimate structural resemblances which bind man to anthropoid apes to be explained? He admits these resemblances. “It must be realised at the outset”, he writes, “that of all animals the giant apes show the nearest structural affinities with man. This fact has always been realised, and it remains an uncontrovertible truth.” He regards these resemblances not as an inheritance which man and anthropoid have derived from a common ancestor, but as independent acquisitions. Now, in the order of Primates we do meet with surprising and definite examples of parallel or convergent evolution. Nevertheless, Prof. Wood Jones under-estimates and under-states the many and intimate structural and biological resemblances which link man to the great anthropoids. He has to presume that man and anthropoids came independently by the same form of uterus, the same elaborate process of placentation, the same tendency to prolong the foetal and infantile periods of growth and development. He attempts to minimise the resemblance of the anthropoid brain to the human brain; if we did not know of the stage of evolution represented by the anthropoid brain, we should have to presume its existence; without such a presumption, it would be impossible to explain how the small and simple brain of a Tarsioid could become transformed into the elaborate brain of man.

Every bone and muscle of man's body have undergone profound structural alterations to fit him to his orthograde posture. The same bones and muscles have undergone similar changes in anthropoids, but to a less degree. If we suppose that adaptation to an orthograde posture is a common inheritance, then we get light on how man came by his postural adaptation, for in their bodies anthropoid apes preserve stages which lead towards

the specialisations found in the human body. Our author rejects such an interpretation; he supposes that man and anthropoids have independently acquired their orthograde posture, and in the process of evolution come by the same structural modifications. He regards all such postural modifications as 'adaptations', and therefore useless as indications of relationship. Relationship, he holds, must be determined on inborn, non-adaptative structural characters. He gives lists of such characters, but a careful analysis of his lists reveals the fact that the structures cited are those the functional significance of which is not apparent. Is there any structure in the animal body which is devoid of functional significance and therefore free from adaptative changes?

The truth of a hypothesis is measured by the ease and naturalness with which it explains the multitude of facts which lie within a field of investigation. When Prof. Wood Jones rejects an anthropoidal stage in man's ancestry, he has to explain away a tremendous number of facts. That the blood of man and anthropoids gives the same reactions when submitted to similar tests our author admits, but denies that similarity of reaction indicates a true 'blood relationship' of man to anthropoid. Man and anthropoids have very similar susceptibilities to disease—a fact which is not discussed. In recent years the existence of 'blood-groups' has been demonstrated in all races of mankind. The only other animals which possess corresponding group reactions are the anthropoid apes.¹ Prof. and Mrs. Yerkes, in the great monograph recently published on "The Great Apes", demonstrate that of all animals the mental reactions of the great anthropoids are the nearest to those of man. All these facts Prof. Wood Jones has to explain away. He has also to meet the fact that the further we trace man backwards in time, the more accentuated do his anthropoid characters become. The skull cap of *Pithecanthropus* has been mistaken for that of a large gibbon; the lower jaw of Piltdown man had been claimed to be that of a chimpanzee; the molar teeth of Neanderthal man reproduces the dental pattern of the extinct anthropoid *Dryopithecus*; Rhodesian man rivalled the gorilla in the development of his supra-orbital ridges. All these facts run counter to Prof. Wood Jones's scheme of man's evolution.

The main criticism which must be made of this work is that it is not a full or fair statement of the great mass of evidence now available for deter-

mining man's evolutionary history and his relationship to anthropoid apes. Nevertheless, it is a brilliantly written book, one which will serve a great and useful purpose in stimulating profitable discussion and further research. A. KEITH.

Geology of Albania.

Geologica Hungarica. Fasciculi ad illustrandam notionem Geologicam et Palaeontologicam Regni Hungariae. Series Geologica, Tomus 3: Geographie und Geologie Nordalbaniens, von Baron Fr. Nopcsa; mit einem Anhang von H. v. Mžik: Beiträge zur Kartographie Albaniens nach orientalischen Quellen. Pp. xiv + 703 + 35 Tafeln. (Budapestini: Edidit Institutum Regni Hungariae Geologicum, 1929.)

NORTHERN Albania is a complex mountainous area which rises above the eastern coast of the Adriatic, where it bends abruptly from its course from north-west to south-east parallel to the grain of the country, and runs south, cutting across both the strike of the rocks and of the mountains. Northern Albania occupies a critical position in the geology and geography of the eastern borderlands of the Adriatic and of the much-debated Dinaric Mountains. The geology of the country, according to the first accounts, appeared perplexing owing to the puzzling sequence of the rocks, which has now been explained by Baron Nopcsa, after field work extending from 1905 to 1925, as due to great overthrusts. This view he has now established in a ponderous monograph, which is published as the third volume of "Geologica Hungarica" by the Geological Survey of Hungary, of which the author was until recently the Director. The most important previous contributions were those of Cvijic, whose work is dealt with briefly, and one of his misunderstandings is described as "catastrophal".

The oldest rocks in northern Albania are the Upper Carboniferous, as during all the preceding part of the Palaeozoic, Albania was included in a great South Balkan land which was traversed by ancient mountains trending east and west. This influence is still seen in the maintenance of that direction by some of the ranges and by the Curzola-Lesina archipelago in the Adriatic. The description of this land begins with the Upper Carboniferous, as marine rocks of that date occur on the North Albanian block (or Tafel). These beds are shown to be Uralian by their fossils, for example, *Productus cora* and *P. uralicus*, and they are followed by Permian Neoschwagerina limestones. The Trias

¹ See "Anthropology and Blood Grouping", by Profs. Woollard and Cleland. *Man*, 1929. Vol. 29, p. 181.

was marked by a wide extension of the sea, and the deposition of dolomitic and massive limestones ranging from the bottom of the Trias to the Rhætic; these limestones are well represented in both the North Albanian block and the Cukali mountain complex to the south. In the Ladinian (Middle Trias), volcanoes discharged sheets of tuff, a material which is now jasper, and ophiolites, which are well known from Steinmann's view of their formation by abyssal eruptions.

The Jurassic is less well developed owing to extensive earth movements. In the Lias, marine limestones and marls were deposited over much of the country, and after a break in the Middle Jurassic, more limestones were formed in the Upper Jurassic on the North Albanian block, and red flaggy limestones and radiolarite in Cukali. In the south-eastern part of the area the Jurassic is doubtfully represented by the basic igneous rocks which range from serpentine and peridotites to diabase, and cover most of the Merdita overthrust sheet.

The Cretaceous is represented in the North Albanian block by massive limestones; but land still lay close on the south, for the system begins in the Merdita with a basal conglomerate, followed by sandstones and shales, and later, owing to the widening subsidence, by flaggy limestones and the massive Hippuritic limestones, which extend throughout North Albania.

At the end of the Cretaceous, further earth movements reversed the conditions. In the Eocene the clearer sea lay to the south and south-west, for the coastal ranges are formed of Nummulitic limestone, while in the North Albanian block are shales with fucoids and beds of flysch. The coastal hills contain Oligocene conglomerates, with granite pebbles from the east, and clays with corals. Then follows an important gap, and the presence in the mountains of highly disturbed Oligocene beds and of undisturbed Lower Pliocene shows that the main Dinaric folding was in the Miocene. It extended the South Balkan land, which was reduced in the Pleistocene by widespread subsidences in some places to the amount of thousands of feet. These movements broke up the land between Greece and Asia Minor into the Ægean Archipelago, enlarged the Adriatic, and produced the poljes in the Dinaric Mountains and the fiords on the Dalmatian coast.

In a volume, "The Nature and Origin of Fiords" (1913), I described the adjacent parts of the Adriatic coastlands as a fractured belt, and interpreted most of the basins or 'poljes' as due to subsidence along faults, and claimed the Gulf of Cattaro as a true fault-formed fiord. This conclusion was supported

by a photograph (*op. cit.* Pl. vi.) of the block opposite Cattaro, which was described as of a fault-block, from evidence seen in a surreptitious visit, as the front of it was closed by military regulations. This explanation has been denied, and the Gulf claimed as due to normal erosion. Baron Nopesa, however, marks a great fault along the very line shown in my illustration. He fully proves the tectonic origin of many of the poljes and of features along this coast, and says that the faults are of such recent origin that the fault scarps are in many places very little worn.

The Pliocene beds include in southern Albania the huge bituminous limestones in the Voyusa valley, near Valona, which are worked for asphalt, and, in association with some traces of petroleum, have encouraged the hope that among the folds of the Dinaric limestones may be a still hidden oilfield.

The volume contains a detailed description of the geography and geology of North Albania, with a coloured map on the scale of 1 to 200,000, numerous sketch maps and diagrams which illustrate the complex tectonics due to overthrusts generally from north-east to south-west. The volume is well printed, and is accompanied by twenty-five clearly explained photographs of the scenery and geological structures, by a bibliography which deals with the literature on the Albanian problems in other parts of the Balkans and Asia Minor, and an article by Hans v. Mžik on Oriental contributions to Albanian cartography.

J. W. GREGORY.

The Polarity of Molecules.

Polar Molecules. By Prof. P. Debye. Pp. 172. (New York: The Chemical Catalog Co., Inc., 1929.) 3.50 dollars.

Polare Molekeln. Von Prof. P. Debye. Pp. viii + 200. (Leipzig: S. Hirzel, 1929.) 14 gold marks.

THE name of Debye is associated with many new and important theories in physics, but none of his theories has more successfully suggested, directed, or stimulated experiment, than his theory of dielectrics. Since Debye's first paper on this subject in 1912, so many advances have been made, and so many new facts established, that an authoritative account of these developments from the pen of Prof. Debye himself is particularly welcome.

The English book is the outcome of a recent visit of Prof. Debye to America, where he gave courses of lectures on the dielectric properties of matter and was induced to put the substance of

his lectures in more permanent form. The book is concerned principally with the molecular interpretation of the dielectric constant and the correlation of dielectric properties with other physical properties such as dispersion and absorption, particularly in the infra-red. At present, theory can deal adequately only with vapours, because, in fluids, the interaction of neighbouring molecules is too important to be neglected and cannot be estimated. Methods of dealing with dilute solutions have, however, been developed recently, and these are described in some detail.

In the simple theory it is assumed that dielectric phenomena are due to two causes: first, to the distortion of the electronic structure of the individual molecules in the presence of an electric field; and secondly, to the fact that the electrical distribution of many molecules is unsymmetrical even in the absence of a field; such molecules are said to possess a permanent electric moment. The magnitude of this electric moment is a molecular constant, which is as important, if not more important than other known molecular constants such as the size of a molecule, as it exercises a controlling influence on many physical phenomena. The methods of determining this constant by a comparison of theory and experiment are described at length and, for the first time, the magnitudes of all known electric moments are brought together in accessible form; in fact, the German book, which is a revised and extended edition of the English book, contains a list of the electric moments of about two hundred molecules. This table is to be extended still further and issued later as a special supplement.

The table of electric moments is instructive. Molecules which consist of two different atoms are non-symmetrical and possess a permanent moment, while molecules like hydrogen and nitrogen, which are symmetrical, have none. Nearly all triatomic molecules have permanent moments, and this result leads to important deductions as to the arrangement of the atoms in a molecule. It shows that the atoms of the water molecule, for example, cannot be situated symmetrically along a line. A chapter is devoted to a discussion of the possible forms of this and other molecules, and it is shown that the arrangement of H_2O is most probably triangular, while that of NH_3 is pyramidal. This conclusion will not surprise the organic chemist, as, on other grounds, he has long ago postulated that the three valencies of the nitrogen atom are not directed in a plane.

Considerable work is now being done on the

relation between the dissymmetry of molecules (as reflected in their electric moments) and their chemical formulæ. Recent advances are reviewed in the English edition, and more fully in the later German edition. The effect of the substitution of two equal molecular groups in a carbon chain or in the benzene molecule depends essentially on the relative positions of the groups. The trans-form of dichloroethylene and the para-form of dinitrobenzene both have small or zero electric moments, but the unsymmetrical isomers have large moments. If the two substituted groups are not equal, a moment remains even in the para-compound, as is illustrated by the three nitrotoluenes. Appropriate measurements of the polarity can therefore be used to determine the electropositive and electronegative character of various molecular groups. It seems likely that it will be possible soon to estimate the polarity of a complicated compound by adding up vectorially the moments of the different groups which constitute the molecule.

The later chapters are devoted to an account of the new wave mechanics in so far as it affects the theory of the dielectric constant and the theory of dispersion. The first formula given by Debye for the dielectric constant was deduced from the classical theory and had to be modified when the quantum theory was first introduced, but the more recent forms of the quantum theory, expressed by the matrix and wave mechanics, have returned the formula to its original form, so that the older determinations of electric moments deduced from the classical formula still stand. The book concludes with a theoretical discussion of the dispersion and absorption of polar gases, with special reference to rotating molecules of the HCl type. It is shown that anomalous dispersion should occur in the region of long wave-lengths, approaching radio frequencies, though experimental results in this region are, of course, still lacking. The notation used is unusual and unfortunate (the rotational quantum number, for example, being denoted by n) and might with advantage be brought into line with that already used in molecular spectra.

This book not only brings together for the first time the accumulated information on electric dipoles, but also points out the gaps which still exist in theory and experiment. It is thus of great value to all physicists and chemists who are interested in molecular structure, and, in suggesting new fields of work, is of the greatest possible value to research workers in this and allied subjects.

J. E. LENNARD-JONES.

Our Bookshelf.

- (1) *The Future of the Earth*. By Dr. Harold Jeffreys. (Psyche Miniatures: General Series, No. 24.) Pp. 72. (London: Kegan Paul and Co., Ltd., 1929.) 2s. 6d. net.
- (2) *Earthquakes and Volcanoes*. By Prof. J. W. Gregory. (Benn's Sixpenny Library, No. 97.) Pp. 80. (London: Ernest Benn, Ltd., 1929.) 6d.
- (3) *The Restless Earth: An Introduction to the History of the Rocks*. By Prof. Herbert L. Hawkins. (Routledge Introductions to Modern Knowledge, No. 10.) Pp. iv + 76. (London: George Routledge and Sons, Ltd., 1929.) 6d. net.

THE first of these "little books on great subjects" is considerably shorter than the other two and costs five times as much. But in view of the facts that it will appeal to a much smaller circle of readers, is well bound and is printed on good paper, it cannot be regarded as overpriced; it is rather the others that are extraordinarily cheap.

(1) Dr. Jeffreys entertainingly summarises some of the theories more technically discussed in his larger book, "The Earth". He deals with the history of the sun, and the age and origin of the solar system; the cooling of the earth and the 50,000 million years of cooling still before it; and the past and future of the moon. The title of the booklet indicates only a point of view.

(2) Prof. Gregory's contribution to Benn's inimitable Sixpenny Library is tightly packed with good things. In eighteen short but intensely interesting chapters, he surveys every important aspect of volcanoes and earthquakes, and it is safe to say that there is no better short account of these subjects available in English. The book should have a big sale, and its influence on teaching in schools, as well as directly on the reading public, should go far to remove many current misconceptions. The chapter on "The Inner Structure of the Earth" is, however, less up-to-date than it might be; it is certainly not in accordance with modern evidence to describe the shell between the rocky crust and the iron-nickel core as consisting "mainly of the rigid nickel-iron mass of the earth". It is much more likely to have a composition akin to that of stony meteorites.

(3) Prof. Hawkins is not altogether happy as a popular writer, despite the attractive vitality of his style. The use of metaphor and analogy is sometimes far-fetched and undignified. Denudation is "grinding the dust"; the interior of the earth is "beneath the dust"; earthquakes are "shivering fits"; and volcanic activity is "feverishness". When the author writes: "the earth is bleeding to—perfection", or "water is more obedient [than the wind] to the call of gravitation", he runs the risk of irritating some of his readers. Apart from this occasional defect of manner, the matter of the book is excellent, and the name of the author is a sufficient guarantee of its trustworthiness as a popular introduction to geology.

Royal Agricultural Society of England. Agricultural Research in 1928. Pp. viii + 193. (London: John Murray, 1929.) 1s.

THE Royal Agricultural Society has issued its fourth annual summary entitled "Agricultural Research in 1928". As in previous years the publication is divided into a number of reports, each written by an acknowledged expert in the particular subject.

Fruit and vegetable canning, though a comparatively new industry, appears to have made a promising start and should provide excellent new markets for farm produce provided suitable organisation, including standardisation and grading, is built up. The importance of obtaining a full and even plant in cereals and sugar beet is emphasised if the best yields are to be secured.

Progress is being made in the production of tuberculin-free herds of dairy cows, and the importance of progeny rather than ancestral performance in estimating the worth of a breeding animal is becoming more clearly recognised. Farm costings of all kinds, including questions concerning marketing and co-operation, are being thoroughly investigated. The effect of the Agricultural Credits Act on insurance and credit is also dealt with. Among engineering problems, drainage is receiving considerable attention, and recent trials in other countries, notably France, are described. Of the newer implements, the combine harvester seems to have proved its usefulness in the English climate, provided that a drier is regarded as a necessary part of the equipment. Methods for drying grain, grass, and sugar beet are also being developed.

No outstanding new discovery is mentioned in the animal nutrition section, but the most recent views as to the nutritive value of grass, sugar beet pulp and tops, silage, and milk are fully discussed. As regards fertilisers, nitrogen occupies the most important position, its world production and consumption having enormously increased during 1927-1928. Potash, on the other hand, shows only a small increase over previous years, and phosphorus none at all. The success of Danish agriculturists in the production of feeding stuffs is attributed to their large increase of acreage under root crops. In England, on the other hand, the reverse is the case. The major portion of the report on veterinary science deals with vaccination against tuberculosis, and it is shown that the different types of tubercle bacilli are capable of infecting species other than those from which they take their name. To each report a large number of references are appended, and the publication should prove useful to farmers, agricultural organisers, and students.

The Theory of the Gyroscopic Compass and its Deviations. By Dr. A. L. Rawlings. Pp. x + 191. (London: Macmillan and Co., Ltd., 1929.) 10s. 6d. net.

It was about eighty years ago that Foucault carried out his ingenious experiments with the gyroscope, but for half a century the apparatus had no practical application. It has now, however, been applied

to the automatic steering of torpedoes, to the mono-rail car, to the reduction of the rolling of ships, and to the steering of ships. Of the gyroscopic compasses now in use, the Anschütz was the first, and this was followed by the Sperry and Brown compasses. H.M.S. *Invincible* was navigated to the Falkland Islands, and the British Submarine *E11* found her way up the Dardanelles into the Sea of Marmora, by Sperry compasses, and such compasses are to be met with in every ocean.

Handbooks on the gyroscopic compasses have been issued by the firms making the various types, but these do not deal fully with the mathematical theory involved. Dr. Rawlings has therefore attempted to place this theory in the reach of anyone with an elementary knowledge of the differential calculus. His book is written primarily for those engaged in the construction of compasses and for navigators, to whom it should prove most useful. The opening chapters are devoted solely to the explanation of the action of the compass, the restraints imposed upon the gyroscope so that it shall be of use, and the problems involved in its oscillation, its damping, and its stability. After this there are descriptions of the Anschütz, Brown, and Sperry-Rawlings-Harrison compasses, while the later chapters deal with compensating weights, rolling error, damping error, and gimbaling error, and the accuracy of the gyro-compass at sea.

The Court of Burgundy: Studies in the History of Civilisation. By Otto Cartellieri. Translated by Malcolm Letts. (The History of Civilisation Series.) Pp. xv+282+25 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1929.) 21s. net.

THIS volume in the History of Civilisation Series is one of peculiar interest for English readers. The Burgundian court was a great formative influence in the history of European culture. The four dukes who united Burgundy and Flanders under their rule in the period extending from the middle of the fourteenth century to the end of the fifteenth, gathered around them sculptors, painters, scholars, and poets from all parts of Europe, while their court was the last school of the dying order of chivalry. The rivalry of the houses of Burgundy and Armagnac gave England the opportunity of intervention. But the alliance between the English kings and the Burgundian dukes, which was a dominating factor in the troubled politics of France, had an abiding effect on English culture. By ensuring an outlet for our wool trade in the great commercial centres of Flanders, it confirmed the development of English rural life and industry along the lines which ended in the formation of the great pastoral estates, with subsequent economic and social consequences known to all. Prof. Cartellieri here deals with a subject which he has made peculiarly his own. His book is no mere recital of political events, but in a very real sense a social history in which every aspect of life, art, and literature is followed in detail. One chapter deals with the famous witchcraft persecution at Arras.

