How practical skills are assessed

Version 1.4 November 2017

- GCSE Combined Science: Trilogy
- GCSE Combined Science: Synergy
- GCSE Biology
- GCSE Chemistry
- GCSE Physics

These questions are taken from the first set of sample assessment papers which can be found on our website and on exampro.

Each question is referenced with its:

- assessment objective (AO)
- level of demand (low targeting grade1-3, standard targeting 4-5 and high targeting 6-9)
- apparatus technique if appropriate (AT)
- working scientifically if appropriate (WS)

Introduction

Assessment of practical skills in science consists of three components:

1. Apparatus and techniques set by the DfE **(ATs)**
2. Required practicals **(RPs)** designed to deliver the apparatus and techniques, of which 15% of the marks on the papers will be assigned to
3. Working scientifically **(WS)**

These three components will be assessed across the papers at each level of demand using our full range of question types.

The practical skills are also assessed across all three of the Assessment Objectives (**AOs)**:

AO1: Demonstrate knowledge and understanding of:

- scientific ideas
- scientific techniques and procedures.

AO2: Apply knowledge and understanding of:

- scientific ideas
- scientific enquiry, techniques and procedures.

AO3: Analyse information and ideas to:

- interpret and evaluate
- make judgements and draw conclusions
- develop and improve experimental procedures.

The GCSE 9-1 subject level guidance for combined science from Ofqual offers further interpretation and definitions of the AOs, especially with reference to scientific enquiry, techniques and procedures. We strongly recommend you refer to this document to gain further clarification of interpreting each strand of the assessment objectives.

In this booklet we have exemplified each of the AOs for a range of practical questions. In exam papers a question is made up of items, which means that any question will often cover **more than one assessment objective and will assess both content as well as practical skills and maths skills.** For this reason you will see that there are few questions that focus solely on a required practical, rather, whole questions assess a number of different aspects.

Due to this, only parts of questions have been used in some of the examples with their accompanying mark schemes.

These items are taken from the first set of specimen assessment materials. The mark scheme is presented in its pre -standardised version, therefore teachers should use their professional judgement when applying it.

Additional resources

You can find more support and guidance for carrying out practical work on our website

Resources include:

- practical handbooks
- subject specific vocabulary
- effective use of practicals - a set of power point slides to use for department Inset.

Biology required practical activity – Photosynthesis

Trilogy – Biology paper 1F, question 07.2/1H question 02.0

AO1

Standard demand

AT 1, 3, 4, 5

WS 2.2

0 7 Plants absorb light to photosynthesise.

0 7 . 1 What is the correct word equation for photosynthesis?

[1 mark]

Tick **one** box.

carbon dioxide + glucose ⟶ oxygen + water ☐

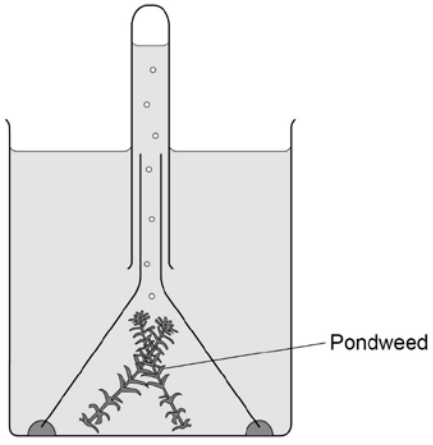
glucose + oxygen ⟶ carbon dioxide + water ☐

oxygen + water ⟶ carbon dioxide + glucose ☐

water + carbon dioxide ⟶ oxygen + glucose ☐

0 7 . 2 **Figure 9** shows some of the apparatus that can be used to measure the rate of photosynthesis.

Figure 9



The rate of photosynthesis in the pondweed is affected by light intensity.
Describe a method you could use to investigate this.
You should include:

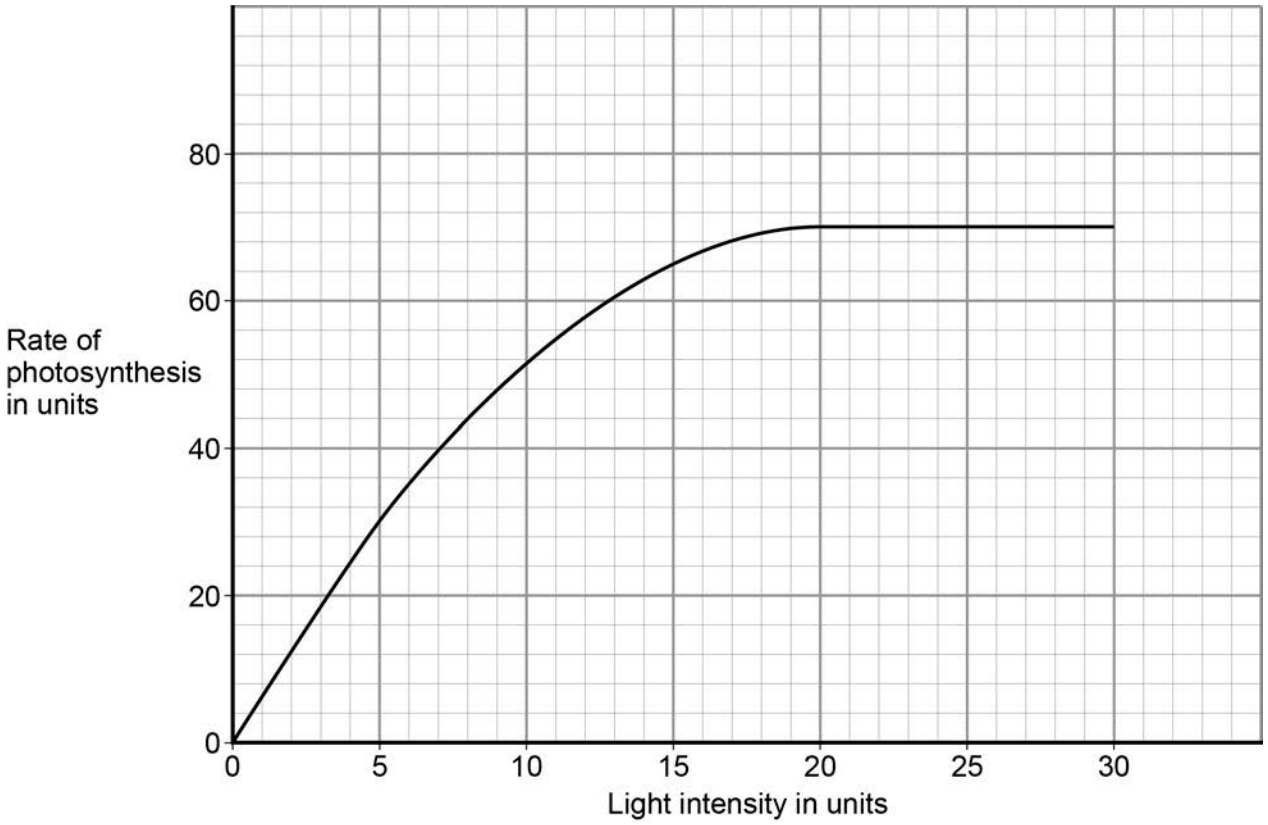
- what you would measure
- variables you would control.

[6 marks]

A scientist carried out a similar investigation.

Her results are shown in **Figure 3**.

Figure 3



0 7 . 3 The scientist said:

'Light stops being a limiting factor at a light intensity of 20 units.'

Give evidence from **Figure 3** to support this statement.

[1 mark]

0 7 . 4 What could be limiting the rate of photosynthesis at a light intensity of 25 units?

Give **one** factor.

