Introduction:

The diffusion rates (velocities) of HCl and NH₃ 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, NH₄Cl, 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:

\[
m_1v_1^2 = m_2v_2^2 \quad \text{which equals} \quad \frac{v_1^2}{v_2^2} = \frac{m_2}{m_1} \quad \text{which equals} \quad \frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}
\]

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.

\[
\begin{align*}
\text{HCl: } d_1 &= \underline{\phantom{0000}} \\
\text{NH}_3: d_2 &= \underline{\phantom{0000}}
\end{align*}
\]

6. Calculate the ratio \( \frac{d_1}{d_2} = \underline{\phantom{0000}} \)

   This is also the ratio of the velocities of the molecules, \( \frac{v_1}{v_2} \).

\[
\frac{v_1}{v_2} = \underline{\phantom{0000}}
\]

7. Calculate the molar masses of the molecules:

\[
\begin{align*}
\text{HCl: } m_1 &= \underline{\phantom{0000}} \\
\text{NH}_3: m_2 &= \underline{\phantom{0000}}
\end{align*}
\]

8. Calculate the ratio:

\[
\sqrt{\frac{m_2}{m_1}} = \underline{\phantom{0000}}
\]

9. Within bounds of experimental error, does \( \frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \) ? \( \underline{\phantom{0000}} \)