in coal-tar contains homologues of benzenes, which may be separated from it by fractional distillation. On the 17th of February, 1856, Mansfield was occupied with the distillation of this hydrocarbon, which he foresaw would find further applications, for the Paris Exhibition, in a still. The liquid in the retort boiled over and took fire, burning Mansfield so severely that he died in a few days.

The next step in the production of colours from benzene and toluene is the manufacture of nitrobenzene, $C_6H_5NO_2$, and nitrotoluene, $C_7H_7NO_2$. The former compound, discovered in 1834 by Mitscherlich, was first introduced as a technical product by Collas under the name of artificial oil of bitter almonds, and Mansfield in 1847 patented a process for its manufacture. It is now used for perfuming soap, but mainly for the manufacture of aniline ($C_6H_5NH_2$) for aniline blue and aniline black and for magenta. It is made on a very large scale by allowing a mixture of well-cooled fuming nitric acid and strong sulphuric acid to run into benzene contained in cast-iron vessels provided with stirrers.

To prepare aniline from nitrobenzene, this compound is acted upon with a mixture of iron turnings and hydrochloric acid in a cast-iron vessel. Commercial aniline is a mixture of this compound with toluidine obtained from toluene contained in commercial benzene. Some idea of the magnitude of this industry may be gained from the fact that in one aniline works near Manchester no less than 500 tons of this material are manufactured annually. From the year 1857, after Perkin's celebrated discovery [1] of the aniline colours, up to the present day, the history of the chemistry of the tar products has been that of a continued series of victories, each one more remarkable than the last.

Coal-tar Colours.—To even enumerate the different chemical compounds which have been prepared during the last thirty years from coal-tar would be a serious task, whilst to explain their constitution and to exhibit the endless variety of their coloured derivatives which are now manufactured would occupy far more time than is placed at my disposal. On the industrial importance of these discoveries the speaker reminded his audience of the wonderful potency of chemical research, as shown by the fact that the greasy material which in 1869 was burnt in the furnaces or sold as a cheap waggon grease at the rate of a few shillings a ton, received two years afterwards, when pressed into cakes, a price of no less than one shilling per pound, and this revolution was caused by Gräbe and Liebermann's synthesis of alizarin, the colouring matter of madder,[2] which is now manufactured from anthracene at a rate of more than two millions sterling per annum ; and it is stated that an offer was once made, in the earlier stages of its history, by a manufacturer of anthracene to the Paris authorities to take up the asphalt used in the streets for the purpose of distilling it, in order to recover the crude anthracene.

Again, we have in the azo-scarlets derived from naphthalene a second remarkable instance of the replacement of a natural colouring matter, that of the cochineal insect, by artificial tar-products, and the naphthol-yellows are gradually driving out the dyes obtained from wood extracts and berries. It is, however, true that some of the natural dye-stuffs appear to withstand the action of light better than their artificial substitutes, and our soldiers' red coats are still dyed with cochineal.

The introduction of these artificial scarlets has, it is interesting to note, greatly diminished the cultivation of cochineal in the Canaries, where, in its place, tobacco and sugar are now being largely grown.

Let us next turn to inquire as to the quantities of these various products obtainable by the distillation of one ton of coal in a gas-retort. The six most important materials found in gas-tar from which colours can be prepared are :—

1. Benzene.
2. Toluene.
3. Phenol.
4. Metaxylene (from solvent naphtha).
5. Naphthalene.
6. Anthracene.

The average quantity of each of these six raw materials obtainable by the destructive distillation of one ton of Lancashire coal is seen in Table I. Moreover, this table shows the average amount of certain colours which each of these raw materials yields, viz. :—

1. } Magenta 0·623 lb.
2. }
3. Aurin 1·2 lb.
4. (*Xylidine* 0·07 lb.)
5. Vermilline scarlet 7·11 lbs.
6. Alizarin 2·25 lbs. (20 per cent.)

Further, it shows the dyeing power of the above quantities of each of these colours, all obtained from one ton of coal, viz. :—

1 and 2. Magenta, 500 yards of flannel.
3. Aurin, 120 yards of flannel 27 in. wide.
4 and 5. Vermilline scarlet, 2560 yards of flannel.
6. Alizarin, 255 yards Turkey red cloth.

Lastly, to point out still more clearly these relationships, the dyeing power of one pound of coal is seen in the lowest horizontal column, and here we have a party-coloured flag, which exhibits the exact amount of colour obtainable from one pound of Lancashire coal.

Let us moreover remember, in this context, that no less than ten million tons of coal are used for gas-making every year in this country, and then let us form a notion of the vast colouring power which this quantity of coal represents.

