Ch. 13.1 & 14 Review Game Problems Answer Key

Pressure

What is the atmospheric pressure, in kPa, when the pressure is sufficient to support 731.2 mm Hg?
Note that this is essentially asking to convert the pressure would be in mmHg (on a barometer) to kPa:

$$?\ \text{kPa} = 731.2\ \text{mm Hg} \times \frac{101.3\ \text{kPa}}{760\ \text{mm Hg}} = 97.46\ \text{kPa}$$

1) Partial Pressure

What is the total pressure of a mixture of gases with P_{He} = 128 mm Hg, P_{Ar} = 421 mm Hg and P_{Ne} = 389 mm Hg?

$$P_{Total} = 128\ \text{mm Hg} + 421\ \text{mm Hg} + 389\ \text{mm Hg}$$
$$= 938\ \text{mm Hg}$$

2) Boyle's Law

A sample of CO_2 gas occupies a volume of 345 mL at 94.8 kPa. At what pressure will its volume be 142 mL?

$$P_1V_1 = P_2V_2;\ P_2 = \frac{P_1V_1}{V_2};\ P_2 = \frac{(345\ \text{mL})(94.8\ \text{kPa})}{142\ \text{mL}} = 230.\ \text{kPa}$$

3) Charles's Law

A balloon full of air has a volume of 8.39 L at 38.0°C. At what T in °C is its volume 3.78 L?

$$T_1 = 38°\text{C} + 273 = 311\ \text{K}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2};\ T_2 = \frac{V_2T_1}{V_1} = \frac{(3.78\ \text{L})(311\ \text{K})}{8.39\ \text{L}} = 140.\ \text{K};\ T_2 = 140.\ \text{K} - 273 = -133°\text{C}$$

4) Gay-Lussac's Law

A lab vessel of Kr gas has a pressure of 83.4 kPa at –45°C. What will its pressure be at 43°C?

$$T_1 = -45°\text{C} + 273 = 228\ \text{K};\ T_2 = 43°\text{C} + 273 = 316\ \text{K}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2};\ P_2 = \frac{P_1T_2}{T_1} = \frac{(83.4\ \text{kPa})(316\ \text{K})}{228\ \text{K}} = 115\ \text{kPa}$$

5) Combined Gas Law

A piston of N_2 gas has a volume of 3.50 L at 1.15 atm and 29.0°C. What is its pressure when compressed to 1.29 L at 56.0°C?

$$T_1 = 29.0°\text{C} + 273 = 302\ \text{K};\ T_2 = 56.0°\text{C} + 273 = 329\ \text{K}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2};\ P_2 = \frac{P_1V_1T_2}{V_2T_1} = \frac{(1.15\ \text{atm})(3.50\ \text{L})(329\ \text{K})}{(1.29\ \text{L})(302\ \text{K})} = 3.40\ \text{atm}$$

6) Avogadro's Principle

What is the mass of 32.8 L of Xe at STP?

$$?\ \text{g Xe} = \underbrace{32.8\ \text{L Xe} \times \frac{1\ \text{mol Xe}}{22.4\ \text{L Kr}}}_{=1.46\ \text{mol Xe}} \times \frac{131.3\ \text{g Xe}}{1\ \text{mol Xe}} = 192\ \text{g Xe}$$

7) Ideal Gas Law

What is the volume of 66.8 g NO_2 at 855 torr and 15°C?

$$n = 66.8\text{ g } NO_2 \times \frac{1\text{ mol } NO_2}{46.01\text{ g } NO_2} = 1.45\text{ mol};\ P = 855\text{ torr} \times \frac{1\text{ atm}}{760\text{ torr}} = 1.13\text{ atm};\ T = 15°C + 273 = 288\text{ K}$$

$$V = \frac{nRT}{P} = \frac{(1.45\text{ mol})\left(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}\right)(288\text{ K})}{1.13\text{ atm}} = 30.3\text{ L}$$

8) Molar Mass Calculations

What is the molar mass of a gas with density = 1.91 g/L at a pressure of 0.572 atm and –14°C?

$T = -14°C + 273 = 259\text{ K}$; Assume $V = 1\text{ L}$

$$n = \frac{PV}{RT} = \frac{(0.572\text{ atm})(1\text{ L})}{\left(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}\right)(259\text{ K})} = 0.0269\text{ mol};\ MM = \frac{1.91\text{ g}}{0.0269\text{ mol}} = 71.0\text{ g/mol}$$

9) Volume-Volume Calculations

$$4\ NH_3(g) + 3\ O_2(g) \rightarrow 2N_2(g) + 6H_2O\ (\ell)$$

How many L of NH_3 are needed to produce 18.6 L N_2 at the same T & P?

$$?\text{ L } NH_3 = 18.6\text{ L of } N_2 \times \frac{4\text{ L } NH_3}{2\text{ L } N_2} = 37.2\text{ L } NH_3$$

10) Mass-Volume Calculations

$$2As_2S_3(g) + 9O_2(g) \rightarrow 2As_2O_3(g) + 6SO_2\ (g)$$

What is the theoretical yield of As_2O_3 for 29.3 L O_2, at STP, reacting with excess As_2S_3?

$MM\ As_2O_3 = 2(74.92\text{ g}) + 3(16.00\text{ g}) = 197.8\text{ g/mol}$

$$?\text{ g } As_2O_3 = \underbrace{29.3\text{ L } O_2 \times \frac{1\text{ mol } O_2}{22.4\text{ L } O_2}}_{=1.31\text{ mol } O_2} \times \underbrace{\frac{2\text{ mol } As_2O_3}{9\text{ mol } O_2}}_{=0.291\text{ mol } As_2O_3} \times \frac{197.8\text{ g } As_2O_3}{1\text{ mol } As_2O_3} = 57.5\text{ g } As_2O_3$$