

Homework #3

Chapter 4

Types of Chemical Reactions and Solution Stoichiometry

13. Determine the concentrations of the solutions

Solution A

$$\frac{4 \text{ particles}}{1.0 \text{ L}} = 4.0 \frac{\text{particles}}{\text{L}}$$

Solution B

$$\frac{6 \text{ particles}}{4.0 \text{ L}} = 1.5 \frac{\text{particles}}{\text{L}}$$

Solution C

$$\frac{4 \text{ particles}}{2.0 \text{ L}} = 2.0 \frac{\text{particles}}{\text{L}}$$

Solution D

$$\frac{6 \text{ particles}}{2.0 \text{ L}} = 3.0 \frac{\text{particles}}{\text{L}}$$

Therefore, the order of solution from most to least concentrated is
solution A > solution D > solution C > solution B

15. a) Polar solutes will mix with water and nonpolar solutes will not. For polar solutes the water molecules will orientate so that the H-atoms are lined up around the anion and the O-atoms are lined up around the cation. If the solutes are liquids then you will see only one solution after water has been mixed with a polar solute and two layers when water has been mixed with a nonpolar solute.
- b) When KF is put into water it will dissociate into K^+ and F^- because it is a strong electrolyte. The water molecules will orientate themselves so that the H-atoms in the water are near the F^- ions and the O-atoms in the water are near the K^+ ions. When $\text{C}_6\text{H}_{12}\text{O}_6$ dissolves in water it will stay as $\text{C}_6\text{H}_{12}\text{O}_6$ molecules and not dissociate into atoms/ions because $\text{C}_6\text{H}_{12}\text{O}_6$ is a nonelectrolyte. The water molecules will orientate themselves so that the H-atoms in the water are near the partially negative locations in $\text{C}_6\text{H}_{12}\text{O}_6$ and the O-atoms in the water are near the partially positive regions of the molecule.
- c) When RbCl is put into water it will dissociate in Rb^+ and Cl^- because it is a strong electrolyte. The water molecules will orientate themselves so that the H-atoms in the water are near the Cl^- ions and the O-atoms in the water are near the Rb^+ ions. When AgCl is put into solution it will stay as a solid because it is not soluble in water.
- d) HNO_3 is a strong acid and will complete dissociate into H^+ and NO_3^- . The water molecules will orientate themselves so that the H-atoms in the water are near the NO_3^- ions and the O-atoms in the water are near the H^+ ions. CO is a nonelectrolyte and will not dissociate in water. The water molecules will orientate themselves so that the H-atoms in the water are near the O of the CO and the O-atoms in the water are near the C of the CO .
17. Determine the formula and ions of each of the names
- a) barium nitrate $\text{Ba}(\text{NO}_3)_2$ which is made up of Ba^{2+} and NO_3^-
matches with beaker iv
- b) sodium chloride NaCl which is made up of Na^+ and Cl^-
matches with beaker ii

- c) potassium carbonate K_2CO_3 which is made up of K^+ and CO_3^{2-}
matches with beaker iii
- d) magnesium sulfate $MgSO_4$ which is made up of Mg^{2+} and SO_4^{2-}
matches with beaker i
21. a) $L NaOH \rightarrow g NaOH$
 $L NaOH \rightarrow mol NaOH \rightarrow g NaOH$

$$2.00 L \left(\frac{0.250 mol NaOH}{1 L NaOH} \right) \left(\frac{40.00 g NaOH}{1 mol NaOH} \right) = 20.0 g NaOH$$
20.0 g of NaOH would be put into a volumetric flask and then water would be added to the 2.00 L mark.
- b) $M_1 V_1 = M_2 V_2$
 $(1.00 M)(V_1) = (0.250 M)(2.00 L)$
 $V_1 = 0.500 L$
0.500 L of the 1.00 M stock solution would be put into a volumetric flask and then water would be added to the 2.00 L mark.
- c) $L K_2CrO_4 \rightarrow g K_2CrO_4$
 $L K_2CrO_4 \rightarrow mol K_2CrO_4 \rightarrow g K_2CrO_4$

$$2.00 L K_2CrO_4 \left(\frac{0.100 mol K_2CrO_4}{1 L K_2CrO_4} \right) \left(\frac{194.20 g K_2CrO_4}{1 mol K_2CrO_4} \right) = 38.8 g K_2CrO_4$$
38.8 g of K_2CrO_4 would be put into a volumetric flask and then water would be added to the 2.00 L mark.
- d) $M_1 V_1 = M_2 V_2$
 $(1.75 M)(V_1) = (0.100 M)(2.00 L)$
 $V_1 = 0.114 L$
0.114 L of the 1.75 M stock solution would be put into a volumetric flask and then water would be added to the 2.00 L mark
26. a) $Ca(NO_3)_2(s) \rightarrow Ca^{2+}(aq) + 2NO_3^-(aq)$
 $V = 100.0 mL \left(\frac{1 L}{1000 mL} \right) = 0.1000 L$
Calculate the molarity of Ca^{2+}

$$n_{Ca^{2+}} = 0.100 mol Ca(NO_3)_2 \left(\frac{1 mol Ca^{2+}}{1 mol Ca(NO_3)_2} \right) = 0.100 mol Ca^{2+}$$

$$M = \frac{n}{V} = \frac{0.100 mol}{0.1000 L} = 1.00 M Ca^{2+}$$
Calculate the molarity of NO_3^-

$$n_{NO_3^-} = 0.100 mol Ca(NO_3)_2 \left(\frac{2 mol NO_3^-}{1 mol Ca(NO_3)_2} \right) = 0.200 mol NO_3^-$$

$$M = \frac{n}{V} = \frac{0.200 mol}{0.1000 L} = 2.00 M NO_3^-$$
- b) $Na_2SO_4(s) \rightarrow 2Na^+(aq) + SO_4^{2-}(aq)$
 $V = 1.25 L$
Calculate the molarity of Na^+

