

Year 12 Chemistry

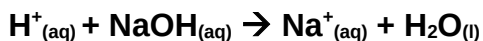
Volumetric Calculations Worksheet 1 ANSWERS

1. White wine contains a number of weak acids that contribute to the overall character of the wine. However, if too much acid is present, the white wine may become 'undrinkable'. In the analysis of one batch of white wine, a chemist titrated some wine with a standard sodium hydroxide solution using phenolphthalein as the indicator.

The results of the experiment are summarised below.

- Concentration of standard sodium hydroxide solution = $0.1030 \text{ mol L}^{-1}$
- Aliquot of white wine used = 25.00 mL
- Average of three concordant titres = 14.78 mL

Determine the amount, in mole, of $\text{H}^+_{(\text{aq})}$ available for reaction with a base in a 100 mL sample of this wine.



$$n(\text{NaOH}) = cV = 0.1030 \times 0.01478 = 0.00152234 \text{ mol}$$

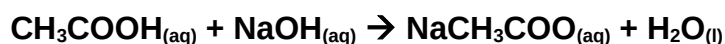
$$\text{SR} = 1/1 = 1$$

$$n(\text{H}^+) = \text{SR} \times n(\text{NaOH}) = 1 \times 0.00152234 = 0.00152234 \text{ mol}$$

$$c(\text{H}^+ \text{ in wine}) = n/V = 0.00152234 / 0.025 = 0.0608936 \text{ mol L}^{-1}$$

$$\begin{aligned} n(\text{H}^+ \text{ in } 100 \text{ mL}) &= cV = 0.0608936 \times 0.1 = 0.00608936 \text{ mol} \\ &= 0.006089 \text{ mol (4 sf)} \end{aligned}$$

2. A particular brand of vinegar was analysed to determine the acetic acid content. A 22.17 g sample of the vinegar was diluted with distilled water to 250.0 mL in a volumetric flask. A 20.00 mL aliquot of 0.1146 mol L⁻¹ sodium hydroxide was placed in a conical flask and titrated with the diluted vinegar solution to a phenolphthalein end point. The average of three concordant titres of diluted vinegar was 33.45 mL. Calculate the percentage by mass of acetic acid in the vinegar.



$$n(\text{NaOH}) = cV = 0.1146 \times 0.020 = 0.002292 \text{ mol}$$

$$\text{SR} = \text{unknown/known} = 1/1 = 1$$

$$n(\text{CH}_3\text{COOH in titration}) = \text{SR} \times n(\text{NaOH}) = 1 \times 0.002292 = 0.002292 \text{ mol}$$

$$c(\text{CH}_3\text{COOH in titration}) = n/V = 0.002292 / 0.03345 = 0.0685202 \text{ mol L}^{-1}$$

Therefore

$$c(\text{CH}_3\text{COOH in volumetric flask after dilution}) \text{ also} = 0.0685202 \text{ mol L}^{-1}$$

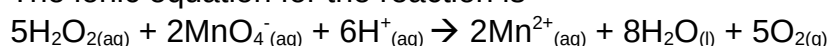
$$n(\text{CH}_3\text{COOH in volumetric flask after dilution}) = cV = 0.0685202 \times 0.2500 = 0.01713 \text{ mol}$$

$$m(\text{CH}_3\text{COOH in volumetric flask}) = nM = 0.01713 \times ((2 \times 12.01) + (2 \times 16.00) + (4 \times 1.008)) = 1.02869 \text{ g}$$

$$\% \text{ by mass} = (1.02869 / 22.17) \times 100 = 4.640 \% (4 \text{ sf})$$

3. Hydrogen peroxide is used as a mild bleaching agent. Analysis of a sample of hydrogen peroxide can be carried out by using potassium permanganate in a redox reaction. While checking a sample of commercial peroxide bleach, a chemist transfers 10.00 mL of the peroxide solution to a 250.0 mL volumetric flask and makes it up to the calibrated mark with deionised water. A 25.00 mL aliquot of the diluted peroxide solution, mixed with acid, is titrated with a standardized solution of potassium permanganate of concentration 0.01894 mol L⁻¹. The average of three concordant titres of permanganate is 28.68 mL. Determine the concentration of hydrogen peroxide in the commercial bleach solution and the percentage by mass. Assume the density of the original peroxide bleach is 1 g mL⁻¹.

The ionic equation for the reaction is



$$n(\text{KMnO}_4) = n(\text{MnO}_4^{-}) = cV = 0.01894 \times 0.02868 = 0.0005431992 \text{ mol}$$

$$\text{SR} = \text{unknown/known} = 5/2 = 2.5$$

$$n(\text{H}_2\text{O}_2) = \text{SR} \times n(\text{KMnO}_4) = 2.5 \times 0.0005431992 = 0.001357998 \text{ mol}$$

$$c(\text{diluted H}_2\text{O}_2) = n / V = 0.001357998 / 0.025 = 0.05431992 \text{ mol L}^{-1}$$

$$c_1V_1 = c_2V_2$$

$$c_1 = c(\text{undiluted H}_2\text{O}_2) = c_2V_2/V_1 = 0.05431992 \times 250/10 = 1.357998 \text{ mol L}^{-1}$$

$$= \mathbf{1.358 \text{ mol L}^{-1} (4 \text{ sf})}$$

$$\text{Density} = \rho = m / V$$

$$\text{Mass of 1 litre} = \rho V = 1 \times 1000 = 1000 \text{ g}$$

$$m(\text{H}_2\text{O}_2 \text{ in 1 litre}) = nM = 1.357998 \times 34.016 = 46.193659968 \text{ g}$$

$$\% \text{ composition by mass} = (46.193659968 / 1000) \times 100 = 4.6193659968 \%$$

$$= \mathbf{4.619 \% (4 \text{ sf})}$$