Unit 13 Problem Set Key

1) Given:

Volume = 2L

Pressure = 1 atm

Temp. = 85°C + 273.15 = 358.15K

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(1\,\text{atm})(2\,\text{L})}{(0.08206\,\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(358.15\,\text{K})}$$

$= 0.07\ \text{mol}$

2) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{6.50\,\text{L}}{80.0^\circ\text{C}} = \frac{65.0\,\text{L}}{T_2}$

$T_2 = 800^\circ\text{C}$

3) $4\,PH_{3(g)} \rightarrow 4\,H_{2(g)} + 2\,P_2H_{2(g)}$

$2\,PH_{3(g)} \rightarrow 2\,H_{2(g)} + P_2H_{2(g)}$

P 4	P 4
H 12	H 12

$$28.6\,\text{g}\ PH_3 \times \frac{\text{mol}\ PH_3}{33.994\,\text{g}} = 0.8413\ \text{mol}\ PH_3$$

$$0.8413\ \text{mol}\ PH_3 \times \frac{2\,\text{mol}\ H_2}{2\,\text{mol}\ PH_3} = 0.8413\ \text{mol}\ H_2$$

$$0.8413\ \text{mol}\ PH_3 \times \frac{1\,\text{mol}\ P_2H_2}{2\,\text{mol}\ PH_3} = 0.42065\ \text{mol}\ P_2H_2$$

} Sum of moles of gas products is 1.26195 mol

moles x molar volume @ STP

$1.26195 \text{ mol} \times \frac{22.4 \text{ L}}{\text{mol}} = 28.3 \text{ L}$

4) Reaction $\rightarrow$ $H_2(g)$

$P_{total} = P_{H_2} + P_{H_2O}$

$685 \text{ mm Hg} = P_{H_2} + 28.3 \text{ mm Hg}$

$P_{H_2} = 656.7 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.86408 \text{ atm}$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(0.86408 \text{ atm})(7.80 \text{ L})}{(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(294.15 \text{ K})} = 0.2792 \text{ moles of } H_2$

$0.2792 \text{ mol } H_2 \times \frac{2.016 \text{ g } H_2}{\text{mol}} = 0.563 \text{ g } H_2$

5) b is a correction for the volume of gas particles

6) Gas A: $P_1V_1 = P_2V_2$

$(1.0 \text{ atm})(4.0 \text{ cm}^3) = P_2(14.0 \text{ cm}^3)$

$0.29 \text{ atm} = 0.2857 \text{ atm} = P_2$

Gas B: $P_1V_2 = P_2V_2$

$(2.0 \text{ atm})(10.0 \text{ cm}^3) = P_2(14.0 \text{ cm}^3)$

$1.4 \text{ atm} = 1.4286 \text{ atm} = P_2$

7) a. $Sn(s) + 2HCl(aq) \rightarrow SnCl_2(aq) + H_2(g)$

b. $1.40\,g\,Sn \times \frac{mol\,Sn}{118.71\,g} = 0.01179\,mol\,Sn$; $710\,Torr = 710\,mmHg \times \frac{1\,atm}{760\,mmHg} = 0.9342\,atm$

$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(0.01179\,mol)\left(0.0826\,\frac{L \cdot atm}{mol \cdot K}\right)(300.15\,K)}{0.9342\,atm}$$

$$= 0.311\,L$$

8) $$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(1.00\,atm)(2.54\,L)}{0.0826\,\frac{L \cdot atm}{mol\,K}(318.15\,K)} = 0.09729\,mol\,Br_2$$

$$P_{final}V = nRT$$

$$P_{final} = \frac{nRT}{V} = \frac{(0.09729\,mol)\left(0.0826\,\frac{L \cdot atm}{mol\,K}\right)(473.15\,K)}{(15.0\,L)} = 0.2518\,atm$$

$$0.2518\,atm \times \frac{760\,mmHg}{1\,atm} = 190\,mm\,Hg$$

9) $2(N_2O(g) + \frac{3}{2}O_2(g) \rightarrow N_2O_4(g))$

N 4 — N 4

O 3 * 8 — O * 8

$2N_2O(g) + 3O_2(g) \rightarrow 2N_2O_4(g)$

1 mol N_2O_4 : 1 mol N_2O

1 mol N_2O_4 : 1.5 mol O_2

9. Avogadro's Law

$V \propto n$

$\therefore$ 1 L N_2O_4 : 1 L N_2O

1 L N_2O_4 : 1.5 L O_2

$$3.6\ L\ N_2O_4 \times \frac{1\ L\ N_2O}{1\ L\ N_2O_4} = 3.6\ L\ N_2O_4$$

$$3.6\ L\ N_2O_4 \times \frac{1.5\ L\ O_2}{1\ L\ N_2O_4} = 5.4\ L\ O_2$$

b. The 4.00 L of O_2 were @ P = 2.00 atm; T = 20°C

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(2.00\ atm)(4.0\ L)}{\left(0.08206 \frac{L \cdot atm}{mol\ K}\right)(293.15\ K)} = 0.3326\ mol\ O_2$$

$$0.3326\ mol\ O_2 \times \frac{2\ mol\ N_2O_4}{3\ mol\ O_2} = 0.2217\ mol\ N_2O_4$$

@ P = 1.0 atm, T = 20°C

$PV = nRT$

$$V = \frac{nRT}{P} = \frac{(0.2217\ mol)(0.08206)(326.15)}{1.0\ atm} = 5.93\ L\ of\ N_2O_4$$

10) $d = \frac{PM}{RT}$ @ $720\ Torr \times \frac{1\ atm}{760\ Torr} = 0.9474\ atm$

$SO_2 \rightarrow 64.07\ g/mol$ T = 310.15 K

$$d = \frac{0.9474\ atm\ \left(64.07 \frac{g}{mol}\right)}{\left(0.08206 \frac{L \cdot atm}{mol\ K}\right)(310.15\ K)} = 2.38 \frac{g}{L}\ SO_2$$

Need to find the molecular mass.

11) $PV = nRT$

$$n = \frac{PV}{RT} = \frac{3.75\ atm\ (1.0\ L)}{\left(0.0826\ \frac{L \cdot atm}{mol\ K}\right)(310.15\ K)} = 0.1473\ mol$$

$$M = \frac{5.02\ g}{0.1473\ mol} = 34.1\ \frac{g}{mol}$$

a. H_2O $\frac{18.016\ g}{mol}$ b. HBr $\frac{80.908\ g}{mol}$ c. HCN $\frac{27.028\ g}{mol}$ d. H_2S $\frac{34.086\ g}{mol}$ e. C_2H_2 $\frac{26.036\ g}{mol}$

12) $P_{total} = 1380\ mm\ Hg$

$a = Ar$

$$\chi_a = \frac{n_a}{n_{total}} = \frac{1.5\ mol\ Ar}{5.81\ mol} = 0.258$$

$$P_a = \chi_a P_{total} = 0.258(1380\ mm\ Hg) = 356\ mm\ Hg$$