CHEM 150 – Fall 2013 – Bodwin – Reactions and Stoichiometry

1. For each of the following, identify the reaction type and write a correctly balanced chemical equation.

Potassium phosphate(aq) + Nickel(II) nitrate(aq) →

$2\ K_3PO_4(aq) + 3\ Ni(NO_3)_2(aq) \rightarrow Ni_3(PO_4)_2(s) + 6\ KNO_3(aq)$

Metathesis/Exchange reaction, Precipitation reaction

Net ionic:

$2\ PO_4^{-3}(aq) + 3\ Ni^{+2}(aq) \rightarrow Ni_3(PO_4)_2(s)$

Calcium hydroxide(aq) + Copper(II) acetate(aq) →

$Ca(OH)_2(aq) + Cu(C_2H_3O_2)_2(aq) \rightarrow Ca(C_2H_3O_2)_2(aq) + Cu(OH)_2(s)$

Metathesis/Exchange reaction, Proecipitation reaction

Net ionic:

$2\ OH^{-1}(aq) + Cu^{+2}(aq) \rightarrow Cu(OH)_2(s)$

Phosphoric acid(aq) + Potassium hydroxide(aq) →

$H_3PO_4(aq) + 3\ KOH(aq) \rightarrow 3\ H_2O(l) + K_3PO_4(aq)$

Metathesis/exchange reaction, Acid-base reaction, Molecule-forming reaction

Net ionic:

$H_3PO_4(aq) + 3\ OH^{-1}(aq) \rightarrow 3\ H_2O(l) + PO_4^{-3}(aq)$

{Phosphoric acid is a weak acid, so it does not completely dissociate when looking at a net ionic equation.}

2. You have combined 30.00mL of 2.637M sodium sulfate solution with 35.00mL of 2.516M strontium perchlorate solution. (strontium atomic# = 38) When you do this reaction, you find that you have achieved 82.738% yield. What is the solid produced by this reaction and how many grams of solid did you recover?

$Na_2SO_4(aq) + Sr(ClO_4)_2(aq) \rightarrow SrSO_4(s) + 2\ NaClO_4(aq)$

Strontium sulfate is the precipitate that forms in this reaction.

$$(0.03000\text{L}\,Na_2SO_4(aq))\left(\frac{2.637\text{mols}\,Na_2SO_4}{1\text{L}\,Na_2SO_4(aq)}\right)\left(\frac{1\text{mol}\,SrSO_4}{1\text{mol}\,Na_2SO_4}\right)\left(\frac{183.682\text{g}\,SrSO_4}{1\text{mol}\,SrSO_4}\right)=14.53\text{g}\,SrSO_4(s)$$

$$(0.03500\text{L}\,Sr(ClO_4)_2(aq))\left(\frac{2.516\text{mols}\,Sr(ClO_4)_2}{1\text{L}\,Sr(ClO_4)_2(aq)}\right)\left(\frac{1\text{mol}\,SrSO_4}{1\text{mol}\,Sr(ClO_4)_2}\right)\left(\frac{183.682\text{g}\,SrSO_4}{1\text{mol}\,SrSO_4}\right)=16.18\text{g}\,SrSO_4(s)$$

Since the $Na_2SO_4(aq)$ added to the reaction produces less product than the $Sr(ClO_4)_2(aq)$ added to the reaction, sodium sulfate is the limiting reactant and the theoretical yield of the reaction is 14.53g strontium sulfate.

(14.53g)(0.82738) = 12.02g actual yield

3. You have added 50.00mL of 1.384M hydrochloric acid to 3.918g of solid calcium carbonate. If the gas that is formed in this reaction is collected in a 750.0mL container at 38.27°C, what is the pressure of the collected gas? (Assume the 750.0mL container contains only the gas generated by this experiment.)

$2\ HCl(aq) + CaCO_3(s) \rightarrow H_2CO_3(aq) + CaCl_2(aq) \rightarrow H_2O(l) + CO_2(g) + CaCl_2(aq)$

Carbonic acid is one of the "gas-forming reaction" substances we identified, it spontaneously decomposes to carbon dioxide and water. How much carbon dioxide is formed?

$$(0.05000\text{L}\,HCl(aq))\left(\frac{1.384\text{mols}\,HCl}{1\text{L}\,HCl(aq)}\right)\left(\frac{1\text{mol}\,CO_2}{2\text{mol}\,HCl}\right)\left(\frac{\left(0.08206\frac{\text{L.atm}}{\text{mol.K}}\right)(273.15+38.27\text{K})}{0.7500\text{L}}\right)=1.179\text{atm}$$

$$(3.918\text{g}\,CaCO_3(s))\left(\frac{1\text{mol}\,CaCO_3}{100.086\text{g}\,CaCO_3}\right)\left(\frac{1\text{mol}\,CO_2}{1\text{mol}\,CaCO_3}\right)\left(\frac{\left(0.08206\frac{\text{L.atm}}{\text{mol.K}}\right)(273.15+38.27\text{K})}{0.7500\text{L}}\right)=1.334\text{atm}$$

HCl(aq) is the limiting reagent, the pressure of the gas would be 1.179atm.