important part of his professional duties to travel frequently and far. I have never been able to settle to my own satisfaction the maximum income which a department of geography might usefully spend, but I have had considerable experience of working a department the income of which was not very far above the minimum. Until now the Oxford School of Geography has been obliged to content itself with three rooms and to make these suffice, not merely for lecture-rooms and laboratories, but also for housing its large and valuable collection of maps and other materials. This collection is far beyond anything which any other university in this country possesses, but it shrinks into insignificance beside that of a rich and adequately supported Geographical Department like that of the University of Berlin. This fortunate department has an income of about 6000*l.* a year, and an institute built specially for its requirements at a cost of more than 150,000*l.*, excluding the site. In Oxford we are most grateful to the generosity of Mr. Bailey, of Johannesburg, which will enable the School of Geography to add to its accommodation by renting for five years a private house, in which there will temporarily be room for our students and for our collections, especially those relating to the geography of the Empire. But even then we can never hope to do what we might if we had a building specially designed for geographical teaching and research. Again, Lord Brassey and Mr. Douglas Freshfield, a former President of this Section, have each generously offered 500*l.* towards the endowment of a professorship if other support is forthcoming. All this is matter for congratulation, but I need hardly point out that a professor with only a precarious working income for his department is a person in a far from enviable position. There is at present no permanent working income guaranteed to any Geographical Department in the country, and so long as this is the case the work of all these departments will be hampered and the training of a succession of competent men retarded. I do not think that I can conclude this brief address better than by appealing to those princes of industry who have made this great city of Sheffield what it is to provide for the Geographical Department of the University on a scale which shall make it at once a model and a stimulus to every other university in the country and to all benefactors of universities.

IONISATION OF GASES AND CHEMICAL CHANGE.[1]

THE term "catalytic" was introduced by Berzelius to describe a number of chemical actions which would only take place in the presence of a third substance, which itself was apparently unchanged throughout the reaction. The first cases of such actions were investigated by Sir Humphry Davy in 1817. He showed that many mixtures of gases were caused to unite in the presence of finely divided platinum at temperatures far below those at which union ordinarily took place. Some years afterwards Faraday investigated similar actions, and attempted to explain them by a supposed condensation of the gases on the surface of the metal.

Thirty years ago Prof. H. B. Dixon investigated the behaviour of carbon monoxide and oxygen when they were dried as completely as possible, and he discovered that in these circumstances electric sparks caused no explosion. Some years before Wanklyn had discovered that purified chlorine did not act on sodium, but he did not identify the impurity, now known to be a trace of water, which causes the vigorous action which takes place in ordinary circumstances.

In 1882 Cowper investigated the action of dried chlorine on several metals, and found that the removal of moisture in many cases inhibited the reaction.

In the following year, working in Prof. Dixon's laboratory at Balliol College, I found that purified carbon could be heated to redness in dried oxygen, and that sulphur and phosphorus could be distilled in the same gas without burning. In the investigations which followed, some thirty simple reactions have been tried by myself and others. It has been shown that hydrogen and chlorine can be exposed to light without explosion, ammonia and hydrogen chloride mixed without union, sulphur trioxide can be crystallised on lime, ammonium chloride and mercurous chloride give undissociated vapours, hydrogen and oxygen can be exposed to a red heat without explosion, and lastly, in 1907, nitrogen trioxide was obtained as an undissociated gas for the first time by carefully drying the liquid and evaporating into a dried atmosphere.

The amount of water necessary to carry on these chemical reactions is extremely small, certainly less than 1 mg. in 300,000 litres. There is no accepted explanation of its catalytic effect, and in the same way the catalytic power of platinum is still a mystery. Dr. Armstrong's theory, that only water which is capable of conducting an electric current is capable of bringing about these chemical actions, seems to be supported by the fact that water can be formed in heated tubes containing very pure hydrogen and oxygen without the explosive combination of the gases taking place. That great purity does affect the chemical activity of water was proved by an experiment shown during the lecture. Two tubes, one containing water of a very high degree of purity and the other containing ordinary distilled water, were placed side by side in the lantern. Into each was filtered some liquid sodium amalgam, and while vigorous effervescence was seen in the less pure water, the very pure specimen was apparently without action for some minutes, and even at the end of the lecture its action had not attained the same vigour as that in the other tube.

