Name Key Date 4/30/15

Gas Laws Review Sheet

Quantitative Chemistry

For problems, be sure to show your work and use significant figures!

1. Write the equation associated with the following laws. What units are associated with each variable? (Where applicable)

Boyle
$P_1V_1 = P_2V_2$

Charles (T in K)
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Gay-Lussac (T in K)
$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Combined
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Avogadro (n in mol)
$\frac{V_1}{n_1} = \frac{V_2}{n_2}$

Dalton
$P_{TOT} = P_1 + P_2 + P_3 + \ldots$

Ideal (n in mol; T in K)
$PV = nRT$

2. Complete the following with the words "increases" or decreases".

   a. As temperature increases, volume increases.

   b. As pressure increases, volume decreases.

   c. As moles increase, volume increases.

3. What are the conditions at STP? 1 atm & 273 K

   How many liters does 1 mole of a gas occupy at STP? 22.41 L

4. What piece of equipment is used to measure pressure? barometer

   Who invented it? Torricelli

5. According to kinetic molecular theory, gas particles are extremely small, and when they collide with the walls of their container, they are exerting pressure.

6. Convert 2.34 atm to mm Hg.

$$2.34\ \text{atm} \times \frac{760\ \text{mm Hg}}{1\ \text{atm}} = 1780\ \text{mm Hg}$$

7. A certain gas occupies 120 milliliters at 770 torr. What is its volume at 590 torr?

Boyles: $P_1V_1 = P_2V_2$

$(770\,\text{torr})(120\,\text{mL}) = (590\,\text{torr})V_2$

$V_2 = 160\,\text{mL}$

8. A sample of neon containing 0.75 moles has a volume of 13 L. How many moles of neon are present at a volume of 100. L?

Avogadro's $\frac{V_1}{n_1} = \frac{V_2}{n_2} \Rightarrow \frac{13\,\text{L}}{0.75\,\text{mol}} = \frac{100.\,\text{L}}{n_2} \Rightarrow n_2 = 5.8\,\text{mol}$

9. A sample of a gas (1.50 L) is collected at 1.0 atm and 25°C. If the pressure increases to 2.5 atm, and the volume is now 800. mL, what must be the new temperature in Celsius?

Combined $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{(1.0\,\text{atm})(1.50\,\text{L})}{298\,\text{K}} = \frac{(2.5\,\text{atm})(0.800\,\text{L})}{T_2}$ $T_2 = 397\,\text{K}$

$800.\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} = 0.800\,\text{L}$

$°\text{C} = \text{K} - 273 = 397\,\text{K} - 273 = 124°\text{C} \rightarrow 120°\text{C}$

10. A mixture of noble gases has a pressure of 1140 torr. If the partial pressure of helium is 1.0 atm, and the partial pressure of neon is 300 torr, what is the partial pressure of the argon?

$1.0\,\text{atm} \times \frac{760\,\text{torr}}{1\,\text{atm}} = 760\,\text{torr}$

Daltons $P_T = P_{He} + P_{Ne} + P_{Ar} \Rightarrow P_{Ar} = P_T - P_{He} - P_{Ne} = 1140\,\text{torr} - 760\,\text{torr} - 300\,\text{torr}$

$= 80\,\text{torr} \rightarrow 100\,\text{torr}$

11. What is the pressure of 50.0 grams of nitrous oxide (N_2O) at 300. K and a volume of 23.0 L?

Ideal $MVP = mRT \Rightarrow P = \frac{mRT}{MV} = \frac{(50.0\,\text{g})\left(0.0821\,\frac{\text{L·atm}}{\text{mol K}}\right)(300.\,\text{K})}{\left(44.04\,\frac{\text{g}}{\text{mol}}\right)(23.0\,\text{L})}$

$P = 1.22\,\text{atm}$

12. How many grams of mercury(II) oxide are needed to produce 8.0 liters of oxygen gas at STP? **$2HgO \rightarrow 2Hg + O_2$**

Stoichiometry $8.0\,\text{L}\,O_2 \times \underbrace{\frac{1\,\text{mol}\,O_2}{22.41\,\text{L}\,O_2}}_{\text{STP}} \times \underbrace{\frac{2\,\text{mol Hg}}{1\,\text{mol}\,O_2}}_{\text{BCE}} \times \underbrace{\frac{200.59\,\text{g Hg}}{1\,\text{mol Hg}}}_{\text{PT}} = 140\,\text{g Hg}$

13. Calcium reacts with water to form calcium hydroxide and hydrogen gas. If 4.00 grams of calcium react at 32°C and 0.93 atm, what volume of hydrogen gas is produced?

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

Stoichiometry $4.00\,\text{g Ca} \times \frac{1\,\text{mol Ca}}{40.08\,\text{g Ca}} \times \frac{1\,\text{mol}\,H_2}{1\,\text{mol Ca}} = 0.0998\,\text{mol}\,H_2$

Ideal $PV = nRT \Rightarrow V = \frac{nRT}{P} = \frac{(0.0998\,\text{mol})\left(0.0821\,\frac{\text{L·atm}}{\text{mol K}}\right)\left(305\,\text{K}\right)}{0.93\,\text{atm}} = 2.7\,\text{L}$