Taking it Further: Titration Calculations

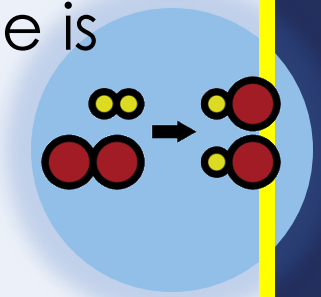
Answer the questions below.

1. State two possible units for concentration.
   g/dm³ or mol/dm³
2. Define concentration.
   The mass (or amount) of solute per given volume of solvent.
3. State the equation that links amount of substance (number of moles), concentration and volume.

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

4. Calculate the relative formula mass of sodium hydroxide (NaOH).
   23+16+1 = 40
5. Calculate the concentration when 0.25 mol of sodium hydroxide is dissolved to make 200 cm³ of solution.

$$\text{Concentration} = \frac{0.25}{0.2} = 1.25\ \text{mol/dm}^3$$



Do Now

Taking it Further: Titration Calculations

Do Now:

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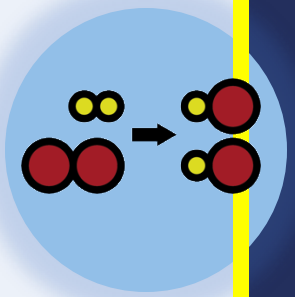
2. Define concentration.
3. State the equation that links amount of substance (number of moles), concentration and volume.
4. Calculate the relative formula mass of sodium hydroxide (NaOH).
5. Calculate the concentration when 0.25 mol of sodium hydroxide is dissolved to make 200 cm^3 of solution.

Drill:

1. State the unit for amount of substance.
2. State the unit for volume.
3. Convert 50 cm3 to dm3.



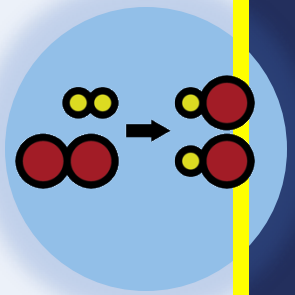
Do Now

Taking it Further: Titration Calculations

Read Now:

Titrations are used to determine the concentration of reactant, based on the known concentration of another reactant. However, these titrations rely on colour changes being seen from the action of an indicator, such as phenolphthalein. But what happens for scientists that are colour-blind or visually impaired? Scientists at the Indian Institute of Science Education and Research in Kolkata have designed a smartphone app that can be used as a multi-sensory tool for detecting the end point of a titration. The app uses the phone's camera to identify the end point of the titration, notifying the investigator that the titration is complete.

1. Describe the function of a titration.
2. Explain what is meant by the end point of a titration.
3. Explain the function of an indicator in a titration.
4. Briefly describe how this app could be useful to visually impaired scientists.

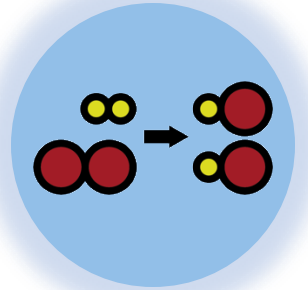


Do Now

Taking it Further: Titration Calculations

C4.3.13

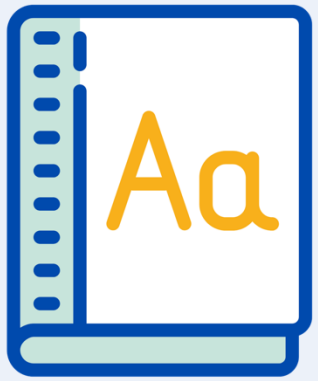
Science Mastery



Following this lesson, students will be able to:

- Explain the purpose of a titration
- Use the equation that links concentration, volume and amount of substance
- Use mole ratios to calculate an unknown concentration

Key Words:



