Reactions in Aqueous Solutions Practice Problems

aqsrxnsprc0607.doc

Molarity and Dilutions:

1. Determines the number of grams of potassium chloride required to make 250.mL of a .010M solution.

$.010 = \frac{x}{.250L}$ $x = .0025$ mol

$.0025$ mol $(74.55$ g/mol$) = .186$

Answer: .19g

2. How much water would need to be added to 50.0mL of a .200M solution to produce a final molarity of .050M?

$(.050)(V_1) = (.200M)(.050L)$ $V_1 = .2L = 200mL$

Answer: 150 mL Amount to add $200mL - 50.0mL$

3. How many potassium ions are contained in a 25.0mL sample of a .002M potassium phosphate (K_3PO_4) solution?

$.002\frac{mol}{L}(.025L) = 5\times10^{-5}$ mol

$(5\times10^{-5}\text{ mol})(6.022\times10^{23}\frac{\text{particles}}{\text{mol}})(3K^+/\text{particle}) = 9.033\times10^{19}$

Answer: 9×10^{19}

4. Calculate the molarity of ammonium chloride in an aqueous solution that is 20.0% NH_4Cl by mass. The density of the solution is 1.06g/mL.

Assume 100 mL

$1.06\frac{g}{mL}(100mL) = 106g(.20) = 21.2g\ NH_4Cl$

$21.2g/(53.49g/mol) = .396$ mol NH_4Cl

Answer: 3.96 $\frac{.396mol}{.100L} = 3.96$

5. A student attempts to produce 600.mL of a .500M solution of potassium nitrate by dissolving 50.0g of the solute in enough water to make 600.mL.

Is the solution the correct molarity? No (too high)

If not, explain how you would help the student fix their error.

Pour 364 mL of student solution into a new graduated cylinder then fill to 600mL mark

$50.0g/101.10g/mol = .4945mol/.600L = .824M$

$M_1V_1 = M_2V_2$ $(.824M)(V_1) = (.500)(600mL)$

$V_1 = 363.96mL$

6. Calculate the final molarity of *potassium* in a solution formed from combining 300.mL of .450M potassium sulfate (K_2SO_4) with 425mL of .650M potassium acetate ($KC_2H_3O_2$). Assume volumes are additive.

$\frac{(2)(.300L)(.450M) + (.425L)(.650M)}{.725L} = .753$

Answer: .753 M

Solubility and Precipitation:

7. Predict whether a precipitation reaction will occur in each of the following cases. If so, write a net ionic equation for the reaction.

a. $Na_2SO_{4(aq)} + MgCl_{2(aq)} \rightarrow$? No reaction Both Sodium chloride and magnesium sulfate are soluble

b. $(NH_4)_2S_{(aq)} + Cu(NO_3)_{2(aq)} \rightarrow$?

$Cu^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow CuS_{(s)}$

c. $K_2CO_{3(aq)} + ZnSO_{4(aq)} \rightarrow$?

$Zn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow ZnCO_{3(s)}$

8. Write a molecular, complete ionic and net ionic equation for the reaction between aqueous solutions of cupric sulfate and ammonium phosphate.

a. $3CuSO_{4(aq)} + 2(NH_4)_3PO_{4(aq)} \rightarrow Cu_3(PO_4)_{2(s)} + 3(NH_4)_2SO_{4(aq)}$

b. $3Cu^{2+}_{(aq)} + 3SO_4^{2-}{}_{(aq)} + 6NH_4^+{}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow$

c. $6NH_4^+{}_{(aq)} + 3SO_4^{2-}{}_{(aq)} + Cu_3(PO_4)_{2(s)}$

$3Cu^{2+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Cu_3(PO_4)_{2(s)}$

$MgCl_{2(aq)} + 2AgNO_{3(aq)} \rightarrow 2AgCl_{(s)} + Mg(NO_3)_{2(aq)}$

9. How much insoluble silver chloride can be formed from the reaction between 10.0mL of .01M magnesium chloride and 20.0mL of .01M silver nitrate?

mol $MgCl_2$ $(.010L)(.01\frac{mol}{L}) = .0001$ mol

mol $AgNO_3$ $(.020L)(.01\frac{mol}{L}) = .0002$ mol

Answer: ~.03g

Based on the mole ratio there is no limiting reagent.

