

- III. "On Parts of the Skeleton of *Meiolania platyceps* (Ow.)."  
By Sir RICHARD OWEN, K.C.B., F.R.S., &c. Received March 29, 1887.

(Abstract).

The subjects of the present paper are additional fossil remains of *Meiolania platyceps* from Lord Howe's Island, transmitted to the British Museum since the author's previous paper on the subject. Additional cranial characters are defined and illustrated by drawings of more or less perfect specimens of the skull, of vertebræ of the neck, trunk, and tail, of limb-bones, and portions of the dermal skeleton.

The author sums up the affinities, deducible from the above parts of the skeleton, to the orders *Chelonia* and *Sauria*, with grounds for the conclusion that the genera *Megalania* and *Meiolania* are more nearly akin to the Saurian division of the class *Reptilia*, in which he proposes to refer those extinct genera to a sub-order called *Ceratosauria*.

- IV. "Some Applications of Dynamical Principles to Physical Phenomena. Part II." By J. J. THOMSON, M.A., F.R.S., Fellow of Trinity College and Cavendish Professor of Experimental Physics in the University of Cambridge. Received March 31, 1887.

(Abstract.)

This is a continuation of a paper with the same title published in the 'Phil. Trans.,' 1885, Part II. In the first paper dynamical principles were applied to the subjects of electricity and magnetism, elasticity and heat, to establish relations between phenomena in these branches of physics. In this paper corresponding principles are applied to chemical and quasi-chemical processes such as evaporation, liquefaction, dissociation, chemical combination, and the like.

Many of the results obtained in this paper have been or can be obtained by means of the Second Law of Thermodynamics, but one of the objects of the paper is to show that there are other ways of attacking such questions, and that in many cases such problems can be solved as readily by the direct use of dynamical principles as by the Second Law of Thermodynamics.

A great deal has been written on the connexion between the Second Law of Thermodynamics and the principle of Least Action; some of these investigations are criticised in the first part of the

paper. After this it is shown that for a collection of molecules in a steady state, the equation (which for ordinary dynamical systems is identical with the well-known Hamiltonian principle)

$$\delta(\bar{T} - \bar{V}) = 0$$

is satisfied, where  $\bar{T}$  and  $\bar{V}$  are respectively the mean values of the kinetic and potential energies taken over unit time, and where the variation denoted by  $\delta$  is of the following kind.

The coordinates fixing the configuration of any physical system, consisting according to the molecular theory of the constitution of bodies of an immense number of molecules, may be divided into two classes:—

(a.) Coordinates, which we may call molar, which fix the configuration of the system as a whole; and

(b.) Molecular coordinates which fix the configuration of individual molecules.

We have the power of changing the molar coordinates at our pleasure, but we have no control over the molecular coordinates.

In the equation—

$$\delta(\bar{T} - \bar{V}) = 0$$

only the molar coordinates are supposed to vary, all velocities remaining unchanged. Hence in applying this equation we need only consider those terms in  $\bar{T}$  and  $\bar{V}$  which involve the molar coordinates, and expressions for these terms for gases, liquids, and solids are given in the paper; the rest of the paper after these have been obtained consists of applications of the above equation.

The density of a vapour in equilibrium with its own liquid is obtained as a function of the temperature, and the effect upon the density of such things as the curvature or electrification of the surface of the liquid is determined.

The phenomenon of dissociation is next investigated, and an expression for the density of a dissociated gas obtained which agrees substantially in form with that given by Professor Willard Gibbs in his well-known paper on the "Equilibrium of Heterogeneous Substances."

The effect of pressure upon the melting point of solids and the phenomena of liquefaction are then investigated, and the results obtained for the effect of pressure upon the solubility of salts are shown to agree with the results of Sorby's experiments on this subject. The effect of capillarity upon solubility is investigated, and it is shown that if the surface-tension increases as the salt dissolves then capillarity tends to diminish the solubility, and *vice versa*.

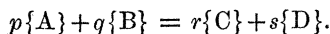
The question of chemical combination is then considered, par-

ticularly the results of what is called by the chemists "mass-action," of which a particular case is the division of a base between two acids.

