Questions are for both separate science and combined science students unless indicated in the question

H_2O

H O H

H^+ OH^-

acid alkali

Q1.

This question is about acids and alkalis.

(a) Which ion do acids produce in aqueous solution?

Tick (✓) **one** box.

H^+	✓	OH^-		O^{2-}	

(1)

(b) Acids react with alkalis.

What is the name of this type of reaction?

Tick (✓) **one** box.

Decomposition	
Electrolysis	
Neutralisation	✓
Redox	

(1)

(c) Balance the equation for the reaction between sulfuric acid and potassium hydroxide.

$$H_2SO_4 + \_2\_ KOH \rightarrow K_2SO_4 + \_2\_ H_2O$$

(1)

(d) Universal indicator turns purple in potassium hydroxide solution.

What is the pH of the solution?

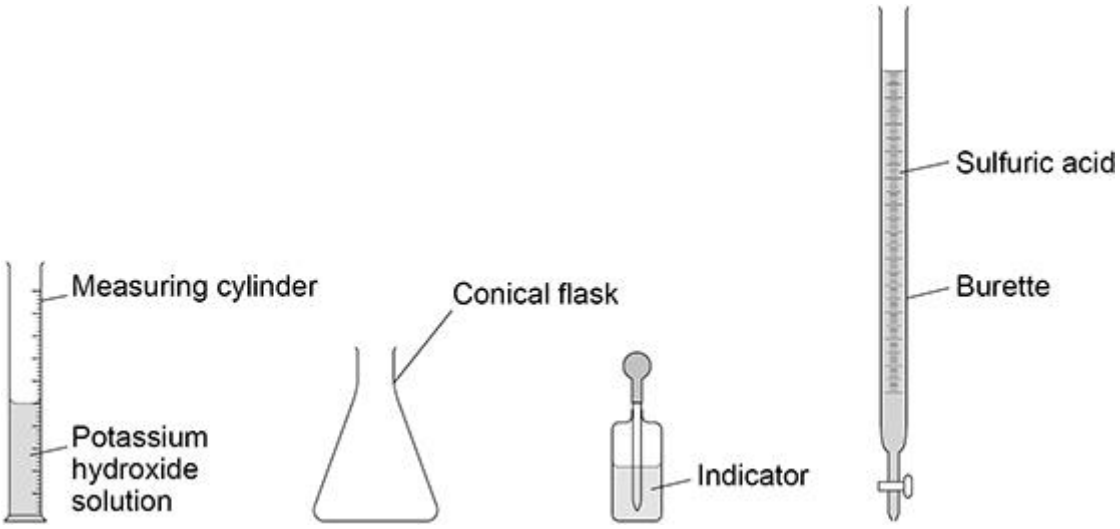
Tick (✓) **one** box.

1		4		7		14	✓

(1)

A student does a titration to find the volume of sulfuric acid that reacts with 25 cm^3 of potassium hydroxide solution.

The figure below shows the equipment used.



(e) The 25 cm^3 of potassium hydroxide solution is measured with the measuring cylinder.

Which piece of equipment could the student use to measure the 25 cm^3 of potassium hydroxide solution more accurately?

Tick (✓) **one** box. **(separate only)**

Beaker	☐
Evaporating basin	☐
Pipette	✓
Test tube	☐

(1)

(f) Describe how the student would use the equipment in the figure above to complete the titration. **(separate only)**

Add potassium hydroxide to the conical flask
Add few drops of indicator
Add the sulfuric acid from the burette until the colour changes
Read the volume from the burette

_____

_____

_____

_____

_____

_____

(5)

(Total 10 marks)

