

Chapter 5: 30, 32, 34, 36, 38, 48, 50, 58, 64, 102, 116, 122

30. Charles' Law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$V_1 = 7.00 \times 10^2 \text{ mL} \quad T_1 = 20.0^\circ\text{C} + 273.15 = 293.15 \text{ K}$$

$$V_2 = ? \quad T_2 = 1.00 \times 10^2 \text{ K}$$

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{(7.00 \times 10^2 \text{ mL})(1.00 \times 10^2 \text{ K})}{293.15 \text{ K}} = \mathbf{239 \text{ mL}}$$

32. Avogadro's Law: $\frac{V_1}{n_1} = \frac{V_2}{n_2}$

$$V_1 = 25.0 \text{ mL} \quad n_1 = 2 \text{ mole (exact)}$$

$$V_2 = ? \quad n_2 = 1 \text{ mole (exact)}$$

$$V_2 = \frac{V_1 n_2}{n_1} = \frac{(25.0 \text{ mL})(1 \text{ mole})}{2 \text{ mole}} = \mathbf{12.5 \text{ mL}}$$

34. a. P $7.74 \times 10^3 \text{ Pa} \times \frac{1 \text{ atm}}{101,325 \text{ Pa}} = \underline{0.0764 \text{ atm}}$

V $12.2 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = \underline{0.0122 \text{ L}}$

n ?

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T $25^\circ\text{C} + 273 = \underline{298 \text{ K}}$

$$PV = nRT; n = \frac{PV}{RT} = \frac{(0.0764 \text{ atm})(0.0122 \text{ L})}{\left(0.0821 \frac{\text{L-atm}}{\text{mole-K}}\right)(298 \text{ K})} = \mathbf{3.81 \times 10^{-5} \text{ mole}}$$

b. P ?

V $43.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = \underline{0.0430 \text{ L}}$

n $\underline{0.421 \text{ mole}}$

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T $\underline{223 \text{ K}}$

$$PV = nRT; P = \frac{nRT}{V} = \frac{(0.421 \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}}\right) (223 \text{ K})}{0.0430 \text{ L}} = \mathbf{1.80 \times 10^2 \text{ atm}}$$

c. P $455 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.598 \text{ atm}}$

V ?

n $\underline{4.4 \times 10^{-2} \text{ mole}}$

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T $331 \text{ }^\circ\text{C} + 273 = \underline{604 \text{ K}}$

$$PV = nRT; V = \frac{nRT}{P} = \frac{(4.4 \times 10^{-2} \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (604 \text{ K})}{0.598 \text{ atm}} = \underline{3.6 \text{ L}}$$

d. P $745 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.980 \text{ atm}}$

V $\underline{11.2 \text{ L}}$

n $\underline{0.401 \text{ mole}}$

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T ?

$$PV = nRT; T = \frac{PV}{nR} = \frac{(0.980 \text{ atm})(11.2 \text{ L})}{\left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (0.401 \text{ mole})} = \underline{333 \text{ K}}$$

36. P ?

V $\underline{5.0 \text{ L}}$

n $0.60 \text{ g O}_2 \times \frac{1 \text{ mole O}_2}{32.00 \text{ g O}_2} = \underline{0.0188 \text{ mole O}_2}$

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T $22 \text{ }^\circ\text{C} + 273 = \underline{295 \text{ K}}$

$$PV = nRT; P = \frac{nRT}{V} = \frac{(0.0188 \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (295 \text{ K})}{5.0 \text{ L}} = \underline{0.0908 \text{ atm}}$$

38. P $775 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{1.02 \text{ atm}}$

V ?

n $2.0 \text{ g He} \times \frac{1 \text{ mole He}}{4.003 \text{ g He}} = \underline{0.50 \text{ mole He}}$

R $\underline{0.0821 \text{ L-atm/mole-K}}$

T $25 \text{ }^\circ\text{C} + 273 = \underline{298 \text{ K}}$

$$PV = nRT; V = \frac{nRT}{P} = \frac{(0.50 \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (298 \text{ K})}{1.02 \text{ atm}} = \underline{12 \text{ L}}$$

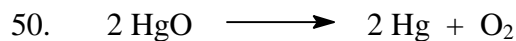
48. P $\frac{1 \text{ atm}}$
V ?

