

Name: Key
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.

$$N_e = 20$$

$$C_4H_{10} = 58$$

$$\sqrt{\frac{m_1}{m_2}} = \frac{V_2}{V_1}$$

$$\sqrt{\frac{20}{58}} = \frac{V_2}{400}$$

$$V_2 = 235 \text{ m/s}$$

$$4(12) + 10 = 58$$

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.

$$H_2S = 2(1) + 32 = 34 \leftarrow \text{smallest mass} \Rightarrow \text{highest velocity}$$

$$C_8H_8O_3 = 8(12) + 8(1) + 3(16) = 152$$

$$C_7H_6O = 7(12) + 6(1) + 16 = 106$$

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

$$N_2 = 28$$

$$He = 4$$

$$\sqrt{\frac{m_1}{m_2}} = \frac{V_2}{V_1}$$

$$\sqrt{\frac{28}{4}} = \frac{V_2}{505}$$

$$V_2 = 1336 \text{ m/s}$$

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.

$$CO_2 = 44$$

$$O_2 = 32$$

$$V = 45.0 \text{ m/s}$$

$$\sqrt{\frac{m_1}{m_2}} = \frac{V_2}{V_1}$$

$$\sqrt{\frac{44}{32}} = \frac{V_2}{45.0}$$

$$V_2 = 52.8 \text{ m/s}$$

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.

$$N_2 = 28$$

$$\sqrt{\frac{m_1}{m_2}} = \frac{V_2}{V_1} = 1.59 = \sqrt{\frac{m_1}{28}}$$

$$2.53 = \frac{m_1}{28}$$

$$m_1 = 71$$

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

$$Cl_2 = 70.9 \text{ amu}$$

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

- a. Calculate the molecular mass of the unknown gas.

$$O_2 = 32$$

$$\sqrt{\frac{m_1}{m_2}} = \frac{V_2}{V_1} = 1.62 = \sqrt{\frac{m_1}{32}}$$

$$2.62 = \frac{m_1}{32}$$

$$m_1 = 84$$

- b. Make a reasonable prediction as to what the unknown gas is. $Kr = 83.8 \text{ amu}$

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