subject a second time, they will be especially useful. Teachers will also find them a great help, forming as they do an excellent series of examination papers.

MESSRS. G. W. BACON AND CO. have published a "New Geological Map of England and Wales." It is "compiled from the best authorities."

THE Royal University of Ireland has published the Examination Papers, 1890, as a supplement to the University Calendar for the year 1891.

AN important communication upon the colour and absorption spectrum of liquefied oxygen is made by M. Olszewski to the January number of the *Anzeiger der Akademie der Wissenschaften in Krakau*, and a brief abstract is published in the current number of the *Chemiker Zeitung*. Liquid oxygen has hitherto been described as a colourless liquid. In thin layers it certainly appears to be colourless; but M. Olszewski in the course of his investigation of the absorption spectrum, has obtained a sufficient quantity of the liquid to form a layer thirty millimetres thick, and makes the somewhat unexpected and very important discovery that it possesses a bright blue colour resembling that of the sky. Great precautions were taken to ensure the purity of the oxygen employed, the absence of ozone, which in the liquid state possesses a deep blue colour, being especially ascertained. Carbon dioxide, chlorine, and water vapour were also completely eliminated, the oxygen having been left in contact under pressure with solid caustic potash for a week. In view of this fact that oxygen in the liquid state transmits a preponderating quantity of blue light, M. Olszewski's latest experiments upon its absorption spectrum are specially interesting. In a former paper to the *Monatshefte*, an account of which was given in NATURE, vol. xxxvi. p. 42, the absorption spectrum of a layer 7 mm. thick was shown to exhibit two strong dark bands, one in the orange, extending from wave-length 634 to wave-length 622, distinguished for its breadth, and one in the yellow, wave-length 581–573, distinguished for its intensity. When the thickness of the layer was increased to 12 millimetres, two further bands appeared, a very faint one in the green, about wave-length 535, and a somewhat stronger one in the blue, extending between wave-lengths 481 and 478. M. Olszewski now finds that his layer 30 millimetres thick, which possesses the blue colour, exhibits a fifth band in the red, corresponding with Fraunhofer's A. This band is rendered still more apparent when a plate of red glass is held between the source of light and the slit of the spectroscope. It is stronger in intensity than the band of wave-length 535, but fainter than the other three bands. This observation of the coincidence of an oxygen band with the telluric band A of the solar spectrum is of considerable interest. For Ångström, in 1864, expressed the opinion that this band A was not due to the aqueous vapour of the atmosphere; and Egoroff and Janssen, who examined the spectrum of long layers of compressed gaseous oxygen, were of opinion that it was due to oxygen. In conclusion, M. Olszewski remarks that the colour exhibited by his 30-millimetre layer is exactly what one would expect from the nature of its absorption spectrum. He also suggests that the blue colour of the sky may be simply due to the atmospheric oxygen, which in gaseous layers of such extent may exhibit the same colour as when compressed into a few centimetres of liquid. Apart from the discussion of this debatable subject, the fact is certainly of interest to chemists, that ordinary oxygen and its condensation allotrope ozone, when compressed into the liquid state, are thus related as regards colour, the former possessing a bright blue and the latter a deep blue tint.

THE additions to the Zoological Society's Gardens during the past week include a Common Otter (*Lutra vulgaris*) from Suffolk, presented by Mr. G. C. Edwardes-Ker; a Common Rhea (*Rhea americana*) from South America, presented by Mrs. Hatfield; a Brazilian Caracara (*Polyborus brasiliensis*) from Brazil, presented by Mr. J. D. Spooner; a Green-cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, presented by Miss Julia Crooke; two Leopard Tortoises (*Testudo pardalis*), five Angulated Tortoises (*Chersina angulata*), a Tuberculated Tortoise (*Homopus femoralis*), four Areolated Tortoises (*Homopus areolatus*), a Hygian Snake (*Elaps hygiæ*), four Smooth-clawed Frogs (*Xenopus lævis*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a L'huy's Impeyan Pheasant (*Lophophorus l'huysi* ♂) from Western China, deposited; two White-throated Capuchins (*Cebus hypoleucus* ♂ ♂) from Central America, a Coqueral's Lemur (*Cheirogalus coquerali* ♂) from Madagascar, a Small-clawed Otter (*Lutra leptonyx*) from India, a Collared Peccary (*Dicotyles tajaçu* ♂) from South America, two Griffon Vultures (*Gyps fulvus*), a Ruddy Sheldrake (*Tadorna casarca*), European, six Amherst's Pheasants (*Thaumalea amherstiæ* 6 ♂) from Szechuan, China, purchased.

