CHEM 0094 Final Exam   Student:_____

                                            Instructor: _____

Fall 2001

Time: 3 Hours

INSTRUCTIONS:

Answer in the spaces provided.
Rough work may be done on the back of the pages.
All work must be shown to receive credit.
There must be a strict adherence to independent work.
A periodic table is provided.
Ensure that this exam has 12 pages (including periodic table), 16 questions and a bonus question.

USEFUL INFO:

Avogadro's number = 6.022×10^{23} mole^{-1} $T(°F) = 1.8 \times T(°C) + 32$
                                                               $T(K) = T(°C) + 273$

SOLUBILITY RULES:

ION:	RULE:
Group IA NH_4^+	All ionic compounds in which the cation is a Group IA element or NH_4^{1+} are soluble.
NO_3^{1-}	All nitrates are soluble.
Cl^-, Br^-, I^-	All halides are soluble except those of Ag^+, Cu^+, and Pb^{2+}
SO_4^{2-}	All sulphates are soluble except for $CaSOP_4$, $SrSO_4$, $BaSO_4$, $PbSO_4$, and Ag_2SO_4
S^{2-}	All sulphides are insoluble except those of the Group IA or IIA elements or NH_4^+

ACTIVITY SERIES OF THE METALS:

Li K Ba Na Mg Al Zn Fe Cd Ni Sn Pb (H) Cu Hg Ag Au
Most Reactive   Least Reactive

1) **(3 marks)** Complete the following mathematical operations. Your answer should be in scientific notation and have the correct number of significant figures and units:

a) $(1.075 \times 10^{-3}$ m$) \times (3.08 \times 10^2$ cm$) = $ _____

b) $(0.0385 \times 10^2$ g$) + (1.05 \times 10^{-1}$ g$) = $ _____

c) $(3.5 \times 10^3$ m/s$) / (7.500$ m$) = $ _____

2) a) **(2 marks)** A can of paint contains 4.00 gallons of paint. You can paint 100. m^2 of wall with this one can of paint. How thick will be the layer of paint on the walls? 1 gallon = 4.546 L

b) **(2 marks)** Show which is colder, -49°C, -49°F, or 200 K?

3) **(2 marks)** A platinum ring, mass 9.50 g, is dropped in to a graduated cylinder containing 21.15 mL of water. The density of platinum is 21.45 g/cm^3. What does the volume in the graduated cylinder read after the ring has been added?

4) **(3 marks)** The same platinum ring is heated to a temperature of 125.0 °C. It is dropped into an insulated container of water at 15.00°C. The final temperature of the water was 15.73°C. What mass of water was in the container? Assume all heat lost by the platinum is gained by the water.

specific heat of water is 4.184 J/g°C

specific heat of platinum is 0.132 J/g°C

5) **(8 marks)** Complete the following:

    a) the symbol of an element that is a gas at room temperature is: _____

    b) the symbol of an element that is a transition metal is: _____

    c) the symbol of an element that is a halogen is: _____

    d) the name of the group of elements that contains Na is: _____

    e) the number of protons in an atom of phosphorus is: _____

    f) the number of neutrons in an atom of ^{84}Kr is: _____

    g) the complete symbol for the atom/ion that has, 20 protons, 20 neutrons and

       18 electrons is: _____

    h) the number of electrons in an ion of oxygen (O^{2-}) is: _____

6) **(1 mark each)** Provide names or formulas for:

a) P_4O_7 _____

b) Cu_2CO_3 _____

c) $H_2SO_3(aq)$ _____

d) $CoCl_2 \cdot 6H_2O$ _____

e) Mg_3N_2 _____

f) dinitrogen pentoxide   _____

g) barium nitrite   _____

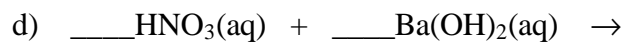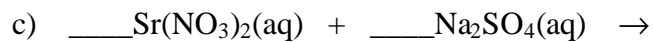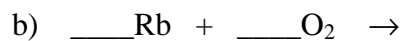h) aluminum chloride   _____

i) carbon tetrabromide   _____

h) hydrosulphuric acid   _____

7) **(1.5 each)** Predict the formulas of the compound that forms between:

a) K and N_2

b) Ca and F_2

8) **(2 marks each)** Complete and balance the equations below: (a reaction occurs in each case)

a) ____C_2H_6O + ____O_2 →

b) ____Rb + ____O_2 →

c) ____$Sr(NO_3)_2(aq)$ + ____$Na_2SO_4(aq)$ →

d) ____$HNO_3(aq)$ + ____$Ba(OH)_2(aq)$ →

e) ____Li(s) + ____$H_2O(l)$ →

9) **(1 mark each)** Question 9 refers to the reactions in question 8:

a) Which reaction(s) is(are) oxidation-reduction reactions: _____

b) What are the spectator ions for reaction c): _____

c) What type of reaction is reaction d): _____

d) Which reaction is a combustion: _____

e) What is the net ionic equation for reaction d):

10) The compound Seconal is a barbiturate. Barbiturates are useful for pain relief but have the serious drawbacks that they tend to be highly addictive and easy to overdose. Seconal has the following percent composition (by mass):

60.49% C   7.61% H
11.76% N   20.15% O

a) **(3 marks)** Determine the empirical formula of Seconal

b) **(2 marks)** Seconal is insoluble in water but it is easily dissolved in alcohol. Determine the concentration (in mol/L) of a solution prepared by dissolving 0.250 g of Seconal in enough alcohol to make 250.0 mL of solution. The molar mass of seconal is 238.29 g/mol.

c) **(1 mark)** For this solution the solute is _____ and the solvent is

_____.

11) Astaxanthin is the compound responsible for the pink colour of cooked shellfish such as shrimp and lobster. The empirical formula of astaxanthin is $C_{10}H_{13}O$.

a) **(1 mark)** A 0.0125 mole sample of astaxanthin was determined to have a mass of 7.46 g. Determine the molar mass of astaxanthin.

b) **(2 marks)** Determine the molecular formula of astaxanthin.