$$n \quad 4.00 \text{ g CO}_2 \times \frac{1 \text{ mole CO}_2}{44.01 \text{ g CO}_2} = \underline{0.0909 \text{ mole CO}_2}$$

R $\frac{0.0821 \text{ L-atm/mole-K}}$

T $0^\circ\text{C} + 273 = \underline{273 \text{ K}}$

$$PV = nRT; V = \frac{nRT}{P} = \frac{(0.0909 \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (273 \text{ K})}{1 \text{ atm}} = \underline{2 \text{ L}}$$



P $725 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.954 \text{ atm}}$

V ?

$$n \quad 4.10 \text{ g HgO} \times \frac{1 \text{ mole HgO}}{216.6 \text{ g HgO}} \times \frac{1 \text{ mole O}_2}{2 \text{ mole HgO}} = \underline{9.46 \times 10^{-3} \text{ mole O}_2}$$

R $\frac{0.0821 \text{ L-atm/mole-K}}$

T $30.^\circ\text{C} + 273 = \underline{303 \text{ K}}$

$$PV = nRT; V = \frac{nRT}{P} = \frac{(9.46 \times 10^{-3} \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (303 \text{ K})}{0.954 \text{ atm}} = \underline{0.247 \text{ L} = 247 \text{ mL}}$$

58. P $750 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.987 \text{ atm}}$

V $256 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = \underline{0.256 \text{ L}}$

g $\underline{0.800 \text{ g}}$

R $\frac{0.0821 \text{ L-atm/mole-K}}$

T $\underline{373 \text{ K}}$

FW ?

$$PV = \frac{gRT}{FW}; FW = \frac{gRT}{PV} = \frac{(0.800 \text{ g}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (373 \text{ K})}{(0.987 \text{ atm})(0.256 \text{ L})} = \underline{97.0 \text{ g/mole}}$$

CHCl FW = 48.47 g/mole

$$\frac{97.0}{48.47} = 2.00 \approx 2; \text{ Molecular formula} = \underline{\text{C}_2\text{H}_2\text{Cl}_2}$$

64. Since the moles (of each gas) is constant and you should assume the temperature is constant (since an initial temperature is not given), this is a Boyle's Law problem, with the final **total** pressure the sum of the **partial** pressures of the two gases:

$$\text{H}_2: \quad P_1 V_1 = P_2 V_2$$

$$P_1 = 360. \text{ torr} \quad V_1 = 2.00 \text{ L}$$

$$P_2 = ? \quad V_2 = 3.00 \text{ L}$$

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{(360. \text{ torr})(2.00 \text{ L})}{3.00 \text{ L}} = \underline{240. \text{ torr}}$$

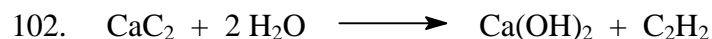
$$\text{N}_2: \quad P_1 V_1 = P_2 V_2$$

$$P_1 = 240. \text{ torr} \quad V_1 = 1.00 \text{ L}$$

$$P_2 = ? \quad V_2 = 3.00 \text{ L}$$

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{(240. \text{ torr})(1.00 \text{ L})}{3.00 \text{ L}} = \underline{80.0 \text{ torr}}$$

$$P_{\text{total}} = P_{\text{H}_2} + P_{\text{N}_2} = 240. \text{ torr} + 80.0 \text{ torr} = \mathbf{320. \text{ torr}}$$



$$P_{\text{C}_2\text{H}_2} = (715 \text{ torr} - 23.8 \text{ torr}) \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.9095 \text{ atm}}$$

$$V \quad ?$$

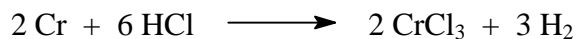
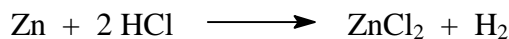
$$n \quad 5.20 \text{ g CaC}_2 \times \frac{1 \text{ mole CaC}_2}{64.10 \text{ g CaC}_2} \times \frac{1 \text{ mole C}_2\text{H}_2}{1 \text{ mole CaC}_2} = \underline{0.0811 \text{ mole C}_2\text{H}_2}$$

$$R \quad \underline{0.0821 \text{ L-atm/mole-K}}$$

$$T \quad 25 \text{ }^\circ\text{C} + 273 = \underline{298 \text{ K}}$$

$$PV = nRT; V = \frac{nRT}{P} = \frac{(0.0811 \text{ mole}) \left(0.0821 \frac{\text{L-atm}}{\text{mole-K}} \right) (298 \text{ K})}{0.9095 \text{ atm}} = \mathbf{2.18 \text{ L}}$$

