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Name Key  
(Please Print)

Student Number \_\_\_\_\_

Chem 115 - Section 1  
Hour Examination I  
October 13, 2006

This test consists of five (5) 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.

A copy of the periodic table will be distributed with this test.

DO NOT WRITE BELOW THIS LINE

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1.

2.

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4.

5.

6.

TOTAL

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

**People**

Becquerel	Chadwick	Dalton	Davy
Lavoisier	Mendeleev	Millikan	Moseley
Nagaoka	Proust	Thomson	Rutherford

**Concepts and Discoveries**

- a. Lavoisier Father of quantitative chemistry
- b. Thomson Proposed "plum pudding" model of the atom
- c. Millikan Determined the charge of the electron
- d. Moseley Determined atomic numbers, basis of modern periodic table
- e. Rutherford Proved that atoms have a positive nucleus and distant electrons

2. (8 points; 4 points each) Give answers to the following items, which refer to  $C_5H_4O_3$  (m.w. = 112.08 u).  $N_A = 6.022 \times 10^{23}$ ; at. wt. C = 12.01, H = 1.008, O = 16.00 u.

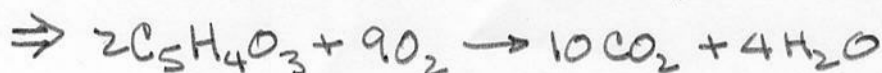
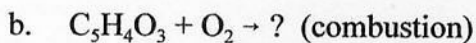
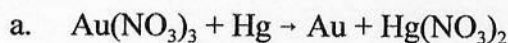
O atoms in 0.4325 g of  $C_5H_4O_3$ 

$$\frac{6.971 \times 10^{21}}{\underline{\hspace{2cm}}}$$

weight percent O in  $C_5H_4O_3$ 

$$\frac{42.83\%}{\underline{\hspace{2cm}}}$$

3. (12 points; 6 points each) In the spaces provided, balance the following skeletal equations, using lowest whole number coefficients.



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4. (36 points; 6 points each part) Fill in the blanks with the correct answers.

a. Name the following compounds, using I.U.P.A.C. rules of nomenclature.

Co(H<sub>2</sub>PO<sub>4</sub>)<sub>2</sub> Cobalt(III) dihydrogen phosphateHClO<sub>3</sub> Chloric acid

b. Give formulas for the following.

ammonium dichromate (NH<sub>4</sub>)<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>tetraphosphorus hexoxide P<sub>4</sub>O<sub>6</sub>

c. Indicate the number of protons (p), neutrons (n), and electrons (e).

<sup>75</sup>As atom    p = 33    n = 42    e = 33<sup>56</sup>Fe<sup>2+</sup> ion    p = 26    n = 30    e = 24

d. Give the symbol and name of the following elements:

3rd period alkaline earth    symbol Mg    name magnesiumtransition element with Z = 26    symbol Fe    name iron

e. Indicate whether each of the following compounds is ionic or molecular.

AlCl<sub>3</sub> ionic    NO molecular

f. Answer the following:

(i) The answer to the problem  $\frac{(1.530 + 9.5762)}{0.245093}$  should have 5 significant figures.

(ii) For each element, give the expected charge when it forms a monatomic ion:

Ba 2+    Br 1- (or just -)

(iii) Which one of the following elements forms ionic compounds in which its monatomic ion might have one of two or more possible charges: Al, I, Pb, Ba, Cs?

Answer Pb

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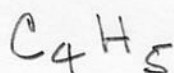
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5. (16 points) Answer both parts. Show work in the spaces provided to justify your answers.
- a. (12 points) A compound contains 90.505 % carbon and 9.495 % hydrogen. What is the empirical formula of this compound? (at. wts.: C = 12.01 u, H = 1.008 u)

Assume 100.00g compound

$$\text{mol C} = (90.505 \text{ g C}) \left( \frac{\text{mol C}}{12.01 \text{ g C}} \right) = 7.5358 \text{ mol C} \\ \Rightarrow 1 \Rightarrow 4$$

$$\text{mol H} = (9.495 \text{ g H}) \left( \frac{\text{mol H}}{1.008 \text{ g H}} \right) = 9.4196 \text{ mol H} \\ \Rightarrow 1.25 \Rightarrow 5$$



- b. (4 points) If the molecular weight of the compound is 106.16 u, what is its molecular formula?

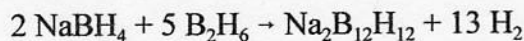
$$f.w. \text{ C}_4\text{H}_5 = 53.08$$

$$\frac{m.w.}{f.w.} = \frac{106.16}{53.08} = 2 \Rightarrow \text{C}_8\text{H}_{10}$$

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6. (18 points + 5 points bonus) The  $B_{12}H_{12}^{2-}$  ion is a cage-like structure of twelve boron atoms. The sodium salt of this anion can be prepared by the following reaction:



How many grams of  $H_2$  gas will be produced when  $Na_2B_{12}H_{12}$  is synthesized in the reaction of 0.250 g  $NaBH_4$  and 0.420 g  $B_2H_6$ ? **You must identify the limiting reagent, based on appropriate calculations.** Show work in the spaces provided to justify your answers. [f.w.  $NaBH_4 = 37.83$  u; m.w.  $B_2H_6 = 27.67$  u; f.w.  $Na_2B_{12}H_{12} = 187.8$  u; m.w.  $H_2 = 2.016$  u.]

$$\text{mol } NaBH_4 = (0.250 \text{ g } NaBH_4) \left( \frac{\text{mol } NaBH_4}{37.83 \text{ g } NaBH_4} \right) = 0.0066085 \text{ mol}$$

$$0.0066085 / 2 = 0.0033043$$

$$\text{mol } B_2H_6 = (0.420 \text{ g } B_2H_6) \left( \frac{\text{mol } B_2H_6}{27.67 \text{ g } B_2H_6} \right) = 0.015179 \text{ mol}$$

$$0.015179 / 5 = 0.0030358$$

$\Rightarrow B_2H_6$  limits

$$\text{g } H_2 = (0.015179 \text{ mol } B_2H_6) \left( \frac{13 \text{ mol } H_2}{5 \text{ mol } B_2H_6} \right) \left( \frac{2.016 \text{ g } H_2}{\text{mol } H_2} \right)$$

$$= 0.07956 \text{ g } H_2 = 0.0796 \text{ g } H_2$$

BONUS (5 points) How many grams of the reactant that is *not* the limiting reagent will be left over after the reaction is complete?

$$\text{g } NaBH_4 \text{ used} = (0.015179 \text{ mol } B_2H_6) \left( \frac{2 \text{ mol } NaBH_4}{5 \text{ mol } B_2H_6} \right) \left( \frac{37.83 \text{ g } NaBH_4}{\text{mol } NaBH_4} \right)$$

$$= 0.22969 \text{ g } NaBH_4 = 0.230 \text{ g } NaBH_4$$

$$\text{g } NaBH_4 \text{ left} = 0.250 \text{ g} - 0.230 \text{ g} = 0.020 \text{ g}$$