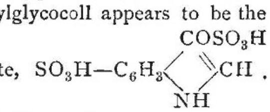
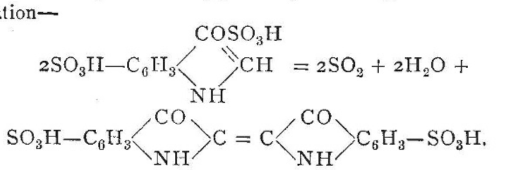
into about twenty times its weight of fuming sulphuric acid at a temperature of about 20°–25°. The fuming acid should contain at least 80 per cent. of sulphuric anhydride, and the temperature should be so controlled that it never exceeds 30° during the process of adding the mixture. The yellow solution thus obtained yields instantly the blue coloration due to indigocarmine on removing the large excess of sulphuric anhydride by the addition of ordinary oil of vitrol, sulphur dioxide being evolved. Upon further diluting with ice and addition of common salt (indigocarmine being more difficultly soluble in salt solutions than in pure water) the colouring-matter is precipitated, and may be readily isolated. The product thus obtained is found to consist of pure indigocarmine. The tints obtained with this product are vastly superior in beauty and clearness to those obtained with even the better kinds of commercial indigocarmine, on account of the higher degree of purity attained by this mode of preparation. The chemical changes occurring during the process appear to be as follows. The first product of the action of fuming sulphuric acid upon phenylglycocoll appears to be the sulphonic acid of indoxyl sulphate, 

This substance, however, is unstable, and decomposes upon the removal of the excess of SO_3 into indigo disulphonic acid, sulphur dioxide, and water, probably according to the following equation—



Of course the most important point of commercial interest about a new reaction is the yield, and in this respect Dr. Heymann is very fortunate, for already 60 per cent. of the theoretical has been attained. The process has consequently been patented by Messrs. Bayer and Co., and appears likely to become a very successful one.

THE additions to the Zoological Society's Gardens during the past week include a Water Buck (*Cobus ellipsiprymnus* ♀), a Leopard (*Felis pardus*), two Vulturine Guinea Fowls (*Numida vulturina*), two Mitred Guinea Fowls (*Numida mitrata*) from East Africa, presented by Mr. G. S. Mackenzie, F.Z.S.; a Peregrine Falcon (*Falco peregrinus*) from Scotland, presented by Mr. Thomas C. Smith; a Mountain Ka-Ka (*Nestor notabilis*) from New Zealand, presented by Mr. Herbert Furber; a Grey Squirrel (*Sciurus griseus*), a Squirrel (*Sciurus* sp. inc.) from North America, a Ducorp's Cockatoo (*Cacatua ducorpsi*) from the Solomon Islands, presented by Mr. Nicholas O'Reilly; two Ravens (*Corvus corax*) from Ireland, presented by Captain Ogilby; a Cheetah (*Cynœlurus jubatus*) from Persia, three Blandford's Rats (*Mus blandfordi*), two —— Terrapins (*Clemmys* sp. inc.) from India, deposited; two Coypus (*Myopotamus coypus*) from South America, two Andaman Starlings (*Sturnia andamanensis*) from the Andaman Islands, two Red-billed Hornbills (*Toccus erythrorhynchus*), two African White Spoonbills (*Platalea alba*) from Africa, two Virginian Eagle Owls (*Bubo virginianus*) from North America, purchased; a Red Deer (*Cervus elaphus* ♂), a Japanese Deer (*Cervus sika* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MERIDIAN PHOTOMETER.—In vol. xxiii. of the *Annals of the Harvard College Observatory*, Prof. E. C. Pickering and O. C. Wendell give and discuss the observations made at Cambridge, U.S., with the meridian photometer during the years 1882–88. The observations relate principally to stars north of the declination −40°. Vol. xiv. of the *Annals* contained the results of observations of the brightness of stars made with a small meridian photometer. The present volume deals with the photometric measurements of somewhat fainter stars, made by means of a similar but larger instrument.

