XXIII. ON THE THEORY OF THE PHOTO-ELECTRIC EFFECT

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Abstract*

A discussion is given of the suggestion by Millikan that in the photo-electric effect the energy of the light is transferred to the free electrons of the metal as well as to the bound electrons, and the product of the threshold frequency and Planck's constant is interpreted to be equal to the difference between the work necessary to remove a free electron from the metal and the kinetic energy of a free electron within th metal. In cases where the latter is not small compared with the former the theory leads to a lack of sharpness in the definition of the threshold. Neglecting variations of kinetic energy, the difference of stopping potentials comes out equal to the Peltier coefficient; hence the uniformity of stopping potentials for adifferent metals observed by Millikan is due, according to the theory, to the smallness of

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the Peltier effect. An expression is derived for the variation of the long wave-length limit with temperature. The variation comes out to be proportional to the Thomson coefficient and to the square of the long wave-length limit. In most cases the long wave-length limit should be practically independent of temperature.

Experiments were made with solid targets of aluminum and nickel. In the case of aluminum, the photo-currents remained strong after heating in vacuum by high frequency induction for many hours to near the melting point. After prolonged heating, the photo-electric current due to 2537A was found to remain constant within ½ per cent as the target was cooled from 400° to 100°C, and this constancy is interpreted as evidence that the shift of the long wave-length limit with change of temperature is less than 1A. The limit was found to be at about 2700A. Similar observations with a nickel target and 2412A gave inconclusive results, as in spite of heating to 1300°C and reduction of the oxide on the surface by heating in hydrogen, reproducible results were not obtained.