## Introduction:

The diffusion rates (velocities) of HCl and  $NH_3$  gases will be compared. Hydrogen chloride fumes will come from hydrochloric acid and ammonia fumes will come from aqueous ammonia. Both will be simultaneously introduced into opposite ends of a glass tube. When the gases meet, they will form a white precipitate,  $NH_4Cl$ , which will form a ring in the tube.

According to the \_\_\_\_\_\_ theory, gas molecules are in constant motion, hitting each other and the sides of their container with perfectly \_\_\_\_\_\_ collisions. The temperature of a gas is a measure of the average \_\_\_\_\_\_ energy of the molecules. The equation for calculating this energy is:  $KE = \frac{1}{2} mv^2$ 

If two gases are at the same temperature, the molecules have the same average kinetic energy. This makes KE a (constant, variable). This means that m and v<sup>2</sup> are \_\_\_\_\_\_ proportional. Heavier molecules move (slower, faster) than light molecules at the same temperature. Mathematically, the relationship can be stated as:

$$m_{1}v_{1}^{2} = m_{2}v_{2}^{2}$$
 which equals  $\frac{v_{1}^{2}}{v_{2}^{2}} = \frac{m_{2}}{m_{1}}$  which equals  $\left|\frac{v_{1}}{v_{2}} = \sqrt{\frac{m_{2}}{m_{1}}}\right|$ 

The last equation is known as Graham's Law of Diffusion.

## Procedure:

- 1. A drop of concentrated hydrochloric acid (a source of HCl fumes) was placed on a cotton swab. A drop of concentrated aqueous ammonia was placed on another cotton swab.
- 2. The swabs were simultaneously inserted into opposite ends of a glass tube.
- 3. The glass tube was left undisturbed for two minutes.
- 4. After two minutes, a white ring was located and the center of the ring was marked.
- 5. The distance from each end of the tube to the mark was measured.

HCl: d<sub>1</sub> = \_\_\_\_\_ NH<sub>3</sub>: d<sub>2</sub> = \_\_\_\_\_

6. Calculate the ratio d1/d2 = \_\_\_\_\_ This is also the ratio of the velocities of the molecules,  $v_1/v_2$ .

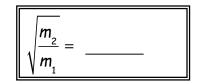
<u><u>v</u><sub>1</sub> =</u>
<i>v</i> <sub>2</sub>

7. Calculate the molar masses of the molecules:

HCI:  $m_1 =$ \_\_\_\_\_

NH <sub>3</sub> : m <sub>2</sub>	2 =	
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8. Calculate the ratio:



9. Within bounds of experimental error, does  $\frac{v_1}{2}$ 

$$\frac{1}{2} = \sqrt{\frac{m_2}{m_1}}$$
 ? \_\_\_\_\_

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