Do the following conversions:

6) If one completely neutralizes a 0.1500 M solution of $Ca(OH)_2$, what is the initial normality of the $Ca(OH)_2$ solution?

$$0.1500\ M * \frac{2\ N}{1\ M} = 0.3000\ N$$

ANS 0.3000 N

7) H_3PO_4 is reacted with NaOH to form Na_3PO_4. If one were to start with 3.50 equivalencies of H_3PO_4, how many mole of H_3PO_4 is this?

$$3.50\ eq * \frac{1\ mol}{3\ eq} =$$

ANS 1.17 mol

8) A 0.1002 M solution of H_2SO_4 is reacted with NaOH to produce $NaHSO_4$ in a titration. If 24.5 mL of the H_2SO_4 solution is used, how many moles of H_2SO_4 solution is used?

$$H_2SO_4 + NaOH \rightarrow NaHSO_4 + H_2O$$

$$\frac{0.1002\ mol}{1\ L\ sol} * 0.0245\ L\ sol =$$

ANS $2.45x10^{-3}$ mol

9) What is the molarity of a 1.035 N solution of HCl?

$$1.035\ N * \frac{1\ M}{1\ N} =$$

ANS 1.035 M

10) For a monoprotic reaction, what is the normality of a 0.547 M solution of $Ca(OH)_2$?

$$\frac{1\ N}{1\ M} * 0.547\ M$$

ANS 0.547 N

11) How many grams of NaOH is contained in 0.500 mL of a 1.0 N solution?

$$\frac{40.0\ g\ NaOH}{1\ mol\ NaOH} * \frac{1\ mol\ NaOH}{1\ eq\ NaOH} * \frac{1.0\ eq\ NaOH}{1\ L\ sol} * \underline{0.500x10^{-3}\ L\ sol}$$

ANS 2.0×10^{-2} g

12) What is the normality of a solution of $Mg(OH)_2$ for a reaction in which both OH^- are consumed if one has 1.34 mg of $Mg(OH)_2$ dissolved in 1.00 L of solution?

$$\frac{2\ eq}{1\ mol} * \frac{1\ mol}{58.3\ g} * \frac{1\ g}{1000\ mg} * 1.34\ mg * \frac{1}{1.00\ L\ sol}$$

ANS $4.60x10^{-5}$ N

Calculate the following:

13) For the reaction (unbalanced):

$Cr_2O_7^{2-} + SO_3^{2-} \rightarrow Cr^{3+} + SO_4^{2-}$

The balanced half reactions are:

$14\ H^+ + 6e^- + Cr_2O_7^{2-} \rightarrow 2\ Cr^{3+} + 7H_2O$

$H_2O + SO_3^{2-} \rightarrow SO_4^{2-} + 2e^- + 2H^+$

a. How many equivalencies of $K_2Cr_2O_7$ is 38.22 g?
MW $K_2Cr_2O_7$ = 294.0 g/mol

$\frac{6\ eq}{1\ mol} * \frac{1\ mol}{294.0\ g} * 38.22\ g$

ANS 0.7794 eq

b. A 0.12 M solution of H_2SO_3 is what normality?

$\frac{2\ N\ H_2SO_3}{1\ M\ H_2SO_3} * 0.12\ M\ H_2SO_3 =$

ANS 0.24 N

c. What is the molarity of a 0.1900 N $K_2Cr_2O_7$ solution?

$0.1900\ N\ K_2Cr_2O_7 * \frac{1\ M\ K_2Cr_2O_7}{6\ N\ K_2Cr_2O_7} =$

ANS 0.03167 M

d. If one has 0.200 moles of H_2SO_3, how many equivalencies does one have?

$0.200\ mol\ H_2SO_3 * \frac{2\ eq\ H_2SO_3}{1\ mol\ H_2SO_3} =$

ANS 0.400 eq

14) For the reaction (not balanced):

$Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$

a) The balanced half reactions are:

$Fe^{2+} \rightarrow Fe^{3+} + 1e^-$

$8H^+ + 5e^- + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$

b) How many grams are there in 1.50 eq. of $FeSO_4$? Formula weight of $FeSO_4$ = 151.8 g/mol.

$$1.50 \text{ eq } FeSO_4 * \frac{1 \text{ mol } FeSO_4}{1 \text{ eq } FeSO_4} * \frac{151.8 \text{ g } FeSO_4}{1 \text{ mol } FeSO_4} =$$

ANS __228____ g

c) What is the normality of a solution which contains 79.0 g of $KMnO_4$ in 2.50 L of solution? Formula weight of $KMnO_4$ = 157.9 g/mol

$$79.0 \text{ g KMnO4} * \frac{1 \text{ mol KMnO4}}{157.9 \text{ g KMnO4}} * \frac{5 \text{ eq KMnO4}}{1 \text{ mol KMnO4}} * \frac{1}{2.5 \text{ L sol}}$$

ANS __1.00____ N

d) What is the molarity of a solution which has 0.150 eq of $FeSO_4$ dissolved in 750.0 L of solution?

$$0.150 \text{ eq } FeSO_4 * \frac{1 \text{ mol } FeSO_4}{1 \text{ eq FeSO4}} * \frac{1}{0.7500 \text{ L sol}} =$$

ANS __0.200____ M

e) What is the normality of a solution which contains 24.99 g of $FeSO_4$ in 1.333 L of solution?

$$24.99 \text{ g } FeSO_4 * \frac{1 \text{ mol } FeSO_4}{151.8 \text{ g } FeSO_4} * \frac{1 \text{ eq } FeSO_4}{1 \text{ mol } FeSO_4} * \frac{1}{1.333 \text{ L sol}} =$$

ANS __0.1235____ N

Calculate the following:

15) An unknown acid is titrated with a standardized base solution. The concentration of the base is 0.1022 N. 45.15 mL of the base solution was used to titrate 25.00 mL of the acid. What is the normality of the acid solution?

