Honors Chemistry Assignment Sheet - Unit 6

**Extra Learning Objectives (beyond regular chem.):**
1. Be able to perform calculations involving **Partial Pressure**
2. Be able to perform calculations involving **Graham's Law**

**Assignments Due class period before Unit 6 Test**
- Use your textbook & reliable internet resources to learn material
- Answer Keys are posted on the WHS chemistry website (see "important handouts")

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**Honors Assign #1 - Dalton's Law of Partial Pressure**
- Read pg 322-324 in your book & see practice problems on pg 324
- You will need to reference Table A-8 "Vapor Pressure of H\(_2\)O" from your book in order to solve these problems. You will be provided one for your test
- Do chapter Review problems pg 329 #39-43. Make sure to show your work.

39. Three of the primary components of the air are carbon dioxide, nitrogen, and oxygen. In a sample containing a mixture of only these gases at exactly one atmosphere pressure, the partial pressures of carbon dioxide and nitrogen are given as \(P_{CO_2} = 0.285\) torr and \(P_{N_2} = 593.525\) torr. What is the partial pressure of oxygen?

\[
P_{\text{total}} = P_{CO_2} + P_{N_2} + P_{O_2}
\]

Given:
- \(P_{\text{total}} = 1\text{atm (or 760 torr)}\)
- \(P_{CO_2} = 0.285\) torr
- \(P_{N_2} = 593.525\) torr

Solution:
- \(760\text{ torr} = 0.285\text{ torr} + 593.525\text{ torr} + P_{O_2}\)
- \(P_{O_2} = 166.190\text{ torr}\)

40. Determine the partial pressure of oxygen (really \(O_2\)) collected by water displacement if the water temperature is 20.0\(^\circ\)C and the total pressure of the gases in the collection bottle is 730.0 torr.

41. A sample of gas is collected over water at a temperature of 35.0\(^\circ\)C when the barometric pressure reading is 742.0 torr. What is the partial pressure of the dry gas?

\[
P_{\text{total}} = P_{\text{gas}} + P_{\text{H}_2\text{O}}
\]

Given:
- \(P_{\text{total}} = 742.0\text{ torr}\)
- \(P_{\text{H}_2\text{O}} \text{ @ 35}^\circ\text{C} = 42.2\text{ mmHg (or 42.2 torr)}\)

Solve: \(742\text{ torr} = P_{\text{gas}} + 42.2\text{ mmHg}\)
- \(P_{\text{gas}} = 699.8\text{ torr}\)

42. A sample of oxygen is collected in a 175 mL container over water at 15\(^\circ\)C and the barometer reads 752.0 torr, what volume would the dry gas occupy at 770.0 torr and 15\(^\circ\)?

**This is a 2 step problem!!** ... 1\(^{st}\) solve for the partial pressure of Oxygen 2\(^{nd}\), plug into PV/T
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43. Suppose 120. mL of argon is collected over water at 25°C and 780.0 torr. Compute the volume of the dry argon at STP.

This is a 2 step problem!! 1st solve for the partial pressure of argon 2nd, plug into PV/T

Step 1: Solve for \( P_{\text{argon}} \) using partial pressure.

\[
P_{\text{total}} = P_{\text{argon}} + P_{\text{H2O}}
\]

Given: \( P_{\text{total}} = 780.0 \text{ torr} \) \( P_{\text{H2O}} @ 25^\circ\text{C} = 23.8 \text{ torr} \)

\[
P_{\text{argon}} = 756.2 \text{ torr}
\]

Step 2: Plug into \( \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \)

\[
P_1 = 756.2 \text{ torr}  \quad V_1 = 120. \text{ mL}  \quad T_1 = 298K
\]

\[
P_2 = 760 \text{ torr}  \quad V_2 = ?  \quad T_1 = 273K
\]

\[
(756.2 \text{ torr})(120. \text{ mL}) = \frac{(760 \text{ torr})V_2}{298K} = \frac{(760 \text{ torr})V_2}{273K}
\]

\[
V_2 = 109 \text{ mL}
\]

Honors Assign #2–Graham’s Law of Effusion

- Read pg 351-355 in your book & see practice problems on pg 355
- Do Section Review problems pg 355 #1-3. Make sure to show your work
- Do Chapter Review problems pg 359 #39-42. Make sure to show your work

Pg 355

1. Compare diffusion with effusion

Effusion is the process by which gas molecules under pressure pass through a tiny opening. Diffusion is the mixing of gases by random molecular motion and there is not a constraint (small hole) preventing their ability to spread out.

