

**City College, Chemistry Department
Chemistry 10301, sections T and T2, Prof. T. Lazaridis
First Midterm exam, Sep. 28, 2006**

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 calcium nitrate?



- b. (4) What is the chemical formula for zinc sulfate?



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

20 protons, 18 electrons

- d. (4) What is the molar mass of carbon tetrachloride (CCl₄) ?

12.01 + 4X 35.45 = 153.81 g/mol

- e. (4) Give the atomic symbol of the elements:

argon: **Ar**

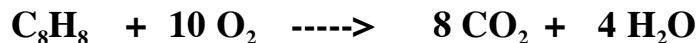
iron: **Fe**

chromium: **Cr**

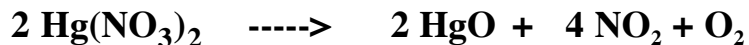
manganese: **Mn**

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

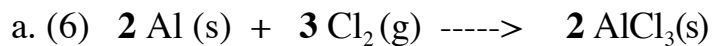
a. (6) Burning of styrene (C₈H₈) in air



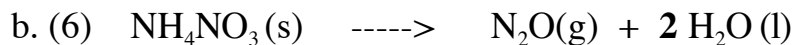
b. (6) Decomposition of mercury(II) nitrate to form solid mercury(II) oxide, gaseous nitrogen dioxide, and oxygen. (mercury: Hg)



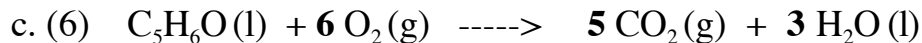
3. Balance the following chemical equations and indicate their type (combustion, combination, or decomposition):



Combination



Decomposition



Combustion

4. (15) Wine production involves the fermentation of glucose to produce ethanol and carbon dioxide:



(a) (5) How many moles of CO_2 are produced from 0.300 mol of $\text{C}_6\text{H}_{12}\text{O}_6$?

0.600 mol

(b) (5) How many grams of $\text{C}_6\text{H}_{12}\text{O}_6$ are needed to form 2.00 g of $\text{C}_2\text{H}_5\text{OH}$?

Molar mass of $\text{C}_6\text{H}_{12}\text{O}_6$: $6 \times 12.01 + 12 \times 1.008 + 6 \times 16.00 = 180.16$

Molar mass of $\text{C}_2\text{H}_5\text{OH}$: $2 \times 12.01 + 6 \times 1.008 + 16.00 = 46.07$

$2.00 \text{ g } \text{C}_2\text{H}_5\text{OH} / 46.07 \text{ (g/mol)} = 0.0434 \text{ mol } \text{C}_2\text{H}_5\text{OH}$

require

$0.0434 / 2 = 0.0217 \text{ mol } \text{C}_6\text{H}_{12}\text{O}_6$ which corresponds to

$0.0217 \text{ mol } \text{C}_6\text{H}_{12}\text{O}_6 \times 180.16 \text{ g/mol} = 3.91 \text{ g } \text{C}_6\text{H}_{12}\text{O}_6$

(c) (5) How many grams of CO_2 form when 2.00 g of $\text{C}_2\text{H}_5\text{OH}$ are produced?

Molar mass of CO_2 : $12.01 + 2 \times 16.00 = 44.01 \text{ g/mol}$

**$2.00 \text{ g (0.0434 mol) } \text{C}_2\text{H}_5\text{OH}$ corresponds to $0.0434 \text{ mol } \text{CO}_2$,
which corresponds to $0.0434 \text{ mol} \times 44.01 \text{ g/mol} = 1.91 \text{ g } \text{CO}_2$**

5. (15) Combustion analysis of toluene gives 5.86 mg of CO_2 and 1.37 mg of H_2O . If the compound contains only carbon and hydrogen, what is its empirical formula?

Amount of C in 5.86 mg CO_2 : $(12.01/44.01) \times 5.86 = 1.60 \text{ mg}$

Amount of H in 1.37 mg H_2O : $(2 \times 1.008/18.02) \times 1.37 = 0.153 \text{ mg}$

Convert to moles:

$1.60 \times 10^{-3} \text{ g C} / 12.01 \text{ (g/mol)} = 0.133 \times 10^{-3} \text{ mol}$

$0.153 \times 10^{-3} \text{ g H} / 1.008 \text{ (g/mol)} = 0.152 \times 10^{-3} \text{ mol}$

Divide by the smallest:

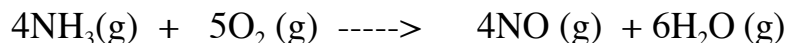
C : $0.133 \times 10^{-3} / 0.133 \times 10^{-3} = 1$

H : $0.152 \times 10^{-3} / 0.133 \times 10^{-3} = 1.14$

To make 1.14 into an integer you need to multiply by at least 7. So multiply both by 7:

Empirical formula: C_7H_8

6. (15) Consider the reaction of ammonia with oxygen



In a certain experiment 2.50 g of NH_3 reacts with 2.85 g of O_2 .

(a) (5) Which one is the limiting reagent?

Molar mass of NH_3 : $14.01 + 3 \times 1.008 = 17.03$ g/mol
Molar mass of O_2 : $2 \times 16.00 = 32.00$ g/mol
 2.50 g NH_3 / 17.03 (g/mol) = 0.147 mol
 2.85 g O_2 / 32.00 (g/mol) = 0.0891 mol
 0.0891 mol O_2 requires $0.0891 \times 4/5 = 0.0713$ mol NH_3 . We have 0.147 mol, therefore NH_3 is in excess and O_2 is the limiting reactant.

(b) (5) How many grams of NO form?

Molar mass of NO: $14.01 + 16.00 = 30.01$ g/mol

0.0891 mol O_2 will react completely and produce 0.0891 mol $\times 4/5 = 0.0713$ mol NO, which corresponds to 0.0713 mol $\times 30.01$ g/mol = 2.14 g

(c) (5) How many grams of the excess reactant remains after the limiting reactant is completely consumed?

0.0713 mol NH_3 will react. The amount remaining will be:

$0.147 - 0.0713 = 0.076$ mol, which corresponds to 0.076 mol $\times 17.03$ g/mol = 1.3 g

7. (5) Name the following compounds:

CaCl_2 **Calcium chloride**

NaClO_3 **Sodium chlorate**

KOH **Potassium hydroxide**

MgCO_3 **Magnesium carbonate**

C_3H_8 **Propane**