

The Mobilities of the Ions produced by Röntgen Rays in Gases and Vapours.

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(Abstract.)

The velocities of the positive and negative ions produced by Röntgen rays in 4 gases and 15 vapours have been measured at normal temperatures over a wide range of pressures and under different electric intensities. Langevin's direct null method was employed throughout.

For a constant pressure the velocity of the ion was found to vary as the electric intensity.

It was found that, in general, the mobility (k) of the ion varied inversely as the pressure (p). In the case of nitrous oxide and carbon dioxide there was a slight tendency for the product pk to increase both for the positive and negative ions as the pressure was reduced below about 7 cm. of mercury. In the case of ethyl chloride there was a marked tendency for the product pk to decrease as the vapour approached the saturated state; there is reason to believe that this tendency for pk to decrease would appear in the case of all the vapours in the neighbourhood of the saturated state.

In the case of vapours there was, in general, little difference in the values of the positive and negative mobilities. The mobility of the positive ion was found greater than that of the negative for aldehyde, ethyl alcohol, acetone, sulphur dioxide, ethyl chloride, pentane, ethyl acetate, methyl bromide, and ethyl iodide.

There appeared to be no direct relation between mobilities and molecular weights; the smaller mobilities invariably belonged to gases possessing high critical temperatures (the vapours); the larger mobilities to gases with low critical temperatures.

From the kinetic theory of gases an expression has been deduced for the mobility of an ion moving through a gaseous medium under the influence of an electric field. This expression takes into account the effect of the charge carried by the ion on its mean free path and involves only known physical constants of the gas.

As a result of the theoretical considerations, it appears that the

experimental values of the mobilities in the different gases at various pressures, as well as certain observed deviations from the law connecting the mobility and gaseous pressure, can be explained approximately on the supposition that the ion consists of a single molecule of the gas with which is associated a charge equal to that carried by the monovalent ion in electrolysis.

The Leakage of Helium from Radio-active Minerals.

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In a paper published in 'Roy. Soc. Proc.' A, vol. 81 (1908), p. 272, I showed that phosphatised bones and similar materials were notably radio-active, and that helium could be detected in them. The quantity of helium found was not, however, uniformly greater in the geologically older materials than in younger ones of equal activity. This was hypothetically attributed to escape of helium in certain cases. I desired if possible to obtain direct experimental confirmation of this conjecture.

It would clearly be impossible to detect leakage of helium from materials such as the mineralised bones, even in a lifetime. For any chance of success it was necessary to have recourse to the ores of uranium and thorium, in which the quantity of helium is something like 100,000 times greater.

The method of experimenting was to place a considerable quantity of the ore (usually a kilo or more) in a bottle provided with an exit tube and stopcock and connected to a mercury pump. The bottle was exhausted and the stopcock closed. After the lapse of a definite interval of time, usually a day or more, a small quantity of oxygen was admitted to the bottle and then collected through the pump, carrying with it any helium which had come off from the mineral. The oxygen was absorbed with melted phosphorus, leaving a small residue of helium, together with impurities. Any hydrogen present in the original gas, which may have been liberated by radio-active decomposition of traces of moisture, was burnt along with the phosphorus, and thus got rid of. The residue was transferred to an apparatus consisting of a McLeod gauge in connection with a reservoir containing charcoal. On cooling the charcoal with liquid air, helium was isolated, and the quantity could be measured. As a test of purity, the spectrum could be examined in the capillary measuring tube of the gauge, using external tinfoil electrodes.