for considerable periods of time, as is often necessary when using X-rays for therapeutic purposes.

The adaptation of tungsten for this purpose is an example of the great value that lies hidden in the rare and little-known elements, and doubtless other instances of a similar nature will develop as the metals become available.

OSMOTIC PRESSURE OR OSMOTIC SUCTION?

IT has often been assumed that van't Hoff's discovery, that the simple gas-law, PV=RT, may be applied to the osmotic pressures of dilute solutions, justifies the view that osmotic pressure is caused by the bombardment of a semi-permeable membrane by the molecules of the solute, just as gas-pressure is caused by the bombardment of the containing vessel by rapidly moving gas-molecules. A recent exposition of this view by Prof. Ehrenfest, in the Proceedings of the Amsterdam Academy (vol. xvii., pp. 1241–1245), has elicited a reply from Prof. J. J. van Laar (*ibid.*, vol. xviii., pp. 184–190), which will be read with very great interest by all those who have seen in the mechanism of osmosis an even more difficult problem than that of expressing the magnitude of the osmotic pressure by means of a mathematical formula. Prof. van Laar's reply is of exceptional value in that it demonstrates the inadequacy of the gas-analogy from the thermodynamic point of view, and so challenges the simple kinetic theory of osmosis on what has generally been supposed to be its strongest ground.

The osmotic pressure may be expressed, according to Van Laar, by the equation,

$$P=RT/v_0\{-\log(1-x)+\alpha x^2\},$$

where x is the molecular concentration of the dissolved substance, and α is an "influencing" coefficient, which expresses the consequences of the interaction of the molecules of the solvent with those of the dissolved substance. The logarithmic term is an essential feature of the thermodynamic equation, and it is urged that all kinetic theories which lead to expressions without a logarithmic member must be rejected.

The thermodynamic equation, it is true, leads to an expression for dilute solutions which is identical with that of van't Hoff. But in practice it is found that in more concentrated solutions deviations appear which are much smaller than those for non-ideal gases. We may therefore surmise that the so-called osmotic pressure has an entirely different ground from that suggested by van't Hoff's application of the gas-equation, and that there is here no close relation but merely an analogy.

If the osmotic pressure were actually caused by the pressure of the dissolved substance, as Ehrenfest, reviving the old theory, suggests, the pressure of the sugar molecules against the semi-permeable membrane would, in van Laar's opinion, cause the reverse effect to that which is actually observed. No water would pass from the pure solvent through the membrane into the solution, giving rise to a hydrostatic pressure in the osmometer; but, on the contrary, the inward flow of water would be checked, since the pressure in the solution would from the outset be greater than in pure water. In reality, osmotic pressure is caused by the water which penetrates through the semi-permeable membrane, giving rise to a hydrostatic pressure which prevents the further intrusion of the water. This excess of pressure is the so-called "osmotic pressure" of the solution.

Generally speaking, every theory which seeks to interpret osmotic pressure kinetically must be based on the *diffusion* of the water molecules on the two sides of the membrane. If this is done, the logarithmic member arises of its own accord, and finds a place in the equation, whether there is interaction between solvent or solute or not, *i.e.* the α-term appears quite independently of the logarithmic term. In van Laar's opinion, the kinetic interpretation of osmotic pressure, which is always reappearing again in new forms, is moving, and has moved, in a wrong direction, and should again be founded on the simple diffusion phenomenon. T. M. L.

POST-GRADUATE SCHOLARSHIPS AND FELLOWSHIPS.

THE new list of scholarships and fellowships offered by the Leeds University has just been issued. It includes some twelve entrance scholarships in arts, science, medicine, and technology, awarded on the results of the matriculation examination of the Joint Matriculation Board, in addition to a certain number (not specified) given by the local education authority. There are also twelve Clothworkers' free studentships in the textile department, and a "William Cooke" scholarship in mining, determined by special examination or selection. In addition to the above are a number of senior scholarships, awarded to students of special merit in the University, by the University, the Leeds City Council, and by various donors who have wished to perpetuate with their names their interest in the University. Such are the Leighton exhibitions established by the trustees of Mrs. Isabel Leighton, of Leeds, the Salt scholarship given by Sir Titus Salt, the John Rutson scholarship, and the Gilchrist studentship in modern languages. The list of post-graduate scholarships and fellowships is a very meagre one. There is one 1851 exhibition scholarship of 150*l.* tenable for two years, and a number of 1851 exhibition industrial bursaries of 100*l.*, both awarded by the 1851 Exhibition Commissioners, the first in science and the second in some branch of technology. There is, further, a research scholarship in colour chemistry founded by the Clothworkers, and a scholarship in gas engineering endowed by Sir Corbet Woodall. There are also two scholarships in the faculty of medicine. A limited number of research fellowships are also awarded by the University to distinguished graduates; there is one in connection with the fuel department in gas research founded by the Institute of Gas Engineers, and one in colour and textile chemistry.

It is generally recognised by university teachers that the year or years immediately following graduation are in a sense the critical years of a student's career. In science more especially he has laid up a fund of knowledge which he is about to turn to practical account. He has collected a store of potential energy; he has played the *rôle* of an "accumulator" during his university course, and his energy is now to be turned to useful work. In the northern universities at least the graduate has to earn his living, and whilst he is on the look-out for congenial, as well as remunerative, occupation he may often have to wait for many months. It is at this critical time that a post-graduate scholarship, sufficient for the student to keep himself and release his parents from the burden of further maintenance, is invaluable. It is invaluable not merely because it gives him time to look round and relieves him from the necessity of accepting the first vacancy that offers; but because he is learning in that excellent school of research how to use his knowledge and more especially how to depend upon himself.

