

Focus on success: GCSE science

A03

Build on your students' assessment performance using our self-guided, modular training pack

Chemistry data
source booklet



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Introduction

In this booklet you will find information from the legacy ISAs which you can use in class with students to develop their AO3 skills. As you look at the materials you will see that they are also relevant for developing many aspects of AO2, particularly if you are looking for practicals set in a different context from what the students have properly experienced in class.

Not all of the legacy ISAs are relevant to use with the new specification, so we have listed only those that have links either to the required practicals or to areas of the subject content where the information could be useful in teaching. The full range of legacy ISA materials are available on [e-AQA](#).

The information we have given for each ISA depends on whether it has a link to the current required practicals.

ISAs linked to the required practicals (RPs)

For these ISAs we have supplied the following materials

- Title
- Context: Brief overview explaining the purpose of the investigation and possible context the teacher could use to set the investigation in.
- Method sheet outlining how you could carry out the practical. If you are carrying out one of the **required practicals** you might find the method sheets in the [practical handbook](#) more useful. Detailed guidance can be found for all the required practicals in the free practical handbooks which include technician and teachers notes plus student worksheets.
- The ISA Section 2 questions relate to both to the practical carried out and the case study for the ISA.
- Section 2 Question 1

All parts of Question 1 in Section 2 are the same for each set of ISAs and refer to the method used. The focus of these questions is the same, regardless of the ISA and ISA set (A, B, etc), so we have selected the most common ones to present here (page 7). They can be applied to all the methods. If you would like to see the original questions for each practical these can be found with the full ISA resources on SKM.

If you are using these questions with the practical lessons from the required practicals students have to carry out, then you will be able to use the students' own data. If you are using them for revision then results for each RP are provided in the technician section of the practical handbook.
- Case studies

These will be very useful because, firstly they set the investigation in a different context which reinforces to students that, on the exam paper, questions will be set in unfamiliar context. Secondly they provide data sets that are the appropriate size and complexity to use with students to practice many of the skills needed in the new papers. These include graphing skills, a number of the maths skills and all the AO3 skills discussed in the previous activity. Teachers will be able to amend the data sets to match the ability of their students, for example, altering the numbers to include decimals raises the level of demand.
- Section 2 Question 2

The second series of questions in section 2 refer to the data on the **secondary data sheet** which are the **case studies**. These questions are AO3 type questions and are very useful as the context for each case study will be unfamiliar. These questions could be used for

homework or to stimulate a discussion during intervention lessons. This is another opportunity to ensure students understand the command words and really do write explanations rather than descriptions.

ISAs linked to areas of subject content

Some of the ISAs do not have a direct links to a required practical but do contain information that is covered in the specification so could be used in teaching these particular areas of the subject content. For each of these ISAs we have given the following:

- ISA title
- context
- case studies.

When you carry out any practical it is the school's responsibility to carry out a risk assessment and any preparatory work to ensure the practical works.

ISAs linked to the required practicals

ISA title	Brief summary of experiment	Link to RPA? (Biology/Trilogy/Synergy)
CU2.2 Self-heating cans	Factor affecting temperature of a chemical reaction	Chemistry 4/Trilogy 10/ Synergy 18
CU3.3a Sports injury packs	Factor affecting temperature changes in chemical reactions	Chemistry 4/Trilogy 10/ Synergy 18
CU2.3 Electrolysis	Factor affecting mass of metal deposited on negative electrode	Chemistry 3/Trilogy 9/ Synergy 21
CU2.7 Electrolysis (Case studies only)	Factor affecting mass of metal deposited on the negative electrode	Chemistry 3/Trilogy 9 / Synergy 21
CU3.3b Titrations	Factor affecting neutralisation of an acid	Chemistry 2
CU3.5a Neutralisation	Factor affecting volume of acid needed to neutralise an alkali	Chemistry 2
CU2.6 Rate of reaction	Factor affecting the rate of chemical reactions	Chemistry 5/Trilogy 11 /Synergy 19
CU2.4 Temperature and rate of reaction	Factor affecting the rate of chemical reactions	Chemistry 5/Trilogy 11 /Synergy 19
CU2.5 Catalyst	Factor affecting the rate of chemical reactions	Chemistry 5/Trilogy 11 /Synergy 19
CU1.5 Reactivity of metals	Temperature rise in a reaction depends on reactivity of metal	Chemistry 4/Trilogy 10 / Synergy 18

Section 2 Question 1:

Possible questions to use with all method sheets

- 1 (a) (i)** Do your results support the hypothesis that you investigated?

You should use any pattern that you can see in your results to support your answer.

You should include examples from your results.

- 1 (a) (ii)** Did you get any anomalous results?

Explain your answer.

Your explanation should include examples from your results.

- 1 (b)** Describe in detail how you could use repeated readings to obtain more accurate results.

- 1 (c)** What was the independent variable in the investigation that you did?

.....

What was the range of the independent variable?

The range was from to

Explain why this was or was not a suitable range.

What was the dependent variable ?

One control variable was?

- 1 (d)** Most investigations contain errors or uncertainties.

What do you think was the cause of the largest error or uncertainty in your investigation?

.....

.....

What could you do to reduce the size of this error or uncertainty if you were to repeat the investigation?

Explain your answer.

CU2.2 Self-heating cans

Context:

Investigating exothermic reactions. An exothermic reaction is one that transfers energy to the surroundings. Examples of exothermic reactions include combustion, many oxidation reactions and neutralisation. Everyday uses of exothermic reactions include self-heating cans (eg for coffee) and hand warmer. Students could develop their own hypotheses or investigate the hypothesis that the temperature rise when anhydrous sodium carbonate reacts with water depends on the mass of anhydrous sodium carbonate used. Students can identify which variables to control and what the dependent and independent variables are.

This method could be used to investigate the following hypothesis:

'The temperature rise when anhydrous sodium carbonate reacts with water depends on the mass of anhydrous sodium carbonate used.'

You will need to prepare a table for the results.

Equipment:

Eye protection ie safety glasses

Measuring cylinder

Access to a balance

Insulated plastic/polystyrene cup standing in a 250cm³ beaker

Dry powdered anhydrous sodium carbonate

Thermometer

Method:

1. Weigh out 0.5g of anhydrous sodium carbonate onto a piece of scrap paper.
2. Place 10cm³ of water into the insulated cup, and record its temperature.
3. Add the anhydrous sodium carbonate, stir well, and record the highest temperature achieved.
4. Repeat the experiment using up to 2g of anhydrous sodium carbonate.

Case studies

Case Study 1

A group of students investigated the temperature rise when different masses of calcium oxide were added to water.

They used equal volumes of water.

These are their results.

Mass of calcium oxide used in grams	Temperature rise of the water in °C
10	11
20	22
30	30
40	35
50	37

Case Study 2

A different group of students did another investigation using calcium oxide and water. They used 10g of calcium oxide but different volumes of water each time. They measured the temperature rise of the water.

These are their results.

Volume of water in cm ³	Temperature rise of the water in °C
20	42
50	35
100	31
150	26
200	22

Case Study 3

A third group of students did another investigation using calcium oxide and water. They added different masses of calcium oxide to the same volume of water and recorded the temperature rise.

These are their results.

Mass of calcium oxide used in grams	Temperature rise of the water in °C			
	Trial 1	Trial 2	Trial 3	Mean
15	14	16	18	16
20	21	20	14	14
25	25	28	25	26
30	29	28	32	30
35	37	34	35	35

Case Study 4

Some students wanted to find out how much calcium oxide was needed to heat different foods.

They put 400 cm³ of baked beans in a large beaker.

They placed a small beaker, containing 50cm³ of water, in the large beaker of beans.

The students then added 15g of calcium oxide to the water.

They stirred the baked beans and recorded the highest temperature the baked beans reached.

They repeated the experiment using 400cm³ each of different foods.

They also determined the density of each food.

These are their results:

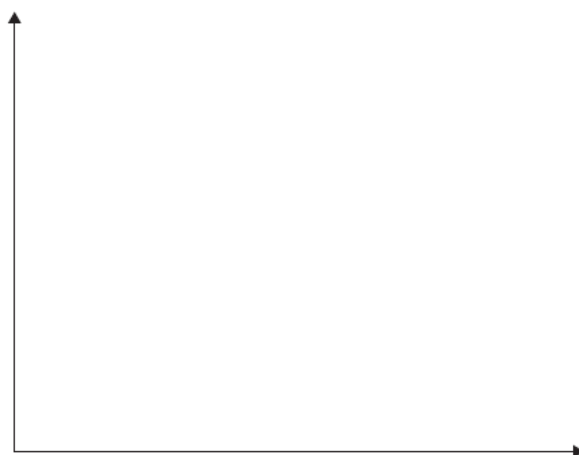
Food	Density of food in grams per cm ³	Mass of food heated in grams	Temperature rise in °C
chicken curry	1.24	496	10
baked beans	1.19	476	15
spaghetti bolognese	1.16	464	20
vegetable soup	1.14	456	25
tomato soup	1.13	452	25

Section 2 questions

2 You have been given a Secondary Data Sheet that provides results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the temperature rise of the water varies with the mass of calcium oxide used.



2 (b) A food manufacturer is designing a range of foods for hikers.

The manufacturer states the following hypothesis:

'The temperature rise for any food depends on the amount of calcium oxide used in the heating pack.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) Look at Case Study 4.