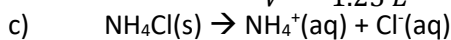
$$n_{Na^+} = 2.5 mol Na_2SO_4 \left(\frac{2 mol Na^+}{1 mol Na_2SO_4} \right) = 5.0 mol Na^+$$

$$M = \frac{n}{V} = \frac{5.0 mol}{1.25 L} = 4.0 M Na^+$$

Calculate the molarity of SO_4^{2-}

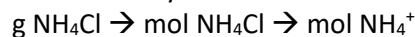
$$n_{SO_4^{2-}} = 2.5 \text{ mol } Na_2SO_4 \left(\frac{1 \text{ mol } SO_4^{2-}}{1 \text{ mol } Na_2SO_4} \right) = 2.5 \text{ mol } SO_4^{2-}$$

$$M = \frac{n}{V} = \frac{2.5 \text{ mol}}{1.25 \text{ L}} = 2.0 \text{ M } SO_4^{2-}$$



$$V = 500.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.5000 \text{ L}$$

Calculate the molarity of NH_4^+



$$5.00 \text{ g } NH_4Cl \left(\frac{1 \text{ mol } NH_4Cl}{53.50 \text{ g } NH_4Cl} \right) \left(\frac{1 \text{ mol } NH_4^+}{1 \text{ mol } NH_4Cl} \right) = 0.0935 \text{ mol } NH_4^+$$

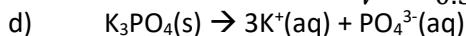
$$M = \frac{n}{V} = \frac{0.0935 \text{ mol}}{0.5000 \text{ L}} = 0.187 \text{ M } NH_4^+$$

Calculate the molarity of Cl^-



$$5.00 \text{ g } NH_4Cl \left(\frac{1 \text{ mol } NH_4Cl}{53.50 \text{ g } NH_4Cl} \right) \left(\frac{1 \text{ mol } Cl^-}{1 \text{ mol } NH_4Cl} \right) = 0.0935 \text{ mol } Cl^-$$

$$M = \frac{n}{V} = \frac{0.0935 \text{ mol}}{0.5000 \text{ L}} = 0.187 \text{ M } Cl^-$$



$$V = 250.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.2500 \text{ L}$$

Calculate the molarity of K^+



$$1.00 \text{ g } K_3PO_4 \left(\frac{1 \text{ mol } K_3PO_4}{212.27 \text{ g } K_3PO_4} \right) \left(\frac{3 \text{ mol } K^+}{1 \text{ mol } K_3PO_4} \right) = 0.0141 \text{ mol } K^+$$

$$M = \frac{n}{V} = \frac{0.0141 \text{ mol}}{0.2500 \text{ L}} = 0.0564 \text{ M } K^+$$

Calculate the molarity of PO_4^{3-}



$$1.00 \text{ g } K_3PO_4 \left(\frac{1 \text{ mol } K_3PO_4}{212.27 \text{ g } K_3PO_4} \right) \left(\frac{1 \text{ mol } PO_4^{3-}}{1 \text{ mol } K_3PO_4} \right) = 0.00471 \text{ mol } PO_4^{3-}$$

$$M = \frac{n}{V} = \frac{0.00471 \text{ mol}}{0.2500 \text{ L}} = 0.0188 \text{ M } PO_4^{3-}$$

27. Calculate the number of moles of Na^+ in 70.0 mL of 3.0 M Na_2CO_3

$$M = \frac{n}{V}$$

$$V = 70.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.0700 \text{ L}$$

$$n_{Na_2CO_3} = MV = (3.0 \text{ M})(0.0700 \text{ L}) = 0.21 \text{ mol } Na_2CO_3$$

$$n_{Na^+} = 0.21 \text{ mol } Na_2CO_3 \left(\frac{2 \text{ mol } Na^+}{1 \text{ mol } Na_2CO_3} \right) = 0.42 \text{ mol } Na^+$$

Calculate the number of moles of Na^+ in 30.0 mL of 1.0 M $NaHCO_3$

$$M = \frac{n}{V}$$

$$V = 30.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.0300 \text{ L}$$

$$n_{NaHCO_3} = MV = (1.0 \text{ M})(0.0300 \text{ L}) = 0.030 \text{ mol } NaHCO_3$$

$$n_{Na^+} = 0.030 \text{ mol } NaHCO_3 \left(\frac{1 \text{ mol } Na^+}{1 \text{ mol } NaHCO_3} \right) = 0.030 \text{ mol } Na^+$$

Calculate total moles of Na^+

$$n_{\text{total moles Na}^+} = 0.42 \text{ mol} + 0.030 \text{ mol} = 0.45 \text{ mol Na}^+$$

Calculate the total volume

$$V_{\text{total}} = 0.0700 \text{ L} + 0.0300 \text{ L} = 0.1000 \text{ L}$$

Calculate the molarity of Na^+ ions

$$M = \frac{n}{V} = \frac{0.45 \text{ mol}}{0.1000 \text{ L}} = 4.5 \text{ M Na}^+$$

28. Calculate molarity of stock solution

$$25.0 \text{ g (NH}_4)_2\text{SO}_4 \left(\frac{1 \text{ mol (NH}_4)_2\text{SO}_4}{132.1382 \text{ g (NH}_4)_2\text{SO}_4} \right) = 0.189 \text{ mol (NH}_4)_2\text{SO}_4$$

$$M = \frac{n}{V} = \frac{0.189 \text{ mol (NH}_4)_2\text{SO}_4}{0.100 \text{ L}} = 1.89 \text{ M (NH}_4)_2\text{SO}_4$$

Calculate molarity of the diluted solution

$$M_1 V_1 = M_2 V_2$$

$$(1.89 \text{ M})(0.0100 \text{ L}) = M_2(0.0600 \text{ L})$$

$$M_2 = 0.315 \text{ M (NH}_4)_2\text{SO}_4$$

Calculate molarity of NH_4^+ ions

$$0.315 \text{ M (NH}_4)_2\text{SO}_4 \left(\frac{2 \text{ mol NH}_4^+}{1 \text{ mol (NH}_4)_2\text{SO}_4} \right) = 0.630 \text{ M NH}_4^+$$

Calculate the molarity of SO_4^{2-} ions

$$0.315 \text{ M (NH}_4)_2\text{SO}_4 \left(\frac{1 \text{ mol SO}_4^{2-}}{1 \text{ mol (NH}_4)_2\text{SO}_4} \right) = 0.315 \text{ M SO}_4^{2-}$$

30. Stock Solution

$$n_{\text{Mn}} = 1.584 \text{ g Mn} \left(\frac{1 \text{ mol Mn}}{54.94 \text{ g Mn}} \right) = 0.02883 \text{ mol Mn}$$

