

Gas Stoichiometry Chemistry 110

1] Given the equation: $2 \text{NH}_3(\text{g}) + 3 \text{Cl}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 6 \text{HCl}(\text{g})$

a. How many milliliters of nitrogen can be made from 13 L of chlorine and 10.0 L of ammonia gas at STP?

$$10.0 \text{ L NH}_3 \times \frac{1 \text{ L N}_2}{2 \text{ L NH}_3} = 5.00 \text{ L N}_2$$

$$13 \text{ L Cl}_2 \times \frac{1 \text{ L N}_2}{3 \text{ L Cl}_2} = 4.3 \text{ L N}_2$$

Answer 4.3 x 10³ mL N₂

b. How many grams of chlorine must react to produce 16 L of nitrogen gas at 1.2 atm and 23°C?

$$n_{\text{N}_2} = \frac{(1.2 \text{ atm}) \times (16 \text{ L})}{(0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (273 + 23) \text{ K}} = 0.790 \text{ mol N}_2$$

$$0.790 \text{ mol N}_2 \times \frac{3 \text{ mol Cl}_2}{1 \text{ mol N}_2} \times \frac{70.1 \text{ g Cl}_2}{1 \text{ mol}} = 1.66 \times 10^2 \text{ L Cl}_2$$

Answer _____

c. How many liters of ammonia gas at 244 torr and 35°C must be used to produce 2.3 kg of HCl gas?

$$2.3 \text{ Kg HCl} \times \frac{10^3 \text{ g}}{1 \text{ Kg}} \times \frac{1 \text{ mol HCl}}{36.5 \text{ g}} \times \frac{2 \text{ mol NH}_3}{6 \text{ mol HCl}} = 21 \text{ mol NH}_3$$

$$V_{\text{NH}_3} = \frac{(21 \text{ mol NH}_3) \times (0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (273 + 35) \text{ K}}{\frac{244 \text{ torr}}{760 \text{ torr/1atm}}} = 1.7 \times 10^3 \text{ L NH}_3$$

Answer _____

2] How many liters of ammonia, measured at STP, must be used to produce of 2.65 grams of calcium hydride 6
 $\text{Ca}(\text{s}) + 2 \text{NH}_3(\text{g}) \rightarrow 3 \text{CaH}_2(\text{s}) + \text{Ca}_3\text{N}_2(\text{g})$

$$2.65 \text{ g CaH}_2 \times \frac{1 \text{ mol CaH}_2}{42.1 \text{ g}} \times \frac{2 \text{ mol NH}_3}{3 \text{ mol CaH}_2} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.940 \text{ L NH}_3$$

Answer _____

3] What volume of oxygen, measured at 35°C and 752 mm Hg, is required to "burn" 3.26 grams of calcium.
 $2 \text{Ca}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2 \text{CaO}(\text{s})$

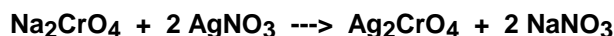
$$3.26 \text{ g Ca} \times \frac{1 \text{ mol Ca}}{40.1 \text{ g}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol Ca}} = 0.0406 \text{ mol O}_2$$

$$V_{\text{O}_2} = \frac{(0.0406 \text{ mol O}_2) \times (0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (273 + 35) \text{ K}}{\frac{752 \text{ mm}}{760 \text{ mm/1atm}}} = 1.04 \text{ L O}_2$$

Answer _____

4] How many mLs of 0.0246 M AgNO₃ required to precipitate as silver chromate all the chromate ion in a solution containing 2.10 g sodium chromate

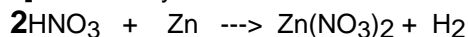
Sodium chromate + Silver nitrate → Silver chromate (solid) + Sodium nitrate



$$2.10 \text{ g Na}_2\text{CrO}_4 \times \frac{1 \text{ mol Na}_2\text{CrO}_4}{161.8 \text{ g}} \times \frac{2 \text{ mol AgNO}_3}{1 \text{ mol Na}_2\text{CrO}_4} \times \frac{1000 \text{ ml AgNO}_3}{0.0246 \text{ mol}} = 1.05 \times 10^3 \text{ ml}$$

Answer _____

5] How many mls of 0.50M nitric acid are required to release 3.44 liters of hydrogen gas at 1.33 atm and 45°C.

