scale is, as far as I know, unique in the world's history, and it is the very marrow of our splendid development. Each large work has the greater part of its scientific staff—and there are often more than 100 *doctores phil.* in a single manufactory—occupied, not in the management of the manfacture, but in making inventions. The research laboratory in such a work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years.

It seems to me a point of the greatest importance that the conviction of the practical usefulness of a theoretical or purely scientific training is fully understood in Germany by the leaders of great manufactories. When, some years ago, I had occasion to preside at a meeting, consisting of about two-thirds practical men and one-third teachers, I was much surprised to observe the unhesitating belief of the former in the usefulness of entirely theoretical investigations. And I know a case where, quite recently, an "extraordinary" professor of a university has been offered a very large salary to induce him to enter a works, only for the purpose of undertaking researches regarding the practical use of some scientific methods which he had been working at with considerable success. No special instructions are given to him, for it is taken for granted that he himself will find the most promising methods; only, in order to increase his interest in the business, part of his remuneration has been made proportional to the commercial success of his future inventions. From this clear understanding of the commercial importance of science by the directors of industrial establishments there science itself gains another advantage. A scientific man can be almost sure, if he wants in his investigations the help of such technical means as only great works can afford, that he will get such assistance at once on application to any work; and the scientific papers of German chemists very often contain acknowledgments, with due thanks, of considerable help they have thus obtained.

Besides these advantages for the development of scientific and technical chemistry in Germany there exists another very important factor—practical assistance from the Government. Universities are in Germany affairs of the State, not of the Empire, and in no other point has the division of the Fatherland into many smaller countries proved itself to such a degree a boon and a blessing. The essential character of the German universities, the freedom conferred by the independence of the numerous universities, is never lost. There have been hard times occasionally for the universities of one country or another; but some universities were always to be found where even in times of hard oppression liberty of teaching and learning remained complete and unaffected, and the spirit of pure unalloyed scientific research was preserved and encouraged. So this palladium of intellectual freedom has never been lost; and it regained the former influence as soon as the casual oppression ceased. In our days there is among all the separate State Governments in Germany a clear conviction of the importance of practical support being given to pure scientific research. To take one instance, in order to facilitate teaching and research in electro-chemistry (a recently developed branch of science) a suggestion by some leading practical scientific men to the members of the Government was sufficient. Upon such a suggestion a considerable sum of money was spent first by the Prussian Government for the endowment of electro-chemical chairs and laboratories in the three "polytechnic" colleges of that country. A short time afterwards it was resolved to erect at one of the universities (Göttingen) an institute for physical chemistry, and especially electro-chemistry, in the shape of a building which has just been completed. At the same time, other German countries have begun to grant to their universities and technical colleges considerable sums of money for similar purposes, *e.g.* the Saxon Landtag alone has unanimously voted half a million marks (= £25,000) for the erection of a splendid laboratory for physical chemistry at Leipzig.

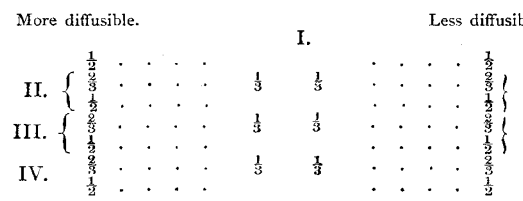
You will excuse my boasting about our German management of this most important question of scientific education. It is no blind admiration without criticism, for I know by practical experience the management in other countries, and I can compare them. And it is only for the sake of science itself that I write these lines. If they should help the spread of the conviction of the incomparable practical usefulness of every support given to pure science, together with the recognition of the fact that the latter can only grow in an atmosphere of liberty and confidence, I should regard it as tending towards the progress of science itself, and destined to exercise such an influence on scientific progress as may be compared with the discovery of the most remarkable scientific fact.

THE HOMOGENEITY OF ARGON AND OF HELIUM.[1]

THE question of the homogeneity of argon has been discussed by Lord Rayleigh and one of us in their memoir on Argon (*Phil. Trans.*, A, p. 236, 1895). But at that epoch the data were not sufficiently numerous to enable us to arrive at very definite conclusions. The discovery of helium and the analysis of its spectrum by Runge and Paschen (*Sitzungsberichte d. Akad. d. Wissenschaften*, pp. 639 and 759, Berlin, 1895) lead to the thought that this body may be a mixture of two gases.