All of the Mn^{2+} came from the Mn(s) therefore $n_{\text{Mn}} = n_{\text{Mn}^{2+}}$

$$n_{\text{Mn}^{2+}} = 0.02883 \text{ mol Mn} \left(\frac{1 \text{ mol Mn}^{2+}}{1 \text{ mol Mn}} \right) = 0.02883 \text{ mol Mn}^{2+}$$

$$M = \frac{n}{V} = \frac{0.02883 \text{ mol}}{1.000 \text{ L}} = 0.02883 \text{ M Mn}^{2+}$$

Solution A

$$M_1 V_1 = M_2 V_2$$

$$V_1 = 50.00 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.05000 \text{ L}$$

$$V_2 = 1000.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 1.0000 \text{ L}$$

$$(0.02883 \text{ M})(0.05000 \text{ L}) = M_2(1.0000 \text{ L})$$

$$M = 0.001442 \text{ M Mn}^{2+}$$

Solution B

$$M_1 V_1 = M_2 V_2$$

$$V_1 = 10.00 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.01000 \text{ L}$$

$$V_2 = 250.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.2500 \text{ L}$$

$$(0.001442 \text{ M})(0.01000 \text{ L}) = M_2(0.2500 \text{ L})$$

$$M = 5.766 \times 10^{-5} \text{ M Mn}^{2+}$$

Solution C

$$M_1V_1 = M_2V_2$$

$$V_1 = 10.00 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.01000 \text{ L}$$

$$V_2 = 500.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.5000 \text{ L}$$

$$(5.766 \times 10^{-5} \text{ M})(0.01000 \text{ L}) = M_2(0.5000 \text{ L})$$

$$M = 1.153 \times 10^{-6} \text{ M Mn}^{2+}$$

36. The name lead nitrate is incorrect, the correct name should be lead(II) nitrate.

Reaction that occurs: $\text{Pb}(\text{NO}_3)_2(\text{s}) + 2\text{KI}(\text{aq}) \rightarrow 2\text{KNO}_3(\text{aq}) + \text{PbI}_2(\text{s})$

Complete ionic equation: $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + 2\text{K}^{+}(\text{aq}) + 2\text{I}^{-}(\text{aq}) \rightarrow 2\text{K}^{+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + \text{PbI}_2(\text{s})$

Yes the solution will still conduct electricity because there will be K^{+} and NO_3^{-} ions in solutions.

Note: all of the Pb^{2+} moles (1.0 mol) and the I^{-} moles (2.0 mol) will go into forming the solid therefore, there will be none of these ions in solution.

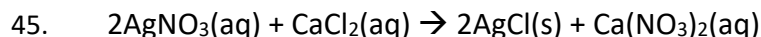
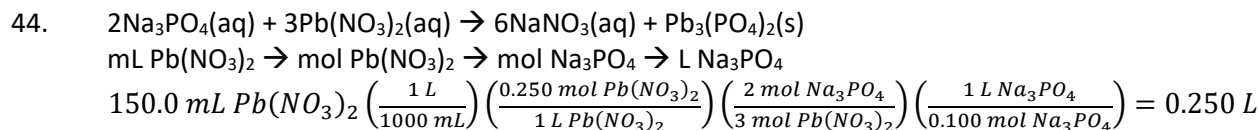
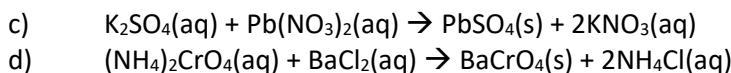
39. a) $(\text{NH}_4)_2\text{SO}_4(\text{aq}) + \text{Ba}(\text{NO}_3)_2(\text{aq}) \rightarrow 2\text{NH}_4\text{NO}_3(\text{aq}) + \text{BaSO}_4(\text{s})$
 $2\text{NH}_4^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Ba}^{2+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) \rightarrow 2\text{NH}_4^{+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + \text{BaSO}_4(\text{s})$
 $\text{SO}_4^{2-}(\text{aq}) + \text{Ba}^{2+}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
- b) $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2\text{NaCl}(\text{aq}) \rightarrow 2\text{NaNO}_3(\text{aq}) + \text{PbCl}_2(\text{s})$
 $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow 2\text{Na}^{+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq}) + \text{PbCl}_2(\text{s})$
 $\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$
- c) $\text{Na}_3\text{PO}_4(\text{aq}) + 3\text{KNO}_3(\text{aq}) \rightarrow 3\text{NaNO}_3(\text{aq}) + \text{K}_3\text{PO}_4(\text{aq})$
 $3\text{Na}^{+}(\text{aq}) + \text{PO}_4^{3-}(\text{aq}) + 3\text{K}^{+}(\text{aq}) + 3\text{NO}_3^{-}(\text{aq}) \rightarrow 3\text{Na}^{+}(\text{aq}) + 3\text{NO}_3^{-}(\text{aq}) + 3\text{K}^{+}(\text{aq}) + \text{PO}_4^{3-}(\text{aq})$
 No reaction
- d) $\text{NaBr}(\text{aq}) + \text{RbCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{RbBr}(\text{aq})$
 $\text{Na}^{+}(\text{aq}) + \text{Br}^{-}(\text{aq}) + \text{Rb}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq}) \rightarrow \text{Na}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq}) + \text{Rb}^{+}(\text{aq}) + \text{Br}^{-}(\text{aq})$
 No reaction
- e) $\text{CuCl}_2(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s}) + 2\text{NaCl}(\text{aq})$
 $\text{Cu}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s}) + 2\text{Na}^{+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq})$
 $\text{Cu}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s})$

40. There are multiple ways to do these problems; this is one way to do them

- a) 1. Add NaCl to the solution this will cause AgCl to precipitate
 2. Add Na_2SO_4 to the solution this will cause BaSO_4 to precipitate (Note: steps one and two could have been switched.)
 3. The Cr^{3+} ions will be left in solution
- b) 1. Add Li_2SO_4 to the solution this will cause PbSO_4 to precipitate
 2. Add LiCl to the solution this will cause AgCl to precipitate (Note: steps one and two cannot be switch because if the Cl^{-} was added first both PbCl_2 and AgCl would have precipitated out.)
 3. The Cu^{2+} ions will be left in solution
- c) 1. Add CaCl_2 to the solution this will cause Hg_2Cl_2 to precipitate
 2. The Ni^{2+} ions will be left in solution

42. There are multiple ways to do these problems; this is one way to do them.

- a) $3\text{NaOH}(\text{aq}) + \text{FeCl}_3(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + 3\text{NaCl}(\text{aq})$
- b) $\text{Hg}_2(\text{NO}_3)_2(\text{aq}) + \text{BaCl}_2(\text{aq}) \rightarrow \text{Hg}_2\text{Cl}_2(\text{s}) + \text{Ba}(\text{NO}_3)_2(\text{aq})$



