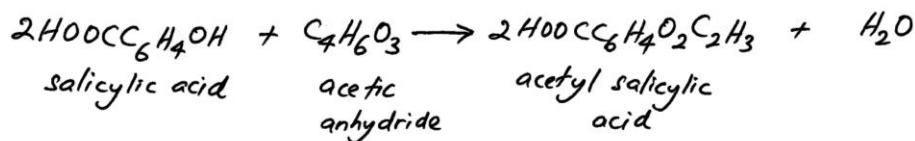


Example 3



Calculate the theoretical yield of acetyl salicylic acid that can be made from 35.0g salicylic acid and 50.0g acetic anhydride. If the percent yield of the reaction is 92%, what is the actual yield of acetyl salicylic acid?

Solution: It is a limiting-reactant problem.

$$n(\text{salicylic acid}) = \left(\frac{35.0}{138}\right) = 0.254 \text{ mol}$$

$$n(\text{anhydride}) = \left(\frac{50.0}{102}\right) = 0.490 \text{ mol}$$

ratio moles of the reactants :

$$r_{\text{theoretical}} = \frac{n(\text{salicylic acid})}{n(\text{anhydride})} = \frac{2}{1} = 2.0$$

$$r_{\text{experimental}} = \frac{n(\text{salicylic acid})}{n(\text{anhydride})} = \frac{0.254}{0.490} = 0.52$$

$$r_{\text{experimental}} < r_{\text{theoretical}}$$

(0.52) (2.0)

This is due to the numerator is small (salicylic acid = limiting reactant), whereas the denominator is big (anhydride - excess)

$$n_{\text{acetyl product}} = n_{\text{salicylic acid}} \quad (\because n_{\text{acetyl}} : n_{\text{salicylic acid}} = 2 : 2)$$

$$= 0.254 \text{ mol}$$

$$m_{\text{acetyl product}} = (0.254 \times 180 \text{ g mol}^{-1}) = \underline{45.72 \text{ g}} \text{ (theoretical yield)}$$

$$\text{Actual yield} = (\% \text{ yield}) (\text{theoretical yield}) \div 100$$

$$= \left(\frac{92 \times 45.72}{100}\right) \text{ g} = \underline{42.09 \text{ g}} \text{ (Ans)}$$

$$M_r(\text{salicylic acid}) = 138 \text{ g mol}^{-1}$$

$$M_r(\text{anhydride}) = 102 \text{ g mol}^{-1}$$

$$M_r(\text{acetyl sal. acid}) = 180 \text{ g mol}^{-1}$$