The several colours here chosen as examples are only a few amongst a very numerous list of varied colour derivatives of each group. Thus we are at present acquainted with about sixteen distinct yellow colours ; about twelve orange ; more than thirty red colours ; about fifteen blues, seven greens, and nine violets ; also a number of browns and blacks, not to speak of mixtures of these several chemical compounds, giving rise to an almost infinite number of shades and tones of colour. These colours are capable of a rough arrangement according as they are originally derived from one or other of the hydrocarbons contained in the coal-tar. The fifty specimens of different colours exhibited may thus be classified, but in Table II., for the sake of brevity, only the commercial names and not the chemical formulæ of these compounds is given.

(*To be continued.*)

[1] See Lectures by Prof. Hofmann, F.R.S., "On Mauve and Magenta," April 11, 1882, and W. H. Perkin, F.R.S., "On the Newest Colouring Matters," May 14, 1869, *Proc. Roy Inst.*; also President's Address (Dr. Perkin, F.R.S.), *Journal of Society of Chemical Industry*, vol. iv., July 1884, on Coal-Tar Colours.

[2] "On the Artificial Production of Alizarine, the Colouring Matter of Madder," by Prof. H. E. Roscoe, *Proc. Roy. Inst.*, April 1, 1870; also Dr. Perkin, F.R.S., "On the History of Alizarine," *Journal Society of Arts*, May 30, 1879.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Liveing has been appointed Chairman of the Examiners for the Natural Sciences Tripos, and Mr. James Ward of those for the Moral Sciences Tripos. There were 106 candidates for the first part of the Natural Sciences Tripos recently held.

Attention has recently been given to the preservation of University buildings from fire, and serious defects have been, or are being, remedied. Such matters should be carefully thought out in regard to every museum and library, and it is to be hoped that attention will be constantly given to the efficiency of means of prevention and extinction of fires. The report on this subject in No. 636 of the *Cambridge University Reporter* is well worthy of the study of officials concerned in guarding precious scientific collections.

Prof. Darwin will lecture in the Long Vacation on the Theory of the Potential, Attractions, and the Figure of the Earth, the first lecture being on Tuesday, July 13.

A recent discussion of a report by the Special Board on Medicine emphasised the desirability of teaching elementary physics as part of general education to those intending to become medical students, and showed that the new "extra subjects" of the Previous Examination do not satisfactorily secure this, dynamics and a mathematical treatment being required, rather than experimental acquaintance with the physical forces. Mr. Oscar Browning said the interests of education were suffering terribly from the want of agreement as to what schoolboys ought to be taught. Mr. Shaw remarked on the importance of a training in inductive reasoning for medical students, for their whole practice would consist in drawing inductions.

The grants from the Worts Fund to Messrs. Bateson, Seward, Gadow, and Potter, to which we recently referred, have been voted by the Senate.

Prof. Alfred Marshall is giving a prize of 15*l.* annually for Political Economy, to be open to all members of the University under the M.A. degree. The examination is to consist of the papers on Political Economy in Part I., and on Advanced Poli-

ical Economy in Part II. of the Moral Sciences Tripos. The first award is to be in June 1887. He desires to concentrate the attention of some students more systematically than hitherto, noting that on some sides Natural Science studies constitute the best preparation.

During the last ten years, grants from the Worts Fund for Antiquarian and Literary subjects have amounted to 1100*l.*; for Biological and Geological subjects, to 1225*l.*; and for Medical subjects, to 100*l.*

Sir J. Lubbock's Rede Lecture will be delivered on Wednesday, June 9, at 2 p.m., in the Senate House, subject, "On the Forms of Seedlings and the Causes to which they are due."

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 27.—"The Influence of Stress and Strain on the Physical Properties of Matter. Part I. Elasticity (continued). The Effect of Magnetisation on the Elasticity and the Internal Friction of Metals." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

The principal object of this investigation was to test the soundness of the view advanced by Prof. G. Wiedemann respecting the cause of the internal friction of a torsionally oscillating wire. According to this view, the internal friction is mainly due to permanent rotation to-and-fro of the molecules about their axes; it seemed probable, therefore, that experiments on the effects of magnetising a wire, either longitudinally with a helix, or circularly by passing a current through it, would aid in elucidating the matter.

The following are the principal results which have been obtained:—

(1) When the deformations produced by the oscillations are small, the internal friction of a torsionally vibrating wire of iron or steel is not affected by sustained longitudinal magnetisation of moderate amount. The internal friction is also not affected by the sustained magnetisation even when the latter is carried to the point of saturation, provided the magnetising current be, previously to experimenting, reversed a great number of times. When no previous reversals have been made, the internal friction is slightly increased by intense magnetisation.

(2) When the deformations produced by the oscillations are large, the internal friction is very sensibly increased by sustained longitudinal magnetisation of large amount.

(3) The torsional elasticity is entirely independent of any sustained longitudinally magnetising stress which may be acting upon an iron or steel wire, provided the deformations produced by the torsional oscillations be small. When the deformations are large, the number of oscillations executed in a given time is very slightly lessened by sustained longitudinal magnetisation of large amount.

(4) When the magnetising current is interrupted and, to a greater extent, when it is reversed repeatedly whilst the wire is oscillating, the internal friction is increased, provided the magnetising stress be of moderate amount. The increase of internal friction may become very considerable when the magnetising stress is great.