This is a limiting reagent problem

Calculate the moles of $AgNO_3$.

$$100.0 mL AgNO_3 \left(\frac{1 L}{1000 mL} \right) \left(\frac{0.20 mol AgNO_3}{1 L AgNO_3} \right) = 0.020 mol AgNO_3$$

Calculate the moles of $CaCl_2$.

$$100.0 mL CaCl_2 \left(\frac{1 L}{1000 mL} \right) \left(\frac{0.15 mol CaCl_2}{1 L CaCl_2} \right) = 0.015 mol CaCl_2$$

Calculate the number of moles of $CaCl_2$ needed to fully react $AgNO_3$.

$$0.020 mol AgNO_3 \left(\frac{1 mol CaCl_2}{2 mol AgNO_3} \right) = 0.010 mol CaCl_2$$

Since we have 0.015 mol of $CaCl_2$ the $AgNO_3$ is the limiting reagent.

	$AgNO_3(aq)$ (L.R)	$CaCl_2(aq)$	$AgCl(s)$	$Ca(NO_3)_2$
I (mol)	0.020	0.015	0	0
C (mol)	-2x=-0.020	-x=-0.010	+2x=0.020	+x=0.010
F (mol)	0	0.005	0.020	0.010

$$0.020 - 2x = 0$$

$$x = 0.010$$

Calculate the grams of $AgCl$ produced.

$$0.020 mol AgCl \left(\frac{143.32 g AgCl}{1 mol AgCl} \right) = 2.9 g AgCl$$

Calculate the concentration of the all the ions.

Final Volume of Solutions

$$100.0 mL + 100.0 mL = 200.0 mL \left(\frac{1 L}{1000 mL} \right) = 0.2000 L$$

Calculate the concentration of Ag^+ ion

0 M Ag^+ all went into forming $AgCl$

Calculate the molarity of Cl^- ions

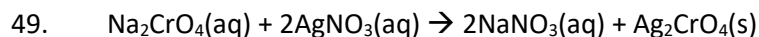
$$M = \frac{n}{V} = \frac{2(0.005 mol)}{0.2000 L} = 0.05 M Cl^- \text{ from the } CaCl_2$$

Calculate the molarity of Ca^{2+} ions

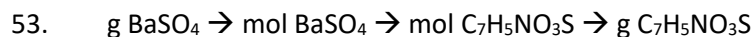
$$M = \frac{n}{V} = \frac{0.010 mol + 0.005 mol}{0.2000 L} = 0.075 M Ca^{2+} \text{ from the } Ca(NO_3)_2 \text{ and } CaCl_2$$

Calculate the concentration of NO_3^- ions

$$M = \frac{n}{V} = \frac{2(0.010 mol)}{0.2000 L} = 0.10 M NO_3^- \text{ from the } Ca(NO_3)_2$$



$$75.0 mL AgNO_3 \left(\frac{1 L}{1000 mL} \right) \left(\frac{0.1 mol AgNO_3}{1 L AgNO_3} \right) \left(\frac{1 mol Na_2CrO_4}{2 mol AgNO_3} \right) \left(\frac{161.98 g Na_2CrO_4}{1 mol Na_2CrO_4} \right) = 0.607 g Na_2CrO_4$$



$$0.5032 \text{ g BaSO}_4 \left(\frac{1 \text{ mol BaSO}_4}{233.40 \text{ g BaSO}_4} \right) \left(\frac{1 \text{ mol C}_7\text{H}_5\text{NO}_3\text{S}}{1 \text{ mol BaSO}_4} \right) \left(\frac{1 \text{ mol C}_7\text{H}_5\text{NO}_3\text{S}}{1 \text{ mol S in C}_7\text{H}_5\text{NO}_3\text{S}} \right) \left(\frac{183.20 \text{ g C}_7\text{H}_5\text{NO}_3\text{S}}{1 \text{ mol C}_7\text{H}_5\text{NO}_3\text{S}} \right) \\ = 0.3950 \text{ g C}_7\text{H}_5\text{NO}_3\text{S}$$

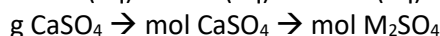
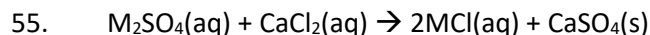
This is the amount of saccharin in 10 tablets therefore there is 0.3950 g of saccharin in one tablet.

The mass of 10 tablets is 0.5032 g and the mass of the saccharin in 10 tablets is

$$\frac{0.3950 \text{ g}}{10} = 0.03950 \text{ g saccharin per tablet}$$

The average mass % saccharin

$$\left(\frac{0.3950 \text{ g}}{0.5894 \text{ g}} \right) 100\% = 67.02\%$$



$$1.36 \text{ g CaSO}_4 \left(\frac{1 \text{ mol CaSO}_4}{136.15 \text{ g CaSO}_4} \right) \left(\frac{1 \text{ mol M}_2\text{SO}_4}{1 \text{ mol CaSO}_4} \right) = 0.00999 \text{ mol M}_2\text{SO}_4$$

$$M_{\text{M}_2\text{SO}_4} = \frac{m}{n} = \frac{1.42 \text{ g}}{0.00999 \text{ mol}} = 142 \frac{\text{g}}{\text{mol}}$$

$$M_{\text{M}_2\text{SO}_4} = 2M_{\text{M}} + M_{\text{S}} + 4M_{\text{O}}$$

$$142 \frac{\text{g}}{\text{mol}} = 2M_{\text{M}} + 32.07 \frac{\text{g}}{\text{mol}} + 4 \left(16.00 \frac{\text{g}}{\text{mol}} \right)$$

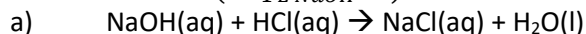
$$M_{\text{M}} = 23 \frac{\text{g}}{\text{mol}}$$

Since the molar mass is 23 the metal is sodium (Na)

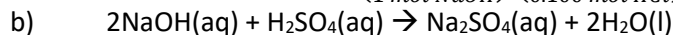


$$50.0 \text{ mL NaOH} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.0500 \text{ L NaOH}$$

