surrounded by extensive morasses. The ore occurs in bed-like masses in porphyries of varying character and composition. The total length of the Kiirunavaara ore body is 15,500 feet. The width is usually 330 feet, but in one place it is as much as 840 feet. The dip varies from 45° to 60°. It is estimated that the quantity of ore available above the level of the lake at Kiirunavaara is 215,000,000 tons, and at Luossavaara 18,000,000 tons.

The Kiirunavaara ores differ widely from most Swedish ores. They are unusually hard and compact, and remarkably free from all foreign minerals except apatite. That mineral is, however, exceedingly abundant. Analyses show that ores occur with less than 0·05 per cent. and from 0·05 to 0·1 per cent. of phosphorus in such quantities that they can be mined separately. The bulk of the ore, however, contains 1 to 4 per cent. of phosphorus. The percentage of sulphur is usually 0·05, and sometimes less than 0·02. Titanium varies from 0·32 to 0·95 per cent., and manganese does not exceed 0·32 per cent. The great bulk of the Luossavaara ore is comparatively low in phosphorus, and much of it appears to be well adapted for the acid Bessemer process.

No serious attempt was made to work these deposits before 1880, when a concession was granted for the construction of a railway from Luleå to the Ofoten fjord; but the concession was withdrawn after the railway had been completed from Luleå to the iron mines at Gellivare. This year, however, the Swedish parliament authorised the construction of a railway from Gellivare, past the Kiirunavaara and Luossavaara deposits, to the Norwegian frontier; and the Norwegian parliament has authorised its being continued to Victoria Harbour, on the Ofoten fjord, a port free from ice throughout the year. The distances from the iron ore deposits along the projected line of railway are—to Gellivare, 63 miles; to Luleå, 182 miles; to the Norwegian frontier, 79 miles; and to Victoria Harbour, 120 miles. Within a short period these vast supplies of iron ore will thus be rendered available, and British ironmasters will have within easy reach sufficient ore to last for many generations to come.

ELECTRICAL STAGE APPLIANCES.

THE proposed application of electrical power for mounting plays at Drury Lane, on the lines advocated by Mr. Edwin O. Sachs, has now taken a tangible form in the completion of the first section of the stage installation in time for the impending pantomime.

Mr. Sach's present work refers principally to the stage floor and its movability in sections above and below the footlights. The total area now already movable by mechanical power exceeds 1200 square feet.

The electrical appliances just completed take the form of so-called "bridges," each working independently. Each individual section measures 40 feet by 7 feet, and weighs about 6 tons, of which about 4 tons are counterbalanced. They can travel about 20 feet vertically.

The motive power is from the ordinary electric supply mains over a four-pole motor, developing 7½ horse-power at 520 revolutions per minute. The "bridges" are suspended from cables, and these, working over the motor, allow the former to be raised with the necessary live load at rates varying from 6 feet to 20 feet per minute.

Every possible safeguard has been taken against accident, the "bridges" themselves being so constructed that in the event of derangement of current the appliances can be worked by hand gear. Automatic switches are provided so as not to be entirely dependent on the attendants, and automatic catches will work in case of rope-breaking. Special locking-gear has been installed to hold the "bridges" stationary at certain points, such as stage level, and a very large factor of safety has been allowed in apportioning the strengths and weights in the various parts of the mechanism, having special regard to the ever-increasing scenic requirements under Mr. Arthur Collins's able management.

As regards the economic aspect of the electrical installation, the initial outlay on the system adopted is about half that of continental hydraulic work. The maintenance is minimal, whilst the actual working only costs a few pence per performance. The saving in manual labour on the stage is very considerable, whilst the hygiene of the theatre is materially raised by the absence of woodwork.

METALLIC ALLOYS AND THE THEORY OF SOLUTION.[1]

THE term alloy in its technical sense is used to indicate a solid mixture of two or more metals. The earlier investigators in this field, such as Matthiesen, Richie and many others, worked mainly with solid alloys, and they endeavoured to investigate the change in properties of the alloy, such as conductivity for heat and electricity, malleability, ductility and the like, with successive small changes in composition.

This method, although well adapted to bring out properties of alloys suitable for use in the arts, has not till recently shed much light on the real constitution of this interesting group of substances. Chemists have neglected the subject because the ordinary processes by which they attack problems fail them when dealing with alloys, on account of their opacity, want of volatility and power of being separated from one another by crystallisation. Another difficulty arises from the fact that the resulting alloy has usually the same colour as the metals from which it is produced, except in a few cases, such as the rich purple alloy of gold and aluminium investigated by Prof. Roberts-Austen, and the alloy of zinc and silver noticed by Matthiesen and investigated by Neville and Heycock, which has the property of taking a superficial rose tint when heated and suddenly cooled.

