Name Key
(Please Print)

Chem 103 - Section 1
Sample Hour Examination I

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

DISCLAIMER

This is a copy of a typical first test given in Chem 103 during the regular academic year. Your test will be different. This test is being posted to give you a sense of the format, style, scope, and level of a typical test on this material. This test may have questions on topics that will not be covered on the test you take. Moreover, your test may have questions on topics that are not covered on this test. Posting this test in no way limits the format, style, scope, or level of the test that you will take. **Do not limit your preparation to the material on this sample test.**

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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
Faraday	Lavoisier	Millikan	Moseley
Proust	Thomson	Rutherford	Mendeleev

Concepts and Discoveries

a. Moseley — Determined atomic numbers, basis of modern periodic law

b. Proust — Law of Definite Composition (Constant Composition)

c. Chadwick — Determined mass of the neutron

d. Rutherford — Showed atom is mostly empty space with a small, positive nucleus

e. Thomson — Determined *e/m* for the electron

2. (8 points; 2 points each) Give answers to the following items, all of which refer to a 15.00-g sample of N_2O_5 (m.w. = 108.02 u). $N_A = 6.022 \times 10^{23}$; at. wt. N = 14.01 u.

moles of N_2O_5 in the 15.00-g sample: 0.1389 mol

moles of oxygen in the sample: 0.6945 mol

atoms of oxygen in the sample: 4.181×10^{23} O atoms

weight percent nitrogen in N_2O_5: 25.94%

3. (10 points; 5 points each) In the spaces provided, balance the following skeletal equations, *using lowest whole number coefficients*.

a. $BCl_3 + H_2O \rightarrow B(OH)_3 + HCl$

$BCl_3 + 3H_2O \longrightarrow B(OH)_3 + 3HCl$

b. $C_6H_{14} + O_2 \rightarrow ?$ (combustion)

$C_6H_{14} + 19/2\ O_2 \longrightarrow 6CO_2 + 7H_2O$

$\Rightarrow 2C_6H_{14} + 19O_2 \longrightarrow 12CO_2 + 14H_2O$

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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.

$Cr(NO_3)_2$ chromium (II) nitrate

P_4S_7 tetraphosphorus heptasulfide

b. Give formulas for the following.

calcium acetate $Ca(C_2H_3O_2)_2$ hypoiodous acid HOI or HIO

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

^{119}Sn atom p = 50 n = 69 e = 50

$^{88}Sr^{2+}$ ion p = 38 n = 50 e = 36

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

4th period chalcogen symbol Se name selenium

transition element with $Z = 47$ symbol Ag name silver

e. Give the empirical formulas for the ionic compounds that would be expected to form when the following pairs of elements react:

aluminum with fluorine AlF_3 magnesium with phosphorus Mg_3P_2

f. Answer the following:

(i) The answer to the problem $\frac{4.356}{0.2225 - 0.2125}$ should have 3 significant figures.

(ii) Stainless steel is a homogeneous (homogeneous/heterogeneous) mixture.

(iii) Obtaining mercury vapor by heating liquid mercury metal is a

physical (chemical/physical) change.

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5. (18 points) Answer both parts. Show work in the spaces provided to justify your answers.

a. (14 points) A 1.140-g sample of a certain hydrocarbon (a compound of carbon and hydrogen only) is subjected to combustion analysis, producing 3.757 g of $CO_2(g)$ and 1.026 g of $H_2O(l)$. What is the empirical formula of the compound? **You must show work in the space below that leads to your answer.** [molecular weights: CO_2 = 44.01 u; H_2O = 18.02 u]

$$\text{mol C} = (3.757\text{ g } CO_2)\left(\frac{\text{mol } CO_2}{44.01\text{ g } CO_2}\right)\left(\frac{\text{mol C}}{\text{mol } CO_2}\right) = 0.08537\text{ mol C}$$

$$\Rightarrow 1 \Rightarrow 3$$

$$\text{mol H} = (1.026\text{ g } H_2O)\left(\frac{\text{mol } H_2O}{18.02\text{ g } H_2O}\right)\left(\frac{2\text{ mol H}}{\text{mol } H_2O}\right) = 0.1139\text{ mol H}$$

$$\Rightarrow 1.33 \Rightarrow 4$$

$$\Rightarrow C_3H_4$$

b. (4 points) If the molecular weight of the compound was determined to be 80.12 u, what is its molecular formula?

$$\text{f.w. } C_3H_4 = (3)(12.01) + (4)(1.01) = 40.07$$

$$\frac{\text{m.w.}}{\text{f.w.}} = \frac{80.12}{40.07} \approx 2 \Rightarrow C_6H_8$$

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6. (18 points) Consider the following balanced equation:

$$P_4O_{10}(s) + 6\ PCl_5(s) \rightarrow 10\ POCl_3(l)$$

How many grams of $POCl_3(l)$ are expected (the theoretical yield) when a 1.55-g sample of $P_4O_{10}(s)$ is reacted with 6.41 g of $PCl_5(s)$ Show work in the space provided to justify your answer. **You must identify the limiting reagent, based on appropriate calculations.** [molecular weights: P_4O_{10} = 283.88 u, PCl_5 = 208.22, $POCl_3$ = 153.32]

$$\text{mol } P_4O_{10} = (1.55\text{g } P_4O_{10})\left(\frac{\text{mol } P_4O_{10}}{283.88\text{g } P_4O_{10}}\right) = 5.46\times10^{-3} \text{ mol } P_4O_{10}$$

$$\frac{5.46\times10^{-3}}{1} = 5.46\times10^{-3}$$

$$\text{mol } PCl_5 = (6.41\text{g } PCl_5)\left(\frac{\text{mol } PCl_5}{208.22\text{g } PCl_5}\right) = 0.0307_8 \text{ mol } PCl_5$$

$$\frac{0.0307_8}{6} = 5.13\times10^{-3}$$

$\Rightarrow PCl_5$ limits

$$\text{g } POCl_3 = (0.0307_8 \text{ mol } PCl_5)\left(\frac{\overset{5}{\cancel{10}}\text{ mol } POCl_3}{\underset{3}{\cancel{6}}\text{ mol } PCl_5}\right)\left(\frac{153.32\text{g } POCl_3}{\text{mol } POCl_3}\right)$$

$$= 7.87\text{g } POCl_3$$