City College, Chemistry Department
Chemistry 10301, sections T, T2, T3 Prof. T. Lazaridis
Second Midterm exam, Nov. 6, 2007
Name (last name first): _____
I.D. Number last 4: _____
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. (5) How many ml of stock solution are needed to make 320 ml of 1.5 M HNO_3 solution from 16 M HNO_3 stock solution?

VdMd = VcMc => Vc= VdMd/Mc = 320 ml X 1.5 M/ 16 M = 30 ml

b. (5) The solubility of DDT has been estimated as $5.0X10^{-5}$ g/100 g of water. Express this solubility in parts per million.

$5.0X10^{-5}$ g/100 g X 10^6 ppm = 0.5 ppm

c. (5) An average pair of human lungs contains about 3.5 L of air after inhalation and about 3.0 L after exhalation. If the temperature is 37 ºC and the pressure is 1.0 atm, how many moles of gas will be present in the lungs (a) after inhalation and (b) after exhalation? [assume ideal gas]

n= PV/RT = 1 atm X 3.5 L / 0.082 (atm L/mol K) (37+273) K = 0.14 mol (after inhalation)
n= PV/RT = 1 atm X 3.0 L / 0.082 (atm L/mol K) (37+273) K = 0.12 mol (after exhalation)

d. (5) Give the oxidation numbers of each element in the compound $KCrO_3Cl$.

O: -2 Cl: -1 K: +1 Cr: +6

2. (10) When an HCl solution was titrated against 0.09850 M NaOH, it was found that 45.00 ml of the acid reacted with 40.10 ml of the base. What is the molarity of the HCl solution?

$HCl + NaOH \rightarrow NaCl + H_2O$

40.10×10^{-3} L of base X 0.09850 mol/L = 3.950×10^{-3} mol of NaOH

This reacted with 3.950×10^{-3} mol of HCl.

molarity: 3.950×10^{-3} mol / 45.00×10^{-3} L = 0.08777 M

3. (15) Using your datasheet, find the standard enthalpy of the following reactions and indicate whether they are exothermic or endothermic:

$$2\ Cu(NO_3)_2\ (s) \quad \text{----> } 2\ CuO\ (s) + 4\ NO_2\ (g) + O_2\ (g)$$

ΔH^o = {4X(+33.2)+ 2X(-157.3)} – {2X(-302.9)} = +424.0 kJ/mol (endothermic)

$$Hg\ (g) + HgCl_2\ (s) \text{ ----> } Hg_2Cl_2\ (s)$$

ΔH^o = {-265.2} – {+61.3-224.3} = -102.2 kJ/mol (exothermic)

$$2KClO_3\ (s) \text{ ----> } 2KCl\ (s) + 3\ O_2\ (g)$$

ΔH^o = {2X(-436.7)} – {2X(-397.7)} = -78.0 kJ/mol (exothermic)

4. (15) Use Hess's law to calculate the standard enthalpy of the reaction
CO_2 (g) + H_2 (g) -----> CO (g) + H_2O (g)
from the following thermochemical equations

CO (g) + ½ O_2 (g) ---> CO_2 (g)	ΔH^o= -283.0 kJ
H_2 (g) + ½ O_2 (g) ---> H_2O (l)	ΔH^o= -285.8 kJ
H_2O (g) ---> H_2O (l)	ΔH^o= -44.0 kJ

Flip the first and third and add to the second:

CO_2 (g) ---> CO (g) + ½ O_2 (g)	**ΔH^o= +283.0 kJ**
H_2 (g) + ½ O_2 (g) ---> H_2O (l)	**ΔH^o= -285.8 kJ**
H_2O (l) ---> H_2O (g)	**ΔH^o= +44.0 kJ**

CO_2 (g) + H_2 (g) -----> CO (g) + H_2O (g) **ΔH^o= +283.0-285.8+44.0= +41.2 kJ**

5. (10) A 13.0 g sample of iron at 95 ºC is dropped into 80.0 g of water at 15.0 ºC. Using your data sheet, calculate the final temperature of the iron and water mixture. Assume that no heat is lost to the surroundings.

Specific heat of iron = 0.449 J/g ºC and of water 4.180 J/g ºC

Iron temperature drops from 95 ºC to X and that of water rises from 15.0 ºC to X. The heat that iron loses is equal to the heat that water gains:

13.0 g X 0.449 J/g ºC X (95 – X) ºC = 80.0 X 4.180 J/ g ºC X (X-15.0) =>

X = 16.4 ºC

6. (18) Use the solubility rules to predict whether or not a precipitation reaction will occur when the following aqueous solutions are mixed. Write the molecular and the net ionic equation for each reaction that does occur.
a) $NaCl\ (aq) + Pb(NO_3)_2\ (aq)$
b) $Fe_2(SO_4)_3\ (aq) + NaOH\ (aq)$
c) $Na_2CO_3\ (aq) + BaCl_2\ (aq)$

a) Chlorides are soluble but Pb is an exception =>
Pb^{+2} and Cl^- will precipitate. Molecular equation:
$2\ NaCl\ (aq) + Pb(NO_3)_2\ (aq) \dashrightarrow PbCl_2\ (s) + 2\ NaNO_3\ (aq)$
Net ionic equation:
$Pb^{+2}\ (aq) + 2\ Cl^-\ (aq) \dashrightarrow PbCl_2\ (s)$

b) Hydroxides are insoluble. Na is an exception but Fe is not =>
Fe^{3+} and OH^- will precipitate. Molecular equation:
$Fe_2(SO_4)_3\ (aq) + 6\ NaOH\ (aq) \dashrightarrow 2\ Fe(OH)_3\ (s) + 3\ Na_2\ (SO_4)\ (aq)$
Net ionic equation:
$Fe^{3+}\ (aq) + 3\ OH^-\ (aq) \dashrightarrow Fe(OH)_3\ (s)$

c) Carbonates are insoluble. Na is an exception but BaCO2 is only slightly soluble => CO_3^{2-} and Ba^{2+} will precipitate. Molecular equation:
$Na_2CO_3\ (aq) + BaCl_2\ (aq) \dashrightarrow BaCO_3\ (s) + 2\ NaCl\ (aq)$
Net ionic equation:
$CO_3^{2-} + Ba^{2+} \dashrightarrow BaCO_3\ (s)$

7. (12) The thermochemical eq. for the combustion of carbon disulfide is:

$CS_2\ (l) + 3\ O_2\ (g) \dashrightarrow CO_2\ (g) + 2SO_2\ (g)\ (aq)$ $\Delta H^o = -1076.9$ kJ

How many kJ of heat are released when 25.0 g of CS_2 is burned?

Molar mass of CS2 = 12.01 + 2X32.06= 76.13 g/mol

25.0 g / 76.13 (g/mol) = 0.328 mol X 1076.9 kJ/mol = 353 kJ