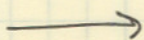


INTRODUCTION TO NATURAL SCIENCE 2006/07
CHEMISTRY HOMEWORK - SPRING - WEEK 2

Chapter 12

⑤

$$\begin{array}{l} P_1 = 67.5 \text{ torr} \\ V_1 = 500. \text{ mL} \end{array}$$



$$\begin{array}{l} P_2 = ? \\ V_2 = 125 \text{ mL} \end{array}$$

T and n are constants (Boyle's law can be applied)

$$P_1 V_1 = P_2 V_2$$

$$\begin{aligned} P_2 &= \frac{P_1 V_1}{V_2} = \frac{(67.5 \text{ torr})(500 \text{ mL})}{(125 \text{ mL})} \\ &= \underline{\underline{270 \text{ torr}}} \end{aligned}$$

⑦

$$\begin{array}{l} V_1 = 3.5 \text{ L} \\ T_1 = 22.0^\circ \text{C} = 295 \text{ K} \end{array}$$

$$\begin{array}{l} V_2 = ? \\ T_2 = 37^\circ \text{C} = 310 \text{ K} \end{array}$$

P and n are constants. Charles's law can be applied

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_2 = \frac{V_1 \cdot T_2}{T_1}$$

$$V_2 = \frac{(3.5 \text{ L})(310 \text{ K})}{(295 \text{ K})} = \underline{\underline{3.68 \text{ L}}}$$

⑩

$$\begin{aligned} V_1 &= 25.0 \text{ mL} \\ T_1 &= 20.5^\circ\text{C} = 293.5 \text{ K} \\ P_1 &= 436.5 \text{ torr} \end{aligned}$$

flask A

$$P_1 V_1 = nRT_1$$

$$\frac{P_1 V_1}{T_1} = nR \quad \text{--- (1)}$$

$$\begin{aligned} P_2 &= 94.3 \text{ torr} \\ T_2 &= 24.5^\circ\text{C} = 297.5 \text{ K} \\ V_2 &= ? \end{aligned}$$

flask B

$$\frac{P_2 V_2}{T_2} = nR \quad \text{--- (2)}$$

$$\text{(1) and (2)} \Rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\begin{aligned} V_2 &= \left(\frac{P_1 V_1}{T_1} \right) \left(\frac{T_2}{P_2} \right) = \frac{(436.5 \text{ atm})(25.0 \text{ mL})(297.5 \text{ K})}{(293.5 \text{ K})(94.3 \text{ torr})} \\ &= \underline{\underline{117.29 \text{ mL}}} \end{aligned}$$

⑫

$$\begin{aligned} V_1 &= 135 \text{ mL} \\ T_1 &= 22.5^\circ\text{C} = 295.5 \text{ K} \\ P_1 &= 165 \text{ mm Hg} \end{aligned}$$

$$\frac{P_1 V_1}{T_1} = nR \quad \text{--- (1)}$$

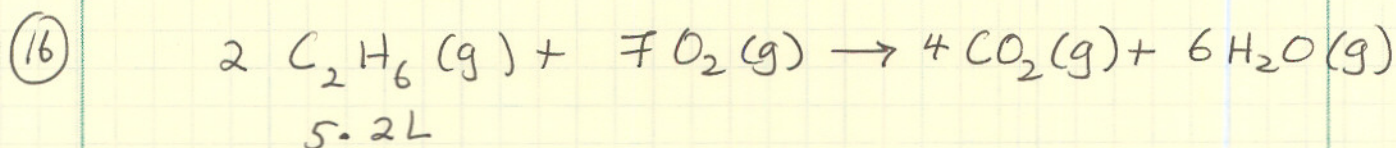
$$\begin{aligned} P_2 &= ? \\ V_2 &= 252 \text{ mL} \\ T_2 &= 0^\circ\text{C} = 273 \text{ K} \end{aligned}$$

$$\frac{P_2 V_2}{T_2} = nR \quad \text{--- (2)}$$

$$\text{(1) and (2)} \Rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_2 = \left(\frac{P_1 V_1}{T_1} \right) \left(\frac{T_2}{V_2} \right)$$

$$= \frac{(165 \text{ torr})(135 \text{ mL})(273 \text{ K})}{(295.5 \text{ K})(252 \text{ mL})} = \underline{\underline{81.66 \text{ torr}}}$$



