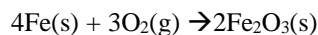


Gas Stoichiometry Problems

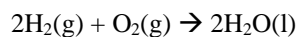
1. Solid iron reacts with oxygen gas to form solid iron(III) oxide. What volume of oxygen gas is needed to produce 84.0 grams of solid iron(III) oxide if the pressure of the gas is 2.77 atm and the temperature is 35°C?



$$\frac{84.0 \text{ g Fe}_2\text{O}_3}{1} \times \frac{1 \text{ mole Fe}_2\text{O}_3}{159.6 \text{ g Fe}_2\text{O}_3} \times \frac{3 \text{ mole O}_2}{2 \text{ moles Fe}_2\text{O}_3} = 0.789 \text{ moles O}_2$$

$$V = \frac{(0.789)(0.08206)(308)}{2.77} = \mathbf{7.20 \text{ L}}$$

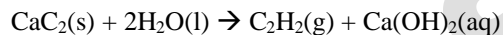
2. Hydrogen gas reacts with oxygen gas to form water vapor. What volume of hydrogen gas is needed to produce 30.0 grams of water if the pressure is 1.80 atm and the temperature is 400. K?



$$\frac{30.0 \text{ grams H}_2\text{O}}{1} \times \frac{1 \text{ mole H}_2\text{O}}{18.0 \text{ grams H}_2\text{O}} \times \frac{2 \text{ moles H}_2}{2 \text{ moles H}_2\text{O}} = 1.67 \text{ moles H}_2$$

$$V = \frac{(1.67)(0.08206)(400)}{1.80} = \mathbf{30.4 \text{ L}}$$

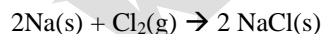
3. Solid calcium carbide, CaC_2 , reacts with liquid water to produce acetylene, C_2H_2 , gas and aqueous calcium hydroxide in a solid metal vessel. What is the final pressure if 38.0 grams of calcium carbide react with excess water if the volume of the vessel is 3.00 L and the temperature is held constant at 250. K? Assume the volume of calcium hydroxide is negligible.



$$\frac{38.0 \text{ grams CaC}_2}{1} \times \frac{1 \text{ mole CaC}_2}{64.1 \text{ grams CaC}_2} \times \frac{1 \text{ mole C}_2\text{H}_2}{1 \text{ mole CaC}_2} = 0.593 \text{ moles C}_2\text{H}_2$$

$$P = \frac{(0.593)(0.08206)(250.)}{3.00} = \mathbf{4.05 \text{ atm (410. kPa)}}$$

4. Solid sodium reacts with chlorine gas to produce solid sodium chloride. What mass of sodium chloride will be produced if 25.0 liters of chlorine gas at a pressure of 2.55 atm and a temperature of 300. K react with excess sodium.



$$n = \frac{(2.55)(25.0)}{(0.08206)(300.)} = 2.59 \text{ moles Cl}_2$$

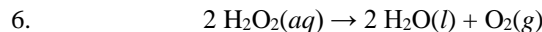
$$\frac{2.59 \text{ moles Cl}_2}{1} \times \frac{2 \text{ moles NaCl}}{1 \text{ mole Cl}_2} \times \frac{58.5 \text{ grams NaCl}}{1 \text{ mole NaCl}} = \mathbf{303 \text{ grams NaCl}}$$

5. Solid calcium carbonate decomposes to form solid calcium oxide and carbon dioxide, CO₂, gas. What is the total pressure if 90.0 grams of calcium carbonate decompose in a 20.0 liter vessel where the temperature is kept constant of 1000. °C?



$$\frac{90.0 \text{ grams CaCO}_3}{1} \times \frac{1 \text{ mole CaCO}_3}{100.1 \text{ grams CaCO}_3} \times \frac{1 \text{ mole CO}_2}{1 \text{ mole CaCO}_3} = 0.899 \text{ moles CO}_2$$

$$P = \frac{(0.899)(0.08206)(1273)}{20.0} = \mathbf{4.70 \text{ atm (or 476 kPa)}}$$



The H₂O₂ in the solution decomposes completely according to the reaction represented above. The O₂(g) produced is collected in an inverted graduated tube over water at 23.4°C and has a volume of 182.4 mL when the water levels inside and outside of the tube are the same. The atmospheric pressure in the lab is 762.6 torr, and the equilibrium vapor pressure of water at 23.4°C is 21.6 torr.

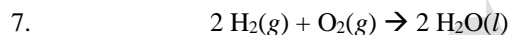
- (a) Calculate the partial pressure, in torr, of O₂(g) in the gas-collection tube.
(b) Calculate the mass of water produced.

$$762.6 - 21.6 = 741.0 \text{ torr}$$

$$741.0 \div 760.0 = 0.975 \text{ atm}$$

$$n = \frac{(0.975)(0.1824)}{(0.08206)(296.4)} = 0.00731 \text{ moles O}_2$$

$$\frac{0.00731 \text{ moles O}_2}{1} \times \frac{2 \text{ moles H}_2\text{O}}{1 \text{ mole O}_2} \times \frac{18.0 \text{ grams H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = \mathbf{0.263 \text{ grams H}_2\text{O}}$$



In a hydrogen-oxygen fuel cell, energy is produced by the overall reaction represented above.

When the fuel cell operates at 25°C and 1.00 atm, 0.0746 mol of O₂(g) is consumed. Calculate the volume of H₂(g) consumed during the same time period. Express your answer in liters measured at 25°C and 1.00 atm.

$$\frac{0.0746 \text{ mol O}_2}{1} \times \frac{2 \text{ mole H}_2}{1 \text{ mol O}_2} = 0.1492 \text{ mol H}_2$$

$$V = \frac{(0.1492)(0.08206)(298)}{1.00} = \mathbf{3.65 \text{ L H}_2}$$



Answer the following questions regarding the decomposition of arsenic pentafluoride, AsF₅(g). A 55.8 g sample of AsF₅(g) is introduced into an evacuated 10.5 L container at 105°C.

- (a) What is the initial pressure, in atmospheres, of the AsF₅(g) in the container?
(b) What is the final pressure when all of the arsenic pentafluoride decomposes?

$$55.8 \div 169.9 = 0.328 \text{ moles AsF}_5$$

$$P = \frac{(0.328)(0.08206)(378)}{10.5} = \mathbf{0.969 \text{ atm}}$$

$$0.969 \text{ atm} \times 2 = \mathbf{1.94 \text{ atm (final pressure)}}$$