Name: Answer Key **Section:_____**

CH141 (Fall, 2010)

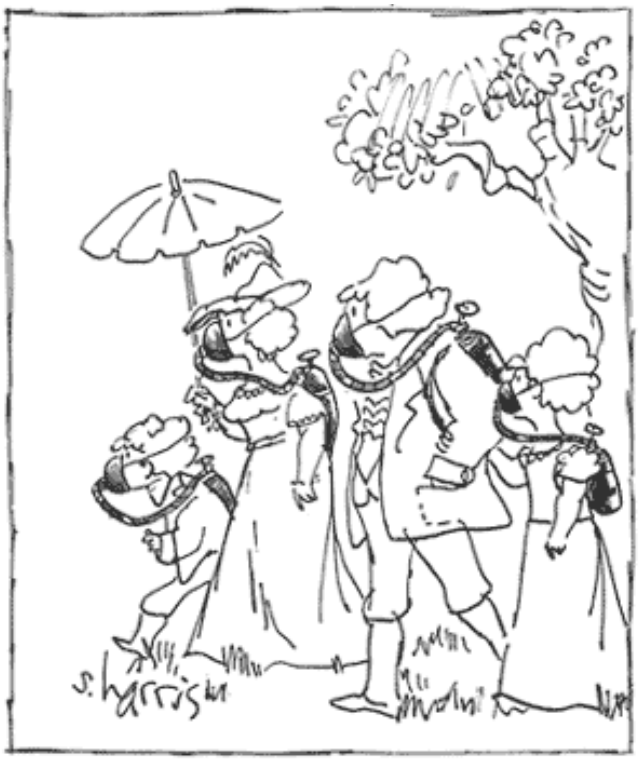
Hour Exam #1
Thursday, September 30, 2010
Duration: 60 minutes (5:30 to 6:30 pm)

Instructions: (a) Check to make sure that this exam has 7 pages including this page.
(b) Write your answers in the space provided.
(c) Please show all your work, unless specified otherwise.
(d) This is a closed book exam.
(e) Calculators are allowed.
(f) Only the periodic table provided with this exam may be used, if needed.
(g) You may use the back of any page on this exam for scratch work.

Points: Part I _____ out of 40 points
Part II _____ out of 30 points
Part III _____ out of 30 points

Total Score _____ out of 100 points

Good Luck!



AFTER ANTOINE LAVOISIER DISCOVERED OXYGEN, HIS WHOLE FAMILY WOULD BREATHE IT REGULARLY AS A SHOW OF SUPPORT

<u>Part I</u> (40 pts) Multiple choice and fill in the blanks. You need not show your work in this section.

(1) How many moles of O_2 will you need to completely react with the 1 mole of C_2H_6 in the following reaction?

$$2\ C_2H_6\ (g)\ +\ 7\ O_2\ (g)\ \rightarrow\ 4\ CO_2\ (g) + 6\ H_2O\ (l)$$

a. 3.50 moles O_2
b. 0.286 moles O_2
c. 7.00 moles O_2
d. 2.00 moles O_2
e. 0.143 moles O_2

(2) Which one of the following is *not* an ionic compound?

a. NH_4Cl
b. CO_2
c. $Mg(OH)_2$
d. K_2SO_4
e. CaF_2

(3) Write the answer to the following expression with the correct number of significant figures.

$(6.022\text{x}10^{23})(0.0032)/(2.657\text{x}10^{14}) =$ **<u>7,300,000</u>**

(4) Each of the following elements is capable of forming an ion in a chemical reaction. Predict the charge of each ion:

Ca **<u>2+</u>**, S **<u>2-</u>** , Cs **<u>1+</u>**

(5) Identify the following elements by name or symbol:

a. $^{41}_{20}X$ is an isotope of **<u>Calcium</u>** (What is X ?)

b. This halogen tends to gain one electron, giving it a total of 36 electrons as an ion. **<u>Br</u>**

c. Of $^{14}_{6}C$, $^{32}_{16}S$, $^{37}_{17}Cl$, which has 20 neutrons **$^{37}_{17}Cl$**

(6) The formula for iron(III) oxide is <u>Fe_2O_3</u> and the correct name for NF_3 is

<u>Nitrogen trifluoride</u>.