In 1893 Sir J. J. Thomson (*Phil. Mag.*, xxxvi., 321) showed that if the combination of atoms in a molecule is electrical in its nature, the presence of liquid drops of water, or drops of any liquid of high specific inductive capacity, would be sufficient to cause a loosening of the tie between the atoms, and this might result in chemical combination of the partially freed atoms to form new molecules. He showed in the same paper that drying a gas very completely stopped the passage of a current of 1200 volts. In the same year I was able in the same way to prevent the passage of discharge from an induction coil, a discharge which would traverse a spark gap of three times the distance in undried gas.

Shortly after the discovery of Röntgen rays, it was found that they would ionise a gas through which they passed. At the time it was thought that this ionisation was similar to that taking place in electrolysis. If this were so the rays would probably cause chemical union to take place even in a dried gas, and accordingly Prof. Dixon and I undertook some experiments on the subject, which were published in a joint paper (Chem. Soc. Jour., 1896). The results were negative; no chemical action could be detected. Since that time the ionisation of gases has been shown to be of quite a different nature. The negative ion has been shown to be a particle of the mass of about 1/1500th that of the hydrogen atom, and the positive ion is the residue. Since the ionisation of gases is different from that in electrolysis, the retention of this term is much to be deprecated. It is suggested that the term ionisation should be retained for electrolytic dissociation, and for the different process which takes place in gases under the action of Röntgen rays, &c., a new name, electromerism, should be adopted. The electron would thus be the negative electromer.

It is probable that electrolysis and true ionisation may take place in gases, as in the decomposition of steam by electric sparks of a particular length. An experiment recently devised seems to show that in mercury vapour, which ordinarily consists of atoms, something of the nature of ionisation without electrolysis can take place. If oxygen be admitted to the interior of a mercury lamp from which the current has just been cut off, a considerable quantity of mercuric oxide is produced, although the temperature of the lamp (about 150°) is far lower than would suffice to bring about the union of ordinary mercury vapour with oxygen.

In order to test further the question as to whether electromerism can bring about chemical change, I have investigated the action of radium bromide on very pure and dry hydrogen and oxygen. The gases were sealed up with some radium bromide contained in an open silica tube. The containing vessel was provided with a vacuum gauge, by means of which the combination of 1/5000th

[1] Discourse delivered at the Royal Institution on Friday, March 11, by Dr. H. Brereton Baker, F.R.S.

part of the gases could be easily detected. No action whatever was observed, although the substances were left in contact for two months. A further experiment showed that, as was to be expected, very dry air undergoes electromerism when subjected to the action of radium. Two more tubes were then set up, similar to the first, containing mixtures of carbon monoxide and oxygen, one very dry and the other containing traces of moisture, and although the radium bromide was in contact with them for more than three months, not the slightest contraction could be observed. In these cases, therefore, electromerism produces no chemical change.

There was, however, a possibility that electromerism might bring about a chemical action in a mixture of gases which was under conditions which were nearly, but not quite, suitable for chemical action to take place. The gaseous mixtures mentioned only combine, even when moist, at a red heat. Since the experiments were done at 20°, they only show that electromerism does not produce chemical action in gases which are otherwise unable to combine.

There remained the possibility that if gases were just on the point of combining, increasing the electromerism might accelerate the rate of action. I sought for a case of simple chemical union which would proceed at a manageable temperature, and at a rate which could be measured. Of those tried, the reaction between hydrogen and nitrous oxide was found to be the most suitable. The gases used were as pure as possible, but dried only by passing through phosphorus pentoxide tubes. They were found to combine with great uniformity when heated in clean Jena glass tubes to 530°. An electric resistance furnace was used, consisting of a wide silica tube which formed the heated chamber. It is known that many substances when heated produce electromers in a gas; lime is fairly efficient, thoria more so, and, of course, radium bromide most of all. In the first experiment two tubes of the same Jena glass, containing the hydrogen and nitrous oxide mixture, were heated side by side. One contained some lime, and in order to make the conditions as similar as possible an equal quantity of powdered Jena glass was introduced into the other. As soon as the requisite temperature was reached, the action proceeded rapidly in the tube containing lime, the rate in the first five minutes being five times the rate of combination in the tube containing only powdered glass. After fifteen minutes the second tube had caught up the first, and the rates of union were equal up to the completion of the action. With thoria the effect was still more marked, the rate increasing to twenty times the rate in the tube containing the glass. Finally, about 2 mg. of radium bromide was heated in the mixture of gases. As soon as the combining temperature was reached, the gases in the radium bromide tube exploded.

From these three experiments it is seen that, as the amount of electromerism was increased, there was a rapid increase in chemical action.