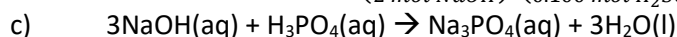
$$0.0500 \text{ L NaOH} \left(\frac{0.100 \text{ mol NaOH}}{1 \text{ L NaOH}} \right) = 0.00500 \text{ mol NaOH}$$



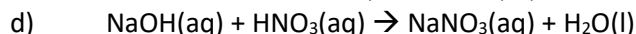
$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L HCl}}{0.100 \text{ mol HCl}} \right) = 0.0500 \text{ L HCl}$$



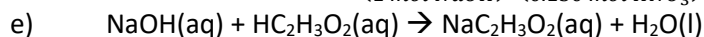
$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L H}_2\text{SO}_4}{0.100 \text{ mol H}_2\text{SO}_4} \right) = 0.0250 \text{ L H}_2\text{SO}_4$$



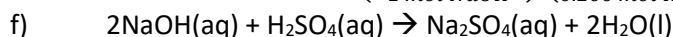
$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol H}_3\text{PO}_4}{3 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L H}_3\text{PO}_4}{0.200 \text{ mol H}_3\text{PO}_4} \right) = 0.00833 \text{ L H}_3\text{PO}_4$$



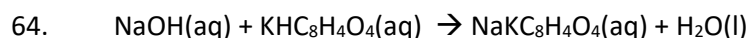
$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol HNO}_3}{1 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L HNO}_3}{0.150 \text{ mol HNO}_3} \right) = 0.0333 \text{ L HNO}_3$$



$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol HC}_2\text{H}_3\text{O}_2}{1 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L HC}_2\text{H}_3\text{O}_2}{0.200 \text{ mol HC}_2\text{H}_3\text{O}_2} \right) = 0.0250 \text{ L HC}_2\text{H}_3\text{O}_2$$



$$0.00500 \text{ mol NaOH} \left(\frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \right) \left(\frac{1 \text{ L H}_2\text{SO}_4}{0.300 \text{ mol H}_2\text{SO}_4} \right) = 0.00833 \text{ L H}_2\text{SO}_4$$

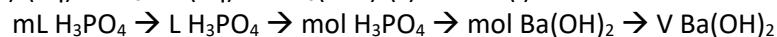


$$0.1082 \text{ g KHP} \left(\frac{1 \text{ mol KHP}}{204.22 \text{ g}} \right) \left(\frac{1 \text{ mol NaOH}}{1 \text{ mol KHP}} \right) = 5.298 \times 10^{-4} \text{ mol NaOH}$$

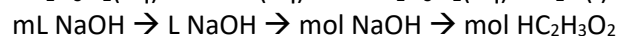
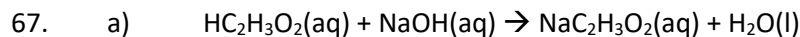
Calculate the molarity of the NaOH solution

$$V = 34.67 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.03467 \text{ L}$$

$$M = \frac{n}{V} = \frac{5.298 \times 10^{-4} \text{ mol}}{0.03467 \text{ L}} = 0.01528 \text{ M NaOH}$$



$$14.20 \text{ mL H}_3\text{PO}_4 \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.141 \text{ mol H}_3\text{PO}_4}{1 \text{ L H}_3\text{PO}_4} \right) \left(\frac{3 \text{ mol Ba}(\text{OH})_2}{2 \text{ mol H}_3\text{PO}_4} \right) \left(\frac{1 \text{ L Ba}(\text{OH})_2}{0.0521 \text{ mol Ba}(\text{OH})_2} \right) = 0.0576 \text{ L Ba}(\text{OH})_2$$



$$16.58 \text{ mL NaOH} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.5062 \text{ mol NaOH}}{1 \text{ L NaOH}} \right) = 0.008393 \text{ mol HC}_2\text{H}_3\text{O}_2$$

Calculate the molarity of the acetic acid

$$V = 10.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.0100 \text{ L}$$

$$M = \frac{n}{V} = \frac{0.008393 \text{ mol}}{0.0100 \text{ L}} = 0.8393 \text{ M HC}_2\text{H}_3\text{O}_2$$

b) Calculate the mass of the acetic acid

$$0.008393 \text{ mol HC}_2\text{H}_3\text{O}_2 \left(\frac{60.06 \text{ g HC}_2\text{H}_3\text{O}_2}{1 \text{ mol HC}_2\text{H}_3\text{O}_2} \right) = 0.5041 \text{ g}$$

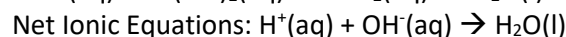
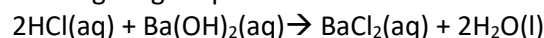
Calculate the mass of the vinegar in 10.0 mL

$$10.00 \text{ mL} \left(\frac{1 \text{ cm}^3}{1 \text{ mL}} \right) \left(\frac{1.006 \text{ g}}{1 \text{ cm}^3} \right) = 10.06 \text{ g}$$

Calculate the mass %

$$\left(\frac{m_{\text{HC}_2\text{H}_3\text{O}_2}}{m_{\text{total}}} \right) 100\% = \left(\frac{0.5041 \text{ g}}{10.06 \text{ g}} \right) 100\% = 5.011\%$$

71. This is a limiting reagent problem. Find out if OH^- or H^+ is present in excess.



Determine the initial moles of H^+

$$75.0 \text{ mL HCl} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.250 \text{ mol HCl}}{1 \text{ L HCl}} \right) \left(\frac{1 \text{ mol H}^+}{1 \text{ mol HCl}} \right) = 0.0188 \text{ mol H}^+$$

Determine the initial moles of OH^-

$$225.0 \text{ mL Ba}(\text{OH})_2 \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.0550 \text{ mol Ba}(\text{OH})_2}{1 \text{ L Ba}(\text{OH})_2} \right) \left(\frac{2 \text{ mol OH}^-}{1 \text{ mol Ba}(\text{OH})_2} \right) = 0.0248 \text{ mol OH}^-$$

Calculate the number of moles of OH^- needed to fully react with 0.0188 mol H^+

$$0.0188 \text{ mol H}^+ \left(\frac{1 \text{ mol HCl}}{1 \text{ mol H}^+} \right) \left(\frac{1 \text{ mol Ba}(\text{OH})_2}{2 \text{ mol HCl}} \right) \left(\frac{2 \text{ mol OH}^-}{1 \text{ mol Ba}(\text{OH})_2} \right) = 0.0188 \text{ mol OH}^-$$

Since we have 0.0248 moles of OH^- , H^+ is the limiting reagent and will be completely consumed.