To elucidate this question we submitted these two gases to a methodical diffusion, causing them to traverse a duct of porous pipe-clay submitted on one of its surfaces to the action of a vacuum. We satisfied ourselves that we might thus effect the separation of hydrogen and helium and that of oxygen and carbonic acid, and that, by measuring the rapidity of the descent of a column of mercury introduced in the circuit of the apparatus, it is possible to arrive at a good determination of the molecular weight of various gases. We have then tried to separate argon into two parts by a method analogous to the separation of liquids by fractionated distillation.

The quantity of argon was close upon 400 c.c. The gas was then treated in the manner shown in the following scheme:—



We determined the density of the two extreme portions, and found that the one which ought to be the lightest had the density (O = 10) of 19·93, and the heaviest of 20·01. The separation, if it takes place, is therefore minimal.

The same experiment executed with helium yielded other results. The density of the specimen which passed first was 1·874, and that of the gas remaining in the apparatus 2·133. A great number of fractionations did not change these figures; even the spectra of the two specimens were absolutely identical. Even the first bubbles of the lighter gas showed the same lines, with the same intensity, as the last bubbles which remained in the apparatus. There was no difference in fifty fractions.

Lord Rayleigh has had the kindness to measure the refraction of the two specimens of gas. Whilst the lighter gives the figure 0·1350 (atmospheric air = 1), the heavier had a refraction expressed by the figure 0·1524. Now these two numbers have a relation almost identical with the relation of the densities, for—

$$\frac{0{\cdot}1350}{0{\cdot}1524} = \frac{1{\cdot}874}{2{\cdot}110} \text{ in place of } \frac{1{\cdot}874}{2{\cdot}133}$$

Let us now consider what happens when we submit a mixture of the two gases to diffusion. Let us take, *e.g.*, a mixture of hydrogen with an excess of oxygen. After a sufficient number of operations we obtain pure oxygen on the one hand, and on the other a mixture of 1 part of hydrogen with 4 parts of oxygen. It will not be possible to separate this mixture into its constituents, on account of the equal diffusion of oxygen and hydrogen when thus mixed. The identity of the spectra of helium prevent us from deciding which is the pure gas and which is the mixture. Calculation establishes that if we suppose the heavier gas is a mixture, the density of the lighter, supposed pure, ought to be 1·58. Helium, lastly, if it consists of a mixture of two gases, is formed either of two gases of the densities

[1] A paper presented to the Paris Academy of Sciences on July 27, by Prof. W. Ramsay and Dr. J. Norman Collie. (Reprinted from the *Chemical News*.)

2·366 and 1·874, or two gases of the densities 2·133 and 1·580.

But although this explanation is the most suitable, there exists another which deserves our attention. The spectrum of these two fractions shows no difference. It is not probable that two gases exist the densities of which are so near each other. The different gases do not possess a refraction proportional to their densities. It seems to us that we might admit that we have effected a real separation of the light mols. from the heavy mols. The idea that all the mols. of a gas are homogeneous has never been submitted to the test of experiment. We do not know of any attempt at a separation of this kind of a gas regarded as homogeneous into two different parts. But our experiments show that this question deserves to be studied. If it can yield us similar results we must change our ideas on the nature of matter.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Marquis of Bute has signified his intention of contributing £10,000 to the University of South Wales, to be applied for the purposes of technical education in Wales, the sum to be handed over to the authorities as soon as required. The Drapers' Company have also promised £10,000 towards the fund for providing new buildings, and the Government have promised £20,000 on condition that an equal amount is raised by public subscriptions.

APROPOS of the complaint from the *Local Government Journal* referred to last week, we see in the recent report of the Somerset County Council that "manual instruction in agricultural processes has made no progress." Though some successful classes in sheep-shearing, thatching, and hedging have been held at a few centres, Committees that have endeavoured to organise instruction of this kind report, as a general rule, that they have been unable to obtain from the farmers that support and co-operation which is indispensable if the work is to be carried out successfully.

WE notice in the report of the Technical Education Committee which was adopted by the Northumberland County Council at their recent meeting, that it has been decided to renew the grant of £500 to the Agricultural Department in the Durham College of Science on the following conditions, which differ somewhat from those which obtained last session:—The college is to undertake the direction of the school of agriculture and demonstration farm in accordance with the Technical Education Committee's requirements, as well as to arrange and supervise not less than six manurial trial stations at local centres in Northumberland, and to arrange for as many as sixty lectures, examinations, or inspections in agriculture and dairy work. On the other hand, the farm in Northumberland is to be open to the students of the Durham College of Science at times which are to be specified. This mutual arrangement should prove very beneficial.

