ANSWER KEY

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1.3 Elemental Composition of Pure Substances

AP Chemistry | ANSWER KEY

Use a periodic table. Show all work with units and correct significant figures.

1. Calculate the percent composition by mass of each element in ammonium sulfate, $(NH_4)_2SO_4$.

M = 2(14.01) + 8(1.008) + 32.07 + 4(16.00) = 132.15 g/mol
N: 28.02/132.15 = 21.20% H: 8.064/132.15 = 6.10%
S: 32.07/132.15 = 24.27% O: 64.00/132.15 = 48.43% (total 100.00%)

2. Without calculating, decide which has the greater mass percent of oxygen, CO or CO_2. Justify your answer.

CO_2. Both have one carbon, but CO_2 has two oxygen atoms for every carbon instead of one, so oxygen makes up a larger share of the mass (72.7% vs. 57.1%).

3. A hydrocarbon is 85.6% carbon and 14.4% hydrogen by mass. Determine its empirical formula.

Assume 100 g: 85.6 g C ÷ 12.01 = 7.13 mol; 14.4 g H ÷ 1.008 = 14.3 mol
Divide by 7.13: C = 1, H = 2.00. Empirical formula: CH_2

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4. When magnesium burns in nitrogen, 1.459 g of Mg combines with 0.561 g of N. Determine the empirical formula of the product.

1.459 g ÷ 24.31 g/mol = 0.06002 mol Mg; 0.561 g ÷ 14.01 g/mol = 0.04004 mol N
Divide by 0.04004: Mg = 1.50, N = 1. Multiply by 2: Mg_3N_2

5. Caffeine is 49.5% C, 5.15% H, 28.9% N, and 16.5% O by mass, and its molar mass is 194.2 g/mol. Determine (a) the empirical formula and (b) the molecular formula.

(a) C: 49.5/12.01 = 4.12; H: 5.15/1.008 = 5.11; N: 28.9/14.01 = 2.06; O: 16.5/16.00 = 1.03 mol
Divide by 1.03: 4 : 5 : 2 : 1, so $C_4H_5N_2O$ (97.10 g/mol)
(b) 194.2 ÷ 97.10 = 2, so $C_8H_{10}N_4O_2$

6. Sample A contains 2.00 g S and 2.00 g O. Sample B contains 3.50 g S and 5.25 g O. Are they the same compound? Use the law of definite proportions, then find each empirical formula.

Mass ratio O : S is 1.00 for A and 1.50 for B, so they are different compounds.
A: 0.0624 mol S, 0.125 mol O, 1 : 2, SO_2. B: 0.109 mol S, 0.328 mol O, 1 : 3, SO_3

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