~~42~~ 49

AP Free Response Practice #2 [10 points]

2. Lysine is an amino acid which has the following elemental composition: C, H, O, N. It is found in the protein of foods such as beans, cheese, yogurt, meat, milk, brewer's yeast, wheat germ, and other animal proteins. The average 70 kg human needs 800 – 3,000 mg of lysine daily. In one experiment, 2.175 g of lysine was combusted to produce 3.94 g of CO_2 and 1.89 g H_2O. The molar mass of lysine is approximately 150 g/mol.

   a) Determine the mass, in grams, of each of the following in the 2.175 g sample of lysine.
      i. carbon [*1 point*]
      ii. hydrogen [*1 point*]

   b) In a separate experiment, 1.873 g of lysine was burned to produce 0.436 g of NH_3.
      i. Determine the mass, in grams, of N in the 1.873 g sample of lysine. [*1 point*]
      ii. Determine mass percent of each element in lysine. [*2 points*]

   c) Determine the mass, in grams, of O in the original 2.175 g sample of lysine. [*1 point*]

   d) Using information derived from the provided data, determine the empirical formula of lysine. [*3 points*]

   e) Determine the molecular formula of lysine. [*1 point*]

(a)(i) $3.94\text{ g } CO_2 \times \frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2} \times \frac{1\text{ mol C}}{1\text{ mol } CO_2} \times \frac{12.01\text{ g C}}{1\text{ mol C}} = \boxed{1.08\text{ g C}}$

(ii) $1.89\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.016\text{ g } H_2O} \times \frac{2\text{ mol H}}{1\text{ mol } H_2O} \times \frac{1.008\text{ g H}}{1\text{ mol H}} = \boxed{0.211\text{ g H}}$

(b)(i) $0.436\text{ g } NH_3 \times \frac{1\text{ mol } NH_3}{17.034\text{ g } NH_3} \times \frac{1\text{ mol N}}{1\text{ mol } NH_3} \times \frac{14.01\text{ g N}}{1\text{ mol N}} = \boxed{0.359\text{ g N}}$

(ii) C: $1.08\text{ g}/2.175\text{ g} \times 100 = 49.7\%$
H: $0.211\text{ g}/2.175\text{ g} \times 100 = 9.70\%$
N: $0.359\text{ g}/1.873\text{ g} \times 100 = 19.2\%$
O: $100 - 49.7 - 9.70 - 19.2 = 21.4\%$

(c) $2.175\text{ g} \times 0.214 = \boxed{0.465\text{ g O}}$

(d) C: $49.7\text{ g}/12.01\text{ g/mol} = 4.14\text{ mol}$; $\div 1.34$; ≈ 3
H: $9.70\text{ g}/1.008\text{ g/mol} = 9.62\text{ mol}$; $\div 1.34$; ≈ 7
N: $19.2\text{ g}/14.01\text{ g/mol} = 1.37\text{ mol}$; $\div 1.34$; ≈ 1
O: $21.4\text{ g}/16.00\text{ g/mol} = 1.34$; $\div 1.34$; $= 1$
$\boxed{C_3H_7NO}$

(e) $\frac{\text{mol. weight}}{\text{FW(empirical)}} = \frac{150}{73.096}$

$= 2 \times C_3H_7NO$

$= \boxed{C_6H_{14}N_2O_2}$