	$\text{H}^+(\text{aq})$ (L.R)	$\text{OH}^-(\text{aq})$	$\text{H}_2\text{O}(\text{l})$
I (mol)	0.0188	0.0248	0
C (mol)	-x=-0.0188	-x=-0.0188	+x=0.0188
F (mol)	0	0.0060	0.0188

$$0.0188 - x = 0$$

$$x = 0.0188$$

Calculate the molarity of OH^- left in solution.

$$V = 75.0 \text{ mL} + 225.0 \text{ mL} = 300.0 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.3000 \text{ L}$$

$$M = \frac{n}{V} = \frac{0.0060 \text{ mol}}{0.3000 \text{ L}} = 0.020 \text{ M } OH^-$$

75. a) K +1, Mn +7, and O -2
b) Ni +4, and O -2
c) Fe +2
d) NH_4 +1 (N -3 and H +1), and HPO_4 -2 (H +1, P +5, and O -2)
e) P +3, and O -2
f) Fe +8/3, and O -2
g) Xe +6, O -2, and F -1
h) S +4, and F -1
i) C +2, and O -2
j) C 0, H +1, and O -2
77. a) Sr 2+, Cr +6, and O -2
b) Cu +2, and Cl -1
c) O 0
d) H +1 and O -1 (peroxide)
e) Mg +2, C +4, and O -2
f) Ag 0
g) Pb 2+, and SO_3 -2 (S +4 and O -2)
h) Pb 4+, and O 2-
i) Na +1, C +3, and O -2
j) C +4, and O -2
k) NH_4 +1 (N -3 and H +1), Ce 4+, and SO_4 2- (S +6 and O -2)
l) Cr +3, and O -2

78. Since they ask for substance oxidized they want entire compound not just element oxidized

- a) Redox reaction

Element	Beginning Oxidation #	Ending Oxidation #
O	0	-2
C	-4	+4

O is reduced, O_2 is species reduced

C is oxidized, CH_4 is species oxidized

O_2 is the oxidizing agent

CH₄ is the reducing agent

- b) Redox reaction

Element	Beginning Oxidation #	Ending Oxidation #
Zn	0	+2
H	+1	0

Zn is oxidized

H is reduced, HCl is species reduced

Zn is the reducing agent

HCl is the oxidizing agent

- c) Not a redox reaction

- d) Redox Reaction

Element	Beginning Oxidation #	Ending Oxidation #
O	0	-2
N	+2	+4

O is reduced, O_3 is species reduced

N is oxidized, NO is species oxidized

O_3 is the oxidizing agent

NO is the reducing agent

e)

Redox Reaction

Element	Beginning Oxidation #	Ending Oxidation #
O	-1	0
O	-1	-2

O is reduced, H_2O_2 is species reducedO is oxidized, H_2O_2 is species oxidized H_2O_2 is the oxidizing agent H_2O_2 is the reducing agent

f)

Redox Reaction

Element	Beginning Oxidation #	Ending Oxidation #
Cu	+1	0
Cu	+1	+2

Cu is reduced, CuCl is species reduced

Cu is oxidized, CuCl is species oxidized

CuCl is the oxidizing agent

CuCl is the reducing agent

g)

Not a Redox Reaction

h)

Not a Redox Reaction

i)

Redox Reaction

Element	Beginning Oxidation #	Ending Oxidation #
Si	+4	0
Mg	0	+2

Si is reduced, SiCl_4 is species reduced

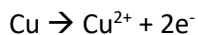
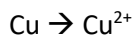
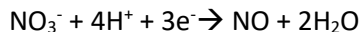
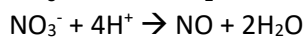
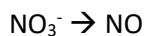
Mg is oxidized

 SiCl_4 is the oxidizing agent

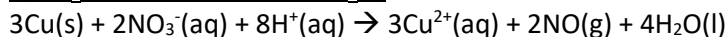
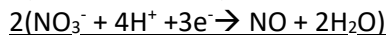
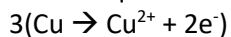
Mg is the reducing agent

81.

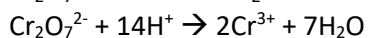
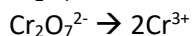
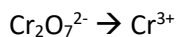
a)

Balance Oxidation $\frac{1}{2}$ ReactionBalance Reduction $\frac{1}{2}$ Reaction

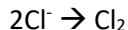
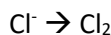
Total Balanced Equation



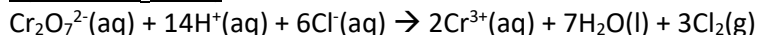
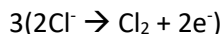
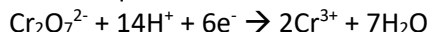
b)

Balance Reduction $\frac{1}{2}$ Reaction

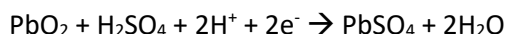
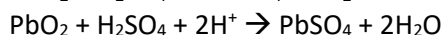
Balance Oxidation $\frac{1}{2}$ Reaction



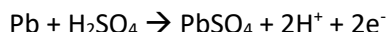
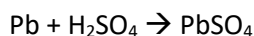
Total Balanced Equation



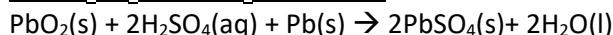
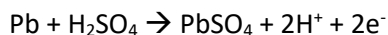
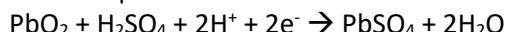
c) Balance Reduction $\frac{1}{2}$ Reaction



Balance Oxidation $\frac{1}{2}$ Reaction

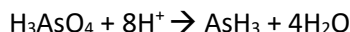
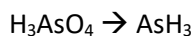


Total Balanced Equation

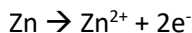
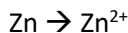


d) Skip this equation. You will not be able to balance this because there is no sodium on the products side of the equation.