Use data from Case Study 4 to explain why these results do **not** support the manufacturer's hypothesis.

CU3.3a Sports injury packs

Context:

Investigating exothermic and endothermic reactions. The amount of energy produced by a chemical reaction in solution can be calculated from the measured temperature change of the solution when the reagents are mixed in an insulated container. This method can be used for reactions of solids with water or for neutralisation reactions. Suitable contexts could include manufacturing cool packs for sports injuries, or cooling packs for insulated food carriers. Students investigate the hypothesis that the temperature change depends on the mass of potassium chloride being dissolved.

This method could be used to investigate the following hypothesis:

'The temperature change obtained when dissolving potassium chloride in water depends on the mass of potassium chloride dissolved.'

Equipment

Measuring cylinder

Balance

100 cm³ beaker

Spatula

Thermometer

Water

Potassium chloride

Stirring rod

Method

1. Measure 50 cm³ of water into the beaker.
2. Use the balance to weigh out 1 g of potassium chloride.
3. Record the temperature of the water
4. Add the potassium chloride to the water. Stir until all the potassium chloride has dissolved and record the temperature of the solution.
5. Repeat steps 1 – 4 using different masses of potassium chloride up to a maximum of 6 g.

Case studies

Case Study 1

A group of students did an investigation to find the temperature change when ammonium nitrate is dissolved in 50 cm³ of water.

These are their results.

Mass of ammonium nitrate dissolved, in grams	Decrease in temperature of the water, in °C
2	2.0
4	4.1
6	6.1
8	7.9
10	10.0

Case Study 2

Some other students did an investigation using different volumes of water and dissolving 10 g of ammonium nitrate.

These are their results.

Volume of water used, in cm ³	Decrease in temperature after dissolving 10 g of ammonium nitrate, in °C			
	Trial 1	Trial 2	Trial 3	Mean
100	6	5	7	6
200	3	2	4	3
300	2	2	3	2
400	1	1	2	1
500	4	1	1	2

Case Study 3

A third group of students investigated the reaction of ammonium nitrate with water.

They wanted to find out how cold the mixture stayed over 15 minutes.

They did the investigation three times using 100 cm^3 of water, and 8 g of ammonium nitrate in a plastic beaker. They measured the temperature over 15 minutes.

Time, in minutes	Decrease in temperature of the water, in $^{\circ}\text{C}$			
	Trial 1	Trial 2	Trial 3	Mean
0	0	0	0	0
3	18	16	17	17
6	13	14	12	13
9	9	9	8	9
12	8	8	8	8
15	7	6	7	7

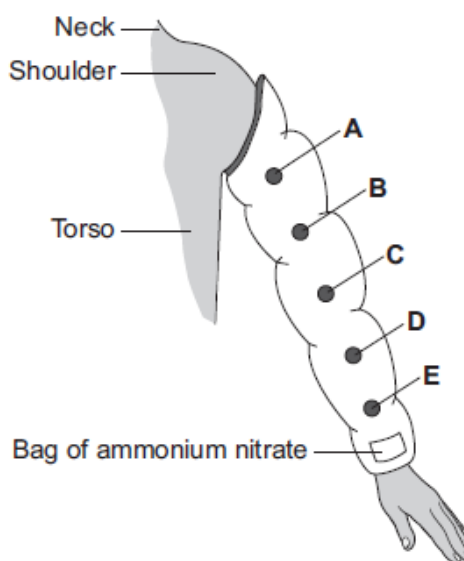
Case Study 4

A medical supplier is designing a cool pack for use on an injured arm.

This pack is used as a sleeve over the injured arm to keep it cool.

The pack is filled with water and contains a plastic bag of ammonium nitrate which can be broken.

The pack was tested by placing temperature sensors on the pack at positions A, B, C, D, and E.



A subject, who was lying down, wore the pack on their arm. The bag of ammonium nitrate was broken. The decrease in the temperature at each sensor was recorded every two minutes for ten minutes. The mean temperature decrease was also calculated.

Time, in minutes	Difference from the temperature of the surroundings at each sensor, in $^{\circ}\text{C}$					
	A	B	C	D	E	Mean
2	-4	-8	-11	-15	-17	-11
4	-5	-9	-12	-14	-16	-11
6	-6	-8	-10	-13	-15	-10
8	-5	-7	-9	-12	-14	-9
10	-4	-6	-8	-11	-13	-8

Section 2 questions

2 You have been given a Secondary Data Sheet. The Data Sheet gives results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the decrease in the temperature of the water varies with the mass of ammonium nitrate dissolved.



2 (b) A medical supplier is designing a cool pack for use on an arm.

The supplier makes the following hypothesis:

‘The more water in the pack, the smaller the temperature decrease will be.’

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To get full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) (i) Look at Case Study 4.

To work well, the cool pack must stay at least 10 °C cooler than the surroundings for 10 minutes.

Do the results in Case Study 4 show that the arm cool pack is going to work well over the whole length of the arm?

Explain your answer.

2 (c) (ii) A scientist thinks that there is a problem with the arm cool pack.

The scientist suggests that the pack could be made to work better if the design was slightly changed.

Describe a problem with the design of the arm cool pack.

Suggest a solution to this problem.

Justify your answer using data from Case Study 4.

CU2.3 Electrolysis

Context:

Investigating factors that affect electrolysis. Electrolysis is used to electroplate objects. This may be for a variety of reasons and includes copper plating and silver plating. During electrolysis, positively charged ions move to the negative electrode, and negatively charged ions move to the positive electrode. At the negative electrode, positively charged ions gain electrons (reduction) and at the positive electrode, negatively charged ions lose electrons (oxidation). Suitable contexts could include the electroplating of an object such as a watch case, piece of car trim or mobile phone case.

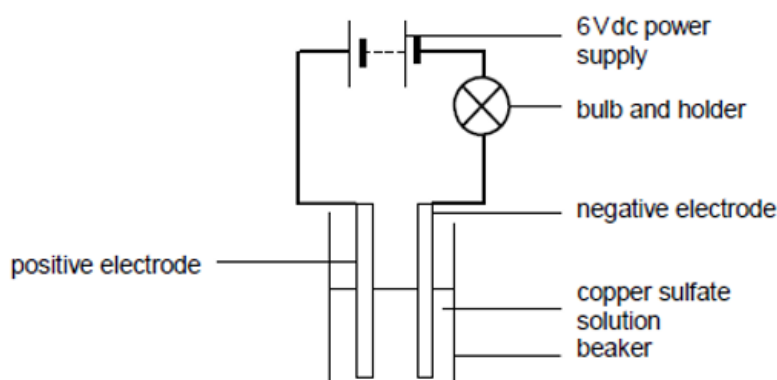
There are two ISAs covering this aspect of the specification CU2.3 and CU2.7. The method below is for CU2.3 investigating if the time the current flows affects the mass of the deposit on the negative electrode. CU2.7 investigated if the depth of the electrode or immersion of the electrode. The case studies and Section 2 questions for this ISA have been included here.

This method could be used to investigate the following hypothesis:

'The mass of copper deposited on the negative electrode depends on the time for which the current flows'.

Equipment:

Measuring cylinder
Balance
Two suitable electrodes eg carbon rods
6V bulb and holder
0.5 moles per dm^3 copper sulfate solution
Stopwatch
Wires
Power supply
100 cm^3 beaker



Method:

1. Measure 50 cm^3 of the copper sulfate solution into the beaker.
2. Measure and record the mass of the negative electrode.
3. Set up the circuit, setting the power pack at 6V dc.
4. Turn on the power supply for the time you have been given, then turn the power pack off.
5. Remove and carefully dry the negative electrode.
6. Measure and record the mass of the negative electrode.

Case studies

Case Study 1

Some scientists did an investigation. They deposited silver on a steel teaspoon.

These are their results.

Time, in minutes	Increase in mass of teaspoon, in grams
1	2.5
2	3.5
3	4.3
4	4.8
5	5.0
6	5.0
7	5.0

Case Study 2

The scientists did a different investigation into electroplating teaspoons.

These are their results.

Time, in minutes	Increase in mass of teaspoon, in grams			
	Trial 1	Trial 2	Trial 3	Mean
2	0.62	0.64	0.45	0.63
4	0.87	0.83	0.86	0.85
6	0.99	1.01	0.97	0.99
8	1.06	1.05	1.08	1.06
10	1.10	1.12	1.10	1.11

Case Study 3

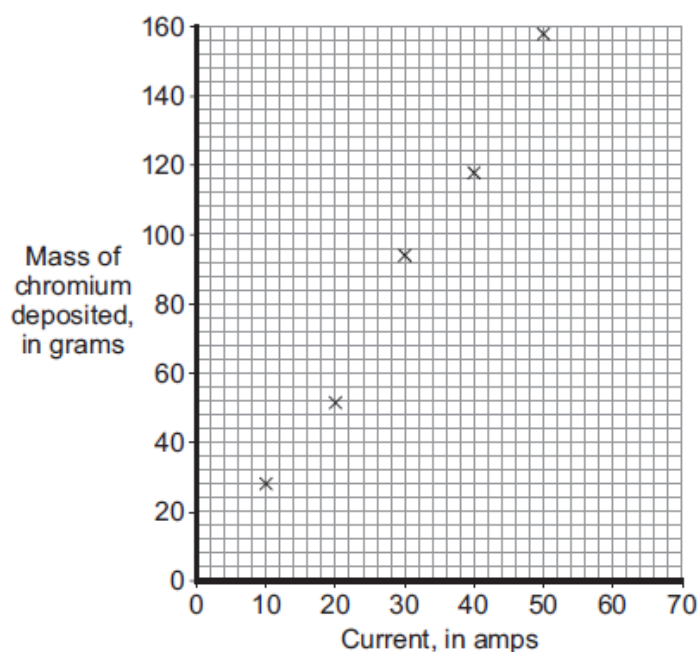
The scientists did some more tests on electroplating, by changing the concentration of the electrolysis solution. They used nickel sulfate solution and a steel negative electrode.

