BREAKUP OF H_2^+, HD^+, AND D_2^+ IONS BY SINGLE COLLISIONS WITH HYDROGEN, DEUTERIUM, AND AIR MOLECULES

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WHEN a beam of accelerated molecular ions passes through a gas at low pressure, the ions are found to break up without a measurable change of the initial velocity.[1,2] The study of such processes[3-6] has shown that breaking up is caused by single collisions of the ions with gas molecules along their path.

When H_2^+, HD^+, and D_2^+ ions are scattered, they may break up in the following ways:*

1) $H_2^+ \rightarrow p + H$, 2) $D_2^+ \rightarrow d + D$,

3) $HD^+ \rightarrow p + D$. 4) $HD^+ \rightarrow d + H$.

We have determined the relative probabilities q for these processes when H_2^+, HD^+, and D_2^+ ions accelerated to 3000 ev are passed through hydrogen, deuterium, and air at pressures of about 5×10^{-4} mm Hg.

The measurements were performed on a modernized MS-1 mass spectrograph. The ions were obtained by using 70 ev electrons to ionize hydrogen enriched to 82% D.

The results are presented in the table. The probability for process (2) is in all cases taken as 1.0. The experimental error is ± 15%.

Molecules used for scattering	q_1	q_2	q_3	q_4
Hydrogen	0.9	1.0	0.4	0.9
Deuterium (82% D)	1.3	1.0	0.4	1.0
Air	1.1	1.0	0.4	1.0

The table gives the ratios between the ion currents of the molecules that have been broken up and the ion currents of the original molecular ions. These ion currents were in all cases measured at the maxima of the respective peaks. This accounts only for those ions which are practically unscattered by the collision processes.

It is seen from the table that the general character of the breakup is independent of the scattering molecule within the experimental limits. The probabilities for processes (1) and (2) are the same, a fact which had been found previously,[5] and the total probability for process (3) plus (4) is somewhat larger. It should be noted that the probability for process (4) is, as may have been expected, much greater than that for process (3).

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66

*For the conditions of our experiment it is less likely that breaking up will occur with the simultaneous formation of two ions.