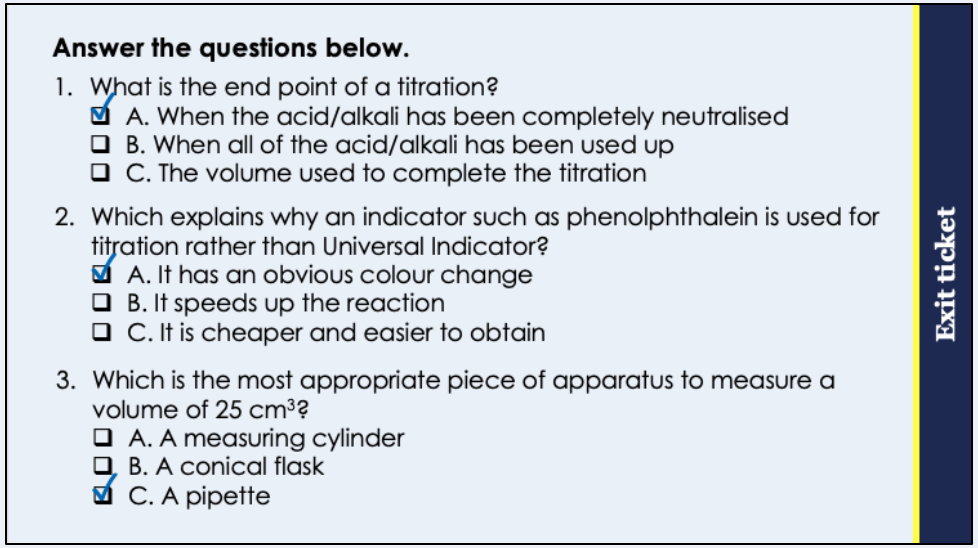
acid	**alkali**	**titration**	**neutralisation**
titre	**concordant**	**concentration**	**moles**

Lesson Objectives

This is the fix-it portion of the lesson

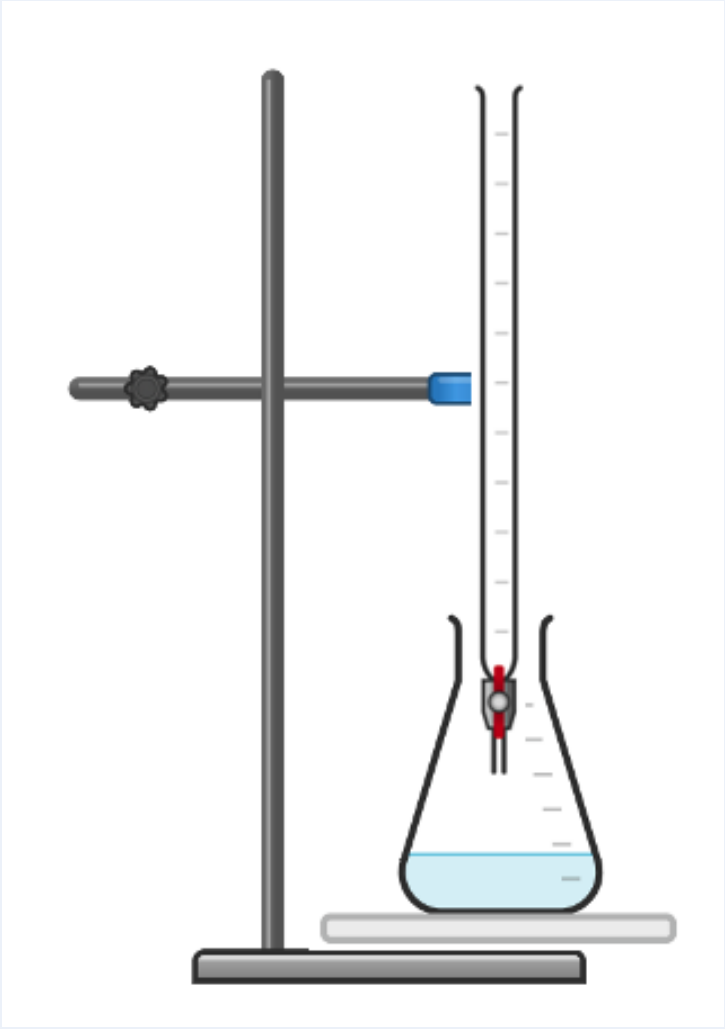
The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.



Fix-it

Titration



We know the volume and concentration of one reactant, which is in the conical flask.

We can calculate the **number** of **moles** of this reactant that reacted.

We can use the balanced chemical equation to determine the number of moles of the other reactant that reacted.

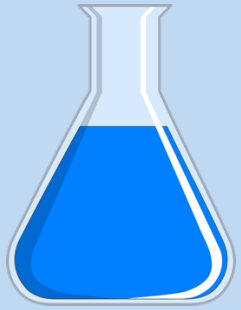
We can then calculate this **unknown concentration** using the **number** of **moles** that reacted and the **volume** of it that was required.

