## Gravimetric Analysis, Redox and Titration Problems

1) When a sample of impure potassium chloride (0.4500g) was dissolved in water and treated with an excess of silver nitrate, 0.8402 g of silver chloride was precipitated. Calculate the percentage KCl in the original sample.

| | NEED (+) $KCl_{(aq)}$ | + $Ag(NO_3)_{(aq)}$ | → | HAVE (-) $AgCl_{(s)}$ | $K(NO_3)_{(aq)}$ |
|---|---|---|---|---|---|
| Molarity or **MM** | **74.5 g/mol** | | | **143 g/mol** | |
| Amount | | | | **0.8402g** | |
| Moles Gram/ MM or Molarity x L | | | | **0.0059 mol** | |
| Moles/rxn (divide moles by SC) | | | | **0.0059 mol** | |
| React (Least Mol/ Rxn) | **+0.0059 mol** | | | **-0.0059 mol** | |
| Final Mole/ Rxn | **0.0059 mol** | | | **0** | |
| Final Moles (SC x final mol/ rxn) | **0.0059mol** | | | **0** | |
| Final Amt (final moles x MM) or Concentration (final mols/ total volume) | **0.0059 mol x 74.5 g/mol = 0.440g** | | | | |

**Percent Purity = $\frac{\text{Pure}}{\text{Impure}}$ x 100 = $\frac{0.440g}{0.450\ g}$ x 100 = 97.78%**

2) Calculate the percent purity of a sample of $Mg(OH)_2$ if titration of 2.568 g of the sample required 38.45 mL of 0.6695 *M* $H_3PO_4$.

| | NEED (+) 3 $Mg(OH)_{2(aq)}$ | HAVE (-) + 2 $H_3PO_{4(aq)}$ | → | $Mg_3(PO_4)_{2(s)}$ | + 6$H_2O_{(l)}$ |
|---|---|---|---|---|---|
| Molarity or **MM** | **58 g/mol** | **0.6695 mol/ L** | | | |
| Amount | **?** | **0.03845 L** | | | |
| Moles Gram/ MM or Molarity x L | | **0.0257 mol** | | | |
| Moles/rxn (divide moles by SC) | | **0.0129 mol** | | | |
| React (Least Mol/ Rxn) | **+0.0129 mol** | **-0.0129 mol** | | | |
| Final Mole/ Rxn | **0.00129** | **0** | | | |
| Final Moles (SC x final mol/ rxn) | **0.0386 mol** | | | | |
| Final Amt (final moles x MM) or Concentration (final mols/ total volume) | **2.24g** | | | | |

**Percent Purity = $\frac{\text{Pure}}{\text{Impure}}$ x 100 = $\frac{2.24g}{2.568\ g}$ x 100 = 87.23%**

3) If 19g of $BaCl_2(aq)$ is mixed with 42g of $Na_2SO_4(aq)$ in 250 mL of water, what is the resulting precipitate and the mass of the precipitate and what is the concentration of all ions left in solution?

| | $BaCl_{2(aq)}$ | + $Na_2(SO_4)_{(aq)}$ | → | $Ba(SO_4)_{(s)}$ | + $2NaCl_{(aq)}$ |
|---|---|---|---|---|---|
| Molarity or **MM** | **208.3 g/mol** | **142 g/mol** | | **233.4 g/mol** | **58.5 g/mol** |
| Amount | **19** | **42** | | | |
| Moles<br>Gram/ MM or Molarity x L | **0.0912 mol** | **0.296 mol** | | | |
| Moles/rxn<br>(divide moles by SC) | **0.0912 mol** | **0.296 mol** | | | |
| React<br>(Least Mol/ Rxn) | **-0.0912 mol** | **-0.0912 mol** | | **+0.0912 mol** | **+0.0912 mol** |
| Final Mole/ Rxn | **0** | **0.205 mol** | | **0.0912 mol** | **0.0912 mol** |
| Final Moles<br>(SC x final mol/ rxn) | **0** | **0.205 mol** | | **0.0912 mol** | **0.182 mol** |
| Final Amt<br>(final moles x MM)<br>or Concentration<br>(final mols/ total volume) | 0 | **$\frac{0.205\ mol}{0.25\ L}$ = 0.82 mol $Na_2SO_4$ / L** | | **21.29g** | **$\frac{0.182\ mol}{0.25\ L}$ = 0.73 mol NaCl / L** |

