City College, Chemistry Department
Chemistry 10301, sections L and L2, Prof. T. Lazaridis
Second Midterm exam, Nov. 6, 2001
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. One point will be subtracted every time you report a numerical result with an incorrect number of significant figures. The last sheet of this exam contains information that may or may not be needed to answer these questions.

Useful data: R=0.0821 atm L/mol K = 8.3145 J/mol K

1. (20) a. (5) What will we obtain by adding $CaCO_3$ to water?
(Use information provide on your data sheet)

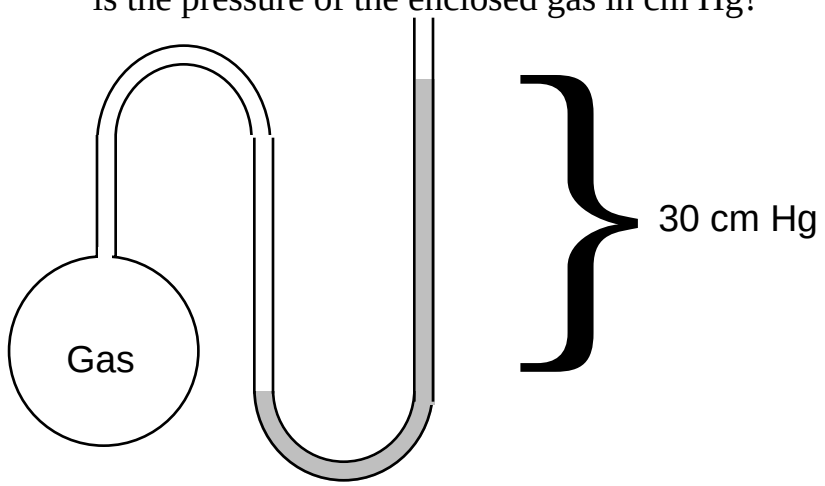
Solution <u>Heterogeneous Mixture</u>

($CaCO_3$ is insoluble)

b. (5) A chemical analysis reports that a sample of water contains 8 ppm of lead. How many grams of lead are in one liter of this water ? (Density of water: 1g/ml)
8 ppm = x g lead / (1000 ml * 1 g/ml) => x = 0.008 g Pb

c. (5) How many ml of 3.0 M H_2SO_4 are required to make 450 ml of 0.10 M H_2SO_4 ?
VcMc = VdMd => Vc = Vc Md/Mc = 450 ml 0.10 M/3.0 M = 15 ml

d. (5) In the picture below, if the atmospheric pressure is 0.9 atm, what is the pressure of the enclosed gas in cm Hg?



0.9 atm * 76 cm Hg / atm + 30 cmHg = 98 cm Hg

2. (15) We need to generate 5.0 L of oxygen (at 25 ^oC and 1 atm) by the following reaction:

$$2KClO_3\ (s) \text{ ------> } 2KCl\ (s) + 3O_2\ (g) \qquad \Delta H = -89.4\ kJ$$

a. (10) How many moles of reactant do we need ?

n = PV/RT = 1 atm 5 L / 0.0821 (atm L/mol K) 298.15 K = 0.20 mol

0.20 mol O_2 X 2/3 = 0.14 mol $KClO_3$

b. (5) How much heat will be released, if the reaction takes place at constant pressure?

89.4 kJ X 0.14 /2 = -6.3 kJ

3. (10) What is the standard enthalpy of the following reaction at 25 ^oC:

$$2SO_2\ (g) + O_2\ (g) \text{ ----> } 2SO_3\ (g)$$

(Hint: use information on your data sheet)

Using enthalpy of formation data:

ΔH = 2(-395.7 kJ/mol) - 2(-296.8 kJ/mol) = -197.8 kJ/mol

4. (15) When a 6.50 g sample of solid sodium hydroxide dissolves in 100.0 g of water in a coffee-cup calorimeter, the temperature rises from 21.6 ^{o}C to 37.8 ^{o}C. Calculate ΔH in kJ/mol for the solution process:

$$NaOH\ (s) \text{-------}> Na^{+}(aq) + OH^{-}\ (aq)$$

Assume that the specific heat of the solution is the same as that of pure water. Use information on your data sheet.

Molar mass of NaOH: 22.99 + 16.00 + 1.008 = 40.00

6.50 g/ 40.00 (g/mol) = 0.163 mol

Total mass of solution : 100.0 + 6.5 = 106.5 g

Specific heat (use the value at 25 ^{o}C, which is closest to the given range) : 4.179 J/g ^{o}C

Heat for 0.163 mol : 106.5 g * 4.179 J/g ^{o}C * (37.8 -21.6 ^{o}C) = 7210 J = 7.21 kJ

For 1 mol (as in the reaction above) : 7.21 * 1/0.163 = 44.2 kJ

Since the reaction is exothermic: ΔH = -44.2 kJ

5. (15) The taste of vinegar is due to acetic acid (CH_3COOH). If 2.50 mL of vinegar requires 34.9 mL of 0.0960 M NaOH to be completely neutralized, what is the concentration of acetic acid in this vinegar? The neutralization reaction is:

$$CH_3COOH\ (aq) + NaOH\ (aq) \text{----}> CH_3COONa\ (aq) + H_2O\ (l)$$

0.0960 mol/L * 34.9 10^{-3} L = 0.00335 mol NaOH
----> 0.00335 mol CH_3COOH

Molarity: 0.00335 mol / 2.50 10^{-3} L = 1.34 M

6. (15) Hydrogen gas is produced when zinc reacts with sulfuric acid:

$$Zn\ (s) + H_2SO_4\ (aq) \text{------>} ZnSO_4\ (aq) + H_2\ (g)$$

If 159 mL of H_2 is collected over water at 24 ^oC and a barometric pressure of 738 torr, how many grams of Zn have been consumed? (Use information on your data sheet)

At 24 ^oC the P_{wat} = 22.377 torr (from Table)

$P = P_{wat} + P_{H2} = 738$ torr => $P_{H2} = 716$ torr

$$\mathbf{n = P_{H2}\ V/\ (RT) = \frac{716\ atm\ (1\ atm/760\ torr)\ 159\ 10^{-3}\ L}{0.0821\ atmL/mol\ K\ 297.15\ K} = 0.00614\ mol}$$

-----> 0.00614 mol Zn

*** 65.39 g/mol = 0.402 g Zn**

7. (10) Separate samples of a solution of an unknown salt are treated with dilute solutions of HBr, H_2SO_4, and NaOH. A precipitate forms only with H_2SO_4. Which of the following cations could the solution contain? (Use information on your data sheet)

K^+ Pb^{2+} Ba^{2+}

K+ salts are always soluble, therefore it is precluded.

Barium and Lead sulfates are insoluble.

Lead should also form a precipitate with HBr ($PbBr_2$). This is not the case, so Pb is precluded.

Therefore, it must be Barium.