They passed the current for 10 minutes in each case.

Concentration of nickel sulfate solution used, in moles per dm ³	Increase in mass of negative electrode after 10 minutes, in grams
0.5	4.6
1.0	9.4
1.5	16.3
2.0	18.8
2.5	18.7
3.0	18.7

Case Study 4

A scientist investigated how increasing the electrical current would affect the mass of chromium deposited. The concentration of the chromium sulfate solution stayed at 2 moles per dm³ throughout the investigation.



Section 2 questions

2 You have been given a Secondary Data Sheet. The Data Sheet gives results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the increase in mass of the teaspoon varies with time.



(2 marks)

2 (b) Look at Case Studies 1, 2 and 3.

The scientists made the following hypothesis:

‘The mass of metal deposited depends on the time the current is flowing.’

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) Look at Case Study 4.

The scientist made this hypothesis:

‘The mass of metal deposited is directly proportional to the current used.’

To what extent do the results in Case Study 4 support this hypothesis?

Explain your answer. You should use data from Case Study 4 in your explanation.

CU2.7 Electrolysis

Case Study 1

A student investigated the effect of the depth of immersion of the negative electrode on the mass of metal deposited during electrolysis.

The depth of immersion of the positive electrode was kept the same for each trial.
The student used the same concentration of a metal sulfate solution and found the change in mass of the negative electrode after 10 minutes.

These are the results.

Depth of immersion of the negative electrode in cm	Increase in mass of the negative electrode after 10 minutes in milligrams
1	30
2	61
3	89
4	120
5	149

Case Study 2

A second group of students did a similar investigation to Case Study 1.
They used the same concentration of solution but a different metal sulfate.

The students allowed the current to flow for 30 minutes

Depth of immersion of the negative electrode in cm	Increase in mass of the negative electrode after 30 minutes in milligrams			
	Trial 1	Trial 2	Trial 3	Mean
0.5	63	61	62	62
1.0	122	125	123	123
1.5	188	183	187	186
2.0	249	287	247	248
2.5	307	311	312	310

Case Study 3

A group of students investigated the effect the depth of immersion of the negative electrode and time on the mass of metal deposited during electrolysis. The depth of immersion of the positive electrode was kept the same for each trial. They did each negative electrode depth for three different time intervals.

Depth of immersion of the negative electrode in cm	Increase in mass of the negative electrode in milligrams		
	after 5 minutes	after 10 minutes	after 20 minutes
1	22	44	88
2	33	87	172
3	44	132	260
4	55	220	248
5	66	220	435

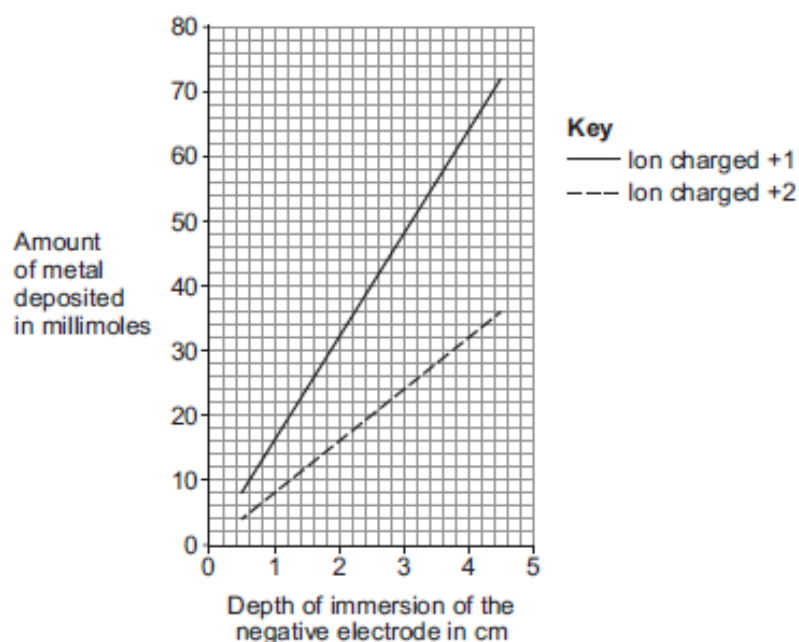
Case Study 4

A scientist investigated how the depth of immersion of the negative electrode affected the number of millimoles of metal deposited on the negative electrode. (1000 millimoles = 1 mole).

For each trial the same current and time was used.

The scientist noted the charge on the metal ions used and plotted the mean of the results for two different charges of ions.

The graph shows the scientist's plots:



CU3.3b Titrations

Context:

The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator. Suitable contexts could include the use of antacids for indigestion treatments, neutralisation of acid-rain polluted lakes.

There are two ISAs covering this aspect of the specification CU3.3b and CU3.5a. The methods are slightly different so we have included both with CU3.5a being less demanding.

This method could be used to investigate the following hypothesis:

'The volume of hydrochloric acid needed to neutralise a solution of sodium hydroxide depends on the concentration of the sodium hydroxide.'

Equipment

Measuring cylinder

100cm³ conical flask

10cm³ pipette and filler

Burette

Funnel to fill burette

White tile

Phenolphthalein

Solutions of:

0.1 moles per dm³ of hydrochloric acid

sodium hydroxide with different concentrations up to 0.5 moles per dm³.

Method

1. Measure 10cm³ of sodium hydroxide solution into the conical flask.
2. Add three drops of phenolphthalein.
3. Place the conical flask on the white tile.
4. Add hydrochloric acid from the burette until the sodium hydroxide is neutralised.
5. Record the volume of hydrochloric acid needed to neutralise the sodium hydroxide.
6. Repeat the investigation using different concentrations of sodium hydroxide up to 0.5 moles per dm³.

Case studies

Case Study 1

A group of students did an investigation on neutralisation.

They used potassium hydroxide solution as the alkali, and hydrochloric acid as the acid.

These are their results.

Concentration of potassium hydroxide, in moles per dm ³	Volume of 0.1 moles per dm ³ hydrochloric acid needed to neutralise the alkali, in cm ³
0.1	15
0.2	29
0.3	45
0.4	59
0.5	74

Case Study 2

A different group of students investigated the neutralisation of potassium hydroxide by nitric acid. They recorded the pH of the solution for different concentrations of potassium hydroxide as the acid was added.

These are their results. The numbers in the shaded boxes show the pH of the solution.

Concentration of potassium hydroxide, in moles per dm ³	Volume of nitric acid added, in cm ³									
	0	5	10	15	20	25	30	35	40	45
0.1	14	14	1	1	1	1	1	1	1	1
0.2	14	14	14	7	1	1	1	1	1	1
0.3	14	14	14	14	10	5	1	1	1	1
0.4	14	14	14	14	14	14	2	1	1	1
0.5	14	14	14	14	14	14	14	12	1	1

Case Study 3

A different group of students used sodium hydroxide and nitric acid.

These are their results.

Concentration of sodium hydroxide, in moles per dm ³	Volume of 0.2 moles per dm ³ nitric acid needed to neutralise the alkali, in cm ³		
	Trial 1	Trial 2	Mean
0.1	6.2	7.4	6.8
0.2	14.4	16.0	15.2
0.3	24.1	21.3	22.7
0.4	32.9	28.5	30.7
0.5	33.7	36.7	35.2

Case Study 4

Cabbages grow best in alkaline soil.

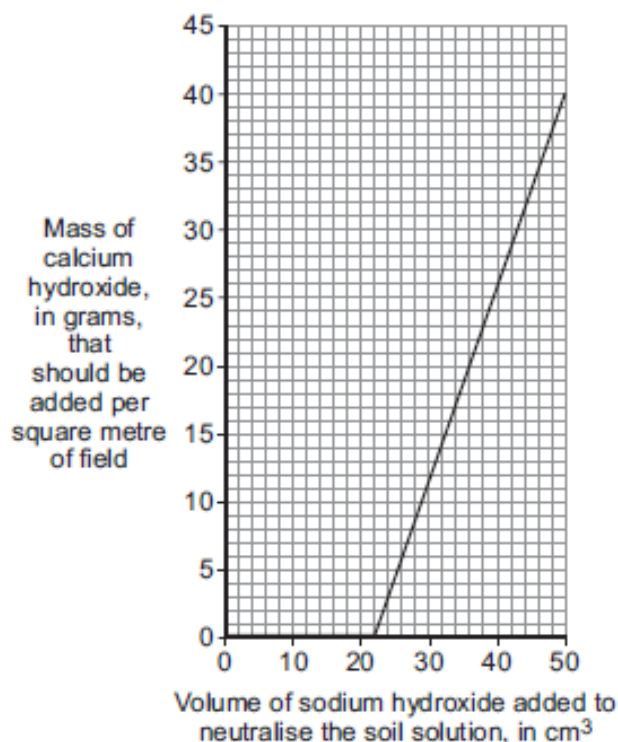
A farmer used a testing kit to find out which of his fields A to E needed to be treated to make them alkaline.

