CHEMISTRY 30a **Gas Law Problem Set** **FALL 2014**

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Group Names: KEY

1. A sample of gas has a volume of 135 mL at 0.600 atm. What would the volume be if the pressure is decreased to 0.200 atm while temperature is held constant?

$$P_1V_1 = P_2V_2$$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{(135)(0.600)}{0.200} = 405 \text{ mL}$$

2. A sealed stainless steel bomb containing 250 mL of gas at a pressure of 1.00 atm and a temperature of 50 deg C is heated to 100 deg C. What is the new pressure inside the bomb?

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}; \quad P_2 = \frac{P_1V_1T_2}{T_1V_2} = \frac{(1.00)(250)(273+100)}{(273+50)(250)}$$

$$= 1.15 \text{ atm}$$

3. A sample of helium has a volume of 480 mL at 47.0 deg C and 740 mm Hg. The temperature is lowered to 22.0 deg C and the pressure to 625 mm Hg. What is the new volume?

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(740)(480)(273+22)}{(625)(273+47)} = 524 \text{ mL}$$

4. How many moles of gas are present in a 10.0 L sample at STP?

$PV = nRT$; STP: 0°C, ~~and~~ (273 K) and 1.00 atm

$$n = \frac{PV}{RT} = \frac{(1.00 \text{ atm})(10.0 \text{ L})}{(0.082 \frac{\text{L-atm}}{\text{mol-K}})(273 \text{K})} = 0.446 \text{ moles}$$

5. Consider the following balanced reaction: $N_2 + 3H_2 \rightarrow 2NH_3$

If 10.3 L of nitrogen are reacted to form ammonia at STP, how many liters of hydrogen will be required to completely consume all of the nitrogen?

Equal volumes of gas at the same T+P contain equal numbers of moles.

$$10.3 \text{ L-}N_2 \times \frac{3 \text{ L-}H_2}{\text{L-}N_2} = 30.9 \text{ L}$$

6. How many grams of nitrogen are contained in a 5.0 L sample at STP? $N_2 = 28 \text{ g/mol}$

$$n = \frac{PV}{RT} = \frac{(1.00)(5.0)}{(0.082)(273)} = 0.223 \text{ moles}$$

$$n = \frac{m}{M} \text{ so } m = nM = (0.223)(28) = 6.2 \text{ g}$$

7. A 3.0 mL sample of methanol, CH_3OH, is completely vaporized at 95 deg C. What is the volume of the vapor if the barometric pressure is 29.61 inches of mercury?

$d(CH_3OH)$ @ $20^\circ C = 0.79 \text{ g/mL}$

$(3.0)(0.79) = 2.37 \text{ g MeOH}$

~~$\frac{29.6 \text{ in}}{25.4 \text{ mm/in}}$~~

$29.61 \text{ in} \times 25.4 \text{ mm/in} = 752 \text{ mm Hg}$ or $\frac{752}{760} = 0.989 \text{ atm}$

$$V = \frac{nRT}{P} = \frac{\left(\frac{2.37}{32}\right)(.082)(273+95)}{0.989} = 2.26 \text{ L}$$

8. Write a balanced equation for the combustion of benzene, C_6H_6. Then calculate the mass of carbon dioxide produced when 50.0 mL of benzene is burned. (The density of benzene is 0.87 g/mL).

$$C_6H_6 + 7.5\,O_2 \rightarrow 6CO_2 + 3H_2O$$

$50 \times .87 = 43.5 \text{ g}$

$$\frac{43.5}{78} = 0.557 \text{ moles } C_6H_6$$

$$0.557 \text{ moles } C_6H_6 \times \frac{6 \text{ moles } CO_2}{\text{mole } C_6H_6} \times \frac{44 \text{ g } CO_2}{\text{mol } CO_2} = 147 \text{ g } CO_2$$

9. What is the pressure in a 1.00 L container of methane, CH_4, that contains 40.0 g of the gas at 25.0 deg C?

$$P = \frac{nRT}{V} = \frac{(2.5)(.082)(298)}{1.0} = 61.1 \text{ atm}$$

$$CH_4: \frac{40}{16} = 2.5 \text{ moles}$$

10. If a 0.614 g sample of a gas maintains a pressure of 238 mm Hg when contained in a 1.0 L flask at 0.0 deg C, what is the molecular weight of the gas?

$$PV = nRT \qquad P = \frac{238}{760} \text{ atm} = 0.313 \text{ atm}$$

$$V = 1.0 \text{ L}$$

$$R = 0.082 \text{ L-atm/mol-K}$$

$$T = 273 \text{ K}$$

$$n = \frac{PV}{RT} = \frac{(0.313)(1.0)}{(0.082)(273)} = 0.0140 \text{ moles}$$

$$n = \frac{m}{M}; \quad M = \frac{m}{n} = \frac{0.614}{0.0140} = 43.9 \text{ g/mol} \sim 44$$