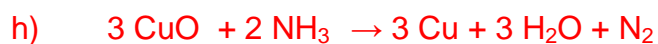
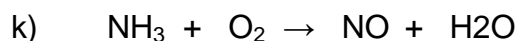
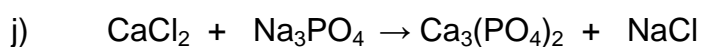
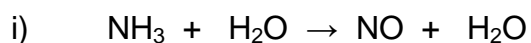
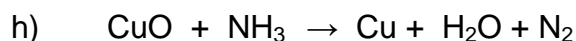
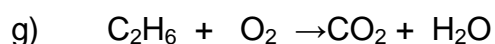
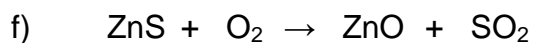
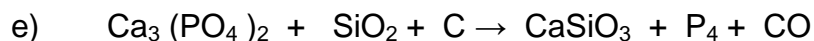
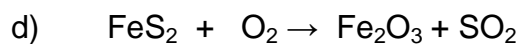
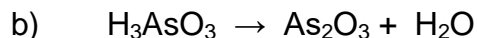


Problem Set 8: Working With Chemical Equations

1) Balance the following chemical reaction equations.



2) Household bleach is an aqueous solution of sodium hypochlorite (NaOCl) that is prepared by the reaction of sodium hydroxide (NaOH) with chlorine. How many grams of sodium hydroxide are required to react with 15.0 g of Cl₂?



Balance the equation: $2 \text{NaOH} + \text{Cl}_2 \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$

$$15.0 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.9 \text{ g Cl}_2} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol Cl}_2} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} = 16.9 \text{ g NaOH}$$

3) Eggshells are mainly comprised of calcium carbonate (CaCO₃), the approximate mass of an average egg shell is 6.3 g. Calcium carbonate dissolves in hydrochloric acid (HCl), what volume of 0.80 M HCl is required to dissolve the shell of an average egg?

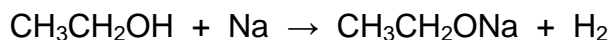


Balance the equation: $\text{CaCO}_3 + 2 \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$

$$6.30 \text{ g CaCO}_3 \times \frac{1 \text{ mol CaCO}_3}{100.09 \text{ g CaCO}_3} \times \frac{2 \text{ mol HCl}}{1 \text{ mol CaCO}_3} = 0.12589 \text{ mols HCl}$$

$$0.12589 \text{ mols HCl} \times \frac{1 \text{ L HCl}}{0.80 \text{ mols HCl}} = 0.15735 \text{ L} = 0.16 \text{ L HCl}$$

4) Sodium reacts with ethanol to form hydrogen gas and sodium ethoxide.



Calculate the mass of hydrogen gas produced from the reaction of 250.0 mL of ethanol with 10.0 g of sodium. What is the limiting reagent? How many grams of excess reagent are left at the end of the reaction? The density of ethanol is 0.789 g/ml.

Balance the equation: $2 \text{CH}_3\text{CH}_2\text{OH} + 2 \text{Na} \rightarrow 2 \text{CH}_3\text{CH}_2\text{ONa} + \text{H}_2$

$$250.0 \text{ mL CH}_3\text{CH}_2\text{OH} \times \frac{0.789 \text{ g}}{1 \text{ mL}} = 197.25 \text{ g CH}_3\text{CH}_2\text{OH}$$

$$197.25 \text{ g CH}_3\text{CH}_2\text{OH} \times \frac{1 \text{ mol CH}_3\text{CH}_2\text{OH}}{46.08 \text{ g CH}_3\text{CH}_2\text{OH}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol CH}_3\text{CH}_2\text{OH}} \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = 4.323 \text{ g H}_2$$

$$10.0 \text{ g Na} \times \frac{1 \text{ mol Na}}{22.99 \text{ g Na}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol Na}} \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = 0.4393 \text{ g H}_2$$

Limiting reagent is sodium.

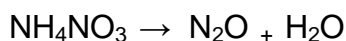
$$197.25 \text{ g CH}_3\text{CH}_2\text{OH} \times \frac{1 \text{ mol CH}_3\text{CH}_2\text{OH}}{46.08 \text{ g CH}_3\text{CH}_2\text{OH}} = 4.2805 \text{ initial mols CH}_3\text{CH}_2\text{OH}$$

$$0.4393 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2.02 \text{ g H}_2} \times \frac{2 \text{ mol CH}_3\text{CH}_2\text{OH}}{1 \text{ mol H}_2} = 0.4349 \text{ mols CH}_3\text{CH}_2\text{OH used}$$

$$4.2805 \text{ initial mols CH}_3\text{CH}_2\text{OH} - 0.4349 \text{ mols CH}_3\text{CH}_2\text{OH used} \\ = 3.8456 \text{ mols CH}_3\text{CH}_2\text{OH remaining}$$

$$3.8456 \text{ mols CH}_3\text{CH}_2\text{OH remaining} \times \frac{46.08 \text{ g CH}_3\text{CH}_2\text{OH}}{1 \text{ mol CH}_3\text{CH}_2\text{OH}} = 177.2 \text{ g CH}_3\text{CH}_2\text{OH remaining}$$

5) The decomposition of ammonium nitrate (NH_4NO_3) produces nitrous oxide, laughing gas, and water. To fill a typical cylinder for medicinal use 3.0 kg of laughing gas is required. How much ammonium nitrate must be decomposed to fill a typical cylinder with 3.0 kg of laughing gas? If 2.5 kg of laughing gas was actually produced in the reaction, what is the percent yield?



Balance the equation: $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} + 2 \text{H}_2\text{O}$

$$3.0 \text{ kg N}_2\text{O} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol N}_2\text{O}}{44.02 \text{ g N}_2\text{O}} \times \frac{1 \text{ mol NH}_4\text{NO}_3}{1 \text{ mol N}_2\text{O}} \times \frac{80.06 \text{ g NH}_4\text{NO}_3}{1 \text{ mol NH}_4\text{NO}_3} \\ = 5456.15 \text{ g NH}_4\text{NO}_3 \times \frac{1 \text{ kg}}{1000 \text{ g}} = 5.5 \text{ kg NH}_4\text{NO}_3$$

$$\frac{2.5 \text{ kg N}_2\text{O}}{3.0 \text{ kg N}_2\text{O}} \times 100 = 83 \%$$