[1 mark]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	water + carbon dioxide → oxygen + glucose	extra box ticked negates mark	1	AO1/1 4.4.1.1
07.2	**Level 3:** A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.		5–6	AO1/2 4.4.1.2
	Level 2: The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical order and may be missing some detail.		3–4	
	Level 1: Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.		1–2	
	No relevant content		0	
	Indicative content • description of how the apparatus would be used • reference to control intensity of light/brightness • use of ruler to measure distance of light from beaker/pondweed • reference to varying colour of light or use of different filters • plant releases gas/oxygen • measure number of bubbles/volume of gas produced • same length of time • reference to control of temperature • reference to control/supply of carbon dioxide in water • do repeats and calculate a mean			
07.3	rate does not increase further if light intensity increased beyond 20	allow graph levels off after 20	1	AO3/1b 4.4.1.2
07.4	any **one** from: • temperature • carbon dioxide (concentration) • amount of chlorophyll	allow number of chloroplasts	1	AO2/2 4.4.1.2
Total			**9**	

Biology required practical activity – Fieldwork investigations

Trilogy – Biology paper 2F question 09 and 2H question 02

AO 1

Standard demand

AT 1, 4, 6

WS 2.2, 2.3, 2.4, 2.5, 3.6

Students should be familiar with a quadrat procedure that yields valid results for population sampling. Students may have used quadrats in the context of a distribution survey along a transect line, so it is important that they are also aware of the use of a sufficiently large number of randomly placed quadrats.

Question 02.2 assess mathematics skills, a mark is available for showing correct working if answer incorrect.

0 2 Students used quadrats to estimate the population of dandelion plants on a field.

0 2 . 1 Describe how quadrats should be used to estimate the number of dandelion plants in a field.

[4 marks]

AO1

0 2 . 2 The field had an area of 6 000 m^2.

The students used 0.25 m^2 quadrats.

The students found a mean of 0.42 dandelions per quadrat.

Estimate the population of dandelions on the field.

[2 marks]

Estimated population of dandelions = _____

AO2/2

0 2 . 3 In one area of the field there is a lot of grass growing in the same area as dandelions.

Suggest why the dandelions may **not** grow well in this area.

[4 marks]

AO1

Question	Answers	Extra information	Mark	AO/Spec. Ref.
02.1	(placed) randomly		1	AO1 4.7.2.1
	sufficient number (of quadrats) used		1	AO1 4.7.2.1
	count (dandelions) in each quadrat		1	AO1 4.7.2.1
	use mean number of dandelions, area of quadrat and area of field to estimate population		1	AO1 4.7.2.1
02.2	10 080	if answer incorrect allow **1** mark for a correct stage from either: 6 000/0.25 = 24 000 **or** (ecf) × 0.42 = correct allowing for ecf	2	AO2 4.7.2.1
02.3	**Level 2:** Two or more factors are described with a linked explanation of why dandelion growth may be limited		3–4	AO1 4.1.3.3 4.4.1.1 4.4.1.2 4.4.1.3 4.7.1.1
	Level 1: An attempt to describe one or more factor and the idea of competition for that factor.		1–2	
	No relevant content		0	
	Indicative content **factors that may be considered:** • light • water • space • mineral ions (allow nutrients/salts/ions from the soil) **reference to why growth may be limited:** • (light) energy for photosynthesis • water as a raw material for photosynthesis/support • space/surface area exposed to light • mineral ions for growth/production of larger molecules/named example			

Biology required practical activity – Osmosis

Biology – paper 1H, question 05

AO2

Standard/High demand

AT: 1, 3, 5

WS 3.1, 3.2, 3.5, 3.8

Students should be aware of the need to choose a scale on the *x*-axis that maximises the area of the grid used. They are instructed to label it, so the correct label from the column heading in the table (Concentration of sugar solution in mol dm^{-3}) should be used.

The level of demand is increased by the need to plot some negative values on the *y*-axis.

The points form a straight line within experimental error. A ruler should be used with an equal distribution of points on either side of the line.

0 5 A student investigates the effect of different sugar solutions on potato tissue.

This is the method used.

1. Add 30 cm^3 of 0.8 mol dm^{-3} sugar solution to a boiling tube.
2. Repeat step **1** with equal volumes of 0.6, 0.4 and 0.2 mol dm^{-3} sugar solutions.
3. Use water to give a concentration of 0.0 mol dm^{-3}.
4. Cut five cylinders of potato of equal size using a cork borer.
5. Weigh each potato cylinder and place one in each tube.
6. Remove the potato cylinders from the solutions after 24 hours.
7. Dry each potato cylinder with a paper towel.
8. Reweigh the potato cylinders.

Table 2 shows the results.

Table 2

Concentration of sugar solution in mol dm^{-3}	Starting mass in g	Final mass in g	Change of mass in g	Percentage (%) change
0.0	1.30	1.51	0.21	16.2
0.2	1.35	1.50	0.15	**X**
0.4	1.30	1.35	0.05	3.8
0.6	1.34	1.28	–0.06	–4.5
0.8	1.22	1.11	–0.11	–9.0

0 5 . 1 Calculate the value of **X** in **Table 2**.

[2 marks]

Percentage change in mass = _____ %

AO2/2

0 5 . 2 Why did the student calculate the percentage change in mass as well as the change in grams?

[1 mark]

AO2/2

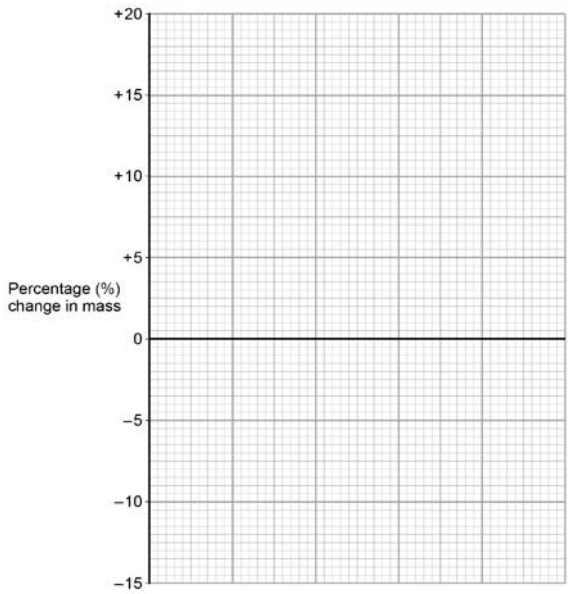
0 5 . 3 Complete **Figure 3** using data from **Table 2**.

- Choose a suitable scale and label for the *x*-axis.
- Plot the percentage (%) change in mass.
- Draw a line of best fit.

[4 marks]

AO2/2

Figure 3



0 5 . 4 Use your graph in **Figure 3** to estimate the concentration of the solution inside the potato cells.

[1 mark]

Concentration = _____ mol dm^{-3}

AO3

0 5 . 5 The results in **Table 2** show the percentage change in mass of the potato cylinders.

Explain why the percentage change results are positive **and** negative.

[3 marks]

AO2/1

0 5 . 6 Suggest **two** possible sources of error in the method given on **page 16**.

[2 marks]

1

2

AO3

Question	Answers	Extra information	Mark	AO/Spec. Ref.
05.1	11.1 (%)	accept for 1 mark (0.15/1.35) × 100	2	AO2 4.1.3.2
05.2	to allow results to be compared **or** they had different masses at the start		1	AO2 4.1.3.2
05.3	axis correct scale and labelled 5 points correctly plotted line through points	 allow 1 mark for 4 points correctly plotted allow ecf	1 2 1	AO2 4.1.3.2 AO2 4.1.3.2 AO2 4.1.3.2
05.4	0.5	allow 0.45–0.55	1	AO3 4.1.3.2
05.5	(0.0 to 0.4) water moves into cells (0.6 to 0.8) water leaves cells by osmosis		1 1 1	AO2/1 4.1.3.2 AO2/1 4.1.3.2 AO1/1 4.1.3.2
05.6	any **two** from: • concentration of solutions • drying of chips • accuracy of balance • evaporation from tubes		2	AO3/3a 4.1.3.2

Trilogy – Biology paper 1H, question 01.5

AO2/2

Standard/High

AT 7

WS 1.2, 3.3

This question is based on the content of the specification (4.1.1.5/4.1.3.1) but could well have been covered in a practical lesson while covering the required practical activity - *Microscopy*

Students will need to rearrange the equation, and recognise that 1 µm = 10^{-3} mm and be able to use this to calculate a correct answer.