2. Estimate the molar mass of a gas that effuses at 1.6 times the effusion rate of carbon dioxide.

Special Note... when setting these up it’s helpful to get the right number on top/ bottom in order to avoid confusion. In this case, the unknown gas is faster (1.6 x’s faster) than CO2. We know then to put this on top. A big rate/ smaller rate will give you a rate greater than 1. I always put the faster one (the one with the smaller molar mass) on top on the left side of my equal sign.

\[
\frac{\text{rate Unknown}}{\text{rate CO2}} = \frac{\sqrt{44.01 \text{ g/mol}}}{\sqrt{x \text{ g/mol}}}
\]

Given: 1.6=Rate \( \text{CO}_2 \)= 44.01 g/mol  Solve for \( x \)
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3. List the following gases in order of increasing average molecular velocity at 25°C: H₂O, He, HCl, BrF, & NO₂

The smaller they are, the faster they go. So the gases should be listed in order from largest (aka slowest) to smallest (aka fastest): BrF NO₂ HCl H₂O He

39. Quantitatively compare the rates of effusion for the following repairs of gases at the same temperature and pressure.

Special Note... when setting these up it's important to get the right number on top/bottom to avoid confusion. I always put the faster one (the one with the smaller molar mass) on top on the left side of my equal sign...the molar masses will be inversed on the right side of the equal sign, though. A big rate/smaller rate will give you a rate greater than 1 vs. getting a decimal for an answer.

a. Hydrogen and Nitrogen (NOTE: both of these are diatomic... always H₂ & N₂)

\[
\frac{\text{Rate of effusion A}}{\text{Rate of effusion B}} = \frac{\sqrt{\text{Molar mass B}}}{\sqrt{\text{Molar mass A}}}
\]

Notice, I put H₂ on top (it's faster because it weighs less)

\[
\frac{\text{Rate of effusion H₂}}{\text{Rate of effusion N₂}} = \frac{\sqrt{28.01 \text{ g/mol}}}{\sqrt{2.02 \text{ g/mol}}} \Rightarrow \sqrt{\frac{28.01 \text{ g/mol}}{2.02 \text{ g/mol}}} \Rightarrow = \sqrt{13.871}
\]

= 3.72 ... H₂ effuses 3.72 x's faster than N₂

b. Fluorine and Chlorine (NOTE: both of these are diatomic... always F₂ & Cl₂)

40. Ratio of average velocity of H₂ to Ne atoms: FYI: Velocity & rate of effusion are proportional to each other and have same formula. See pg. 35

\[
\frac{\text{velocity or rate H₂}}{\text{velocity or rate Ne}} = \sqrt{\frac{20.18}{2.02}} = 3.16
\]

41. At a certain temperature and pressure, Cl₂ molecules have average velocity of 0.0380 m/s. What is the average velocity of SO₂ molecules under the same conditions? (SO₂ = 64.06 g/mol + Cl₂ = 70.9 g/mol)
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42. A sample of He effuses through a porous container 6.50 times faster than does unknown gas X. What is the molar mass of the unknown gas?

Given: 6.5=Rate He=4 g/mol Solve for X

Note: He is smaller and therefore faster, I put the faster one (6.50 times faster) on top with the unknown underneath.

EQN: \( \frac{\text{He}}{\text{Unknown}} = \frac{\sqrt{x \text{ g/mol}}}{\sqrt{4 \text{ g/mol}}} \) \rightarrow (6.5) = \( \frac{\sqrt{x}}{\sqrt{4}} \) \rightarrow \text{Square everything} \rightarrow 42.25 = \( \frac{x}{4} \)

\( x = 169 \text{ g/mol} \)