The organic solvent thiophene is a carbon-hydrogen-sulfur compound that yields CO₂, H₂O, and SO₂ on complete combustion. When subjected to combustion analysis, a 1.086-g sample of thiophene produces 2.272 g CO₂, 0.465 g H₂O, and 0.827 g SO₂. What is the empirical formula of thiophene?

Solution:

The goal of the problem is to determine the simplest formula for CₓHᵧSᵦ. One way to approach the problem is to determine the percentage composition of C, H, and S. Alternatively, the mole quantity of each element can simply be calculated using the mass of each product.

\[ n_C = \frac{2.272 \text{ g CO}_2}{44.01 \text{ g mol}^{-1}} \times \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.05162 \text{ mol C} \]

\[ n_H = \frac{0.465 \text{ g H}_2\text{O}}{18.015 \text{ g mol}^{-1}} \times \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.05162 \text{ mol H} \]

\[ n_S = \frac{0.827 \text{ g H}_2\text{O}}{64.06 \text{ g mol}^{-1}} \times \frac{1 \text{ mol S}}{1 \text{ mol SO}_2} = 0.01291 \text{ mol S} \]

Now, normalize to the least common multiple (i.e., divide by the smallest n)....

\[ x = 4 \]
\[ y = 4 \]
\[ z = 1 \]

so the empirical formula is C₄H₄S