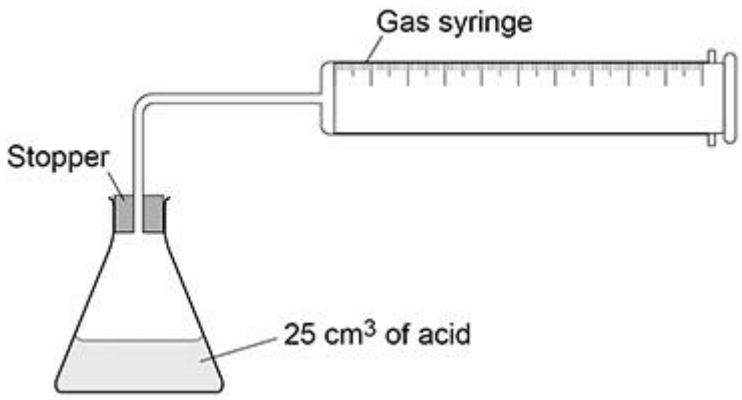
Q2.

This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 1 shows the apparatus.

Figure 1

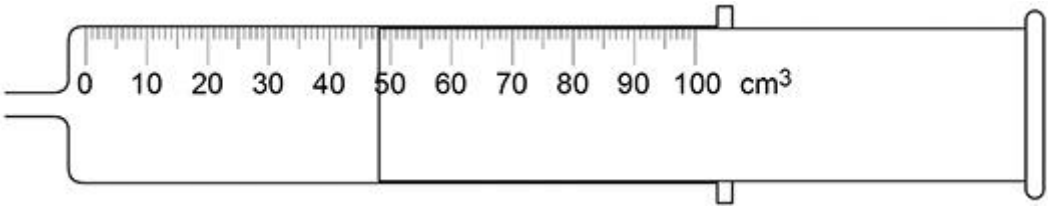


This is the method used.

1. Pour 25 cm^3 of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

(a) **Figure 2** shows the gas syringe during the experiment.

Figure 2



What is the reading on the gas syringe?