$$\text{moles of C}_2\text{H}_6 = \frac{P \cdot V}{RT} = \frac{P(5.2 \text{ L})}{RT}$$

$$\text{moles of O}_2 \text{ required} = (\text{moles of C}_2\text{H}_6) \left(\frac{7 \text{ mol O}_2}{2 \text{ mol C}_2\text{H}_6} \right)$$

$$= \frac{P(5.2 \text{ L})}{RT} \left(\frac{7}{2} \right) = \frac{P(18.2 \text{ L})}{RT}$$

moles
~~Volume~~ of O₂ required (n) = $\frac{PV}{RT}$ where V = volume of O₂

$$\therefore \frac{PV}{RT} = \frac{P(18.2 \text{ L})}{RT} \Rightarrow \underline{\underline{V = 18.2 \text{ L}}}$$

$$\text{moles of H}_2\text{O}(\text{g}) \text{ produced} = (\text{moles C}_2\text{H}_6) \left(\frac{6 \text{ mol H}_2\text{O}(\text{g})}{2 \text{ mol C}_2\text{H}_6} \right)$$

$$= \frac{P(5.2 \text{ L})}{RT} \cdot \left(\frac{6}{2} \right) = \frac{P(15.6 \text{ L})}{RT}$$

moles of H₂O(g) produced = $\frac{PV}{RT}$ (V = volume of H₂O)

$$\frac{PV}{RT} = \frac{P(15.6 \text{ L})}{RT} \Rightarrow \underline{\underline{V = 15.6 \text{ L}}}$$

(19)

$$\text{mass of CO}_2 = 2.2\text{g}$$

$$T = 22^\circ\text{C} = 295\text{K}$$

$$P = 318\text{ torr}$$

$$V = ?$$

$$\text{moles of CO}_2 = 2.2\text{g} \times \left(\frac{1\text{ mol}}{44.01\text{g}} \right) = 4.999 \times 10^{-2}\text{ mol}$$

$$PV = nRT \Rightarrow V = \frac{nRT}{P}$$

$$V = \frac{(4.999 \times 10^{-2}\text{ mol})(0.08206\text{ atm L K}^{-1}\text{ mol}^{-1})(295\text{K})}{(318\text{ torr}) \left(\frac{1\text{ atm}}{760\text{ torr}} \right)}$$

$$= 2.89\text{ L}$$

(22)

$$P = 1.1\text{ atm} \quad V = 5.0\text{ L} \quad T = 25^\circ\text{C} = 298\text{ K}$$

$$PV = nRT \Rightarrow n = \frac{PV}{RT}$$

$$n = \frac{(1.1\text{ atm})(5.0\text{ L})}{(0.08206\text{ atm L K}^{-1}\text{ mol}^{-1})(298\text{K})} = 0.2249\text{ mol}$$

$$0.2249\text{ mol} \times \left(\frac{4.0026\text{g}}{1\text{ mol}} \right) = 0.900\text{g of He}$$

$$P = 233\text{ torr} \quad T = 298\text{ K} \quad d = ?$$

$$d = \frac{PM}{RT}$$

M - molar mass

$$d = \frac{(233\text{ torr})(4.0026\text{g/mol})}{(0.08206\text{ atm L K}^{-1}\text{ mol}^{-1})(298\text{K})} = 3.9\text{ g/mol}$$

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$$d = \frac{(233 \text{ torr}) (74.114 \text{ g mol}^{-1})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1}) (298 \text{ K})} \cdot \left(\frac{\text{atm}}{760 \text{ torr}} \right)$$

$$d = \cancel{760} \underline{\underline{0.929 \text{ g/L}}}$$

$$(27) \quad PV = nRT \quad n = \frac{PV}{RT} \quad T = 23^\circ\text{C} = 296 \text{ K}$$

$$n = \frac{(715 \text{ torr}) (452 \text{ mL})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1}) (296 \text{ K})} \times \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right) \left(\frac{\text{L}}{10^3 \text{ mL}} \right)$$

$$n = 1.75 \times 10^{-2} \text{ mol}$$

$$\text{mass of sample} = 1.007 \text{ g}$$

$$\text{molar mass} = \frac{\text{mass}}{\# \text{ moles}} = \frac{1.007 \text{ g}}{1.75 \times 10^{-2} \text{ mol}} = \underline{\underline{57.5 \text{ g/mol}}}$$

$$(28) \quad n = \frac{PV}{RT} = \frac{(13.7 \text{ torr}) (165 \text{ mL})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1}) (295.5 \text{ K})} \times \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right) \left(\frac{\text{L}}{10^3 \text{ mL}} \right)$$

$$= 1.227 \times 10^{-4} \text{ mol}$$

$$\text{mass} = 0.0125 \text{ g}$$

$$\text{molar mass} = \frac{0.0125 \text{ g}}{1.227 \times 10^{-4} \text{ mol}} = 101.91 \text{ g/mol}$$

