of sesquisulphide of phosphorus in carbon bisulphide and evaporating. The second iodo-sulphide of phosphorus has the composition PSI or $P_2S_2I_2$, and was obtained by the action of sulphuretted hydrogen upon the tri-iodide of phosphorus, PI_3. A lower temperature than that required for the formation of the compound just described is advisable at first; it should not be much higher than 55°, the melting point of the tri-iodide; before the conclusion of the reaction, however, it may safely be raised to 120°. The solution of the product in carbon bisulphide deposits red crystals of the new compound PSI. These crystals are much more rapidly attacked by moist air than those of the first iodo-sulphide, and the reaction is accompanied by the liberation of fumes of hydriodic acid. They take fire upon warming in the air, disseminating the odour of sulphur dioxide and the violet vapour of iodine. Water dissolves them rapidly, producing trisulphide of phosphorus and hydriodic and phosphorous acids, and sulphuretted hydrogen is subsequently evolved owing to the decomposition of the trisulsphide. The third iodo-sulphide was obtained by reacting with excess of tri-iodide of phosphorus upon the trisulphide. It is deposited from carbon bisulphide in deep red crystals, very rapidly decomposed by moist air, and its composition is P_2SI_4. It thus appears that iodine is capable of replacing more or less of the sulphur contained in the sulphides of phosphorus, although it does not succeed in totally eliminating sulphur from its combination with phosphorus. M. Ouvrard has also obtained several new halogen derivatives of the sulphides of arsenic and antimony. English readers of the original paper cannot but be sorry, however, that M. Ouvrard employs the old notation, which renders it difficult at first sight to follow the equations representing the reactions. The formulæ above given are translated into the modern notation now universally employed in this country and Germany.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. F. Erskine Paton; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss Florence Marryat; two Common Peafowl (*Pavo cristatus*, ♂ ♀) from India, presented by Mr. A. Tannenbaum; a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; four Common Snakes (*Tropidonotus natrix*), a Common Viper (*Vipera berus*), British, presented by Mr. Harold Attewell; a Smooth Snake (*Coronella lævis*) British, presented by Mr. Harry Furniss; a Natterjack Toad (*Bufo calamita*), British, presented by Mr. F. Wallace; a Raven (*Corvus corax*), British, presented by Mr. Robert O. Callaghan; two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, four Yellow-bellied Liothrix (*Liothrix luteus*), two Hamadryads (*Ophiophagus elaps*) from India, deposited; an Ashy-black Macaque (*Macacus ocreatus*, ♂) from the East Indies, a Beech Marten (*Mustela foina*) from Russia, a Red and Yellow Macaw (*Ara chloroptera*) from South America, a Yellow-headed Vulture (*Cathartes urubitinga*) from Brazil, a Turkey Vulture (*Cathartes aura*) from America, a Guianan Crested Eagle (*Morphnus guianensis*) from the Amazons, purchased; an English Wild Cow (*Bos taurus*, var.), three Varied Rats (*Isomys variegatus*), a Bennetts Wallaby (*Halmaturus bennetti*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

REPORT OF THE ASTRONOMER-ROYAL FOR SCOTLAND.—The fourth annual report of Prof. Copeland on the Royal Observatory, Edinburgh, informs us that great progress has been made in the construction of the new Observatory. The masonry of all the buildings is complete, and some parts are ready for the internal fittings.

A comparison of the earlier Edinburgh star places with the catalogue of the *Astronomische Gesellschaft* has shown the necessity of a complete new reduction of the observations, in order to bring them into line with modern practice in this kind of work. For this purpose considerable progress has been made in an investigation of the errors of the transit instrument.

At the request of M. d'Abbadie, of the Paris Academy of Sciences, a bifilar pendulum was temporarily erected on the rock at Calton Hill on March 24. This extremely sensitive instrument, constructed by Mr. Horace Darwin on a principle suggested by Lord Kelvin, indicates the minutest change of level in the foundation to which it is attached. Prof. Copeland hopes shortly to commence a series of systematic observations in conjunction with allied observations made by M. d'Abbadie nearly on the same meridian in the south of France. These investigations will probably show if any considerable tilt takes place at the same time at both stations. It is thought that the bifilar pendulum may serve to detect the occurrence of sudden displacements in the foundations of observatories.