The farmer made a solution by shaking 200 g of soil from each field with 25 cm³ of 0.1 moles per dm³ hydrochloric acid. He filtered each mixture and titrated each solution using sodium hydroxide solution with a concentration of 0.1 moles per dm³.

These are the results.

Field	Volume of sodium hydroxide solution added to neutralise the soil solution, in cm ³
A	15
B	25
C	19
D	32
E	36

There was a graph supplied with the testing kit. The graph showed the mass of calcium hydroxide that should be added per square metre of field to make the soil condition best for growing cabbages.

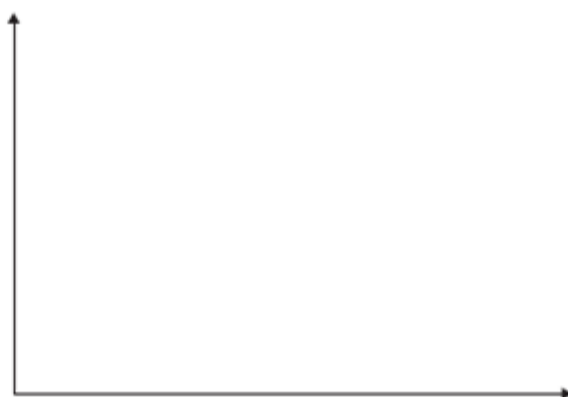


Section 2 questions

2 You have been given a Secondary Data Sheet. The Data Sheet gives results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the volume of hydrochloric acid needed to neutralise the alkali varies with the concentration of the alkali.



2 (b) A student makes this hypothesis:

'Increasing the concentration of any alkali increases the volume of acid needed to neutralise the alkali.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) Describe the relationship shown by the graph in Case Study 4.

2 (d) Look at Case Study 4.

The farmer wants to grow cabbages in all five fields, **A** to **E**.

Which field or fields should the farmer treat with calcium hydroxide in order to neutralise them?

Justify your answer using data from Case Study 4.

CU3.5a Neutralisation

Context:

The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator. Suitable contexts could include: ensure enough lime is added to fields to neutralise acid soils, or when making ammonium nitrate fertiliser ensuring that the yield is economic, ie only sufficient ammonia solution is used to neutralise the nitric acid.

Neutralisation

This method could be used to investigate the following hypothesis:

'Increasing the volume of the alkali solution increases the volume of the acid solution needed for neutralisation.'

Equipment

100 cm³ conical flask
10 cm³ pipette and filler or measuring cylinder
Burette
Funnel to fill burette
White tile
Phenolphthalein solution
Dilute hydrochloric acid
Sodium hydroxide solution

Method

- 1 Measure 10 cm³ of sodium hydroxide solution into the conical flask.
- 2 Add three drops of phenolphthalein.
- 3 Place the conical flask on the white tile.
- 4 Add hydrochloric acid from the burette until the sodium hydroxide is neutralised.
- 5 Record the volume of hydrochloric acid needed to neutralise the sodium hydroxide.
- 6 Repeat the investigation using different volumes of sodium hydroxide up to 40 cm³

Case studies

Case Study 1

Ammonium hydroxide solution is an alkaline solution.

A group of students investigated the volume of sulfuric acid needed to neutralise different volumes of ammonium hydroxide solution.

The students used the same concentrations of sulfuric acid and ammonium hydroxide solution.

These are their results.

Volume of ammonium hydroxide solution in cm ³	Volume of sulfuric acid needed for neutralisation in cm ³
10	5
20	10
30	15
40	20
50	25

Case Study 2

Some students investigated the volume of hydrochloric acid needed to neutralise different volumes of sodium hydroxide solution.

The students used the same concentrations of hydrochloric acid and sodium hydroxide solution.

These are their results.

Volume of sodium hydroxide solution in cm ³	Volume of hydrochloric acid needed for neutralisation in cm ³			
	Trial 1	Trial 2	Trial 3	Mean
10	9	12	11	10.7
20	22	19	21	20.7
30	19	27	29	25.0
40	42	39	41	40.7
50	53	48	51	50.7

Case Study 3

Some students investigated neutralisation. The students used 10 cm^3 of ammonium hydroxide solution for each titration. They neutralised the ammonium hydroxide solution with sulfuric acid. The concentration of sulfuric acid was the same for each titration.

These are their results.

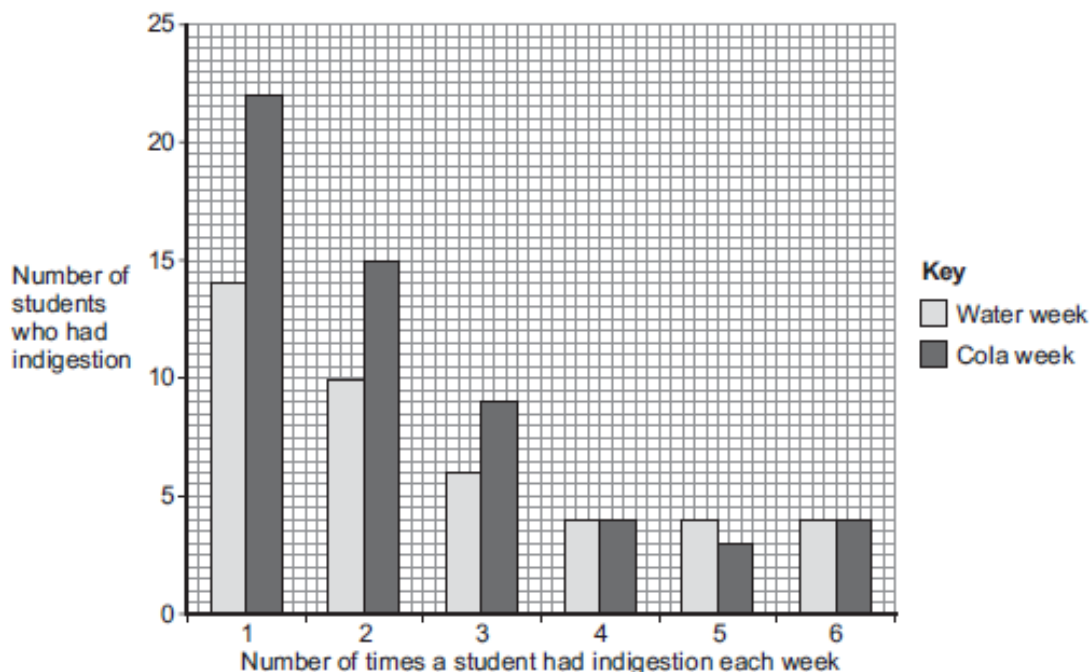
Concentration of ammonium hydroxide solution in moles per dm^3	Volume of sulfuric acid needed for neutralisation in cm^3			
	Trial 1	Trial 2	Trial 3	Mean
0.1	9	11	11	10
0.2	21	23	19	21
0.3	29	34	33	32
0.4	40	39	38	27
0.5	47	48	49	48

Case Study 4

A group of students investigated whether drinking cola causes indigestion. Cola drinks contain phosphoric acid. This raises the concentration of hydrogen ions in the stomach.

For the first week, the students drank only 300 cm^3 of water with each meal, but drank no cola. For the second week, the students drank only 300 cm^3 of cola with each meal but drank no water.

The number of students who had indigestion, and how many times each week they had indigestion, are shown in the chart below.

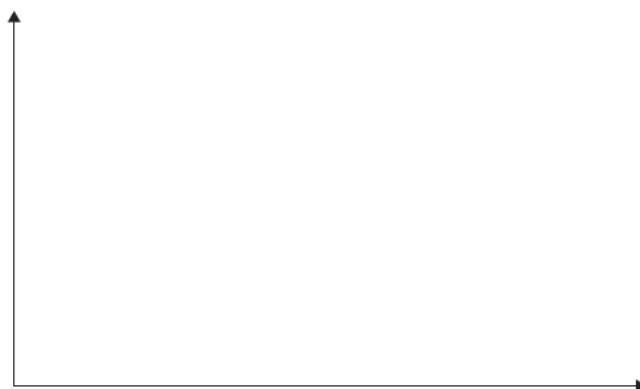


Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the volume of sulfuric acid needed for neutralisation varies with the volume of the ammonium hydroxide solution.



2 (b) A student made this hypothesis:

'If the volume of an alkali solution is increased, then the volume of acid solution needed to neutralise it also increases.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) The students in Case Study 2 did three trials for each volume of sodium hydroxide. They then calculated the mean values by adding the three results together and dividing by three.

Suggest **two** problems with the mean values, and explain how the mean values should have been calculated.

2 (d) Look at Case Study 4.

A student concludes that:

'The bar chart shows that drinking cola every day causes indigestion.'

Do the results of Case Study 4 support the student's conclusion?

Explain your answer.

You should refer to the data in Case Study 4 in your explanation.

CU2.6 Rate of reaction

Context:

The variable concentration is investigated as a required practical. We have included all the rates resources here as it is all part of the same theme.

There are three ISAs covering this aspect of the specification, each investigating different variables. CU2.6 investigates concentration of the reactant, CU 2.4 investigate the effect of temperature and CU2.5 investigating the effect of a Catalyst. All set of materials have been included in full.

