WKS
Rates of Effusion

Name Answer Key
Date_____ Period_____

Refer to p. 351-355 in your Modern Chemistry Textbook by Holt for help on this worksheet.

PART I: **Concepts of Temperature, Kinetic Energy and Effusion**

True or False: *Note--Temperature is a measure of the average kinetic energy of all molecules.*

F 1) When at the same temperature, all O_2 gas molecules move at the same speed.

T 2) When at the same temperature, lighter molecules move, on average, faster than heavier molecules.

F 3) According to the diagram shown below, gas A is lighter than gas B.

Gas A ← *Slower so heavier* | *Faster so lighter* → Gas B

Products of Gas A + Gas B reaction.

$\frac{v_X}{v_Y} = \frac{2}{1} = \frac{\sqrt{MM_Y}}{\sqrt{MM_X}}$ so $\sqrt{MM_X} = 2\sqrt{MM_Y}$ and $MM_X = 4(MM_Y)$

F 4) If Gas X effuses through a tube at twice the speed of Gas Y, then Gas Y is twice as heavy as Gas X.

PART II: Graham's Law Calculations ***(Problems taken from Holt, p359 #39-42)***

$$\frac{\text{rate of effusion of Gas A}}{\text{rate of effusion of Gas B}} = \frac{\text{velocity of Gas A}}{\text{velocity of Gas B}} = \frac{\sqrt{\text{molar mass of Gas B}}}{\sqrt{\text{molar mass of Gas A}}}$$

5) What is the ratio of the rate of effusion of hydrogen gas (H_2) to that of nitrogen gas (N_2)?

$$\frac{v_{H_2}}{v_{N_2}} = \frac{\sqrt{MM_{N_2}}}{\sqrt{MM_{H_2}}} = \sqrt{\frac{28.0\ \text{g/mol}}{2.0\ \text{g/mol}}} = \frac{3.72}{1} = \boxed{3.72}$$

6) What is the ratio of the velocity of hydrogen molecules (H_2) to that of Ne atoms (Ne)?

$$\frac{v_{H_2}}{v_{Ne}} = \frac{\sqrt{MM_{Ne}}}{\sqrt{MM_{H_2}}} = \sqrt{\frac{20.2\ \text{g/mol}}{2.0\ \text{g/mol}}} = \frac{3.16}{1} = \boxed{3.16}$$

7) At a certain temperature and pressure, chlorine molecules (Cl_2) have an average velocity of 0.0380 m/s. What is the average velocity of sulfur dioxide molecules (SO_2) under the same conditions?

$$\frac{v_{SO_2}}{v_{Cl_2}} = \frac{\sqrt{MM_{Cl_2}}}{\sqrt{MM_{SO_2}}} \Rightarrow \frac{v_{SO_2}}{0.0380\ \text{m/s}} = \sqrt{\frac{71.0\ \text{g/mol}}{64.1\ \text{g/mol}}} = 1.052 \Rightarrow v_{SO_2} = 1.052 \times 0.0380\ \text{m/s} = \boxed{0.0400\ \text{m/s}}$$

8) A sample of helium (He) effuses through a porous container 6.50 times faster than does unknown Gas X. What is the molar mass of the unknown gas?

$$\frac{v_{He}}{v_X} = \frac{\sqrt{MM_X}}{\sqrt{MM_{He}}} \Rightarrow \frac{6.50}{1} = \frac{\sqrt{MM_X}}{\sqrt{4.00\ \text{g/mol}}} \Rightarrow (6.50)^2 = \frac{MM_X}{4.00\ \text{g/mol}} \text{ so } MM_X = \boxed{169\ \text{g/mol}}$$