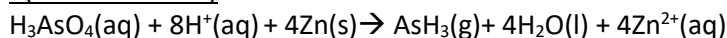
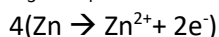
e) Balance Reducation $\frac{1}{2}$ Reaction



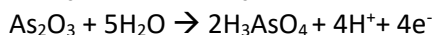
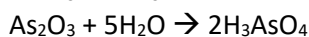
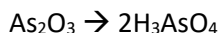
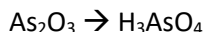
Balance Oxidation $\frac{1}{2}$ Reaction



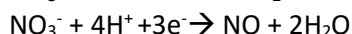
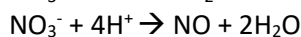
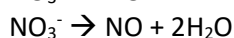
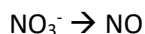
Total Balanced Equation



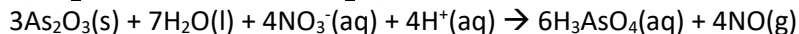
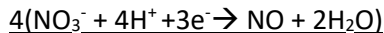
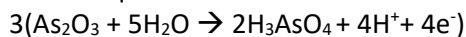
f) Balance Oxidation $\frac{1}{2}$ Reaction



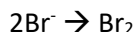
Balance Reducation $\frac{1}{2}$ Reaction



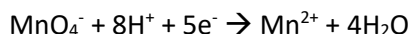
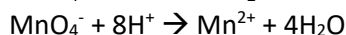
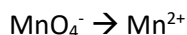
Total Balanced Equation



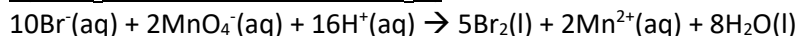
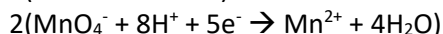
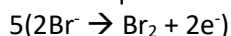
g) Balance Oxidation $\frac{1}{2}$ Reaction



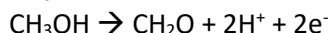
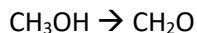
Balance Reduction $\frac{1}{2}$ Reaction



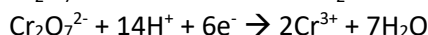
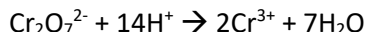
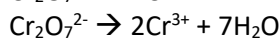
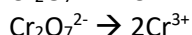
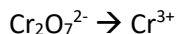
Total Balanced Equation



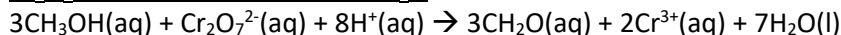
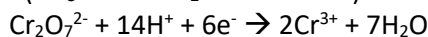
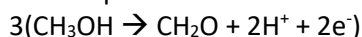
h) Balance Oxidation $\frac{1}{2}$ Reaction



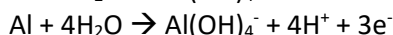
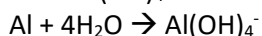
Balance Reduction $\frac{1}{2}$ Reaction



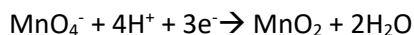
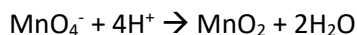
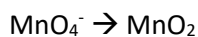
Total Balance Equation



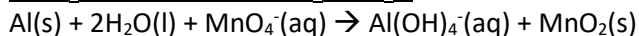
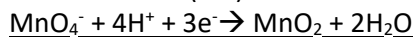
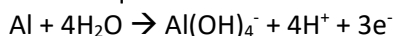
82. a) Balance Oxidation $\frac{1}{2}$ Reaction



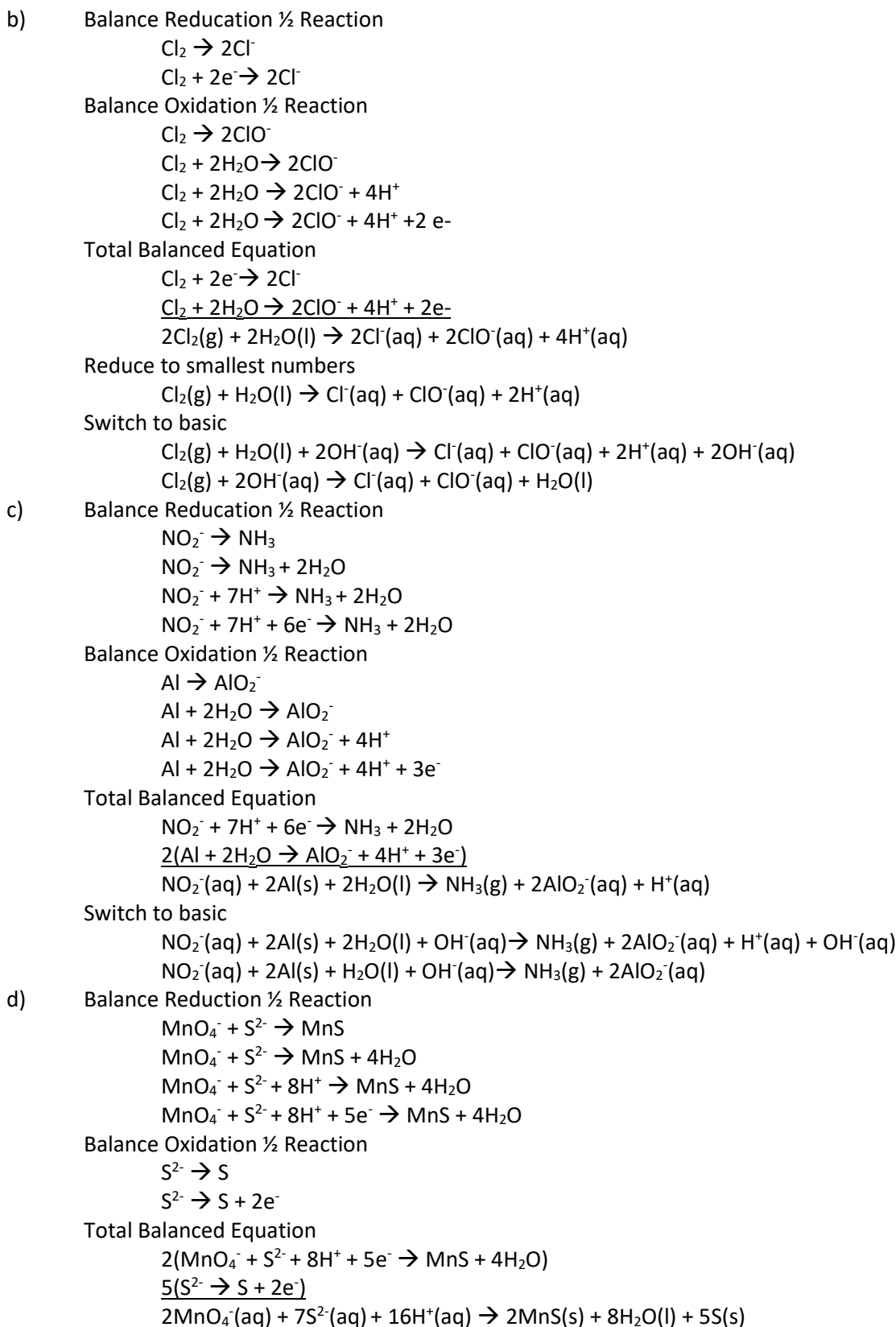
Balance Reduction $\frac{1}{2}$ Reaction



