AP Chemistry Chapter 12 Answers - Kotz

Text Problems: 5, 7, 11, 13, 15, 19, 21, 26, 30, 31, 34, 40, 41, 50, 51, 55, 87

12.5 $P_2 = \dfrac{P_1V_1}{V_2} = \dfrac{(67.5 \text{ mm Hg})(500.\text{ mL})}{125 \text{ mL}} = 270.\text{ mm Hg}$

12.7 $V_2 = T_2\left(\dfrac{V_1}{T_1}\right) = (310.\text{ K})\left(\dfrac{3.5 \text{ L}}{295.2 \text{ K}}\right) = 3.7 \text{ L}$

12.11 $P_2 = P_1\left(\dfrac{T_2}{T_1}\right) = (360 \text{ mm Hg})\left(\dfrac{268.2 \text{ K}}{298.7 \text{ K}}\right) = 320 \text{ mm Hg}$

12.13 $P_2 = P_1\left(\dfrac{V_1}{V_2}\right)\left(\dfrac{T_2}{T_1}\right) = (1.00 \text{ atm})\left(\dfrac{400.\text{ cm}^3}{50.0 \text{ cm}^3}\right)\left(\dfrac{350.\text{ K}}{288 \text{ K}}\right) = 9.72 \text{ atm}$

12.15 (a) $150 \text{ mL NO} \cdot \dfrac{1 \text{ L } O_2}{2 \text{ L NO}} = 75 \text{ mL } O_2$

(b) $150 \text{ mL NO} \cdot \dfrac{2 \text{ L } NO_2}{2 \text{ L NO}} = 150 \text{ mL } NO_2$

12.19 $2.2 \text{ g} \cdot \dfrac{1 \text{ mol } CO_2}{44.0 \text{ g}} = 0.050 \text{ mol } CO_2$

$313 \text{ mm Hg} \cdot \dfrac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.418 \text{ atm}$

$V = \dfrac{nRT}{P} = \dfrac{(0.050 \text{ mol})(0.082057 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(295 \text{ K})}{0.418 \text{ atm}} = 2.9 \text{ L}$

12.21 $737 \text{ mm Hg} \cdot \dfrac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.970 \text{ atm}$

$n = \dfrac{PV}{RT} = \dfrac{(0.970 \text{ atm})(1.2 \times 10^7 \text{ L})}{(0.082057 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(298 \text{ K})} = 4.8 \times 10^5 \text{ mol He}$

$4.8 \times 10^5 \text{ mol He} \cdot \dfrac{4.00 \text{ g}}{1 \text{ mol He}} = 1.9 \times 10^6 \text{ g He}$

12.26 $195 \text{ mm Hg} \cdot \dfrac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.257 \text{ atm}$

$M = \dfrac{dRT}{P} = \dfrac{(1.25 \text{ g/L})(0.082057 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(298.2 \text{ K})}{0.257 \text{ atm}} = 119 \text{ g/mol}$

12.30 $d = \dfrac{0.107 \text{ g}}{0.125 \text{ L}} = 0.856 \text{ g/L}$

$331 \text{ mm Hg} \cdot \dfrac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.436 \text{ atm}$

$M = \dfrac{dRT}{P} = \dfrac{(0.856 \text{ g/L})(0.082057 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(273.2 \text{ K})}{0.436 \text{ atm}} = 44.1 \text{ g/mol}$

12.31 $2.2\text{ g}\cdot\dfrac{1\text{ mol Fe}}{55.9\text{ g}}\cdot\dfrac{1\text{ mol }H_2}{1\text{ mol Fe}}=0.039\text{ mol }H_2$

$$P=\frac{nRT}{V}=\frac{(0.039\text{ mol})(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(298\text{ K})}{10.0\text{ L}}=0.096\text{ atm}$$

12.34 $0.095\text{ g}\cdot\dfrac{1\text{ mol }C_8H_{18}}{114\text{ g}}=8.3\times10^{-4}\text{ mol }C_8H_{18}$

$$8.3\times10^{-4}\text{ mol }C_8H_{18}\cdot\frac{18\text{ mol }H_2O}{2\text{ mol }C_8H_{18}}=0.0075\text{ mol }H_2O$$

$$P_{H_2O}=\frac{n_{H_2O}RT}{V}=\frac{(0.0075\text{ mol }H_2O)(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(303.2\text{ K})}{4.75\text{ L}}=0.039\text{ atm}$$

$$8.3\times10^{-4}\text{ mol }C_8H_{18}\cdot\frac{25\text{ mol }O_2}{2\text{ mol }C_6H_6}=0.010\text{ mol }O_2$$

$$P_{O_2}=\frac{n_{O_2}RT}{V}=\frac{(0.010\text{ mol }O_2)(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(295\text{ K})}{4.75\text{ L}}=0.053\text{ atm}$$

12.40 (a) $n=\dfrac{PV}{RT}=\dfrac{(1.00\text{ atm})(12.5\text{ L})}{(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(294.7\text{ K})}=0.517\text{ mol He}$

$$0.517\text{ mol He}\cdot\frac{4.003\text{ g}}{1\text{ mol He}}=2.07\text{ g He}$$

(b) $P=\dfrac{nRT}{V}=\dfrac{(0.517\text{ mol He})(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(294.7\text{ K})}{26\text{ L}}=0.48\text{ atm}$

(c) $P_{O_2}=P_{total}-P_{He}=1.00\text{ atm}-0.48\text{ atm}=0.52\text{ atm}$

(d) $X_{He}=\dfrac{0.48\text{ atm}}{1.00\text{ atm}}=0.48$ $\qquad X_{O_2}=\dfrac{0.52\text{ atm}}{1.00\text{ atm}}=0.52$

12.41 (a) The two gases are at the same temperature so the average kinetic energy per molecule is the same.