AWARD OF THE WATSON MEDAL.—At Washington a few weeks ago Mr. S. C. Chandler was awarded the Watson medal by the National Academy of Sciences. A description of the founding of the award and the work of previous recipients, given by Mr. John Ritchie, jun., in the *Boston Commonwealth*, recalls a few facts of interest. Prof. J. C. Watson, the founder of the award, was for many years professor of astronomy and physics in the Universities of Michigan and Wisconsin, and for some time previous to his decease was director of the Washburn Observatory at Madison. His treatise on theoretical astronomy is known to every computing astronomer. During the later years of his life he devoted his attention to the minor planets, of which he discovered twelve. It is common knowledge that, at the eclipse of July 29, 1878, he and Dr. Swift reported observations of an intra-mercurial planet, and he believed in the existence of such a body up to his death in 1880. At his death he left his estate, some family legacies excepted, in trust to the National Academy of Sciences, the fund having since been designated the Watson Fund. The amount of money realised was in all some twenty or thirty thousand dollars. The income of this is to be expended for the promotion of astronomical science, specific provision being made for the presentation of a gold medal and a gratuity of one hundred dollars in gold coin, from time to time, to an astronomer who shall have accomplished work of high merit. He nominated as trustees of his fund his friends Hilgard, Coffin and Newcomb, with provision for the appointment of their successors. The high quality of the trust has been continued by the selection of Dr. B. A. Gould and Prof. Asaph Hall as successors to Hilgard and Coffin, who passed away some three years ago. Four medals only have been given: the first to Dr. B. A. Gould in 1887; the second to Prof. Edward Schönfeld, Director of the University of Bonn, in 1888; the third to Dr. Arthur Auwers, of Berlin, in 1891; and the fourth to Mr. Chandler. It need hardly be said that the award was chiefly given to Mr. Chandler for his brilliant investigations on the variations of latitude.

TWO NEW CATALOGUES.—*Astronomische Nachrichten* No. 3232 contains a long list of stars with remarkable spectra, observed by the Rev. T. E. Espin. The catalogue comprises 167 stars, most of which have not had their spectra previously recorded, 206 stars found to have spectra belonging to Type III., and a list of 136 stars, of which it is doubtful whether they belong to Type II. or III. Nos. 3233–34 of the same publication contain a catalogue of 187 new double stars discovered with the 18½ inch refractor of the Deerhorn Observatory, U.S.A., and measures of 152 double stars, by Prof. G. W. Hough.

THE DENSITY OF NITROGEN GAS.[1]

IN a former communication[2] I have described how nitrogen, prepared by Lupton's method, proved to be lighter by about 1/1000 part than that derived from air in the usual manner.

[1] "On an Anomaly encountered in Determinations of the Density of Nitrogen Gas." A paper read before the Royal Society on April 19, by Lord Rayleigh, Sec. R.S.

[2] "On the Densities of the Principal Gases," *Roy. Soc. Proc.* vol. liii. p. 146, 1893.

In both cases a red hot tube containing copper is employed, but with this difference. In the latter method the atmospheric oxygen is removed by oxidation of the copper itself, while in Lupton's method it combines with the hydrogen of ammonia, through which the air is caused to pass on its way to the furnace, the copper remaining unaltered. In order to exaggerate the effect, the air was subsequently replaced by oxygen. Under these conditions the whole, instead of only about one-seventh part of the nitrogen is derived from ammonia, and the discrepancy was found to be exalted to about one half per cent.

Upon the assumption that similar gas should be obtained by both methods, we may explain the discrepancy by supposing either that the atmospheric nitrogen was too heavy on account of imperfect removal of oxygen, or that the ammonia nitrogen was too light on account of contamination with gases lighter than pure nitrogen. Independently of the fact that the action of the copper in the first case was pushed to great lengths, there are two arguments which appeared to exclude the supposition that oxygen was still present in the prepared gas. One of these depends upon the large quantity of oxygen that would be required in view of the small difference between the weights of the two gases. As much as 1/30th part of oxygen would be necessary to raise the density by 1/200, or about one-sixth of all the oxygen originally present. This seemed to be out of the question. But even if so high a degree of imperfection in the action of the copper could be admitted, the large alteration caused by the substitution of oxygen for air in Lupton's process would remain unexplained. Moreover, as has been described in the former paper, the introduction of hydrogen into the gas made no difference, such hydrogen being removed by the hot oxide of copper subsequently traversed. It is surely impossible that the supposed residual oxygen could have survived such treatment.