$.0001 mol\ MgCl_2 \left(\frac{2\ mol\ AgCl}{1\ mol\ MgCl_2}\right) = .0002\ mol\ AgCl$

$.0002\ mol\ AgCl\ (143.32 g/mol) = .02866 g$

10. In a reaction between solutions of lithium sulfate and barium chloride, if 25.0mL of .050M lithium sulfate reacts with 25.0mL of the barium chloride solution to produce .263g of insoluble barium sulfate, what is the molarity of the original barium chloride solution (assume a 100% yield)? Is this a limiting reagent problem?

$Li_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow BaSO_{4(s)} + 2LiCl_{(aq)}$

$(.025L)(.050M) = 1.25\times10^{-3}$ mol

(.025L) $.263g/233.39 g/mol = 1.13\times10^{-3}$ mol

$1.13\times10^{-3} mol/.025L$

Answer: .045M. yes, it is limiting

only 1.13×10^{-3} mol out of 1.25×10^{-3} mol Li_2SO_4 is used.

Acid-Base Neutralization / Titration:

11. What is the concentration of HCl molecules in a 0.100M solution of HCl? Explain.

zero. HCl is a strong acid that completely dissociates. It is 0.100M in H^+ and 0.100 M in Cl^-

12. Write net ionic equations for the following neutralization reactions:

a. The strong base KOH and the weak acid $HC_2H_3O_2$.

$HC_2H_3O_{2(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + C_2H_3O_2^-{}_{(aq)}$

b. The strong base barium hydroxide and the strong acid perchloric acid.

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

c. The weak base methyl amine (CH_3NH_2) and the strong acid hydrobromic acid (HBr).

$CH_3NH_{2(aq)} + H^+_{(aq)} \rightarrow CH_3NH_3^+{}_{(aq)}$

13. How many milliliters of .015M barium hydroxide are required to titrate exactly 50.0mL of a .112M hydrochloric acid solution?

$2HCl_{(aq)} + Ba(OH)_{2(aq)} \rightarrow BaCl_{2(aq)} + 2H_2O_{(l)}$

$(.0500L)(.112 mol/L) = .00560$ mol HCl

$.00560\ mol\ HCl \left(\frac{1\ mol\ Ba(OH)_2}{2\ mol\ HCl}\right) = .0028\ mol\ Ba(OH)_2$

$.0028\ mol\ Ba(OH)_2 \left(\frac{1L}{.015 mol}\right) = .1867 L$

Answer: 187 mL

14. What is the molarity of a solution of hydroiodic acid if exactly 35.0mL of .010M lithium hydroxide is required to titrate 30.0mL of the acid solution to the equivalence point?

$HI_{(aq)} + LiOH_{(aq)} \rightarrow LiI_{(aq)} + H_2O_{(l)}$

$(.0350L)(.010M) = .00035$ mol

Reaction is 1:1 $M_{HI} = \frac{.00035 mol}{.0300L} = .011667 M$

Answer: .012 M

15. What is the difference between the equivalence point and the endpoint in a titration?

The equivalence point is when the correct ratio of acid & base have reacted. The endpoint is when an indicator changes color.

Chemistry
Redox Practice

redoxprac.doc

Name Key

Date _____ Period ____

1. Assign oxidation numbers to each element:

a. nitrogen dioxide (write formula) $\overset{+4}{N}\overset{-2}{O_2}$

b. ammonia (write formula) $\overset{-3}{N}\overset{+1}{H_3}$

c. sulfur hexafluoride (write formula) $\overset{+6}{S}\overset{-1}{F_6}$

d. dinitrogen pentoxide (write formula) $\overset{+5}{N_2}\overset{-2}{O_5}$

e. $\overset{-2}{N_2}\overset{+1}{H_4}$

f. $\overset{+6}{Cr_2}\overset{-2}{O_7^{2-}}$

g. $\overset{+7}{Cl}\overset{-2}{O_4^-}$

2. For the unbalanced equation given below

$$Ag_{(s)} + NO_3^-{}_{(aq)} \rightarrow Ag^+{}_{(aq)} + NO_{(g)}$$

a. write unbalanced half reactions.

$Ag_{(s)} \rightarrow Ag^+$ oxidation

$NO_3^-{}_{(aq)} \rightarrow NO_{(g)}$ reduction

b. identify the species oxidized and the species reduced. Ag is oxidized

N is reduced

c. identify the oxidizing and reducing agents.

Ag is the reducing agent.

NO_3^- is the oxidizing agent.