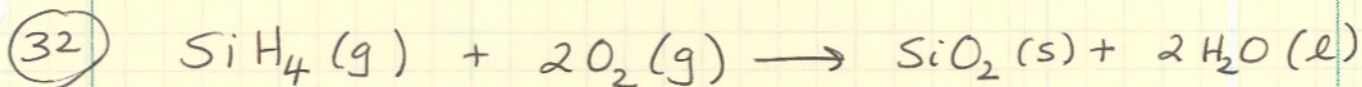
$$\text{empirical formula } [\text{CHF}_2] \text{ mass} = [12.011 + 1.008 + 2(18.998)] \text{ g}$$

$$= 51.015 \text{ g}$$

$$\# \text{ of empirical formula units in molecular formula} \left. \vphantom{\# \text{ of empirical formula units in molecular formula}} \right\} = \frac{101.91}{51.015} = 2$$

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∴ Molecular formula = $2(\text{CHF}_2) = \underline{\underline{\text{C}_2\text{H}_2\text{F}_4}}$



5.20 L
356 torr
298 K

425 torr
298 K
V = ?

$$\# \text{ of moles}_{\wedge}^{(n)} \text{ of SiH}_4 = \frac{PV}{RT} = \frac{(356 \text{ torr})(5.20 \text{ L})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1})(298 \text{ K})} \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right)$$

$$= 9.96 \times 10^{-2} \text{ mol}$$

$$\# \text{ of moles of O}_2 \text{ required } \left. \begin{array}{l} \text{to react w/ silane} \end{array} \right\} = 9.96 \times 10^{-2} \text{ mol SiH}_4 \times \left(\frac{2 \text{ mol O}_2}{1 \text{ mol SiH}_4} \right)$$

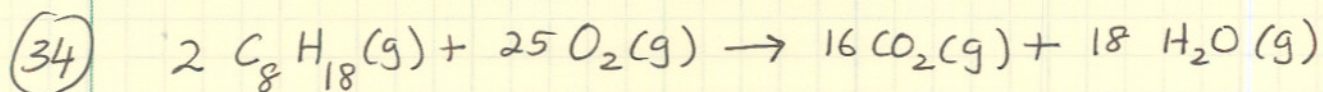
$$= 0.1992 \text{ mol O}_2$$

For O₂ $V = \frac{nRT}{P}$

$$V = \frac{(0.1992 \text{ mol})(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1})(298 \text{ K})}{(425 \text{ torr})} \times \left(\frac{760 \text{ torr}}{1 \text{ atm}} \right)$$

$$= \underline{\underline{8.71 \text{ L}}}$$

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$$0.095 \text{g}$$

$$V = 4.75 \text{L}$$

$$P = ?$$

$$\text{molar mass of } \text{C}_8\text{H}_{18} = [8(12.011) + 18(1.008)] \text{g/mol}$$

$$= 114.232 \text{g/mol}$$

$$\# \text{ of moles of } \text{C}_8\text{H}_{18} = \frac{0.095 \text{g}}{114.232 \text{g/mol}} = 8.32 \times 10^{-4} \text{mol}$$

$$\text{mol of } \text{H}_2\text{O} \text{ produced} = 8.32 \times 10^{-4} \text{mol } \text{C}_8\text{H}_{18} \times \left(\frac{18 \text{mol } \text{H}_2\text{O}}{2 \text{mol } \text{C}_8\text{H}_{18}} \right)$$

$$= 7.48 \times 10^{-3} \text{mol } \text{H}_2\text{O}$$

$$\text{For } \text{H}_2\text{O}(\text{g}) \quad P = \frac{nRT}{V}$$

$$P = \frac{(7.48 \times 10^{-3} \text{mol})(0.08206 \text{atmL K}^{-1} \text{mol}^{-1})(303 \text{K})}{(4.75 \text{L})}$$

$$P = \underline{\underline{3.92 \times 10^{-2} \text{atm}}}$$

$$\text{moles of } \text{O}_2 \text{ required} = 8.32 \times 10^{-4} \text{mol } \text{C}_8\text{H}_{18} \times \left(\frac{25 \text{mol } \text{O}_2}{2 \text{mol } \text{C}_8\text{H}_{18}} \right)$$