0 1 . 4 A scientist observed a cell using an electron microscope.
The size of the image was 25 mm.
The magnification was × 100 000

Calculate the real size of the cell.
Use the equation:

$$\text{magnification} = \frac{\text{image size}}{\text{real size}}$$

Give your answer in micrometres.

[3 marks]

Real size = _____ micrometres

Question	Answers	Extra information	Mark	AO/Spec. Ref.
01.5	0.25 (micrometres)	allow **2** marks for 0.00025 allow **1** mark for correct substitution or rearrangement 100 000 = 25/real size **or** real size = 25/100 000 allow **1** mark for conversion of mm to µm 25 000	3	AO2 4.1.1.5

Biology required practical activity - Microbiology (Biology only)

Biology – paper 1F, question 06.3

AO3

Low demand

AT 1,3,4,8

WS 2.7, 3.5

This is an example of a question set in an unfamiliar context as students are unlikely to have used the named oils. However students should be familiar with the practical investigating the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.. A basic understanding of the idea that the effectiveness of an antiseptic can be measured using zones of inhibition on agar lawn plates is required.

In question 06.4 students need to recognise the limitations of any conclusion that can be drawn from the results which is part of WS.

Q6 (part)

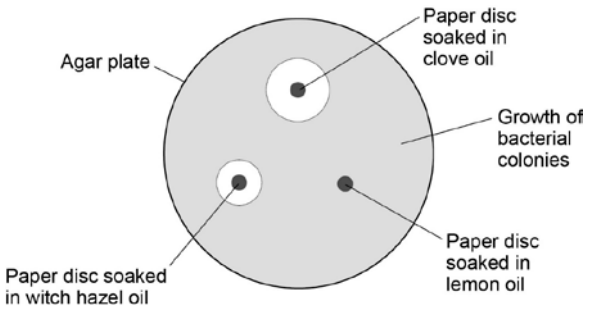
Witch hazel is another plant adapted for defence.

Witch hazel produces oil with antiseptic properties. The oil prevents bacteria from attacking the plant.

A student investigated how effective three different plant oils were at preventing the growth of bacteria.

Figure 10 shows the results.

Figure 10



0 6 . 2 Which plant oil is the most effective at preventing the growth of bacteria?

Give a reason for your answer.

[2 marks]

Oil _____

Reason _____

0 6 . 3 The student tested tea tree oil using the same method.

The results showed tea tree oil was the most effective at preventing bacterial growth.

The student concluded that tea tree oil could be used to treat bacterial infections instead of antibiotics.

Give **one** reason why this is **not** a valid conclusion.

[1 mark]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
06.2	clove (oil)		1	AO3 4.3.3.2
	it has the largest areas with no bacteria growing	allow largest inhibition zone **or** description of largest inhibition zone	1	AO3 4.3.3.2
06.3	antibiotics were not tested		1	AO3 4.3.3.2

Biology – paper 1F, questions 07.3, 07.4

AO3
Low/ Standard demand

WS3.5

Question 07 requires students to handle data provided in tabular form, which will have been obtained by experimental methods. Students do not need any knowledge of the practical procedures needed to obtain the data, but should be able to comment on patterns and trends shown in it. The focus of this is working scientifically.

0 7 Carbohydrates are broken down into glucose molecules in the small intestine.

Table 3 shows the concentration of glucose at different distances along the small intestine.

Table 3

Distance along the small intestine in cm	**Concentration of glucose in mol dm^{-3}**
100	50
300	500
500	250
700	0

0 7 . 1 At what distance along the small intestine is the glucose concentration highest?

[1 mark]

_____ cm

0 7 . 2 Use the data in **Table 3** to plot a bar chart on **Figure 11**.

- Label the *y*-axis.
- Choose a suitable scale.

[4 marks]

(Graph paper outline provided on the question paper)

0 7 . 3 Describe how the concentration of glucose changes as distance increases along the small intestine.

[2 marks]

0 7 . 4 Explain why the concentration of glucose in the small intestine changes between
300 cm and 700 cm.

[3 marks]

AO3

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	300		1	AO2/1 4.2.2.1
07.2	suitable scale on *y*-axis		1	AO2/2 4.2.2.1
	label *y*-axis		1	AO2/2 4.2.2.1
	4 bars drawn correctly	allow **1** mark for 3 correct bars	2	AO2/2 4.2.2.1
07.3	increases **or** 50 to 500		1	AO3 4.2.2.1
	then decreases **or** 500 to 0		1	AO3 4.2.2.1
07.4	absorption of glucose		1	AO3 4.2.2.1
	into blood		1	AO3 4.2.2.1
	by active transport	allow diffusion	1	AO3 4.1.3.3

Biology required practical – Reaction times

Biology – paper 2H, questions 06.1, 06.3

AO 2 and 3

Standard/High demand

AT 1, 3, 4

WS 2.2

A variety of control variables are accepted so the command word is 'suggest'. Note that no credit is available for repeating the test more times, nor for doing it with more people.

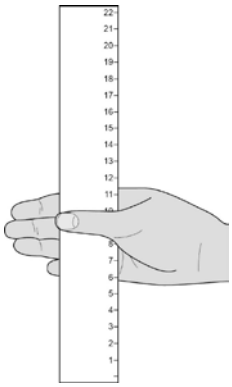
Candidate errors may include: failing to convert 116 mm to centimetres and taking the square root of the mean drop distance and then dividing by 490.

0 6 Two students investigated reflex action times.

This is the method used.

1. Student **A** sits with her elbow resting on the edge of a table.
2. Student **B** holds a ruler with the bottom of the ruler level with the thumb of Student **A**.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler and records the distance, as shown in **Figure 7**.
5. Steps **1** to **4** were then repeated.

Figure 7



0 6 . 1 Suggest **two** ways the students could improve the method to make sure the test would give valid results.

[2 marks]

AO3

0 6 . 2 What is the **median** result?

[1 mark]

Tick **one** box.

106 ☐

115 ☐

116 ☐

117 ☐

123 ☐

0 6 . 3 The mean distance the ruler was dropped is 116 mm.

Calculate the mean reaction time.

[3 marks]

Use the equation:

$$\text{reaction time (s)} = \sqrt{\frac{\text{mean drop distance (cm)}}{490}}$$

Mean reaction time = _____ s

AO2

0 6 . 4

The students then measured Student **A**'s reaction time using a computer program.

This is the method used.

1. The computer shows a red box at the start.
2. As soon as the box turns green the student has to press a key on the keyboard as fast as possible.
3. The test is repeated five times and a mean reaction time is displayed.

Student **A**'s mean reaction time was 110 ms.

Using a computer program to measure reaction times is likely to be more valid than the method using a dropped ruler.

Give **two** reasons why.

[2 marks]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
06.1	any **two** from: • drop the ruler from the same height each time • let the ruler drop without using any force • same type/weight of ruler • thumb should be same distance from the ruler each time at the start • use the same hand to catch the ruler each time • carry out the experiment with the lower arm resting in the same way on the table	allow description of holding bottom edge of ruler opposite the catcher's thumb	2	AO3 4.5.2.1
06.2	117		1	AO2/2 4.5.2.1
06.3	$\sqrt{\frac{11.6}{490}}$ 0.1539 0.154	 allow 01539 with no working shown for **2** marks allow 0.154 with no working shown for **3** marks allow ecf as appropriate	1 1 1	AO2/2 4.5.2.1 AO2/2 4.5.2.1 AO2/2 4.5.2.1
06.4	no indication beforehand when the colour will change **or** you might be able to tell when the person is about to drop the ruler measurement of time is more precise (than reading from a ruler) **or** resolution (of computer timer) is higher		1 1	AO3/2a 4.5.2.1 AO3/2a 4.5.2.1

Biology – paper 1F, questions 02.1, 02.2 and 02.3

AO1, 2 ,3

Low demand

WS 3.5, 3.7

This question is not on a required practical, is set in the context of enzyme activity. Aspects of working scientifically are assessed and understanding of subject specific vocabulary is required.