I have recently been able to show that if the union of carbon monoxide and oxygen takes place in a strong electric field, which has the effect of removing electromers, the chemical action is diminished. Similar experiments are in progress with the mixture of hydrogen and chlorine, combining under the influence of light.

The next experiment tried illustrates one way in which the electromerism of a gas may bring about chemical change. Hydrogen sulphide and sulphur dioxide can be mixed at the ordinary temperature in presence of traces of moisture, but in presence of liquid water decomposition takes place into sulphur and water. The gases were dried before mixing by calcium chloride, which leaves about 4 mg. of water vapour per litre in the gas. After mixing, a small open silica tube containing about 2 mg. of dried radium bromide was introduced. After six hours no apparent change had taken place in the gas; there was no deposit of sulphur on the sides of the jar, and it seemed at first as if no action had been produced. On opening the jar, however, an inrush of air was noticed, and the contents were almost odourless. On heating the radium tube a large quantity of water was driven off, and a copious sublimate of sulphur was seen. The whole of the gaseous contents of the jar had condensed in the small tube containing the radium bromide. The explanation of this action of radium bromide is probably simple. Water vapour condenses on the electromers emitted, liquid drops are formed, and in them the chemical action takes place.[1]

Prof. Townsend has recently published an account of some experiments in which he has shown that there is a very marked decrease in the mobility of negative electromers in the presence of an amount of water vapour represented by a pressure of 1/10th mm. The air, in his experiments, was subjected to the action of Röntgen rays.

It is concluded that water in a form approaching to that of a drop is condensed on the electron even when a very small quantity is present. If this deposition of water molecules on electromers goes on when the amount of water present is still smaller, the theory of Sir J. J. Thomson affords a satisfactory explanation of the influence of moisture on chemical change, since some electromers are always present in ordinary gases.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Lancet* states that the University of Bristol is to receive the sum of 1000*l*. from the estate of the late Miss J. L. Woodward for the foundation of a scholarship in music or botany, to be known as the "Vincent Stuckey Lean Scholarship."

IT is proposed that the Congress of the Universities of the Empire shall be held in London in June, 1912, and a meeting of the Vice-Chancellors of the British universities is to take place in November next with the object of drawing up a provisional scheme of subjects to be discussed at the congress, which scheme will then be submitted to the overseas universities for suggestions.

AN Institute of Colonial Medicine has been established in connection with the faculty of medicine of the University of Paris. The first session will begin on October 13 and end at the close of the year. The following courses of instruction are announced:—Technical bacteriology and hæmatology, by Prof. Roger; parasitology, by Prof. Blanchard; surgery in tropical countries, by Dr. Morestin; ophthalmic affections, by Dr. Lapersonne; general epidemiology, by Prof. Chantemesse; tropical pathology and tropical hygiene, by Dr. Wurtz; and dermatology, by Prof. Gaucher in collaboration with Dr. Jeanselme.

ATTENTION has been directed here from time to time to the movement in this country to establish universities in China. We learn from the *Times* of September 13 that the success of the proposed Hong Kong University seems assured. Sir Frederick Lugard, the Governor of Hong Kong, has taken a prominent part in demonstrating the advantages likely to accrue from the undertaking, and he has been generously assisted by large contributions from the leading Chinese and others in the colony. Sir Hormusji Mody has offered to erect the buildings, whatever their cost (estimated at about 30,000*l*.), in accordance with the approved plans. Dr. Ho Kai, C.M.G., has given 18,000*l*.; Mr. J. H. Scott, senior partner of Messrs. Butterfield and Swire, has announced a gift of 40,000*l*. on behalf of his own and allied firms; and the Central Government at Peking has sent a substantial contribution. The bare minimum sum required has now been practically raised, and Sir Frederick Lugard and his helpers are appealing to the British public for the amount required to make the University worthy of British prestige. It may be pointed out that though there is no antagonism between them, there is no connection between this scheme and that associated with Oxford and Cambridge for the establishment of a university at Hankau, on the Yangtsze.

THE annual meeting of the Institution of Mining Engineers was held at the University College, Nottingham, last week. In welcoming the members, Sir Joseph Bright, chairman of the council of the college, said they hoped in the near future to establish a chair of mining

[1] I have invariably noticed that water collects in tubes containing radium preparations exposed to undried air. The salts are not at all deliquescent, the crystals appearing quite sharp-edged under the microscope. I found that 10 mg. of radium bromide exposed to an atmosphere saturated at 0° for two days caused a deposition of water on its surface weighing 1·5 mg.