2. *Resolved*, further, that the council be requested to enter into negotiations with the editors of the PHYSICAL REVIEW to determine under what conditions the control of the REVIEW may be transferred to the society.

Adjourned at 1:30 P.M.

ERNEST MERITT,
Secretary.

THE ELECTRON THEORY OF CONTACT ELECTROMOTIVE FORCE AND OF THERMOELECTRICITY.¹

BY O. W. RICHARDSON.

A DISCUSSION of the nature of contact electromotive force and of the laws of thermoelectricity on the view that metals contain a large number (n per c.c.) of free electrons, dynamically equivalent to the molecules of a gas, which are retained in the metal by the action of forces near the boundary giving rise to work functions, w_1 , w_2 , etc., characteristic of each metal. This hypothesis has already been very successful in accounting for the laws which regulate the emission of negative electrons from hot bodies. Extensive use is also made of the theorem which has been proved by writers on the kinetic theory with sufficient generality to cover the conditions postulated, that if W is the work done in taking an electron from a point A to a point B then

$$W = R\theta \log \frac{n_1}{n_2},$$

where R is the gas constant calculated for a single molecule, θ is the absolute temperature, and n_1 and n_2 are the concentrations of the free electrons at A and B respectively.

By considering the case of a number of electrons in a thermally and electrically insulated enclosure it is shown that the condition for equilibrium is the invariance of $w_A - eV_A - R\theta \log n_A$ for every point A in the enclosure: where e is the charge of an electron, V_A is the electric potential at A and w_A is the work done by an electron in escaping from the metal in which A is. If A is in the space between the conductors $w_A = 0$. It follows that there is a permanent difference of electric potential $V_m - V_g$ between any two conductors which is given by

$$V_m - V_g = \frac{1}{e} \left\{ w_m - w_g + R\theta \log \frac{n_g}{n_m} \right\}$$

Experimental indications are that $w_m - w_g$ is much larger than the logarithmic term and is in all probability comparable with the observed Volta effects. If more complete knowledge of the values of the w 's confirms these indications it would follow that the observed contact differences are intrinsic properties of the metals and not due to chemical action. Several weak points in the current evidence in favor of chemical action are pointed out.

¹ Abstract of a paper presented at the New York meeting of the Physical Society, Oct. 14, 1911.

By considering the transportation of a number of electrons around suitable circuits of different metals and at different temperatures, so that the transference is partly along connecting conductors and partly through the surrounding space, but always in a reversible manner, it is shown that:

$$\begin{aligned}\pi e &= R\theta \log \frac{P_2}{P_1} = R\theta \log \frac{n_2}{n_1}, \\ \sigma &= \frac{1}{\epsilon} \left\{ \frac{Rr}{\gamma - 1} - R\theta \frac{d}{d\theta} \left(\log \frac{P}{P_0} \right) \right\} = \frac{1}{\epsilon} \left\{ \frac{R}{\gamma - 1} - R\theta \frac{d}{d\theta} \left(\log \frac{n}{n_0} \right) \right\}, \\ Te &= R \int_{\theta_0}^{\theta'} \log \left(\frac{P_2}{P_1} \right) d\theta = \epsilon \int_{\theta_0}^{\theta'} \frac{\pi}{\theta} d\theta, \\ \frac{dT}{d\theta} &= \frac{R}{\epsilon} \log \frac{P_2}{P_1} = \frac{\pi}{\theta} = \frac{R}{\epsilon} \log \frac{n_2}{n_1},\end{aligned}$$

where π is the Peltier effect between the metals 1 and 2 at temperature θ , P_2 and P_1 are the respective pressures of the free electrons inside the same metals, n_2 and n_1 are the corresponding concentrations, σ is the specific heat of electricity, γ is the ratio of the specific heats of the electrons at constant pressure and constant volume, n_0 and P_0 are concentration and pressure of the internal free electrons at a fixed temperature θ_0 , and n and P the corresponding quantities at the variable temperature θ . Finally T is the thermoelectromotive force of a circuit of the metals 1 and 2 whose junctions are at θ' and θ_0 respectively.

These formulæ agree with the results of Lord Kelvin's theory of thermoelectric phenomena, but they are not in entire accordance with formulæ which other writers on the electron theory have deduced by using other methods. Reasons are given, however, for believing them to be correct.

PALMER PHYSICAL LABORATORY,
PRINCETON, N. J.

THE INFLUENCE OF CONTACT DIFFERENCE OF POTENTIAL ON THE MEASUREMENT OF ELECTRON VELOCITIES IN THE PHOTO-ELECTRIC EFFECT.¹

BY KARL T. COMPTON.

THE writer finds that when the velocities of the electrons liberated from metals by ultra-violet light are determined in the usual way, *i. e.*, by the relation

$$v = \sqrt{\frac{2P\epsilon}{m}},$$

where ϵ and m are the charge and mass associated with an electron and P is the greatest retarding difference of potential against which the electron can escape from the emitting plate, the results are incorrect unless the contact

¹ Abstract of a paper presented at the New York meeting of the Physical Society, Oct. 14, 1911.