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Name Key
(Please Print)

Student Number _____

Chem 115 - Section 1
Hour Examination II
November 8, 2006

This test consists of six (6) pages, including this cover page. Be sure your copy is complete before beginning your work. If this test packet is defective, ask for another one.

Show all numeric answers to the proper number of significant digits.

A separate copy of the periodic table will be distributed with this test packet. Feel free to use it in conjunction with any test question. In addition you may need some of the following relationships and constants:

$1 \text{ \AA} = 1 \times 10^{-10} \text{ m} = 0.1 \text{ nm}$ (exact relationships) Planck's constant = $6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
speed of light *in vacuo* = $2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$

DO NOT WRITE BELOW THIS LINE

1.

2.

3.

4.

5.

6.

TOTAL

a

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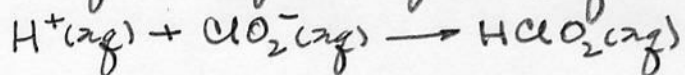
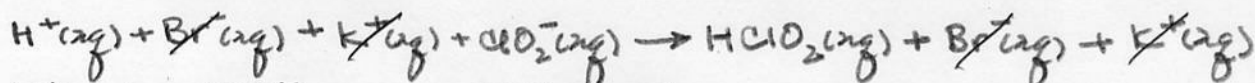
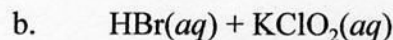
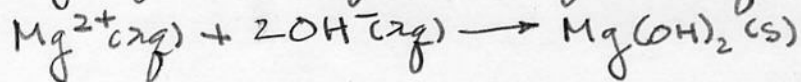
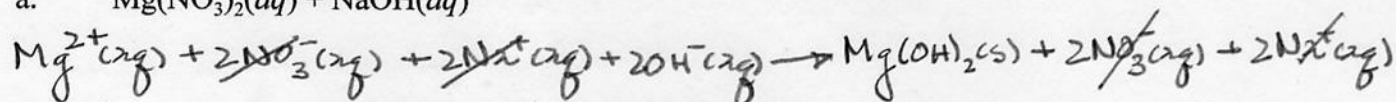
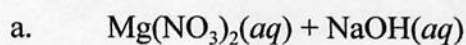
1. (10 points; 2 points each) Who did what? Match the person with the concept or discovery.

People

Arrhenius	Balmer	Bohr	Brackett
Einstein	Hess	Lenard	Lymann
Pfund	Planck	Rutherford	Thomson

Concepts and Discoveries

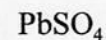
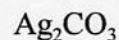
- a. Hess Enthalpy does not depend upon path
- b. Planck Used the idea of quantized energy to explain black-body radiation
- c. Einstein Explained photoelectric effect in terms of particles of light
- d. Arrhenius Described acids and bases in terms of electrolyte theory
- e. Bohr Predicted lowest energy electron in hydrogen has $r = 0.529 \text{ \AA}$

2. (12 points; 6 points each) Write the *net ionic equations* for the reactions that occur when the following are mixed together. Indicate all states (e.g., s, l, g, aq).

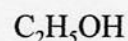
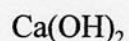
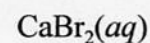
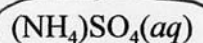
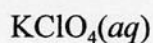
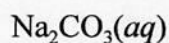
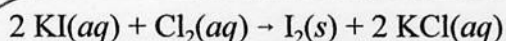
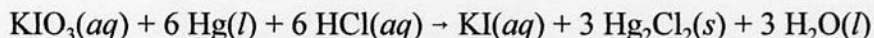
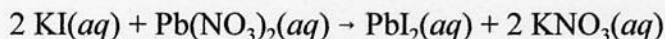
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3. (32 points; 4 points each) Circle the correct answer to each of the following.

a. Which one of the following is *soluble* in water (i.e., all others are insoluble or only sparingly soluble)?

b. Which one of the following is a weak electrolyte in water?

c. If the following solutions were each treated with excess $\text{NaOH}(\text{aq})$, which one would produce a gas?d. Which one of the following has the highest concentration of *anions* in solution?e. In which one of the following reactions is iodine undergoing *oxidation*?f. Each of the following denotes an electronic transition from an initial to a final state in the hydrogen atom, $n_{\text{initial}} \rightarrow n_{\text{final}}$. Which transition results in the emission of infrared radiation?

$1 \rightarrow \infty$

$2 \rightarrow 5$

$5 \rightarrow 4$

$3 \rightarrow 2$

$2 \rightarrow 1$

g. Which of the following has the highest energy?

x-rays

gamma rays

infrared

red light

radio waves

h. What is the energy in joules (J) of a photon whose wavelength is 436 nm?

$1.52 \times 10^{-27} \text{ J}$

$1.52 \times 10^{-36} \text{ J}$

$4.56 \times 10^{-19} \text{ J}$

$4.56 \times 10^{-28} \text{ J}$

$6.88 \times 10^{+14} \text{ J}$

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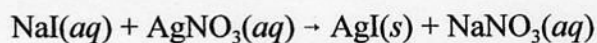
4. (16 points; 8 points each part) Answer both parts. Show work in the spaces provided to justify your answers.

a. How many grams of $\text{NaI}(s)$ (f.w. = 149.9 u) are needed to prepare exactly 250 mL of a 0.1252 M $\text{NaI}(aq)$ solution?