Exact Colour Matching and Specifying. By L. Blin Desbleds. Pp. 116. (Paris: Technological and Industrial Service, n.d.) 25 francs; 4s.

IN this work the industrial method of accurate colour measurement, and consequently of matching colours, made possible by the use of Toussaint's photo-electric photo-colorimeter, is set forth, with many practical examples, in a clear way. It will generally be dyers and those dealing with fabrics who will find it useful.

The uncertainty that must always be associated with eye observations, because of the variations of colour sensitiveness even in the same eye, is eliminated by the use of a photo-electric cell through which an electric current is passed and upon which impinges the light reflected by or transmitted through the substance the colour of which is to be measured. The readings therefore are of the position of a spot of light on a scale, as customary in the use of a reflecting galvanometer. The light that impinges on the sample passes through one or other of (generally) six Wratten-Kodak monochromatic filters transmitting known wave-lengths. Violet, blue, green, yellow, orange, and red are appropriate colours, and the results are plotted on a prepared form of wave-lengths as compared with the same light as reflected from a white surface of plaster of Paris, or better, as more uniform, barium sulphate, which is taken as 100. From these curves all the information required for practical purposes can be found by simple calculations, and these are fully illustrated. The volume is a manual for use in the works' laboratory.

In the Land of the Lion. By Cherry Kearton. Pp. 256+60 plates. (London: J. W. Arrowsmith, Ltd., 1929.) 10s. 6d. net.

MR. KEARTON is probably our oldest and best-known African picture shikari. Having given us "Photographing Wild Life Across the World", in which he recounts many 'hairbreadth escapes' and exciting incidents with denizens of the wild, the actions of which he tried to portray, he now presents us with a book to gladden the heart of the Nature lover, dedicated by the by to his wife, herself an author of repute. In its twenty short chapters the author has something to say about most of the animals of the African bush and many birds and insects. The best, perhaps, is his chapter on the white ant. Systematic natural history is not his strong point, but his light sketches of the doings, family life, and frolics of the larger animals, lion, elephant, giraffe, hippopotamus, rhinoceros, and many more, are excellent reading, and conjure up fascinating pictures of wild life in sun-scorched bush, river, and swamp.

The eighty-eight illustrations are mostly photographs from the author's film "Tembi", in our opinion one of the best Central African films yet produced. The magnificent photograph of equatorial glaciers and snowfields up in the clouds and far away is alone worth the cost of the book, which is tastefully got up and supplied with an efficient index.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Grating Errors and Electronic Charge.

AN investigation of the focal properties of small plane gratings has led to a discussion concerning the influence of grating errors on X-ray spectra obtained by means of plane gratings. It may be of some interest to give here a brief account of the results, as they are of some importance with respect to the accuracy of the value of the electronic charge deduced from X-ray measurements.

As is well known, a linear change of spacing along the grating gives rise to focal properties. Thus, the incident beam being parallel, the diffracted beam will be convergent or divergent according to the direction in which the spacing varies and the location of the spectral line with respect to the central image.

If, now, in the portion of the grating effective in the formation of the spectrum the spacing varies linearly only in one direction, this will be of no influence on the wave-length measurements, as the diffraction pattern (in the Fraunhofer case) is symmetrical and the principal maximum is in its proper position, that is, in the same position as the principal maximum of a perfect grating with a spacing equal to the mean spacing of the

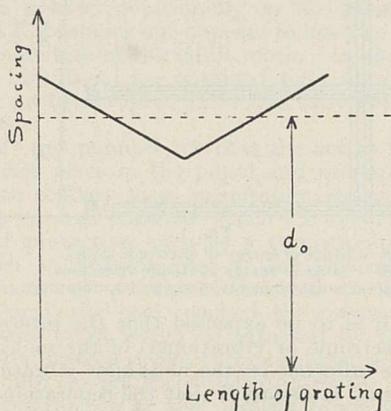


FIG. 1.

defective grating (see, for example, Sparrow, *Astrophys. Jour.*, 49, p. 65; 1919).

When, however, the effective portion of the grating contains certain regions where the spacing increases and other regions where it decreases along the grating, this may cause asymmetry and misplacing of the spectral lines.

A simple mode of demonstrating this is the following. We may, for example, assume that the spacing of the grating varies as in Fig. 1. Thus there is one portion of the grating where the spacing decreases linearly, and another, adjacent and equal in width, where it increases at the same rate along the grating. The diffracted beam from one portion will therefore converge to a real focus, and that coming from the other portion will diverge from a virtual focus behind the grating (see Fig. 2). Thus the maximum intensity

will be shifted in relation to the central beam of the bundle. A more detailed communication, where this point of view will be more closely discussed, will be published in *Zeitschrift für Physik* shortly. In each case the only method which is without doubt entirely free from objections is the exact calculation of the diffraction pattern, but this is a work of some difficulty for the less simple geometrical conditions of the X-ray spectrographs.

Now all gratings ruled with the aid of a screw are affected with periodical errors, where the period of the error is equal to the pitch of the screw. When the number of periods in the effective portion of the grating is large, we know from theory and experiment that ghosts will occur in the spectrum ('Rowland ghosts'). When, however, the number of periods is small—this

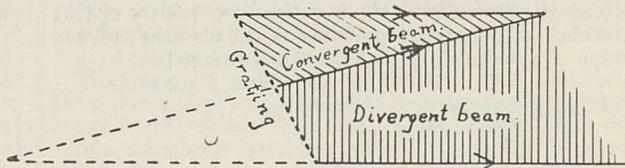


FIG. 2.

being the essential point in this account of the conditions—we may anticipate asymmetries of the kind above described.

As the pitch of the screws used in the common grating machines is about 1.2 mm. and the length of the effective portion of the grating is about 2-3 mm. in the case of the experimental arrangements of the X-ray measurements considered, it is clear that the number of periods is small and that the risk of asymmetry of the spectral lines really exists. (As a matter of fact it is necessary to work with small portions of the grating in order to avoid the correction originating from lack of parallelism of the beams. See Porter, *Phil. Mag.* (7), 5, p. 1067; 1928.)

In order to get some quantitative account I have calculated the diffraction pattern (in the Fraunhofer case) for the case shown in Fig. 1. The result is given in Fig. 3. The total number of lines in the grating is about 160. The maximum misplacing of a line (the misplacing at the ends and in the middle of the grating) in reference to the lines in a perfect grating of grating-constant d_0 is $0.12 d_0$, where d_0 is the mean spacing of the defective grating. Fig. 3 gives the amplitude as a function of wave-length. The vertical line denotes the position of the principal maximum for a perfect grating of grating-constant d_0 . Thus the principal maximum of the defective grating is shifted (in this special case about 0.0015λ), and the distribution of intensity in the total diffraction pattern is asymmetrical.

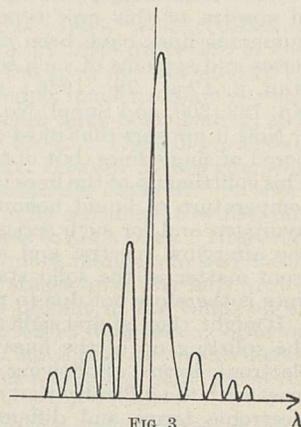


FIG. 3.

A general calculation of the shift of the principal maximum (in the conditions illustrated in Fig. 1) gives the following result:

$$\text{Error of wave-length } (\delta) = \frac{2 m_{\max}}{l} \cdot \lambda$$

where m_{\max} is the *maximum* misplacing of a line in the grating and l is the length of the grating.

For $l = 1$ mm. we get :

if $m_{\max} = 0.0005$ mm.	$a = 0.001 \lambda$
„ $= 0.00025$ „	$a = 0.0005 \lambda$
„ $= 0.0001$ „	$a = 0.0002 \lambda$

The X-ray measurements considered are, as said above, of considerable interest on account of their importance as regards the value of the electronic charge (e). Now a certain error in the wave-length gives rise to an error in e three times as large. From the above discussion it appears that the error in e originating from the grating errors is very likely to amount to values comparable to the total error in e stated by some authors. The object of this paper is thus to direct attention especially to the fact that the quality of the grating is of decisive importance to the accuracy of the value of e deduced from X-ray measurements.

SVEN FAGERBERG.

Physics Laboratory, University,
Upsala, Nov. 15.

New Types of Emission Spectra.

THE emission spectra which we observe in the visible and ultra-violet region are divided into line and band spectra, of which the first type corresponds to electronic changes of state of single atoms either in neutral or in an ionised state. The band spectra originate from molecules, and the energy quanta emitted in a certain spectral line draw their energy from three sources : (1) change of electronic orbits, (2) change of vibrational energy, and (3) change of rotational energy.

The study of the luminescence from solidified gases at very low temperatures has revealed a new type of spectra, which is a combination of electronic jumps and atomic oscillations, and we obtain a type of vibrational band spectra free from the influence of rotational energy. Since their discovery in 1924 (*Comm. Lab. Leiden*, No. 175) a considerable number of spectra of this new type has been studied, and numerous lines have been classified into vibrational series and systems of such series. (See, for example, *Ann. d. Phys.*, 79; 1926; and *Comm. Lab. Leiden*, No. 183, 200, and Suppl. No. 59.)

Now it appears that most of the series are not composed of single lines, but of two or more components. This splitting up of the lines is more pronounced at the temperature of liquid helium than at that of liquid hydrogen and for such series which appear strong in the afterglow spectra, and are undoubtedly emitted from matter in the solid state. The multiplicity of lines is therefore not due to rotational energy.

It might, then, at first sight seem reasonable to ascribe the splitting up of the lines to a multiplicity of the electronic terms. Following up this idea, however, we meet with the difficulty that series with quite different electronic terms and different principal vibrational frequencies show very nearly the same frequency difference between successive components. Thus the series called *C*, *D*, and *E* show a separation of about 45 cm.^{-1} , and about the same difference is found for the doublets of the ϵ -system. In the case of the principal series of the ϵ -system (the η -series), we find, under certain conditions, that the 'lines' are split up into 4-7 components, with an approximately constant difference between successive components of about 40 cm.^{-1} . The α -series gives a separation of 69 cm.^{-1} . A multiplicity of this type cannot be accounted for by the theory of electronic terms.

Now the α -form of solid nitrogen was shown (*Zeits. f. Phys.*, 58, 497; 1929. *NATURE*, Aug. 17, 31; 1929) to have a pronounced molecular structure, and the

atomic distance and dissociation energy of the molecular elements of the lattice were found to be approximately identical with those of the gaseous molecules. The ordinary oscillatory series correspond to atomic oscillations of the atoms of molecular elements in various states of electronic excitation. The strong binding between the two atoms of a molecule corresponds to the high principal vibrational frequencies of the order of magnitude $1200\text{-}2400 \text{ cm.}^{-1}$. But a molecule with vibrating atoms may itself be vibrating on account of the forces which bind the molecules in the crystal lattice, and which are closely related to the elastic forces of the crystal.

As the distance between the molecules is much greater than that between the atoms of a molecular

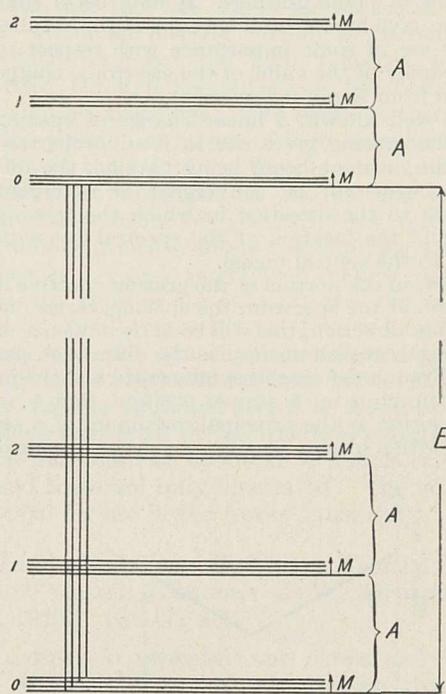


FIG. 1.

E —Change of energy of electronic states.
 A —Change of energy of atomic vibrations.
 M —Change of energy of molecular vibrations.

element, it is to be expected that the internal state (either electronic or vibrational) of the molecule will have little influence on the molecular vibrations, and thus we may understand that the separation of lines on account of molecular vibrations may be approximately the same for series corresponding to different internal states of the molecular elements.

Thus we are dealing with a type of spectrum where the frequencies are modified from the following three causes : (1) Change of electronic states. (2) Change of vibrational energy of the atoms of a molecular element. (3) Change of vibrational energy of the molecular elements in the crystal lattice.

The formation of a spectrum of this type is shown in Fig. 1.

L. VEGARD.

Physical Institute,
University, Oslo, Nov. 28.

Recovery from Parasitism.

THE pine shoot moth, *Evetria buoliana*, Schiff., one of the best known Lepidopterous pests of young Scots pine in Europe, has during the past decade been causing much concern by its increasing prevalence in the numerous young pine plantations in East Anglia. Just over a year ago a thorough study was begun of

the biology and forest relations of the species, the first results of which have been worked out. Amongst other things it has been found that a slight check is exercised on the increase of the insect by a number of different species of parasites which oviposit in the newly hatched caterpillars and the flight periods of which correspond roughly to that of the moths, and in this connexion an interesting fact has already been brought to light.

Caterpillars collected from different areas were bred out either to the adult moths or to parasites, and it was found that those which came from areas in which the percentage internal parasitism of the caterpillars was high, yielded some fertile moths which were much smaller than the 19 mm. wing-span given by Meyrick¹ as the minimum for the species. From others which came from areas in which the percentage parasitism was low, such small moths were extremely rare. For example, from 300 caterpillars parasitised to the extent of 80 per cent, 7 per cent of the emerging moths had a wing-span ranging from 13 mm. to 17 mm., while caterpillars parasitised to the extent of 70 per cent only gave about 2 per cent moths of the small type; and from caterpillars with a percentage parasitism of less than 60 per cent, only two small moths were bred out as against more than 400 of the normal type.

In considering the significance of these results, it has occurred to me that the prevalence of these small moths may be connected in some way with the high percentage of internal parasitism and that they may possibly be the results of a recovery from parasitism.

Recovery from parasitism by phagocytosis of the parasites' eggs or newly hatched larvæ has been described in detail by Timberlake,² and such recovery has been noticed occasionally in the young caterpillars of *E. buoliana* but appears to have no effect on the ultimate size of the adult moth. In the present case the results so far obtained tend to show that recovery probably takes place at a later stage in the life-history.

Tothill³ has pointed out that the active histolysis which takes place in the pupal and prepupal stages of a moth renders them unsuitable feeding grounds for those internal parasites which are devoid of some means of protection such as a trophamnion. It is easy then to imagine that if for any reason the development of a normal internal parasite was delayed until the host reached the prepupal stage, the parasite larva would be attacked by the active phagocytes, broken down, and its substance probably built up into the tissues of the adult moth.

Such retardation of the parasite larvæ was often noted when super- or multiple parasitism occurred. Caterpillars containing two or more living first-stage parasite larvæ which would have taken well over a month to develop, were found less than three weeks prior to the date of the last recorded emergence of the parasites. That these parasites would have emerged is highly improbable, and one must suppose, therefore, that in such cases there would be either a recovery from parasitism, or that total death by mutual exhaustion of the complex would have taken place.

The caterpillars are, however, only slightly retarded in their development by the presence of internal parasites, but after the first instar are invariably found to be smaller both in general bulk and in the measurements of the head capsule than unparasitised specimens of the same stage. This

makes it impossible to apply Dyer's law for the separation of the stages, to any but unparasitised individuals. From the above evidence it seems probable that a recovery from parasitism has taken place in the prepupal or pupal stage of the moth.

The type of small pupæ from which these moths emerged also showed a greater percentage mortality than the normal type, and if the hypothesis advanced is correct, it is natural that after a severe drain of blood plasma from the feeding of the parasite larvæ their vitality should be lowered.

No direct evidence of this recovery has been noted in the small amount of preserved material yet examined, but this need not be taken as negative evidence. The actual process may be very rapid, and as it only occurs in a small percentage of the caterpillars at a stage not yet definitely known, many hundreds of futile dissections may have to be made before one can expect results.

If it can be definitely established that recovery from parasitism can take place as suggested at a later stage in the host's life-cycle, it may throw light on many details of parasitic (internal) control of pests in general and account for their usual incompleteness in exterminating a host. It is generally considered that 100 per cent parasitism brings about total extinction, but such a percentage would involve a large proportion of supernumerary parasites which, causing mutual retardation, would allow a large percentage recovery of the host. In all probability the maximum mortality will occur when the host has a percentage parasitism of less than 100, but this maximum will never be 100 per cent in hosts in which such recovery occurs.

C. CRAWSHAW BROOKS,
Imperial Forestry Institute,
University of Oxford,
Dec. 6.

Occurrence of *Craspedacusta (Limnocoedium) Sowerbii* in the Exeter Ship Canal.

DURING the summer of 1928, while collecting Crustacea and other forms of fresh-water life in the Exeter ship canal, I had the good fortune on July 21 to find in a hand-net gathering, made midway between the Turf Hotel and Topsham ferry-boat landing, two small medusæ quite new to me. These I preserved, and later sent them to Mr. Edward T. Browne, who identified them as *Craspedacusta Sowerbii*. A short time later, Mr. Browne kindly sent me a tow-net, but the great difficulty then was to get a boat. However, I succeeded in obtaining more than a hundred specimens, ranging from early stages up to the fully grown adult. The medusa was present in the canal up to Sept. 8, when some early stages were taken. During the past summer (1929) I have been more successful, and have been able to get a suitable punt whenever I wanted one.

My studies in this interesting medusa have not been so complete as I could have wished, but I have published these notes in the hopes that others younger than I will be attracted to study the fresh-water life in this interesting canal.

According to Mr. P. C. De la Garde—"On the Antiquity and Invention of the Lock Canal of Exeter" in a letter from Philip Chidwell de la Garde, to Sir Henry Ellis, F.R.S., Secy.: Read Jan. 11, 1838. From *Archæologia*, 5, 28—the Exeter ship canal was completed about the year 1698 so far as Topsham. "In the year 1829", writes Mr. de la Garde, "... it was extended to Turf. It is now upwards of five miles and a half in length. It has two entrance locks, one at Turf and another opposite Topsham. Between these and Exeter it has only one lock, the old double

¹ E. Meyrick. "Revised Handbook of British Lepidoptera", 1927.
² P. H. Timberlake. "Experimental Parasitism", U.S. Department of Agriculture. Bur. Ent. Tech. Ser., No. 19, Pt. 5, 1912.

³ J. D. Tothill. "Natural Control of the Fall Webworm." Dom. Can. Dept. of Agric., Ottawa, Bull. 3, 1922.

lock altered and improved. . . . The Canal is 34 feet wide at the bottom, and 94 feet at the surface of the water, with 15 feet of water throughout. . . ."

This fresh-water canal, which receives its water from the River Exe, teems at certain seasons of the year with an abundance of microscopic life. Besides fish of various species, *Paludina vivipara* and *Dreissena polymorpha*, two most interesting molluscs, are always present; while *Cristatella mucedo* can be found in the higher parts of the canal; *Plumatella repens* and *Cordylophora lacustris*, near the Topsham lock gate.

It is interesting to record that, up to the present, I have been unable to make one addition to the lists of fresh-water Crustacea recorded by Canon Norman and Thomas Scott in "The Crustacea of Devon and Cornwall".

