α

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

1.

2.

3.

4.

5.

6.

TOTAL

α Name Key

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. Proust — His Law of Definite Proportions lead to atomic theory

b. Millikan — Determined the charge of the electron

c. Thomson — Proposed "plum pudding" model of the atom

d. Chadwick — Characterized the neutron from calculations on nuclear reactions

e. Rutherford — Characterized radioactive emissions as α, β, and γ radiation

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.

C atoms in 0.4325 g of $C_5H_4O_3$ — 1.162×10^{22}

weight percent C in $C_5H_4O_3$ — 53.58%

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

a. $Hg(NO_3)_2 + Fe \rightarrow Hg + Fe(NO_3)_3$

$3Hg(NO_3)_2 + 2Fe \rightarrow 3Hg + 2Fe(NO_3)_3$

b. $C_4H_6O_2 + O_2 \rightarrow ?$ (combustion)

$C_4H_6O_2 + \frac{9}{2}O_2 \rightarrow 4CO_2 + 3H_2O$

$\Rightarrow 2C_4H_6O_2 + 9O_2 \rightarrow 8CO_2 + 6H_2O$

α Name Key

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.

$Fe(HCO_3)_2$ iron(II) hydrogen carbonate

$HClO_4$ perchloric acid

b. Give formulas for the following.

ammonium chromate $(NH_4)_2CrO_4$

tetraphosphorus decoxide P_4O_{10}

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

^{70}Ga atom p = 31 n = 39 e = 31

$^{59}Co^{3+}$ ion p = 27 n = 32 e = 24

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

3rd period alkali metal symbol Na name sodium

transition element with $Z = 24$ symbol Cr name chromium

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

SO_2 molecular CaS ionic

f. Answer the following:

(i) The answer to the problem $\frac{(10.53 - 9.5762)}{0.235093}$ should have 2 significant figures.

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

Sr 2+ I 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, Fe, Ba, Cs?

Answer Fe

α Name Key

5. (16 points) Answer both parts. Show work in the spaces provided to justify your answers.

a. (12 points) A compound contains 88.818 % carbon and 11.182 % hydrogen. What is the empirical formula of this compound? (at. wts.: C = 12.01 u, H = 1.008 u)

Assume 100.00 g compound.

$$\text{mol C} = (88.818\ \text{g C})\left(\frac{\text{mol C}}{12.01\ \text{g C}}\right) = 7.395\ \text{mol C}$$
$$\Rightarrow 1 \quad \Rightarrow 2$$

$$\text{mol H} = (11.182\ \text{g H})\left(\frac{\text{mol H}}{1.008\ \text{g H}}\right) = 11.09\ \text{mol H}$$
$$\Rightarrow 1.5 \quad \Rightarrow 3$$

C_2H_3

b. (4 points) If the molecular weight of the compound is 54.09 u, what is its molecular formula?

f.w. $C_2H_3 = 27.04$

$$\frac{\text{m.w.}}{\text{f.w.}} = \frac{54.09}{27.04} = 2 \Rightarrow C_4H_6$$

α Name Key

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:

$$2\ NaBH_4 + 5\ B_2H_6 \rightarrow Na_2B_{12}H_{12} + 13\ H_2$$

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 0.400 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.]

$$\text{mol } NaBH_4 = (0.250\text{g } NaBH_4)\left(\frac{\text{mol } NaBH_4}{37.83\text{g } NaBH_4}\right) = 0.00660_{85}\text{ mol}$$

$$0.00660_{85}/2 = 0.00330_{43}$$

$$\text{mol } B_2H_6 = (0.400\text{g } B_2H_6)\left(\frac{\text{mol } B_2H_6}{27.67\text{g } B_2H_6}\right) = 0.0144_{56}\text{ mol}$$

$$0.0144_{56}/5 = 0.00289_{12}\text{ mol}$$

$\Rightarrow B_2H_6$ limits

$$g\,H_2 = (0.0144_{56}\text{mol } B_2H_6)\left(\frac{13\text{ mol } H_2}{5\text{ mol } B_2H_6}\right)\left(\frac{2.016\text{g } H_2}{\text{mol } H_2}\right)$$

$$= 0.0757_7\text{g } H_2 = 0.0758\text{g } H_2$$

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

$$g\,NaBH_4\text{ used} = (0.0144_{56}\text{mol } B_2H_6)\left(\frac{2\text{ mol } NaBH_4}{5\text{ mol } B_2H_6}\right)\left(\frac{37.83\text{g } NaBH_4}{\text{mol } NaBH_4}\right)$$

$$= 0.218_7\text{g } NaBH_4 = 0.219\text{g } NaBH_4$$

$$g\,NaBH_4\text{ left} = 0.250\text{g} - 0.219\text{g} = 0.031\text{g}$$