City College, Chemistry Department
Chemistry 10301, sections T, T2, T3, Prof. T. Lazaridis
First Midterm exam, Oct. 2, 2007
Name (last name first): _____
I.D. Number: _____
Workshop leader: _____

Note: There are 7 questions in this exam (check both sides of the sheet).
Fill in your answer in the blank space provided immediately following each question. Half a point will be subtracted every time you report a numerical result with an incorrect number of significant figures. A copy of the periodic table is attached. Good luck!

1. a. (4) What is the chemical formula of aluminum hydroxide?

$Al(OH)_3$

b. (4) What is the name of the compound CH_3OH ?

methanol

c. (4) How many protons and electrons does the chloride ion have?

17 protons, 18 electrons

d. (4) What is the molar mass of NaOH ?

22.99 + 16.00 + 1.008= 40.00

e. (4) Give the atomic symbol of the elements:

silicon: **Si**

silver: **Ag**

titanium: **Ti**

potassium: **K**

2. Write a balanced equation for each of the following reactions (it is not necessary to indicate the states of each substance):

a. (6) Burning of acetone (CH_3COCH_3) in oxygen

$CH_3COCH_3 + 4\ O_2$ ----> $3\ CO_2$ + $3\ H_2O$

b. (6) Sodium metal reacts with water to give hydrogen gas and sodium hydroxide.

$2\ Na + 2\ H_2O$ ----> $H_2 + 2\ NaOH$

3. Balance the following chemical equations:

a. (6) $Pb(NO_3)_2\ (aq)$ + **2** $KCl\ (aq)$ -----> $PbCl_2\ (s)$ + **2** $KNO_3\ (aq)$

b. (6) **2** $NaBr\ (aq)$ + $Cl_2\ (aq)$ -----> **2** $NaCl\ (aq)$ + $Br_2\ (aq)$

c. (6) $P_4O_{10}\ (s)$ + **6** $H_2O\ (l)$ -----> **4** $H_3PO_4\ (aq)$

4. (15) Caustic soda (NaOH) is prepared commercially by passing an electric current through a concentrated solution of sodium chloride in water:

$$2NaCl\,(aq) + 2\,H_2O \text{ -----> } 2NaOH\,(aq) + H_2(g) + Cl_2(g)$$

(a) (10) Calculate the theoretical yield of caustic soda if 125 Kg of NaCl is electrolyzed.

Molar mass of NaCl = 22.99+ 35.45= 58.44 and of NaOH= 40.00 g/mol
125 X 10^3 g NaCl/ 58.44 (g/mol) = 2.14 X 10^3 mol
This will produce 2.14 X 10^3 mol NaOH X 40.00 g/mol = 85.6 Kg

(b) (5) Calculate the percent yield if the electrolysis in part (a) produces 55.4 Kg of caustic soda.

55.4/85.6 X 100% = 64.7 %

5. (15) The following reaction occurs when aluminum is heated with oxygen:

$$4\,Al\,(s) + 3\,O_2\,(g) \text{ -----> } 2Al_2O_3\,(s)$$

A reacting mixture contains 50.0 Kg of Al and 50.0 Kg of oxygen.

a) (5) Find the limiting reactant

50.0 X 10^3 g Al / 26.98 (g/mol) = 1.85 X 10^3 mol Al
50.0 X 10^3 g O_2 / 32.00 (g/mol) = 1.56 X 10^3 mol O_2
1.85 X 10^3 mol Al requires 1.85 X 10^3 * ¾ = 1.39 X 10^3 mol O_2.
We have 1.56 X 10^3 , so O_2 is in excess
=> Al is limiting.

b) (5) How many grams of aluminum oxide will form ?

Molar mass of Al_2O_3 is 2X26.98 + 3X 16.00 = 101.96 g/mol
1.85 X 10^3 mol Al will react with 1.39 X 10^3 mol O_2 to form
1.85 X 10^3 X 2/4 = 0.925 X 10^3 mol Al_2O_3 * 101.96 g/mol
= 94.3 X 10^3 g Al_2O_3

c) (5) How many grams of excess reactant will remain?

(1.56-1.39) X 10^3 = 0.17 X 10^3 mol O_2 X 32.00 g/mol = 5.44 X 10^3 g O_2

6. (10) Calculate the percentage composition in the compound oxalic acid ($H_2C_2O_4$).

Molar mass: 2X1.008 + 2X12.01 + 4X16.00 = 90.04 g/mol

H: 2X1.008 / 90.04 X 100% = 2.239 %

C: 2X12.01 / 90.04 X 100% = 26.68 %

O: 4X16.00 / 90.04 X 100% = 71.08 %

7. (10) Calculate the empirical formula of the compound formed when 6.58 g of nitrogen combines with 1.42 g of hydrogen.

N: 6.58 / 14.01 = 0.470 mol divide by smallest /0.470 = 1
H: 1.42 / 1.008= 1.41 mol /0.470 = 3

So empirical formula is NH_3