Increasing the concentration of reactants in solutions increases the frequency of collisions and so increases the rate of reaction. Suitable contexts could include: the effect on the time taken for a metal to react with acid rain of different concentrations, or the time taken for oven cleaners of different concentrations to de-grease an oven. Students investigate the hypothesis that concentration of a reactant affects the rate of a reaction.

Rate of Reaction

This method could be used to investigate the following hypothesis:

'The rate of a chemical reaction depends on the concentration of a reactant.'

Equipment

100 cm³ conical flask

Stopwatch

25 cm³ measuring cylinder

Hydrochloric acid (1 mole per dm³)

Magnesium ribbon

Ruler

Scissors

Method

Eye Protection should be worn

- 1 Measure 25 cm³ of hydrochloric acid into the conical flask.
- 2 Add a 2 cm length of magnesium ribbon to the flask, swirl the mixture, and start the stopwatch.
- 3 Record the time taken for the magnesium ribbon to completely react.
- 4 Rinse out the flask with water.
- 5 Measure 20 cm³ of hydrochloric acid into the conical flask. Add 5 cm³ of distilled water to the acid.
- 6 Repeat steps 2 – 4.
- 7 Repeat the experiment for a range of different concentrations of hydrochloric acid.

Case studies

Case Study 1

A student investigated the effect of concentration on the rate of a chemical reaction.

The student put pieces of zinc strip, 1 cm long, into 30 cm³ of dilute nitric acid of different concentrations.

These are the results.

Concentration of nitric acid in moles per dm ³	Time for the zinc strip to react completely in seconds
0.50	250
0.75	205
1.00	175
1.25	155
1.50	145
1.75	140

Case Study 2

A group of students investigated how changing the temperature and concentration of sodium thiosulfate would affect the rate of a chemical reaction.

The students used 40 cm³ of sodium thiosulfate solution and 4 cm³ of hydrochloric acid.

The students placed the reaction mixture on a piece of paper with a cross on it. They measured the time taken for the cross to 'disappear'.

Concentration of sodium thiosulfate solution in moles per dm ³	Time for the cross to 'disappear' at each temperature in seconds			
	20 °C	30 °C	40 °C	50 °C
0.2	62	31	15	8
0.4	31	15	8	5
0.6	23	12	6	3
0.8	10	8	4	2
1.0	8	7	3	2

Case Study 3

A group of students investigated the effect of temperature on the rate of a reaction. The students reacted tablets of calcium carbonate weighing 1 g with 50 cm³ of hydrochloric acid. They measured the time taken for 100 cm³ of carbon dioxide gas to be produced at different temperatures.

Temperature of hydrochloric acid in °C	Time for 100 cm ³ of carbon dioxide gas to be produced in seconds			
	Trial 1	Trial 2	Trial 3	Mean
20	119	122	85	109
25	82	76	78	79
30	61	56	62	60
35	44	36	38	39
40	28	34	30	31

Case Study 4

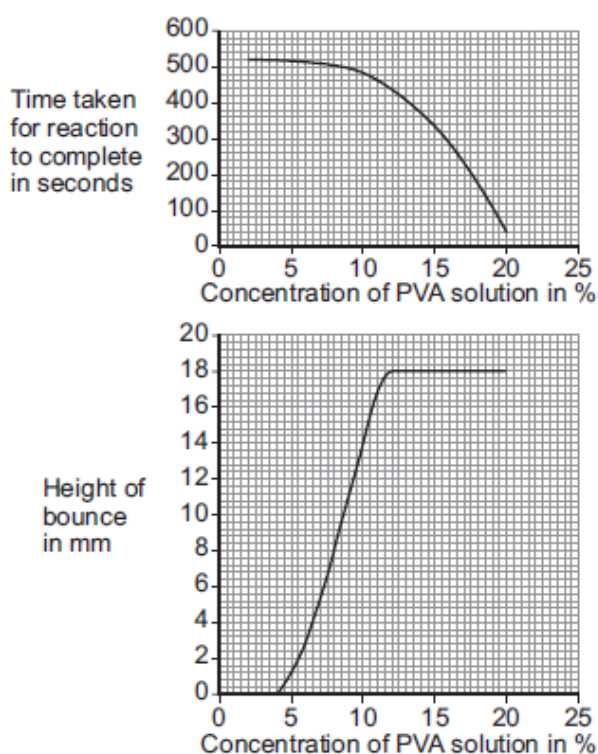
A group of students made slime by reacting dilute PVA adhesive with borax solution. They used different concentrations of PVA adhesive solution and measured the time taken for the reaction to complete.

A ball of slime bounces when dropped on a hard surface.

The group of students investigated the effect of the rate of reaction on the height of the bounce.

They dropped a ball of each of the different slimes they had made from a height of 1 metre onto a hard surface. The students measured the height of the bounce for different concentrations of PVA.

Here are their results.



Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the time taken for the zinc strip to react completely varies with the concentration of nitric acid.



2 (b) A scientist made this hypothesis:

'Increasing the concentration of a reactant in a chemical reaction will decrease the time it takes for the reaction to finish.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) Look at Case Study 4.

One of the students said:

'If the time taken for the reaction to complete is less than 240 seconds, the height of the bounce remains constant.'

To what extent do the results in Case Study 4 support this statement?

Explain your answer. You should use data from Case Study 4 in your explanation.

CU2.4 Temperature and rate of reaction

Context:

Increasing the temperature increases the speed of the reacting particles so that they collide more frequently and more energetically. This increases the rate of reaction. Suitable contexts could include the time taken for an adhesive to set in different temperatures, or how controlling the temperature can control the time taken to manufacture a particular chemical.

Temperature and Rate of Reaction

This method could be used to investigate the following hypothesis:

'The temperature of the reactants affects the rate of a chemical reaction.'

Equipment

100 cm³ conical flask
Stopwatch
100 cm³ measuring cylinder
10 cm³ measuring cylinder
Teat pipette
Thermometer
Water bath
Sheet of white paper
2 moles per dm³ hydrochloric acid
0.2 moles per dm³ solution of sodium thiosulfate

Method

- 1 Measure 40 cm³ of water into the conical flask.
- 2 Add 10 cm³ of sodium thiosulfate to the conical flask.
- 3 Warm the solution to about 30 °C.
- 4 Remove from heat and put the flask on a piece of paper with a pencil cross drawn on the paper.
- 5 Add 5 cm³ of hydrochloric acid to the flask, swirl the mixture, and start the stopwatch.
- 6 Look through the solution from above and stop the stopwatch when the cross cannot be seen.
Record the time.
- 7 Measure and record the temperature of the mixture.
- 8 Repeat for a range of different temperatures of sodium thiosulfate solution up to 50°C.

Case studies

Case Study 1

A student investigated the effect of temperature on the rate of a chemical reaction.

The student put pieces of magnesium ribbon, 2 cm long, into 25 cm³ of hydrochloric acid at different temperatures.

The table shows the results.

Temperature of hydrochloric acid in °C	Time for the magnesium ribbon to completely react in seconds
15	195
20	130
25	91
30	68
35	50
40	45

Case Study 2

A group of students investigated the effect of temperature on the rate of a reaction.

The students dissolved pieces of magnesium ribbon, 4 cm long, in 25 cm³ of hydrochloric acid. They measured the time taken for 100 cm³ of hydrogen gas to be produced at different temperatures.

Temperature of hydrochloric acid in °C	Time for 100 cm ³ of hydrogen gas to be produced in seconds			
	Trial 1	Trial 2	Trial 3	Mean
20	62	61	58	60
25	41	39	38	39
30	28	31	31	30
35	19	18	22	20
40	17	14	15	15

Case Study 3

A group of students investigated the effect of temperature on the rate of a reaction. The students reacted tablets of calcium carbonate weighing 1 g with 50 cm³ of hydrochloric acid. They measured the time taken for 100 cm³ of carbon dioxide gas to be produced at different temperatures.

Temperature of hydrochloric acid in °C	Time for 100 cm ³ of carbon dioxide gas to be produced in seconds			
	Trial 1	Trial 2	Trial 3	Mean
20	119	122	85	109
25	82	76	78	79
30	61	56	62	60
35	44	36	38	39
40	28	34	30	31

Case Study 4

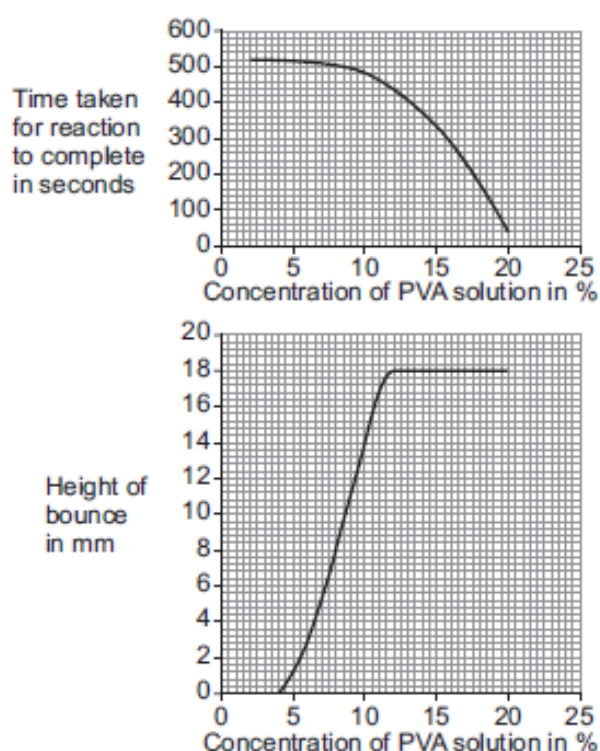
A group of students made slime by reacting dilute PVA adhesive with borax solution. They used different concentrations of PVA adhesive solution and measured the time taken for the reaction to complete.

