

Introduction:

The diffusion rates (velocities) of HCl and NH<sub>3</sub> 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<sub>4</sub>Cl, 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  $v^2$  are \_\_\_\_\_ proportional. Heavier molecules move (slower, faster) than light molecules at the same temperature. Mathematically, the relationship can be stated as:

$$m_1 v_1^2 = m_2 v_2^2 \quad \text{which equals} \quad \frac{v_1^2}{v_2^2} = \frac{m_2}{m_1} \quad \text{which equals} \quad \boxed{\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}}$$

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:  $d_1 =$  \_\_\_\_\_

NH<sub>3</sub>:  $d_2 =$  \_\_\_\_\_

6. Calculate the ratio  $d_1/d_2 =$  \_\_\_\_\_

*This is also the ratio of the velocities of the molecules,  $v_1/v_2$ .*

$\frac{v_1}{v_2} =$ _____
---------------------------

7. Calculate the molar masses of the molecules:

HCl:  $m_1 =$  \_\_\_\_\_

NH<sub>3</sub>:  $m_2 =$  \_\_\_\_\_

8. Calculate the ratio:

$\sqrt{\frac{m_2}{m_1}} =$ _____
----------------------------------

9. Within bounds of experimental error, does  $\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$  ? \_\_\_\_\_