0 2 Catalase is an enzyme.

Catalase controls the following reaction:

hydrogen peroxide ⟶ water + oxygen

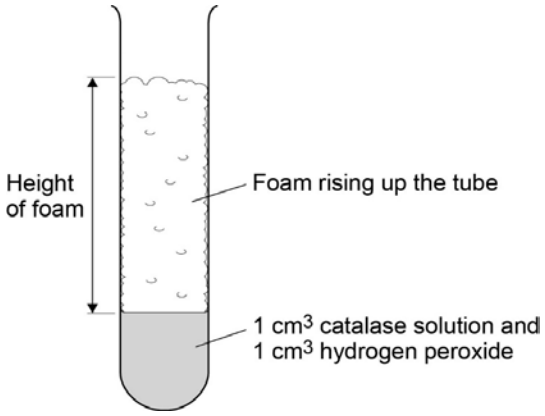
A student did an investigation on catalase activity.

This is the method used.

1. Put 1 cm^3 hydrogen peroxide solution in a test tube.
2. Add 1 cm^3 of catalase solution.
   - Bubbles of oxygen are produced.
   - Bubbles cause foam to rise up the tube.
3. Measure the maximum height of the foam.

Figure 4 shows the experiment.

Figure 4



The experiment is carried out at 20 °C.

Table 1 shows some results from the investigation.

Table 1

Temperature in °C	Maximum height of foam in cm			
	Test 1	**Test 2**	**Test 3**	**Mean**
10	1.3	1.1	0.9	1.1
20	0.0	3.3	3.1	3.2
30	5.2	5.0	5.3	5.2
40	4.2	3.5	4.4	4.0
50	2.1	1.9	2.3	2.1
60	0.0	0.0	0.0	0.0

0 2 . 1 Why did the student carry out the experiment three times at each temperature?

[1 mark]

Tick **one** box.

To make the experiment more accurate ☐

To prove the experiment was correct ☐

To show the experiment was more repeatable ☐

AO1

0 2 . 2 The student thought one result was an anomaly.

Circle the anomaly in **Table 1**.

[1 mark]

AO3

0 2 . 3 What did the student do with the anomalous result?

[1 mark]

AO2/2

0 2 . 4 Look at **Table 1** on **page 9**.

What conclusion can be made as the temperature increases?

[1 mark]

Tick **one** box.

Decreases the rate of reaction up to 30°C ☐

Decreases the rate of reaction up to 40°C ☐

Increases the rate of reaction up to 30°C ☐

Increases the rate of reaction up to 40°C ☐

0 2 . 5 At which temperature was catalase denatured?

[1 mark]

Tick **one** box.

10 °C ☐

30 °C ☐

40 °C ☐

60 °C ☐

0 2 . 6 The student thought the optimum temperature for catalase activity was between 30 °C and 40 °C.
How could the investigation be improved to find a more precise value for the optimum temperature?
Tick **one** box.

[1 mark]

Do the experiment at 70 °C and 80 °C ☐

Do the experiment at 30 °C, 35 °C and 40 °C ☐

Use less hydrogen peroxide solution ☐

Use more catalase solution ☐

0 2 . 7 Amylase is the enzyme that controls the breakdown of starch to glucose.

Describe how the student could investigate the effect of pH on the breakdown of starch by amylase.

[4 marks]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
02.1	to show the experiment was more repeatable		1	AO1 4.2.2.1
02.2	(circle) 0.0 at 20 °C		1	AO3 4.2.2.1
02.3	ignored it/did not use it	ignore repeated it	1	AO2 4.2.2.1
02.4	increases the rate of reaction up to 30 °C		1	AO3/3a 4.2.2.1
02.5	60 °C		1	AO2/1 4.2.2.1
02.6	do the experiment at 30 °C, 35 °C and 40 °C		1	AO3/3b 4.2.2.1
02.7	**Level 2:** A detailed and coherent plan covering all the major steps is provided. The method is set out logically taking into account control variable and appropriate measurements. The plan could be repeated by another person to determine the effect of pH on breakdown of starch by amylase.		3–4	AO1/1 4.2.2.1
	Level 1: Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to determine the effect of pH on breakdown of starch by amylase.		1–2	
	No relevant content		0	
	Indicative content • range of at least 3 pH values/use of buffer solutions • control variables/keep amount or concentration of starch and amylase the same • keep temperature the same using water bath/electric heater • use iodine test to make qualitative observations • observe colour changes at different temperatures • do repeats at each pH			

Trilogy – Biology paper 1H, questions 07.1, 07.2

AO 2/3

Standard /High demand

AT N/A

WS 3.5, 3.6, 3.7

Although this question is not based on a required practical, it is set in the context of photosynthesis and respiration and addresses AT 3 and AT4. Understanding the idea of controls is also required.

0 7 A student investigated the effect of pond organisms on the amount of carbon dioxide in their surroundings.

The student set up six boiling tubes as shown in **Figure 6**.

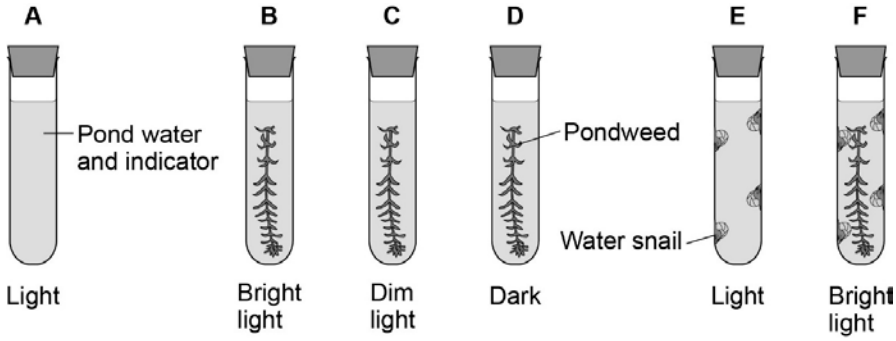
They were left for 2 days.

Each boiling tube contained pond water with an indicator.

The indicator was pink at the start of the investigation.

- If the amount of carbon dioxide in the water increased the indicator turned yellow.
- If the amount of carbon dioxide in the water decreased the indicator turned purple.

Figure 6



0 7 . 1 What is the purpose of boiling tube **A**?

[2 marks]

AO2/2

0 7 . 2 In which boiling tube would the indicator be the **most yellow** after 2 days?

Explain your answer.

[3 marks]

Boiling tube _____

Explanation _____

AO2/2 and AO3

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	control		1	AO2 4.4.1.1 4.4.2.1
	to check that the indicator colour does not change on its own **or** to check any changes in colour are due to the organisms		1	AO2 4.4.1.1 4.4.2.1
07.2	(tube) **E**		1	AO3 4.4.2.1
	most carbon dioxide	allow no carbon dioxide used for photosynthesis	1	AO2 4.4.2.1
	(due to) **only** respiration occurring	allow **1** mark **max** if chose tube **D** and give a correct reason	1	AO3 4.4.1.1

Trilogy - Chemistry Paper 1F question 5

AO 1

Low/Standard demand

AT 2, 3, 4, 6

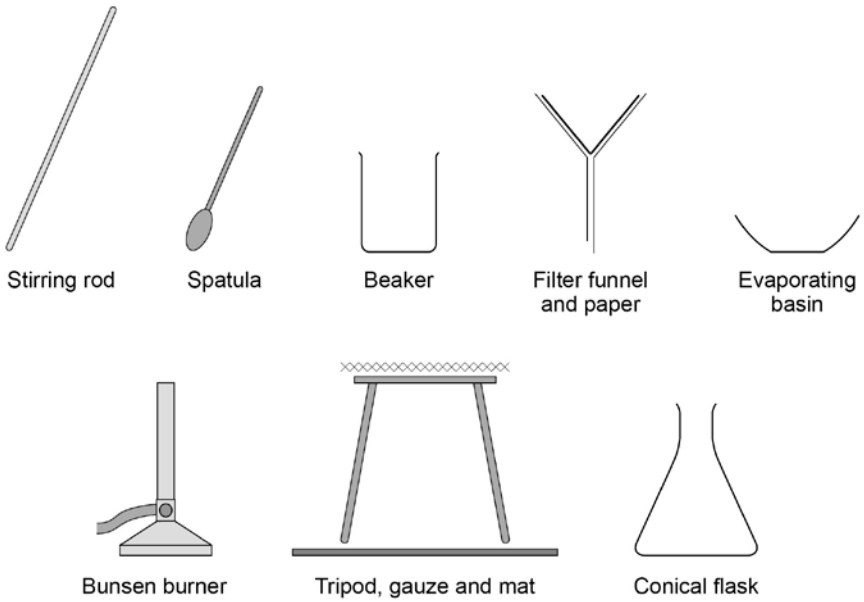
WS

This is a required practical which assesses students understanding of the method. The apparatus is shown to support the students when answering. Answers need to be structured and in a logical order as this is an extended response question. Answers can be written as numbered or bulleted points.