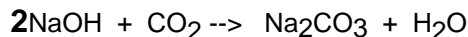


$$n_{\text{H}_2} = \frac{(1.33\text{atm}) \times (3.44\text{L})}{(0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (273 + 45)\text{K}} = 0.175 \text{ mol H}_2$$

$$0.175 \text{ mol H}_2 \times \frac{2\text{mol HNO}_3}{1\text{mol H}_2} \times \frac{1000\text{mL}}{0.50\text{mol HNO}_3} = 7.0 \times 10^2 \text{ ml HNO}_3$$

Answer _____

6] What is the molarity of a 5.00 L sodium hydroxide solution that would completely react with 2.00 L of carbon dioxide gas measured at STP..



Find the **Molarity** of the sodium hydroxide solution

$$2.00 \text{ L CO}_2 \times \frac{1\text{mol CO}_2}{22.4\text{L}} \times \frac{2\text{mol NaOH}}{1\text{mol CO}_2} = 0.179 \text{ mol NaOH}$$

$$M_{\text{NaOH}} = \frac{0.179\text{mol NaOH}}{5.00\text{L soln}} = 0.0357 \text{ M}$$

Answer _____

7] How many liters of dry hydrogen gas, measured at 796 torr and 25°C, will be released by the decomposition of 255 milliliters of H₂O(g) at 1.33 atm and 25°C?

Write the balanced equation $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$

$$n_{\text{H}_2\text{O}} = \frac{(1.33\text{atm}) \times (0.255\text{L})}{(0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (298\text{K})} = 0.0139 \text{ mol H}_2\text{O}$$

$$0.0139 \text{ mol H}_2\text{O} \times \frac{2\text{mol H}_2}{2 \text{ mol H}_2\text{O}} = 0.0139 \text{ mol H}_2$$

$$V_{\text{H}_2} = \frac{(0.0139 \text{ mol H}_2) \times (0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (298\text{K})}{\frac{796\text{torr}}{760\text{torr}/1\text{atm}}} = 0.325 \text{ L H}_2$$

Answer _____

8] For the following reaction: $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g})$

1.5 mol of CO and 2.0 mol of oxygen react in a closed 10 L vessel.

a. How many moles of CO, O₂ and CO₂ are present at the end of the reaction

$$1.5 \text{ mol CO} \times \frac{2\text{mol CO}_2}{2\text{mol CO}} = 1.5 \text{ mol CO}_2 \quad \leftarrow \text{amount made}$$

$$2.0 \text{ mol O}_2 \times \frac{2\text{mol CO}_2}{1\text{mol O}_2} = 4.0 \text{ mol CO}_2$$

$$1.5 \text{ mol CO} \times \frac{1\text{mol O}_2}{2\text{mol CO}} = 0.75 \text{ mol O}_2 \text{ used}$$

$$2.0 \text{ mol O}_2 - 0.75 \text{ mol O}_2 \text{ used} = 1.25 \text{ mol} = 1.3 \text{ mol remaining}$$

Answer: Moles CO 0 Moles O₂ 1.3 Moles CO₂ 1.5

b. What will be the total pressure in the flask at 273K?

Total moles of gas = 1.3 mol + 1.5 mol = 2.8 mol

$$P = \frac{(2.8\text{mol}) \times (0.0821 \frac{\text{L-atm}}{\text{mol-K}}) \times (273\text{K})}{10 \text{ L}} = 6.3 \text{ atm or } 4.8 \times 10^3 \text{ torr}$$