Another argument may be founded upon more recent results, presently to be given, from which it appears that almost exactly the same density is found when the oxygen of air is removed by hot iron reduced with hydrogen, instead of by copper, or in the cold by ferrous hydrate.

But the difficulties in the way of accepting the second alternative are hardly less formidable. For the question at once arises, of what gas, lighter than nitrogen, does the contamination consist? In order that the reader may the better judge, it may be well to specify more fully what were the arrangements adopted. The gas, whether air or oxygen, after passing through potash was charged with ammonia as it traversed a small wash-bottle, and thence proceeded to the furnace. The first passage through the furnace was in a tube packed with metallic copper, in the form of fine wire. Then followed a wash-bottle of sulphuric acid by which the greater part of the excess of ammonia would be arrested, and a second passage through the furnace in a tube containing copper oxide. The gas then traversed a long length of pumice charged with sulphuric acid, and a small wash-bottle containing Nessler solution. On the other side of the regulating tap the arrangements were always as formerly described, and included tubes of finely divided potash and of phosphoric anhydride. The rate of passage was usually about half a litre per hour.

Of the possible impurities, lighter than nitrogen, those most demanding consideration are hydrogen, ammonia, and water vapour. The last may be dismissed at once, and the absence of ammonia is almost equally certain. The question of hydrogen appears the most important. But this gas, and hydrocarbons, such as CH_4, could they be present, should be burnt by the copper oxide; and the experiments already referred to, in which hydrogen was purposely introduced into atmospheric nitrogen, seem to prove conclusively that the burning would really take place. Some further experiments of the same kind will presently be given.

The gas from ammonia and oxygen was sometimes odourless, but at other times smelt strongly of nitrous fumes, and, after mixture with moist air, reddened litmus paper. On one occasion the oxidation of the nitrogen went so far that the gas showed colour in the blow-off tube of the Töppler, although the thickness of the layer was only about half an inch. But the presence of nitric oxide is, of course, no explanation of the abnormal lightness. The conditions under which the oxidation takes place proved to be difficult of control, and it was thought desirable to examine nitrogen derived by *reduction* from nitric and nitrous oxides.

The former source was the first experimented upon. The gas was evolved from copper and diluted nitric acid in the usual way, and, after passing through potash, was reduced by *iron*, copper not being sufficiently active, at least without a very high temperature. The iron was prepared from blacksmith's scale. In order to get quit of carbon, it was first treated with a current of oxygen at a red heat, and afterwards reduced by hydrogen, the reduction being repeated after each employment. The greater part of the work of reducing the gas was performed outside the furnace in a tube heated locally with a Bunsen flame. In the passage through the furnace in a tube containing similar iron, the work would be completed, if necessary. Next followed washing with sulphuric acid (as required in the ammonia process), a second passage through the furnace over copper oxide, and further washing with sulphuric acid. In order to obtain an indication of any unreduced nitric oxide, a wash-bottle containing ferrous sulphate was introduced, after which followed the Nessler test and drying tubes, as already described. As thus arranged, the apparatus could be employed without alteration, whether the nitrogen to be collected was derived from air, from ammonia, from nitric oxide, from nitrous oxide, or from ammonium nitrite.

The numbers which follow are the weights of the gas contained by the globe at zero, at the pressure defined by the manometer when the temperature is 15°. They are corrected for the errors in the weights, but not for the shrinkage of the globe when exhausted, and thus correspond to the number 2·31026, as formerly given for nitrogen.

Nitrogen from NO by Hot Iron.

November 29, 1893 ...	2·30143	Mean, 2·30008
December 2, 1893 ...	2·29890	
December 5, 1893 ...	2·29816	
December 6, 1893 ...	2·30182	

Nitrogen from N_2O by Hot Iron.[1]

December 26, 1893 ...	2·29869	Mean, 2·29904
December 28, 1893 ...	2·29940	

Nitrogen from Ammonium Nitrite passed over Hot Iron.