Owing to ill-health, I was unable to commence my fresh-water collecting until July 8 last, when no medusæ were to be found. My next collecting trip was made two weeks later, when I found the medusæ plentiful. Surface temperature 65° F. From that date until Oct. 14, medusæ were present in varying numbers. On Sept. 5 the surface temperature was 72° F. and the canal was found swarming with medusæ; they were so abundant that one could see them with the naked eye. From that day until the fall of the year, the medusæ gradually decreased in numbers. On Oct. 1 not more than twenty medusæ were caught, surface temperature being 60° F., and on Oct. 14 they vanished for the year, surface temperature being 57° F. Although I have collected at various points along the whole canal, I have not found any medusæ above the double lock.

According to my observations there appear to have been at least four distinct broods of medusæ in the canal during the past summer on or about the following dates: July 20, Aug. 24, Sept. 5 and 19.

All the specimens taken were males, and a special search was made for its hydroid, known as *Microhydra*, without success, but it must be somewhere in the canal.

Both the hydroid and its medusa have been found in streams and ponds in the United States, but this is, so far as I know, the first time the medusa has been taken under natural conditions in Europe, where it has been found under artificial conditions; usually in warm water tanks belonging to botanical gardens.

RUPERT VALLENTIN.

12A Alexandra Terrace,
Bath Road, Exeter.

Magnetic Moments of Atomic Nuclei.

THE hyperfine structures of atomic spectra are considered as due to the interaction of the nuclear spin with the electronic orbital and spin moments. A theoretical calculation of this interaction enables one to obtain information on the magnitude of the magnetic moments of the nuclei from the separation of the hyperfine structures. This can be done for the case of the alkali atoms. Hargreaves (*Proc. Roy. Soc.*, **124**, 568; 1929) has calculated the separation due to a nuclear moment $h/4\pi$ for the case of atoms with only one electron. In his calculations, however, the interaction between the electronic and nuclear spins, which is of the same order of magnitude as the other terms, has been neglected. I have therefore carried out the calculations with the following improvements. For the s -terms, which is the most important case, since they give the largest contribution to the separation, I have used Dirac's theory of the electron, since the simpler Pauli's theory gives a wrong result. For the p -terms I have used Pauli's method, taking into account the interaction of the nuclear and electronic spins. For the p -terms it is not necessary to evaluate numerically the eigenfunctions, since the constants

involved in the formulæ can be derived from empirical data on the separation of the electronic spin doublets. For the s -terms this is of course impossible, and I have calculated the eigenfunctions by the statistical method.

If the mechanical and the magnetic moments of the nucleus are respectively $kh/2\pi$ and μ_0 , one finds that the s -terms split into two components with a separation

$$(1) \quad \Delta = \frac{2k+1}{k} \frac{8\pi}{3} \mu\mu_0 \psi^2(0),$$

where μ is Bohr's magneton and $\psi(0)$ is the value of the normalised eigenfunction at the origin. The separation of the p -terms is much smaller. Each line of the principal series of the alkalis splits, therefore, into two components with the separation Δ , each of them having a finer structure, which is not resolved, and gives rise to small differences in the observed separation for the different lines. The ratio of the intensities of the two components is $(k+1)/k$, the weaker component being shifted towards the violet. The ratio of the intensities is also 3, 2, 5/3 . . . 1 for $k=1/2, 1, 3/2, \dots, \infty$.

For caesium one finds, in wave numbers,

$$\Delta = 146 \frac{\mu_0}{\mu} \frac{2k+1}{k},$$

and for sodium

$$\Delta = 13.4 \frac{\mu_0}{\mu} \frac{2k+1}{k}.$$

The observed values are, for caesium (D. A. Jackson, *Proc. Roy. Soc.*, **121**, 432; 1928) $\Delta=0.3$, and for sodium (H. Schüler, *Naturwiss.*, **16**, 512; 1928) $\Delta=0.06$ wave numbers. From this, on the assumption of the values $1/2, 1, 3/2, \dots, \infty$ for k , we obtain the following values for the ratio μ/μ_0 of the Bohr magneton to the magnetic moment of the nucleus:

$k =$	1/2	1	3/2	∞
Caesium	1950	1460	1300	980
Sodium	890	670	600	450

From the observed ratio of the intensities in sodium one should expect a probable value for k of 1 or 1/2.

The uncertainty of the given values arises from the lack of precision of the empirical data and from the application of the statistical method to the evaluation of the eigenfunctions. This latter source of error might be evaluated to within 20 or 30 per cent.

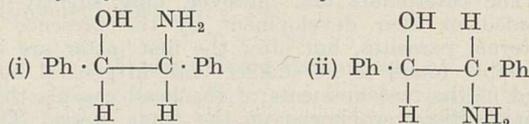
Further details will be published later.

E. FERMI.

Physical Institute of the University,
Rome, Dec. 4.

Optically Active Diphenylethylene Oxide.

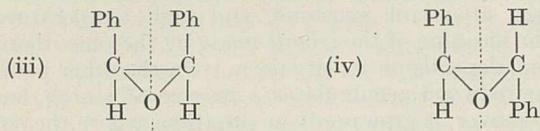
WE have recently been able to obtain optically pure d - and l -isohydrobenzoin, $\text{Ph} \cdot \text{CH}(\text{OH}) \cdot \text{CH}(\text{OH}) \cdot \text{Ph}$, by the action of nitrous acid on d - and l -isodiphenylhydroxyethylamine (*Jour. Chem. Soc.*, 1929, 2305). This result might be considered to point to configuration (ii), rather than (i), for isodiphenylhydroxyethylamine, except for the circumstance that l -isohydrobenzoin is furnished in this way by d -diphenylhydroxyethylamine as well as by the l -isobase:



In order to settle the ambiguity, we have now prepared specimens of 2:3-diphenylethylene oxide from each of these bases, through the quaternary ammonium hydroxides, $\text{Ph} \cdot \text{CH}(\text{OH}) \cdot \text{CH}(\text{NMe}_3\text{OH}) \cdot \text{Ph}$. The

optically active and externally compensated forms of the *isobase* yielded an identical optically inactive diphenylethylene oxide, which therefore corresponds to the *cis*-configuration (iii), with a plane of symmetry (indicated by the broken line). *d*-Diphenylhydroxyethylamine, however, gave a strongly *levo*-rotatory oxide, to which the *trans*-configuration (iv) must be assigned. It follows that the relative molecular configurations allocated to the above bases by Erlenmeyer in 1899 must be reversed, the base and the *isobase* being represented by (ii) and (i), respectively. We propose to explore further this valuable general method for determining the relative molecular configurations of such substances.

The stereoisomeric diphenylethylene oxides present several features of unusual interest :



The *trans*-form (iv) is an example of the simplest type of cyclic structure which can give rise to dissymmetry of molecular configuration : it will be noticed that the assemblage of five single atoms carrying two identical radicals still displays axial symmetry, although a plane of symmetry is no longer present. These simple structural constituents may be compared instructively with the four single atoms and one group of the simplest known acyclic dissymmetric compound, chloriodomethanesulphonic acid, that is, $\text{CHCl} \cdot \text{SO}_3\text{H}$. The specific rotatory power of the *l*-form of the above oxide (iv), observed in absolute alcohol for sodium light, exceeds -300° , while the corresponding value for *l*-isohydrobenzoin (its configurational analogue) is only -92° : thus, the optical effect of the 3-membered ring is strikingly apparent. The extraordinary stability of these well-defined crystalline oxides is in keeping with the views of Thorpe and Ingold on the effect of substituents in relieving the strain inherent in small rings.

Other compounds of the same general type which we are at present investigating exhibit an equally pronounced stability ; among them, the *cis*-form of 2 : 3-dianisylethylene oxide has been obtained by the direct interaction of nitrous acid and the corresponding dianisylhydroxyethylamine, as well as from the same base by the general method indicated above. Details of these studies and of further work directed towards the preparation of optically active ethylene oxides, containing aromatic or aliphatic substituents, will be published elsewhere.

JOHN READ.
ISHBEL G. M. CAMPBELL.

The University,
St. Andrews.

Do Oceanic Plankton Animals Lose Themselves ?

RECENT researches into the behaviour of plankton animals in the sea as to their vertical movements from day to day indicate that light intensity is an important factor. The animals appear in Nature to be brought around an optimum intensity by some tropistic mechanism and, assuming this, there seems likely to be a lower limiting or threshold intensity below which no stimulation takes place. Such, indeed, appears to be the case at night with animals living in our shallower offshore waters, when, with the release of the light stimulus in darkness, they are free to roam anywhere and become evenly distributed throughout the water layers, within the limits of other controlling factors such as temperature and salinity. This lower threshold intensity idea receives

support from a paper published in 1926 by two Japanese workers, M. Tauti and H. Hayasi (*Jour. Imper. Fisher. Instit.*, Tokyo, vol. 21, No. 4, p. 42), who found that if a light be projected at night vertically downwards into the water, fish swimming in numbers deeper in the water are only attracted individually to the light when by random movements they swim upwards into a certain threshold intensity.

In view of these observations, the suggestion arises whether certain plankton animals which normally live in light of moderate intensities near the surface, but are to be found also in the deep, dark layers of the open ocean, are not, so to speak, lost in these latter layers. Have they moved out of their normal light zone, perhaps at night, and reached layers at which the intensity is below the threshold, thus to be doomed to everlasting night until perchance by random movements one bright day they swim once more into the threshold intensity zone and are attracted upwards to their optimum intensity ?

F. S. RUSSELL.
Marine Biological Association,
Plymouth.

Magic Square of Fifth Order.

I VENTURE to send you what I believe to be a very rare magic square of fifth order. Although there are more than 260,000 bordered squares of fifth order with the number 13 in the centre of the square, it seems a very rare thing indeed for any other number than 13 to be in the centre. I have not found any with the

23	20	10	4	8	
22	2	16	18	7	36/29.
14	13	17	6	15	Magic
5	21	3	12	24	number
1	9	19	25	11	65.

usual proportion (39/26) between the Row of the Heart and the rest of the Row, and it was not until the proportion 36/29 arrived that I found it was possible to make one. I append the square. Subtracting each number from 26 will give the proportion 42/23. I believe there are only two (not including inversions) with 17 in the centre of the square.

J. C. BURNETT.
Barkston, near Grantham, Dec. 2.

Legitimate Uncertainty.

ADVANCE of inquiry into fundamental tracts of Nature is often perforce conducted by means of symbolism. The comprehensive character of the symbols counts for increase of knowledge, even though their physical interpretation is still shrouded in uncertainty. Thus it is that, for example, Prof. Eddington, on page 291 of "The Nature of the Physical World", amusingly sums up our present knowledge of electronic operations inside atoms by saying : "Something unknown is doing we don't know what—that is what our theory amounts to". Similarly the sentences quoted from one of my books, at the end of a review on page 942 of NATURE for Dec. 21, should be understood, not as a hopeless and helpless admission of ignorance but as a scrupulously fair and cautious stage in the advance of knowledge ; for it is no gain to science to attempt the formulation of a nascent theory prematurely.

OLIVER LODGE.
Lake, Salisbury.

Cycles in Natural Phenomena.

IN December 1922, Dr. Merriam, president of the Carnegie Institution of Washington, called a conference to discuss the question of 'cycles'. The report of this, and of a second conference held in December 1928, have now been published by the Carnegie Institution,¹ and the two reports form a stimulating contribution to the subject. The members took a very broad view, which was set out by F. E. Clements in an introductory paper as follows: "It seems desirable to use cycle as the inclusive term for all recurrences that lend themselves to measurement, and period or periodicity for those with a definite time interval, recognising, however, that there is no fixed line between the two. On this basis there can be no question of the existence of climatic and other cycles, though there may be the gravest doubt of the reality of periodicities in climate beyond that of the year."

The greatest emphasis naturally falls on cycles of climate, which underlie most known cycles of other terrestrial phenomena, such as crops and prices, growth of plants, and fluctuations in numbers of animals, while climatic cycles are themselves most probably reflections of cycles of solar activity. Unfortunately, however, the systematic observation of climate is of comparatively recent growth, and very few homogeneous series of meteorological records exceed one hundred years. This is sufficient for the accurate study of weather periodicities of a few years in length, but is quite inadequate for the determination of longer cycles, from twenty or thirty years upwards. The meteorological records, for example, have hitherto proved insufficient to determine the real nature and extent of the well-known Brückner cycle of about 35 years.

On the other hand, there exist several natural agencies which have the power to integrate the meteorological conditions during a period of a few months or a year, and register the results in some permanent form. The two most notable of these agencies are trees, which by the width of their annual rings show their rate of growth during each of a long succession of years, and melting glaciers, which leave behind them records of the volume of thaw water.

The investigation of the annual rings of trees has found its home in the United States, where it is associated especially with the name of A. E. Douglass, who in 1922 was able to present conclusions based on the dating and measurement of more than 110,000 rings in nearly 500 trees, all carefully collated and compared. It has been generally accepted that in the dry climate of Arizona and California the redwood, *Sequoia*, grows most rapidly in relatively rainy seasons, but the nature of the relationship between tree-growth and weather is examined more closely in a paper read at the 1928 conference by O. T. MacDougal. Since 1918, MacDougal has been obtaining measure-

ments by means of the 'dendrograph', an instrument which makes a continuous record of the diameter of a tree between two contact points on opposite sides of the trunk.

The trees chiefly examined were the Monterey pine and the coast redwood. From the records illustrated, it seems that the pine grows most rapidly in late spring; the tree forms no reserve of starch, and in a dry situation the growth is closely related to the rainfall of the preceding winter. If abundant soil moisture is available, however, growth is greatest in dry years with few fogs, abundant sunshine, and high temperature. The meaning of the record made by the pine, therefore, depends on its situation. On the other hand, the redwood accumulates a reserve of starch, and moreover, it grows only in situations where the soil moisture does not fall below a certain percentage. Hence the correlation between the width of the annual rings and the rainfall in individual years is smaller than with the pine, but the redwood gives an excellent measure of the long-period fluctuations of rainfall. It also seems probable that temperature plays a more important part in the growth of the redwood than that of the pine.

On the whole, the pine is probably the better index of rainfall, but it is relatively short-lived. Four of the Sequoias measured began their existence more than 3000 years ago, but few pines go back more than 500 years, the oldest covering a period of 640 years. This difficulty has been partly overcome by the use of historic and prehistoric material, and the available pine records now cover two nearly equal periods, totalling about 1255 years, but unfortunately separated by a gap of unknown duration. When this gap has been filled, the whole series will become a continuous climatic record of the highest value.

The harmonic analysis of a very long series of data is a laborious occupation, and for the purpose of studying the variations of his tree measurements, in 1913 Douglass invented an ingenious optical instrument for determining the lengths of periodicities. A large instrument with photographic attachment was constructed with a fund given by Mr. Clarence G. White, and the instrument has been termed the 'White Cyclograph'. The earlier form suffered from the disadvantage of a rather limited range, the longest periodicity which could be determined being only seven times the shortest, but in an improved form described at the 1928 conference a device is incorporated which more than doubles this ratio. The principal result obtained up to the present is that most of the cycles of growth shown by the western tree-rings are probably simple fractions of a Brückner cycle of 34 years.

Another series of data which may prove of value is that relating to waves of infectious diseases, discussed by Dr. W. C. White. These may be related to cycles of solar radiation of various wavelengths, but very little is yet known as to the nature of the relationships, and the conclusion

¹ "Reports of the Conferences on Cycles." Pp. 83. (Washington, D.C.: Carnegie Institution, 1929.) Free on request.

reached is that there is a greater likelihood that a knowledge of weather cycles will help the study of preventive measures against disease than that a knowledge of the history of epidemics will further the study of weather cycles.

The view has often been expressed that by far the greater number of weather cycles will prove to be intimately related to cycles of solar variation. Unfortunately, only one of the latter can be regarded as fairly established, namely, the double sunspot period of $22\frac{1}{2}$ years. The shorter cycles which are believed to exist in solar radiation are not well shown by the sunspot numbers, and reliable measurements of solar radiation do not yet cover a sufficiently long period to give conclusive results. At the second conference, C. G. Abbot presented the results of the harmonic analysis of 100 months of data ending in October 1928, but probably the only periodicity so found which has any claims to reality is that of 25 months (an inspection of the author's diagram suggests that the real periodicity is slightly longer, perhaps 26 months). It seems that we shall have to wait many years for a full study of the periodic variations of solar radiation based on a sufficiently long series of observations.

The greatest mass of material awaiting systematic periodogram research is to be found in the deposits left by the waters issuing year after year from the ends of the glaciers. These waters deposit a fine clay, but the winter deposit, when the glacial streams are at a minimum, differs in colour and texture from that of the streams swollen by the summer thaw. Hence the layer added each year can be readily detected and its thickness measured, giving what is essentially a representation of the average summer temperature. These glacial deposits have been carefully studied by de Geer, Antevs, and others in Scandinavia, Finland, North America, the Argentine, and the Himalayas, and in Scandinavia it has proved possible to connect up the deposits with those forming at the

present day and so obtain an accurately dated series of measurements covering a period of more than 20,000 years.

Hitherto, statisticians have quailed before the immense task of analysing this record for periodicities, and in his paper Antevs quotes only two determinations, both rather casual. In the Argentine series periodicities of 5.1, 10.4, and 51 years were found, while in the North American series there is a strongly marked periodicity of two years, besides others of three to eight years. Neither investigation discovered the eleven-year sunspot cycle, a remarkable result which is at variance with the claim of de Geer, embodied in his title "the solar curve", that the series of clay thicknesses is a measure of the variations of solar radiation from year to year.

This does not exhaust the possibilities of wresting from Nature detailed evidence of her past vicissitudes. Peat bogs in many countries enshrine the history of post-glacial vegetation, and though by its nature this record cannot be made to give numerical annual values comparable with those from the trees or the glacial clays, it should—when it is fully understood—provide valuable information as to the longer sweeps of climate, which will form a base-line for the variations of shorter period revealed by the more detailed sources.

From the reports as a whole, it appears that on all sides forces are being marshalled for a combined attack on the weather changes in post-glacial times, which cannot but throw much light on the changes in process at present. As Dr. White phrased the problem in the discussion, "Surely it should be possible by careful planning and co-ordinated study to construct relatively complete records from the present year backward into Pleistocene time, though that is but a beginning of the baffling if not insuperable task of constructing a continuous record that will reach back into the Tertiary".

C. E. P. B.

Recent Work on Yellow Fever.

THE opening address of the Cambridge Philosophical Society on Nov. 11 last was delivered by Prof. E. Hindle, the Beit research fellow in tropical medicine, who gave an account of recent work on yellow fever. The paper for the most part was a description of experiments on yellow fever which have resulted in his discovery of a method of vaccination against this disease.

West Africa is now the main endemic centre of yellow fever, although serious epidemics have occurred in Brazil during the year 1929. A new era in the study of the disease was opened by the discovery in 1927 by Stokes, Bauer, and Hudson, that Asiatic monkeys, and especially *Macacus rhesus*, can easily be infected with yellow fever. Afterwards, Dr. Adrian Stokes working at Lagos, and also Drs. Young and Noguchi at Accra, died of yellow fever acquired in the course of their investigations. Prof. Hindle described how he

succeeded in getting the virus of the disease brought back to London. Pieces of the liver of an infected monkey in Senegal, killed at the height of the disease, were kept frozen during the voyage to London, a period of 12 days, and with this material the disease was reproduced in England at the end of March 1928. Since that date, the strain has been maintained by Prof. Hindle at the Wellcome Bureau of Scientific Research and has been distributed to laboratories in Paris, Berlin, and Amsterdam. The method consists of keeping the virus frozen, in which form it will survive for three to four weeks, or preferably to dry infected blood or tissues *in vacuo*, and keep it in the presence of a desiccating agent, when the virus will survive for 3-4 months. Monkeys can easily be infected by the inoculation of blood or liver from an infected animal, and 1/1000000 c.c. of infected blood has been found sufficient to produce infection.