3. Write balanced equations for the following reactions in acid solution.

a. $Ni^{2+}{}_{(aq)} + IO_4^-{}_{(aq)} \rightarrow Ni^{3+}{}_{(aq)} + I^-{}_{(aq)}$

$(Ni^{2+} \rightarrow Ni^{3+} + 1e^-) \times 8$

$8e^- + 8H^+ + IO_4^- \rightarrow I^- + 4H_2O$

$8Ni^{2+} + 8H^+ + IO_4^- \rightarrow 8Ni^{3+} + I^- + 4H_2O$

b. $Ca_{(s)} + Cr_2O_7^{2-}{}_{(aq)} \rightarrow Ca^{2+}{}_{(aq)} + Cr^{3+}{}_{(aq)}$

$(Ca \rightarrow Ca^{2+} + 2e^-) \times 3$

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

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

$2CrO_2^- + 3ClO^- + 2OH^- \rightarrow 3Cl^- + 2CrO_4^{2-} + H_2O$

4. Write balanced equations for the following reactions in basic solution.

a. $SO_{2(g)} + I_{2(aq)} \rightarrow SO_{3(g)} + I^-{}_{(aq)}$

$+H_2O$

$2OH^- + H_2O + SO_2 \rightarrow SO_3 + 2H^+ + 2e^- + 2OH^-$

$2e^- + I_2 \rightarrow 2I^-$

$2OH^- + SO_2 + I_2 \rightarrow SO_3 + H_2O + 2I^-$

b. $ClO^-{}_{(aq)} + CrO_2^-{}_{(aq)} \rightarrow Cl^-{}_{(aq)} + CrO_4^{2-}{}_{(aq)}$

$(2e^- + 2H^+ + ClO^- \rightarrow Cl^- + H_2O) \times 3$

$(2H_2O + CrO_2^- \rightarrow CrO_4^{2-} + 4H^+ + 3e^-) \times 2$

$2OH^- + H_2O + 2CrO_2^- + 3ClO^- \rightarrow 3Cl^- + 2CrO_4^{2-} + 2H^+ + 2OH^- + H_2O$

5. Laws passed in some states define a drunk driver as one who drives with a blood alcohol level of 0.10% by mass or higher. The level of alcohol can be determined by titrating blood plasma with potassium dichromate according to the unbalanced equation

$16H^+{}_{(aq)} + 2Cr_2O_7^{2-}{}_{(aq)} + C_2H_5OH_{(aq)} \rightarrow 4Cr^{3+}{}_{(aq)} + 2CO_{2(g)} + 11H_2O$

Assuming that the only substance that reacts with dichromate in blood plasma is alcohol, is a person legally drunk if 38.94mL of 0.0723M potassium dichromate is required to titrate a 50.0g sample of blood plasma?

$(.03894L)(0.0723) = .0028$ mol dichromate

1:2 mole ratio $= .0014$ mol ethanol titrated

grams ethanol $= (.0014mol)(46.0689g/mol)$

$= .064g$ alcohol

$.064g/50.0g = .00128 = .128\%$

yes, the person is legally drunk

6. The iron content of hemoglobin is determined by destroying the hemoglobin molecule and producing small water soluble ions and molecules. The iron in the aqueous solution is reduced to iron(II) ion and then titrated against potassium permanganate. In the titration, iron(II) is oxidized to iron(III) and permanganate is reduced to manganese(II) ion. A 5.00g sample of hemoglobin requires 32.3mL of a 0.002100M solution of potassium permanganate. What is the mass percent of iron in hemoglobin?

$(Fe^{2+} \rightarrow Fe^{3+} + 1e^-) \times 5$

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

$5Fe^{2+} + 8H^+ + MnO_4^- \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$