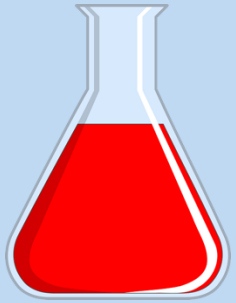
Calculating an Unknown Concentration

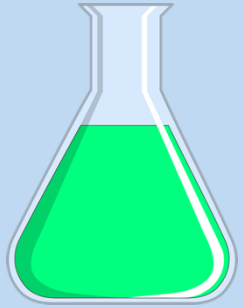
Higher Tier only

Sodium hydroxide + sulfuric acid → sodium sulfate + water

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$







Volume = 25 dm³
Concentration = 0.02 mol/dm³

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

$$\text{number of moles} = \textit{concentration x volume}$$

$$\text{number of moles} = 0.02 \times 25$$

$$= 0.5 \text{ moles}$$

Volume = 15 dm³
Concentration = ?

The molar ratio of alkali : acid is 2 : 1, or 0.5 : 0.025

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

$$\text{Concentration} = \frac{0.025}{15} = 0.002 \text{ mol/dm3}$$

Calculate your unknown concentration

Sodium hydroxide + sulfuric acid → sodium sulfate + water

$2NaOH$ + **H_2SO_4** → **Na_2SO_4** + **$2H_2O$**

2 : **1**

We used 25 cm^3 of 0.1 mol/dm^3 sodium hydroxide solution.

What is the mole ratio?

2 : 1

How many moles of sulfuric acid reacted?

0.00125 mol

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

$$0.1 = \frac{\text{number of moles}}{0.025}$$

$$\text{number of moles} = 0.0025 \text{ mol}$$

Calculate your unknown concentration

Sodium hydroxide + sulfuric acid → sodium sulfate + water

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Titration	Volume of acid used (cm^3)
1	18.7
2	16.5
3	16.5
4	16.6
5	16.9

How many moles of sulfuric acid reacted?

0.00125 mol

Which of these results are concordant?

What is the mean volume of acid used?

$$\text{Mean} = \frac{16.5 + 16.5 + 16.6}{3}$$

$$\text{Mean} = 16.53\ \text{cm3}$$

What is the concentration of acid used?

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

$$\text{Concentration} = \frac{0.00125}{0.01653}$$

$$\text{Concentration} = 0.076\ \text{mol/dm3}$$

Is this correct?

The reactant in a titration with the unknown concentration always has to be the alkali.

Talk Task

Which values should we use?

A student performs a titration 5 times.
They obtain these results for the volume of alkali needed to neutralise a known volume and concentration of acid.

Titration	Volume of alkali used (cm^3)
1	24.2
2	21.80
3	21.75
4	21.80
5	21.75

The student want to use the values to determine the concentration of the alkali.

What values should they use?
Why?
How should they use these results?
What is the name for these results?
What do these results fall within?

Talk Task

True or false?

1. Volume can be measured in cm^3 **True**
2. Number of moles is measured in mol **True**
3. Concentration is measured in dm^3 **False**
4. Concordant results fall within 0.5 cm^3 of each other. **False**

Check for understanding

Drill

1. Describe the function of a titration.
2. Give the name for the volume of liquid that is measured using a titration.
3. Define concordant results.
4. State the equation that links concentration, number of moles and volume.
5. State the unit for concentration.
6. State the unit for number of moles.
7. State the unit for volume that should be used in calculations.
8. Convert 25 cm^3 to dm^3.

Check for understanding

Drill answers

1. To determine an unknown concentration.
2. Titre
3. Results that fall within 0.2 cm^3 of each other.
4. $Concentration = \frac{number\ of\ moles}{volume}$
5. mol/dm^3 (or g/dm^3)
6. mol
7. dm^3
8. 0.025 dm^3

Check for understanding

Answer the questions below.

1. What is the purpose of a titration?
   - ☑ A. To determine an unknown concentration
   - ☐ B. To determine how long it takes for an acid to react with an alkali
   - ☐ C. To produce a neutralisation reaction

2. What is the function of an indicator in a titration?
   - ☑ A. To signify the end point of a titration
   - ☐ B. To speed up the titration
   - ☐ C. To show the concentration of a substance

3. What is the concentration of 25 cm^3 sodium hydroxide solution that neutralises 20 cm^3 of 0.2 mol/dm^3 hydrochloric acid solution?
   The equation for the reaction is:

   $$NaOH + HCl \rightarrow NaCl + H_2O$$

   - ☐ A. 0.004 mol/dm^3
   - ☐ B. 0.00001 mol/dm^3
   - ☑ C. 0.16 mol/dm^3

Exit ticket

Feedback

Lesson C4.3.13	
What was good about this lesson?	What can we do to improve this lesson?

Send us your feedback by clicking this link
or by emailing sciencemastery@arkonline.org
Thank you!