OUR ASTRONOMICAL COLUMN.

DETERMINATION OF THE CONSTANT OF ABERRATION.—*Comptes rendus* for March 16 contains an abstract of a memoir by MM. Lœwy and Puiseux, on determinations of the aberration constant, in which some of the results obtained by M. Lœwy's method are given. Up to 1828, astronomers accepted, as the constant of aberration, values which were comprised between 20″·255 and 20″·708, these being respectively due to Delambre and Bessel. Richardson then obtained the value 20″·446 from a discussion of 4000 observations made with the Greenwich mural circle by his predecessors. In 1843, W. Struve proposed a value almost identical with this, viz. 20″ 445, as the result of a discussion of his careful observations made in the prime vertical. He estimated the probable error as 0″·011, and remarked that he did not think any astronomical element had been determined with so great an accuracy. Struve's work was received with much favour, and appeared to render unnecessary, for a number of years, all researches on the same subject. However, in 1844, Baily deduced 20″·419 as the most probable value, and in after years, Peters, Lundhal, and Lindhagen subjected to a minute discussion all the meridian observations, made at Dorpat and Pulkova, of circumpolar stars. From their researches, a value a little greater than that of Struve was found. Still, when these results were taken in conjunction with the determinations the most worthy of confidence the values 20″·45 and 20″·46 were obtained, thus supporting Struve's work. Nyren, from a discussion of observations made by Struve in the prime vertical as material for the study of nutation, derived the value 20″·43. In 1853, Struve himself proposed to increase his number to 20″·463 with a probable error of 0″·017, but the reasons given to justify the change do not appear to be sufficient. Gylden, Wagner, and Nyren's ulterior observations at Pulkova of circumpolar stars gave the higher value 20″·49. Later, in 1879–82, Nyren made another determination by Struve's method, and used a large number of stars for the investigation. He then found 20″·540 or 20″·517, according to the method of grouping adopted. More recently, in 1885, Küstner, of Berlin Observatory, found 20″·313 by Horrebow and Talcott's method Between these two last numbers, both of which represent a large amount of work executed with much care, the difference is somewhat greater than 0″·2—that is, about twenty times the probable error estimated by Struve in 1843. This seems to indicate that the astronomers have taken a step backwards. MM. Lœwy and Puiseux do not enumerate the work done on the same subject at Greenwich, the Cape, Washington, and other Observatories, but point out that similar sources of error exist in all the methods employed. Lœwy's method, as is now well known, consists in placing before the object-glass of an equatorial a double plane mirror formed by silvering the sides of a prism of glass. This acts as a sort of compass of strictly constant opening, and brings to the eyes rays which make a constant angle with each other. Pairs of stars separated by a wide angle on the celestial sphere, but which together appear in the field of view, can easily be found, and the variations in relative position due to refraction or aberration can be measured micrometrically with great precision. The adoption of this method leads the

authors to the following tentative conclusions :—(1) The number 20″·445, proposed by Struve, is very near to the truth. It would be premature, in our opinion, to wish to modify it. (2) As M. Fizeau supposed, reflected rays behave in the same manner as direct rays from an aberration point of view. (3) The new method for the investigation of aberration may be regarded as proved and definite.

In a future communication the authors will give some details of the method, the observations made on four couples of stars, and the numerical value they find for the aberration constant.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday of last week, the spring meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the Council of the latter Society, the President, Mr. Joseph Tomlinson, being in the chair. There were but two items in the programme—namely, the fourth Report of the Research Committee on Friction, and a paper on rock drills, contributed by Messrs. Carbutt and Davey. The meeting suffered a good deal, especially on the second evening, from the fact that the Institution of Naval Architects was in session at the same time. On both evenings very interesting papers on engineering subjects were being read before the latter Society, where the attraction appeared to be greater, for, whilst the Mechanical Engineers meeting was very thinly attended, the Naval Architects had, we hear, an overflowing house on both evenings. It is a pity the secretaries of two Societies having objects so nearly akin, cannot arrange for their meetings not to clash. There is this to be said in favour of the Naval Architects, however, that they were adhering to a time-honoured fixture.

FRICTION OF A PIVOT BEARING.

The Friction Committee's report was taken charge of by Mr. Beauchamp Tower, who was practically the author. The experiments were carried on last year at Simpson and Co.'s engine works, Pimlico, &c. The thanks of the Institution, and of the engineering world at large, are due to this firm for the assistance they have lent, and perhaps the name of Mr. Mair-Rumley should be especially mentioned in this connection.

