

Question

What is the percentage purity of 10 g KMnO_4 if it reacts with 100 ml of 10% volume H_2O_2 solution?

Solution

$$V(\text{H}_2\text{O}_2) = V(\text{solution}) \cdot 10/100 = 100 \cdot 10/100 = 10 \text{ ml}$$

$$\text{Density of pure } \text{H}_2\text{O}_2 - \rho(\text{H}_2\text{O}_2) = 1.45 \text{ g/ml}$$

$$m(\text{H}_2\text{O}_2) = V(\text{H}_2\text{O}_2) \cdot \rho(\text{H}_2\text{O}_2) = 10 \cdot 1.45 = 14.5 \text{ g}$$

$$\text{Molar weight of hydrogen peroxide} - M(\text{H}_2\text{O}_2) = 34 \text{ g/mol}$$

$$n(\text{H}_2\text{O}_2) = m(\text{H}_2\text{O}_2)/M(\text{H}_2\text{O}_2) = 14.5/34 = 0.43 \text{ mol}$$

The reaction equation is as follows



2 mol of KMnO_4 react with 3 mol of H_2O_2

$$n(\text{KMnO}_4) = n(\text{H}_2\text{O}_2) \cdot 2/3 = 0.43 \cdot 2/3 = 0.28 \text{ mol}$$

$$\text{Molar weight of potassium permanganate} - M(\text{KMnO}_4) = 158 \text{ g/mol}$$

$$m(\text{KMnO}_4) = n(\text{KMnO}_4) \cdot M(\text{KMnO}_4) = 0.28 \cdot 158 = 43.3 \text{ g}$$

So, the task condition is incorrect!

100 ml of 10% volume H_2O_2 solution reacts with much greater amount of potassium permanganate. If 10 g of KMnO_4 reacts with 100 ml of 10% volume H_2O_2 solution there is unreacted hydrogen peroxide.

(Even in acidic medium: $2\text{KMnO}_4 + 5\text{H}_2\text{O}_2 + 3\text{H}_2\text{SO}_4 \rightarrow 2\text{MnSO}_4 + \text{K}_2\text{SO}_4 + 5\text{O}_2 + 8\text{H}_2\text{O}$)

$$n(\text{KMnO}_4) = n(\text{H}_2\text{O}_2) \cdot 2/5 = 0.43 \cdot 2/5 = 0.14 \text{ mol}; m(\text{KMnO}_4) = n(\text{KMnO}_4) \cdot M(\text{KMnO}_4) = 0.14 \cdot 158 = 22.1 \text{ g but not 10 g !}$$

If the task condition would be correct the last step would be as follows

$$\text{Purity, \%} = m(\text{KMnO}_4)/m(\text{KMnO}_4)_{\text{given}} \cdot 100 = 43.3/10 \cdot 100 = 433 \text{ \%}$$