(7) What is the mass of 8.65×10^{26} cesium (Cs) atoms? (Avogadro's number = 6.02×10^{23})

a. 57.6 kg
b. 1.14×10^{26} kg
c. 191. kg
d. 0.0925 g
e. 0.0279 g

(8) Identify the following as combination, decomposition, or combustion reactions:

a. $C_3H_8O\ (l) + 4\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 3\ H_2O\ (l)$ **Combustion**

b. $NH_4NO_3\ (s) \rightarrow N_2O\ (g) + 2\ H_2O\ (g)$ **Decomposition**

c. $2\ Al\ (s) + 3\ Br_2 \rightarrow 2\ AlBr_3\ (s)$ **Combination**

(9) Balance the following equation.

$$\underline{4}\ NH_3\ (g) + \underline{7}\ O_2\ (g) \rightarrow \underline{4}\ NO_2\ (g) + \underline{6}\ H_2O\ (g)$$

(10) Osmium has a density of 22.6 g/cm^3. The mass of a block of osmium that measures 1.01 cm × 0.233 cm × 0.648 cm is

a. 6.75×10^{-3} g
b. 3.45 g
c. 148 g
d. 6.75×10^{3} g
e. 34.5 g

Part II (1) (8 pts) Calculate the percentage composition (by mass) of oxygen in $Zn(NO_3)_2$ to 3 significant figures.

$Zn(NO_3)_2$ contains one zinc atom, two nitrogen atoms, and six oxygen atoms. Thus,

$$1 \text{ x Zn} = 65.4 \text{ amu}$$
$$2 \text{ x N} = 28.0 \text{ amu}$$
$$6 \text{ x O} = 96.0 \text{ amu}$$
$$\text{Sum} = 189 \text{ amu} = \text{mass of } Zn(NO_3)_2$$
$$\text{Percent oxygen} = \frac{\text{mass of O in } Zn(NO_3)_2}{\text{mass of } Zn(NO_3)_2} \text{ x } 100$$
$$= \frac{96.0 \text{ amu}}{189 \text{ amu}} \text{ x } 100 = 50.8\% \text{ oxygen}$$

(2) (14 pts) Automobile air bags inflate when sodium azide, NaN_3, rapidly decomposes to its component elements:

$$2\ NaN_3\ (s) \rightarrow \quad 2\ Na\ (s) \quad + \quad 3\ N_2\ (g)$$

(a) How many moles of N_2 are produced by the decomposition of 1.50 moles of NaN_3? Show calculation.

(See problem 3.63 in text.)

$$1.50\ \text{mol}\ NaN_3 \left(\frac{3\ \text{mol}\ N_2}{2\ \text{mol}\ NaN_3}\right) = 2.25\ \text{mol}\ N_2$$

(b) How many grams of NaN_3 are required to produce 10.0 g of N_2? Show calculation.

$$10.0\ \text{g}\ N_2 \left(\frac{1.00\ \text{mol}\ N_2}{28.0\ \text{g}\ N_2}\right)\left(\frac{2.00\ \text{mol}\ NaN_3}{3.00\ \text{mol}\ N_2}\right)\left(\frac{65.0\ \text{g}\ NaN_3}{1.00\ \text{mol}\ NaN_3}\right) = 15.5\ \text{g}\ NaN_3$$

(3) (8 pts) The exact atomic masses of the three naturally occurring isotopes of silicon, with their abundances shown in parenthesis, are: ^{28}Si 27.97693 amu (92.23%); ^{29}Si 28.97649 amu (4.68%); and ^{30}Si 29.97377 amu (3.09%). Calculate the average atomic mass of silicon.