**Mass = 21.29 g $BaSO_4$**

**Concentrations**

**$Ba^{2+}$ = 0 is part of the limiting reagent**

**$Na^+ = \frac{0.82\ mol\ Na_2SO_4}{1\ L} \times \frac{2\ mol\ Na^+}{1\ mol\ Na_2SO_4} = 0.164\ M + \frac{0.73\ mol\ NaCl}{1\ L} \times \frac{1\ mol\ Na^+}{1\ mol\ NaCl} = 0.073\ M \quad = 0.237\ M$**

**$Cl^- = \frac{0.73\ mol\ NaCl}{1\ L} \times \frac{1\ mol\ Cl^-}{1\ mol\ NaCl} = 0.073\ M$**

4) In each of the following equations, indicate the element that has been oxidized and the one that has been reduced. You should also label the oxidation state of each before and after the process:

**Ox # +2 -2 0 +4 -2 +2 -2**

A) $2\ PbS + 3\ O_2 \rightarrow 2\ SO_2 + 2\ PbO$

**S goes from a -2 to a +4 which means it's getting more positive or being oxidized and is the "reducing agent"**
**O goes from a 0 to a -2 which means it's getting more negative or being reduced and is the "oxidizing agent"**

**Ox # 0 0 +1 -2**

B) $2\ H_2 + O_2 \rightarrow 2\ H_2O$

**H goes from a 0 to a +1 which means it's getting more positive or being oxidized and is the "reducing agent"**
**O goes from a 0 to a -2 which means it's getting more negative or being reduced and is the "oxidizing agent"**

5) When aqueous solutions, like AgF and $Sr(NO_3)_2$ combine, the precipitate, $SrF_2$ forms. Calculate the mass of the precipitate formed if 3.0L of 6.0*M* AgF and 12.0L of 0.10*M* $Sr(NO_3)_2$ are mixed. Also, give the concentration of all ions in solution.

| | 2 $AgF_{(aq)}$ | + $Sr(NO_3)_{2(aq)}$ | → | $SrF_{2(s)}$ | + $2Ag(NO_3)_{(aq)}$ |
|---|---|---|---|---|---|
| Molarity or **MM** | **6 mol/ L** | **1 mol/ L** | | **125.6 g/mol** | |
| Amount | **3 L** | **12** | | | |
| Moles<br>Gram/ MM or<br>Molarity x L | **18 mol** | **12 mol** | | | |
| Moles/rxn<br>(divide moles by SC) | **9 mol** | **12 mol** | | | |
| React<br>(Least Mol/ Rxn) | **-9** | **-9 mol** | | **+9 mol** | **+9 mol** |
| Final Mole/ Rxn | **0** | **3 mol** | | **9 mol** | **9 mol** |
| Final Moles<br>(SC x final mol/ rxn) | **0** | **3 mol** | | **9 mol** | **18 mol** |
| Final Amt<br>(final moles x MM)<br>or Concentration<br>(final mols/ total volume) | 0 | **3 mol / 15 L = 0.2 mol $Sr(NO_3)_2$ / L** | | **1130.4 g** | **18 mol / 15 L = 1.2 mol $Ag(NO_3)$ / L** |

**Mass = 1130.4 g $SrF_2$**

**Concentrations**

**$F^-$ = 0 is part of the limiting reagent**

**$NO_3^- = \frac{0.2 \text{ mol } Sr(NO_3)_2}{1 \text{ L}} \times \frac{2 \text{ mol } NO_3^-}{1 \text{ mol } Sr(NO_3)_2} = 0.4 \text{ M} + \frac{1.2 \text{ mol } Ag(NO_3)}{1 \text{ L}} \times \frac{1 \text{ mol } NO_3^-}{1 \text{ mol } Ag(NO_3)} = 1.2 \text{ M} \quad = 1.6 \text{ M}$**

**$Ag^+ = \frac{1.2 \text{ mol } Ag(NO_3)}{1 \text{ L}} \times \frac{1 \text{ mol } Ag^+}{1 \text{ mol } Ag(NO_3)} = 1.2 \text{ M}$**