REPORT OF HARVARD COLLEGE OBSERVATORY.—Prof. Pickering has just issued his Report for last year. He again urges the necessity of a fire-proof building for storing the 27,000 photographic plates of spectra, 9000 of which were taken in 1890. Legacies for the endowment of science in America are so common that it is not surprising to learn that the Observatory has received a gift of 25,000 dollars through the late Mr. J. I. Bowditch. During the past year 1309 photographs of stellar spectra have been taken with the Bache telescope at the station near Closica, in Peru. Nearly all of them relate to the region south of −20°. Mrs. Draper has added another instrument of the same kind to the Henry Draper Memorial. This is mounted in the Observatory grounds at Cambridge, and since September 1889, 2157 photographs have been taken with it, covering the sky north of −20°. By placing a prism of small angle over the objective, the spectra of stars as faint as the tenth magnitude have been obtained. Six stars with Type IV. spectra have been discovered. Spectra of fifteen planetary nebulæ have been photographed. The hydrogen line F has been shown to be bright in eight stars. Bright line stars of the Wolf-Rayet type now number twenty-eight, three having been added to the list during the past year. The names are given of thirty variable stars of long period, in which the hydrogen lines are bright at maximum. This peculiarity has furnished a means of discovering seven new variable stars. The 11-inch telescope has been used for a detailed study of the spectra of the brightest stars, with the result that β Aurigæ and ζ Ursæ Majoris have been discovered to be close binaries. One photograph of σ Herculis seems to show that this star also is double, but this has not been confirmed. With the 12-inch telescope a number of "canals" on Mars have been recognized, but only one of them was distinctly seen to be double. An important accession to the white spot surrounding the southern pole was found by photographs to have occurred between the nights of April 9 and 10. The Report concludes with a list of the numerous publications issued by the Observatory during the year.

THE SOLAR PARALLAX AND ITS RELATED CONSTANTS.

IT would be difficult to conceive a more masterly and comprehensive exposition of astronomical and physical constants than one just issued by Prof. W. Harkness, of the United States Naval Observatory. As is rightly pointed out, "The solar parallax is not an independent constant. On the contrary, it is entangled with the lunar parallax, the constants of precession and nutation, the parallactic inequality of the moon, the lunar inequality of the earth, the masses of the earth and moon, the ratio of the solar and lunar tides, the constant of aberration, the velocity of light, and the light equation." It should therefore be determined simultaneously with all these quantities by means of a least-square adjustment, and Prof. Harkness develops such a method. The equations connecting the constants are given, whilst the numerical values which are discussed are based upon an enormous mass of astronomical, geodetic, gravitational, and tidal observations which have required more than two hundred years for their accumulation. The sources of probable error are also examined, and it is suggested how some of the constants may be improved in the future. The completeness of the lists of constants, and the careful manner in which they are discussed and corrected by the comprehensive least-square adjustment which is developed, justifies our giving *seriatim* the results obtained:—

Equatorial semi-diameter of the earth—

$$3963 \cdot 124 \pm 0 \cdot 078 \text{ miles.}$$

Polar semi-diameter of the earth—

$$3949 \cdot 922 \pm 0 \cdot 062 \text{ miles.}$$

One earth quadrant—

$$10001816 \pm 125 \cdot 1 \text{ metres.}$$

Oblateness or flattening of the earth—

$$1/300 \cdot 205 \pm 2 \cdot 964.$$

Eccentricity of the earth—

$$0 \cdot 006651018.$$

©1891 Nature Publishing Group

Mean density of the earth—

$$5{\cdot}576 \pm 0016.$$

Surface density of the earth—

$$2{\cdot}56 \pm 0{\cdot}16.$$

Length of the seconds pendulum (ϕ = latitude)—

$$39{\cdot}012540 + 0{\cdot}208268 \sin^2\phi \text{ inches.}$$

Acceleration due to gravity—

$$32{\cdot}086528 + 0{\cdot}171293 \sin^2\phi \text{ feet.}$$

Length of the sidereal year—

365d. 6h. 9m. 9·314s.

Length of the tropical year at time t—

$$365\text{d. } 5\text{h. } 48\text{m. } 46{\cdot}069\text{s.} - 0{\cdot}53675\text{s.}\left(\frac{t-1850}{100}\right).$$

Length of the sidereal month—

$$27\text{d. } 7\text{h. } 43\text{m. } 11{\cdot}524\text{s.} - 0{\cdot}022671\text{s.}\left(\frac{t-1800}{100}\right).$$

Length of the synodical month—

$$29\text{d. } 12\text{h. } 44\text{m. } 2{\cdot}841\text{s.} - 0{\cdot}026522\text{s.}\left(\frac{t-1800}{100}\right).$$

Length of the sidereal day—

86164·09965 mean solar seconds.

Ratio of the mean motions of the sun and moon—

0·074801329112.

Mass of Mercury (Sun = 1), $\dfrac{1}{8374672 \pm 1765762}$

,, Venus ,, $\dfrac{1}{408968 \pm 1874}$

,, Earth ,, $\dfrac{1}{327214 \pm 624}$

,, Mars ,, $\dfrac{1}{3093500 \pm 3295}$

,, Jupiter ,, $\dfrac{1}{1047{\cdot}55 \pm 0{\cdot}20}$

,, Saturn ,, $\dfrac{1}{3501{\cdot}6 \pm 0{\cdot}78}$

,, Uranus ,, $\dfrac{1}{22600 \pm 36}$

,, Neptune ,, $\dfrac{1}{18780 \pm 300}$

,, Moon (Earth = 1) $\dfrac{1}{81{\cdot}068 \pm 0{\cdot}238}$

Constant of solar parallax—

$$8''{\cdot}80905 \pm 0''{\cdot}00567.$$

Mean distance of earth from sun—

$$92796950 \pm 59715 \text{ miles.}$$

Eccentricity of the earth's orbit—

0·016771049.

