Honors Chem Unit 11 Gases
Avogadro's Law Notes

Avogadro's Law: Volume and moles relationships in gases

Review:

- There are four variables related to gases: P, V, T, and n (moles)
- Boyle's Law deals with P & V $P_1V_1 = P_2V_2$
- Charles' Law covers T & V $V_1 / T_1 = V_2 / T_2$
- Combined Gas Law covers P, V, T $P_1V_1/T_1 = P_2V_2/T_2$
- STP, 0°C and 1 atm

Notes:

- The next gas law is very simple. It is called Avogadro's Law and deals with the relationship between V and n (number of moles)
- If P and T are kept constant, then increasing the number of moles of a gas will increase it volume proportionally. (diagram p. 413)
- Mathematically: $V_1 / n_1 = V_2 / n_2$
- At STP 1 mole of any ideal gas has a volume of 22.4L

Cautions:

1. Always watch your units … use the same P, V on both sides.
2. Use common sense … think about your answer!

Examples:

1. $n_1 = 3.2$ mol, $V_1 = 2.5$ L, $V_2 = ?$, $n_2 = 2.0$ mol

$$V_2 = \frac{V_1 n_2}{n_1} \qquad \frac{2.5\text{L} \,/\, 2.0\text{mol}}{3.2\text{mol}} = \boxed{1.6\text{L}}$$

2. $V_1 = 3.25$ L at $n_1 = 5.25$ mol, $V_2 = 4.45$ L at $n_2 = ?$ mol

$$n_2 = \frac{n_1 V_2}{V_1} \qquad \frac{5.25\text{mol} \,/\, 4.45\text{L}}{3.25\text{L}} = \boxed{7.19\text{mol}}$$

3. V= 475 mL at n = 12.2 g (He), V = ? at n = 4.50 g (He)

Note: 1 mol He = 4.003 g

Cancels out!

$$V_2 = \frac{V_1 n_2}{n_1}$$

$$\frac{475\text{ mL} \,/\, 4.50\text{ g}}{12.2\text{ g}} = \boxed{175\text{ mL}}$$

4. If 0.214 moles of argon gas occupies a volume of 652 mL at a particular temperature and pressure, what volume would 0.375 moles of argon occupy under the same conditions? V_2

$$V_2 = \frac{V_1 n_2}{n_1} \qquad \frac{652\text{ mL} \,/\, .375\text{ mol}}{.214\text{ mol}} = \boxed{1140\text{ mL}}$$

n_1 V_1

5. If 46.2 g of oxygen gas occupies a volume of 100. L at a particular temperature and pressure, what volume will 5.00 g of oxygen gas occupy under the same conditions? n_2

$$V_2 = \frac{V_1 n_2}{n_1} \qquad \frac{100.\text{ L} \,/\, 5.00\text{ g}}{46.2\text{ g}} = \boxed{10.8\text{ L}}$$

grams cancel so would mol and molar mass.)

6. How many moles of O_2 are in 500.0 mL of oxygen gas at STP?

$$\frac{500.0\text{ mL} \,/\, 1\text{ mol} \,/\, 1\text{ L}}{22.4\text{ L} \,/\, 1000\text{ mL}} = \boxed{.0223\text{ mol}}$$

7. What is the density of O_2 gas at STP?

$1\text{ mol } O_2 = 32.00\text{ g}$

$1\text{ mol } O_2 = 22.4\text{ L (STP)}$

$D = m/V$

$$\frac{32.00\text{ g}}{22.4\text{ L}} = \boxed{1.43\text{ g/L}}$$