12) Isopentyl acetate, $C_7H_{14}O_2$, is a compound used in synthetic banana flavouring.

a) **(1 mark)** Determine the molar mass of isopentyl acetate.

b) **(1 mark)** What mass of isopentyl acetate would contain 0.084 moles of carbon?

c) **(2 marks)** How many H atoms are there in 7.83 x 10^{-4} g of isopentyl acetate?

d) **(2 marks)** If 725. mg of isopentyl acetate was combusted in excess oxygen, what mass of water would be produced?

13) The reaction that occurs with the drain cleaner, Draino, is:

$$2Al(s) \ + \ 2NaOH(aq) \ + \ 6H_2O(l) \ \rightarrow \ 2NaAl(OH)_4(aq) \ + \ 3H_2(g)$$
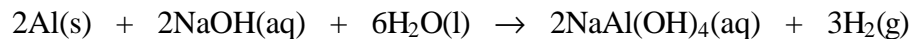
a) **(3 marks)** What mass of NaOH is required to react with 5.0 g of aluminum in the presence of excess water?

b) **(2 marks)** What mass of H_2 could be produced by the reaction of 5.0 g Al?

c) **(3 marks)** What mass of $NaAl(OH)_4$ (molar mass 118.0 g/mol) will be produced if the reaction proceeds with a 68.9% yield?

d) **(1 mark)** What safety precautions (and why) should you take when using Draino?

14) Chlorine can be prepared by the reaction: (Use back of paper for rough work and circle the correct answers.)

$$MnO_2(s) + 4HCl(aq) \rightarrow Cl_2(g) + MnCl_2(aq) + 2H_2O(l)$$
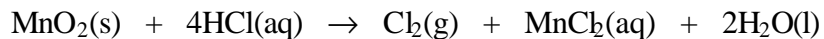
Molecular masses in amu are:

MnO_2 86.9   HCl   36.5 $MnCl_2$ 125.8 Cl_2 70.9 H_2O 18.02

a) **(1 mark)** How many grams of Cl_2 can be produced from 25.0 g of MnO_2? Assume HCl is present in excess.

i) 0.0326 g   ii) 10.2 g   iii) 20.4 g   iv) 30.6 g   v) 246 g

b) **(1 mark)** How many moles of HCl are required to react with 25.0 g of MnO_2?

i) 1.15   ii) 3.48   iii) 10.5   iv) 13.9   v) 42.0

c) **(2 marks)** How many moles of Cl_2 can be prepared from 0.75 mol of MnO_2 and 2.0 mol of HCl?

i) 2.0   ii) 1.3   iii) 1.0   iv) 0.75   v) 0.50

d) **(2 marks)** If 0.75 mol of MnO_2 and 2.0 mol of HCl are used, how many moles of which reactant will be left over?

i) 1.3 mol HCl   ii) 0.75 mol HCl   iii) none of either

iv) 0.25 mol MnO_2 v) 0.50 mol MnO_2

15) A sulphuric acid (H_2SO_4(aq)) solution has a molarity of 4.50 M, and a density of 1.26 g/mL.

a) **(2 marks)** Convert this concentration to % by mass.

b) **(2 marks)** If 15.00 mL of this acid solution is diluted with water to a total volume of 500.0 mL what is the concentration of the diluted solution?

16) A 10.00 mL sample of phosphoric acid was titrated with 17.94 mL of 0.520 M NaOH. The balanced chemical equation for the reaction of phosphoric acid with sodium hydroxide is:

$$H_3PO_4(aq) \ + \ 3NaOH(aq) \ \rightarrow \ Na_3PO_4(aq) \ + \ 3H_2O(l)$$
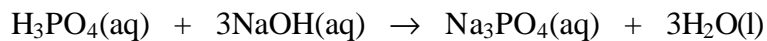
a) **(2 marks)** Determine the concentration of the phosphoric acid sample in moles/L.

b) **(2 marks)** If the density of the acid solution is the same as that of water (1.00 g/mL), what is the percent by mass of H_3PO_4 in the acid?

Bonus Question: **(4 marks)**

Four solutions were prepared in the lab, but unfortunately were left unlabelled. You were given the task of identifying the four solutions so that they may be properly labeled. You label the four unknown solutions 1,2,3 and 4, and observe what happens when combining each with a small piece of Mg metal and with $BaCl_2$ solution. Your tabulated observations are given below. You know that the four solutions are: hydrochloric acid, sulphuric acid, copper(II) sulphate and sodium carbonate. Identify which solution is which.

Unknown	Observations when combined with Mg metal	Observations when combined with BaCl₂ solution
1 clear and colourless	solution bubbles	no change
2 clear and colourless	no change	white precipitate forms
3 clear blue solution	no change	white precipitate forms
4 clear and colourless	solution bubbles	white precipitate forms