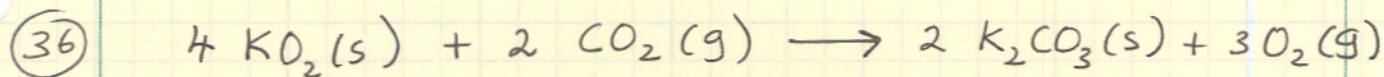
$$= \underline{\underline{0.0104 \text{mol } \text{O}_2}}$$

$$\text{For } \text{O}_2(\text{g}) \quad P = \frac{nRT}{V}$$

$$P = \frac{(0.0104 \text{mol})(0.08206 \text{atmL K}^{-1} \text{mol}^{-1})(295 \text{K})}{(4.75 \text{L})}$$

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$$P = \frac{0.212 \text{ atm}}{\underline{\quad}} \quad \underline{0.053 \text{ atm}}$$



$$\begin{aligned} & 8.90 \text{ L} \\ & 767 \text{ torr} \\ & 295 \text{ K} \end{aligned}$$

$$\# \text{ of moles } (n) \text{ of } \text{CO}_2 = \frac{PV}{RT}$$

$$= \frac{(767 \text{ torr})(8.90 \text{ L})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1})(295 \text{ K})} \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right)$$

$$= 0.371 \text{ mol}$$

$$\left. \begin{array}{l} \text{moles of } \text{KO}_2 \text{ required} \\ \text{for the reaction} \end{array} \right\} = 0.371 \text{ mol } \text{CO}_2 \times \left(\frac{4 \text{ mol } \text{KO}_2}{2 \text{ mol } \text{CO}_2} \right)$$

$$= 0.742 \text{ mol } \text{KO}_2$$

$$\begin{aligned} \text{molar mass of } \text{KO}_2 &= [39.0983 + 2(15.99)] \text{ g/mol} \\ &= 71.0783 \text{ g/mol} \end{aligned}$$

$$\begin{aligned} \therefore \text{Mass of } \text{KO}_2 &= 0.742 \text{ mol } \text{KO}_2 \times \left(\frac{71.0783 \text{ g}}{\text{mol}} \right) \\ &= \underline{\underline{52.74 \text{ g } \text{KO}_2}} \end{aligned}$$

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(39) Total pressure = sum of partial pressures
 $P_{\text{tot}} = (170 + 570) \text{ torr} = 740 \text{ torr}$

$$P_i = x_i P_{\text{total}}$$

$$x_i = \frac{P_i}{P_{\text{tot}}}$$

$$x_{\text{halothane}} = \frac{170 \text{ torr}}{740 \text{ torr}} = 0.229 = \frac{n_{\text{halothane}}}{n_{\text{tot}}}$$

$$x_{\text{O}_2} = \frac{570 \text{ torr}}{740 \text{ torr}} = 0.771 = \frac{n_{\text{O}_2}}{n_{\text{tot}}}$$

$$\frac{n_{\text{halothane}}}{n_{\text{tot}}} : \frac{n_{\text{O}_2}}{n_{\text{tot}}} = 0.229 : 0.771$$

$$\begin{aligned} n_{\text{halothane}} : n_{\text{O}_2} &= 0.229 : 0.771 \\ &= \underline{\underline{0.297}} \end{aligned}$$

mass of $\text{O}_2 = 160 \text{ g}$

$$\text{moles of } \text{O}_2 = 160 \text{ g} \times \left(\frac{\text{mol}}{32 \text{ g}} \right) = \overset{5}{\cancel{16}} \text{ mol } \text{O}_2$$

$$x_{\text{O}_2} = \frac{\text{mol of } \text{O}_2}{n_{\text{tot}}} = 0.771$$

$$\Rightarrow \frac{5 \text{ mol } \text{O}_2}{n_{\text{tot}}} = 0.771 \Rightarrow n_{\text{tot}} = 6.49 \text{ mol}$$