THE East Sussex Committee for Technical Instruction complain that attention is given too exclusively to elementary science teaching in the various classes throughout their county, and that scarcely any work of an advanced character is attempted. This is bad, but it will be much worse if they attempt advanced teaching too soon. A completely new form of agricultural instruction has been undertaken by the authorities of the agricultural school at Uckfield, which is maintained by this Committee. The students are taken to many of the sales of agricultural implements and produce which occur in the neighbourhood, as well as to the fortnightly cattle auctions. The idea, which is to give the students an acquaintance with current values of farm and live stock, seems to have some good in it, though considerable discretion will have to be used by the instructors to prevent erroneous notions being imbibed by the students.

THE programme of the Princeton University sesqui-centennial celebration has just been announced as follows:—Tuesday, October 20, commemorative religious services in Marquand Chapel, discourse by President Patton; reception and introduction of delegates in Alexander Hall; probably a musical concert in Alexander Hall, not yet fully arranged, and some other suitable event may be substituted. Wednesday, October 21, Alumni Day, oration and poem in Alexander Hall, Prof. Woodrow Wilson, orator; Rev. Dr. Henry Van Dyke, poet; reception by President and Mrs. Patton at Prospect; students' torchlight procession and illumination of the campus; addresses from the steps of Nassau Hall, and student songs by alumni and undergraduates. Thursday, October 22, one hundred and fiftieth anniversary day; the sesqui-centennial celebration, academic procession marches to Alexander Hall; announcement of university title; announcement of endowment secured; conferring of honorary degrees, and other appropriate ceremonies; farewell dinner to the invited guests in Alexander Hall.

THERE are, it seems, only twelve scholars at the Swanley College in Kent, including six who hold scholarships which have just been awarded. Since the Kent County Council are bound to pay for twenty pupils as a minimum, the Technical Education Committee desire a more satisfactory state of things, and have recommended an entire reconstruction of the college. Nor is everything quite what is desired in Berkshire. The lectures for teachers provided by the education authority in this county cost £550 a year, yet it is reported that there is a want of appreciation of the value of the courses on the part of those for whom they are intended. Moreover, the object for which the lectures were instituted, viz. the provision of teachers to hold evening continuation schools, has not been attained. The Committee for Technical Instruction has therefore recommended that no new students be admitted for attendance at science lectures, but that the three years of existing students (if duly qualified) be completed. It is further complained that teachers have not availed themselves of the good work which is being done at the Reading University Extension College.

THE Programme of Technological Examinations of the City and Guilds of London Institute (Whittaker and Co.) furnishes abundant information on the valuable work which the Institute is doing for technology and manual training. The programme contains the syllabuses of the sixty-six subjects in which examinations are now held (a helpful list of works of reference being given at the end of each), and the examination questions set this year. Among the changes in the Institute's programme, we notice the following:—The subject of "Brickwork and Masonry" has been divided into two, "Brickwork" and "Masonry," and a practical examination, to be held in London, has been added to each. The regulations for the examination in "Photography" have been altered. In future, all candidates will be required to pass a local practical examination before being admitted to the written examination in the ordinary grade. The syllabus in "Paper Manufacture," in "Pottery and Porcelain," in "Boot and Shoe Manufacture," in "Dressing of Skins," in "Cotton Spinning," has been re-written. In several other subjects the syllabus has been altered. Provision has been made for admitting, under certain conditions, teachers of secondary schools to the manual training examinations.

THE report of the Somerset County Education Committee for the financial year ending March 31, 1896, gives abundant evidence of the accomplishment of much good work. The plans of the Committee are laid upon a carefully thought-out basis, and reflect no small credit on the wisdom of their organising adviser. These arrangements have been the same as in previous years, with the exception of discontinuing the courses of University Extension Science Lectures, which has meant a saving of more than £1000 per annum. We are glad to notice that the Committee are able to report that the work as a whole "shows a distinct and satisfactory tendency to develop along certain well-marked and permanent lines, with a corresponding reduction in the number of classes of a more or less ephemeral character." In no case has an evening continuation school been reported to them by the inspectors as generally inefficient; and "there is a general tendency towards an increase in the average attendances" in all of the 141 of these schools. As regards the work in the secondary schools of the county, many of which have been substantially aided by the Committee, it has been rightly laid down "that the best foundation for technical instruction is a really good secondary education sufficiently comprehensive in its character to include, in addition to the ordinary English subjects, natural science, mathematics, modern languages, drawing, and some manual training, and it is with a view to place an education of this kind at moderate fees within the reach of all in the county who wish to avail themselves of it, that the County Committee gives the aid specified." It is not to be wondered at, after so sensible a declaration, that the report is able to call attention to excellent results from all divisions of their administrative area.