Name: _____
Hour: ____ Date: _____

Chemistry: *Graham's Law*

Do the following problems, showing your work and including all proper units.

1. If neon gas travels at 400 m/s at a given temperature, calculate the velocity of butane, C_4H_{10}, at the same temperature.

2. Hydrogen sulfide, H_2S, has a very strong rotten egg odor. Methyl salicylate, $C_8H_8O_3$, has a wintergreen odor, and benzaldehyde, C_7H_6O, has a pleasant almond odor. If the vapors for these three substances were released at the same time from across a room, which odor would you smell first? Show your work and explain your answer.

3. A nitrogen molecule travels at about 505 m/s at room temperature. Find the velocity of a helium atom at the same temperature.

4. A carbon dioxide molecule travels at 45.0 m/s at a certain temperature. At the same temperature, find the velocity of an oxygen molecule.

5. Nitrogen gas effuses through an opening 1.59 times faster than does an unknown gas.

   a. Calculate the molecular mass of the unknown gas.

   b. Make a reasonable prediction as to what the unknown gas is.

6. An unknown gas diffuses 1.62 times slower than does oxygen gas.

   a. Calculate the molecular mass of the unknown gas.

   b. Make a reasonable prediction as to what the unknown gas is.

Answers:
1. 236 m/s
2. H_2S
3. 1336 m/s
4. 52.8 m/s
5a. 71 a.m.u.
5b. Cl_2
6a. 84 a.m.u.
6b. Kr

KEY

Chemistry: *Graham's Law*

Do the following problems, showing your work and including all proper units.

1. If neon gas travels at 400 m/s at a given temperature, calculate the velocity of butane, C_4H_{10}, at the same temperature.

$$\text{Neon}\begin{cases} m_2 = 20.2\text{ g} \\ v_2 = 400\text{ m/s} \end{cases} \qquad \text{Unknown}\begin{cases} m_1 = 58\text{ g} \\ v_1 = ?\text{ m/s} \end{cases}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \qquad \frac{v_1}{400\text{ m/s}} = \sqrt{\frac{20.2\text{ g}}{58\text{ g}}} \qquad v_1 = 236\text{ m/s}$$

2. Hydrogen sulfide, H_2S, has a very strong rotten egg odor. Methyl salicylate, $C_8H_8O_3$, has a wintergreen odor, and benzaldehyde, C_7H_6O, has a pleasant almond odor. If the vapors for these three substances were released at the same time from across a room, which odor would you smell first? Show your work and explain your answer.

$H_2S = 34$ amu
$C_8H_8O_3 = 152$ amu
$C_7H_6O = 106$ amu

All substances have the same kinetic energy (all are at the same temperature).
Therefore, the lightest molecules will move fastest.

3. A nitrogen molecule travels at about 505 m/s at room temperature. Find the velocity of a helium atom at the same temperature.

$$N_2\begin{cases} m_2 = 28\text{ g} \\ v_2 = 505\text{ m/s} \end{cases} \qquad \text{Helium}\begin{cases} m_1 = 4\text{ g} \\ v_1 = ?\text{ m/s} \end{cases}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \qquad \frac{v_1}{505\text{ m/s}} = \sqrt{\frac{28\text{ g}}{4\text{ g}}} \qquad v_1 = 1336\text{ m/s}$$

4. A carbon dioxide molecule travels at 45.0 m/s at a certain temperature. At the same temperature, find the velocity of an oxygen molecule.

$$CO_2\begin{cases} m_2 = 44\text{ g} \\ v_2 = 45\text{ m/s} \end{cases} \qquad O_2\begin{cases} m_1 = 32\text{ g} \\ v_1 = ?\text{ m/s} \end{cases}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \qquad \frac{v_1}{45\text{ m/s}} = \sqrt{\frac{44\text{ g}}{32\text{ g}}} \qquad v_1 = 52.8\text{ m/s}$$

5. Nitrogen gas effuses through an opening 1.59 times faster than does an unknown gas.

   a. Calculate the molecular mass of the unknown gas.

$$\text{Nitrogen}\begin{cases} m_2 = 28\text{ amu} \\ v_2 = 1.59x \end{cases} \qquad \text{Unknown}\begin{cases} m_1 = 58\text{ amu} \\ v_1 = 1x \end{cases}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \qquad \frac{1.59x}{1x} = \sqrt{\frac{m_2}{28\text{ g}}} \qquad m_2 = 70.8\text{ amu}$$

   b. Make a reasonable prediction as to what the unknown gas is.

Chlorine gas, Cl_2 2 Cl @ 35.453 amu = 70.9 amu

Chemistry: *Graham's Law*

6. An unknown gas diffuses 1.62 times slower than does oxygen gas.

   a. Calculate the molecular mass of the unknown gas.

$$\text{Oxygen}\begin{cases} m_1 = 32 \text{ amu} \\ v_2 = 1.62x \end{cases} \qquad \text{Unknown}\begin{cases} m_2 = ? \text{ amu} \\ v_2 = 1x \end{cases}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}} \qquad \frac{1.62x}{1x} = \sqrt{\frac{m_2}{32 \text{ amu}}} \qquad m_2 = 84 \text{ amu}$$

   b. Make a reasonable prediction as to what the unknown gas is.

      Krypton, Kr molecular mass is 83.80 amu

Answers:
1. 236 m/s
2. H_2S
3. 1336 m/s
4. 52.8 m/s
5a. 71 a.m.u.
5b. Cl_2
6a. 84 a.m.u.
6b. Kr