which was recently established at the Utah Agricultural College and Experiment Station.

M. E. GRABER, professor of mathematics at Heidelberg University, has been appointed professor of physics at Morningside College, Sioux City, Iowa.

DR. S. I. KORNHAUSER, formerly associate professor of zoology at Northwestern University and recently relieved from duty in the Sanitary Corps of the Army, has been appointed acting professor of zoology at Denison University in the absence of Professor Fish.

M. PAUL APPELL, dean of the faculty of sciences, Paris, has resigned from the office that he has held for sixteen years and has been succeeded by M. Houssay, professor of zoology.

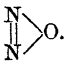
AT the University of Bristol, Dr. Otto Vernon Darbishire, lecturer in botany, has been promoted to a professorship; Dr. H. Ronald Hassé has been appointed professor of mathematics; Dr. Arthur Mannering Tyndall, professor of physics; George A. Buckmaster, professor of physiology, and Major Andrew Robertson, professor of mechanical engineering.

DISCUSSION AND CORRESPONDENCE

THE VALENCE OF NITROGEN IN NITROUS OXIDE

PROFESSOR W. A. NOYES in his address before the American Association for the Advancement of Science in December, 1918,[1] spoke very convincingly in favor of the theory of positive and negative valences. The work of Falk, Nelson and Fry in attempting to apply the conception of electrons to the theory of valence was commended and the theory of G. N. Lewis with regard to non-polar valencies in organic substances was justly criticized. While pointing out that some of our ideas need revision, Professor Noyes advocated a new formula for the well-known compound, nitrous oxide. According to Noyes, the formula should be $O = N \equiv N$.

Nitrous oxide, N_2O, is usually given the following structural formula:



According to this formula each nitrogen atom is given a valence of three, but two of the bonds from each nitrogen atom are arranged so that they neutralize one another. The oxygen atom is by common consent given a negative valence of two, so that the polarity (*i. e.*, sum of the positive and negative valences) of each nitrogen atom may be regarded as $+1$. According to the conception of positive and negative valences, and in line with Abbegg's assumption that the non-metallic elements exhibit maximum positive and negative valences the sum of which is eight, the nitrogen series embraces at least nine stages which, starting with ammonia, in which nitrogen has a negative valence of three, and ending with nitric acid, in which nitrogen has a positive valence of five, runs as follows:

$$NH_3 — NH_2 \cdot NH_2 — NH_2OH — N_2 — N_2O — NO — N_2O_3(HNO_2) — NO_2 — N_2O_5(HNO_3).$$

The commonly accepted formula for nitrous oxide, which is to be discarded according to Noyes, fits very nicely in this series. In Dr. Noyes's formula, to be sure, he would assume that one nitrogen has a positive valence of five and the other a negative valence of three and, since the algebraic sum of all of the valences on both atoms of nitrogen is $+2$, the average polarity of the nitrogen is $+1$ as in the old formula. It is obvious that this explanation is a little more complicated than that suggested by the old formula.

Professor Noyes justifies his new formula for nitrous oxide by an ingenious explanation of the way in which this substance is formed from ammonium nitrate. In ammonium nitrate, Noyes is willing to admit that one nitrogen has a negative polarity of three and the other a positive valence of five. When ammonium nitrate is heated, Noyes assumes that the salt is decomposed at first into ammonia and nitric acid,

$$NH_4NO_3 \rightleftarrows NH_3 + HNO_3.$$

The ammonia and nitrate acid then tend to form an isomer of ammonium nitrate,

[1] SCIENCE, 44, 175–182, 1919.

$$NH_3 + HNO_3 \rightarrow O = N \begin{matrix} \diagup OH \\ -OH \\ \diagdown NH_2 \end{matrix},$$

but this compound is unstable and it loses water to form H_2N_2O,

$$O = N \begin{matrix} \diagup OH \\ -OH \\ \diagdown NH_2 \end{matrix} \rightarrow H_2O + O = N \begin{matrix} \diagup OH \\ \\ \diagdown NH \end{matrix},$$

and finally this H_2N_2O loses another molecule of water to form $O = N \equiv N$ in which one atom of nitrogen has a negative valence of three and the other a positive valence of five as in the original molecule of ammonium nitrate. In other words, neither atom of nitrogen has experienced any change with regard to its state of oxidation.

This hypothesis is certainly no more difficult to understand than many hypotheses which have been advocated in the past by chemists in both the so-called "organic" and "inorganic" fields. It is objectionable, however, because it assumes the formation of two very unstable, hypothetical, intermediate products. These intermediate compounds are certainly not very well known and there appears to be no proof of their formation during the progress of the reaction in question. Such a hypothesis is in line with the assumption of "nascent hydrogen" being formed when a chemical reduction is accomplished by a metal far above hydrogen in the electromotive series and it reminds one of the "primary products" which electro-chemists formerly believed to be formed as a result of electrolysis.

Such an explanation, moreover, is contrary to the evidence which can be deduced from the behavior of other ammonium salts upon ignition. It loses sight of the fact that nitrogen in its lowest state of oxidation is relatively unstable and easily oxidized and of the fact that nitrogen in its highest state of oxidation is easily reduced. In general, when an element is present in a compound in two states of oxidation, the decomposition of the compound is likely to result in the element assuming a state of oxidation intermediate between the two states in which it previously existed.

When ammonium dichromate is heated, nitrogen gas is evolved and chromic oxide is left behind. Heating ammonia sulfate results in the formation of nitrogen and sulfur dioxide. When ammonium nitrate is heated one atom of nitrogen is oxidized to form free nitrogen and the other is reduced to form nitrogen. In this case, Noyes would assume that neither atom of nitrogen is affected by oxidation or reduction but does not all our information with regard to the stability of ammonia and of nitrous acid make it seem simpler to assume that the polarity of nitrogen is zero when in the free condition rather than to insist that one atom has a positive valence of three and the other a negative valence of three?

Finally, Noyes claims that his formula seems more in accord with the ease with which nitrous oxide gives up its oxygen. As one writes the formula on paper it seems very easy to take away the oxygen from the $O = N \equiv N$ molecule and "organic" chemists always love to get atoms on the blackboard where they can easily erase them to show students how new compounds are formed, but it isn't quite clear why ammonium nitrate should withstand strong ignition without any effect upon the state of oxidation of either atom of nitrogen and yet after undergoing all this severe treatment, with the nitrous oxide retaining one nitrogen like that of nitric acid and the other like that of ammonia, be very susceptible to reduction. It would seem far simpler to assume that nitrogen with a valence of one is easily reduced.

The writer has respect for the views of Professor Noyes and has been under obligation to him in the past for helpful advice. He rejoices to learn that Professor Noyes is willing to accept much of the modern theory of valence.

WILLIAM T. HALL

CAMBRIDGE

A SNOW EFFECT

TO THE EDITOR OF SCIENCE: On March 3 of the present year a very interesting snow effect occurred in Orono and vicinity, which is perhaps worth recording in the columns of SCIENCE. The writer has not been able to find any one who ever saw a similar effect, and it