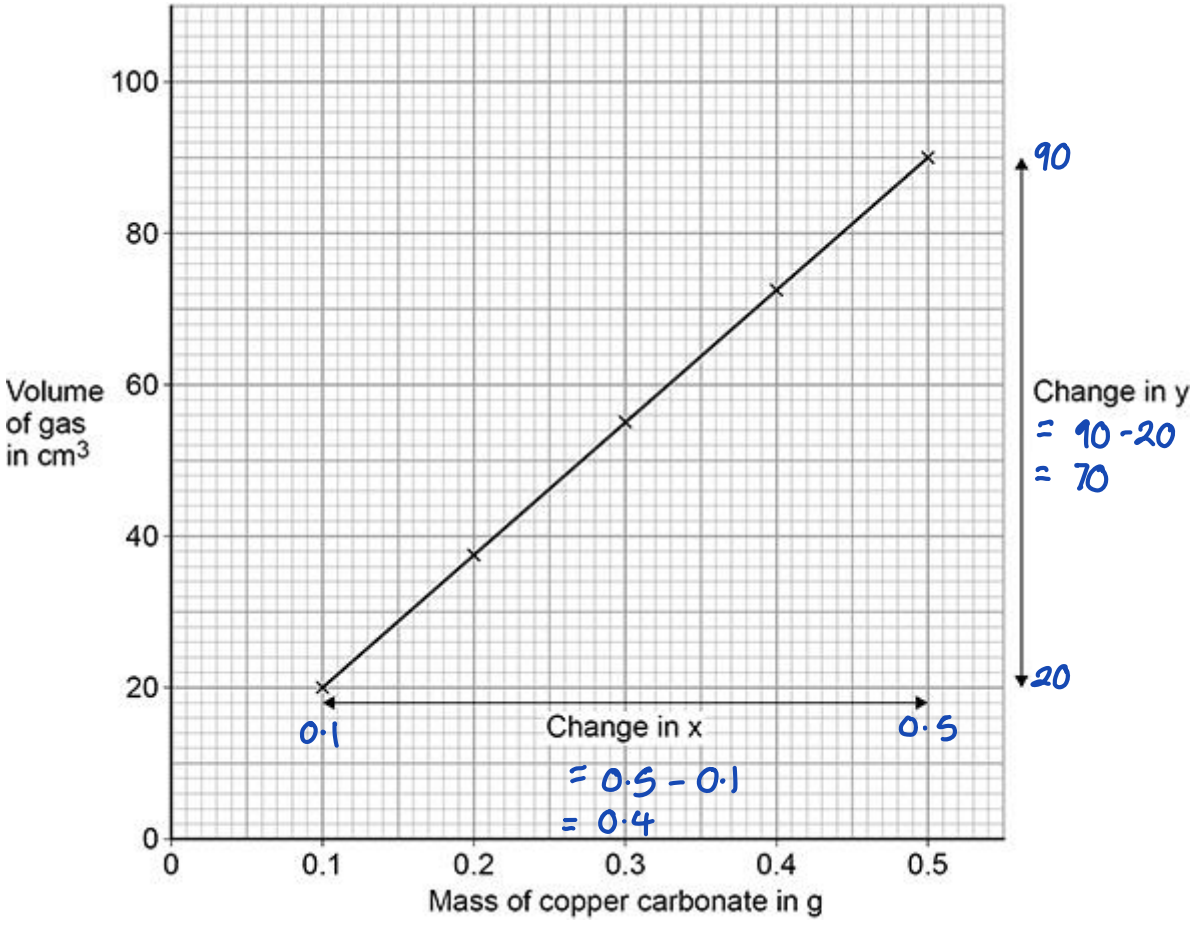
48 cm^3

(1)

(b) The student plotted the results on a graph.

Figure 3 shows the student's graph.

Figure 3



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

Change in y = 90 - 20 = 70 cm^3

Change in x = 0·5 − 0·1 = 0·4 g

Gradient = change in y / change in x = 70 cm³ / 0·4 g

Gradient = 175 cm³/g

(4)

(c) Copper chloride was produced in the reaction.

Which acid reacts with copper carbonate to produce copper chloride?

Tick (✓) **one** box.

- Hydrochloric acid ✓
- Nitric acid
- Sulfuric acid

(1)

(d) The reaction between copper carbonate and the acid produced a gas.

What was the gas?

Tick (✓) **one** box.

- Carbon dioxide ✓
- Chlorine
- Hydrogen
- Oxygen

(1)

A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

1. Add excess copper carbonate to the acid.

2. Filter the mixture.
3. Heat the solution gently until crystals start to form.
4. Leave for 24 hours.
5. Remove the crystals.
6. Rinse with water and dry the crystals.

(e) Why was the solution heated gently in **step 3**?

Tick (✓) **one** box.

To evaporate acid	☐
To evaporate copper carbonate	☐
To evaporate water	✓

(1)

(f) How should the solution be heated gently in **step 3**?

Using a boiling water bath

(1)

(Total 9 marks)

Q3.

This question is about salts.

(a) Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

Potassium chloride

(1)

(b) Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

$H^+ + OH^- \rightarrow H_2O$

(1)

(c) Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

Tick (✓) **one** box.

Copper and copper carbonate only	☐
Copper and copper oxide only	☐
Copper carbonate and copper oxide only	✓
Copper, copper carbonate and copper oxide	☐

(1)

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

(d) Give **one** reason for:

- step 2
- step 5
- step 6.

Step 2 To speed up the reaction

Step 5 To make sure all the hydrochloric acid reacts

Step 6 To remove the excess magnesium oxide

(3)

(e) How should the filtrate be evaporated gently in **step 7**?

Using a boiling water bath

(1)

(f) Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3 **(separate only)**

No. moles Fe = $\frac{14\ g}{56\ g\ mol^{-1}}$ = 0·25 mol

From equation 2 mol Fe needs 3 mol Cl_2

1 " " " 3/2 " "

0·25 " " " 3/2 × 0·25 = 0·375 mol

Volume of Cl_2 = 0·375 mol × 24 dm^3 / mol

Volume of chlorine = 9·0 dm^3

(3)

(Total 10 marks)

Q4.

This question is about acids.