116. Let x = mass of Zn
 y = mass of Cr



$$P \quad 750. \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{0.987 \text{ atm}}$$

$$V \quad 225 \text{ mL H}_2 \times \frac{1 \text{ L}}{1000 \text{ mL}} = \underline{0.225 \text{ L}}$$

$$n \quad ?$$

$$R \quad \underline{0.0821 \text{ L-atm/mole-K}}$$

$$T \quad 27^\circ\text{C} + 273 = \underline{300. \text{ K}}$$

$$PV = nRT; n = \frac{PV}{RT} = \frac{(0.987 \text{ atm})(0.225 \text{ L})}{\left(0.0821 \frac{\text{L-atm}}{\text{mole-K}}\right)(300. \text{ K})} = \underline{9.015 \times 10^{-3} \text{ mole H}_2}$$

$$x \text{ g Zn} \times \frac{1 \text{ mole Zn}}{65.38 \text{ g Zn}} \times \frac{1 \text{ mole H}_2}{1 \text{ mole Zn}} + y \text{ g Cr} \times \frac{1 \text{ mole Cr}}{52.00 \text{ g Cr}} \times \frac{3 \text{ mole H}_2}{2 \text{ mole Cr}} = 9.015 \times 10^{-3} \text{ mole H}_2$$

Simplified, this is:

$$0.0153x + 0.0288y = 9.015 \times 10^{-3} \quad (1)$$

$$x + y = 0.362 \text{ g}; y = 0.362 - x \quad (2)$$

Plugging equation 2 into equation 1 gives:

$$0.0153x + 0.0288(0.362 - x) = 9.015 \times 10^{-3}$$

$$x = 0.1053 \text{ g Zn}$$

$$y = 0.362 - 0.1053 = 0.2567 \text{ g Cr}$$

$$\frac{0.105 \text{ g Zn}}{0.362 \text{ g sample}} \times 100 = \underline{29.1 \% \text{ Zn}}$$

$$\frac{0.257 \text{ g Cr}}{0.362 \text{ g sample}} \times 100 = \underline{70.9 \% \text{ Cr}}$$

122. 1 ppbv is 1.0×10^{-9} volumes at 0°C and 1 atm. That means the partial pressure of CH_2O is $1.0 \times 10^{-9} \times 1 \text{ atm} = 1.0 \times 10^{-9} \text{ atm}$. To find the concentration in mole/L, we need

$$PV = nRT; \frac{n}{V} = \frac{P}{RT} = \frac{(1.0 \times 10^{-9} \text{ atm})}{\left(0.0821 \frac{\text{L-atm}}{\text{mole-K}}\right)(298 \text{ K})} = \frac{4.5 \times 10^{-11} \text{ mole CH}_2\text{O}}{\text{L}}$$

$$\frac{4.5 \times 10^{-9} \text{ mole CH}_2\text{O}}{\text{L}} \times \frac{1 \text{ L}}{1000 \text{ cm}^3} \times \frac{6.022 \times 10^{23} \text{ molecules CH}_2\text{O}}{1 \text{ mole CH}_2\text{O}}$$

$$= \mathbf{2.7 \times 10^{10} \text{ molecules CH}_2\text{O/cm}^3}$$

$$\text{The room's volume} = 18.0' \times 24.0' \times 8.0' = 3456.0 \text{ ft}^3$$

$$3456.0 \text{ ft}^3 \times \frac{(12 \text{ in})^3}{(1 \text{ ft})^3} \times \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} \times \frac{1 \text{ L}}{1000 \text{ cm}^3} = 9.79 \times 10^4 \text{ L}$$

$$\frac{4.5 \times 10^{11} \text{ mole CH}_2\text{O}}{\text{L}} \times 9.79 \times 10^7 \text{ cm}^3 \times \frac{30.03 \text{ g CH}_2\text{O}}{1 \text{ mole CH}_2\text{O}} = \mathbf{1.3 \times 10^{-4} \text{ g CH}_2\text{O}}$$