January 9, 1894	2·29849	Mean, 2·29869
January 13, 1894... ...	2·29889	

With these are to be compared the weights of nitrogen derived from the atmosphere.

Nitrogen from Air by Hot Iron.

December 12, 1893 ...	2·31017	Mean, 2·31003
December 14, 1893 ...	2·30986(H)	
December 19, 1893 ...	2·31003(H)	
December 22, 1893 ...	2·31007	

Nitrogen from Air by Ferrous Hydrate.

January 27, 1894	2·31024	Mean, 2·31020
January 30, 1894	2·31010	
February 1, 1894	2·31028	

In the last case a large volume of air was confined for several hours in a glass reservoir with a mixture of slaked lime and ferrous sulphate. The gas was displaced by deoxygenated water, and further purified by passage through a tube packed with a similar mixture. The hot tubes were not used.

If we bring together the means fa atmospheric nitrogen obtained by various methods, the agreement is seen to be good, and may be regarded as inconsistent with the supposition of residual oxygen in quantity sufficient to influence the weights.

Atmospheric Nitrogen.

By hot copper, 1892	2·31026
By hot iron, 1893	2·31003
By ferrous hydrate, 1894	2·31020

Two of the results relating to hot iron, those of December 14 and December 19, were obtained from nitrogen, into which hydrogen had been purposely introduced. An electrolytic generator was inserted between the two tubes containing hot iron, as formerly described. The generator worked under its own electromotive force, and the current was measured by a tangent galvanometer. Thus, on December 19, the deflection throughout the time of filling was 3°, representing about 1/15

[1] The N_2O was prepared from zinc and very dilute nitric acid.

ampère. In two hours and a half the hydrogen introduced into the gas would be about 70 c.c., sufficient, if retained, to reduce the weight by about 4 per cent. The fact that there was no sensible reduction proves that the hydrogen was effectively removed by the copper oxide.

The nitrogen, obtained altogether in four ways from chemical compounds, is materially lighter than the above, the difference amounting to about 11 mg., or about 1/200 part of the whole. It is also to be observed that the agreement of individual results is less close in the case of chemical nitrogen than of atmospheric nitrogen.

I have made some experiments to try whether the densities were influenced by exposing the gas to the silent electric discharge. A Siemens tube, as used for generating ozone, was inserted in the path of the gas after desiccation with phosphoric anhydride. The following were the results:—

Nitrogen from Air by Hot Iron, Electrified.

January 1, 1894	2·31163	Mean, 2·31059
January 4, 1894	2·30956	

Nitrogen from N_2O by Hot Iron, Electrified.

January 2, 1894	2·30074	Mean, 2·30064
January 5, 1894	2·30054	

The somewhat anomalous result of January 1 is partly explained by the failure to obtain a subsequent weighing of the globe empty, and there is no indication that any effect was produced by the electrification.

One more observation I will bring forward in conclusion. Nitrogen prepared from oxygen and ammonia, and about one-half per cent. lighter than ordinary atmospheric nitrogen, was stored in the globe for eight months. The globe was then connected to the apparatus, and the pressure was readjusted in the usual manner to the standard conditions. On reweighing no change was observed, so that the abnormally light nitrogen did not become dense by keeping.

DR. ARMSTRONG ON THE PUBLICATION OF SCIENTIFIC LITERATURE.

THE presidential address delivered by Dr. Armstrong at the last annual meeting of the Chemical Society, and published in the May number of the Society's *Journal*, contains numerous suggestive remarks on questions affecting all branches of science. A subject that has lately been attracting some attention is the publication of the proceedings of societies. On this Dr. Armstrong has much to say, and as he has had abundant opportunity of proving the value of the system followed by the Chemical Society, and comparing it with those of other societies, his opinions carry weight. Our space will not permit us to reprint the address, but the following extracts will suffice to show its character.

