

**Do the following conversions:**

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

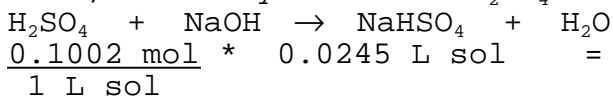
$$0.1500 \text{ M} * \frac{2 \text{ N}}{1 \text{ M}} = 0.3000 \text{ N} \quad \text{ANS } \underline{0.3000} \text{ N}$$

- 7)  $\text{H}_3\text{PO}_4$  is reacted with NaOH to form  $\text{Na}_3\text{PO}_4$ . If one were to start with 3.50 equivalencies of  $\text{H}_3\text{PO}_4$ , how many mole of  $\text{H}_3\text{PO}_4$  is this?

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

$$\text{ANS } \underline{1.17} \text{ mol}$$

- 8) A 0.1002 M solution of  $\text{H}_2\text{SO}_4$  is reacted with NaOH to produce  $\text{NaHSO}_4$  in a titration. If 24.5 mL of the  $\text{H}_2\text{SO}_4$  solution is used, how many moles of  $\text{H}_2\text{SO}_4$  solution is used?



$$\text{ANS } \underline{2.45 \times 10^{-3}} \text{ mol}$$

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

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

$$\text{ANS } \underline{1.035} \text{ M}$$

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

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

$$\text{ANS } \underline{0.547} \text{ N}$$

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

$$\frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}} * \frac{1 \text{ mol NaOH}}{1 \text{ eq NaOH}} * \frac{1.0 \text{ eq NaOH}}{1 \text{ L sol}} * \frac{0.500 \times 10^{-3} \text{ L sol}}{1}$$

$$\text{ANS } \underline{2.0 \times 10^{-2}} \text{ g}$$

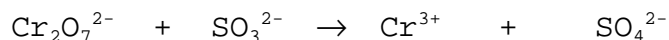
- 12) What is the normality of a solution of  $\text{Mg}(\text{OH})_2$  for a reaction in which both  $\text{OH}^-$  are consumed if one has 1.34 mg of  $\text{Mg}(\text{OH})_2$  dissolved in 1.00 L of solution?

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

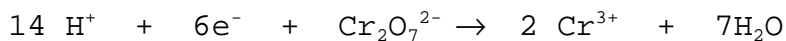
$$\text{ANS } \underline{4.60 \times 10^{-5}} \text{ N}$$

Calculate the following:

13) For the reaction (unbalanced):



The balanced half reactions are:



a. How many equivalencies of  $\text{K}_2\text{Cr}_2\text{O}_7$  is 38.22 g?

$$\text{MW } \text{K}_2\text{Cr}_2\text{O}_7 = 294.0 \text{ g/mol}$$

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

$$\text{ANS } \underline{0.7794} \text{ eq}$$

b. A 0.12 M solution of  $\text{H}_2\text{SO}_3$  is what normality?

$$\frac{2 \text{ N } \text{H}_2\text{SO}_3}{1 \text{ M } \text{H}_2\text{SO}_3} * 0.12 \text{ M } \text{H}_2\text{SO}_3 =$$

$$\text{ANS } \underline{0.24} \text{ N}$$

c. What is the molarity of a 0.1900 N  $\text{K}_2\text{Cr}_2\text{O}_7$  solution?

$$\frac{0.1900 \text{ N } \text{K}_2\text{Cr}_2\text{O}_7}{6 \text{ N } \text{K}_2\text{Cr}_2\text{O}_7} * \frac{1 \text{ M } \text{K}_2\text{Cr}_2\text{O}_7}{6 \text{ N } \text{K}_2\text{Cr}_2\text{O}_7} =$$

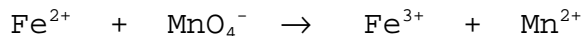
$$\text{ANS } \underline{0.03167} \text{ M}$$

d. If one has 0.200 moles of  $\text{H}_2\text{SO}_3$ , how many equivalencies does one have?

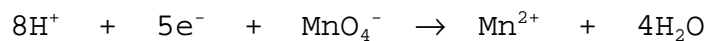
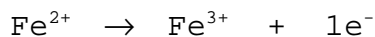
$$0.200 \text{ mol } \text{H}_2\text{SO}_3 * \frac{2 \text{ eq } \text{H}_2\text{SO}_3}{1 \text{ mol } \text{H}_2\text{SO}_3} =$$

$$\text{ANS } \underline{0.400} \text{ eq}$$

14) For the reaction (not balanced):



a) The balanced half reactions are:



b) How many grams are there in 1.50 eq. of  $\text{FeSO}_4$ ? Formula weight of  $\text{FeSO}_4 = 151.8 \text{ g/mol}$ .

$$1.50 \text{ eq FeSO}_4 * \frac{1 \text{ mol FeSO}_4}{1 \text{ eq FeSO}_4} * \frac{151.8 \text{ g FeSO}_4}{1 \text{ mol FeSO}_4} =$$

