Dougherty Valley HS AP Chemistry
Gas Laws – Graham's Law of Effusion

WORKSHEET #8

Name: **Date:** **Period:** **Seat #:**

Effusion

$$\frac{Rate\ of\ Effusion\ of\ Gas\ 1}{Rate\ of\ Effusion\ of\ Gas\ 2} = \frac{\sqrt{M_2}}{\sqrt{M_1}}; M = Molar\ mass$$

Diffusion

$$\frac{Distance\ traveled\ of\ Gas\ 1}{Distance\ traveled\ of\ Gas\ 2} = \frac{\sqrt{M_2}}{\sqrt{M_1}}; M = Molar\ mass$$

Must show work for each problem:

Under conditions in which the density of carbon dioxide is 1.96 g/L and that of nitrogen is 1.25 g/L, which gas will effuse more rapidly? What will be the ratio of the rates of effusion of nitrogen to carbon dioxide? (**1.25 times faster**)	
Uranium hexafluoride is a white solid that readily passes directly into the vapour state. At room temperature (20□C), its vapour pressure is 16 kPa. A trace amount (about 0.7%) of the uranium in this compound is of the type that can be used in nuclear power plants or atomic bombs. It's called uranium-235. Essentially all of the rest, called uranium-238, is useless for direct applications in power plants or bombs. In fact, its presence interferes. During World War II a massive government effort was made to separate the two kinds of uranium. Gas effusion was used because the density of the hexachloride made from uranium-235 is 2.2920 g/L at 16 kPa and 20□C while under the same conditions the density of the hexafluoride made from uranium-238 is 2.3119 g/L. (In the gaseous states, these compounds behave remarkably like ideal gases.) Calculate how much more rapidly the lower-density compound will effuse compared to the higher-density compound. (The very small difference that you will find was actually enough, but repeated effusions were necessary). (**1.004 times**)	
A store receives a shipment of defective balloons. Each has a tiny pinhole of the same size. If one balloon is filled with helium and another is filled with air to the same volume and pressure, which balloon will deflate faster and how much faster? The density of helium at room temperature is 0.00016 g/mL and that of air is 0.0012 g/mL. (**2.74 times**)	
Natural gas pipelines cannot be kept totally free of developing microscope leaks. Natural gas is methane, which has a density at room temperature and 101.3 kPa of 0.654 g/L. Under these conditions the density of hydrogen is 0.0818 g/L. This difference in density, in the light of Graham's law, suggests a potential problem in using natural gas pipelines for sending hydrogen if we should ever adopt hydrogen as an alternative fuel to methane. What is this problem? Compare the rate of effusion of hydrogen to the rate for methane. (**2.83 H faster than CH_4**)	

Under the same conditions of temperature and pressure, does hydrogen iodide or ammonia effuse faster? Calculate the relative rates at which they effuse. (**NH_3 2.74 times faster**)	
Solar energy may someday be used to split water into hydrogen and oxygen and the hydrogen then used as a fuel. The different rates of effusions of hydrogen and oxygen from a mixture of the two and through a very tiny hole might be the basis of separating them. Which gas effuses more rapidly, and by what relative amount? (**4 times faster H_2**)	
What is the formula weight of a gaseous element if at room temperature it effuses though a pinhole 2.16 times as rapidly as xenon? Which element is it? (**28.14 g/mol, N_2**)	
Compute the relative velocities of H_2 and CO_2 through a fine pin-hole in a barrier. (**H_2, 4.69 times faster**)	
A small bicycle pump is filled with helium (He) gas. With constant pressure, the gas is forced out through a small aperture in two seconds. The same pump is filled with hydrogen bromide (HBr) gas. Using the same pressure, how long will it take to force out this gas? (**8.99 s**)	
Calculate the relative rates of diffusion of H_2 (g) and Br_2 (g) at the same temperatures. (**H_2, 8.904 times faster**)	
A bicycle pump is filled with helium (He) gas. With constant pressure, the gas is forced out through a small aperture in five seconds. How long will it take to expel Sulphur dioxide, SO_2, from this same pump under the same constant pressure? (**20.0 s**)	
An unknown gas effuses through a capillary in 60 seconds. The same volume of hydrogen escapes in 10 seconds. Calculate the molecular mass of the unknown gas. (**72.6 g/mol**)	

Agent 86 opens a vial of knockout gas at the end of a hallway 5 m from a guard. But Agent 99 is 4 m away and is wearing a powerful perfume, which, if the guard notices will mean immediate capture. The knockout gas has a molar mass of 255 g/mol and takes 1.5 seconds to work. The perfume odor has a molecule mass of 400 g/mol and will reach the guard in 12 seconds. Will Agents 86 and 99 be caught? (**Agent will be caught**)	
Your friend has "gambler's disease." He bets you that his 2 mL of HCl gas will diffuse through a 100 cm length of glass tubing faster than your 2 mL of NH_3 gas will pass through a 130 cm length of identical tubing. He gives you 5:1 odds that he will win. He will increase the odds to 10:1 if you come up with a foolproof means of judging the race. (i) What "foolproof means" would you use to judge this race? (ii) Who will win? Why? (iii) If you win, how much do you bet? You need $1000.00 for the weekend.	