$$n_{\text{tot}} = n_{\text{halothane}} + n_{\text{O}_2}$$

$$\therefore n_{\text{halothane}} = (6.49 - 5) \text{ mol} = 1.49 \text{ mol}$$

$$\begin{aligned} \text{molar mass of halothane} &= [2(12.011) + 1.008 + 79.904 \\ &\quad + 35.45 + 3(18.99)] \text{ g/mol} \\ &= 197.354 \text{ g/mol} \end{aligned}$$

$$\begin{aligned} \text{mass of halothane} &= 1.49 \text{ mol} \times \left(\frac{197.354 \text{ g}}{\text{mol}} \right) \\ &= 294.0 \text{ g} \\ &= \underline{\underline{294 \text{ g}}} \end{aligned}$$

(40)

$$T = 21.5^\circ\text{C} = 294.5 \text{ K}$$

$$\begin{array}{l} V_1 = 12.5 \text{ L} \\ P_1 = 1.00 \text{ atm} \\ T_1 = 294.5 \text{ K} \end{array}$$

He only

$$\begin{array}{l} V_2 = 26 \text{ L} \\ P_2 = 1.00 \text{ atm} \\ T_2 = 294.5 \text{ K} \end{array}$$

He + O₂

$$(a) \text{ He only } n_1 = \frac{P_1 V_1}{RT_1} = \frac{(1.00 \text{ atm})(12.5 \text{ L})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1})(294.5 \text{ K})}$$

$$n_1 = 0.517 \text{ mol of He}$$

$$\text{mass of He} = 0.517 \text{ mol} \times \left(\frac{4.0026 \text{ g}}{\text{mol}} \right) = \underline{\underline{2.070 \text{ g}}}$$

(b)

$$\text{He + O}_2 \text{ mixture } n_2 = \frac{P_2 V_2}{RT_2}$$

$$n_2 = \frac{(1.00 \text{ atm})(26 \text{ L})}{(0.08206 \text{ atm L K}^{-1} \text{ mol}^{-1})(294.5 \text{ K})} = 1.076 \text{ mol}$$

$$= \text{mol of He} + \text{mol of O}_2$$

$$\therefore \text{mol of O}_2 = n_2 - \text{mol of He} = (1.076 - 0.517) \text{ mol}$$

$$= 0.559 \text{ mol of O}_2$$

$$\text{mole fraction of He} = \frac{\text{moles of He}}{\text{total moles}} = \frac{0.517 \text{ mol}}{1.076 \text{ mol}}$$

$$= 0.480$$

$$P_i = x_i P_{\text{tot}}$$

$$P_{\text{He}} = x_{\text{He}} P_{\text{tot}}$$

$$= (0.480) 1.00 \text{ atm} = \underline{\underline{0.480 \text{ atm}}}$$

$$(c) \quad P_{\text{O}_2} = x_{\text{O}_2} P_{\text{tot}} = \left(\frac{0.559}{1.076} \right) 1 \text{ atm}$$

$$= \underline{\underline{0.519 \text{ atm}}}$$

$$(d) \quad x_{\text{He}} = \underline{\underline{0.480}} \quad x_{\text{O}_2} = \underline{\underline{0.519}}$$

(43)

$$\sqrt{\bar{u}^2} = \sqrt{\frac{3RT}{M}}$$

let $O_2 = 1$
 $CO_2 = 2$

$$\sqrt{\bar{u}_1^2} = \sqrt{\frac{3RT}{M_1}} \quad \text{--- (1)}$$

$$\sqrt{\bar{u}_2^2} = \sqrt{\frac{3RT}{M_2}} \quad \text{--- (2)}$$

$$\frac{\text{(2)}}{\text{(1)}} \quad \frac{\sqrt{\bar{u}_2^2}}{\sqrt{\bar{u}_1^2}} = \sqrt{\frac{M_1}{M_2}}$$

$$\frac{\bar{u}_2^2}{\bar{u}_1^2} = \frac{M_1}{M_2} = \frac{32 \text{ g mol}^{-1}}{44 \text{ g mol}} = 0.727$$

$$\bar{u}_2^2 = (0.727) \bar{u}_1^2 = 0.727 (4.28 \times 10^4 \text{ cm s}^{-1})$$

$$= 3.11 \times 10^4 \text{ cm s}^{-1} = \underline{\underline{311 \text{ m s}^{-1}}}$$

$$= \underline{\underline{311 \text{ m s}^{-1}}}$$