

**City College, Chemistry Department  
Chemistry 10301, sections T, T2, T3, Prof. T. Lazaridis  
First Midterm exam, Oct. 1, 2009**

**Name (last name first):** \_\_\_\_\_

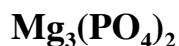
**I.D. Number:** \_\_\_\_\_

**Workshop leader:** \_\_\_\_\_

**Note: There are 7 questions in this exam (check both sides of the sheet).**

**Fill in your answer in the blank space provided immediately following each question. Half a point will be subtracted every time you report a numerical result with an incorrect number of significant figures. A copy of the periodic table is attached. Good luck!**

1. a. (4) What is the chemical formula of magnesium phosphate?



- b. (4) What is the name of the compound  $\text{KClO}_4$  ?

**Potassium Perchlorate**

- c. (4) How many protons and electrons does the sodium ion have?

**$\text{Na}^+$  : 11 protons, 10 electrons**

- d. (4) What is the molar mass of  $\text{PbCO}_3$  ?

$$207.2 + 12.01 + 3 * 16.00 = 267.2$$

- e. (4) Give the name of the elements with the following atomic symbols:

**Hg: Mercury**

**P: Phosphorus**

**F: Fluorine**

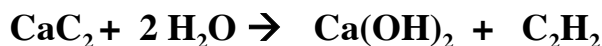
**Mn: Manganese**

2. Write a balanced equation for each of the following reactions (it is not necessary to indicate the states of each substance):

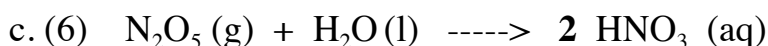
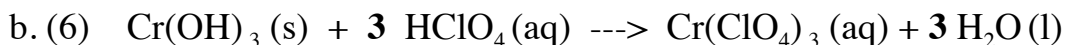
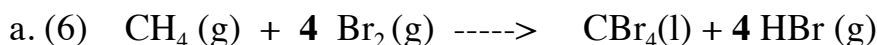
a. (6) Burning butane in oxygen



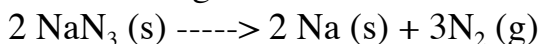
b. (6) Calcium Carbide ( $\text{CaC}_2$ ) reacts with water to form an aqueous solution of calcium hydroxide and acetylene ( $\text{C}_2\text{H}_2$ )



3. Balance the following chemical equations:



4. (10) Automotive air bags inflate when sodium azide rapidly decomposes:



a) (5) How many moles of  $\text{N}_2$  are produced by the decomposition of 1.50 moles of  $\text{NaN}_3$ ?

$$1.50 \text{ mol NaN}_3 \times (3 \text{ mol N}_2) / (2 \text{ mol NaN}_3) = 2.25 \text{ mol N}_2$$

b) (5) How many grams of  $\text{NaN}_3$  are required to form 5.00 g of nitrogen gas?

$$\text{Molar mass NaN}_3 = 22.99 + 3 \times 14.01 = 65.02 \text{ g/mol}$$

$$\text{Molar mass N}_2 = 2 \times 14.01 = 28.02 \text{ g/mol}$$

$$5.00 \text{ g N}_2 / (28.02 \text{ g N}_2 / \text{mol N}_2) \times (2 \text{ mol NaN}_3 / 3 \text{ mol N}_2) \\ \times 65.02 \text{ g NaN}_3 / \text{mol NaN}_3 = 7.73 \text{ g NaN}_3$$

5. (15) Vanillin, the dominant flavoring in vanilla, contains C, H, and O. When 1.050 g of this substance is completely combusted, 2.43 g of CO<sub>2</sub> and 0.500 g of H<sub>2</sub>O are produced. What is the empirical formula of vanillin?

$$2.43 \text{ g CO}_2 \times (12.01 \text{ g C} / 44.01 \text{ g CO}_2) = 0.663 \text{ g C}$$

$$0.500 \text{ g H}_2\text{O} \times (2 \times 1.008 \text{ g H} / 18.02 \text{ g H}_2\text{O}) = 0.0559 \text{ g H}$$

$$1.050 - 0.663 - 0.0559 = 0.331 \text{ g O}$$

Convert to moles:

$$0.663 / 12.01 = 0.0552 \text{ mol C}$$

$$0.0559 / 1.008 = 0.0555 \text{ mol H}$$

$$0.331 / 16.00 = 0.0207 \text{ mol O}$$

Divide by the smallest (0.0207):

$$\text{C: } 0.0552 / 0.0207 = 2.66$$

$$\text{H: } 0.0555 / 0.0207 = 2.68$$

$$\text{O: } 0.0207 / 0.0207 = 1$$

To get whole numbers multiply all by 3. Empirical formula:



6. (15) When chlorine gas is bubbled into hot potassium hydroxide solution, it reacts according to the equation:



A reacting mixture contains 6.00 mol of chlorine and 8.00 mol of potassium hydroxide.

a) (5) Find the limiting reactant

$$\text{Cl}_2 : \text{KOH} = 6 / 8 > 3 / 6 \Rightarrow \text{KOH is limiting reactant}$$

b) (5) How many moles of  $\text{KClO}_3$  will form and how many moles of excess reactant will remain?

**8.00 mol KOH X ( 1 mol  $\text{KClO}_3$  /6 mol KOH) = 1.33 mol  $\text{KClO}_3$  will form**

**8.00 mol KOH X ( 3 mol  $\text{Cl}_2$  /6 mol KOH) = 4.00 mol  $\text{Cl}_2$  will react**

**6.00-4.00 = 2.00 mol  $\text{Cl}_2$  will remain**

c) (5) How many grams of KOH are needed to form 50.0 Kg of  $\text{KClO}_3$ ?

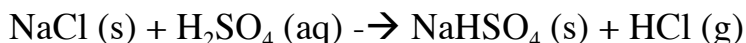
**molar mass of  $\text{KClO}_3$  = 39.10 + 35.45 + 3\*16.00 = 122.55 g/mol**

**molar mass of KOH: 39.10 + 16.00 + 1.008 = 56.11 g/mol**

**50.0 Kg  $\text{KClO}_3$  X 1000 g/Kg /122.55 (g /mol ) = 408 mol  $\text{KClO}_3$**

**408 mol  $\text{KClO}_3$  X (6 mol KOH/1 mol  $\text{KClO}_3$ ) X 56.11 g/mol /(1000 g/Kg)  
= 137 Kg KOH**

7. (10) Hydrogen chloride is prepared commercially by the reaction of sodium chloride with concentrated sulfuric acid:



If the percent yield is 81.5%, how many grams of HCl will be obtained by treating 25.0 Kg of NaCl with excess sulfuric acid?

**molar masses:**

**NaCl: 22.99+35.45 = 58.44 g/mol      HCl: 35.45+1.008=36.46 g/mol**

**25.0 Kg X 1000 (g/Kg) / (58.44 g/mol) = 428 mol NaCl**

**theoretical yield: 428 mol NaCl X (1 mol HCL/1 mol NaCl)X 36.46 g/mol / (1000g/Kg) = 15.6 Kg HCl**

**actual yield= 15.6 Kg X 81.5% = 12.7 Kg**