Transmission experiments with both Indian and West African races of *Aedes ægypti* (*Stegomyia fasciata*) reared in England have shown that the disease can easily be transmitted from infected monkeys to normal animals by the bites of these insects, on condition that an interval of at least 9 days at 28° C. is allowed to lapse after the infective feed. During this incubation period the virus has been found to be constantly present, not only in the gut, but also in the coelomic fluid, as determined by inoculation experiments into susceptible monkeys. Once infected, a mosquito remains infective for the duration of its life, and, moreover, it was found that this infectivity persists even if the temperature is continually below 18° C. Formerly, it was supposed that the distribution of the disease was restricted by the mosquito being unable to transmit the infection below a certain temperature, but Prof. Hindle's experiments show that this view can no longer be maintained. The results of experiments with the Indian race of *Aedes* constitute the first proof that they are capable of transmitting yellow fever, and it is evident that if, by any ill chance, this disease ever reached the Orient, the local race of mosquitoes could serve as efficient carriers.

It has been known from early times in the history of the disease that an attack is followed by a high degree of immunity, and the serum of convalescent patients, if inoculated into monkeys, will protect them against infection for a period of about one month. The presence of active immune bodies in the blood of recovered patients furnishes a means of finding out whether a person has had the disease, for it is only necessary to inoculate a rhesus monkey with the serum of a suspected case and at the same time with yellow fever virus. Employing these methods in West Africa, the Rockefeller Commission had detected the existence of yellow fever in villages where no obvious signs of the disease were present.

Employing these methods, the nature of two atypical cases of yellow fever contracted in the laboratory in London was discovered. In both patients (Prof. Hindle and his laboratory attendant), the symptoms, a sharp fever of short duration, closely simulated, and at the time were attributed to, influenza. After the fever, however, in both cases the blood contained immune bodies against yellow fever, as tested by inoculation into monkeys, and therefore there can be no doubt that they had both had an attack of this disease.

It may be added that jaundice and albuminuria, although looked for, were not detected, and the only characteristic symptom was hyperæsthesia of various parts of the body in one patient which persisted for 3 to 4 weeks. These results, combined with the production of immunity by the inoculation of sub-lethal doses of virus, furnish additional evidence in support of the view that mild cases of yellow fever may occur which present none of the ordinary symptoms of the disease. These cases would never be recognised in the ordinary course of events, but would be capable of infecting mos-

quitoes that fed on them and thus maintain the infection in a latent or hidden form.

An interesting case of tissue immunity was described. The liver and spleen of monkeys that have recovered from yellow fever, when inoculated into normal monkeys in 1 gm. doses, immunised them against subsequent inoculations of fresh virus. The brain, kidney, and lymphatic glands of convalescent monkeys did not possess this property. The inoculation of hyperimmune serum into infected monkeys, after the commencement of fever, had no obvious effect on the course of the infection, and consequently there is doubt as to the value of serum treatment in human cases of yellow fever.

Great hopes had been placed on Noguchi's vaccine prepared from *Leptospira icteroides*, erroneously supposed by him to be the causative organism of yellow fever. It is now known that this organism is identical with that of spirochætal jaundice, therefore the vaccine prepared from it can have no value in yellow fever prophylaxis and its use has been abandoned.

Prof. Hindle decided to apply methods of vaccination which have proved successful in the production of vaccines against such diseases as fowl plague, dog distemper, etc. In June 1928 (*Brit. Med. Jour.*, June 9, 1928) he showed that a phenol-glycerine emulsion of the liver and spleen of infected monkeys confers a very high degree of protection against very large amounts (10,000 to 100,000 lethal doses) of the virus. A formalinised suspension shows the same vaccinating property. During the past eighteen months these experiments have been extended and full details were given of the method of preparing this vaccine. The earlier phenol-glycerine vaccine has been replaced by a formalinised one, as the infection of glycerine is painful.

The present method of preparing the vaccine is as follows: The liver is removed from an infected monkey killed in the last stage of the disease, when the temperature begins to fall. The organ is weighed and ground up in a mortar with fine sand. A measured quantity of 9 per cent salt solution, equal to half the original weight of the tissue, is added and the mixture allowed to stand for a few hours. Then distilled water is added equal to nine times the volume of the strong salt solution. As a result, all the cells are cytolysed liberating the contained virus, and one obtains a 20 per cent suspension of tissue extract in normal saline. This suspension is allowed to sediment, then filtered through muslin. Part of it is tested for virus content, and a 1 in 10,000 dilution of the original tissue should produce a fatal infection in a monkey.

The virus suspension is killed by the addition of 1 to 2 per 1000 formaldehyde, and after twenty-four hours can be used as a vaccine, if it passes the usual sterility tests.

Both phenol-glycerine and formalinised vaccines, when kept in the ice chest, have been found to preserve their properties for some months. The first has also been dried *in vacuo*, after removing

the glycerine by dialysis, and found to retain its properties.

Monkeys inoculated with these vaccines show a high degree of protection against yellow fever, and this protection has been tested against the inoculation of fresh virus and the bites of infected mosquitoes up to $4\frac{1}{2}$ months after vaccination, without showing any signs of diminution. In the majority of cases, about ten days after being vaccinated the monkeys were inoculated with 0.1 gm. infected liver material, equivalent to 1000 to 10,000 lethal doses, and in some instances with very much greater quantities of virus.

These results have been confirmed by Pettit and his collaborators working in Paris, and Aragão in Rio de Janeiro, who used a Brazilian strain of yellow fever. Aragão obtained constant protection in monkeys, and therefore tested the vaccine in human beings, using a 20 per cent suspension of liver, spleen, brain, and kidney containing 2 per 1000 formaldehyde and 0.5 per cent phenol. This vaccine was administered subcutaneously in 2 c.c. doses to the laboratory workers at the Institute Oswaldo Cruz, with no ill effects, and afterwards used in a small epidemic of yellow fever. Between three hundred and four

hundred people were vaccinated, including the health officers working in the infected neighbourhoods, and people living either in the same house or the vicinity of yellow fever cases. Although no unwarranted conclusions were drawn, none of the vaccinated contracted the disease, although some of them must have been exposed to infection.

The use of this modification of Hindle's vaccine has now been adopted by the Public Health Department of Brazil, and during the epidemic in Rio de Janeiro early in 1929 approximately 30,000 persons were vaccinated against yellow fever.

In West Africa, there is urgent need for some additional method of protection against yellow fever, as evidenced by the number of past epidemics, for at present there seems to be no likelihood of anti-mosquito campaigns succeeding in eradicating all chance of infection. Accordingly, the British Colonial Office, and also the French and Belgian Governments, have decided to test this vaccine in their West African colonies.

Prof. Hindle is of opinion that, by the general use of a vaccine of this nature of proved efficiency in monkeys, there is every hope of yellow fever ceasing to be a source of danger in the world.

Scientific Centenaries in 1930.

THOUGH the year 1930 will not see the commemoration of any scientific centenary of such widespread interest as that of Faraday's discovery of electromagnetic induction, which will be celebrated in 1931, the year will recall a number of eminent men who have made notable contributions to many departments of science.

The most famous name which appears among the centenaries for 1930 is that of Kepler, who died on Nov. 15, 1630, at the age of fifty-eight years. Kepler forms a link between the sixteenth and seventeenth centuries. Among those born in 1630 were the German chemist, Kunckel (1630-1703), who assisted in emancipating the literature of chemistry from the mysticism of alchemy, and Isaac Barrow (1630-1677), Gresham professor of geometry, first Lucasian professor at Cambridge and master of Trinity College, teacher and predecessor of Newton and one of the greatest religious scholars of his time. Another name, also associated with Cambridge, is that of Thomas Plume (1630-1704), vicar of Greenwich and archdeacon of Rochester, whose preaching appealed to Pepys and Evelyn, and who, through reading Huygens' "Cosmotheoros", recommended to him by Flamsteed, left funds for erecting an observatory at Cambridge and for maintaining a professor of astronomy and experimental philosophy. The first to become a Plumian professor was Roger Cotes, while the first observatory founded through Plume's generosity was over the King's Gate of Trinity College.

The work of the eighteenth century is recalled by the names of Bezout (1730-1783), a mathematician of distinction; of Bochart de Saron (1730-1794), one of the first astronomers to suggest that Her-

schel's newly discovered body was a planet, and one of the French men of science who perished beneath the guillotine; of Messier (1730-1817), Louis XV.'s 'comet ferret', regarded at one time as the leading practical astronomer in France; and by that of Bossut (1730-1814), friend of Condorcet, D'Alembert, Baily, and Lavoisier, a pioneer in the study of hydrodynamics and one whose work contributed to the improvement in the sailing qualities of the ships of the French Navy.

Other scientific workers also born in 1730 include the English amateur astronomer, Aubert (1730-1805), the intimate of Smeaton, Banks, and Herschel; Josiah Wedgwood (1730-1795), the Boulton of the pottery industry; Ingenhousz (1730-1799), the Dutch physicist who spent the latter part of his life in England; and Duhamel (1730-1816), to whom France is indebted for improvements in steel-making.

Of men of science who died a hundred years ago, Fourier (1768-1830) was the most famous. His "Théorie analytique de la chaleur" appeared in 1822, and it was Comte who predicted that when Fourier's doctrine was better known much use of it would be made in other branches of physics. If Fourier recalls the golden age of French mathematics, the name of Cremona (1830-1903) brings to mind one who, last century, reorganised mathematical instruction throughout Italy. His birth took place on Dec. 7, 1830, and to 1830 also belong the names of H. A. Newton (1830-1896), both mathematician and astronomer; Carl Bruhns (1830-1881), friend of Encke and Galle, and director of the Leipzig Observatory; and the three eminent chemists, Raoult (1830-1901), recipient of the Davy Medal in 1892; Bemmelen (1830-1911),

who contributed to the founding of the Dutch school of physical chemistry; and Lothar Meyer (1830–1895), best known for the share he had in the periodic classification of the elements, and whose memorial lecture before the Chemical Society was delivered by Prof. Bedson in 1896.

The year 1830 also witnessed the death of Major James Rennel (1742–1830), the eminent geographer, who is buried in Westminster Abbey; of Richard Chenevix (1774–1830), the Irish chemist and mineralogist, whose name, like that of Rennel, is in the list of Copley medallists; and of Henry Bell (1767–1830), the steadfast but unfortunate promoter of steam navigation, whose *Comet* was

the forerunner of the *Mauretania*; and it also saw the birth of David Edward Hughes (1830–1900), inventor and physicist, founder of famous scientific prizes and benefactor of the London hospitals; of Sir Edward Reed (1830–1906), the most prominent naval architect of his time; and of Gerhard von Rath (1830–1888), the Bonn mineralogist. It also was marked by the founding of the Royal Geographical Society, while in January 1830, Lyell, then thirty-two years of age, published the first part of his "Principles of Geology", that classic which Geikie said "must form an early part of the reading of every man who would wish to make himself an accomplished geologist".

News and Views.

SUPPLEMENTING our article entitled "Pleistocene Man in China" in NATURE of Dec. 28, 1929, p. 973, we are informed that Prof. Davidson Black has cabled from Peking (or, as the Chinese Government now calls the city, Peiping) on Dec. 28 as follows: "Recovered Chou Kou Tien uncrushed adult *Sinanthropus* skull entire except face letter follows". This presumably is a correction of the unofficial cablegrams that appeared in the newspapers on Dec. 15 and 16 mentioning "a complete skull with both the cranial and facial bones perfectly preserved". Prof. Davidson Black's promised statement was made at a meeting of the Geological Society of China held on Dec. 28. According to a message in the *Times* of Dec. 30 from its Peking correspondent, the credit for the actual discovery lies with a young Chinese geologist, Mr. W. C. Pei, who is in charge of the field work of the Geological Survey at Chou Kou Tien. Some four tons of fossils have been excavated, including parts of two lower jaws, several teeth, and cranial fragments of man. Among the mammalian remains is included the sabre-toothed tiger, which is contemporary with Peking Man. The evidence would appear to point to a very high antiquity indeed. Dr. Grabau, of the Chinese Geological Survey, is said to assign the skull to the beginning of the Quaternary Age, while that well-known authority on Chinese geology and archæology, Père Teilhard de Chardin, gives it an estimated antiquity of 400,000 to 500,000 years. If either of these estimates is confirmed, it would place this relic at comparatively little later than *Pithecanthropus* of Java. The skull is at present embedded in hard travertine, but the right side and vault have been freed by the removal of a relatively softer part of the matrix. It would appear that while the whole of the facial region is lacking, the brain case is almost complete and massive jaw sockets have been exposed. The brow ridges are also said to be massive. As compared with the Java skull, the length is approximately the same, but relatively there appears to be greater brain capacity.

We propose to publish week by week throughout this year a calendar of historic natural events; and the first set of notes in this series appears on pp. 32, 33. It is intended to include in the weekly record as wide a range as possible of remarkable natural occurrences

and phenomena observed in past times. Great storms, floods, frosts, and similar meteorological phenomena will naturally make up a large part of the collected events, and notable earthquakes, volcanic eruptions, and like terrestrial disturbances will also frequently come into the calendar. Whatever has commanded scientific attention on the earth or in the heavens—including of course the appearances of new stars, bright comets, and meteor showers—will, it is hoped, be brought back to memory under their appropriate dates during the year. Events in the natural history or biological field are more difficult to assign to particular dates, and we shall be grateful to any readers of NATURE who will assist us with references or notes upon remarkable occurrences of this kind. Without such aid it will be difficult to make the historic records so comprehensive as we should like them to be.

THE material for the calendar will be derived from a great variety of sources, too numerous to mention individually. Special reference should be made, however, to the *Quarterly Journal of the Royal Meteorological Society*, the *Meteorological Magazine*, Dr. C. Easton's work, "Les hivers dans l'Europe occidentale" (Leyden, 1928), W. Andrew's "Famous Frosts and Frost Fairs in Great Britain" (London, 1887), and a manuscript collection of extracts from the Saxon Chronicle and Holinshed's Chronicles, compiled by the late Miss Eleanor A. Ormerod and now in the possession of the Royal Meteorological Society. In compiling the records, the dates employed have been those of the actual calendar in use at the time. It will be recalled that, in 1752, eleven days were added to the date in the British Isles, Sept. 2 being directly followed by Sept. 14, in order to bring the calendar into conformity with that introduced by Pope Gregory XIII.

In the second week of this month the centenary of the discovery of the Murray River by Captain Charles Sturt will be commemorated by representatives of South Australia, New South Wales, and Victoria, who will meet at Wentworth on Jan. 7. The next day the delegates will witness the opening of No. 6 Lock, near the Victorian border, and during the following week they will proceed down the river, unveiling memorials at historic spots, arriving at Hindmarsh Island on

Jan. 19. Here the Deputy Governor of South Australia will unveil a granite column 40 feet high, with a bronze tablet, to commemorate Capt. Sturt's landing place after his journey in a whaleboat down the river a hundred years ago. Sturt, who was born in 1795 and was educated at Harrow, served in the Peninsula and in France, and in 1827 became military secretary to Sir Ralph Darling, the Governor of New South Wales. He made several hazardous journeys into the interior, and in 1829 descended the River Murrumbidgee to its confluence with the Murray, and by the latter travelled to the coast. His discoveries led to the founding of South Australia, of which Captain (afterwards Rear-Admiral Sir John) Hindmarsh became the first Governor in 1836. Sturt afterwards became the assistant-commissioner of lands and colonial secretary of the new colony, and one of the counties bordered by the Murray River bears his name. He published accounts of his journeys and received the founder's gold medal of the Royal Geographical Society. Sturt returned to England in 1853 and died at Cheltenham on June 16, 1869.

THE Report on the Administration of the Meteorological Department of the Government of India in 1928-29 has recently been issued. It covers the period during which the head office was reorganised and moved from Simla to commodious new buildings at Poona. The opening ceremony, which took place on July 20, 1928, is described in this report, and the speeches made on that occasion give a good conspectus of the present position and future prospects of the department. The men who occupy the superintendships of the various branches at headquarters are all Indians. It is to them and their younger colleagues that we must chiefly look for new contributions to our meteorological knowledge of India during the next decade or so, and it is perhaps a good augury that the dislocation caused by the move has not prevented research work from being carried out during the period under review. Some of these researches have already been reviewed in our columns.

SIMLA was badly placed for three very important pieces of work. Mr. J. H. Field, the late Director-General of the Department, had to conduct his pioneer work in the exploration of the upper atmosphere, by means of sounding balloons carrying self-recording instruments, far from the central office, for balloons liberated at Simla are generally lost outright in remote parts of the Himalayas or in Tibet, carried eastwards in the circumpolar westerly circulation that is in evidence at high levels in northern India throughout a large part of the year. An equally important line of investigation—the study of the tropical cyclones of the Arabian Sea—is also more readily conducted with Poona as a base. Lastly, there is the forecasting of the monsoon, upon which the economic life of India is so dependent. The rain-bearing south-westerlies from the far side of the equator reach Poona early, and in full strength, while Simla not only experiences them long after the greater part of India, but also as a 'wave' that has nearly spent its poleward impulse.

THE Safety in Mines Research Board has come to the conclusion that its technical papers are somewhat

too difficult for the ordinary miner to understand, and it has, therefore, commenced to issue a series of pamphlets headed "What Every Mining Man Should Know". The first two of these have now been published, and are priced at a very low sum (*6d.* and *3d.* respectively) in order to make them generally available. The first deals with research problems that have already been more or less completely solved and those that are now undergoing investigation, the object apparently being to bring before the ordinary coal miner the large volume of data which are as yet unknown and will have to be found out before coal mining can be made as safe as is humanly possible. The second pamphlet is on gas and flame, and attempts to make clear to the unscientifically trained mind the rationale of gas ignition and gas explosion. The authors have attempted to attain this object by photographs of a number of experiments; no doubt if the experiments could actually be seen, they would make the matter quite clear to the uninitiated, but it cannot be said that the photographs alone are equally conclusive. Upon the whole, the effort, and especially the objects underlying it, are praiseworthy; unfortunately, it may be gravely doubted whether the great body of coal miners will be sufficiently interested even to read these pamphlets.

DURING recent years there has grown up a general recognition of the value of international conferences. This is especially evident in connexion with illumination, a subject which is in a state of constant development. International co-operation has been greatly fostered by the reconstitution of the original International Photometric Commission, on a wider basis, as the International Illumination Commission, to which are linked national committees in all the chief countries of the world. Since the War, meetings held in Paris (1921), Geneva (1924), Bellagio (1927), and New York (1928) have revealed continuous progress. The conference held in the United States last year, which was attended by five hundred delegates from eleven different countries, was perhaps the most important ever held in connexion with illumination. The next International Illumination Congress will be held in Great Britain on Sept. 3-13, 1931, and will be combined with excursions to places of interest in England and Scotland. Papers dealing with varied aspects of lighting will be presented, and topics of local interest will be dealt with at each centre. The congress will be followed by the technical meetings of the International Commission on Illumination, which will be held in Cambridge on Sept. 13-19. In Great Britain the machinery for the study of illumination is perhaps more perfectly organised than elsewhere, and the aid of all the leading scientific and technical bodies interested, and of organisations concerned with gas and electric lighting, is being secured. The honorary general secretary of the Congress is Col. C. H. Silvester Evans (c/o The Illuminating Engineering Society, 32 Victoria Street, London, S.W.1), to whom all communications should be addressed.

MR. T. G. N. HALDANE read a remarkable paper to the Institution of Electrical Engineers on Dec. 19. He described a new method of producing low grade

heat from electricity by means of a device which he calls a heat pump. In 1824, Carnot imagined a perfect reversible heat engine and proved that its efficiency is the ratio of the difference of temperature between the high and low temperatures of the working substance to the high temperature when the temperatures are expressed in the absolute scale. If we imagine the Carnot engine reversed, that is, if it be supplied with mechanical energy, then a small amount of mechanical energy will allow a very much larger amount of heat to be pumped from the low source to the high source. The general principle of this process was first pointed out by Kelvin in 1852. Little practical application has been made of it hitherto, possibly because it appears at first sight to contradict ordinary engineering principles. Mr. Haldane points out that the process of producing cold is simply that of pumping heat from a relatively cold to a relatively hot source. Hence the refrigerator is the most familiar type of heat pump. It is shown both from theoretical considerations and from practical tests on refrigerating plant that where heat at a comparatively low temperature is required, an 'efficiency' of the order of from 300 to 500 per cent can be obtained. The heating efficiency is the ratio of the heat produced by the heat pump to the heat equivalent of the electrical energy expended. The principle can be applied to the heating of large buildings and very usefully to the heating of public baths. A description is given of experiments which demonstrate the soundness of the principles used. Engineering estimates are given. It appears that the heating of swimming baths is the most suitable field for the immediate application of the system.