In the "Scheme for the Organisation and Development of Scientific and Industrial Research" issued by the Board of Education we have the promise of a large extension of post-graduate research studentships and

fellowships. Although there may be cause for criticism of the method of administration of the fund placed in the hands of the committee of the Privy Council, there is no doubt that, if wisely administered, it will have very far-reaching results, not only in developing our scientific industries, but in stimulating research in our universities and levelling up the standard of scientific attainment among the whole body of our science students.

INSTITUTION OF MECHANICAL ENGINEERS.

THE annual report of the council of the Institution of Mechanical Engineers for the year 1915 shows that the fund raised in conjunction with other institutions to establish a memorial to the late Sir W. H. White, K.C.B., amounted to more than 3000*l*. After providing for a medallion portrait, to be placed in the Institution of Civil Engineers, and a donation to the Westminster Hospital, the bulk of the fund, together with any further contributions, is being devoted to the establishment of a research scholarship in naval architecture, to be administered by the Institution of Naval Architects. The report also states that the Thomas Hawksley medal for 1916 has been awarded to Prof. H. L. Callendar, for his paper "On the Steady Flow of Steam through a Nozzle or Throttle," and premiums of 5*l*. each have been awarded to Prof. A. H. Gibson and Mr. W. J. Walker, for their paper on "The Distribution of Heat in the Cylinder of a Gas Engine." A grant of 15*l*. has been made from the Bryan Donkin Fund, for original research in mechanical engineering, to Mr. A. H. Barker, in aid of his research at University College, London, "to investigate a new method of determining the radiant temperature and air temperature in a room." The balance of the third triennial award has been devoted to aiding the steam-nozzles and hardness tests researches of the institution.

The report contains particulars of the work done during the year by the various research committees of the institution. The work of the Alloys Research Committee, on the alloys of aluminium with zinc and copper, has been continued at the National Physical Laboratory. The importance of light alloys in connection with aeronautics has led to a Government grant for the erection and working of an experimental rolling-mill capable of dealing with ingots and billets. Further progress has been made with other branches of the work, including the study of the constitution of the alloys and the "disintegration" research. The series of researches relating to the double carbides of iron, under the direction of Profs. J. O. Arnold and A. A. Read, has been completed. The results of the studies on the carbides of cobalt and of molybdenum have been embodied in papers on "The Chemical and Mechanical Relations of Iron, Cobalt, and Carbon" and "The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon," both printed in the Proceedings of the Institution. A report was also submitted by Sir Robert Hadfield describing the effects of molybdenum upon iron, up to 18 per cent. of Mo. The Steam-Nozzles Research Committee has held three meetings and is engaged on the design of apparatus for conducting experiments relating to the action of steam passing through nozzles and steam-turbines. The British Westinghouse Electric and Manufacturing Company has offered to lend two large condensers to the committee, and substantial progress has been made with the design of nozzle-testing apparatus. The Hardness Tests Research Committee has been considering the design of a machine to determine rate of wear as a measure of hardness. An existing machine at the National Physical Laboratory was adapted as a preliminary procedure, but the results obtained from this machine and modifications thereof have not yet been satisfactory. The work of the Refrigeration Research Committee has been suspended, Prof. C. Frewen Jenkin, the reporter, being on active service.

Interesting particulars of the war work undertaken by members of the institution are contained in the report. The engineer unit of the Royal Naval Division, which was principally recruited from the members of the Institutions of the Civil, the Mechanical, and the Electrical Engineers, was on active service in Gallipoli. In the early stages of the war, a list was compiled of the engineering and other qualifications of members desiring to obtain commissions in the Army, and copies were forwarded to quarters where they were likely to be of use. The names of selected members have been put forward as candidates for commissions in the 12th King's Own (Yorkshire Light Infantry), Pioneer Companies, the Mechanical Transport branch of the Army Service Corps, and other engineering branches of the Army. Particulars of the engineering training and other qualifications of 159 members who expressed a desire to undertake engineering work in connection with the war have been forwarded to the Ministry of Munitions and other Government departments from time to time throughout the year. In response to an application from the Ministry of Munitions for the nomination of engineers for employment in connection with contracts for the manufacture of munitions, the council appointed a small committee to select possible candidates. The qualifications of sixty-seven members and others were considered, and the names of twenty-seven were submitted to the Ministry. In August last a list of 543 members on active service in the Army was compiled for transmission to the War Office. During the year 661 members had been on active service. Several designs for a mechanical bomb-thrower have been received from members and submitted to the War Office. Designs have also been submitted of apparatus for destroying barbed-wire entanglements, for clearing mines from the products of the explosion of the mine, and for non-slip chains for rubber tyres of motor-wagons. At the request of the Director of Fortifications and Works, a list was compiled of the names of mechanical engineers with whom the War Office might communicate in connection with problems arising out of the war.

THE ORIGIN OF ENGLISH MEASURES OF LENGTH.[1]

ALTHOUGH there is considerable variety in the measures of length used by the different nations of the world, there can be no doubt that they are, for the most part, derived from a common origin, and that their ancestors, if the expression may be used, existed in times so remote that the date of their invention has been completely lost.

For the sake of clearness, it is convenient to divide the measures of length into four categories which are, to a certain extent, independent of one another, and may be defined as follows:—

(1) The shorter measures of length, used for building and manufacturing purposes, of which the more important in ancient times were the cubit, the palm, and the digit, or finger breadth, and the English representatives are the yard, the foot, and the inch.

[1] Abridged from a paper in the Journal of the Royal Society of Arts, December 31, 1915, by Sir Charles M. Watson, K.C.M.G., C.B.