Lunar inequality of the earth—

$$6''{\cdot}52294 \pm 0''{\cdot}01854.$$

Lunar parallax—

$$3422''{\cdot}54216 \pm 0''{\cdot}12533.$$

Mean distance from earth to moon—

$$238854{\cdot}75 \pm 9{\cdot}916 \text{ miles.}$$

Eccentricity of moon's orbit—

0·054899720.

Inclination of moon's orbit—

$$5^\circ\ 8'\ 43''{\cdot}3546.$$

Mean motion of the moon's node in 365¼ days—

$$-19^\circ\ 21'\ 19''{\cdot}6191 + 0''{\cdot}14136\left(\frac{t-1800}{100}\right).$$

Parallactic inequality of the moon—

$$124''{\cdot}95126 \pm 0''{\cdot}08197.$$

Constant of luni-solar precession—

$$50''{\cdot}35710 \pm 0''{\cdot}00349.$$

Constant of nutation—

$$9''{\cdot}22054 \pm 0''{\cdot}00859.$$

Constant of aberration—

$$20''{\cdot}45451 \pm 0''{\cdot}01258.$$

The time taken by light to traverse the mean radius of the earth's orbit (the light equation)—

$$498{\cdot}00595\text{s.} \pm 0{\cdot}30834\text{s.}$$

The velocity of light *in vacuo* per second of mean solar time—

$$186337{\cdot}00 \pm 49{\cdot}722 \text{ miles.}$$

In order to improve the system of constants discussed, Prof. Harkness thinks that the parallax of the moon should be determined by the diurnal method at one or more stations as near as possible to the equator, and that the Observatories in the northern and southern hemispheres should co-operate with each other for two or three years in systematically making meridian observations of the moon to improve our knowledge of its parallax. Numerous pendulum observations are required, and new determinations of the constants of aberration and nutation by as many different methods as possible. The most probable coefficient of the lunar inequality of the earth's motion should be obtained from Greenwich and Washington meridian observations of the sun, whilst the opposition of Mars in 1892, and favourably situated asteroids, should be utilized for new determinations of the solar parallax.

The laborious character of an investigation which leads to the results here given is patent to all. To say, therefore, that all the computations involved were made and checked by Prof. Harkness himself is to testify to industry very rarely excelled.

TECHNICAL EDUCATION IN RUSSIA.

AN interesting report on technical education in Russia has been laid before Parliament by the Foreign Office. It is a digest by Mr. Harford of a very voluminous Report, compiled by Mr. Anopoff, Director of the Nicholas Industrial School at St. Petersburg, on technical education in Russia, and is described by Sir R. Morier as giving an exhaustive review of all that has been done during the last 20 years in Russia in this important branch of national education, and is of special interest as furnishing information on the most recent legislation respecting schools about to be founded.

M. Anopoff confines himself to giving full details of intermediate and elementary technical and industrial teaching institutions, without attempting a description of the higher schools. The establishment of these former classes of schools dates, he says, from only some 25 years back, but in that short space of time they have spread to the confines of the Russian Empire. In 1883, a special section for technical and professional education was created in the Ministry of Education. According to the new regulations of the *Realschulen*, intermediate and elementary technical and industrial schools are to be opened at the public expense. M. Anopoff remarks, however, that these new schools cannot be expected to be at first as successful as the existing schools with their long practical experience. He adds, too, that the greater number of the technical schools in Russia were founded at the initiative, and often even at the expense, of local societies and private persons. The various technical and industrial institutions in Russia are divided into five groups:—(1) Technical schools with the course of intermediate schools resembling the *Realschulen*, but differing from them by their professional character being more strongly marked. The task of these schools, which, as regards the knowledge required, is about equivalent to the standard of the *Realschulen*, with a course of from six to eight years, consists in imparting a general acquaintance with the technical and partly commercial subjects which are indispensable for the assistants of engineers, and for independent managers of small technical undertakings. (2) To the second group may be referred institutions in which subjects of general education are taught within the scope of the courses of municipal schools and district and village schools with two classes. From those who enter them a knowledge is required approximate to the scope of primary schools, the full course of study lasting from four to six years. In these schools, besides the subjects taught in the municipal schools under the regulations of 1872, the following additional subjects are taken up: physics, mechanics, technology of metals and woods, bookkeeping, &c., while to drawing, both freehand and geometrical, much attention is given. The object of these institutions is the preparation of skilled artisans for factories, of lesser mechanical specialists, machinists, and draughtsmen. In this category should be included the railway schools, but as they are under the control of the Ministry of Communications, and serve certain special ob-

©1891 Nature Publishing Group