"Chemical literature is fast becoming unmanageable and uncontrollable from its very vastness. Not only is the number of papers increasing from year to year, but new journals are constantly being established. Something must be done in order to assist chemists to remain in touch with their subject and to retain their hold on the literature generally. This object would be best attained if chemists could agree to publish everything in one journal; but for many reasons, and until the world has recognised one language, such an idea must remain but a dream. This being the case, we must endeavour to have as few journals as possible, which is desirable even from the point of view of our pockets and of the dimensions of our book-shelves and houses, none of which are infinitely elastic. It is clear that in the British Isles but one journal is necessary; a large majority of the papers by workers in British laboratories, containing matter new to chemical science, are at present communicated to us, and I see no reason why all should not be. I do not mean that all should be read before the Chemical Society, because the mere reading is frequently but a formal proceeding, or, in some cases, may take place with advantage elsewhere. The Society of Chemical Industry has set us a good example in this respect by publishing in one journal the papers read at various places in the country; it matters little that the papers are read before affiliated sections of the Society, as these sections are practically independent organisations. . . .

"It seems to me, that eventually one of two courses must be adopted in this country—either the societies engaged in doing similar work must become affiliated, or our Society must return to the practice of early days and publish lengthy abstracts of papers communicated to societies such as the Royal Societies of London and Edinburgh, in order to bring these papers properly under the notice of chemists generally. The former course would involve an agreement amongst us to print in some uniform manner, less expensive, magnificent and stately than that adopted by the Royal Societies; a somewhat larger octavo than that of our present journal would probably suffice, such as is adopted for the *Annals of Botany*. If such an agreement were arrived at, a paper read and discussed before the Royal Society of London or Edinburgh, for example, might be printed off, and the necessary number of copies supplied to the society; while, if the paper interested chemists, we might at the same time take an appropriate number, and issue the paper as part of our Transactions. . . .

"The policy thus advocated with reference to English chemical papers is already being elsewhere adopted. The *Monatshefte für Chemie*, for example, is advisedly a collection of the papers of Austrian chemists, although, unfortunately, this does not yet include the whole of the work done in Austria-Hungary. The *Gazzetta chimica italiana* appears to contain very nearly all the Italian work. All that is done in Holland is brought together in the *Recueil des travaux chimique des Pays-Bas*. France and Germany, however, each have a variety of journals. In France the prestige of the Academy is such that for some time to come it will probably be difficult to consolidate the interests of French chemists. In Germany, however, the *Deutsche chemische Gesellschaft* is no longer hampered by the words *zu Berlin*, which it has boldly dropped, while we still remain the Chemical Society *of London* in name; it is to be hoped that in the interests of the scientific world it will ere long acquire and quash the private interests by which other journals are supported. I see no good reason even why journals devoted to special branches of our subject should exist, and I regard the appearance, for example, of a special journal of inorganic chemistry as an unmitigated evil. Political colouring and a tendency to adopt methods akin to those of the newspaper editor, of which we have had evidence in one of these journals, are most undesirable features in science. Moreover, we cannot afford to buy everything; and no effort should be spared to prevent our being split up into factions and becoming narrow-minded specialists: the more the student of chemistry—and every original worker must be and remain a student throughout his life—is brought directly into contact with the work which is being done in the several departments of his science, the better it will be for him; he cannot and need not read everything, but do not let us deprive him of the opportunity of easily indulging in a mixed diet, and of exercising his mental faculties generally, while devoting himself specially to some one section of the vast subject which it is the privilege of the chemist to command.

"To complete my scheme—which I trust is not altogether visionary, for so great is the toleration and sympathy between all true-minded scientific workers that if union be possible in any field of human activity it is possible in the field of science—it will be necessary that the Scandinavian and Danish chemists, say, should unite; and also that the Russian chemists should give us a 'recueil des travaux chimiques' in *French*, so that the world may no longer be deprived of the knowledge of their labours, which we know, from experience, are of high value. As to America, it would be a great achievement if the political separation of our two nations could be disregarded and we were to unite with our cousins in establishing one journal for the publication of the work of chemists speaking English. There would be no real difficulty in doing this in these days of type-written manuscript, the proof of which need but be revised by the printers' reader. But if motives of expediency render such union impracticable, then it is to be hoped that steps may be taken to make the title *American Chemical Journal* truly and completely significant. I hope that we shall be successful in arranging to co-operate with all chemists in our own colonies and India. . . .

"There has been much discussion during the past few months, especially in the columns of NATURE, on the question of the publication of physical papers, which, strange to say, is in a very inchoate condition. I feel sure that the problem will soon be successfully solved by the Physical Society boldly coming forward and undertaking to do for physics what we have proved can be done for chemistry; there is no other solution possible,