During the past twelve years considerable advance has been made in the study of alloys by investigating some of their properties whilst in the liquid state, such as the temperature at which solidification commences; it is convenient to term this temperature the freezing point. Le Chatelier, Roberts-Austen, Neville, myself and others have all worked in this way. The result of this work may be very briefly stated as follows.

Solutions of metals in one another obey the same laws that regulate the behaviour of solutions of such substances as sugar in water. For example, if we take solutions of sugar of different concentrations, but not exceeding 3 or 4 per cent., we find that within these limits the lowering of the freezing point is nearly proportional to the concentration. Exactly in the same way, if we add to a quantity of molten sodium (freezing point 97° C.) some gold, we find the gold dissolves much in the same way that sugar dissolves in water. On determining the freezing point of the alloy we find that it is lowered in direct proportion to the weight of gold added, notwithstanding the fact that pure gold by itself melts at a temperature of 1060° C. It is remarkable that the effect of increasing the quantity of gold in the alloy continues to depress the freezing point of the sodium, until the alloy contains more than 20 per cent. of gold when the minimum freezing temperature 81·9° C. (eutect temperature) is reached. The case of gold dissolving in sodium may be taken as a very general one, for a large number of pairs of metals have been examined, and with but few exceptions, such as antimony dissolved in bismuth, the effect is almost always to produce a lowering of the freezing point of the solvent metal. By the solvent metal we generally mean the metal which is present in the largest quantity.

A second point in which metallic alloys resemble ordinary solutions is in the fact that the depression of the freezing point is inversely proportional to the molecular weight of the dissolved substance. Thus, if we dissolve 342 grams (molecular weight in grams) of cane sugar in 10 litres of water, and determine the freezing point of the solution, it is found to be depressed a definite number of degrees below that of pure water. But the same depression of the freezing point is produced by the solution of 126 grams of crystallised oxalic acid, or only 32 grams of formic acid, in 10 litres of water.[2] Alloys again appear to obey the same law; thus it is found that if we dissolve 197 grams of gold, or 112 grams of cadmium, or 39 grams of potassium, respectively, in a constant weight of sodium, the freezing point of the sodium will be lowered by almost the same number of degrees in each case. Now the numbers 197, 112 and 39 are the atomic weights of the metals, and it can be shown that these numbers are also probably the molecular weights of these elements. Hence we conclude that metals dissolved in each other obey the same laws as ordinary solutions.

The above facts for the behaviour of solutions of substances

[1] A discourse delivered at the Royal Institution by Mr. Charles T. Heycock, F.R.S.

[2] Although water is used as a solvent by way of illustration in these cases, it should be stated that it is by no means a suitable liquid for such experiments, owing to the changes it brings about in the substances dissolved. In making such experiments it is far preferable to use benzene or acetic acid as a solvent.

in water and organic liquids have been gradually accumulated by the work of Blagden, Rüdorff, Coppet and Raoult, extending from about 1780 to the present time, but no general explanation of them was brought forward until Van 't Hoff advanced the remarkable theory that a dissolved substance was in a condition somewhat analogous to that of a gas, the solvent substance serving the part of the vessel in which the gas is confined, but also exerting other effects.

He further gave strong reasons for believing that substances in dilute solution obeyed the same laws that gases do—*i.e.* the laws of Boyle and Charles for temperature and pressure. Several other theories of solution, besides what may be termed the gaseous theory, have been proposed. Notwithstanding that some weighty objections can be urged against this theory, it is remarkable that we can by aid of it predict the numerical values for the fall of the freezing point of different solvents produced by the solution of other substances, provided that we know the latent heat of fusion of the solvent.

On applying the same reasoning to alloys, we find that the theory holds good, as the table below shows.[1] We see from

Observed Depression in the Freezing Point of a Solvent Metal, caused by the Addition of One Atomic per cent. of a Second Metal.

Solvent		Tin	Bismuth	Cadmium	Lead	Zinc
Depression calculated on theory of Van 't Hoff		3·0° C.	2·08° C.	4·5° C.	6·5° C.	5·11° C.
Metal dissolved	At. Wt.					
Sodium ...	23	2·8	2·0	4·5	1·2	—
Copper ...	63	2·9	1·2	3·6	6·3	1·5 (rise)
Silver ...	108	2·9	2·0	10·8 (rise)	6·6	5·15 (rise)
Platinum ...	195	—	2·1	4·5	6·4	—
Gold ...	197	2·9	2·1	1·6	6·4	3·4 (rise)
Bismuth ...	209	2·4	—	4·5	3·0	5·1

this table that in no cases are the observed depressions of the freezing points greater than those calculated from the theory, but in many cases they fall below this quantity; this latter fact admits of explanation.

On the theory of Van 't Hoff it is necessary that when a solution begins to freeze the pure solvent should separate out first. This admits, in case of aqueous solutions, of simple proof; for if we take a dilute solution of potassium of permanganate and make it freeze slowly, we find that pure colourless ice separates out on the walls of the vessel, whilst the purple permanganate is concentrated towards the centre. This experiment led Neville and myself to try if a similar state of things could be shown for metallic alloys.