USERS of the telephone will find a paper, on interruptions on telephone conversations, by Mr. K. W. Waterson, published in the *Bell Telephone Quarterly* (vol. 7, p. 166), both interesting and useful. Everyone has felt annoyance when a telephone conversation is suddenly interrupted by what is technically called a 'cutoff'. It is small consolation to know that this only occurs about six times in a thousand. Half of these are due to failure in human effort by the operators or to a fault in the extensive network connecting the two subscribers. The other half are in private switchboards which are outside the company's control. 'Cutoffs' on conversations from dial telephones occur less frequently than on connexions completed manually, as there is less opportunity for human error. All long-distance calls are subject to a greater risk of a cutoff. In a long distance cable connexion from New York to Chicago there are 1500 relay or movable contacts and 9000 other fixed contacts of various kinds. In addition, there are 40,000 soldered connexions in the toll line itself. Considering the complication of handling the calls on a switchboard, the operator does well to keep his mistakes down to 1 in 1500, which is less than one in a day's work.

THE errors due to the telephone subscriber generally arise when he trusts too much to his memory when calling a number, when he speaks indistinctly, or when, in the case of a dial telephone, he dials before hearing the dial tone. During the last ten years the percentage of wrong numbers asked for by the sub-

scribers has remained practically constant. On the other hand, the wrong numbers attributable to the telephone company have diminished to half their former value. At present it is difficult to see how the causes of 'bell rang' complaints can ever be eliminated. However good the maintenance of the apparatus, it will occasionally get out of order, and however excellent the training and supervision, operators will sometimes err. It is not always convenient for a subscriber to carry on a conversation the moment he is called, and the caller is often not able to wait until he gets a reply. All efforts should be made to effect improvements in this direction.

THE lure of spectroscopic investigation as applied to industry fascinates many a chemist until he reads a treatise, studies the subject in detail, and concludes that the goal is beyond his reach owing to high cost of equipment and the need for long training in the technique. However far from or near to the truth this may be in the ordinary way, the reader will find his fears greatly reduced or even dispelled in a new publication entitled "Spectroscopic Outfits for Metallurgical Analysis" (4to., pp. 40), published by Messrs. Adam Hilger, Ltd. Equipments of various types are so clearly described with regard to both their construction and the purposes to which they are adaptable, that the reader can scarcely fail to make a wise selection and to be assured that the cost will not greatly exceed the sum estimated, since accessories are listed together with the main equipment. Part 2 opens up three new methods of quantitative spectrographic analysis; Barratt's twin spark photometric method, in which the unknown intensity of the given lines is adjusted to equality with that of known lines; Scheibe and Neuhausser's method employing a 'rotating logarithmic wedge sector', which expresses in the length of the photographed line a function of its intensity; and Occhialini's method, also depending on measurements of the lengths of lines.

SINCE the Arctic Islands of Canada were incorporated in the North-West Territories of the Dominion, a great deal of exploration and survey work have been done annually, both in respect of routine patrols and in definitive pieces of investigation. A small chart, published by the National Resources Intelligence Branch of the Department of the Interior, shows the routes of officers carrying out patrols, inspection, and investigation during the present year, by land and by sea. Nearly the whole of the north-west passage was visited, and extensive explorations were made in the little known Foxe peninsula, the eastern side of Foxe basin, and the northern coasts of Hudson Strait. Most of the coasts of Baffin Island were visited, and in the far north patrols touched Melville Island, Bathurst Island, and Alex Heiberg Island, besides Ellesmere Island, where there is a police post. The Department keeps in active touch with all the areas inhabited by Eskimo, and has made Canadian jurisdiction much more than nominal in these arctic territories.

ON Dec. 23, according to the *Times*, a memorial to Sir Stamford Raffles was unveiled in Batavia. Born at sea, off Jamaica, in July 1781, Raffles at the age of

fourteen entered the East India house and in 1805 was sent to the Far East as assistant-secretary of Penang. Rising rapidly to more responsible positions, from 1811 until 1816 he was Lieutenant-Governor of Java, where he abolished slavery, instituted schools, and in other ways ameliorated the lot of the natives. His work, it was said, "will make his memory adored on the island of Java for ages to come". Afterwards Governor of Bencoolen in Sumatra, in 1819 he hoisted the British flag in Singapore. He returned to England in 1824, where he founded the Zoological Society, of which he was the first president. His death occurred on July 5, 1826, and his statue was afterwards placed in the north aisle of the choir of Westminster Abbey.

In his address at the twelfth anniversary meeting of the Bose Institute, Sir J. C. Bose said that the advance of plant physiology had been obstructed by narrow specialisation. His new type of 'growth balance' not only visualises imperceptible growth but makes an immediate measurement of the rate. The establishment of the laws of growth, on which the advance of scientific agriculture depends, has been rendered possible by this new method. Experiments carried out side by side on plant and animal tissue have established identical life mechanism in the two kingdoms. The leg of the frog and the leaf of *Mimosa* produce similar motile response under nervous impulse caused by cathodic excitation of an electric current. The characteristic effects of drugs are shown in automatic pulsations of both plant and animal. Indian plants are being found having medicinal properties which were not previously suspected, and the efficacy of which in reviving the failing heart appears to be exceptionally high. Further steps necessitate the isolation of the active principles from plant extracts, as well as prolonged investigation for standardisation of dose on human subjects.

In the November *Scientific Monthly*, Prof. M. F. Guyer describes the marine biological stations of Japan. So much good work has come out of these institutions that it is interesting to have some general account of them, and the attractive photographs inspire one with a desire to work in these laboratories. Two are described, the Marine Biological Station at Asamushi on the north-eastern coast of the main Island of Japan, and the Misaki Marine Biological Station, which lies on the southern extremity of a peninsula which separates the Bay of Tokyo from Sagami Sea. Both offer hospitality to foreign workers and both have much to offer in interesting plants and animals and ideal collecting grounds. The Asamushi Station has a staff of fourteen, with Prof. Hatai as director. There is a well-equipped laboratory and aquarium and an under-sea laboratory which is half submerged. The Misaki Station was founded by the Japanese Government in 1887 at the suggestion of Prof. Mitsukuri. It is now under the direction of Prof. Yatsu of the Tokyo Imperial University. The wonderful fauna and flora of this part of the world is well known for its richness, and regular courses are given for teachers in fisheries, planktology, and oceanography. Here also the laboratory is well equipped,

and there is a library and aquarium, besides research rooms for investigators. Both of these stations are of the greatest possible value.

THE question of growing crops subsidiary to the staple products of a country is discussed in a recent issue of the *Bulletin of the Imperial Institute*, vol. 27, p. 307, with particular reference to the tropical colonies. The danger of depending solely on one crop has recently been emphasised by the occurrence of a slump in the tobacco industry in Rhodesia, Nyasaland, and elsewhere, but many factors, notably transport, need to be considered before a suitable subsidiary export crop is selected. The industry suggested is the manufacture of essential oils, of which peppermint, geranium, and lavender appear the most promising. The oil is prepared from the plants by steam distillation, the process being carried out by the grower on the spot. A full account of the different varieties, the methods of cultivation, harvesting, and preparation of the oil, is given for each plant, together with the average yields to be expected and the present market conditions. Co-operation with the Royal Botanic Gardens at Kew is being arranged, plants for trial cultivation being sent to certain areas and the resulting oil being returned to the Imperial Institute for analysis and valuation. For those desiring further information a list of useful references is appended; the Imperial Institute is prepared to advise planters with regard to the type of still required and to put them into touch with makers of the necessary apparatus and merchants through whom the oils may be marketed. Intending planters are, however, also recommended to consult the agricultural officers of the country concerned so that they may obtain advice based on a thorough knowledge of local conditions.

THE growing appreciation of the value of trade associations for protecting the interests of their members is exemplified by the formation of the British Disinfectant Manufacturers' Association, the inaugural meeting of which was held on Dec. 16 last. About fifty firms, representative of all the branches of the disinfectant trade, have signified their intention of joining the new Association. One of the main objects of the Association is to protect and further the mutual trade interests of its members, to foster the manufacture of British disinfectants and promote closer co-operation between British disinfectant manufacturers. The Association will also serve as a medium for placing before government departments or other public bodies, at home and abroad, the views of British disinfectant manufacturers on matters affecting their industry. Mr. N. F. Kingzett, of the Sanitas Co., Ltd., was elected chairman, Mr. W. H. Hivey, of Taylor's Automatic Disinfectant, Ltd., vice-chairman, and Mr. R. A. Blair, of Burt, Boulton, and Haywood, Ltd., honorary treasurer of the new Association, which will be affiliated to the Association of British Chemical Manufacturers, 166 Piccadilly, W.1. The Association has already taken steps to investigate certain questions of tests which have arisen in connexion with the standardisation of disinfectant specifications by a government committee.

WE much regret to announce the death, on Dec. 25, of Major P. A. MacMahon, F.R.S., president in 1917-19 of the Royal Astronomical Society, who was formerly Deputy Warden of Standards, Board of Trade, at the age of seventy-five years; also of Major P. H. Hepburn, president in 1920-22 of the British Astronomical Association and treasurer in 1927-28 of the Royal Astronomical Society, on Dec. 25, aged fifty-six years.

THE fourteenth series of "Methods and Problems of Medical Education" has been issued by the Rockefeller Foundation, New York. Methods of keeping records are dealt with in this series, and as models specimens of the following are given: (1) the complete case sheets of a case of fracture, Massachusetts General Hospital, (2) the blank forms used

in a sanitary survey, Peking Union Medical College, and (3) a summary of the records and record system of the Children's Hospital, Cincinnati, Ohio.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the County Technical College and School of Art, and organiser of evening school work in the Borough of Newark—The Clerk to the Governors, Education Offices, Old Magnus Buildings, Newark (Jan. 14). A principal of the County Technical Institute, Worksop—The Director of Education, Shire Hall, Nottingham (Jan. 25). A lecturer in physical and stratigraphical geology in the Egyptian University, Faculty of Science, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (Jan. 31).

Our Astronomical Column.

An Active Region on the Sun.—Although the maximum of the present cycle was reached in 1928, the sun has shown considerable activity during the past three months in the appearance of several large spots (see NATURE, Oct. 19, p. 631, Nov. 9, p. 737, Dec. 7, p. 888, Dec. 28, p. 998). During the latter part of December, another group of spots crossed the disc, covering with its attendant faculae a great extent of the sun's surface. The group (or possibly two separate but allied groups), which consisted of a long stream extending over 18° of longitude or 130,000 miles, occupied the place of the big naked-eye spot, No. 16 of the previous rotation, which also was the return of a complex stream beginning its development on Oct. 30. Notes relating to the early history of this active region are given in the *Observatory* for December last, p. 365.

The present group was observed at Greenwich with the spectrohelioscope presented to the Royal Observatory by Dr. Hale, and it was seen to be associated with extensive bright hydrogen flocculi. Preceding the group, on Dec. 24-26 (the only days when observation was possible), there was a very long, slender, dark filament which represented a prominence of considerable size and activity. Measures taken with the velocity recorder or 'line-shifter' of the spectrohelioscope showed on Dec. 25 a difference of 95 km./sec. in radial velocity between the two ends of the filament, the southern end rising from the sun with a velocity of 25 km./sec. and the northern end falling back with a velocity of 70 km./sec. A detailed account of a similar observation of a dark filament but connected directly with a sunspot is given by Dr. Hale in NATURE of May 14, 1927, p. 711.

The following table completes the list of large sunspots seen during the year 1929.

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Maximum Area.
19	Dec. 21-Jan. 2	Dec. 27.5	16° N.	2000

Comets.—A new comet, 1929*d*, was discovered on Dec. 20 by Mr. Wilk of Cracow Observatory, who will be remembered as one of the discoverers of comet 1925*XI* (Peltier-Wilk). The following positions, of which the first is only approximate, have been transmitted by telegram from the I.A.U. Bureau, Copenhagen:

U.T.	R.A. 1929-0.	N. Decl. 1929-0.	Observer.	Place.
Dec. 20 ^d 17 ^h 45 ^m	18 ^h 8 ^m 35 ^s	36° 19'	Wilk	Cracow
21 17 32.1	18 20 15.67	35 23 30	Wolf	Königstuhl

The magnitude was noted as 7 on Dec. 20, 9 on Dec. 21. The deduced rate of daily motion is +11^m 48^s, -56'. This gives the rough position for the evening of Dec. 28, R.A. 19^h 43^m, N. Decl. 28° 52', which is some 5° east of β Cygni. This is the first comet readily visible with small instruments in European latitudes for nearly two years, and the first orbit likely to prove parabolic since the bright comet 1927*IX* (Skjellerup).

As the comet is approaching the sun, though receding from the earth, it is likely to become somewhat brighter: the following positions were secured by Dr. W. H. Steavenson at Norwood:

		R.A. 1929-0.	N. Decl. 1929-0.
Dec. 25.	18 37.3 U.T.	19 ^h 5 ^m 36.64 ^s	30° 42' 14"
" 26.	18 21.0 "	19 15 47.91	29 24 37

Prof. Banachiewicz, Director of Cracow Observatory, has deduced the following orbit from observations on Dec. 21, 23, 25:

T	1930 Jan. 22-257
ω	157° 8'
Ω	178 41
i	124 31
log q	9.82840

EPHEMERIS FOR 18^h U.T.

	R.A.	N. Decl.	log r.	log Δ.
Jan. 1.	20 ^h 9 ^m 50 ^s	21° 1'	9.9006	9.9789
" 5.	20 38 1	15 24	9.8783	0.0054
" 9.	21 1 4	10 8	9.8586	0.0359
" 13.	21 19 45	5 18	9.8430	0.0679
" 17.	21 34 51	1 3	9.8328	0.0990

An observation by Dr. A. C. D. Crommelin on Dec. 29, not yet fully reduced, shows that the position was within 1' or 2' of the ephemeris place, so that the elements are probably near the truth: the comet must be looked for in the evening as soon as the sky is dark enough.

Prof. van Biesbroeck followed Forbes's Comet, 1929*c*, at Yerkes Observatory until Nov. 22: on Nov. 5 it was of mag. 15, with a diffused nucleus and a tail on the following side. On Nov. 22 the magnitude was 16.5. He is still following Stearns's Comet, 1927*IV*, with the 24-inch reflector. Its magnitude is 16. Carpenter's reported comet of Nov. 2 may be written off as unconfirmed.

Research Items.

The Earliest Civilisation of Egypt.—In *Antiquity* for December, Mr. Guy Brunton gives a brief account of the progress of excavation at Badari since it was initiated in 1922. He sketches in outline the civilisation of the Badarians so far as it can be reconstructed from the evidence, dating it approximately at 5000 B.C., going on to describe the differing and, it is suggested, earlier culture of the Tasians, discovered in the expeditions of the last two years. Certain points differentiate them sharply from the Badarians. The typical form of pottery is a jar having a small flat base, wide mouth, and a rather sharp angle at the bulge. The ware is greyish with black patches, and shows a vague coarse rippling which is vertical. There is sometimes a definite irregular black band around the rim. Associated with these people are beaker pots with broad flaring mouths and incised designs filled with white. Two more or less whole and many fragments come from the village sites, none so far from graves. In five places they have been found with polished celts, either of hard limestone or greyish green igneous rock. The Tasians are definitely connected with the celts by an undisturbed grave at Deir Tasa, in which was typical Tasian pottery. A poor example of the beaker was found in a Badarian grave at Qau in 1923, and may indicate an overlap of the two cultures. The Tasian culture is more primitive than the Badarian, and everything points to its being earlier. A few skulls have been found in good condition. They are rounder than the pre-dynastic or the Badarian, and have broad faces and square jaws quite unlike the Badarian. The graves are wider and deeper than the Badarian, with a niche in the side to take the pot.

Change in an African Society.—In the *Sudan Notes and Records*, vol. 12, Part 1, Mr. G. O. Whitehead publishes a study of the social organisation of the Bari, with special reference to the changes which have taken place comparatively recently in the status of the various social groups. The Bari were formerly composed of freemen, *Lui*, and servile groups, collectively called *Dupi*. The *Dupi* proper were serfs who cooked, and were of a physique markedly distinct from their masters. They did not own cattle, but are supposed to have lost them to the freemen. Yet they had to pay cattle on marriage, these being obtained from their masters. For this the masters had a claim on their services. Probably they were racially distinct from the freemen who had conquered them when they invaded the land. Other classes were the hunters, neither owning cattle nor cultivating land. They paid tribute to their chief. Two other classes were the Artisans of the Forge and the Artisans of the River, each living in separate villages. They were not so servile as the *Dupi*. They had few or no cattle, yet married independently of their chief's assistance owing to the value of the goods they produced. The introduction of money, the increase in agriculture, and disturbance due to unrest in the Sudan have brought about a redistribution in the ownership of cattle, which no longer belong exclusively to the *Lui*, and a dislocation of the pastoral life. This has blurred the hard-and-fast lines between the classes. The *Dupi* no longer depend on the *Lui* for their marriage arrangements, while under European control the position of the chief is changed and depends upon the relation with the Government rather than his own intrinsic position. The advice of the fathers of the soil is no longer listened to as it once was.

Yellow Fever Vaccine.—Stokes, Bauer, and Hudson in 1927 made the important discovery that Asiatic monkeys, particularly *Macacus rhesus*, can be readily infected with yellow fever, and that the disease may be maintained in these animals either by direct inoculation of infected blood or tissues, or by mosquito transmission. By this means, Hindle has been able to maintain and propagate the virus in London for more than a year, and through a large series of animals (*Trans. Roy. Soc. Trop. Med. and Hyg.*, 22, p. 405; 1929). Hindle finds that a suspension of the ground and cytolised liver and spleen taken from an animal *in extremis* will produce infection in a dilution of 1:10,000, but if to the suspension two parts of formaldehyde per thousand are added and the mixture is kept in the ice-chest for twenty-four hours, virulence is lost and the material may be used as a preventive vaccine. A monkey inoculated about ten days previously with this vaccine resists a dose of 1000-10,000 minimal lethal doses of active virus, and the immunity produced lasts for more than six months, the longest period so far tested.

Snakes of Ceylon.—A useful paper, by L. Nicholls, deals with the simpler recognition marks of the land snakes of Ceylon (*Ceylon Jour. Sci.*, Sect. D, vol. 2, Pt. 3, 1929, p. 91). Since every year deaths in Ceylon are attributed to non-poisonous snakes, the diagnoses have been arranged so that medical men may have at hand a ready means of determining any species and its possible harmfulness to man. In all, 61 species are described, 14 of which are earth snakes, 1 a constrictor, 42 colubrids, and 4 vipers. So far as possible, technically difficult descriptions have been avoided and identification rests for the most part on the external characters of coloration, markings, and general appearance, and simple scale characters.

Teleostean Fishes of Tortugas.—Mr. E. W. Gudger ("On the Morphology, Coloration, and Behaviour of Seventy Teleostean Fishes of Tortugas, Florida"). Papers of the Tortugas Laboratory of the Carnegie Institution of Washington, vol. 26, No. 5) gives an account of his observations on various fishes. The work is specially valuable as it has to do mainly with living material, giving details of the colouring, variation, and habits both in natural surroundings and in the aquarium. Special stress is laid on the importance of the variability in colouring. The fishes also vary much in number of fin rays, scales, and relative proportions of the body. The small clupeoid *Jenkinsia stolifera* is present in schools of many thousands; often swarming round a large grey snapper, leaving a space round it and moving when it moves, only to rearrange themselves in the same way when it comes to rest. The account of the feeding habits of the grey snapper itself is interesting. *Apogonichthys puncticulatus* was found swimming inside the mouth of the shell of a large conch (*Strombus bituberculatus*), and probably lives symbiotically with this mollusk, in the same way in which *Apogonichthys strombi* lives in *Strombus gigas* as described by Plate from the Bahamas. Anatomical details of many of the fishes are given, including many notes on the internal organs besides the external features.