Hydrogen chloride and ethanoic acid both dissolve in water.

All hydrogen chloride molecules ionise in water.

Approximately 1% of ethanoic acid molecules ionise in water.

(a) A solution is made by dissolving 1 g of hydrogen chloride in 1 dm^3 of water.

Which is the correct description of this solution?

Tick (✓) **one** box.

A concentrated solution of a strong acid	☐
A concentrated solution of a weak acid	☐
A dilute solution of a strong acid	✓
A dilute solution of a weak acid	☐

(1)

(b) Which solution would have the lowest pH?

Tick (✓) **one** box.

0.1 mol/dm^3 ethanoic acid solution	☐
0.1 mol/dm^3 hydrogen chloride solution	☐
1.0 mol/dm^3 hydrogen chloride solution	✓

↑ conc^n more H^+ strong acid

(1)

A student investigated the concentration of a solution of sodium hydroxide by titration with a 0.0480 mol/dm^3 ethanedioic acid solution.

This is the method used.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a 25.0 cm^3 pipette.
2. Add two drops of indicator to the sodium hydroxide solution.
3. Fill a burette with the 0.0480 mol/dm^3 ethanedioic acid solution to the 0.00 cm^3 mark.
4. Add the ethanedioic acid solution to the sodium hydroxide solution until the indicator changes colour.
5. Read the burette to find the volume of the ethanedioic acid solution used.

(c) Suggest **two** improvements to the method that would increase the accuracy of the result. **(separate only)**

1 Swirl the solution

2 Add ethanedioic acid dropwise near the end point.

(2)

(d) Ethanedioic acid is a solid at room temperature.

Calculate the mass of ethanedioic acid ($H_2C_2O_4$) needed to make 250 cm^3 of a solution with concentration 0.0480 mol/dm^3

Relative formula mass (M_r): $H_2C_2O_4$ = 90 **(separate only)**

N° moles $H_2C_2O_4$ in solution $= \frac{250\ cm^3}{1000} \times 0.048\ mol\ dm^{-3}$

$= 0.012\ mol$

Mass of $H_2C_2O_4$ needed $= 0.012\ mol \times 90\ g\ mol^{-1}$

$= 1.08\ g$

Mass = 1.08 g

(2)

(e) The student found that 25.0 cm^3 of the sodium hydroxide solution was neutralised by 15.00 cm^3 of the 0.0480 mol/dm^3 ethanedioic acid solution.

The equation for the reaction is:

$$H_2C_2O_4 + 2\ NaOH \rightarrow Na_2C_2O_4 + 2\ H_2O$$

1 : 2

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

(separate only)

N° moles $H_2C_2O_4$ used $= \frac{15.0\ cm^3}{1000} \times 0.048\ mol\ dm^{-3}$

$= 7.2 \times 10^{-4}\ mol$

From reaction 1 mol $H_2C_2O_4$ neutralised by 2 mol NaOH

7.2×10^{-4} mol " " $7.2 \times 10^{-4} \times 2$

$= 1.44 \times 10^{-3}$ mol

Conc^n of NaOH $= \frac{1.44 \times 10^{-3}\ mol}{(25.0 \div 1000)\ dm^3} = 0.0576$

Concentration = 0.0576 mol/dm^3

(3)

(Total 9 marks)

Q5.

This question is about acids, bases and salts.

Zinc nitrate is a salt.

A student produces zinc nitrate using an acid and a base.

(a) Which acid should the student use to produce zinc nitrate?

Tick (✓) **one** box.

Hydrochloric acid	☐
Nitric acid	✓
Sulfuric acid	☐

(1)

(b) Which is a base the student could use to produce zinc nitrate?

Tick (✓) **one** box.