A ball of slime bounces when dropped on a hard surface.

The group of students investigated the effect of the rate of reaction on the height of the bounce.

They dropped a ball of each of the different slimes they had made from a height of 1 metre onto a hard surface. The students measured the height of the bounce for different concentrations of PVA.

Here are their results.



CU2.5 Catalysts

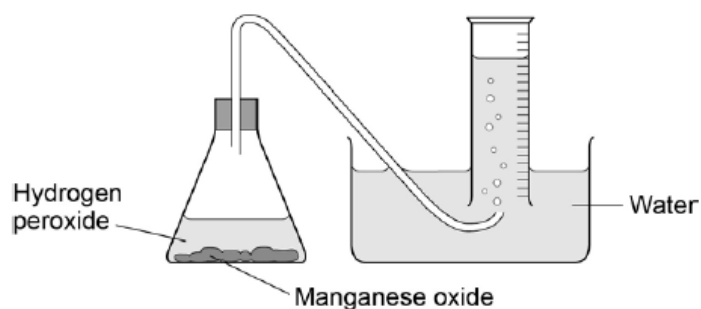
Context: Catalysts change the rate of chemical reactions but are not used up during the reaction. Different reactions need different catalysts. Catalysts are important in increasing the rates of chemical reactions used in industrial processes to reduce costs. Suitable contexts could include: using catalysts to control the setting times for resins used in wood repairs, car repairs, or controlling the setting times of epoxy resin adhesives. The AQA method sheet students investigate the hypothesis that the greater the mass of manganese oxide catalyst used, the faster the rate of decomposition of hydrogen peroxide.

This method could be used to investigate the following hypothesis:

'The greater the mass of manganese oxide catalyst used, the faster the rate of decomposition of hydrogen peroxide.'

Equipment

Conical flask with delivery tube
Trough or washing up bowl
100 cm³ measuring cylinder
25 cm³ measuring cylinder
10 vol hydrogen peroxide
Manganese oxide
Spatula
Balance
Stopwatch
Eye protection



Method

- 1 Measure 15 cm³ of hydrogen peroxide solution into the flask.
- 2 Weigh out 0.01 g of manganese oxide.
- 3 Fill the 100 cm³ measuring cylinder with water and invert it over the end of the delivery tube.
- 4 Add the manganese oxide to the flask. Insert the bung and delivery tube.
- 5 Start the stopwatch.
- 6 Measure and record the time taken for 50 cm³ of oxygen to be produced.
- 7 Repeat with greater masses of manganese oxide up to 0.07 g, or until the time taken is too small to measure.

Case studies

Case Study 1

Manganese oxide is a catalyst. Different masses of manganese oxide were used to catalyse the decomposition of hydrogen peroxide solution. The time taken to collect 100 cm³ of oxygen gas produced was recorded.

The table shows the results.

Mass of manganese oxide in grams	Time taken to collect 100 cm ³ of oxygen gas in seconds
0.2	75
0.4	60
0.6	45
0.8	30
1.0	15

Case Study 2

One type of glue uses a catalyst to make it set. A group of students investigated the time taken for 10 cm³ of this glue to set. They used different volumes of catalyst.

These are their results.

Volume of catalyst used in cm ³	Time taken for the glue to set in seconds			
	Trial 1	Trial 2	Trial 3	Mean
1	226	219	231	225
2	202	210	203	205
3	177	121	182	160
4	150	159	154	154
5	119	116	114	116

Case Study 3

Plastic repair resin contains a catalyst.

Some students investigated the time taken for the resin to set at different temperatures.

These are their results.

Temperature in °C	Time taken for the resin to set in seconds			
	Trial 1	Trial 2	Trial 3	Mean
20	365	374	368	369
40	154	159	161	158
60	87	91	89	89
80	41	38	44	41
120	10	8	12	10

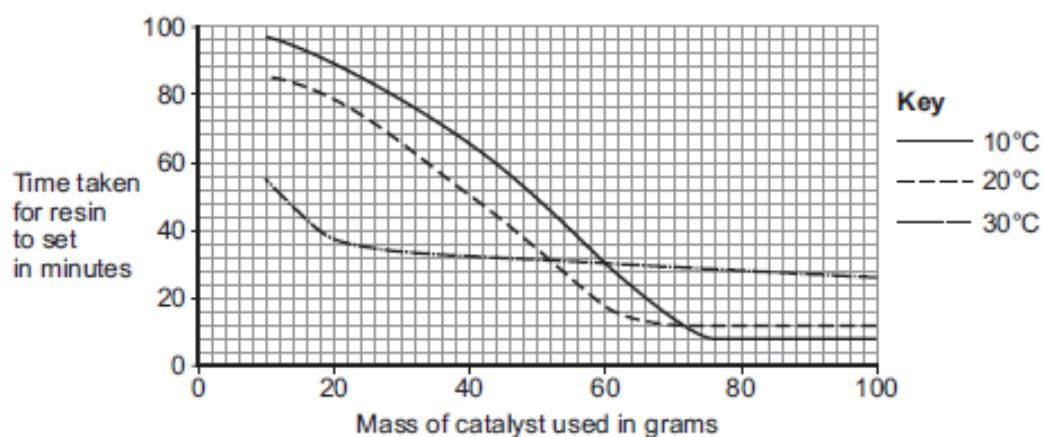
Case Study 4

Plastic repair resins can be used to repair car bodywork. They contain a catalyst.

A manufacturer of car repair resins investigated the time taken for a resin to set using different masses of catalyst.

The manufacturer used 500 g of repair resin for each experiment.

The investigation was done at three different temperatures.



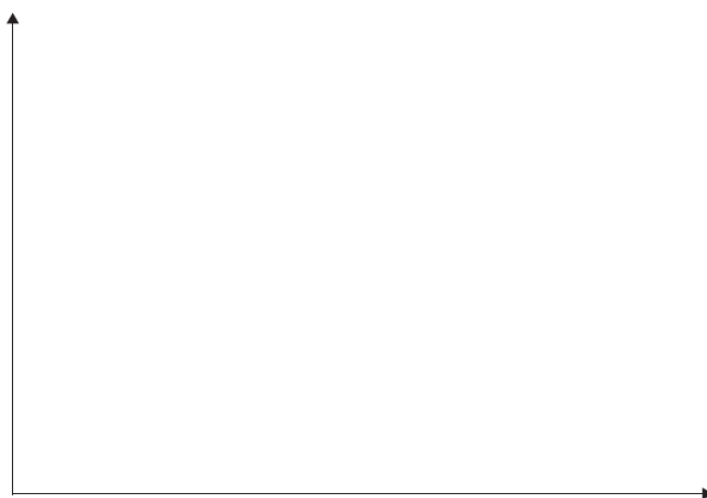
Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the time taken to collect 100 cm³ of oxygen gas varies with the mass of manganese oxide.

[2 marks]



2 (b) A scientist made this hypothesis:

‘The greater the mass of catalyst used, the faster the reaction will take place.’

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

[3 marks]

2 (c) Look at Case Study 4.

The information for the car repair resin stated:

‘The higher the temperature used, the faster the resin will set.’

Do the results in Case Study 4 support this information?

Explain your answer. You should use data from Case Study 4 in your explanation.

[3 marks]

CU1.5 Reactivity of metals

Context:

Unreactive metals such as gold are found in the Earth as the metal itself, but most metals are found as compounds that require chemical reactions to extract the metal. Metals that are less reactive than carbon can be extracted from their oxides by reduction with carbon, for example iron oxide is reduced in the blast furnace to make iron. Metals that are more reactive than carbon, such as aluminium, are extracted by electrolysis of molten compounds. The use of large amounts of energy in the extraction of these metals makes them expensive. Copper can be obtained from solutions of copper salts by electrolysis or by displacement using scrap iron. Suitable contexts could include: the choice of sacrificial anodes to prevent submerged iron from rusting, or the choice of metal to use to displace copper from impure copper solutions.

This method could be used to investigate the following hypothesis:

'The temperature rise when a metal reacts with a solution of copper chloride varies with the reactivity of the metal.'

Equipment

25 cm³ measuring cylinder
Stirring thermometer
Plastic cup
Beaker to hold the plastic cup
Spatula
Glass rod
Balance
Copper chloride solution (0.2 mol per dm³)
Metal powders

Method

- 1 Place the plastic cup in the beaker. Measure 25 cm³ of copper chloride solution into the plastic cup.
- 2 Measure and record the initial temperature of the copper chloride solution.
- 3 Weigh out 0.5 g of one of the metals.
- 4 Add the metal to the copper chloride solution, stir with the glass rod.
- 5 Measure and record the highest temperature of the solution.
- 6 Wash out the plastic cup and repeat for different metals.

Case studies

Case Study 1

A group of students investigated the temperature rise when different masses of magnesium ribbon were reacted with copper chloride solution.

These are their results.

Mass of magnesium ribbon in grams	Temperature rise of copper chloride solution in °C
0.25	3
0.50	6
0.75	9
1.00	12
1.25	15

Case Study 2

Three students measured the temperature rise when 0.5 g of different metal powders was reacted with copper chloride solution.

