to agree approximately with the observed angle. If this should prove to be generally the case, it will not only be a solution of the problem which forms the subject of this note for crystals of the oblique system, but it will prove that these crystals are formed according to the same laws of symmetry as crystals of the prismatic system.

9. A Contribution to the History of the Oxides of Manganese. By W. Dittmar, Esq.

It is known that oxides of manganese, when ignited in air, either absorb or lose oxygen, until they attain the composition expressed by the formula Mn_3O_4 . Schneider found that when they are heated in pure oxygen, they leave the oxide Mn_2O_3 .

This latter result is not what one might have expected, for we know of no positive action exerted on manganese oxides or on pure oxygen by nitrogen. Thus air should act like dilute oxygen, producing the same oxide.

To explain Schneider's result, we must suppose either that artificial oxygen differs from that contained in air, or, what is more likely, that the amount of oxygen which any given quantity of manganese can take up when heated in it, depends not only on the temperature, but also *on the tension of the oxygen* employed.

If, then, it is true, that at a red heat, in presence of oxygen of the tension of one atmosphere, Mn_2O_3 is a stable compound, while the same oxide, exposed to the same temperature in presence of oxygen of the tension of one-fifth of an atmosphere, is reduced to Mn_3O_4 , the question naturally arises, What oxides will be formed in presence of oxygen of different tensions from those two above mentioned? Is there a continuous series of oxides corresponding to a continuous series of oxygen-tensions under which they have been formed?

These questions seemed to me to merit investigation, especially as their results would form an addition to our very imperfect knowledge of the influence of physical conditions on chemical reactions.

In the first series of experiments, pure peroxide of manganese, in a porcelain or platinum boat, was placed in a porcelain tube, kept at a bright red heat, while a current of nitrogen or oxygen, or of a mixture of these two gases, was passed over it. The

resulting oxide was weighed and analysed by determining the quantity of protoxide it yielded when heated in a current of hydrogen. Most of the experiments were carried on under ordinary atmospheric pressure; but in a few cases, the tension of the gas was made less than one atmosphere by connecting the exit end of the porcelain tube with a large bell-jar, within which the pressure was diminished, and kept constant by means of an air-pump.

Eighteen experiments gave the following results.

In all cases, either black Mn_2O_3 , or brown Mn_3O_4 was obtained; *no intermediate oxides were formed.*

In all the cases in which Mn_3O_4 was obtained, the partial tension of the oxygen lay between 0 and 0.21 atmospheres (the latter tension being that of the oxygen of the atmosphere). In all the experiments in which Mn_2O_3 was obtained, the partial tension of the oxygen lay between 0.25 and one atmosphere.

Oxygen tensions intermediate between 0.21 and 0.25 did not occur in the series; but in spite of this gap, the results obtained render it highly probable that the function expressing the relation between the composition of an oxide of manganese which is formed at a red heat in an atmosphere of oxygen, and the tension of that oxygen is discontinuous, so that Mn_2O_3 is formed whenever the tension *exceeds*, and Mn_3O_4 whenever it is *below a certain definite limit.*

To determine whether such a point of discontinuity really exists, and if so, its position, a second series of experiments was performed, which were made as uniform, and therefore comparable, as possible. In all cases, the MnO_2 was heated in mixtures of nitrogen and oxygen of exactly known composition, kept at, or very near to, the tension of the surrounding atmosphere. The percentages of oxygen in those mixtures were so chosen as gradually to inclose the value sought for within narrower and narrower limits. In each experiment, the height of the barometer was determined, in order to know exactly the partial tension of the oxygen in the mixture.

Eleven experiments were made in all. In eight, the oxides obtained were either pure Mn_2O_3 , or Mn_3O_4 . In three, the oxides were obtained together, not mixed, but as it were side by side, and occupying different parts of the boat. In those cases, in which

Mn_3O_4 was obtained alone, or at least in which it predominated, the partial tension of the oxygen (when measured by the height of the equivalent column of mercury) did not exceed 7·07 inches.

In those cases in which Mn_2O_3 was obtained, or at least predominated, the partial tension of the oxygen was equal to, or greater than, 6·9 inches. Thus the point of discontinuity lies between the two limits 6·9 and 7·07 inches.

Within these two tensions, sometimes the one and sometimes the other oxide was obtained. This fact does not speak, however, against the existence of some definite point of discontinuity, as the composition of the resulting oxide depends on the temperature at which the experiment is performed, as well as the tension of the oxygen employed. A diminution of temperature is probably of the same effect as an increase in the tension of the oxygen, and *vice versa*. Thus, if the tension of the oxygen in a given mixture of that gas and nitrogen is just equal to that corresponding to the point of discontinuity, for a definite temperature t , a temperature slightly above that will cause the formation of Mn_3O_4 , and one slightly below will produce Mn_2O_3 .

In one experiment I succeeded in producing the two oxides by means of the same mixture of nitrogen and oxygen, only the tension being slightly varied. Mn_2O_3 , heated in this mixture at the atmospheric pressure of 29·9 inches, remained unchanged, while at the tension of 29·5 it was reduced to Mn_3O_4 . This is quite within the limit of ordinary barometrical variations.

10. Notice of Glacial Clay, with Arctic Shells, near Errol, on the Tay. By the Rev. Thomas Brown, F.R.S.E.

The author referred to the paper on the Elie Glacial Clay, with Shells, read by him on the 2d of March 1863. During the succeeding summer he learned from Dr M'Bain, that shells had been found in a brickfield near Errol, but so badly preserved, that none of the species had been determined. During the autumn, while staying in the neighbourhood of Perth, he took occasion to visit the Errol brickfield, and found that the shells, which occur in considerable abundance, are precisely the same group with those at Elie. The *Leda truncata*, for example, which is the characteristic shell of the