(See Practice Exercise at the bottom of page 47 in text.)

$$\begin{aligned} 27.97693\ \text{amu} \times 0.9223 &= 25.80\ \text{amu} \\ 28.97649\ \text{amu} \times 0.0468 &= 1.36\ \text{amu} \\ 29.97377\ \text{amu} \times 0.0309 &= 0.926\ \text{amu} \\ \text{Sum} &= 28.09\ \text{amu} \end{aligned}$$

<u>Part III</u>: Answer **two** of the next three questions. Make sure to show your work.

(1) (15 pts) A sample of Ketonox is found to be composed of 46.15% carbon, 7.746% hydrogen, and 46.11% oxygen.

(a) What is the empirical formula of Ketonox?

The mole ratio of C:H:O in 100 g of ketonox is given by,

$$\text{Moles C} = 46.15\ \text{g C}\left(\frac{1\ \text{mol C}}{12.01\ \text{g C}}\right) = 3.843\ \text{mol C}$$

$$\text{Moles H} = 7.746\ \text{g H}\left(\frac{1\ \text{mol H}}{1.008\ \text{g H}}\right) = 7.685\ \text{mol H}$$

$$\text{Moles O} = 46.11\ \text{g C}\left(\frac{1\ \text{mol O}}{16.00\ \text{g O}}\right) = 2.882\ \text{mol O}$$

Dividing the above ratios by 2.882 (the smallest number of the three) gives

$$\text{C}: \frac{3.843}{2.882} = 1.33 \; ; \; \text{H}: \frac{7.685}{2.882} = 2.66 \; ; \; \text{O}: \frac{2.882}{2.882} = 1$$

$$\therefore \; \text{C} : \text{H} : \text{O} = 1.33 : 2.66 : 1$$

Multiplying the above ratio by three gives the simplest whole number ratio which is the empirical formula. Thus the empirical formula is $C_4H_8O_3$

(b) If the formula weight is 208.2 amu, what is the molecular formula?

As the molecular formula weight is about twice the empirical formula weight (104 amu), the molecular formula has twice as many atoms as the empirical formula. So the empirical formula is $C_8H_{16}O_6$

(2) (15 pts) An unknown compound contains only carbon, hydrogen, and oxygen. When 100.0 g of the compound is burned with an excess of oxygen, 39.2 g of water and 95.6 g of carbon dioxide are formed. What is the empirical formula of the compound? (The molar mass of CO_2 is 44.01 g/mol and H_2O is 18.02 g/mol).

$$39.2 \text{ g } H_2O \left(\frac{2.00 \text{ g H}}{18.0 \text{ g } H_2O} \right) = 4.36 \text{ g H in 100 g of sample. So the sample has 4.36\% H}$$

$$95.6 \text{ g } CO_2 \left(\frac{12.0 \text{ g C}}{44.0 \text{ g } CO_2} \right) = 26.1 \text{ g C in 100 g of sample. So the sample has 26.1\% C}$$

So the remainder, [100 - (%C + %H)] is %O. So O is 69.6%

Given the percentages of C, H, and O, and using the same procedure as shown for the previous problem, the empirical formula works out to CH_2O_2.

(3) (15 pts) Dinitrogen tetroxide can be prepared by a decomposition according to the following unbalanced equation: $\underline{2}\ Pb(NO_3)_2\ (s) \rightarrow \underline{2}\ N_2O_4\ (g) + \underline{2}\ PbO\ (s) + O_2\ (g)$

If 3.47 g of $Pb(NO_3)_2$ is allowed to decompose, how many grams of O_2 are produced? The molar mass of $Pb(NO_3)_2$ is 331.2 g/mol.

$$3.47 \text{ g } Pb(NO_3)_2 \left(\frac{1 \text{ mol } Pb(NO_3)_2}{331.2 \text{ g } Pb(NO_3)_2} \right) \left(\frac{1 \text{ mol } O_2}{2 \text{ mol } Pb(NO_3)_2} \right) \left(\frac{32.0 \text{ g } O_2}{1 \text{ mol } O_2} \right) = 0.168 \text{ g } O_2$$