AP CHEMISTRY

TOPIC 1: CHEMICAL FOUNDATIONS, PART D

Day 5:

- Atomic Masses
- The mole
- Molar mass

Homework problems:

1) The atomic mass for sulfur is given in the periodic table as 32.06, yet no single atom of sulfur has a mass of 32.06 amu. Explain how this atomic mass is possible.

Answer:

The atomic mass for sulfur (on the periodic table) is 32.06 amu because of all the isotopes of sulfur. Recall, the number of protons and neutrons determine the molar mass of the atom. Since the number of protons IDENTIFIES the element, there are different numbers of neutrons for the isotopes.

2) An element consists of 8.90% of an isotope with a mass of 203.0 amu, 1.50% of an isotope with a mass of 205.0 amu, 22.20% of an isotope with a mass of 206.0 amu, 50.50% of an isotope with a mass of 208.0 amu, and 16.90% of an isotope with a mass of 209.0 amu. Calculate the average atomic mass and identify the element.

Answer:

0.0890	***x***	***203.0***	***=***	***18.067 amu***
0.0150	***x***	***205.0***	***=***	***3.075 amu***
0.2220	***x***	***206.0***	***=***	***45.732 amu***
0.5050	***x***	***208.0***	***=***	***105.040 amu***
0.1690	***x***	***209.0***	***=***	***35.321 amu***
				207.235 amu

Lead, Pb

3) Calculate the mass of 4000 atoms of iron.

Answer:

$$\frac{4000\ atoms\ Fe}{} \times \frac{1\ mol\ Fe}{6.02\times10^{23}\ atoms\ Fe} \times \frac{55.85\ grams}{1\ mol\ Fe} = 4\times10^{-19}\ g\ \ ;\ \ (3.71\times10^{-19}\ g)$$

4) Aluminum metal is produced by passing an electric current through a solution of aluminum oxide (Al_2O_3) dissolved in molten cryolite (Na_3AlF_6). Calculate the molar masses of Al_2O_3 and Na_3AlF_6.

Answer:

Al_2O_3 : (2)26.98 g + (3)16.00 g = 101.96 g

Na_3AlF_6 : (3)22.99 g + 26.98 g + (6) 19.00 g = 209.95 g

5) Ascorbic acid, or vitamin C ($C_6H_8O_6$), is an essential vitamin. It cannot be stored by the body and must be present in the diet. What is the molar mass of ascorbic acid? **PART 2,** Vitamin C tablets are taken as a dietary supplement. If a typical tablet contains 500.0 mg of vitamin C, how many molecules does the tablet contain?

Answer:

$C_6H_8O_6$ = (6) 12.01 g + (8) 1.008 g + (6) 16.00 g = 176.12 g

$$\frac{500\ mg\ C_6H_8O_6}{} \times \frac{1\ gram}{1000\ mg} \times \frac{1\ mole\ C_6H_8O_6}{176.12\ grams} \times \frac{6.02\times10^{23}\ molecules}{1\ mol} = 2\times10^{21}\ _{molcules}\ ;\quad (1.71\times10^{21})$$

6) How many moles are represented in the following samples?

a) 150.0 grams of iron(III) oxide

Answer:

$$\frac{150.0\ g\ Fe_2O_3}{} \times \frac{1\ mole\ Fe_2O_3}{(2)55.85g + (3)16.00g} = 0.9393\ mole$$

b) 1.5 x 10^{20} molecules of sulfur trioxide

Answer:

$$\frac{1.5\times10^{20}\ molecules\ SO_3}{} \times \frac{1\ mole\ SO_3}{6.02\times10^{23}\ molecules} = 2.5\times10^{-4}\ mole$$

7) Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed as Nutra-Sweet. The molecular formula for aspartame is $C_{14}H_{18}N_2O_5$.

a) Calculate the molar mass of aspartame

Answer:

$C_{14}H_{18}N_2O_5$ = (14) 12.01 g + (18) 1.008 g + (2) 14.01 g + (5) 16.00 g = 294.304 g

b) How many molecules of aspartame are present in 15.0 grams of aspartame?

Answer:

$$\frac{15.0\ g\ C_{14}H_{18}N_2O_5}{} \times \frac{1\ mole\ C_{14}H_{18}N_2O_5}{294.304\ grams} \times \frac{6.02\times10^{23} molecules}{1\ mole} = 3.07\times10^{22}\ molecules$$

c) How many atoms of nitrogen are in a 3.7 gram sample of aspartame?

Answer:

$$\frac{3.7\ g\ C_{14}H_{18}N_2O_5}{} \times \frac{1\ mole\ C_{14}H_{18}N_2O_5}{294.304\ grams} \times \frac{6.02\times10^{23}\ molecules}{1\ mole} \times \frac{2\ atoms\ N}{1\ molecule\ C_{14}H_{18}N_2O_5} = 1.5\times10^{22}\ atoms\ N$$

d) What is the mass (in grams) of 1.0 x 10^{11} molecules of aspartame?

Answer:

$$\frac{1.0\times10^{11}\ molecules\ C_{14}H_{18}N_2O_5}{} \times \frac{1\ mole}{6.02\times10^{23}\ molecules} \times \frac{294.304\ grams}{1\ mole} = 4.9\times10^{-11}\ g$$