A STUDY OF THE COLLISIONS BETWEEN SLOW ELECTRONS AND GAS MOLECULES.

by

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1. INTRODUCTION.

The work to be described in this thesis was performed primarily with the object of studying the motions of electrons in air when the mean energy of the electrons only slightly exceeds the mean energy of the surrounding gas molecules. The results of accurate measurements of the parameters of the electronic motion in this region are essential for the development of such investigations as radio wave interaction in the ionosphere, and the only methods available in this range of energies are those based on diffusion as developed in the first place by Townsend. At the instigation of Professor Huxley a programme of research was undertaken to investigate electron diffusion in gases with the aim of achieving the greatest possible accuracy and self-consistency in the measurements and with accurate determinations in air as the ultimate objective.

The gases chosen for first study were hydrogen and nitrogen since in them inaccuracies arising from the attachment of electrons to molecules are unimportant. When the experimental inconsistencies revealed by these investigations had been overcome the techniques developed were applied to air and oxygen, but it was found necessary to modify the techniques to deal with negative ions present in the stream of electrons.

As a check on the results for nitrogen, oxygen and air the method of mixtures was applied to deduce the parameters of the electronic motion in air from the values of these parameters measured in nitrogen and oxygen. The values predicted theoretically by this method were found to be in poor agreement with those obtained by direct
measurement in air, and to test the validity of the theory experiments were conducted in mixtures of hydrogen and nitrogen, since the values of the parameters in these gases were considered as established beyond doubt. With the failure of the method for these mixtures also it was considered that there was no reason to doubt the trustworthiness of the measurements in air and consequently they were applied to the ionosphere with some interesting results.

A brief historical survey is given of work done previously on the gases investigated here, and the theoretical section contains the theory upon which experiments on lateral diffusion are based together with the derivation of formulae for the parameters of the electronic motion in terms of experimentally measureable quantities. A comparison and discussion of the earlier results and the results of the present experiments on the four gases will be found at the end of the appropriate sections.

The work to be described in what follows was carried out in collaboration with Mr. D. J. Sutton, B. Sc. of this department.