City College, Chemistry Department
Chemistry 10301, sections T and T2, Prof. T. Lazaridis
Second Midterm exam, Nov. 2, 2006
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. 1/2 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.

1. (20) a. (6) Predict whether each the following compounds is soluble in water:

K_3PO_4	**Soluble**	Not Soluble
$BaSO_4$	Soluble	**Not Soluble**
$NaClO_4$	**Soluble**	Not Soluble

b. (4) What is the molarity of a solution that contains 0.0345 mol NH_4Cl in 400 mL of solution?

0.0345 mol / 400 X 10^{-3} L = 0.0863 M

c. (5) Which element is oxidized and which is reduced in the following reaction?

$Ni\ (s) + Cl_2\ (g) \rightarrow NiCl_2\ (s)$

Ni goes from O.N. 0 to +2 so it is oxidized.
Cl goes from O.N. 0 to –1, so it is reduced.

d. (5) If the partial pressure of ozone (O_3) in the stratosphere is 3.0 X 10^{-3} atm and the temperature is 250 K, how many ozone molecules are in a liter? (Nav = 6.022 X 10^{23})

PV= nRT => n= PV/RT = 3.0 X10^{-3} atm X 1 L / 0.082 (L atm /mol K) 250 K = 1.5 X 10^{-4} mol X Nav = 9.0 X 10^{19} molecules

2. (15) Ammonium sulfate, a fertilizer, can be prepared by the reaction of ammonia (NH_3) with sulfuric acid (H_2SO_4). Write a balanced equation for the reaction and calculate the volume of ammonia gas needed at 20.0 ºC and 25.0 atm to react with 150 Kg of H_2SO_4.

$$\mathbf{2NH_3 + H_2SO_4 ---> (NH_4)_2SO_4}$$

Molar mass of H_2SO_4: 2X1.008+ 32.06+ 2X16.00 = 98.08 g/mol

Convert to mol: 150 000 g / 98.08 g/mol = 1530 mol H_2SO_4

This requires 2X1530 = 3060 mol ammonia.

PV = nRT => V= 3060 mol X 0.082058 L atm / (mol K) X (20.0 +273.15 K) / 25.0 atm = 2940 L

3. (10) Using your datasheet, find the standard enthalpy of the thermite reaction:

$$2\ Al\ (s) + Fe_2O_3\ (s)\ \text{----}> Al_2O_3\ (s) + 2\ Fe\ (s)$$

Is it exothermic or endothermic?

ΔH = -1676 – (-824.2) = -852 kJ / mol

Exothermic

4. (15) From the following enthalpies of reaction:

H_2 (g) + F_2 (g) ---> 2HF (g) ΔH= -537 kJ

C (s) + $2F_2$ (g) ---> CF_4 (g) ΔH= -680 kJ

$2C$ (s) + $2H_2$ (g) ---> C_2H_4 (g) ΔH= +52.3 kJ

calculate the ΔH for the reaction:

C_2H_4 (g) + $6F_2$ (g) ---> $2CF_4$(g) + 4HF (g)

Invert the third equation, multiply the first and second equation by 2, and add them up to get the desired equation.

ΔH= -52.3 + 2 (-537) + 2 (-680) = -2486 kJ

5. (10) What volume of 0.128 M HCl is required to neutralize 2.87 g of $Mg(OH)_2$?

$2\ HCl + Mg(OH)_2$ ---> $MgCl_2 + 2H_2O$

Molar mass of $Mg(OH)_2$: 24.31 + 2X16.00+ 2X1.008 = 58.33 g/mol

Convert to moles: 2.87 g / 58.33 g/mol = 0.0492 mol

This requires 2X 0.0492 = 0.0984 mol HCl

Volume = 0.0984 mol / 0.128 (mol/L)= 0.769 L

6. (15) Write balanced net ionic equations for the reactions that occur in each of the following cases. Identify the spectator ions in each reaction:

a) $Pb(NO_3)_2$ (aq) + Na_2SO_4(aq) --->
b) $CuBr_2$ (aq) + NaOH (aq) --->
c) $AgNO_3$ (aq) + KI (aq) --->

Check the solubility rules to see what precipitate will form in each case.

a) Pb^{2+} combined with SO_4^{2-} produces an insoluble salt:

Net ionic eq: Pb^{2+} + SO_4^{2-} ---> $PbSO_4$ (s)
Spectators: NO^{3-}, Na^+

b) Cu^{2+} combined with OH^- produces an insoluble salt:

Net ionic eq: Cu^{2+} + $2OH^-$ ---> $Cu(OH)_2$ (s)
Spectators: Br^-, Na^+

c) Ag^+ combined with I^- produces an insoluble salt:

Net ionic eq: Ag^+ + I^- ---> AgI (s)
Spectators: NO^{3-}, K^+

7. (15) When a 4.25 g sample of solid ammonium nitrate dissolves in 60.0 g of water in a coffee-cup calorimeter, the temperature drops from 22.0 ºC to 16.9 ºC. Calculate the ΔH for the following reaction:

NH_4NO_3 (s) ---> NH_4^+ (aq) + NO_3^- (aq)

(assume that the specific heat of the solution is the same as that of pure water and use your datasheet)

Specific heat of water: 4.180 J/g ºC

Amount of heat absorbed: (60.0+4.25 g) X 4.180 J/g ºC X (22.0-16.9 ºC) = 1370 J

Molar mass of Amm. Nitrate: 2X14.01+4X1.008+3X16.00= 80.05 g/mol
4.25 g / 80.05 g/mol = 0.0531 mol

So, heat per mol of Amm. Nitrate is 1370 J/ 0.0531 mol = 25800 J

ΔH= + 25.8 kJ