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 = $\frac{0.440\text{g}}{0.450\text{ g}}$ 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 = $\frac{2.24\text{g}}{2.568\text{ g}}$ 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 Gram/ MM or Molarity x L	0.0912 mol	0.296 mol			
Moles/rxn (divide moles by SC)	0.0912 mol	0.296 mol			
React (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 (SC x final mol/ rxn)	0	0.205 mol		0.0912 mol	0.182 mol
Final Amt (final moles x MM) or Concentration (final mols/ total volume)	0	$\frac{0.205 \text{ mol}}{0.25 \text{ L}}$ = 0.82 mol Na_2SO_4 / L		21.29g	$\frac{0.182 \text{ mol}}{0.25 \text{ L}}$ = 0.73 mol NaCl / L

Mass = 21.29 g $BaSO_4$

Concentrations

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

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

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

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.

	$2\ AgF_{(aq)}$	$+\ Sr(NO_3)_{2(aq)}$	$\rightarrow$	$SrF_{2(s)}$	$+\ 2Ag(NO_3)_{(aq)}$
Molarity or **MM**	6 mol/ L	1 mol/ L		125.6 g/mol	
Amount	3 L	12			
Moles Gram/ MM or Molarity x L	18 mol	12 mol			
Moles/rxn (divide moles by SC)	9 mol	12 mol			
React (Least Mol/ Rxn)	-9	-9 mol		+9 mol	+9 mol
Final Mole/ Rxn	0	3 mol		9 mol	9 mol
Final Moles (SC x final mol/ rxn)	0	3 mol		9 mol	18 mol
Final Amt (final moles x MM) or Concentration (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

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

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