

$$PV = nRT$$

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

Ideal Gas Problems

$$V = \frac{nRT}{P} \quad T = \frac{PV}{nR} \quad n = \frac{PV}{RT}$$

1.) 10.0 grams of He, 10.0 grams of N₂, and 10.0 grams of Ar gas are all mixed in a 5.00 liter container at 27.0 °C. Calculate the partial pressure of each gas in the container and then find the total pressure in the container.

$$P = \frac{nRT}{V} \quad P = \frac{n(0.0821)(300K)}{5.00L}$$

2.50 mol He 0.357 mol N₂ 0.250 mol Ar

P = 12.3 atm P = 1.76 P = 1.23

$$P_{\text{tot}} = 15.3 \text{ atm}$$

2) A 0.586 g sample of helium is collected by water displacement at 25.0 °C and 1.00 atm total pressure.

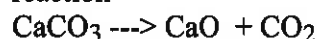
What volume is occupied by the helium gas? (At 25°C the vapor pressure of water is 23.8 mmHg) $\left(\frac{1 \text{ atm}}{760 \text{ mmHg}}\right) = 0.03 \text{ atm}$

$$V = \frac{nRT}{P} \quad P_{\text{tot}} - P_{\text{H}_2\text{O}} = P_{\text{He}} \quad 1 - 0.03 = 0.97 \text{ atm}$$

$$V = \frac{(0.147 \text{ mol})(0.0821)(298K)}{0.97 \text{ atm}} = 3.7 \text{ L}$$

$$0.586 \text{ g He} \left(\frac{1 \text{ mol}}{4.003 \text{ g}} \right) = 0.147 \text{ mol He}$$

3) Quicklime (CaO) is produced by the thermal decomposition of calcium carbonate (CaCO₃). Calculate the volume of CO₂ at 25.0 °C and 1.20 atm. from the decomposition of 152 g of CaCO₃ according to the reaction



$$152 \text{ g CaCO}_3 \left(\frac{1 \text{ mol CaCO}_3}{100.09 \text{ g}} \right) \left(\frac{1 \text{ mol CO}_2}{1 \text{ mol CaCO}_3} \right) = 1.52 \text{ mol CO}_2$$

$$V = \frac{(1.52 \text{ mol})(0.0821)(298K)}{1.20 \text{ atm}}$$

$$V = 30.99 \text{ L}$$

4) A sample of gas was collected near a raging volcano in a 1.5 liter glass vessel. The sample of gas was brought back to the lab where the temperature was 23.0°C and the pressure was 100.6 kPa. The lab technicians weighed the vessel and found that the gas inside had a mass of 4.65 grams. Help the lab guys out and find out what the molecular weight of the gas is.

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

$$n = \frac{(0.993 \text{ atm})(1.5 \text{ L})}{(0.0821 \text{ atm} \cdot \text{L} / \text{mol} \cdot \text{K})(296K)} = 0.0613 \text{ mol}$$

$$\frac{4.65 \text{ g}}{0.0613 \text{ mol}} = 75.86 \text{ g/mol}$$

5) Dry ice is solid carbon dioxide (CO₂). It sublimates (turns directly to gas) to give CO₂ gas. If a 386.4 gram sample of dry ice is placed in a tank with a volume of 2.500 dm³, what is the pressure when all the dry ice has sublimed? The temperature is a constant 32.0 °C.

$$V = 2.5 \text{ L} \quad T = 305 \text{ K} \quad n = 386.4 \text{ g} \left(\frac{1 \text{ mol}}{44.01 \text{ g}} \right) = 8.78 \text{ mol CO}_2$$

$$P = \frac{nRT}{V} = \frac{(8.78 \text{ mol})(0.0821)(305K)}{2.5 \text{ L}} = 88 \text{ atm}$$

6) Butane gas (C₄H₁₀) burns by the following reaction: $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$. How many liters of O₂ gas would be needed to completely react with 27.6 grams of butane at 25.0 °C and a pressure of 1.05 atm.

$$27.6 \text{ g C}_4\text{H}_{10} \left(\frac{1 \text{ mol C}_4\text{H}_{10}}{58.14 \text{ g}} \right) \left(\frac{13 \text{ mol O}_2}{2 \text{ mol C}_4\text{H}_{10}} \right) = 3.09 \text{ mol O}_2$$

$$V = \frac{(3.09)(0.0821)(298K)}{1.05} = 72.0 \text{ L}$$

7) A gas has a molecular mass of 143.0 g/mol. What is the mass of 3.65 liters of this gas at 18.0 °C if it exerts a pressure of 98.6 kPa? $\left(\frac{1 \text{ atm}}{101.3 \text{ kPa}}\right) = 0.973 \text{ atm}$

$$n = \frac{(0.973 \text{ atm})(3.65 \text{ L})}{(0.0821)(291K)} = 0.149 \text{ mol} \left(\frac{143.0 \text{ g}}{1 \text{ mol}} \right) = 21.3 \text{ g}$$