Name: KEY Section: _____

CHM 151 Exam 3: Chapters 3 and 4

You must show all work to receive credit. Clearly mark your final answer!

1. Balancing equations when products are given:

   a. $\underline{2}\ CrF_3\,(aq) + \underline{3}\ H_2SO_4\,(aq) \rightarrow \underline{6}\ HF(aq) + \underline{1}\ Cr_2(SO_4)_3\,(aq)$

   b. $\underline{\frac{4}{2}}\ NH_3\,(g) + \underline{5}\ O_2\,(g) \rightarrow \underline{4}\ NO\,(g) + \underline{\frac{6}{3}}\ H_2O\,(g)$

2. How many hydroxide ions are present in 22.6g of aluminum hydroxide?

   Al^{3+} OH^- $Al(OH)_3$ $26.98\ g/mol + 3\times(15.9994\ g/mol) + 3(1.0079\ g/mol)$

   $= (26.989\ g/mol + 47.998\ g/mol + 3.0238\ g/mol)$

   $= 78.002\ g/mol$

   $22.6\ g\ Al(OH)_3 \times \frac{1\ mol}{78.002\ g/mol} = 0.2897\ mol\ Al(OH)_3$

   $0.2897\ mol\ Al(OH)_3 \times \frac{3\ OH^-}{Al(OH)_3} = 0.8692\ mol\ OH^- \times \frac{6.0221\times10^{23}}{mol}$

   $= 5.23\times10^{23}\ OH^-$ ions

3. List the 7 common strong acids. Give both the name and the formula of each acid

   HCl hydrochloric acid

   HBr hydrobromic acid

   HI hydroiodic acid

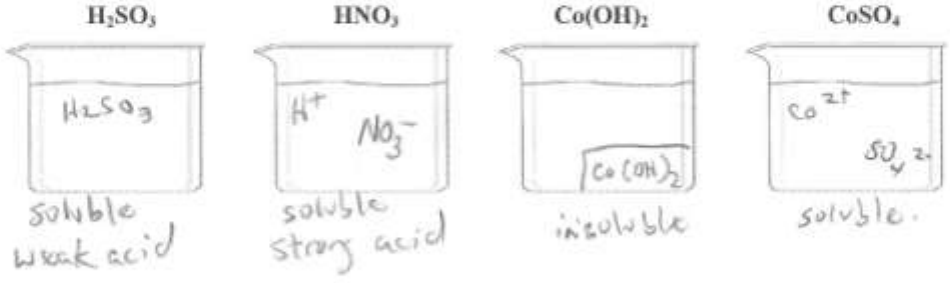
   HNO_3 nitric acid

   H_2SO_4 sulfuric acid

   $HClO_3$ chloric acid

   $HClO_4$ perchloric acid

4. Draw what 1 formula unit of each compound would look like if placed in its beaker of water.



Name: _____ Section: _____

5. A student is asked to combine sodium sulfide and hydrochloric acid solutions in a lab experiment. Complete the molecular equation with reactants and products (including phases) and balancing. Then write the complete ionic and net ionic equations for this reaction. Identify the spectator ions.

Molecular: $1\ Na_2S_{(aq)} + 2\ HCl_{(aq)} \rightarrow 1\ H_2S_{(g)} + 2\ NaCl_{(aq)}$

Ionic: $2Na^+_{(aq)} + S^{2-}_{(aq)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow H_2S_{(g)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$

Net Ionic: $S^{2-}_{(aq)} + 2H^+_{(aq)} \rightarrow H_2S_{(g)}$

Spectators: $Na^+_{(aq)} + Cl^-_{(aq)}$

6. For the following reactants,

a) Determine what type of reaction will occur, indicating all that apply
   - Combination (C), Decomposition (D), Single-replacement (SR), Combustion (B), Double-Replacement/Precipitation (P), Acid-Base Neutralization (AB), or No Reaction (NR)

b) Predict the product(s) of the reaction

c) Write correct phases of the product(s)

d) Balance the equation

Reaction Type	Reactants	Products
C	$Cl_2(g) + 2\ Ag(s) \rightarrow$	$2\ AgCl_{(s)}$
SR	$3\ Zn(s) + 2\ CrCl_3(aq) \rightarrow$	$3\ ZnCl_{2(aq)} + 2\ Cr_{(s)}$
NR	$Zn(s) + H_2O(aq) \rightarrow$	NR – Zn is not active enough
P	$Hg(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow$	$2\ NaNO_{3(aq)} + HgSO_{4(s)}$