Zinc chloride	☐
Zinc oxide	✓
Zinc sulfate	☐

(1)

(c) Name the salt with the formula $MgBr_2$

Magnesium bromide

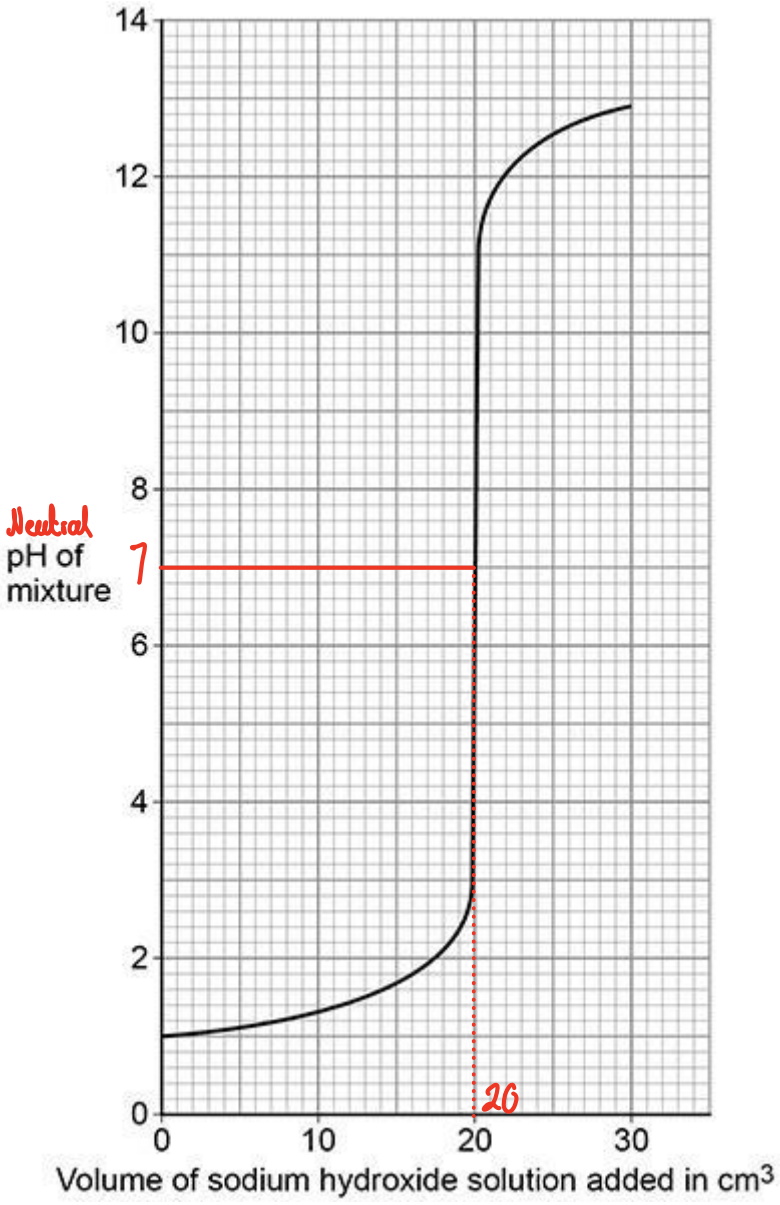
(1)

A student investigated how pH changes during a titration. **(separate only)**

This is the method used.

1. Pour 25.0 cm^3 of hydrochloric acid into a beaker.
2. Measure the pH of the hydrochloric acid with a pH probe.
3. Add 1.0 cm^3 of sodium hydroxide solution from a burette.
4. Swirl the mixture.
5. Measure the pH of the mixture.
6. Repeat steps 3 to 5 until a total of 30.0 cm^3 of sodium hydroxide solution has been added.

The graph below shows the student's results.



(d) Describe how the pH of the mixture changes as sodium hydroxide solution is added to hydrochloric acid.

Use the data from the graph above in your answer. **(separate only)**

From 0 - 20 cm^3 the pH increases gradually
at 20 cm^3 the pH changes from pH 3 to pH 11
From 20 cm^3 the pH increases gradually

(3)

(e) What volume of sodium hydroxide solution is needed to neutralise 25.0 cm^3 of hydrochloric acid?