0 5 This question is about making copper salts.

Figure 8 shows the apparatus given to a student.

Figure 8



Outline a safe plan the student could use to make pure, dry, crystals of the soluble salt copper sulfate from the insoluble metal oxide and dilute acid.

[6 marks]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
05	**Level 3:** A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques, procedures and safety precautions. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.		5–6	AO1/2 5.4.2.3
	Level 2: The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques, procedures and safety precautions. The method may not be in a completely logical sequence and may be missing some detail.		3–4	
	Level 1: Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques, procedures and safety precautions. The response may lack a logical structure and would not lead to the production of valid results.		1–2	
	No relevant content		0	

Chemistry paper 1F, question 02.2

AO2

Low demand

AT N/A

WS 2.3

This question requiring students to link variables with the instruments used to measure them.

The question does not relate to required practical activity – *Temperature changes*, since the context, although concerning metal displacement reactions, does not involve the measurement of a temperature rise. However, the context has much in common with it.

0 2

A student investigated the reactivity of three different metals.

This is the method used.

1. Place 1 g of metal powder in a test tube.
2. Add 10 cm^3 of metal sulfate.
3. Wait 1 minute and observe.
4. Repeat using the other metals and metal sulfates.

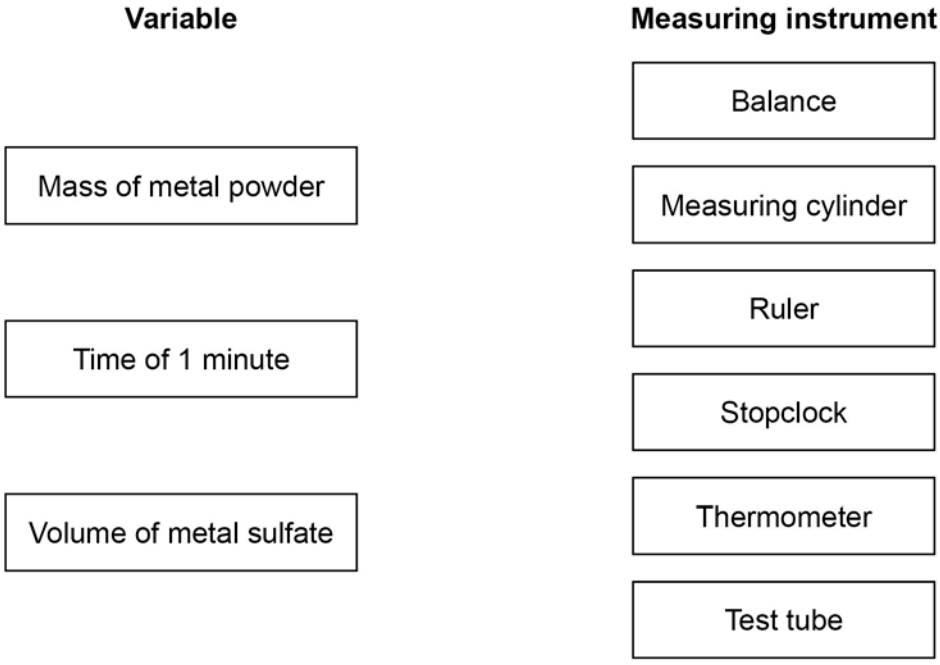
The student placed a tick in **Table 1** if there was a reaction and a cross if there was no reaction.

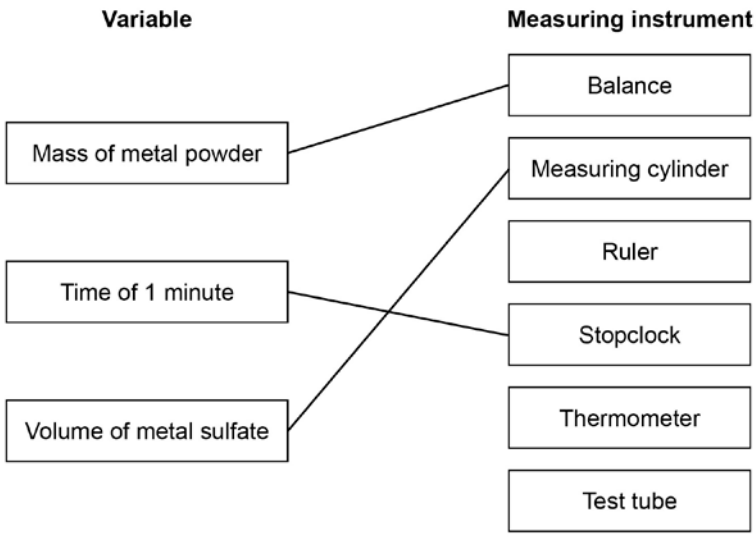
	Zinc	**Copper**	**Magnesium**
Copper sulfate	✓	x	✓
Magnesium sulfate	x	x	x
Zinc sulfate	x	x	✓

0 2 . 2 The student used measuring instruments to measure some of the variables.

Draw **one** line from each variable to the measuring instrument used to measure the variable.

[3 marks]



Question	Answers	Mark	AO/Spec. Ref.
02.2	 More than one line drawn from a variable negates the mark.	1 1 1	AO2 4.4.1.2

Chemistry required practical activity – Neutralisation (Chemistry only)

Chemistry – paper 1H, questions 08.3, 08.5

AO 1 and 2

Standard/High demand

AT 1, 8

WS 2.4, 2.6

Question 08.3 extended writing

Question 08.5 is a high demand multi-step calculation.

0 8

A student used a pipette to add 25.0 cm^3 of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of 0.100 mol/dm^3 sulfuric acid needed to neutralise the sodium hydroxide.

0 8 . 3 Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

[4 marks]

AO1

The student carried out four titrations. Her results are shown in **Table 5**.

Table 5

	Titration 1	Titration 2	Titration 3	Titration 4
Volume of 0.100 mol/dm^3 sulfuric acid in cm^3	28.25	27.85	27.05	27.15

0 8 . 5 The equation for the reaction is:

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

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

[5 marks]

AO2/2

Question	Answers	Extra information	Mark	AO/Spec. Ref.
08.3	adds indicator, eg phenolphthalein/methyl orange/ litmus added to the sodium hydroxide (in the conical flask)	do **not** accept universal indicator	1	AO1 4.3.4 4.4.2.4
	(adds the acid from a) burette		1	
	with swirling **or** dropwise towards the end point **or** until the indicator just changes colour		1	
	until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red (for methyl orange) or blue to red (for litmus)		1	

08.5	Moles H_2SO_4 = conc × vol = 0.00271	allow ecf from 8.4	1	AO2 4.3.4 4.4.2.4
	Ratio H_2SO_4:NaOH is 1:2		1	
	Moles NaOH = Moles H_2SO_4 × 2 = 0.00542		1	
	Concentration NaOH = mol/vol = 0.00542/0.025 = 0.2168		1	
	0.217 (mol/dm^3)	allow 0.2168 with no working for **4** marks allow 0.217 with no working for **5** marks	1	

Chemistry – paper 2F question 9

AO1/2/3

Standard demand

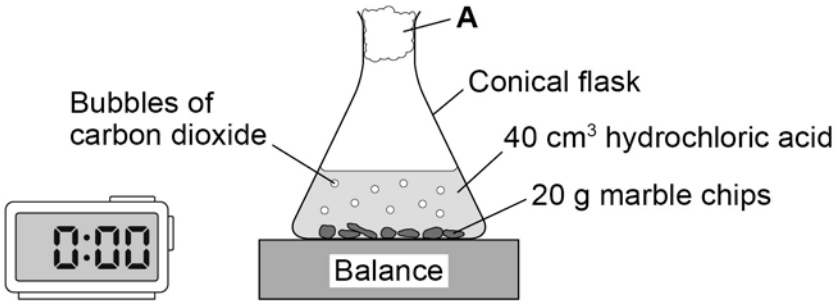
AT

WS

The majority of this question is assessing the WS skills in the context of rates of reaction. Students do not need to have done this investigation as all the information required is in the question. Having had a broad experience of practical work while learning the content of the specification will help embed the learning and support students to access these types of questions.