Gonophores of Myriothela.—E. A. Briggs (*Records Austr. Mus.*, vol. 18, 1929) describes the gonophores of *Myriothela australis*. All the gonophores on one individual are of the same sex; they are spherical when mature, supported on narrow cylindrical peduncles

arising from the sides of the blastostyles. The male cells are derived from cells on the floor of the subumbrellar cavity, and the first stage in spermatogenesis begins in the mass of cells covering the spadix. The secondary spermatocytes derived therefrom fill the subumbrellar cavity. At the distal pole of the gonophore, the ectoderm becomes invaginated to form the velar aperture, which breaks through into the subumbrellar cavity, and permits the escape of the sperms. In the female gonophore the cells of the germinal mass are arranged in several layers, the outer of which forms the external epithelium of the future spadix, and the others are the reproductive cells and form the oogonia. These multiply and finally fill the space between the manubrium and the subumbrellar epithelium. The oogonia give rise to primary oocytes, and here and there two of these come into contact and their cytoplasm fuses. The fusion products increase by accretion of other similar ones or of primary oocytes. The end result is that in the gonophore are five or six plasmodial masses separated by non-cellular partitions. The large definitive egg is produced by the withdrawal of these partitions and the fusion of the plasmodia, and becomes charged with yolk. At the distal pole of the gonophore is the velar aperture through which probably the sperm enters.

Cardita beaumonti Beds of Sind.—The *Cardita* [or *Venericardia*] *beaumonti* beds as they occur in Baluchistan were treated of by M. Henri Douvillé in a previous paper (see NATURE, Oct. 6, 1928, p. 552), and he now deals with them as developed in Sind (*Pal. Ind.*, New Series, vol. 10, mem. 3, fasc. 2). The fauna of these beds in Sind is definitely marine, as evinced by the abundance of Nautili and Fusidæ, whereas in Baluchistan more brackish water forms, and particularly Melaniidæ, prevail. Stratigraphical evidence shows that in Baluchistan the beds represent the lower Danian, whilst in Sind they are at the top and underlie the basaltic trap of the Lakhi hills. Many of the Sind species differ solely in specific characters from Eocene forms. Just fifty species of mollusca are described, half of which are held to be new and illustrated on eleven photolitho plates, which, considering the nature of the objects depicted, are remarkably good.

Petrographic Nomenclature.—In the *Travaux du Musée Minéralogique près l'Académie des Sciences de l'U.R.S.S.*, vol. 3, 1929, Dr. Beliankin gives an interesting discussion (in English) of the meaning of the term 'rock'. He arrives at the definition: "Rock is a mineral body, homogeneous in matter and structure", where 'mineral body' includes aggregates of one or more minerals, mineral mixtures or glasses. From this it is deduced that the classification and nomenclature of rocks should be primarily mineralogical. Beliankin points out that geographical names are not suitable, and that "a text-book of petrography turns out to be a certain kind of universal manual of geography". As a concrete suggestion for a practicable alternative, he proposes to name rocks from the first syllables of the names of their dominant minerals. For feldspathoidal rocks he thus arrives at the following names, based on the abbreviations italicised in *egirine*; *pyroxene*; *diopside*; *titan-pyroxene*; *amphibole*; *barkevikite*; *biotite*; *nepheline*; *sodalite*; *nosean*; *analcite*; *melilite*:

<i>Geographical Names.</i>	<i>Rational Names.</i>
Urtite	Leuco-æginéite
Ijolite	Æginéite
Melteigite	Melano-æginéite
Monmouthite	Amnite
Congressite	Bineite

<i>Geographical Names.</i>	<i>Rational Names.</i>
Tawite	Ægisodite
Naujaite	Anam-ægisodite
Bekinkinite	Barneite
Fasinite	Tipyneite
Riedenite	Pynosite
Turjaite	Binemelite
Uncompahgrite	Dimelite.

The suggestion is an excellent one; it deserves serious discussion at the next International Congress of Geology.

Wave-Mechanics of α -Ray Tracks.—In a note in the December number of the *Proceedings of the Royal Society*, Mr. N. F. Mott discusses the apparent contradiction between the wave-mechanical theory of radioactive disintegration, according to which an α -particle leaks out from its parent nucleus as a spherical wave, and its particle-like attribute of leaving an almost linear trail in a Wilson cloud chamber. The discrepancy is, of course, only apparent. The wave of the α -particle must not be considered by itself, but as contributing to a wave-function in a space of many dimensions formed by the co-ordinates both of the α -particle and of every atom in the expansion chamber. Mr. Mott develops the appropriate theory for the case when there are two atoms of hydrogen present, and finds that both must lie within a cone of small angle having its apex at the radioactive nucleus, if they are both to be ionised. In other words, the α -particle should, apart from collisions with atomic nuclei, leave an almost straight trail. Mr. Mott's paper is an elaboration of one of the points raised by Prof. C. G. Darwin in his paper on collision problems in wave mechanics in the June issue of the *Proceedings*.

Measurement of Refractive Indices.—A rapid method for investigating the dispersion of liquids is described by Prof. T. M. Lowry and Mr. C. B. Allsopp in the December number of the *Proceedings of the Royal Society*. A small quantity of the substance is enclosed in a quartz etalon, and the interference fringes formed in the film in parallel light are focused on to the slit of a spectrometer, when the variation in fringe-width in passing along the spectrum—photographed in the usual way—leads readily to a knowledge of the dispersion in the liquid. The accuracy obtainable is not so high as in some methods, being largely limited by the number of fringes which can be thrown on to the slit, but the device of working with thin films in quartz makes it possible to follow the dispersion curve of even poorly transmitting substances well into the ultra-violet, and the information so obtained is very complete. A curve for nicotene, which was obtained without very elaborate precautions in the control of temperature, is reproduced in the paper, and extends to 2900 Å.: hollow prism methods could only be used down to about 4300 Å., below which it was impracticable to proceed, because of absorption in the liquid.

Photoelasticity.—In the first part of volume 12 of the *Scientific Papers* of the Institute of Physical and Chemical Research, Tokyo, Mr. Z. Tuzi describes a new method of studying the elastic stresses in structures by means of the kinematograph. A model in phenolite is placed between crossed nicol prisms through which monochromatic green light is sent. The light and dark bands produced by the stressed specimen are photographed either in the usual way with a steady load or on a kinematograph film during the application of the load. Photographs of the bands produced when the steel side of a railway carriage with its doors and windows is loaded at nine points on its top edge, are reproduced for a steady load and

for its gradual application, and are remarkably clear. The stresses are calculated from the photographs and are compared with the values calculated by the approximate methods used in designing the carriage. The agreement is not satisfactory, and the author gives more accurate methods of calculation which agree better with the experimental results.

Shearing and Punching Metals.—More than 110 pages of the *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale for July-August-September are devoted to M. Charles Fremont's account of his researches on the shearing and punching of metals, which have been carried out with the support of the Society. He has investigated the influence of the form of the shears or punch on the work which has to be done in the shearing or punching process, and by means of photomicrographs determined the distortion the material undergoes. The 268 figures add greatly to the interest of the memoir.

Precipitated Selenium Dioxide.—In the November issue of the *Journal of the American Chemical Society*, Hoffmann and Lenher show that the precipitate formed by the action of ozonized oxygen on a solution of selenium in selenium oxychloride is selenium dioxide. The density of the precipitated dioxide is appreciably lower than that of the sublimed substance, although the molecular weights of the two were found to be identical. The precipitated dioxide absorbs dry hydrogen chloride to form a fuming, straw-coloured liquid similar in composition and density to selenium hydroxychloride. No evidence of the existence of selenium trioxide or chloroselenic acid was found.

Union of Hydrogen and Chlorine.—When a mixture of equal volumes of hydrogen and chlorine is exposed to white light of constant intensity, combination occurs more slowly in narrow capillary tubes than in wider. D. L. Chapman and Grigg, who discovered this effect, explained it by assuming that the combination is due to an unstable catalyst which is destroyed in contact with glass or a film of water. In the November number of the *Journal of the Chemical Society*, they describe further experiments which show that the mean life of the catalyst is of the order of magnitude of the time taken by the catalyst molecules to reach the surface, although there are some points in which the theory proposed is not closely followed. The mean life always increases with decreasing pressure, which seems to show that one or both of the reacting gases have an inhibitive effect, a conclusion which is supported by an observation of M. C. C. Chapman that hydrogen can act as a weak inhibitor. The results are consistent with those of Weigert and Kellermann, published in 1923, these authors being the first to attempt to estimate the life of the catalyst which is formed when the gas is exposed to light. The experiments give no indication as to whether this catalyst is a chain of alternately formed chlorine and hydrogen atoms, as postulated by Nernst and Bodenstein, or unstable nuclei of unknown structure.

Glycogen.—Glycogen is a peculiar material very similar to starch which is found in the livers of mammalia. It is coloured wine-red by iodine. In the November number of the *Journal of the Chemical Society*, Haworth, Hirst, and Webb describe some preliminary experiments with glycogen which indicate that the hypothesis supported by Karrer, that starch and glycogen are similarly constituted, both structurally and configurationally, is correct. The difference in the colour reaction with iodine may be distinctive, but it is possible to prepare a starch fraction which gives the same colour as glycogen. In accordance

with modern views, glycogen is assumed to be constituted on the basis of continuous maltose units, that is, of a conjugated chain of α -glucose units. The difference in properties of the two substances is supposed to be due to a difference in size of their respective micelles. The experiments involved acetylation of glycogen with acetic anhydride, in presence of either chlorine or sulphur chloride as catalysts or of pyridine, when the triacetate was obtained in almost quantitative yield as a white powder. Although this was denser than starch triacetate, the two products showed nearly the same optical rotation in chloroform solution. Deacetylation gave a regenerated glycogen having all the characteristic properties of the original polysaccharide. Similar results were obtained by methylation following simultaneous deacetylation of the two triacetates.

Experimental Cold-rolling Mill.—The invention of rolls for metal working dates back at least so far as the twelfth century, probably being used then for producing gold strip. Leonardo da Vinci was the first to suggest their use for heavier work, but the rolling of iron did not come in until the eighteenth century. The Swedish man of science and engineer Triewald had a rolling mill with 10-inch rolls, but it was in England that the mill was fully developed and rolling both hot and cold is widespread. To further the study of the cold-rolling of steel and other metals, a cold-rolling mill has been placed in a new laboratory attached to the metallurgical and engineering departments of the University of Sheffield, see NATURE, July 13, p. 66). The machine, constructed by Messrs. W. H. A. Robertson and Co., Ltd., of Bedford, is described in *Engineering* for Dec. 6. The rolls, of Hadura alloy steel, made and presented by Messrs. Hadfields, Ltd., are 10 in. diameter by 10 in. face and are suitable for the cold-rolling of strip up to 6 or 7 inches wide. Special attention has been given to the cooling of the rolls and the lubrication of the bearings, and the rolls are driven by an electric motor of 50-120 h.p., giving a speed of anything from 59.3 ft. to 300 ft. per minute. A good deal of the work done will naturally be in the direction of metallurgical research, but it is hoped that opportunity will be taken to obtain reliable data on the effect of rolling speed on power consumption, accuracy, etc., matters of the greatest value to the industry.

Fuel Tests.—Canada's resources in fuel are abundant, but the distribution is unfortunate. Ontario and Quebec rely largely on anthracite from the United States. This dependence has been inconvenient in recent years owing to recurrent shortages, and many substitutes have been tried. In order to determine the relative value of these, the Dominion Department of Mines has instituted a series of "Comparative tests of various fuels when burned in a domestic hot water boiler", reported by E. S. Malloch and C. E. Baltzer (*Report No. 705*. Ottawa: F. A. Acland, 1929, 20 cents). These tests were carried out with great elaboration and on thirty fuels of the most varied type, ranging from anthracite to peat, consumed in a typical domestic appliance and for house-heating. The most efficient fuel tested was Welsh anthracite, 8.4 tons of which was equal to 10 tons of American anthracite, taken as standard. Scotch semi-anthracite was nearly as good. The tests showed that more than 70 per cent of the heat of anthracites and coals could be transferred to the water. With semi-bituminous coals 65 per cent, and with low-grade fuel less than 55 per cent, of the heating value of the fuel could be utilised. The results should be very encouraging to those interested in the export of British coals.

Nickel Steel in the *Golden Arrow*.

THE publications of the Bureau of Information on Nickel of the Mond Nickel Co., Ltd., have from time to time provided most valuable information on many different aspects of the use of nickel in all types of metallurgical and engineering activity. Paper A, No. 4, recently issued, deals with the use of nickel steel in the *Golden Arrow*, in which Sir Henry Seagrave attained an average speed in two runs in opposite directions of 231.36 miles per hour.

The whole of the main and sub-frames of the *Golden Arrow* were made of a nickel steel containing 3.5 per cent of nickel and 0.3 per cent of carbon, and it is of interest to note that the side members, which were 19 ft. 6 in. long, were pressed in one length. The very extensive use of this steel, which incidentally was largely used in the brake equipment, indicates its dependability and the wide range of properties obtainable from it with different heat treatments. In the normalised condition it will give a tensile strength of 35 tons per square inch, together with 25 per cent elongation. A $1\frac{1}{2}$ in. diameter bar oil-hardened from 840° C. and tempered at 550° C. gave a yield point of 42 tons per square inch, a maximum stress of 55 tons per square inch, an elongation of 25 per cent, a reduction of area of 61 per cent, and an impact figure of 56 ft.-lb.

For the main parts of the axles, where a particularly strong material was needed, a nickel-chrome-molybdenum steel of the following composition was chosen: Carbon 0.3 per cent, manganese 0.4 per cent, nickel 3.5 per cent, chromium 0.65 per cent, molybdenum 0.2 per cent. This material, which was also used for the gears, gives in the heat-treated condition a yield point of 56 tons per square inch, a maximum stress of 63 tons per square inch, 20 per cent elongation, 60 per cent reduction of area, and an Izod value of 67 ft.-lb. This steel gives exceptional uniform properties throughout its cross-section when properly heat-treated, which, no doubt, influenced the designer in his selection.

A 5 per cent nickel case-hardening steel containing

about 0.1 per cent of carbon was extensively used for parts subject to considerable wear, such, for example, as the swivel-pins. Refined at 830° C. and quenched from 760° C., the approximate tensile figures given are: Maximum stress 55 tons per square inch, elongation 15 per cent, reduction of area 40 per cent, with an impact value of 20 ft.-lb. For several parts of the steering mechanism where the stresses involved may be exceptionally high, a nickel-chrome-molybdenum steel of the following composition was chosen: Carbon 0.25 per cent, manganese 0.5 per cent, nickel 3 per cent, chromium 1.2 per cent, molybdenum 0.2 per cent. In the quenched and tempered condition, the mechanical properties obtained from this steel are: Yield point 62.5 tons per square inch, maximum stress 69 tons per square inch, elongation 19.5 per cent, reduction of area 61.5 per cent, impact value 54 ft.-lb.

For the clutch casing, cover plates, and certain small levers, a nickel-chrome steel was specified containing 0.3 per cent of carbon, 3.5 per cent of nickel, and 0.6 per cent of chromium. When hardened in oil from 830° C. and tempered at 600° C. the material gave: Yield point 49 tons per square inch, maximum stress 58 tons per square inch, elongation 22 per cent, reduction of area 55 per cent. For the clutch centre, withdrawal sleeve, and several other details, a high tensile case-hardening steel containing 3.5 per cent of nickel and 1 per cent of chromium was employed. After carburising, the steel was given two quenching treatments, one from 830° C. and one from 770° C., and afterwards tempered at 200° to obtain a maximum toughness. The properties of this material in the form of a $1\frac{1}{2}$ in. diameter bar were: Yield point 55 tons per square inch, maximum stress 69 tons per square inch, elongation 15 per cent, reduction of area 45 per cent, and impact value 28 ft.-lb.

It will be appreciated that, apart from the use of nickel steels, the construction of this machine would have been impossible.

Investigations in Greenkeeping Problems.

THE St. Ives Research Station, Bingley, Yorkshire, which has been established by the British Golf Unions for the purpose of studying greenkeeping problems from the scientific aspect, has issued the first number of the *Journal* of the Board of Greenkeeping Research. The development and organisation of the scheme are explained in a foreword, and an interesting account is given by the Director, Mr. R. B. Dawson, of the surroundings and historical associations of the St. Ives estate. A general discussion follows of the kind of problems confronting the greenkeeper and the line of attack to be undertaken in their solution. The station has an ambitious programme, and useful work has already been accomplished.

It is realised that the present condition of a turf is largely due to its previous treatment, and that much valuable knowledge may be obtained by collecting and classifying existing information. All those interested are invited to contribute their experiences for this purpose. An advisory system is already active and a special feature of the *Journal* will be the publication of inquiries dealing with problems of general interest, together with their respective replies. Excellent examples of such correspondence are given in the first number.

The choice of site for the research station has been fortunate. There is a wide range of soils within the relatively small confines of the estate, and further, a difference in elevation from 300 ft. to 900 ft. is available. More than three acres of adjoining land

have been acquired and some 400 plots are to be set up to determine the best conditions, both manurial and cultural, for the production of first-class putting greens, for comparative tests with selected seed mixtures, and for vegetative propagation trials of other grasses, notably *Agrostis canina*, which produces stolons. The use of stolon-forming grasses for lawns in India is the subject of a further article of interest.

Greenkeeping problems have changed considerably in recent years, owing largely to such alterations in practice as the use of compost in place of the heavy roller, and by the introduction of mowers of improved design and numerous chemical fertilisers. Hitherto, agricultural methods have usually been employed, and too often the supposition that what is suitable for pasture is equally good for the golf green has proved a fallacy. A special type of turf is required for greens, free from coarse grasses, weeds, and worm casts. For this purpose the effect of various fertiliser treatments will be determined and a thorough, unbiased investigation of the so-called acid theory, which maintains that the type of turf required is obtained under acid soil conditions, will also be undertaken. Consideration will be given to climatic, physiographic, edaphic, and biotic factors.

For the success of the work it is essential that the various golf clubs themselves should give their hearty co-operation and such financial support as they are able. Later, it is hoped to increase the scope of the work and to extend the investigations to the problems of turf culture peculiar to other sports.

Canadian National Research Laboratories.

TENDERS have been invited by the Government of Canada for the construction of a National Research Laboratories building that will cost, when finished, approximately three million dollars (Fig. 1). Appointment of chiefs to two of the laboratory divisions has been announced.

Dr. H. M. Tory, formerly president of the University of Alberta and now the president of the National Research Council, has expressed the view publicly that the new home for research in Canada will be one of the finest to be found in any country. It is being built on the banks of the Ottawa River in the capital city. Designed in the form of a giant figure '8', it will stand 60 feet (four stories) high, 418 feet long, and 176 feet deep. Two hundred and fifty thousand feet of floor space will be provided. Library accommodation will

the anti-submarine division; and in that work he developed important applications of ultra-sonics. In 1924 he tested apparatus for the detecting of icebergs and the sounding of depths in the Belle Isle Straits.

Dr. Whitby studied chemistry under Sir William Tilden at the Imperial College of Science and Technology, London, graduating in 1906 with the Frank Hatton prize. He was one of the first scientific workers to study the rubber industry, and one of his books thereon, "Plantation Rubber and the Testing of Rubber", 1920, has markedly influenced the trend of rubber research. In recognition of his contribution in that field, the Institution of the Rubber Industry (Great Britain) recently awarded him the Colwyn gold medal. In 1928 the distinction of Officier d'Académie was conferred upon him by the Government of France. The same year he was president of the Canadian Chemical Association.