We have great pleasure in bringing before the Royal Institution this evening the first announcement of the results we have obtained. For this purpose we took two metals, gold and sodium, the former being very opaque to X-rays, whilst the latter is very transparent to them. A quantity of sodium was melted in a tube, and gold dissolved in it to the extent of about ten per cent. The alloy was then allowed to cool extremely slowly, and sections (about $\frac{1}{8}$ inch thick) were cut from different parts of the solid alloy and placed between thin plates of aluminium to protect them from the air. These sections were then placed on a photographic plate, enclosed in a light tight bag, and exposed to the action of the X-rays. On developing the plate we found a complete picture of the inside of the alloy. Positives obtained from these negatives are thrown upon the screen. The sodium is seen to have crystallised out in plates, as is evident from its transparency, whilst the opaque gold is seen to have become concentrated in the mother liquor between these plates, where it finally solidified along with some of the sodium.

Very similar results are produced with other pairs of metals, such as aluminium and gold and aluminium and copper. Behrens, Roberts-Austen, Osmond and others have examined alloys, after superficial etching, with high microscopic powers, and they find a similar separation of the constituents.

We thus see that solution of metals in one another follows extremely closely the same laws that regulate solutions with which we are ordinarily familiar. I should like to state here that the matter of this lecture is largely drawn from the work carried out by Mr. Neville, F.R.S., and myself during the past six years.

[1] For the nature of this calculation, *vide* Heycock and Neville, *Chem. Soc. Jour.*, vol. lvii. p. 339. Also Neville, *Science Progress*, October 1895.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The electors to the Linacre Professorship of Comparative Anatomy will proceed to an election in the course of Hilary Term, and candidates are desired to send in their names to the Registrar of the University not later than January 31, 1899. The Board of Electors consists of the Visitor of Merton College (the Archbishop of Canterbury), the Presidents of the College of Physicians and the College of Surgeons, the Waynflete Professor of Physiology, the Regius Professor of Medicine, an elector appointed to represent Merton College, and an elector appointed to represent the Hebdomadal Council. The Hon. G. C. Brodrick, Warden of Merton, has been appointed by Merton College, and the Dean of Christchurch by the Hebdomadal Council.

The electors to the Sedleian Professorship of Natural Philosophy, vacant by the resignation of Prof. Price, will also proceed to an election in the course of Hilary Term, and names of candidates are to be sent in not later than January 31. The Board of Electors consists of the Vice-Chancellor, the President of the Royal Society, the Provost of Queen's College, the Professor of Experimental Philosophy, Savilian Professor of Geometry, an elector appointed to represent Queen's College, and an elector appointed to represent the Hebdomadal Council. Prof. Elliot and Prof. Rücker have been chosen as the last-mentioned electors.

THE Calendar of University College, London, for the session 1898–99, has just been received. The purpose of the College, as expressed in the Act of 1869, whereby the College was re-incorporated with additional powers, and divested of its proprietary character, is "to afford at a moderate expense the means of education in literature, science, and the fine arts, and in the knowledge required for admission to the medical and legal professions, and in particular for so affording the means of obtaining the education required for the purpose of taking the degrees now or hereafter granted by the University of London." During last session the following new departments were created: Laboratory of Experimental Psychology, Pender Chair of Electrical Engineering, the Edwin Chadwick Chair of Municipal Engineering. It is interesting to note that in the department of applied mathematics, Prof. Pearson gives, in the place of advanced class examinations, subjects for dissertations referring to the mathematical theory of statistics.

MR. W. C. MCDONALD'S benefactions to the McGill University, Montreal, have often been the subjects of notes in these columns, and last week we recorded that he had received the honour of a knighthood in recognition of his gifts to philanthropical and educational objects in Canada. Mr. McDonald's princely gifts to the McGill University include 20,000 dollars to the Workman endowment for mechanical engineering; the erection of the W. C. McDonald engineering building, valued, with its equipment, at 350,000 dollars, and an endowment for its maintenance; the endowment of the chair of electrical engineering with the sum of 40,000 dollars; the erection and endowment of the physics building, valued at 300,000 dollars, and two chairs of physics with endowments amounting to 90,000 dollars; the endowment of the faculty of law with 150,000 dollars; the endowment and equipment of the chair of architecture; a further sum of 150,000 dollars for the maintenance of the engineering building; 50,000 dollars towards the endowment of the pension fund; and the erection of a new building for the Department of Chemistry, Mining, and Agriculture, at a cost of 500,000 dollars, making the total amount contributed to the institution upwards of 1,600,000 dollars.

THE Executive Committee of the Central Welsh Board have unanimously passed the following resolutions, among others, referring to the Board of Education Bill, and have forwarded copies to the Education Department and the Charity Commission, with an intimation that they will be brought before the