$(.0323L)(.0021M) = 6.783 \times 10^{-5}$ mol MnO_4^-

mol Fe $= (6.783 \times 10^{-5})(5) = 3.39 \times 10^{-4}$ mol

$g = (3.39 \times 10^{-4})(55.845g/mol) = .01898$ Fe

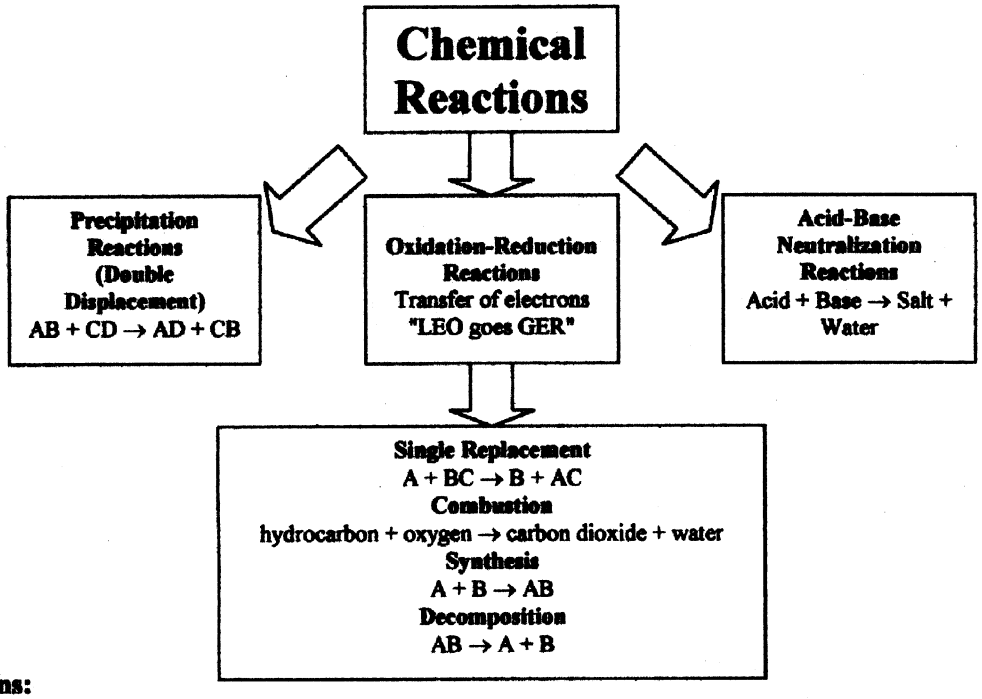
$(.0189g)/(5.00g) = .0038 = .38\%$

Chemistry

Reaction Types Worksheet chmrxnws.doc

Name Key Date _____ Period _____

Information:



Questions:

Balance and identify the chemical equations in the table below:

Balance	Types (List all that apply)	Element oxidized (if redox)	Element reduced (if redox)	Salt formed (if acid-base neutralization)	Precipitate (if double displacement)
$2Na + Br_2 \rightarrow 2NaBr$	Redox Synthesis	Sodium $0 \rightarrow 1+$	Bromine $0 \rightarrow 1-$		
$C_3H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$	Redox Combustion	Carbon $-2\frac{2}{3} \rightarrow 4+$	Oxygen $0 \rightarrow 2-$		
$2AgNO_3 + Na_2S \rightarrow Ag_2S + 2NaNO_3$	Double displacement (precipitation)				Silver Sulfide Ag_2S
$2Al_2O_3 \rightarrow 4Al + 3O_2$	Redox decomposition	Oxygen $2- \rightarrow 0$	Aluminum $3+ \rightarrow 0$		
$HMnO_4 + KOH \rightarrow KMnO_4 + H_2O$	Acid-base Neutralization			Potassium permanganate $KMnO_4$	

$16K + S_8 \rightarrow 8K_2S$	synthesis Redox	potassium $0 \rightarrow 1+$	Sulfur $0 \rightarrow 2-$		
$2Ca + O_2 \rightarrow 2CaO$	Synthesis Redox	Calcium $0 \rightarrow 2+$	Oxygen $0 \rightarrow 2-$		
$C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$	Redox Combustion	Carbon $\rightarrow 4+$	Oxygen $0 \rightarrow 2-$		
$(NH_4)_2CO_3 + MgCl_2 \rightarrow NH_4Cl + MgCO_3$	Double Displacement (precipitation)				Magnesium carbonate $MgCO_3$
$HBr + NaOH \rightarrow NaBr + H_2O$	Acid-base neutralization			Sodium Bromide NaBr	
$2AlCl_3 \rightarrow 2Al + 3Cl_2$	Decomposition (Redox)	Chlorine $1- \rightarrow 0$	Aluminium $3+ \rightarrow 0$		
$2H_2O_2 \rightarrow 2H_2O + O_2$ (Note: O is a 1- in hydrogen peroxide)	Decomposition (Redox)	Oxygen $1- \rightarrow 0$	oxygen $1- \rightarrow 2-$		
$2H_2 + O_2 \rightarrow 2H_2O$	Synthesis (Redox)	Hydrogen $0 \rightarrow 1+$	Oxygen $0 \rightarrow 2-$		
$2Al + 3CuBr_2 \rightarrow 3Cu + 2AlBr_3$	Single Replacement (Redox)	Aluminium $0 \rightarrow 3+$	Copper $2+ \rightarrow 0$		
$2AlN \rightarrow 2Al + N_2$	decomposition Redox	Nitrogen $3- \rightarrow 0$	Aluminium $3+ \rightarrow 0$		
$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$	Single Replacement (Redox)	copper $0 \rightarrow 2+$	silver $1+ \rightarrow 0$		