Chemistry 105-Fundamental Chemistry
Exam 2-Tuesday, 4 November 1997

Name_____
Laboratory Section _____
ID Number_____

PLEASE ANSWER IN THE SPACE PROVIDED. SHOW **ALL** WORK WHEREVER POSSIBLE-ESPECIALLY STOICHIOMETRIC FACTORS AND UNIT CONVERSIONS. THERE WILL BE ABSOLUTELY NO TALKING DURING THIS EXAM PERIOD. IF YOU HAVE A QUESTION, RAISE YOUR HAND. IF YOU FINISH EARLY, BRING YOUR EXAM TO ME AND LEAVE QUIETLY. DURING THE LAST TEN MINUTES OF THE EXAM PERIOD, DO NOT LEAVE YOUR SEAT AND DO NOT SPEAK TO OTHERS UNTIL ALL PAPERS HAVE BEEN COLLECTED. INITIAL EACH PAGE SO THAT IF THE PAGES BECOME SEPARATED I CAN PIECE YOUR EXAM BACK TOGETHER. USE A PEN. FILL YOUR STUDENT ID NUMBER IN THE SPACE PROVIDED. GOOD LUCK.

Selected equations, constants, and information:

$M_1V_1=M_2V_2$, $PV = nRT$, $1J = 1\ kg\ m^2\ s^{-2}$, 4 qts = 1 gal, 1.057 qts = 1L, 4.184 J = 1 cal, 2.54 cm = 1 in, 2000 lbs = 1 ton, 5280 ft = 1 mile, 453.6g = 1.00lb, 12 = dozen, 101.325 kps = 1 atm, 1.00 troy oz. = 1.10 avoirdupois [ordinary] oz., 16.0 avoirdupois oz. = 1.00 avoirdupois pound, R=0.08206L atm/K mol, 1atm=29.92 in=760torr=760mm Hg

Soluble compounds	**Insoluble compounds**
compounds of Group 1 elements	carbonates, chromates, and phosphates, **except** those of the Group 1 elements and NH_4^+
ammonium compounds	sulfides, **except** those of the Group 1 and 2 elements and NH_4^+
chlorides, bromides, and iodides, **except** those of Ag^+, Hg_2^{2+}, and Pb^{2+}*	hydroxides and oxides, **except** those of the Group 1 and 2 elements**
nitrates, acetates, chlorates, and perchlorates	
sulfates, **except** those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Hg_2^{2+}, and Ag^+***	

*$PbCl_2$ is slightly soluble.
**$Ca(OH)_2$ and $Sr(OH)_2$ are sparingly (slightly) soluble; $Mg(OH)_2$ is only very slightly soluble.
***Ag_2SO_4 is slightly soluble.

Part I. Vocabulary (10pts) Place the most appropriate term in the space provided.

In a typical acid-base _____, the base is slowly added from a _____ to an acidic solution. In this case, the base is termed the _____ and the acid the _____. Often an _____ will be used to show the point at which a complete reaction has taken place. When the color of this compound changes, it signals the _____ of the titration. This point should not be confused with the _____ point, the stage at which the volume of titrant added is exactly that required by the _____ relationship between the reactants. If too much base were added such that an excess of this reactant were present, no useful information could be gleaned from this procedure. Likewise, if the true concentration of the base were unknown, error would be introduced. One way to remedy this is to _____ the base against a _____ such as potassium hydrogen phthalate, (KHP).

Part III. Problems (65pts)

1. (10pts) The surface atoms of aluminum metal corrode in air to form an impervious aluminum oxide coating that prevents further corrosion of the lower layers of atoms. The oxidation reaction is

$$4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$$

(a) Calculate the mass of aluminum oxide formed from the corrosion of 10.0 g of aluminum. (b) In the reaction of 10.0 g of aluminum, what mass of oxygen is needed?

2. (15pts) If a magnesium hydroxide solution (200.0 mL, 0.563 M) were added to a solution of ammonium carbonate (255 mL, 0.713 M) what would be the result? For full credit, give (a) the complete, balanced chemical equation; (b) the net ionic equation; (c) the mass of all products formed; (d) the amount of excess reactant remaining; and (e) identify the limiting reactant.

3. (10pts) A 9.670-g sample of barium hydroxide is dissolved and diluted to the mark in a 250.0-mL volumetric flask. It was found that 11.56 mL of this solution was needed to reach the stoichiometric point in a titration of 25.00 mL of a nitric acid solution. (a) Calculate the molarity of the HNO_3 solution. (b) What mass of HNO_3 is in solution?

4. (10pts) In a titration, a 3.25-g sample of an acid, HX, requires 68.8 mL of a 0.750 M $NaOH_{(aq)}$ solution for complete reaction. What is the molar mass of the acid?

5. (5pts) A helium balloon has a volume of 22.0 L at sea level, where the atmospheric pressure is 0.951 atm. Upon release, the balloon ascends to an altitude where the atmospheric pressure is 375 torr and the temperature of −5.0 °C whereupon the balloon bursts. If the temperature at sea level was a balmy 28 °C, what was the volume of the balloon upon bursting?