0 9 A student investigated the rate of reaction between marble chips and hydrochloric acid.
Figure 9 shows the apparatus the student used.

Figure 9



0 9 . 1 What is **A**?

[1 mark]

Tick **one** box.

- cotton wool ☐
- limestone ☐
- poly(ethene) ☐
- rubber bung ☐

0 9 . 2 **Table 4** shows the student's results for one investigation.

Table 4

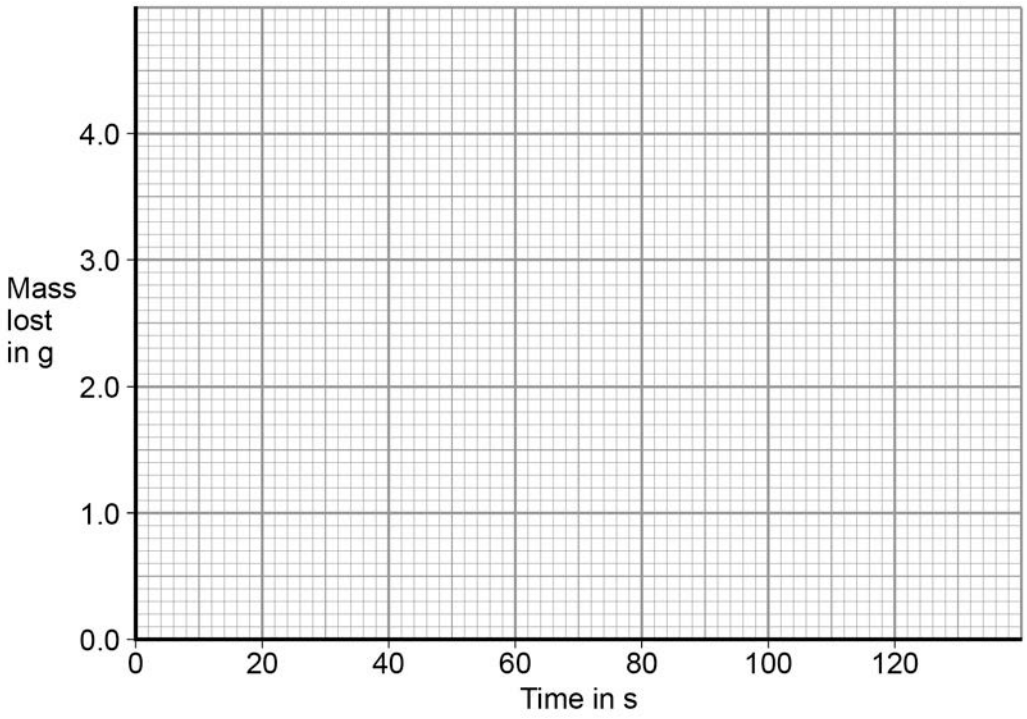
Time in s	Mass lost in g
0	0.0
20	1.6
40	2.6
60	2.9
80	3.7
100	4.0
120	4.0

On **Figure 10**:

- Plot these results on the grid.
- Draw a line of best fit.

[3 marks]

Figure 10



0 9 . 3 Use **Figure 10** to complete **Table 5**.

[2 marks]

Table 5

Mass lost after 0.5 minutes	…….. g
Time taken to complete the reaction	…….. s

0 9 . 4 The equation for the reaction is:

$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Explain why there is a loss in mass in this investigation.

[2 marks]

0 9 . 5 Another student investigated the rate of a different reaction.

Table 6 shows the results from the different reaction.

Table 6

Mass lost when the reaction was complete	9.85 g
Time taken to complete the reaction	2 minutes 30 seconds

Calculate the mean rate of the reaction using **Table 6** and the equation:

[2 marks]

$$\text{mean rate of reaction} = \frac{\text{mass lost in g}}{\text{time taken in s}}$$

Give your answer to two decimal places.

Mean rate of reaction = _____ g/s

0 9 . 6 The student measured the change in mass of the reactants.

Describe another method, other than measuring the change in mass of the reactions, that the student could have used to find the rate of the reaction between marble chips and hydrochloric acid.

[2 marks]

0 9 . 7 Another student planned to investigate the effect of temperature on the rate of reaction.
The student predicted that the rate of reaction would increase as the temperature was increased.

Give **two** reasons why the student's prediction is correct.

[2 marks]

Tick **two** boxes.

- The particles are more concentrated. ☐
- The particles have a greater mass. ☐
- The particles have a larger surface area. ☐
- The particles have more energy. ☐
- The particles move faster. ☐

Question	Answers	Extra information	Mark	AO/Spec. Ref.
09.1	cotton wool		1	AO1/2 4.6.1.2
09.2	all points correct	± ½ small square allow **1** mark if 5 or 6 of the points are correct	2	AO2/2
	best fit line	must not deviate towards anomalous point	1	AO3/2a 4.6.1.1, 2
09.3	(mass) 2.1 (g) (time) 100 (s)	allow ecf from drawn best fit line	1 1	AO2/2 4.6.1.1, 2
09.4	a gas is produced which escapes from the flask		1 1	AO1/1 4.3.1.3
09.5	$\frac{9.85}{150} = 0.0656$ 0.07 (g/s)	 allow ecf answer correctly calculated to 2 decimal places	1 1	AO2/2 4.6.1.1, 2
09.6	collect the gas in a gas syringe measured the volume of gas	 allow carbon dioxide for gas allow for **1** mark collected gas **or** counted bubbles	1 1	AO1/2 4.6.1.1, 2
09.7	The particles have more energy The particles move faster		1 1	AO1/1 4.6.1.2, 3

Chemistry required practical activity – Temperature changes

Chemistry – paper 1F, question 04.2

AO3

Low demand

AT 1, 5, 6

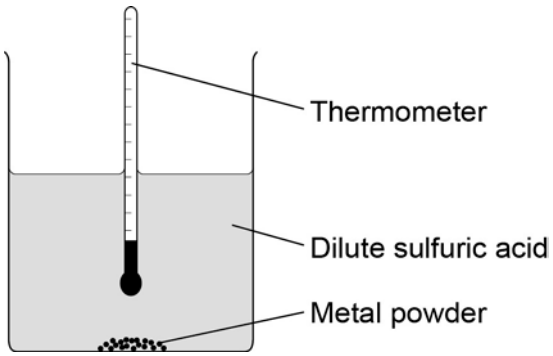
WS 2.7

This question is set in the context of the required practical on temperature change and assesses aspects of WS

0 4 A student investigated the reactivity of different metals.

The student used the apparatus shown in **Figure 7**.

Figure 7



The student used four different metals.

The student measured the temperature rise for each metal three times.

0 4 . 1 Give **two** variables the student should control so that the investigation is a fair test.

[2 marks]

The student's results are shown in **Table 2**.