The concentration and volume of the copper chloride solution used was the same for each reaction.

These are their results.

Metal in order of increasing reactivity	Temperature rise of copper chloride solution in °C			
	Student 1	Student 2	Student 3	Mean
lead (least reactive)	2	1	3	2
nickel	3	2	4	3
iron	5	4	3	4
zinc	8	12	7	9
magnesium (most reactive)	13	15	15	14

Case Study 3

Some students investigated the temperature rise when 0.5 g of magnesium powder reacts with copper chloride solutions of different concentration.

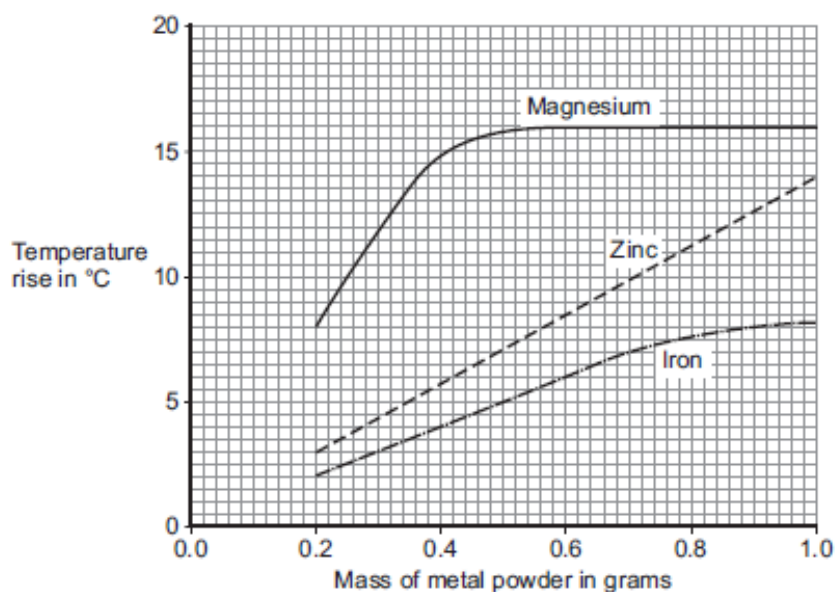
These are their results.

Concentration of copper chloride solution in moles per dm ³	Temperature rise of copper chloride solution in °C			
	Trial 1	Trial 2	Trial 3	Mean
0.2	2.2	2.5	2.4	2.4
0.4	4.7	4.9	4.6	4.7
0.6	6.7	5.3	6.9	6.8
0.8	9.2	9.3	9.1	9.2
1.0	11.8	11.5	11.4	11.6

Case Study 4

A scientist reacted increasing masses of zinc, magnesium and iron powders with copper sulfate solution. The temperature rise in each case was recorded.

The concentration and volume of the copper sulfate solution used was the same for each reaction.



Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the temperature rise of copper chloride solution varies with the mass of magnesium ribbon.



2 (b) Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3, support the hypothesis you were given.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2, and 3.

2 (c) Look at Case Study 4.

To what extent does the data in Case Study 4 show that the relationship between the mass of metal powder and the temperature rise is directly proportional?

ISAs linked to the content in the specification

Context and case studies given

ISA title	Brief summary of experiment
CU3.2b Energy from fuels	Energy from combustion of different fuels
CU3.4b Fuels	Energy released by combustion depends on carbon chain length
CU3.6a Fuels	Energy released by burning alcohols
CU3.6b Precipitates	Factor affecting mass of precipitate formed in a reaction

CU3.2b Energy from fuels

Context:

The relative amounts of energy released when substances burn can be measured by simple calorimetry, eg by heating water in a glass or metal container. This method can be used to compare the amount of energy produced by fuels and foods.

Students investigate how the **type of fuel** used affects the energy available on combustion. The AQA method sheet investigates the hypotheses that the temperature rise of the heated water depends on the number of carbon atoms in the formula of the alcohol being burned. Five different alcohol burners were used. Suitable contexts could include: determining the best fuel to use in a portable liquid fuel stove, or for use in vehicle engines.

Case studies

Case Study 1

A group of students did an investigation into energy in different alcohols.

The students heated 200 cm³ of water with each alcohol. They measured the mass of alcohol needed to achieve a 5 °C temperature rise.

These are their results:

Alcohol	Number of carbon atoms in molecule	Mass burnt to produce a 5°C temperature rise in grams
methanol	1	5.7
ethanol	2	5.0
propanol	3	4.6
butanol	4	4.4
pentanol	5	4.2

Case Study 2

A second group of students did an investigation with alkanes instead of alcohols. The students heated 200 cm³ of water with each alkane and measured the mass needed to achieve a 5 °C temperature rise.

They carried out the investigation three times.

These are their results.

Alkane name	Number of carbon atoms in molecule	Mass burnt to get a 5°C temperature rise in grams			
		Trial 1	Trial 2	Trial 3	Mean
methane	1	11.5	11.8	12.1	11.8
ethane	2	7.6	7.0	7.6	7.4
propane	3	6.1	6.2	6.3	6.2
butane	4	5.5	5.7	5.6	5.6
pentane	5	5.0	5.1	5.4	5.2

Case Study 3

A different group of students carried out some tests on the alcohols, burning 5 g of fuel and recording the temperature rise when heating 100 cm³ of water.

These are their results:

Alcohol	Number of carbon atoms in molecule	Mean temperature rise in °C
methanol	1	23
ethanol	2	30
propanol	3	34
butanol	4	36
pentanol	5	38

Case Study 4

A group of students heated 500 cm³ of water with different alcohols. They measured the mass of alcohol needed to achieve a 5 °C temperature rise.

These are their results.

Alcohol	Number of carbon atoms in molecule	Mass of alcohol in grams			
		Trial 1	Trial 2	Trial 3	Mean mass burnt
methanol	1	14.6	14.9	15.2	14.9
ethanol	2	10.7	10.1	10.7	10.5
propanol	3	6.5	9.3	9.4	9.4
butanol	4	8.6	8.8	8.7	8.7
pentanol	5	8.1	8.2	8.5	8.3

CU3.4b Fuels

Context:

The following two ISAs are similar investigations to the previous 'energy from fuels' but look more at the chemical structure of the fuel. CU3.4b investigates the hypothesis that the energy that is released when burning 1g of an alcohol depends on **the number of carbon atoms** in the molecule. CU3.6a investigated the hypothesis that the energy that is released when burning 1g of an alcohol depends on **the relative formula mass of the alcohol**.

Spirit burners were used to heat 100cm³ of water for 4mins and the temperature change was recorded and the formula below was applied to the results.

$$\text{Temperature rise for 1 gram} = \frac{\text{temperature rise of water}}{\text{mass of alcohol burnt}}$$

Case studies

Case Study 1

A group of students investigated whether the number of carbon atoms in an alcohol affected the temperature rise when 1 g of fuel was burned.

They used spirit burners containing different alcohols. Each time they heated 100 cm³ of water for the same length of time.

The table shows the results.

Number of carbon atoms in the alcohol molecule	Temperature rise for burning 1 g of alcohol in °C
1	7
2	11
3	14
4	16
5	17

Case Study 2

A different group of students repeated the investigation.

The students calculated the energy released by burning 1 g of each alcohol.

Number of carbon atoms in the alcohol molecule	Energy released by burning 1 g of each alcohol in kJ			
	Trial 1	Trial 2	Trial 3	Mean
1	20.6	20.2	20.5	20.4
2	26.2	26.9	26.9	26.7
3	30.3	29.6	30.6	30.2
4	32.5	26.5	32.6	32.6
5	33.9	34.0	34.2	34.0

Case Study 3

Students investigated the burning of alcohols.

The students burned different alcohols to heat 1000 cm³ of water for 5 minutes and recorded the temperature change.

The students measured the mass of each alcohol that was burned.

These are the results.

Number of carbon atoms in the alcohol molecule	Mean temperature rise after 5 minutes in °C	Mass of alcohol burned in grams		
		Trial 1	Trial 2	Mean
1	2.3	1.6	1.8	1.7
2	3.0	2.1	2.3	2.2
3	3.4	2.6	2.4	2.5
4	3.6	2.9	2.5	2.7
5	3.8	2.8	2.7	2.8

Case Study 4

Jet aircraft use a fuel called kerosene.

Kerosene is a mixture of alkane molecules with a mean number of 10 carbon atoms per molecule.

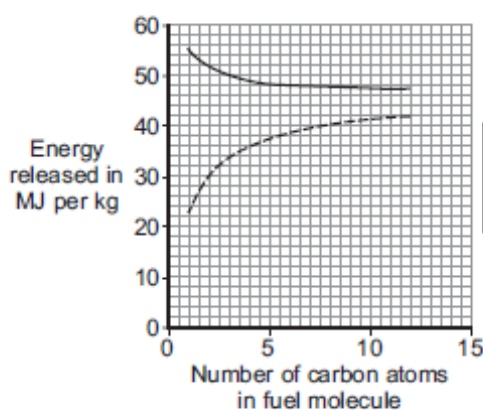
A scientist investigated whether alcohols might replace kerosene as a fuel for jet aircraft.

The scientist used the results of the investigation to calculate the energy that would be released when 1 kg of each fuel was burned.

Jet aircraft store the fuel in flight at temperatures of about -30°C.

The table shows the state of each fuel at -30°C.

Here are the results of the scientist's investigation.