6. (15pts) Hydrogen can be made in the "water gas reaction."

$$C_{(s)} + H_2O_{(g)} \longrightarrow H_{2(g)} + CO_{(g)}$$

If you begin with 250 L of gaseous water at 120 ˚C and 2.00 atm pressure, and 150.6754g of carbon, how many liters of H_2 can be made?

Part III. Laboratory (25pts)

A student follows the procedure outlined below and obtains the data given in the table.

PROCEDURE

1. Check out another crucible from the stockroom and thoroughly wash your crucibles and lids and rinse with distilled water . After it has been cleaned, handle both parts only with tongs. (Cleaning two crucibles will allow you to run $BaCl_2 \cdot 2H_2O$ and your unknown (see number 7) simultaneously.)

2. Adjust a Bunsen burner to give a sharp, rustling blue flame. Place the crucible with lid slightly ajar on a clay triangle which in turn is supported by an iron ring on a ring stand. Heat the crucible and lid with the burner, gently at first.. Then heat strongly for about 5 minutes. Hold the base of the burner in your hand and "play" the tip of the inner blue cone of the flame over the entire surface of the crucible and its lid. Before removing the burner, place the lid on the crucible with tongs. Using tongs, transfer the crucible and lid to a clean, dry wire gauze and allow it to cool to room temperature (10-15 minutes). When the crucible is cool, it must be handled only with tongs. Transport the crucible and lid to the balance in a clean, dry 250 mL beaker.

   Note: use the same balance for all mass determinations.

   Weigh the cooled crucible and lid on the electronic balance (±0.001 g). Record the weight in the space provided on the Report Form. Repeat the heating, cooling, and weighing procedure until the weight of the crucible and lid is constant to within 5 mg (±0.005 g).

3. Weigh (on weighing paper or in a small beaker) between 0.8 and 1.0 gram of barium chloride ($BaCl_2 \cdot 2H_2O$). Transfer all the $BaCl_2 \cdot 2H_2O$ to the crucible, reweigh the crucible and lid on the electronic balance, and record this weight on the Report Form.

4. Place the crucible on the clay triangle with the lid slightly ajar. Heat for no more than 5 minutes total. Begin to heat gently at first and then increase the heating so as to heat the bottom and sides as strongly as possible. After 2-3 minutes, set the lighted burner directly under the crucible. With tongs, carefully lift the lid, and with a clean glass stirring rod, cautiously and gently stir the contents of the crucible to break up any lumps. Be careful not to cause the loss of any material in the crucible by spilling, spattering or transfer on the rod. RECORD your observations concerning the behavior of the hydrate upon heating (color changes, appearance of solid, etc.) Before removing the burner, place the lid on the crucible with tongs.

5. Allow the crucible, lid and its contents to cool to room temperature on a wire gauze (keep the lid on to prevent reabsorption of water) and weigh it on the electronic balance. Record the weight on the Report Form. Reheat the crucible, lid and contents a second time; cool and reweigh. If the two weights are not within 5 mg of each other, repeat the heating, cooling, and weighing until two successive weighings are constant within 5 mg.

6. Calculate the weight of the sample and its loss of weight upon heating. Calculate the percentage of water in your sample. Now calculate the theoretical percentage of water in $BaCl_2 \cdot 2H_2O$ and compare with the value which you determined experimentally. If the two values are different, suggest possible explanations for the differences. Calculate the percent error (difference) from the theoretical value.

7. Obtain a sample of an unknown hydrate from your laboratory instructor. Using approximately the same mass of unknown as $BaCl_2 \cdot 2H_2O$ and the above procedure, determine the percentage of water in your unknown. Also, record your observations of the unknown upon heating.

Note: discard all dehydrated solids in the waste container.

A. Data

Unknown # _____

	$BaCl_2 \cdot 2H_2O$	**Unknown**
l. Weight of crucible and lid		
a. after lst heating.....	_____	_____
b. after 2nd heating.....	_____	_____
c. after 3rd heating (if necessary).....	_____	_____
d. after 4th heating (if necessary).....	_____	_____
2. Weight of crucible, lid and sample.....	_____	_____
3. Weight of sample.....	_____	_____
4. Weight of crucible, lid and residue		
a. after lst heating.....	_____	_____
b. after 2nd heating.....	_____	_____
c. after 3rd heating (if necessary).....	_____	_____
d. after 4th heating (if necessary).....	_____	_____
5. Weight of water in sample.....	_____	_____

1. Calculate the percentage of water observed to be present in the student unknown hydrate

2. What is the purpose of heating the hydrate two or more times?

3. Suppose a compound, after all the water has been removed, decomposes further giving off a gas. Would this cause the calculated percentage of water to be too high or too low? Explain.

4. If a customer purchases l0.0 kilograms of washing soda ($Na_2CO_3 \cdot 10H_2O$) at a store, how many kilograms of water has the customer purchased?

5. The formula weight of a particular hydrate of sodium phosphate, Na_3PO_4, is 380 gram/mole. How many moles of water are in the hydrate per mole of Na_3PO_4?