Metal	Temperature rise in °C			Mean temperature rise in °C
	Test 1	Test 2	Test 3	
Calcium	17.8	16.9	17.5	
Iron	6.2	6.0	6.1	6.1
Magnesium	12.5	4.2	12.3	12.4
Zinc	7.8	8.0	7.6	7.8

0 4 . 2 One of the results for magnesium is anomalous.

Which result is anomalous?

Suggest **one** reason why this anomalous result was obtained.

[2 marks]

Result _____

_____

Reason _____

_____

0 4 . 3 Calculate the mean temperature rise for calcium.

[1 mark]

_____

Mean temperature rise = _____ °C

0 4 . 4 The temperature rose when the metals were added to sulfuric acid.

Give **one** other observation that might be made when the metal was added to sulfuric acid.
How would this observation be different for the different metals?

[2 marks]

_____

0 4 . 5 Aluminium is more reactive than iron and zinc but less reactive than calcium and magnesium.

Predict the temperature rise when aluminium is reacted with dilute hydrochloric acid.

[1 mark]

_____

Temperature rise = _____ °C

Question	Answers	Extra information	Mark	AO/Spec. Ref.
04.1	any **two** from: • concentration/volume of dilute hydrochloric acid • mass of metal powder • surface area of metal powder • stirring (of any)/rate of stirring	allow reacted for the same length of time	2	AO1/2 4.4.1.2
04.2	4.2 °C and any **one** from: • lower mass of magnesium added • surface area of magnesium too low • magnesium coated in magnesium oxide (so took a while to start reacting) • not stirred • not stirred as quickly as the other metals • not reacted for as long a time as the other metals	allow Magnesium Test 2 allow reason for break in circuit	1 1	AO3/1a AO3/3a 4.4.1.2
04.3	17.4(°C)		1	AO2/2 4.4.1.2
04.4	bubbles of gas more (bubbles) seen with calcium than other metals	allow any correct comparison between two metals	1 1	AO3/2a 4.4.1.2
04.5	any value between 7.9 °C and 12.3 °C		1	AO3/2a 4.4.1.2

Chemistry – paper 2F, question 11.5 HT Q

AO2 /AO3

Standard demand

WS 3.5

The question is not based on a required practical activity. Students should be able to access the question without having performed the experiment as all the relevant information is provided in the question.

1 1 **Figure 12** shows four test tubes a student set up to investigate the rusting of iron.
This is the method used for each test tube.
1. Measure the mass of the nail using a balance.
2. Leave the nail in the test tube for 6 days.
3. Measure the mass of the nail after 6 days.

Figure 12

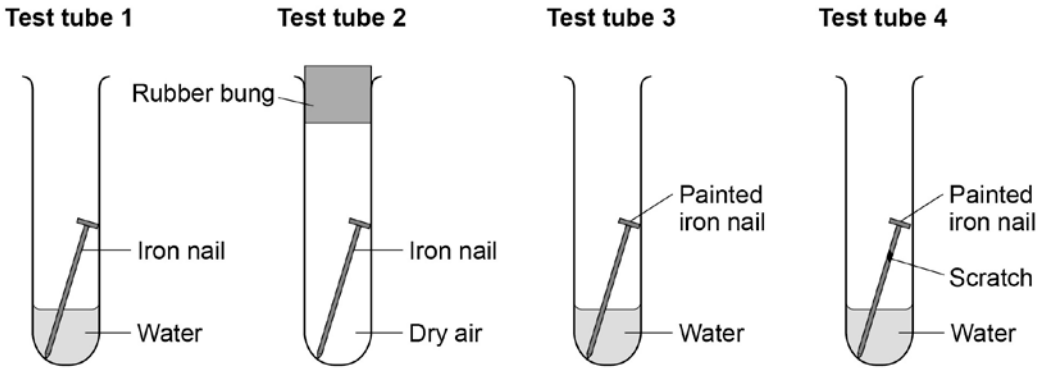


Table 7 shows the student's measurements.

Table 7

Test tube	Mass of nail in g	Mass of nail after 6 days in g	Change in mass in g
1	8.45	8.91	**M**
2	8.46	8.46	0.00
3	9.65	9.65	0.00
4	9.37	9.45	0.08

1 1 . 1 What is the resolution of the balance the student used?

[1 mark]

Tick **one** box.

1×10^{-3} g ☐

1×10^{-2} g ☐

1×10^{-1} g ☐

1×10^{2} g ☐

1 1 . 2 Calculate the difference in percentage increase in mass after 6 days of the nail in test tube **1** and the nail in test tube **5**.
Give your answer to **three** significant figures.

[4 marks]

Difference in percentage increase in mass = _____ %

1 1 . 3 Use the results of the student's investigations to draw conclusions about the factors affecting the rusting of iron. Include an evaluation of the effectiveness of different coatings at preventing the rusting of iron.

[6 marks]

Question 11

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
11.1	1×10^{-2} g		1	AO2/2 4.10.3.1
11.2	$\frac{0.46}{8.45} \times 100$ (test tube 1) 5.44 % **and** (test tube 2) 0.854 % 4.586 4.59	 allow ecf answer correctly calculated to 3 significant figures allow 4.59 with no working for **4** marks allow 4.586 with no working for **3** marks	1 1 1 1	AO2/2 4.10.3.1

Question	Answers	Extra information	Mark	AO/Spec. Ref.
11.3	**Level 3:** Detailed and coherent conclusions based on the evidence together with an evaluation are given in a response that is coherent and well-structured. A range of relevant points is made demonstrating a broad understanding of the key scientific ideas.		5-6	AO3/2b
	Level 2: An attempt to relate relevant points and draw conclusions or to make an evaluation. The logic may be inconsistent at times but builds towards a coherent argument.		3-4	AO3/1b
	Level 1: Simple descriptive statements are made. The logic may be unclear and any conclusions, if present, may not be consistent with the reasoning.		1-2	AO2/2
	Indicative Content Simple statements • nail rusted in test tubes 1 and 5 • test tubes 1 and 4 contained air/oxygen and water • nail did not rust in test tubes 2, 3 and 4 • test tube 2 no water present • test tube 3 no air/oxygen present • test tube 4 paint stopped rusting • test tube 6 scratched galvanised iron did not rust • test tube 6 galvanising stopped rusting Conclusions • both water and oxygen are required for rusting • coatings that prevent water and oxygen reaching the metal prevent rusting • when paint is scratched, iron comes into contact with water and oxygen and the iron rusts • in test tube 5 less iron exposed so less rusting than in test tube 1 • galvanising is better at resisting rusting than paint when scratched • zinc is more reactive than iron, so when galvanised metal is scratched, zinc reacts with water and oxygen first/ sacrificially Evaluation • oil and paint are effective at preventing rusting when the coating is intact • galvanising is the most effective coating because it prevents rusting even when scratched.			4.10.3.1

Chemistry required practical activity – Rates of reaction

Synergy – paper 4F, questions 09.1, 09.2

AO1/2/3

Standard demand

AT 1, 3, 5

WS 1.2, 3.5

In question 09.2, students need to be familiar with collision theory in order to answer the question. One AO1 mark and two AO2 marks are available for knowledge, understanding and application to the specific context of the question. Note that students are instructed to answer in terms of particles, though references to molecules or ions would be equally acceptable.

0 9 A student investigates how the concentration of an acid affects the rate of a reaction.

This is the method used.

1. Put a 3 cm piece of magnesium ribbon into a conical flask.
2. Add 50 cm^3 of 0.5 mol/dm^3 hydrochloric acid to the flask.
3. Collect and measure the volume of gas produced at 10 second intervals.
4. Repeat with different concentrations of hydrochloric acid using the same length of magnesium ribbon and volume of acid.

The student's results are shown in **Figure 14**.

Figure 14

0 9 . 1 How do the results show that increasing the concentration of acid increases the rate of reaction?

[2 marks]

AO3

0 9 . 2 Explain why the rate of reaction changes as the concentration of the acid increases.

You should answer in terms of particles.

