Lesson 112: Graham's Law of Diffusion Lab

Chemistry with Lab

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 = ½mv^2.

If two gases are 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:

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

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_3: 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_3: m_2 = _____

8. Calculate the ratio:

$$\sqrt{\frac{m_2}{m_1}} = \_\_\_\_\_$$

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