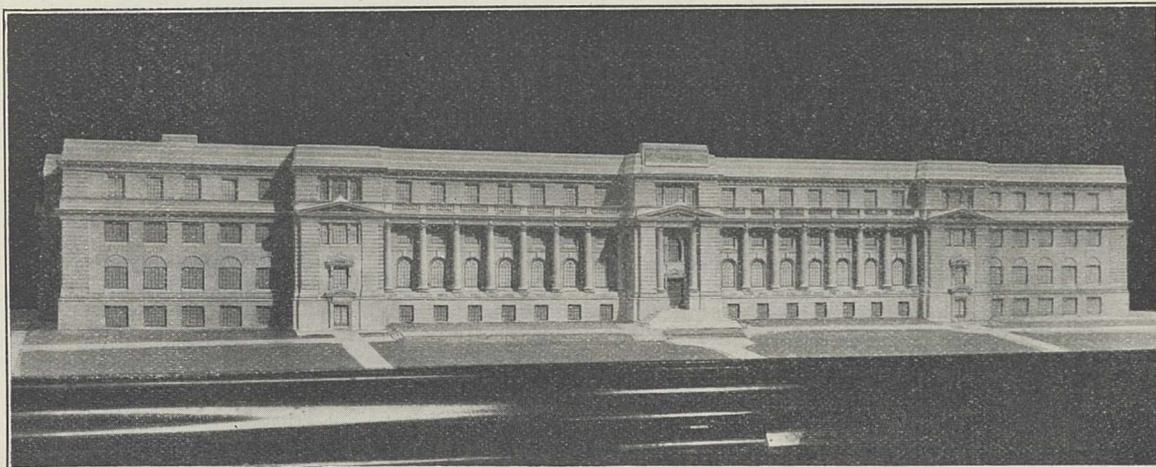


FIG. 1.—Architect's model of the National Research Laboratories building to be constructed by the Government of Canada in the capital city of Ottawa.

be for 300,000 volumes. An assembly hall and associated rooms will be capable of accommodating the staff and the various scientific societies of the Dominion.

Plans call for the development of the following divisions: the divisions of physics and engineering physics, to the head of which Dr. Robert William Boyle, dean of the faculty of applied science at the University of Alberta, has already been appointed; the division of industrial chemistry, to the head of which Dr. George Stafford Whitby, professor of organic chemistry at McGill University, has been appointed; the division of economic biology and agriculture, to which Dr. Robert Newton, professor of field crops and plant bio-chemistry at the University of Alberta, is the acting head; the division of industrial engineering, the division of textiles, the division of standards, and such other divisions as improvement in industrial processes, the development of natural resources, and the utilisation of waste require.

Dr. Boyle was graduated from McGill University in 1906, and from then until 1909, when he received the Ph.D. degree and the 1851 scholarship, he did research on the properties of matter and radioactivity. From 1909 until 1911 he continued his work under the direction of Sir Ernest Rutherford at the University of Manchester. Returning to Canada, he lectured at McGill, was appointed assistant professor in 1912, and the same year was made professor in the University of Alberta. During the War years, on the recommendation of Sir Ernest Rutherford, Dr. Boyle was engaged in research for the Admiralty Board of Invention and

As assistant director of the division of physics and engineering physics, Prof. John Hamilton Parkin, associate professor of mechanical engineering at the University of Toronto, has been appointed to direct the development of national aeronautical research laboratories.

Plans for the new National Laboratories building call for completion early in 1931. Meanwhile, temporary laboratory space has been provided.

University and Educational Intelligence.

EDINBURGH.—Dr. Alexander Nelson, formerly superintendent of research in the Department of Agriculture in Tasmania, has been appointed lecturer in the Department of Botany, and Dr. W. H. McCrea, formerly senior scholar of Trinity College and Isaac Newton fellow in the University of Cambridge, has been appointed lecturer in the Department of Mathematics.

MANCHESTER.—Prof. H. J. Fleure, professor of geography and anthropology in the University College of Wales, Aberystwyth, has been appointed professor of geography.

THE Carnegie Foundation for the Advancement of Teaching published in its last annual report an account of an educational inquiry differing from those which

it has hitherto undertaken or promoted, in that it involves tracing the progress of individual students throughout their careers in secondary schools and in college. Previous studies have presented in cross section pictures of a situation at a selected time without regard to what went before or followed in the experience of the individual student. The investigations, which will necessarily be prolonged through a period of ten years, will embrace the work done in most of the secondary schools and fifty colleges in Pennsylvania, and will, it is hoped, throw light on the validity of currently used methods of classification of pupils according to abilities and interests, on the degree of consistency to be looked for in normal educational growth, and on the actual efficiency of secondary and higher institutions in the organisation and administration of courses of study, the evaluation of educational products, and the rewarding of student effort. In tracing the progress of individual students through college, material will, it is thought, be obtained for dealing with difficulties resulting from the kaleidoscopic nature of the elective curriculum and the bewildering variety of personal contact and advice, much of it of a partisan character, to which the college entrant is exposed. Much might be done, it is suggested, in "initiating vigorous, wholly avowed and official measures to *understand* the student, and thus to discharge primary obligations of the college". Other matters of general interest in the report are reviews of the rise and present position of endowed foundations in the United States, of professional salaries, and of pension systems.

THE League of Nations sets a high value on the dissemination among the children and youth of a knowledge of its aims and achievements. The question how this may best be accomplished has been investigated during the past eighteen months by a joint committee representative of English and Welsh education authorities and teachers' professional associations, and the conclusions arrived at as a result of its labours are now published in a pamphlet entitled "Education and the League of Nations". The committee's investigations embraced work done in elementary and secondary schools and in training colleges and university training departments. It is in the elementary schools that progress has been most marked. In secondary schools there is a disposition to look askance at instruction in the principles and activities of the League as 'propaganda', and to mark time pending adaptation of examination syllabuses by the various school examination authorities to the League's educational policy. The teacher training institutions do not seem to have made hitherto an adequate response to Lord Eustace Percy's appeal to the conference of local education authorities in June 1927, when he pointed out that it is above all the students at these institutions for whom opportunities must be provided for acquiring a sound knowledge and a balanced view of the origin and work of the League. In its recommendations the joint committee has shown how this ideal may be translated into practice. It deals also with such matters as school celebrations, visits to Geneva, interchange of correspondence, school journeys, and the interchange of schoolboys and girls. If the minds of the rising generation are to develop the attitude postulated by the Kellogg Pact, it is essential that measures such as those recommended should be adopted, and not only in Great Britain but also among other, including less peace-loving, peoples. Copies of the pamphlet can be obtained (price 3*d.* each) from the office of the League of Nations Union, 15 Grosvenor Crescent, London, S.W.1.

Historic Natural Events.

Jan. 1, 1926. Rhine Floods.—The river began to rise rapidly on Dec. 27, and by Jan. 1 stood 32 feet above normal low water at Cologne, the highest level of the Rhine on record. Three-quarters of the town was under water, which stood 13 feet above the river banks. Great damage was done by the Rhine, Scheldt, and Maas in Holland; dykes burst, and wide areas of low ground were flooded. The floods were caused by heavy rain on the hills coinciding with high winter temperature and the melting of the snows.

Jan. 6-7, 1889. Rime.—After two days of frost and dense fog in Norfolk, the wind changed to south-west, and an unusually thick deposit of ice-needles, up to two inches in length, was formed on the windward sides of exposed objects. Many isolated deciduous trees, especially birch, oak, elm, and poplar, were badly damaged, while nearly all overhead telephone and telegraph wires were broken down.

Jan. 6-7, 1839. Great Storm.—On the night of Jan. 6-7, western and northern Ireland, northern England, and southern Scotland were visited by an exceedingly violent gale from the south-west, probably the worst since that of 1703. Many thousands of trees were uprooted in Ireland, houses were unroofed, chimney stacks and walls blown down. Many vessels were wrecked and there was great loss of life. Menai Suspension Bridge was damaged.

Jan. 6-7, 1928. Thames Flood.—The predicted height of the high tide at London Bridge on the early morning of Jan. 7, that is, the height to which the water would rise if the meteorological conditions were normal, was 21 feet above Admiralty datum. This is not especially high, for the predicted height sometimes reaches 25 feet. The water actually rose nearly six feet above the predicted height, making the highest known level of the Thames in London, and flowed over or through the embankments at several points in the City, Southwark, Westminster, and westward to Hammersmith. The low-lying riverside districts are below the level of spring tides, and were deeply flooded, while fourteen people, most of whom were sleeping in basements, were drowned.

The abnormal rise was due to a 'storm surge' in the southern North Sea. On Jan. 6 a deep barometric depression travelled rapidly across Scotland in an east-south-east direction, and in its rear a gale blew from north-west and north over the North Sea during the evening, driving a storm wave southwards. At 3 P.M. on Jan. 6 the level was 1.6 feet above the normal tide at Dunbar. Travelling along the east coast the wave grew in height and reached Southend at 11 P.M., raising the level 5 feet. Opposite the Thames estuary it divided into three parts; only a small part passed through the narrow Straits of Dover, raising the level about 3 feet, another part travelled north-eastwards along the coast of Holland, and the remainder entered the Thames estuary, reaching London at 1 A.M. on Jan. 7. An auxiliary factor in the London flood may have been the high level of the Thames itself, due to heavy rain and melting snow. On Jan. 7 the flow at Teddington Weir was 9500 million gallons a day, more than double the flow when the river is 'bank high'. This river water would, however, be rapidly distributed in the widening estuary, and probably did not contribute more than a few inches to the height of the tide at London Bridge.

Jan. 7, 1558. 'Calais' Storm.—It is recorded by Holinshed that at the taking of Calais "began a marvellous sore and rigorous tempest, continuing the space of four or five days together". A severe thunderstorm beat down houses and churches.

Jan. 7, 1831. Luminosity.—Owing to the presence of a kind of luminous mist, print could be read at midnight in Italy and Germany. The abnormally light nights continued for a considerable period.

Jan. 8, 1924. Cyclonic Wave.—A small but deep barometric depression passed from Ireland across France. It was accompanied by a cyclonic wave which struck the coast of Brittany, causing the sea to rise 3 feet above the level of the highest spring tides, and inundating the coast.

Jan. 9, 1857. Californian Earthquake.—An earthquake, preceded by strong shocks, was felt in southern California, from Sacramento to Fort Yuma, a distance of nearly 600 miles. It was most severe at Fort Tejon, in the neighbourhood of which a fissure 40 miles long was formed. A remarkable feature of the earthquake was its effect on the rivers of the district. The water of the Mokelumne River was thrown on its banks so as to leave the bed bare in one place, while the stream of the Kern River was reversed.

Jan. 9, 1896. High Pressure over Scotland.—During the second week of January, an anticyclone moved westward from the continent of Europe over the British Isles, where it combined with another anticyclone lying off our north-west coasts, and increased suddenly in intensity. At 8 A.M. on Jan. 9 the barometer exceeded 31 inches (1050 millibars) over the whole of Scotland, the first appearance of that isobar on our weather charts. The highest reading, corrected for gravity, was 31.139 inches (1054.5 mb.) at 9 A.M. at Ochtertyre, Perthshire. After Jan. 9 the whole system moved away south-westwards, and on Jan. 10 the highest reading was just below 31 inches. A remarkable return of high pressure occurred at the end of the month, when the corrected barometer rose to 30.975 inches (1048.9 mb.) at Valentia, Ireland. A peculiarity of both anticyclones was the mild weather associated with them. In the British Isles high pressure in winter is generally associated with frost and fog, but on both occasions in January 1896 temperature was almost everywhere above the freezing-point.

Jan. 10, 1608. Severe Winter.—The winter of 1607-8 was probably the most severe on record in western Europe, and was long remembered as "the great winter". In England the cold continued from Dec. 5 to Feb. 14, but on the continent of Europe it continued until the middle of March. On Jan. 10, in a church in Paris, the wine froze in the chalice. All the great rivers of western Europe were frozen, fires were lit on the Thames, and the Zuider Zee was crossed from Harlingen to Amsterdam. Many human beings, cattle, and young trees were killed. The break-up of the ice was followed by great floods.

Jan. 10-15, 1820. Great Cold.—A short period of very intense cold occurred from England to Italy. Arago remarks that on Jan. 10 a great number of mulberry trees split along their whole length, mostly trees from ten to thirty years old. The openings remained until the end of the frost, after which they healed up and the trees survived. An observer at Tunbridge Wells recorded that on Jan. 15 the thermometer fell to -10° F., "the lowest by fourteen degrees that I ever remember it". The details of this thermometer and its exposure are not known, so that this reading cannot be compared with modern 'records'.

Jan. 11, 1900. Haloes and Mock Suns.—Brilliant optical phenomena were visible over the greater part of south-east England during the morning. The common halo of 22° and the rarer halo of 46° were both visible and brilliantly coloured. Above both haloes were arcs of contact, and a mock sun appeared to the right of the true sun on the 22° halo. Some observers also saw a second mock sun to the left of the true sun.

Societies and Academies.

LONDON.

Geological Society, Dec. 18.—Frederick Walker: The geology of the Shiant Isles. The Shiant Isles form a small uninhabited archipelago in the North Minch, some five miles east of the Park district of Lewis. The group is made up almost entirely of crinanite sills separated by relatively thin argillaceous strata which have undergone considerable contact-alteration, but the fossil content of which (ammonites, belemnites, and one species of *Inoceramus*) assigns them to a low position in the Upper Lias. The two largest islands are each over a mile in length, and are joined by a shingle beach. A third large island lies about a mile to the east, and is also to a great extent made up of a single thick sill of crinanite. East of this island, however, the crinanite passes gradually into syenite, towards the centre of the sill, the thickness of the alkaline rock being at least 60 feet. The age of the igneous activity is almost certainly Tertiary, and is probably the same as that of the Trotternish sills in Skye. Although glacial striae are not seen on the islands, their general aspect indicates a flow of ice from south to north during the Glacial Period.

DUBLIN.

Royal Irish Academy, Dec. 9.—Gertrude Connolly: The vegetation of southern Connemara. The paper dealt with the vegetation of a large area lying west of Galway between the sea and the mountains—a vast tract of almost unbroken bog. This area had not previously been examined botanically save along its margins. Rainfall and humidity are very high, and in consequence the bogland is perennially extremely wet and difficult to explore. The vegetation proved to be limited in number of species, and alternated mainly between those of drier and wetter bog.

LEEDS.

Philosophical and Literary Society, Dec. 10.—G. W. Brindley: (1) On the dielectric constants of helium and argon. The dielectric constants of these gases are calculated from the charge distributions obtained by Hartree, using an expression due to Pauling and others for the dielectric constant of an electron in a central field of charge Z^1e , Z^1 being chosen so that r^4 is the same for the hydrogen-like distribution as for the Hartree charge distribution. The calculated value of $(K - 1)$ for helium agrees well with the experimental value, but the calculated value for argon is not good.—(2) Note on the accuracy of constants in an optical dispersion formula. The accuracy is considerably less than the accuracy of the experimental values of the refractive index. In the case of methane, if $(\mu - 1)$ is assumed accurate to 1 part in 50,000, the constants in the formula $(\mu - 1) = C/(p^2 - n^2)$ can only be accurate to about 1 per cent, owing to the form of the dispersion curve and the limited range of experimental data.—(3) Note on distribution of charge with carbon atom (2). A continuation of a previous paper, pointing out that some new experimental measurements of the X-ray scattering factor F are in good agreement with the theoretical value given in Part 1.—R. Whiddington: Note on the electron gun. Experiments are described in which the electron beam from a gun is used in a cathode ray oscillograph and is found to possess a velocity much less than that calculated from the applied potential. A curious shortening of the beam under certain conditions was also observed.—J. E. Roberts and R. Whiddington: Note on inelastic electron

collisions in oxygen at low pressures. Experiments are described in which electrons of about 100 volts velocity traverse oxygen gas at low pressure. Quantum losses are observed and certain interpretations suggested.—A. E. Battye and H. M. Dawson: The nature of the reaction between phorone and iodine and the influence of the acidity of the aqueous medium on the reaction velocity. The rate at which iodine disappears from the reaction mixture is determined by the velocity of the keto \rightarrow enol transformation of the phorone. The variation of the speed of the reaction in buffer solutions ranging from pH 3 to pH 9 shows that the major catalytic effects are due to the joint action of the hydrogen and hydroxyl ions. The graph of the velocity against pH gives a catenary curve.—J. Grainger: (1) The appearance of bean mozaic in England. A short descriptive note on an infection in dwarf kidney beans at Weetwood, Leeds. The symptoms of the malady are identical with those of bean mozaic described in America by Reddish and Stewart, Fajardo and others.—(2) An attempt to cultivate the virus of tobacco mozaic *in vitro*. Two experiments on the cultivation of the virus of tobacco mozaic *in vitro* are described. One followed the method of Olitsky, and in the other a chloroplast suspension was employed. Neither showed an increase in virus concentration during cultivation.—W. H. Pearsall and Alice Wright: The proportions of soluble and insoluble nitrogenous materials in fresh and dried plant tissues. An examination has been made of the effect of drying leaves by the method of Link and Tottingham, upon the distribution of protein and non-protein nitrogen. The amount of non-protein nitrogen extracted by 60 per cent alcohol is only slightly increased (1.5-2.0 per cent of total) by this method of drying. The variations in the ratio of protein nitrogen to soluble nitrogen in dried leaves follow those in fresh leaves, but are proportionately lower. In leaves having a higher water content there is no increase in the relative amount of hydrolysis on drying.—T. M. Naylor and A. G. Abel: An analysis of the link gear of an old beam engine. A short illustrated description of the link gear of an old beam engine constructed by Boulton and Watt in 1792 and dismantled in 1888.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 18).—N. N. Nasonov: Contribution to the freshwater fauna of *Turbellaria rhabdocelida* of Japan. Fourteen species have been found on the island Chondo, several of them new to science. One of the latter, *Macrostomum saifunicum*, is very near to the American *M. sensitivum*.—K. K. Flerov: Some new data on *Capreolus* of eastern Asia. Supplementary distributional data are given (see author's paper in *C.R.*, p. 479, 1928), and descriptions of young animals of all species are presented.—M. Galadzhiev and E. Malm: The influence of some physico-chemical factors on marine water Protozoa. Studies on the influence of oxygen, hydrogen, and carbon dioxide in the water on marine Protozoa indicate that the effects may be very different even when the pH value is the same. The main physiological factor proved to be the carbonic acid, towards which there is a specific reaction; for example, the Protozoa of the family *Tintinninoidea* are killed within 40 seconds in sea water saturated with carbon dioxide, while *Metopus signoides* can survive up to 9 days.—A. B. Verigo: An apparatus for the determination of the electrostatic capacity of electroscopes. An apparatus is described which can be fitted on to the lid of an electroscope and permits of determining its capacity within 1-2 per cent.—A. B. Verigo: A rotary apparatus for increasing electric

