

Qualities of Valency.

IN a letter under the above heading in NATURE for October 13, p. 210, Dr. R. M. Caven directs attention to the difficulty felt by chemists in accepting Dr. Langmuir's view that the sodium and chlorine in sodium chloride are not united by a chemical bond, being always ionised, although molecules of sodium chloride actually exist in a state of vapour at 2000° C. Perhaps the following considerations may help to remove the difficulty.

In the first place it is necessary to distinguish between the two separate processes of intramolecular ionisation and electrolytic dissociation. Intramolecular ionisation is the expression introduced by Sir J. J. Thomson to describe the transfer of an electron from one atom to another *within* the molecule, an "ionic molecule" being thereby produced. Electrolytic dissociation is the breaking up of such an ionic molecule into separate ions.

Sodium chloride is therefore an intramolecularly ionised compound, and the chemist's difficulty is the question of how the ions are united in the molecule.

Now the conception of the valency bond can be retained if we accept the convention first suggested by Sir Oliver Lodge (NATURE, vol. 70, p. 176, 1904), according to which the electron and positive charge are united by a very large number of lines of force when in combination. In the chloride ion we have a kernel with seven positive charges surrounded by eight electrons. The electrons will, therefore, be unsaturated, and in a molecule of sodium chloride we shall have a bundle of lines of force passing from the electrons of the chloride ion to the nucleus of the sodium ion. This is a typical instance of a strong electrolyte.

In non-electrolytes two or more electrons are shared between two atoms, giving Dr. Langmuir's covalency bond. In this case, without specifying the particular electrons involved, we may assume a double bond consisting of two equal bundles of lines of force passing in opposite directions, that is to say, in a molecule AB, one bundle will pass from the electrons of A to the nucleus of B, and the other one from the electrons of B to the nucleus of A. All intermediate stages of combination between these two extremes are possible, as I have pointed out in a series of papers, in which the subject is discussed in detail (Trans. Chem. Soc., vol. 111, p. 253, 1917; vol. 115, p. 278, 1919; *Phil. Mag.*, vol. 42, p. 448, 1921).

Full consideration of the question, as shown in the papers referred to, leads to the conclusion that a simple and all-embracing theory of valency is not possible, but that different theories of valency must be devised for different types of compounds, such as electrolytes, non-electrolytes, and molecular compounds. In view of this difficulty I have used affinity formulæ only, and it would appear that the time is approaching when the chemist will have to decide whether the conception of valency can be retained for general purposes, or whether it would not be better to restrict its use to certain special branches of the science, such as the chemistry of carbon compounds, in which it has proved of supreme value.

To the inorganic chemist the valency conception has been of doubtful value. This is particularly noticeable if we compare the rapid development of inorganic chemistry since Werner introduced the coordination theory less than thirty years ago with the slow rate of progress in the previous thirty years under the valency theory.

In any case the restricted use of the valency bond to the particular type of combination termed covalency by Dr. Langmuir will scarcely be accepted by

chemists if the conception of valency is to be retained for general purposes.

The other facts mentioned by Dr. Caven all indicate that there is no clear-cut distinction between electrovalency and covalency, but that they represent extreme types of combination with an indefinite number of intermediate grades.

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October 24.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

WITH reference to Dr. W. R. G. Atkins's interesting communication in NATURE of September 15, may I be allowed to submit the following comments? The importance of the study of hydrogen-ion concentration in physiology and biochemistry, soil science, and other branches of research cannot be over-emphasised, and is rapidly becoming appreciated by workers. There appears, however, to be a tendency to apply methods of measurement that have been standardised in one branch of study to other departments—soils, for example—with a minimum change of technique. With the exception of Gillespie's pioneer, but by no means exhaustive, work in America, the colorimetric method of measuring the hydrogen-ion concentration of soils has never been critically examined. After considerable preliminary work with this method—an account of which has been published elsewhere—the present writer feels that the conditions under which it can be applied in soil work so as to yield accurate and reproducible results have not yet been fully worked out. As an example may be cited the fineness of division of the soil sample which is often a factor influencing the apparent pH as determined colorimetrically. Until much more work has been done from this point of view the data being accumulated by ecologists can scarcely have the strict quantitative significance often attached to them, although when regarded as provisional only they are undoubtedly of great interest and no little importance.

A further point is perhaps worthy of attention: it may possibly happen that in some soils the actual pH at the moment of measurement is of less importance than the *rate of change* of the pH under natural conditions. The "buffer effects" imposed by the nature of the soil on its reaction vary enormously in magnitude from soil to soil; a dressing of basic slag may alter considerably the pH of a light sand while having no appreciable effect on that of a heavy loam; and the pH of a light soil may vary regularly or erratically with fluctuations in local conditions. Such variations may be important in many cases, and would well repay study. The whole problem of the nature of soil reaction is complicated, but some light would undoubtedly be thrown upon it by measuring, not merely the pH of soils, but the variations in pH with additions of acids and alkalis, *i.e.* by plotting titration curves the slopes of which can be correlated with the magnitude of the buffer action of the soil. Very little work along these lines has so far been done in this country—or, indeed, in any country—but that little has afforded indications that such work would be fruitful of result if attacked systematically and with due appreciation of all the difficulties.

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The University, Leeds, September 28.

Absorption of X-rays.

AT the suggestion of Prof. Richardson, we have for some time been engaged in an investigation of the connection between X-ray absorption coefficients and critical frequencies. In this work we have met with