ANS 228 g

c) What is the normality of a solution which contains 79.0 g of  $\text{KMnO}_4$  in 2.50 L of solution? Formula weight of  $\text{KMnO}_4 = 157.9 \text{ g/mol}$

$$79.0 \text{ g KMnO}_4 * \frac{1 \text{ mol KMnO}_4}{157.9 \text{ g KMnO}_4} * \frac{5 \text{ eq KMnO}_4}{1 \text{ mol KMnO}_4} * \frac{1}{2.5 \text{ L sol}} =$$

ANS 1.00 N

d) What is the molarity of a solution which has 0.150 eq of  $\text{FeSO}_4$  dissolved in 750.0 L of solution?

$$0.150 \text{ eq FeSO}_4 * \frac{1 \text{ mol FeSO}_4}{1 \text{ eq FeSO}_4} * \frac{1}{0.7500 \text{ L sol}} =$$

ANS 0.200 M

e) What is the normality of a solution which contains 24.99 g of  $\text{FeSO}_4$  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  $N_a V_a = N_b V_b$  :

$$(25.00 \text{ mL}) N_a = (0.1022 \text{ N})(45.15 \text{ mL}) \text{ and solve for } N_a$$

$$\text{ANS } \underline{0.1846} \text{ N}$$

- 16) In a titration to determine the concentration of  $\text{Ca}(\text{OH})_2$  in a solution, both  $\text{OH}^-$  were neutralized. 10.00 mL of the  $\text{Ca}(\text{OH})_2$  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  $\text{Ca}(\text{OH})_2$  solution?

Using  $N_a V_a = N_b V_b$  :

$$(0.1100 \text{ N})(23.98 \text{ mL}) = N_b(10.00 \text{ mL}) \quad N_b = 0.2638 \text{ N}$$

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

$$\text{ANS } \underline{0.1319} \text{ M}$$

- 17) In the reaction between  $\text{FeSO}_4$  (formula weight = 151.93 g/mol) and  $\text{KMnO}_4$ ,  $\text{Fe}_2(\text{SO}_4)_3$  and  $\text{MnSO}_4$  are produced. A laboratory worker reacted 6.08 g of solid  $\text{FeSO}_4$  with a solution of  $\text{KMnO}_4$  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  $\text{FeSO}_4 = 151.9 \text{ g/mol}$       1 eq  $\text{FeSO}_4 = 1 \text{ eq KMnO}_4$

$$\frac{1}{0.03798 \text{ Lsol}} * 6.08 \text{ g FeSO}_4 * \frac{1 \text{ mol FeSO}_4}{151.9 \text{ g FeSO}_4} * \frac{1 \text{ eq FeSO}_4}{1 \text{ mol FeSO}_4} * \frac{1 \text{ eq KMnO}_4}{1 \text{ eq FeSO}_4}$$

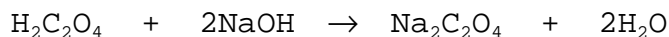
$$\text{ANS } \underline{1.054} \text{ N}$$

$$1.054 \text{ N KMnSO}_4 * \frac{1 \text{ M KMnO}_4}{5 \text{ N KMnSO}_4}$$

$$\text{ANS } \underline{0.2108} \text{ M}$$

18) An oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) 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 an 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.



b) Calculate the normality and molarity of the oxalate in the acid-base case.

Using  $N_a V_a = N_b V_b$  :

$$N_a (25.00 \text{ mL}) = (0.1011 \text{ N})(45.34 \text{ mL})$$

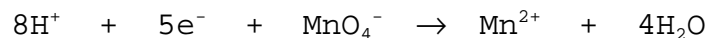
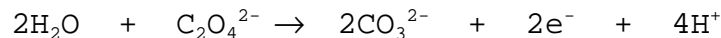
and solving

$$\text{ANS } \underline{0.1834} \text{ N}$$

diprotic therefore:  $2 \text{ N} = 1 \text{ M}$  (unit factor or by formula  $N = 2M$ )

$$\text{ANS } \underline{0.09168} \text{ M}$$

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



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

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

$$\text{ANS } \underline{0.1834} \text{ N}$$

e) Calculate the normality and molarity of the permanganate in the redox case.

Using  $N_o V_o = N_r V_r$  :

$$N_o (35.03 \text{ mL}) = (0.1834 \text{ N})(25.00 \text{ mL})$$

$$N_o = 0.1309 \text{ N}$$

$$\text{ANS } \underline{0.1309} \text{ N}$$

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

$$\text{ANS } \underline{0.02618} \text{ M}$$

- 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:

$$0.202 \text{ g ox} * \frac{1 \text{ mol ox}}{134.0 \text{ g ox}} * \frac{2 \text{ eq ox}}{1 \text{ mol ox}} * \frac{1 \text{ eq KMnO}_4}{1 \text{ eq ox}} * \frac{1}{0.03241 \text{ L sol}} =$$

$$\text{ANS } \underline{0.0930} \text{ N}$$

$$\frac{0.0930 \text{ eq KMnO}_4}{1 \text{ L sol}} * 0.04151 \text{ L sol} * \frac{1 \text{ eq Fe}}{1 \text{ eq KMnO}_4} * \frac{1 \text{ mol Fe}}{1 \text{ eq Fe}} * \frac{55.83 \text{ g Fe}}{1 \text{ mol Fe}}$$

= 0.2156 g Fe in the 1.012 g sample therefore

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

$$\text{ANS } \underline{21.3} \% \text{ Fe}$$