Using $N_aV_a = N_bV_b$:

(25.00 mL) N_a = (0.1022 N)(45.15 mL) and solve for N_a

ANS 0.1846 N

16) In a titration to determine the concentration of $Ca(OH)_2$ in a solution, both OH^- were neutralized. 10.00 mL of the $Ca(OH)_2$ solution were titrated with a standard acid. This standard acid was 0.1100 N and 23.98 mL of it was used for the titration. What is the molarity of the $Ca(OH)_2$ solution?

Using $N_aV_a = N_bV_b$:

(0.1100 N)(23.98 mL) = Nb(10.00 mL) Nb = 0.2638 N

$$\frac{1\ \text{M}}{2\ \text{N}} * 0.2638\ \text{N} = 0.1319\ \text{M}$$

ANS 0.1319 M

17) In the reaction between $FeSO_4$ (formula weight = 151.93 g/mol) and $KMnO_4$, $Fe_2(SO_4)_3$ and $MnSO_4$ are produced. A laboratory worker reacted 6.08 g of solid $FeSO_4$ with a solution of $KMnO_4$ until an endpoint is reached. 37.98 mL of the solution was used in the titration. What is the normality and molarity of the solution?

FW of $FeSO_4$ = 151.9 g/mol 1 eq FeSO4 = 1 eq KMnO4

$$\frac{1}{0.03798\ \text{Lsol}} * 6.08\ \text{g}\ FeSO_4 * \frac{1\ \text{mol}\ FeSO_4}{151.9\ \text{g}\ FeSO_4} * \frac{1\ \text{eq}\ FeSO_4}{1\ \text{mol}\ FeSO_4} * \frac{1\ \text{eq}\ KMnO_4}{1\ \text{eq}\ FeSO_4}$$

ANS 1.054 N

$$1.054\ \text{N}\ KMnSO_4 * \frac{1\ \text{M}\ KMnO_4}{5\ \text{N}\ KMnSO_4}$$

ANS 0.2108 M

18) An oxalic acid ($H_2C_2O_4$) solution was used to standardize a potassium permanganate solution in a redox titration. Before using the oxalic acid as a standard, however, it (oxalic acid) was standardized in a acid-base titration using NaOH solution. In the first (acid-base) titration, 25.00 mL of oxalic solution was used and 45.34 mL of NaOH solution of 0.1011 N was used. In the second (redox) titration, 25.00 mL of oxalic solution was used and 35.03 mL of permanganate solution was used.

a) Write the balanced equation for the acid-base reaction.

$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

b) Calculate the normality and molarity of the oxalate in the acid-base case.
Using $\mathbf{N}_a\mathbf{V}_a = \mathbf{N}_b\mathbf{V}_b$:

$\mathbf{N}_a$ (25.00 mL) = (0.1011 N)(45.34 mL)
and solving

ANS 0.1834 N

diprotic therefore: 2 N = 1 M (unit factor or by formula **N** = 2**M**)

ANS 0.09168 M

c) Write half reactions and the balanced equation for the redox reaction.

$2H_2O + C_2O_4^{2-} \rightarrow 2CO_3^{2-} + 2e^- + 4H^+$

$8H^+ + 5e^- + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$

d) What is the normality of the oxalate in the redox case?

$0.09168\text{ M} * \frac{2\text{ N}}{1\text{ M}} = 0.1834\text{ N}$

ANS 0.1834 N

e) Calculate the normality and molarity of the permanganate in the redox case.
Using $\mathbf{N}_o\mathbf{V}_o = \mathbf{N}_r\mathbf{V}_r$:

$\mathbf{N}_o$ (35.03 mL) = (0.1834 N)(25.00 mL)
$\mathbf{N}_o$ = 0.1309 N

ANS 0.1309 N

$0.1309\text{ N} * \frac{1\text{ M}}{5\text{ N}} =$

ANS 0.02618 M

19) A sample of sodium oxalate of mass 0.202 g was used to standardize a potassium permanganate solution in a redox titration. The potassium permanganate solution was in turn used to find the percent iron in a 1.012 g sample. 32.41 mL of the solution was used in the standardization step and 41.51 mL of solution was used when reacting with iron. The molecular weight of sodium oxalate is 134.00 g/mol and the redox reaction involves two electrons from the sodium oxalate. The iron reacted by changing from iron(II) to iron(III). What was the normality of the potassium permanganate solution and what is the percent iron in the iron sample? Give you answer to the proper number of significant digits.

BALANCED REACTIONS

Notice above the oxalate is a $2e^-$ process. That is all that is needed.

CALCULATIONS:

$$0.202 \text{ g ox} * \frac{1 \text{ mol ox}}{134.0 \text{ g ox}} * \frac{2 \text{ eq ox}}{1 \text{ mol ox}} * \frac{1 \text{ eq KMnO4}}{1 \text{ eq ox}} * \frac{1}{0.03241 \text{ L sol}} =$$

ANS 0.0930 N

$$\frac{0.0930 \text{ eq } KMnO_4}{1 \text{ L sol}} * 0.04151 \text{ L sol} * \frac{1 \text{ eq Fe}}{1 \text{ eq } KMnO_4} * \frac{1 \text{ mol Fe}}{1 \text{ eq Fe}} * \frac{55.83 \text{ g Fe}}{1 \text{ mol Fe}}$$

= 0.2156 g Fe in the 1.012 g sample therefore

$$\% \text{ Fe} = \frac{0.2156 \text{ g Fe}}{1.012 \text{ g total}} * 100\% =$$

ANS 21.3 % Fe