Key
 — Alkanes
 - - Alcohols

Number of carbon atoms in the molecule	State at -30 °C	
	Alcohol	Alkane
1	liquid	gas
2	liquid	gas
3	liquid	gas
4	liquid	liquid
5	liquid	liquid
6	liquid	liquid
7	solid	liquid
8	solid	liquid
9	solid	liquid
10	solid	liquid
11	solid	solid
12	solid	solid

Fuels CU3.6a

Case Study 1

A group of students did an investigation into the energy released when 1 g of different alcohols was burned.

These are their results.

Alcohol	Number of carbon atoms in one molecule of the alcohol	Relative formula mass	Energy released by burning 1 g of alcohol in kJ
methanol	1	32	23
ethanol	2	46	30
propanol	3	60	34
butanol	4	74	36
pentanol	5	88	38

Case Study 2

A second group of students heated 100 cm³ of water using each alcohol and measured the mass needed to achieve a 10 °C temperature increase.

They carried out the investigation three times. These are their results.

Alcohol	Relative formula mass	Mass of alcohol burnt in grams			
		Trial 1	Trial 2	Trial 3	Mean
methanol	32	11.5	11.8	12.1	11.8
ethanol	46	7.6	7.0	7.6	7.4
propanol	60	5.8	4.5	6.0	5.4
butanol	74	5.5	5.7	5.6	5.6
pentanol	88	5.0	5.1	5.4	5.2

Case Study 3

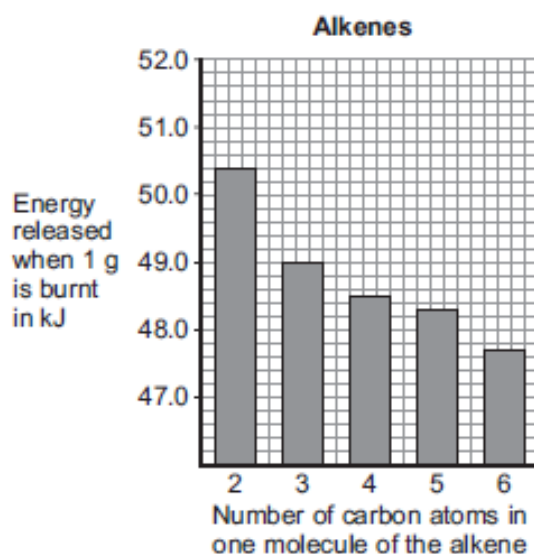
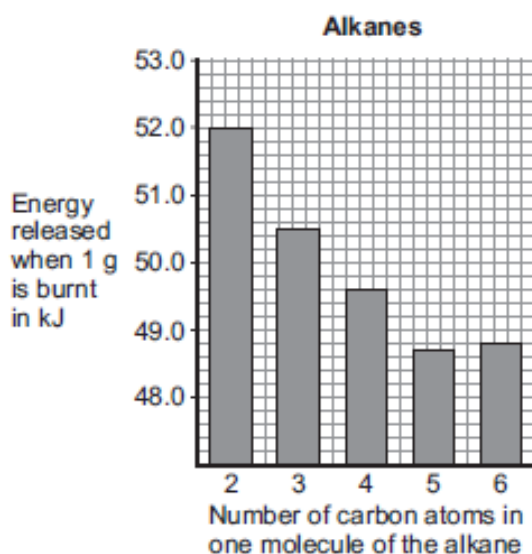
A third group of students carried out some tests on alcohols. They burnt 5 g of each alcohol to heat 100 cm³ of water and recorded the temperature increase.

Alcohol	Relative formula mass	Mean temperature increase in °C
methanol	32	28
ethanol	46	35
propanol	60	39
butanol	74	41
pentanol	88	43

Case Study 4

A student researched how much energy is released by burning 1 g of different alkanes and alkenes.

The student used information from the research to produce the bar charts shown below.



CU3.6b Precipitates

Context:

Copper(II), iron(II) and iron(III) ions form coloured precipitates with sodium hydroxide solution. Copper forms a blue precipitate, iron(II) a green precipitate and iron(III) a brown precipitate. Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid. Suitable contexts could include: determining the concentration of a reactant to use to maximise the precipitate obtained when making paint pigments, or in the manufacture of pharmaceutical drugs.

The AQA method sheet investigated the hypothesis that the mass of precipitate formed depends on the concentration of a reactant.

Method

- 1 Measure 10 cm³ of barium chloride solution into the beaker.
- 2 Place 2 cm³ of sodium carbonate solution in a measuring cylinder. Dilute the solution using distilled water to make 10 cm³ of solution.
- 3 Add the sodium carbonate solution to the beaker. Stir with the stirring rod.
- 4 Take a piece of dried filter paper and write your name on it in pencil.
- 5 Measure and record the mass of the piece of filter paper.
- 6 Filter the solution to obtain as much of the precipitate as possible.
- 7 Remove the filter paper from the filter funnel and dry the paper and precipitate as instructed by your teacher.
- 8 Measure and record the mass of the filter paper and precipitate.
- 9 Calculate the mass of the precipitate.
- 10 Repeat for different concentrations of sodium carbonate solution.

Case studies

Case Study 1

A group of students investigated the mass of precipitate produced in a chemical reaction.

The students reacted different concentrations of barium chloride with 1 mole per dm^3 sulfuric acid to make a precipitate of barium sulfate. The volume of barium chloride solution and sulfuric acid used was constant.

These are the students' results.

Concentration of barium chloride in moles per dm^3	Mass of barium sulfate produced in g
0.2	2.4
0.4	4.8
0.6	7.2
0.8	9.6
1.0	12.0

Case Study 2

A group of students investigated the mass of barium sulfate precipitate produced when different volumes of 1 mole per dm^3 copper sulfate solution was added to 25 cm^3 of barium chloride solution.

These are their results.

Volume of copper sulfate solution used in cm^3	Mass of barium sulfate in g			
	Trial 1	Trial 2	Trial 3	Mean
10	2.1	2.1	2.2	2.13333
20	4.5	4.1	4.3	4.0
30	6.4	6.3	6.2	6.3
40	8.5	8.6	8.2	8.43333
50	9.8	9.4	9.6	9.6

Case Study 3

A group of students investigated the mass of cobalt hydroxide precipitate produced when 25 cm³ of 1 mole per dm³ cobalt chloride solution was mixed with 25 cm³ of 1 mole per dm³ potassium hydroxide solution. They did the investigation at five different temperatures.

Temperature in °C	Mass of cobalt hydroxide in g
25	2.1
35	1.9
45	2.2
55	2.1
65	1.8

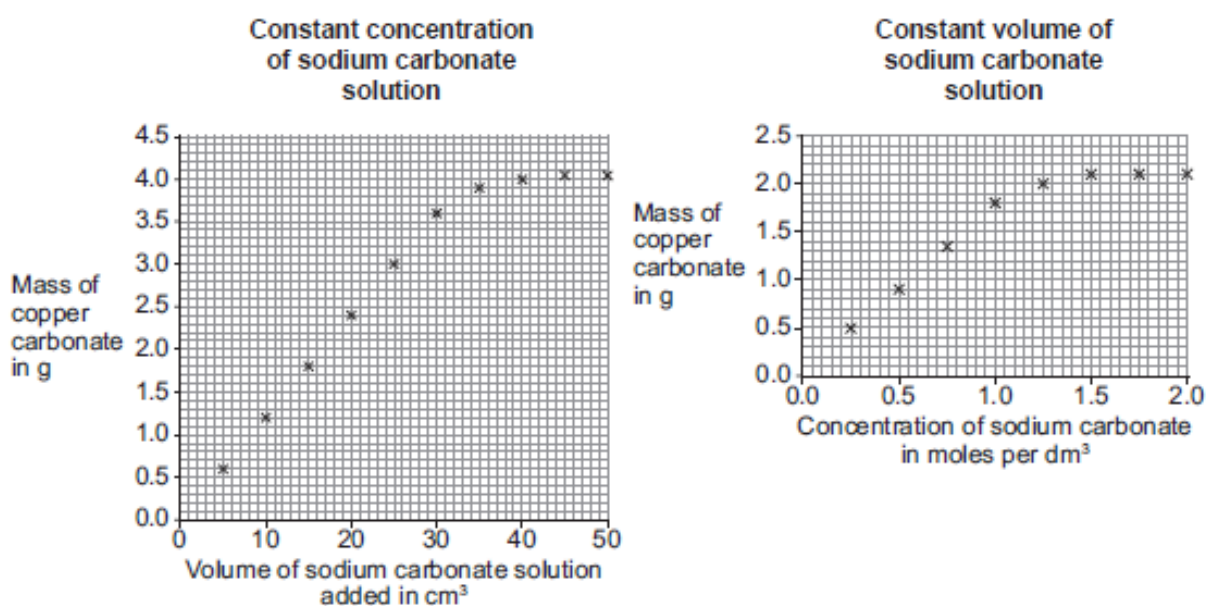
Case Study 4

A group of students investigated the reaction between sodium carbonate solution and copper nitrate solution to produce a precipitate of copper carbonate.

They measured the mass of copper carbonate produced when:

- 1 they used different volumes of a constant concentration of sodium carbonate solution
- 2 they used different concentrations of a constant volume of sodium carbonate solution.

Their results are plotted below.



Notes

Notes

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

Tel: 01483 477756

Email: gcsescience@aqa.org.uk

Twitter: @AQA

aqa.org.uk