(b) The molar mass of H_2 (2.02 g/mol) is less than the molar mass of CO_2 (44.0 g/mol). Flask A has molecules with higher average velocity.

(c) At constant T and V, $n\propto P$. Flask B contains more molecules.

(d) $\dfrac{n_{H_2}}{n_{CO_2}}=\dfrac{(1\text{ atm})(V)/(R)(273\text{ K})}{(2\text{ atm})(V)/(R)(298\text{ K})}=\dfrac{0.5\text{ mol }H_2}{1\text{ mol }CO_2}$

1 mol CO_2 (44 g) has a greater mass than 0.5 mol H_2 (1.0 g). Flask B has a greater mass.

$$\frac{\text{Rate of }I_2}{\text{Rate of uranium fluoride}}=\sqrt{\frac{M_{\text{uranium fluoride}}}{M_{I_2}}}$$

12.50 $\dfrac{\left(\dfrac{0.0150\text{ g}}{1\text{ hr}}\cdot\dfrac{1\text{ mol }I_2}{253.8\text{ g}}\right)}{\left(\dfrac{0.0177\text{ mg}}{1\text{ hr}}\cdot\dfrac{1}{M_{\text{uranium fluoride}}}\right)}=\sqrt{\dfrac{M_{\text{uranium fluoride}}}{253.8\text{ g/mol}}}$

$$(0.00334)^2(M_{\text{uranium fluoride}})^2=\frac{M_{\text{uranium fluoride}}}{253.8\text{ g/mol}}$$

$$M_{\text{uranium fluoride}}=353\text{ g/mol}$$

12.51 $P_{\text{ideal}} = \dfrac{nRT}{V} = \dfrac{(8.00\text{ mol})(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(300.2\text{ K})}{4.00\text{ L}} = 49.3\text{ atm}$

$$\left(P + a\left[\frac{n}{V}\right]^2\right)(V - bn) = nRT$$

$$\left(P + (6.49\text{ atm}\cdot\text{L}^2/\text{mol}^2)\left[\frac{8.00\text{ mol}}{4.00\text{ L}}\right]^2\right)\big(4.00\text{ L} - [0.0562\text{ L/mol}][8.00\text{ mol}]\big)$$

$$= (8.00\text{ mol})(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(300.2\text{ K})$$

$P = 29.5$ atm

12.55 $2.82\text{ g } H_2O \cdot \dfrac{1\text{ mol } H_2O}{18.02\text{ g}} \cdot \dfrac{2\text{ mol H}}{1\text{ mol } H_2O} = 0.31\text{ mol H}$

At STP, 1 mol of a gas occupies 22.414 L

$$2.0\text{ L } CO_2 \cdot \frac{1\text{ mol } CO_2}{22.414\text{ L}} \cdot \frac{1\text{ mol C}}{1\text{ mol } CO_2} = 0.089\text{ mol C}$$

$$0.5\text{ L } N_2 \cdot \frac{1\text{ mol } N_2}{22.414\text{ L}} \cdot \frac{2\text{ mol N}}{1\text{ mol } N_2} = 0.045\text{ mol N}$$

$$\frac{0.31\text{ mol H}}{0.045\text{ mol N}} = \frac{7\text{ mol H}}{1\text{ mol N}} \qquad \frac{0.089\text{ mol C}}{0.045\text{ mol N}} = \frac{2\text{ mol C}}{1\text{ mol N}}$$

The empirical formula is C_2H_7N

12.87 $n_{CO_2} = \dfrac{PV}{RT} = \dfrac{\left(44.9\text{ mm Hg}\cdot\dfrac{1\text{ atm}}{760\text{ mm Hg}}\right)(1.50\text{ L})}{(0.082057\text{ L}\cdot\text{atm/K}\cdot\text{mol})(298\text{ K})} = 0.00362\text{ mol } CO_2$

$$0.00362\text{ mol } CO_2 \cdot \frac{1\text{ mol CO}}{1\text{ mol } CO_2} \cdot \frac{28.01\text{ g}}{1\text{ mol CO}} = 0.102\text{ g CO}$$

mass of Fe in sample = 0.142 g sample – 0.102 g CO = 0.040 g Fe

$$0.040\text{ g Fe} \cdot \frac{1\text{ mol Fe}}{55.8\text{ g}} = 7.3 \times 10^{-4}\text{ mol Fe}$$

$$\frac{0.00362\text{ mol CO}}{7.3 \times 10^{-4}\text{ mol Fe}} = \frac{5\text{ mol CO}}{1\text{ mol Fe}}$$

The empirical formula is $Fe(CO)_5$