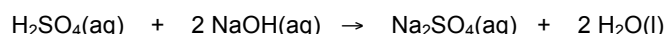




TITRATIONS 2

- 1 25.0 cm³ of a solution of sodium hydroxide solution required 21.5 cm³ of 0.100 mol/dm³ sulfuric acid for neutralisation.



- a Find the concentration of the sodium hydroxide solution in mol/dm³. Give your answer to 3 significant figures.

$$\text{moles H}_2\text{SO}_4 = \text{conc} \times \text{vol} (\text{dm}^3) = 0.100 \times \frac{21.5}{1000} = 0.00215 \text{ mol}$$

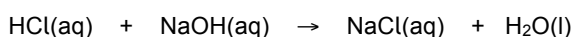
$$\text{moles NaOH} = 2 \times \text{moles of H}_2\text{SO}_4 = 2 \times 0.00215 = 0.00430 \text{ mol}$$

$$\text{conc NaOH} = \frac{\text{moles}}{\text{volume} (\text{dm}^3)} = \frac{0.00430}{\frac{25.0}{1000}} = 0.172 \text{ mol/dm}^3$$

- b Find the concentration of the sodium hydroxide solution in g/dm³. Give your answer to 3 significant figures.

$$\text{conc NaOH} = 40 \times 0.172 = 6.88 \text{ g/dm}^3$$

- 2 Find the volume of 1.20 mol/dm³ hydrochloric acid that reacts with 25.0 cm³ of 1.50 mol/dm³ sodium hydroxide. Give your answer to 3 significant figures.

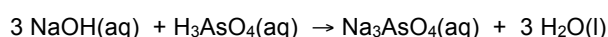


$$\text{moles NaOH} = \text{conc} \times \text{vol} (\text{dm}^3) = 1.50 \times \frac{25.0}{1000} = 0.0375 \text{ mol}$$

$$\text{moles HCl} = \text{moles of NaOH} = 0.0375 \text{ mol}$$

$$\text{volume HCl} = \frac{\text{moles}}{\text{conc}} = \frac{0.0375}{0.120} = 0.313 \text{ dm}^3$$

- 3 25.0 cm³ of arsenic acid, H₃AsO₄, required 37.5 cm³ of 0.100 mol/dm³ sodium hydroxide for neutralisation.



- a Find the concentration of the arsenic acid in mol/dm³. Give your answer to 3 significant figures.

$$\text{moles NaOH} = \text{conc} \times \text{vol} (\text{dm}^3) = 0.100 \times \frac{37.5}{1000} = 0.00375 \text{ mol}$$

$$\text{moles H}_3\text{AsO}_4 = \frac{1}{3} \times \text{moles of NaOH} = \frac{1}{3} \times 0.00375 = 0.00125 \text{ mol}$$

$$\text{conc H}_3\text{AsO}_4 = \frac{\text{moles}}{\text{volume} (\text{dm}^3)} = \frac{0.00125}{\frac{25.0}{1000}} = 0.0500 \text{ mol/dm}^3$$

- b Find the concentration of the arsenic acid in g/dm³. Give your answer to 3 significant figures.

$$\text{conc H}_3\text{AsO}_4 = 142 \times 0.0500 = 7.10 \text{ g/dm}^3$$

- 4 What volume of 0.0400 mol/dm³ calcium hydroxide just neutralises 25.0 cm³ of 0.100 mol/dm³ nitric acid? Give your answer to 3 significant figures

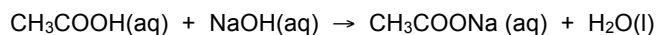


$$\text{moles HNO}_3 = \text{conc} \times \text{vol} (\text{dm}^3) = 0.100 \times \frac{25.0}{1000} = 0.00250 \text{ mol}$$

$$\text{moles Ca}(\text{OH})_2 = \frac{1}{2} \times \text{moles of HNO}_3 = \frac{1}{2} \times 0.00250 = 0.00125 \text{ mol}$$

$$\text{volume Ca}(\text{OH})_2 = \frac{\text{moles}}{\text{conc}} = \frac{0.00125}{0.0400} = 0.0313 \text{ dm}^3$$

- 5 A series of titrations was carried out to find the concentration of the ethanoic acid in white vinegar.



In each titration, a student placed 25.0 cm³ samples of the vinegar in a conical flask. She then added a few drops of the indicator phenol red. She titrated the vinegar against a solution of sodium hydroxide with concentration 0.100 mol/dm³. She recorded the results in the table below.

	titration 1	titration 2	titration 3	titration 4
start reading / cm ³	0.0	23.5	0.1	22.8
final reading / cm ³	23.5	46.9	22.8	46.1
volume used / cm ³	23.5	23.4	22.7	23.3

- a Name the piece of apparatus that should be used to measure the 25.0 cm³ samples of the vinegar into the conical flask.

pipette

- b Name the piece of apparatus that is used for the sodium hydroxide solution. **burette**

- c Complete the table to show the volume used in each titration.

- d Calculate the mean volume of sodium hydroxide, leaving out any anomalous results.

$$\frac{(23.5 + 23.4 + 23.3)}{3} = 23.4 \text{ cm}^3$$

- e Find the concentration of the ethanoic acid in mol/dm³. Give your answer to 3 significant figures.

$$\text{moles NaOH} = \text{conc} \times \text{vol} (\text{dm}^3) = 0.100 \times \frac{23.4}{1000} = 0.00234 \text{ mol}$$

$$\text{moles CH}_3\text{COOH} = \text{moles NaOH} = 0.00234 \text{ mol}$$

$$\text{conc CH}_3\text{COOH} = \frac{\text{moles}}{\text{volume} (\text{dm}^3)} = \frac{0.00234}{\frac{25.0}{1000}} = 0.0936 \text{ mol/dm}^3$$

- f Find the concentration of the ethanoic acid in g/dm³. Give your answer to 3 significant figures.

$$\text{conc CH}_3\text{COOH} = 60 \times 0.0936 = 5.62 \text{ g/dm}^3$$

- g Explain why this titration may have been difficult to do with brown vinegar.

Hard to see the colour of the indicator as the vinegar is brown

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can convert mol/dm ³ to g/dm ³			Can find mean (excluding anomalous)		
Shows suitable working			Does not round too much			Understands issue of coloured solution		
Can work out moles from conc & vol			Can use sig figs			Gives units		
Uses equation for other reactant moles			Can use readings to find titres					
Can find conc or vol of other reagent			Can name suitable apparatus					