7. Identify the oxidation number of **each element** in the following substances. Write each oxidation number above the element it corresponds to in the formula.

a) H_2CrO_4 (+1 +6 -2)

$2H + Cr + 4O = 0$

$2(+1) + Cr + 4(-2) = 0$ $\quad Cr = +6$

b) AlH_4^- (+3 -1)

$Al + 4(H) = -1$

$Al + 4(-1) = -1$

$Al = +3$

8. In the following equation, identify the a) species being reduced, b) species being oxidized, c) reducing agent, and d) oxidizing agent.

$\overset{+1\ -1}{LiCl}_{(s)} + \overset{0}{Fe}_{(s)} + \overset{0}{H_2}_{(g)} \rightarrow \overset{+1\ -1}{2\ LiH}_{(s)} + \overset{+2\ -1}{FeCl_2}_{(s)}$

Oxidized: Fe Oxidizing agent: H_2

Reduced: H_2 Reducing agent: Fe

Li^+ no change $\quad Fe \rightarrow Fe^{2+} + 2e^-$ oxidized

$e^- + H \rightarrow H^-$ reduced

Name: _____ Section: _____

9. In lab you prepare aqueous solutions of NaOH and $FeCl_2$, mix them in a beaker and separate the precipitate. The formula weights of all reactants and products are given.

	2 NaOH (aq) +	$FeCl_2$ (aq) →	$Fe(OH)_2$ (s) +	2 NaCl (s) typo, (aq)
Mol	4.500 mol	3.500 mol	0.00g	0.00g
FW	40.00 g/mol	126.76 g/mol	89.87g/mol	58.44 g/mol

greatly shortened + simplified!!

a) Determine the theoretical mass of the precipitate formed if 4.500 mol of NaOH are reacted with 3.500 mol of $FeCl_2$. Show all work clearly. You do not need to figure out how much of the other product is formed or how much of the excess reagent is left over. You can do that if you want to show off.

Limiting

$$4.500 \text{ mol NaOH} \times \frac{1 \text{ Fe(OH)}_2}{2 \text{ NaOH}} = 2.25 \text{ mol Fe(OH)}_2$$

$$3.500 \text{ mol } FeCl_2 \times \frac{1 \text{ Fe(OH)}_2}{1 FeCl_2} = 3.5 \text{ mol Fe(OH)}_2$$

$$2.25 \text{ mol Fe(OH)}_2 \times 89.87 \text{ g/mol} = 202. \text{ g Fe(OH)}_2$$

b) Indicate which reagent is the limiting reagent. NaOH

$FeCl_2$ is in excess

Name: _____ C_6H_{14} should be formula Section: _____

10. Find the empirical formula of cyclohexane (just another really cool hydrocarbon) if it contains 83.625% carbon and also contains hydrogen.

$$83.625\ \text{g C} \times \frac{1\ \text{mol}}{12.011\ \text{g}} = 6.9624\ \text{mol C}$$

$$16.375\ \text{g H} \times \frac{1\ \text{mol}}{1.0079\ \text{g}} = 16.247\ \text{mol H}$$

$$\frac{C_{6.9624}H_{16.247}}{6.9624} = C_1H_{2.33} \quad (\times 3) = C_3H_7$$

Bonus. You place 50.0 mL of hydrochloric acid of unknown concentration in a beaker and add 23.6 mL of 0.1012 M calcium hydroxide to it to reach the endpoint of the reaction. Balance the equation. What is the concentration of the acid?

$$2HCl_{(aq)} + Ca(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + CaCl_{2(aq)}$$

	$2HCl_{(aq)}$	$Ca(OH)_{2(aq)}$
V	0.0500 L	0.0236 L
M	0.0955 mol/L	0.1012 mol/L
# mol	0.004777 mol	0.002388 mol

$$0.0236\ \text{L} \times 0.1012\ \frac{\text{mol}}{\text{L}} = 0.002388\ \text{mol } Ca(OH)_2$$

$$0.002388\ \text{mol } Ca(OH)_2 \times \frac{2HCl}{Ca(OH)_2} = 0.004777\ \text{mol}$$

$$\frac{0.004777\ \text{mol}}{0.0500\ \text{L}} = 0.095528\ \frac{\text{mol}}{\text{L}}$$