The pivot bearing operated upon was 3 inches in diameter, and flat ended. The vertical shaft carrying the footstep was geared to a horizontal shaft, which was driven by a belt from the works shafting. Variations of speed were obtained by varying the size of pulley. The bearing was pressed upwards against the footstep by an oil press with a 6-inch diameter plunger. This plunger was made a good but perfectly free fit in its cylinder for a length of 9 inches, a number of grooves being turned in the cylinder throughout its whole length at close intervals. The pressure was applied by means of a small hand-pump, provided with an air-vessel, pumping oil out of a tank into the press. It was found that the leakage of the oil past the plunger, even with the highest pressures, was exceedingly slow, requiring only an occasional stroke of the pump to keep the pressure constant ; and at the same time the friction was practically *nil*. Into the top of the plunger was let a piece of hard steel, having a conical depression, wherein rested a hard steel conical centre, which was formed on the bottom of the plate L that carried the bearing. This plate was circular, and had a groove turned in its periphery ; a small chain was fastened to the plate and lay in the groove round a portion of the circumference, from whence it led off to a spring-balance attached to the fixed frame of the apparatus ; so that the rotation of the plate stretched the spring-balance, and the force tending to turn the plate was thereby indicated. The upper end of the vertical shaft that carried the footstep had a piston fixed on it, which revolved in a cylinder 6 inches diameter. This upper cylinder was connected by a pipe with the cylinder of the lower press, so that, whatever oil-pressure there was in the lower cylinder pressing the bearing upwards, there was the same in the upper cylinder pressing the footstep downwards. This was a convenient way of providing for taking the upward thrust upon the experimental bearing. The footstep having been set running at the desired speed, the hand pump was worked until the pressure gauge on the oil press indicated the desired pressure ; and the friction was then read off the spring balance connected with the bearing plate. The load could be quickly removed from the bearing by opening a cock for discharging the oil from the air-vessel of the pump. This method of applying the load was found to be exceedingly convenient. Efficient automatic means of lubrication were provided, which are well worth following, but which we have not space to describe. In the results the coefficient of friction was obtained by dividing the friction in inch-pounds by the product of the load multiplied by the area of the bearing.

The results of the experiments were given in the report by means of a table and in a graphic form. From these we extract the following outline particulars ; and must refer our readers to the report itself, which will be published in the Proceedings of the Institution, for fuller details upon this important and interesting subject.

Experiments on the Friction of a Pivot Bearing. Steel Footstep on Manganese Bronze Bearing.

Revolutions per min.	Load : lbs. per sq. in.	Oil drops per min.	Friction. Total.	Friction. Coefficient.
			In. lbs.	
50	20	20	2·77	0·0196
	120	56	18·72	0·0221
128	20	79	1·13	0·0080
	160	84	12·82	0·0113
194	20	196	1·44	0·0102
	160	168	7·69	0·0068
290	20	Continuous stream	2·51	0·0178
	140	,, ,,	4·51	0·0046
	160	200	5·03	0·0044
353	20	Continuous stream	2·36	0·0167
	160	,, ,,	6·15	0·0054

The friction given is that of one face of the flat circular bearing surfaces, at the effective radius of the face, viz. 1 inch.

A white metal bearing surface was next substituted for the manganese bronze. The coefficient of friction was a little larger, but the difference was so small that the results may be looked upon as practically identical.

That the coefficient of friction is less at the higher speeds is doubtless due to the more perfect action of the lubricating device. After the completion of these experiments, the endurance of the manganese bronze and white metal bearings were tested. The former heated and seized at 260 pounds per square inch load on one occasion, and 300 pounds on another, running at 128 revolutions per minute without lubrication. The white metal bearing heated and seized in a load of 240 pounds per square inch at 128 revolutions per minute, without lubrication.

These experiments should be studied with those on the same subject which have preceded them.[1] A short but interesting discussion followed the reading of the paper.

ROCK DRILLS.

The paper on rock drills does not call for an extended notice at our hands. It grew out of some trials made last year at the Crystal Palace, in connection with the Mining Exhibition there held.

One cannot help comparing the carefully thought-out trials last described with those now before us. The only point upon which we can commend those responsible for the present competition is that they awarded no prize. Perhaps one of the most difficult subjects to decide by competition would be the superiority of any one rock drill over its fellows, and the conditions of trial would require careful planning and elaborate preparation. We were not present at the trials, but, to judge by the description, they seem to have been organized by persons having a very elementary knowledge of the conditions under which these machines are called upon to work. One of the judges stated that his qualification to act arose from the fact that he had been in the steam-hammer business, and the

[1] For previous reports see Proceedings of the Institution, 1883, p. 632 ; 1885, p. 58 ; and 1888, p. 173.