$$\text{mL NaI} = (0.2500\text{L})(0.1252\text{M}) = 0.03130\text{ mol}$$

$$\text{g NaI} = (0.03130\text{ mol})\left(\frac{149.9\text{g}}{\text{mol}}\right) = 4.692\text{ g}$$

b. How many milliliters (mL) of 0.1252 M $\text{NaI}(aq)$ solution are need to completely precipitate all the silver ion in 25.00 mL of 0.1000 M $\text{AgNO}_3(aq)$ solution by the reaction



$$\begin{aligned} \text{mmol AgNO}_3 &= (25.00\text{mL})(0.1000\text{M}) = 2.500\text{ mmol} \\ &= \text{mmol NaI} \end{aligned}$$

$$\text{mL NaI soln} = \frac{2.500\text{ mmol}}{0.1252\text{ mmol/mL}} = 19.97\text{ mL}$$

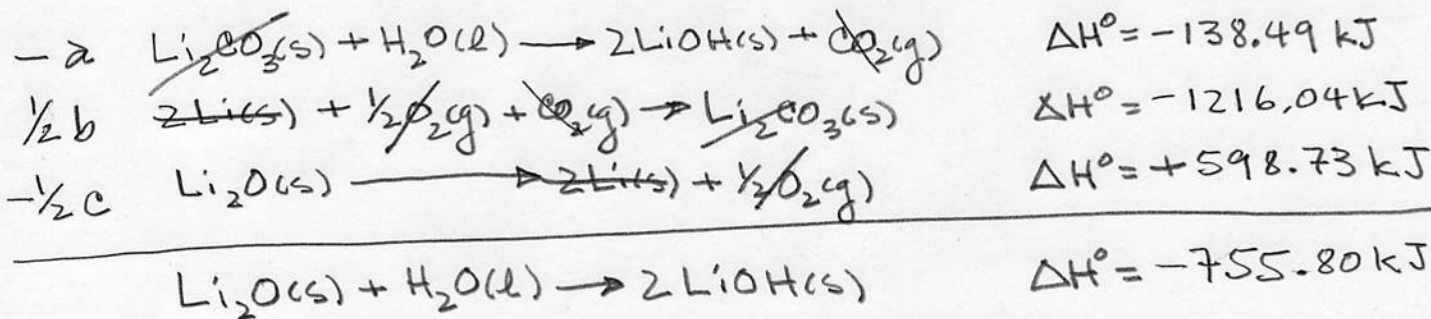
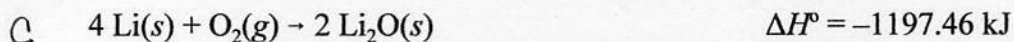
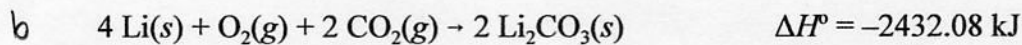
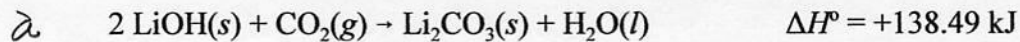
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5. (16 points) Calculate the enthalpy of the following reaction



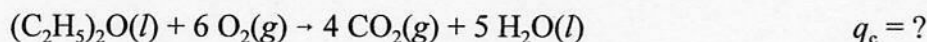
Given the following thermochemical equations:



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6. (14 points + 5 point bonus) The standard heat of combustion of diethyl ether, $(C_2H_5)_2O(l)$ (m.w. 74.12 u), is defined by the following thermochemical equation:



- a. (10 points) A student combusted a 2.250-g sample of diethyl ether in the bomb of a calorimeter having a heat capacity of 7.638 kJ/°C. The temperature of the water in the calorimeter rose from 22.15 °C to 33.01 °C. Based on this experiment, what is the value of the heat of the reaction *per gram* of diethyl ether?

$$\Delta T = (33.01 - 22.15)^\circ C = 10.86^\circ C$$

$$q_{cal} = (7.638 \text{ kJ}/^\circ C)(10.86^\circ C) = 82.9487 \text{ kJ}$$

$$q_{rxn} = \frac{-82.9487 \text{ kJ}}{2.250 \text{ g}} = -36.866 \text{ kJ/g} = -36.87 \text{ kJ/g}$$

- b. (4 points) What is the value of the heat of combustion *per mole* of diethyl ether?

$$q_c = \left(\frac{-36.87 \text{ kJ}}{\text{g}} \right) \left(\frac{74.12 \text{ g}}{\text{mole}} \right) = -2732.51 \text{ kJ/mol} \\ = -2733 \text{ kJ/mol}$$

- c. (5 point bonus) Given the thermochemical equation for the combustion of diethyl ether and the following standard enthalpies of formation, calculate the standard enthalpy of formation, ΔH_f° , for $(C_2H_5)_2O(l)$, assuming that your calculated value of q_c is essentially the standard enthalpy of combustion, ΔH_c° . (Your answer to part b must be essentially correct to receive bonus credit.)

$CO_2(g)$	$H_2O(l)$
-393.5 kJ/mol	-285.8 kJ/mol

$$\Delta H_c^\circ = 4\Delta H_f^\circ(CO_2) + 5\Delta H_f^\circ(H_2O) - \Delta H_f^\circ((C_2H_5)_2O)$$

$$\Delta H_f^\circ((C_2H_5)_2O) = 4\Delta H_f^\circ(CO_2) + 5\Delta H_f^\circ(H_2O) - \Delta H_c^\circ$$

$$= (4)(-393.5 \text{ kJ}) + (5)(-285.8 \text{ kJ}) - (-2733 \text{ kJ})$$

$$= -1574.0 \text{ kJ} - 1429.0 \text{ kJ} + 2733 \text{ kJ}$$

$$= -270. \text{ kJ}$$