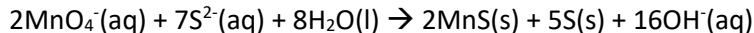
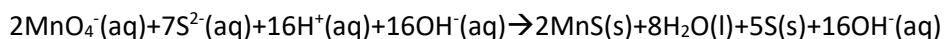
Total Balanced Equation



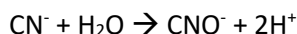
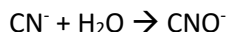
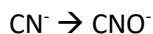
Since there are no H^+ in the equation the equation is the same for acid or basic conditions.



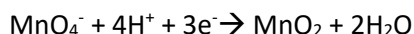
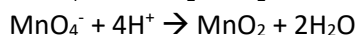
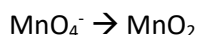
Switch to Basic



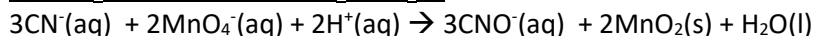
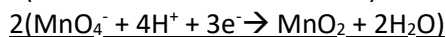
e) Balance Reduction $\frac{1}{2}$ Reaction



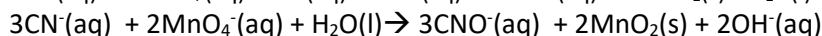
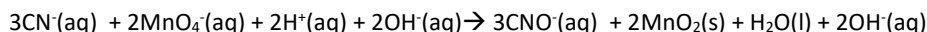
Balance Oxidation $\frac{1}{2}$ Reaction



Total Balanced Equation

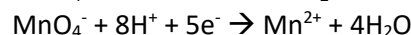
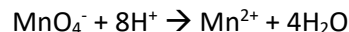
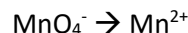


Switch to basic conditions

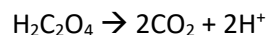
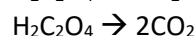
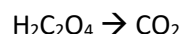


85. 1st balance the equation

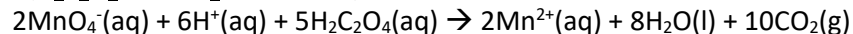
Balance Reduction $\frac{1}{2}$ Reaction



Balance Oxidation $\frac{1}{2}$ Reaction



Total Balanced Equation



Calculate the moles of MnO_4^-

$$0.1058 \text{ g } \text{H}_2\text{C}_2\text{O}_4 \left(\frac{1 \text{ mol } \text{H}_2\text{C}_2\text{O}_4}{90.04 \text{ g } \text{H}_2\text{C}_2\text{O}_4} \right) \left(\frac{2 \text{ mol } \text{MnO}_4^-}{5 \text{ mol } \text{H}_2\text{C}_2\text{O}_4} \right) = 4.700 \times 10^{-4} \text{ mol } \text{MnO}_4^-$$

Calculate the molarity of the MnO_4^- solution

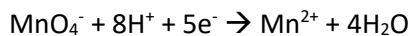
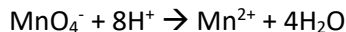
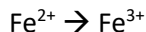
$$M = \frac{n}{V}$$

$$V = 28.97 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.02897 \text{ L}$$

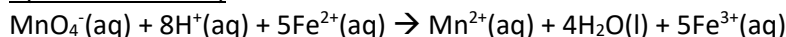
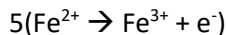
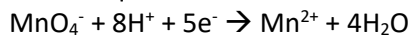
$$M = \frac{n}{V} = \frac{4.700 \times 10^{-4} \text{ mol}}{0.02897 \text{ L}} = 0.01622 \text{ M } \text{MnO}_4^-$$

86.

a) Balance the equation

Balance Reduction $\frac{1}{2}$ ReactionBalance Oxidation $\frac{1}{2}$ Reaction

Total Balanced Equation

Calculate the moles of Fe^{2+} 

$$20.62 \text{ mL KMnO}_4 \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.0216 \text{ mol KMnO}_4}{1 \text{ L KMnO}_4} \right) \left(\frac{1 \text{ mol MnO}_4^-}{1 \text{ mol KMnO}_4} \right) \left(\frac{5 \text{ mol Fe}^{2+}}{1 \text{ mol MnO}_4^-} \right) \\ = 0.00222 \text{ mol Fe}^{2+}$$

Calculate the molarity of the Fe^{2+} solution

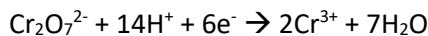
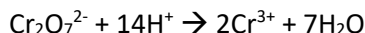
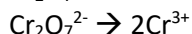
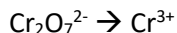
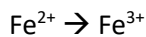
$$M = \frac{n}{V}$$

$$V = 50.00 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.05000 \text{ L}$$

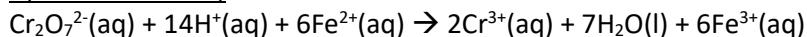
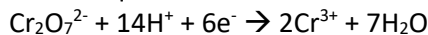
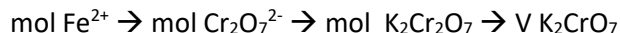
$$M = \frac{n}{V} = \frac{0.00222 \text{ mol}}{0.05000 \text{ L}} = 0.0445 \text{ M Fe}^{2+}$$

b)

Balance the equation

Balance Reduction $\frac{1}{2}$ ReactionBalance Oxidation $\frac{1}{2}$ Reaction

Total Balanced Equation

Calculate the V of K_2CrO_7 

$$0.00222 \text{ mol Fe}^{2+} \left(\frac{1 \text{ mol Cr}_2\text{O}_7^{2-}}{6 \text{ mol Fe}^{2+}} \right) \left(\frac{1 \text{ mol K}_2\text{Cr}_2\text{O}_7}{1 \text{ mol Cr}_2\text{O}_7^{2-}} \right) \left(\frac{1 \text{ L K}_2\text{Cr}_2\text{O}_7}{0.0150 \text{ mol K}_2\text{Cr}_2\text{O}_7} \right) \\ = 0.0247 \text{ L K}_2\text{Cr}_2\text{O}_7$$