Problem Set 3: Molar Mass, Mass Percent, Empirical Formulas

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday September 8th, 2017

Problem 1

Consider the following isotopic abundance data for argon (Ar) and silicon (Si):

Argon			Silicon		
Isotope	Isotopic Molar Mass	Abundance	Isotope	Isotopic Molar Mass	Abundance
^{36}Ar	35.96755 g/mol	0.337%	^{28}Si	27.97693 g/mol	92.23%
^{38}Ar	37.96272 g/mol	0.063%	^{29}Si	28.97649 g/mol	4.67%
^{40}Ar	39.96240 g/mol	99.600%	^{30}Si	29.97376 g/mol	3.10%

a) Use the data to calculate the atomic masses of naturally occurring argon and silicon.

b) Calculate the number of atoms in 78.2 g of naturally occuring Si.

c) ^{42}Ar is one of the longest lived radioactive isotopes of Argon. Mass spectroscopy data yields the following ratio of the mass of ^{42}Ar to ^{40}Ar:

$$\frac{\text{Mass of } ^{42}\text{Ar}}{\text{Mass of } ^{40}\text{Ar}} = 1.05006$$

use this ratio to find the atomic mass of ^{42}Ar.

Problem 2

Calculate the mass percent of oxygen in each of the following compounds: (a) SO_2; (b) Na_2SO_4; (c) C_2H_5COOH; (d) $Al(NO_3)_3$; (e) NH_4NO_3

Problem 3

Very small crystals composed of 1000 to 100,000 atoms, called quantum dots, are often investigated for use in electronic devices.

a) Calculate the mass in grams of a quantum dot consisting of 10,000 atoms of silicon.

b) Assuming that the silicon dot has a density of 2.3 g/cm^3, calculate its volume.

c) Assuming that the dot has the shape of a cube, calculate the length of each edge of the cube.

Problem 4

What is the molecular formula for each of the following compounds:

a) empirical forumla: NH_2Cl, molar mass = 51.5 g/mol

b) empirical forumla: CH_2, molar mass = 84.0 g/mol

c) empirical forumla: HCO_2, molar mass = 90.0 g/mol

d) empirical forumla: C_2H_4O, molar mass = 88.0 g/mol

Problem 5

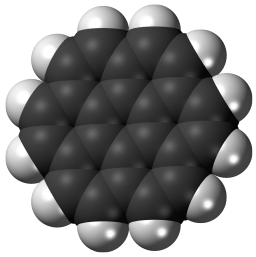
The koala dines exclusively on eucalyptus leaves. Its digestive system detoxifies the eucalyptus oil, a poison to other animals. The chief constituent in eucalyptus oil is a substance called eucalyptol, which contains 77.87% C, 11.76% H, and the remainder O.

a) What is the empirical formula for this substance?

b) A mass spectrum of eucalyptol reveals its molar mass to be 154 amu. What is the molecular formula for this substance?

Problem 6

Coronene is a compound that contains **ONLY** carbon and hydrogen. The space-filling model for this compound is shown below. Combustion analysis of a 1.3g sample of coronene produces 4.58 g of CO_2 and 0.45 g of H_2O. The molar mass of coronene is 300.35 g/mol.



a) Using this information, determine the empirical and molecular formulas of coronene.

b) Another compound with yields the exact same combustion data as coronene, however, has a mass of 100.12 g/mol. Propose a molecular formula for this compound.