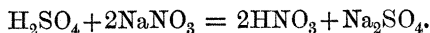
The general problem investigated is that in which we have four substances A, B, C, D present, such that A by its action on B produces C and D, while C by its action on D produces A and B. The relation between the quantities of A, B, C, D present when there is equilibrium is obtained and found to involve the temperature; when the temperature is constant it agrees in some cases with that given by Guldberg and Waage, though in others it differs in some important respects. Thus if  $\xi$ ,  $\eta$ ,  $\zeta$ ,  $\epsilon$  be the number of molecules of A, B, C, D respectively, when there is equilibrium,  $\theta$  the absolute temperature,  $H$  the amount of heat given out when the chemical process which results in the increase of  $\xi$  by unity takes place, and  $k$  a quantity which is the same for all substances, then it is proved that—

$$\frac{\xi^p \eta^q}{\zeta^r \epsilon^s} = C e^{\frac{pH}{k\theta}},$$

where  $C$  is a constant;  $p$ ,  $q$ ,  $r$ ,  $s$  are quantities such that if (A) represents the molecule of A, with a similar notation for the other molecules, then the chemical reaction can be represented by the equation—



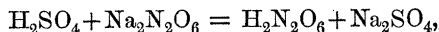
Thus if A, B, C, D be respectively sulphuric acid, sodium nitrate, nitric acid, and sodium sulphate, in which case the reaction is represented by—



Then if the molecules of sodium nitrate and nitric acid be represented by  $NaNO_3$  and  $HNO_3$ ,

$$p = 1, \quad q = 2, \quad r = 3, \quad \text{and } s = 1.$$

If, however, the molecules of sodium nitrate and nitric acid are represented respectively by  $Na_2N_2O_6$  and  $H_2N_2O_6$ , then since the chemical reaction may be written—



$$p = 1, \quad q = 1, \quad r = 1, \quad \text{and } s = 1.$$

According to Guldberg and Waage the relation between  $\xi$ ,  $\eta$ ,  $\zeta$ ,  $\epsilon$  is—

$$\xi\eta = k\zeta\epsilon;$$

this when the temperature is constant, agrees with the above expression if  $p = q = r = s$ .

We see that the state of equilibrium will vary rapidly with the temperature if  $H$  be large, that is, if the chemical process is attended by the evolution of a large quantity of heat.

The effect of alterations in the external circumstances such as those which may be produced by capillarity, pressure, or electrification are investigated, and it is shown that anything giving rise to potential energy which increases as the chemical combination goes on tends to stop the combination.

The last part of the paper is taken up with the consideration of irreversible effects such as those accompanying the passage of electric currents through metallic conductors or electrolytes. These are looked upon as the average of a large number of discontinuous phenomena which succeed each other with great rapidity. The ordinary electrical equations with the usual resistance terms in, represent on this view the average state of the system, but give no direct information about its state at any particular instant. It is shown that if we take this view we can apply dynamical principles to these irreversible effects, and the results of this application to the case of electrical resistance are given in the paper.

- V. "Conduction of Heat in Liquids." By C. CHREE, B.A., King's College, Cambridge. Communicated by Professor J. J. THOMSON, F.R.S. Received March 31, 1887.

(Abstract.)

In this research the liquid layer through which the conduction takes place is of a moderate thickness, the object being to obtain results not open to the objections which can be raised against most previous methods, in which conduction has taken place through layers of very small thickness.

Two similar forms of apparatus, differing chiefly in size, were employed, but from the larger apparatus few results were obtained, and to these little independent weight is assigned.

The liquid was contained in a wooden tub, and heat was applied by pouring hot water into a metal dish supported so as to be in contact with the liquid surface. At a given depth was fixed a fine platinum wire, and the variation in its temperature was determined by observing the variation in its electrical resistance. By this means the temperature at a given depth in the liquid is determined for any instant subsequent to the application of heat.

In applying the heat a given quantity of water, heated to a given