When the number of interruptions or reversals in a given time of the magnetising current exceeds a certain limit, the effect on the internal friction begins to decline.

(5) When the deformations produced by the oscillations are small, the torsional elasticity is not affected by either repeatedly interrupted or reversed longitudinal magnetisation even when the magnetising stress is large.

(6) There exists a limit of magnetic stress within which no permanent rotation whatever of the molecules is produced. This limit may be widened by previous repeated reversals of a large magnetising stress.

(7) The passage of a moderate electric current, whether sustained or interrupted, through a torsionally vibrating wire of iron, steel, or nickel does not affect, except by heating, either the internal friction or the torsional elasticity, provided the deformations produced by the oscillations be small.

(8) The effect of longitudinal magnetisation, even when carried to the point of saturation, on the longitudinal oscillation of an iron or steel wire, is *nil*.

(9) The passage of an electric current, whether sustained or interrupted, through a longitudinally oscillating wire of iron or steel does not, except by heating, affect the number of oscillations executed in a given time.

Chemical Society, May 6.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. John W. King, William Herbert Hyatt, and George T. Holloway were admitted Fellows of the Society.—The following papers were read:—Paranitrobenzoylacetic acid and some of its derivatives, by Dr. W. H. Perkin, jun., and Dr. E. Bellinot.—An acetic ferment which forms cellulose, by Adrian J. Brown.

Victoria Institute, May 28.—Annual Meeting.—The chair being taken by Prof. Stokes, P.R.S., Capt. Francis Petrie, as Honorary Secretary, read the report, which showed that the home, colonial, and American members were now upwards of 1150, and an increasing number of leading men of science had contributed to its transactions, and the Institute was much indebted to many other scientific men of eminence, at present outside its ranks, who had kindly given their aid and advice, so that the Institute might the more worthily foster a true appreciation of the results of scientific inquiry.—Prof. Hull, F.R.S., Director of the Geological Survey of Ireland, delivered the address, in which he gave an account of the work, discoveries, and general results of the recent Geological and Geographical Expedition to Arabia and Western Palestine, of which he had charge. Prof. Hull, having sketched the course taken by the scientific Expedition (which to a considerable extent took the route ascribed to the Israelites), the physical features of the country, evidences of raised beaches, &c., showed that at one time an arm of the Mediterranean had occupied the valley of the Nile as far as the First Cataract, the level of the land being 200 feet lower than at present (an opinion which had also been arrived at by another of the Institute's members, Sir W. Dawson), and that, at the time of the Exodus, the Red Sea ran up into the Bitter Lakes, and clearly must have formed a barrier to the travellers' progress at that time; he then alluded to the great changes of elevation in the land eastward of these lakes, mentioning that the waters of the Jordan valley once stood 1300 feet above their present height. The various geological and geographical features of the country were so described as to make the address a condensed report of all that is now known of that part of the East.—A vote of thanks was accorded to Dr. Hull, after which the members and their guests adjourned to the museum, where refreshments were served.

EDINBURGH

Mathematical Society, May 14.—Dr. R. M. Ferguson, President, in the chair.—Mr. J. S. Mackay gave a construction, due to the Right Hon. H. C. E. Childers, for solving the problem of medial section; Mr. W. Peddie read the second part of a paper on the theory of contour lines and its application to physical science; and Mr. A. Y. Fraser submitted a paper, by Mr. Charles Chree, on the vibrations of a spherical or cylindrical body surrounded by or containing fluid.

PARIS

Academy of Sciences, May 24.—M. Jurien de la Gravière, President, in the chair.—Order of appearance of the first vessels in the leaves of the Cruciferæ: mixed formation (part 5), by M. A. Trécul. In a previous paper the author showed that the primary lobes in the type of mixed formation presented by certain Cruciferæ appear on either side of the young leaves in two superimposed series—a lower *basipetal* and an upper *basifugal*. He now proves that the first vessels of the nervous system corresponding to these lobes usually appear in the same order. Those opposed to the lobes of the basifugal series follow from below upwards, while those opposed to the lobes of the basipetal series make their appearance successively from above downwards.—A study of the movements communicated to the air by the action of a bird's wing: M. Müller's experiments, by M. Marey. A description is given of M. Müller's mechanical experiments, which are conducted at night by the aid of phosphorescent vapours, and during the day by means of smoke in the way adopted by Tyndall.—Note accompanying the presentation of M. Verbeek's fresh studies on the Krakatão eruption, by M. Daubrée. Besides a detailed account of the eruption this comprehensive work contains a full description of the meteorological and magnetic phenomena attending it, together with some theoretical considerations on their causes. The author calculates that the quantity of matter ejected was at least 18 cubic kilometres in volume, all incoherent, consequently unaccompanied by any flow of lava.—Presentation of various maps of France, Algeria, Tunisia, and Africa, issued by the Geo-