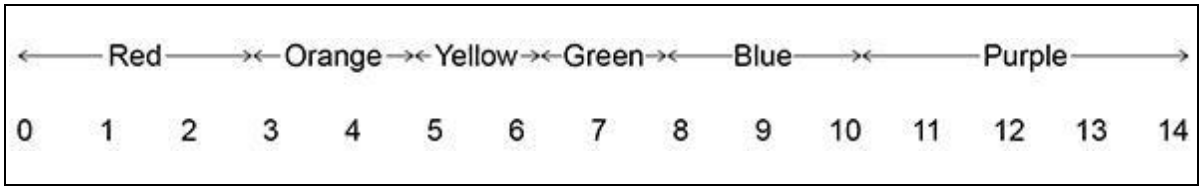
Use the graph above. **(separate only)**

Volume = 20 cm^3

(1)

(f) **Figure 1** shows the colour of universal indicator at different pH values.

Figure 1



The student could have used universal indicator instead of a pH probe.

Determine the colour of universal indicator when 10.0 cm^3 of sodium hydroxide solution has been added to 25.0 cm^3 of hydrochloric acid.

Use the graph above and **Figure 1**. **(separate only)**

Colour = Red

(1)

(g) The student used a pipette to measure 25.0 cm^3 of hydrochloric acid.

Figure 2 shows a pipette.

Figure 2

The pipette is labelled 25.0 ± 0.06 cm^3

Calculate the percentage uncertainty in the volume measured using this pipette. **(separate only)**

Use the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{volume measured}} \times 100$$

% uncertainty = $\frac{0.06}{25.0} \times 100$

= 0.24 %

Percentage uncertainty = 0.24 %

(2)

(h) Give **one** advantage of using a pipette rather than using a measuring cylinder to measure the volume of hydrochloric acid. **(separate only)**

Pipette measures volume more accurately.

(1)

(Total 11 marks)

Q6.

This question is about acids and alkalis.

(a) Which ion do all acids produce in aqueous solution?

Tick (✓) **one** box.

- H^+ ☑
- H^- ☐
- O^{2-} ☐
- OH^- ☐

(1)

(b) Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

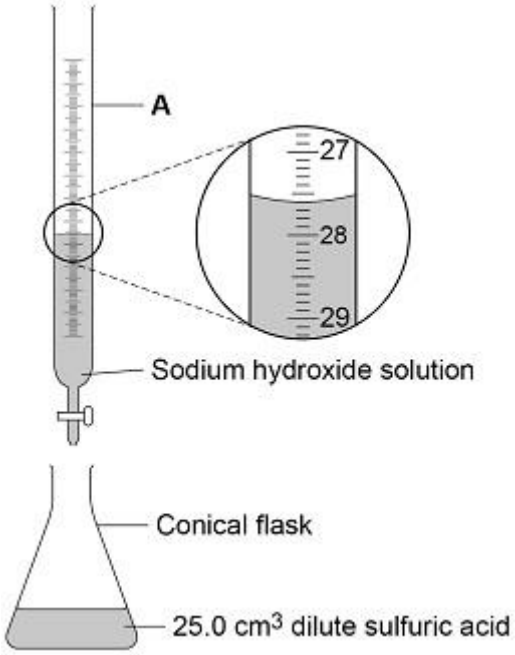
calcium hydroxide + hydrochloric acid → calcium chloride + water

(2)

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 1 shows the apparatus the student uses.

Figure 1



Use **Figure 1** to answer parts (c) and (d).

(c) Name apparatus **A**. **(separate only)**

burette

(1)

(d) What is the reading on apparatus **A**? **(separate only)**

27·6 cm^3

(1)

(e) The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated. **(separate only)**

Measure the volume of acid
Add indicator to the acid
Add sodium hydroxide solution
until the colour changes
Record volume of sodium hydroxide solution added
Repeat procedure with the other acid.

Compare the two volumes of NaOH to find
which sample P or Q is more concentrated