tension. The apparatus described increases the tension up to five times.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—G. Abetti and B. Nováková: Structure of the line $H\alpha$ and period of rotation of the solar chromosphere. A note on the dissymmetry of the line $H\alpha$ at the sun's border, as determined by spectrograms obtained at Arcetri, was published in 1926. A large number of measurements made in 1927 and 1928 give the result $H\alpha_3 - H\alpha_2 = -0.059 \pm 0.002\text{A.}$, the centre of the dark component $H\alpha_3$ being hence displaced with respect to $H\alpha_2$, together with the emission components, by 0.059 A. A series of spectrograms comparing opposite edges of the sun at various latitudes shows that the velocity of the hydrogen layer giving rise to the line $H\alpha_3$ is greater than that corresponding with $H\alpha_2$, that of the inverting stratum lying between the two. The equatorial acceleration is sensibly the same for the three layers. The dissymmetry appears to be greater in the east than in the west.—D. Mercogliano: The quadratic complexes containing the congruence of the axes of a cubic hump and the conditions for two binary cubics having two common roots.—E. Persico and F. Scandone: The Hall effect with extended electrodes (1).—M. Merola: *R* Scuti. A series of 85 photometric observations on this variable, made at Capodimonte between Aug. 10, 1927, and Dec. 6, 1928, indicate two maxima and four minima, and confirm the irregularity of the period and of the light curve, in accordance with the observations of Jacchia, Spears, Peltier, Carr, and Ford, and in the discussions of Sawyer and of Campbell.—F. de Carli: Viscosity isotherms of binary mixtures (4): The system, benzaldehyde-sulphur monochloride. Thermal analysis of this system being impossible, since all the mixtures give, on cooling, viscous masses with scarcely appreciable velocities of crystallisation, use has been made of the viscosity. The maximum divergence of the observed from the calculated viscosities occurs with mixtures containing 60 per cent of the aldehyde, the formation of the compound $2\text{C}_6\text{H}_5\cdot\text{CHO}, \text{S}_2\text{Cl}_2$ being thus indicated.—A. Ferrari and A. Inganni: The importance of the crystalline form in the formation of solid solutions (6): Thermal and X-ray analysis of the anhydrous systems $\text{CaCl}_2 - \text{CoCl}_2$, $\text{CaCl}_2 - \text{FeCl}_2$, $\text{CaCl}_2 - \text{MnCl}_2$, and $\text{CaCl}_2 - \text{CdCl}_2$. Cobaltous and ferrous chlorides give eutectics with calcium chloride at 614° and 592° , the molecular proportions of the calcium salt being 54.3 and 44.5 per cent respectively. Manganese and cadmium chlorides give mixed crystals with calcium chloride in all proportions, and these crystals, even with small proportions of one of the components, decompose into their constituents at about 475° and 414° respectively. The behaviour of these systems points to a difference between the structure of calcium chloride and those of the rhombohedral chlorides of cobalt, iron, magnesium, manganese, and cadmium, since none of the systems shows the complete miscibility devoid of maximum and minimum solidification temperatures characteristic of isomorphous mixtures. Assuming Goldschmidt's values, the radii of the ions are: $\text{Co}^{++} 0.82\text{A.}$, $\text{Mg}^{++} 0.78\text{A.}$, $\text{Fe}^{++} 0.83\text{A.}$, $\text{Mn}^{++} 0.91\text{A.}$, $\text{Cd}^{++} 1.03\text{A.}$, $\text{Ca}^{++} 1.06\text{A.}$ —G. Piccardi: Spectrographic detection of bismuth in the ashes of animal organisms. If certain modifications are made in the circuit, the detection of very small amounts of bismuth is possible by means of lines in the ultra-violet region of the spark spectrum, especially the line $\lambda 3067$, which is observable with solutions containing only 0.001 per

cent of the metal.—G. Scagliarini and P. Pratesi : The colour reaction between sodium nitroprusside and creatinine. Two possible formulæ are suggested for the ruby-coloured substance formed, according to Weyl's test, by the action of sodium nitroprusside on creatinine in alkaline solution.—G. Scagliarini and G. Tartarini : Additive compounds of halides of bivalent metals with organic bases (7). The following hexamethylenetetramine compounds are described: $2MgCl_2, 16H_2O, 5C_6H_{12}N_4$; $2MgI_2, 16H_2O, 5C_6H_{12}N_4$; $2MgBr_2, 16H_2O, 5C_6H_{12}N_4$; $2CaCl_2, 8H_2O, 5C_6H_{12}N_4$.—Giambattista Dal Piaz : Geological notes on the region of the Aurine Alps and of the Giant Vedrettes (Upper Adige).—A. Palombi : The biological cycle of *Diphterostomum brusinae* Stossich (Digenetic trematode : fam. Zoogonidae Odhner).—M. Tirelli : Opening of Malpighian tubes in the meso-intestine.—G. Mezzadrolì and E. Varetton : Action of Wood's light on the germination of seeds and on the growth of plants. Experiments on barley, beans, peas, and maize show that Wood's light exerts a favourable influence on the germination of seeds and on the growth of plants when applied for 15 minutes to some hours per day. The action is especially favourable during the early stages of development, the plants being increased in number, vigour, and height.—G. Mezzadrolì and E. Varetton : Comparison between the actions exerted by ultra-short electromagnetic waves ($\lambda 2-3$ mm.) and by the Lakhovsky oscillating circuit on the germination of seeds and the growth of plants. The favourable influence of electromagnetic waves on seeds and plants is similar to, but more marked and more constant than, that of the Lakhovsky circuit, and is a function of the intensity of the waves themselves.—P. Pasquini and G. Meldolesi : Investigations on radio-sensitiveness in the development of the eggs of amphibia (1). Differential radio-susceptibility of the various embryonic stages (Anurans).—M. Curzi : A new and serious disease of maize. During last June certain maize was attacked, with loss of about 80 per cent of the plants, by a malady which resulted in necrosis at the base of the stalk. The plants affected fell to the ground and there continued to grow without any sign of withering, communications between the aerial and subterranean organs remaining uninterrupted. The disease is due to a mould, probably communicated from the previous year's crop of beet.—Constantino Gorini : Acido-proteolytic enzymes of tanning.

SYDNEY.

Royal Society of New South Wales, Nov. 6.—A. R. Penfold and J. L. Simonsen : Note on the leaf oil from *Dacrydium Franklinii* Hooker. The chemical composition of the terpene fraction as previously revealed was confirmed, but the principal terpene for which the name dacrydene was proposed has now been shown to consist of Δ^4 -carene and beta pinene. The former is a new bicyclic terpene first isolated by Dr. Simonsen from Indian pine oil. The solid diterpene, phyllocladene, was also isolated from this oil.—A. R. Penfold and F. R. Morison : The essential oils *Melaleuca decora* (Salisbury) Druce and *M. Nodosa* var. *Tennifolia* (de Candolle) from the Port Jackson District (1). The principal constituents of oil from the former are δ -a-pinene (50-60 per cent) and sesquiterpenes (25-30 per cent), with small quantities of α -terpineol, dipentene, and sesquiterpene alcohol. The oil from the later yields cineol (40-55 per cent), α -pinene, dipentene, α -terpineol, sesquiterpene, etc. Both these species of paper bark tea tree occur in extensive areas close to Sydney, but the rapid advancement of settlement foreshadows their extermination at an early date.

Official Publications Received.

BRITISH.

Canada. Department of Mines : Mines Branch. Core Drilling Bituminous Sands of Northern Alberta. By S. C. Ellis. (No. 710-1.) Pp. 26. (Ottawa : F. A. Acland.)
 Southern Rhodesia. Report of the Education Commission. Pp. ii+187. (Salisbury.)
 Report on the Somaliland Agricultural and Geological Department for the Years 1927 and 1928. Pp. 48. (London : The Crown Agents for the Colonies.) 5s.
 Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research, for the Year 1928. Pp. viii+141+13 plates. (London : H.M. Stationery Office.) 3s. 6d. net.
 Tide Tables for the Eastern Coasts of Canada for the Year 1930 : including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits, and Information on Currents ; in addition Tide Tables for New York and Boston, U.S.A. Issued by the Tidal and Current Survey Division of the Hydrographic Service, in the Department of Marine and Fisheries of the Dominion of Canada. (Thirty-fourth year of Issue.) Pp. 90. (Ottawa : F. A. Acland.)
 Canada. Department of Mines : Mines Branch. Summary Report, 1928, Part A. (No. 2202.) Pp. 210A+4 plates. Summary Report, 1928, Part B. (No. 2206.) Pp. 131B+5 plates. Memoir 158 : Britannia Beach Map-area, British Columbia. By H. T. James. (No. 2193.) Pp. ii+139+4 plates. 25 cents. (Ottawa : F. A. Acland.)
 The Scottish Forestry Journal : being the Transactions of the Royal Scottish Arboricultural Society. Vol. 43, Part 2, October. Pp. xiv+81-168+37-46. (Edinburgh.) 7s. 6d.
 Ministry of Agriculture and Fisheries. Marketing Leaflet No. 15 : The Commercial Pig ; Interim Report by the Pig Industry Council. Pp. 12. (London : Ministry of Agriculture and Fisheries.)
 Proceedings of the Society for Psychological Research. Part 113, Vol. 39, December. Pp. 193-246. (London : Francis Edwards, Ltd.) 1s. 6d.

FOREIGN.

Scientific Papers of the Institute of Physical and Chemical Research. No. 217 : On the Difference of Behaviours of Different Parts of Three-Part Spark in Igniting Combustible Gas Mixture. By Torahiko Terada, Kiyohiko Yumoto and Ryūzō Yamamoto. Pp. 132-148+plate 15. (Tōkyō : Iwanami Shoten.)
 Contributions from the Dudley Herbarium of Stanford University. Vol. 1, No. 3 : A New Genus of the Saxifrage Family, by Leroy Abrams and Rimo Bacigalupi ; Two New Downings from Oregon, by Elmer I. Applegate ; Four New Plants from San Diego County, California, by Ira L. Wiggins. Pp. 89-102+4 plates 5-9. (Stanford University, Calif. : Stanford University Press.) 50 cents.
 Stanford University Publications. University Series : Biological Sciences. Vol. 5, No. 3 : The Principles of Systematic Entomology. By Prof. Gordon Floyd Ferris. Pp. 169. 2 dollars. Vol. 6, No. 1 : A Contribution toward a Monograph of the Adelgidae (Phylloxeridae) of North America. By Dr. P. N. Annand. Pp. 146. 2 dollars. (Stanford University, Calif. : Stanford University Press.)
 Department of the Interior : U.S. Geological Survey. Bulletin 800 : Geology and Mineral Deposits of Southeastern Alaska. By A. F. Buddington and Theodore Chapin. Pp. x+398+22 plates. 75 cents. Bulletin 804 : Geology and Coal and Oil Resources of the Hanna and Carbon Basins, Carbon County, Wyoming. By C. E. Dobbin, C. F. Bowen and H. W. Hoots. Pp. vi+88+27 plates. 60 cents. Bulletin 812-A : The Forsyth Coal Field, Rosebud, Treasure and Big Horn Counties, Montana. By C. E. Dobbin. (Contributions to Economic Geology, 1929, Part 2.) Pp. v+55+10 plates. 20 cents. (Washington, D.C. : Government Printing Office.)
 Department of the Interior : U.S. Geological Survey. Water-Supply Paper 597-C : Problems of the Soft-Water Supply of the Dakota Sandstone, with Special Reference to the Conditions at Canton, South Dakota. By Oscar E. Meinzer. (Contributions to the Hydrology of the United States, 1928.) Pp. ii+147-170+plate 20. Water-Supply Paper 597-E : Surface Water Supply of the Sacramento River Basin, California, 1895-1927. By H. D. McGlashan. (Contributions to the Hydrology of the United States, 1928.) Pp. vi+189-250. 10 cents. Water-Supply Paper 611 : Surface Water Supply of the United States, 1925. Part 11 : Pacific Slope Basins in California. Pp. viii+883. 50 cents. Water-Supply Paper 612 : Surface Water Supply of the United States, 1925. Part 12 : North Pacific Slope Drainage Basins. A : Pacific Basins in Washington and Upper Columbia River Basin. Pp. v+160. 25 cents. (Washington, D.C. : Government Printing Office.)

Diary of Societies.

FRIDAY, JANUARY 3.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.
 INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Eng. Vice-Admiral R. W. Skelton : Progress in Marine Engineering (Thomas Lowe Gray Lecture).
 INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—J. G. Wellings and C. G. Mayo : Instrument Transformers.
 ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.
 JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—F. T. Wood : Speedy Draughtsmanship.

SATURDAY, JANUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—S. R. K. Glanville : How Things were done in Ancient Egypt (Christmas Lectures) (4) : Boats and Furniture.

MONDAY, JANUARY 6.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Major C. K. Cochran-Patrick: Places seen from the Air (Christmas Lectures) (1).
 INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 7.—W. L. Morgan: Organisation of Public Service Motor Vehicle Repairs and Maintenance Systems.
 BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—W. H. Ambler: Single Dry Spun Yarns.
 ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. R. Unwin: Regional Planning, with Special Reference to Greater London.
 SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—C. J. Fox: The Micelle Chemistry of Cellulose.—J. A. Pickard: Metafiltration.
 TWICKENHAM LITERARY AND SCIENTIFIC SOCIETY (at Free Library, Twickenham), at 8.—Dr. E. H. Rayner: Power Transmission at High Voltages.

TUESDAY, JANUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—S. R. K. Glanville: How Things were done in Ancient Egypt (Christmas Lectures) (5): The Workshops.
 BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (jointly with Nursery School Association) (at University College), at 5.30.—Principles and Practice in Nursery School Education.—Mrs. S. Isaacs: What the Nursery School can do for the Young Child.—Miss Lillian de Lissa: Nursery School Aims and Problems.
 ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—L. Richmond: The Modern Tendency in Art.
 INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—J. R. Harnott: The Rigid Six-wheeled Vehicle.
 INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—T. W. Cooper: Roller Bearings.
 TELEVISION SOCIETY (at Engineers' Club, Coventry Street), at 8.—W. S. Newton: Photographic Problems of Picture Telegraphy.

WEDNESDAY, JANUARY 8.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. Stanley Smith: On some Valentian Corals from Shropshire and Montgomeryshire; with a Note on a New Stromatopoid.—Dr. Stanley Smith: The Carboniferous Inliers at Codrington and Wick (Gloucestershire).
 INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at 20 Hart Street, W.C.1), at 7.—C. A. Masterman: Combustion, Wind and Flue Equipment.
 ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—E. Downs: Electrolytic Gold Refining.

THURSDAY, JANUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—S. R. K. Glanville: How Things were done in Ancient Egypt (Christmas Lectures) (6): Hieroglyphs.
 LINNEAN SOCIETY OF LONDON, at 5.—W. H. Thorpe: Further Notes on Biological Races in *Hyponomeuta patella* (Linn.).—J. T. Cunningham: The Origin of Adaptations.
 INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—T. W. Ross and H. G. Bell: Recent Developments in the Protection of Three-Phase Transmission Lines and Feeders.
 ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—R. McKinnon Wood: The New American Wind Tunnel.
 INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.
 ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group—Informal Meeting), at 7.—F. W. Sharp: Dyebox.—F. R. Newsen: A New Formula and Method for 3-colour Carbo.
 INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—G. H. Chalmers: Lubrication.
 INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—G. Mortimer: The Aluminium Industry.
 SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—F. G. Conyers: Wood Distillation.
 OIL AND COLOUR CHEMISTS' ASSOCIATION, at 7.30.
 INSTITUTE OF BREWING (North of England Section) (at Midland Hotel, Manchester)—Dr. L. H. Lampitt: The Historical Development of Work on Yeast.
 INSTITUTE OF CHEMISTRY.—Dr. A. M. Bronté: The Medical Witness.
 NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Teesside Branch).—J. W. Hobson: Locomotives for Industrial Purposes and their Maintenance.
 INSTITUTION OF THE RUBBER INDUSTRY (Birmingham and District Section) (at Grand Hotel, Birmingham).—H. Standing: Outstanding Features in the Progress of the Rubber Industry.

FRIDAY, JANUARY 10.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—H. G. Watkins: By Canoe and Dog Sledge in Labrador (Christmas Lectures) (2).
 ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Basil P. Blackett: The Economic Progress of India.
 ROYAL ASTRONOMICAL SOCIETY, at 5.—E. A. Kræiken: The Frequency of Double Stars of Different Spectral Types and Absolute Magnitudes.—J. Jackson: The Shortt Clocks of the Royal Observatory, Greenwich, with Special Reference to the Effect of Variation in Arc.—H. Jones: Deviations from Boyle's Law in Stellar Interiors.
 MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.
 NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—L. C. Burrill: Design and Construction of the Rail-car-carrying Steamship *Seatrain*.
 SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. E. K. Rideal: Some Aspects of Surface Chemistry and their Industrial Implications.
 INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Free Trade Hall, Manchester), at 7.—Capt. P. P. Eckersley: Broadcasting by Electric Waves (Faraday Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.—Prof. T. P. Hilditch: Recent Research on Fats bearing upon the Drying of Oils in Paint and Varnish.
 GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—J. Pringle: The Geology of Ramsey Island (Pem.).—*Papers to be taken as read*:—The Palæobotany of the Kent Coalfield, Dr. R. Crookall and J. Pringle; The Preparation of Thin Sections of Friable and Weathered Materials by Impregnation with Synthetic Resins, R. J. Schaffer and P. Hirst.
 JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. J. N. Riddle: The Track Circuit in Railway Signalling.
 SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Burlington House), at 8.—J. R. Booer: Autogenous Welding in Chemical Works.
 PHILOLOGICAL SOCIETY (at University College), at 8.—G. G. Loane: Notes on N.E.D.
 SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Cardiff).—E. H. Williams: Graphitic Lubricants.

PUBLIC LECTURE.

TUESDAY, JANUARY 7.

PHILOSOPHICAL HALL, LEEDS, at 6.—E. G. Boulenger: Behind the Scenes of the Zoo Aquarium (Christmas Lecture).

CONFERENCES.

JANUARY 3.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at University College), at 2.30.—K. D. Young: School Sanatoria.
 BRITISH ASSOCIATION FOR PHYSICAL TRAINING (at University College), at 5.30.—Dr. D. J. Harris: The Electrical Phenomena of Muscle.

JANUARY 3 AND 4.

SCIENCE MASTERS' ASSOCIATION (at Imperial College of Science).
 Friday, Jan. 3, at 9.30 A.M.—W. Corbridge: Lecture Demonstration on Some Home-Made Physical Apparatus.
 At 10.45 A.M.—Dr. J. C. Munro: Industrial Biology (Lecture).
 At 12.—Prof. Truscott and others: Discussion on Openings for College Trained Men in the Mineral Industry.
 At 5.15.—Discussion with the Physical Society on Examinations in Practical Physics.
 At 8.15.—Discussion on School Certificate Biology.
 Saturday, Jan. 4.—Visits to the National Physical Laboratory and the Government Laboratory.

GEOGRAPHICAL ASSOCIATION (at London School of Economics).

Friday, Jan. 3, at 10 A.M.—Discussions:—The Physical Basis of Geography in Independent Schools. Opened by B. B. Dickinson.—Geography and the Training of Teachers. Opened by T. Herdman.
 At 11.30 A.M.—Col. H. L. Crosthwait: Air Survey (Lantern Lecture).
 At 2.30.—The Geography I was Taught, by Members of the Association.
 Saturday, Jan. 4, at 10.30 A.M.—Sir E. J. Russell: Agricultural Developments in South Africa (Lantern Lecture).
 At 11.45 A.M.—Dr. Vaughan Cornish: National Parks.

JANUARY 6 AND 7.

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College).
 Monday, Jan. 6, at 4.—B. L. Gimson and others: Discussion on Arithmetic of Citizenship.
 At 5.30.—Prof. S. Chapman: The Use of Spherical Harmonic Functions in Mathematical Physics.
 Tuesday, Jan. 7, at 10 A.M.—G. W. Spriggs and others: Discussion on Problems of Individual Education, with Special Reference to Work in Mathematics.
 At 11.45 A.M.—Prof. W. M. Roberts: Gunnery and some of its Mathematical Problems (Lecture).
 At 2.30.—Dr. W. F. Sheppard: Mathematics for Study of Frequency Statistics.
 At 3.45.—Miss Hilda P. Hudson and others: Discussion on The Mathematician in Ordinary Intercourse.

JANUARY 7.

NATIONAL COUNCIL FOR MENTAL HYGIENE (at University College), at 3.—Discussion: Preventable Mental and Physical Strains of School Life.

EXHIBITION.

JANUARY 7, 8, AND 9.

ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science), from 3 to 6, and from 7 to 10.
 Jan. 7, at 8.—Lord Rayleigh: Iridescent Colours in Nature from the Standpoint of Physical Optics (Lecture).
 Jan. 8.—S. G. Brown: Gyro Compasses for Gun-Fire Control (Lecture).
 Jan. 9.—Sir Ambrose Fleming: Television, Present and Future (Lecture).

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
 Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.