[3 marks]

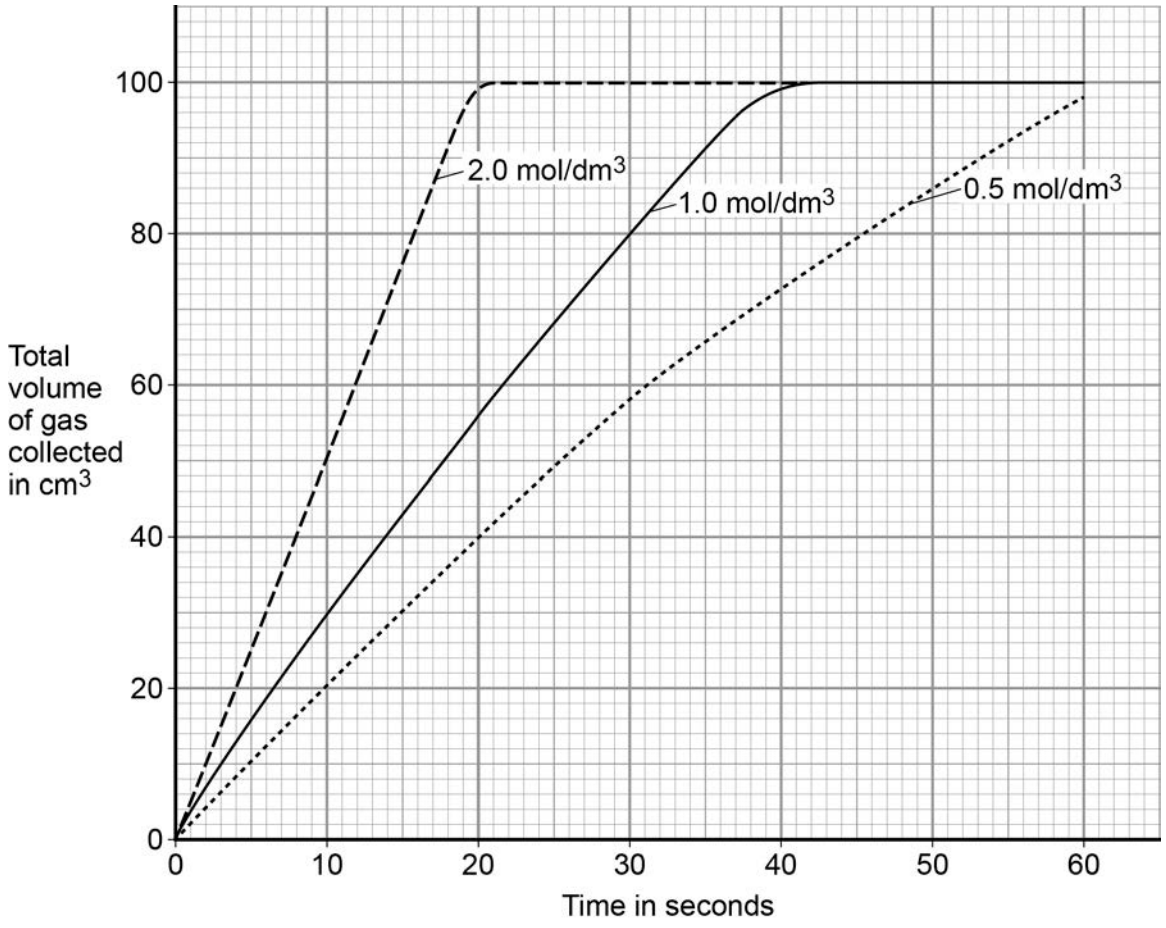
AO1 AO2/1

0 9 . 3 Student **A** said that the final volume of gas collected was lower for a concentration of 0.5 mol dm^3 because the reaction had not finished.
Student **B** said it was because all the acid had reacted.

Describe further experimental work the students could do to find out which student was correct.

[2 marks]

Question	Answers	Extra information	Mark	AO/Spec. Ref.



09.1	(as concentration increases) same volume of gas is collected in a shorter time		1 1	AO3 4.7.4.3

09.2	reactions occur when particles collide increasing concentration brings particles closer together which increases the number of collisions		1 1 1	AO1 AO2 AO2 4.7.4.3

09.3	leave for longer if gas continues to be produced student A is right **or** repeat with more acid (1) if more gas is produced student B is right (1)		1 1	AO3/3b RPA19

Total			**7**

Chemistry required practical activity - Chromatography

Trilogy – Chemistry paper 2H, questions 05.1, 05.2, 05.3

AO1/2/3

Standard /High demand

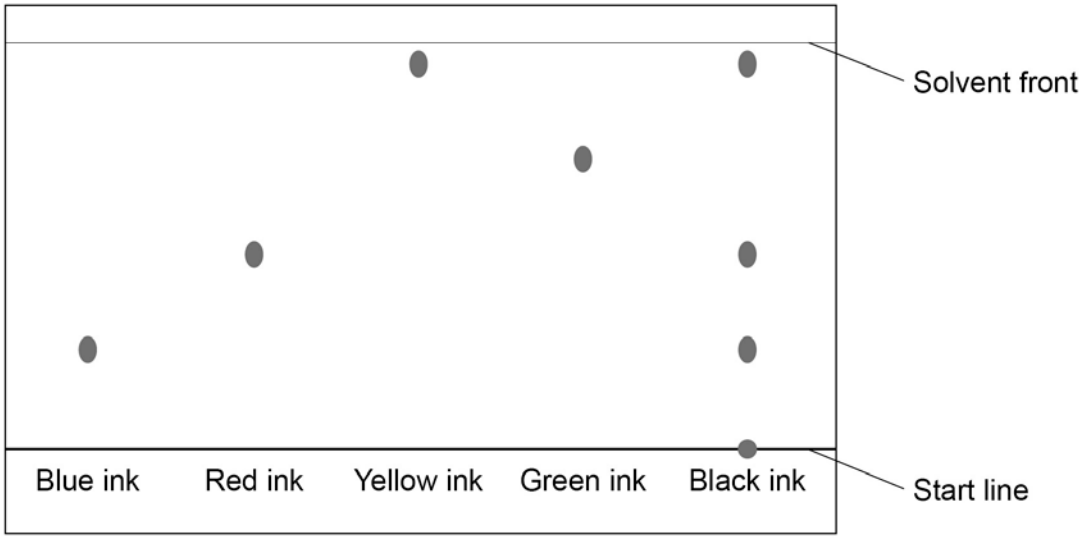
AT1, 4

WS 2.6, 3.3, 3.5

Note that the equation for R_f calculation is not provided at this level.

0 5 **Figure 9** shows a paper chromatogram of five different inks.

Figure 9



0 5 . 1 Explain how paper chromatography separates substances.

[3 marks]

AO1

0 5 . 2 What does the chromatogram tell you about the black ink?

[4 marks]

AO3

0 5 . 3 Use **Figure 9** to calculate the R_f value of the blue ink.

[3 marks]

AO1 AO2/2

Question	Answers	Extra information	Mark	AO/Spec. Ref.
05.1	mobile phase/solvent moves through paper		1	AO1 5.8.1.3
	and carries substances different distances		1	
	which depend on their attraction for paper and solvent	allow which depend on solubility in solvent and attraction to paper	1	
05.2	Level 2: A relevant and coherent description which provides a clear analysis of the chromatogram. The response makes logical links between the points raised and uses sufficient examples to support these links.		3-4	AO3 5.8.1.3
	Level 1: Simple statements are made which demonstrate a basic attempt to analyse the chromatogram. The response may fail to make logical links between the points raised.		1-2	
	No relevant content		0	
	Indicative content • black ink is a mixture • because more than one spot • contains blue, red and yellow • because Rf values/positions match • does not contain green • contains an unknown • which is insoluble • yellow is most soluble or has highest Rf value, blue is least			
05.3	correct R_f value (0.25 +/− 0.02)	with or without working gains full marks if answer incorrect, allow: both measurements from artwork for 1 mark (1.3 +/− 0.1 cm and 5.3 +/− 0.1 cm) correct equation used for 1 mark allow ecf from incorrect measurement to final answer for 2 marks	3	AO1 AO2 5.8.1.3

Trilogy Physics 2H question 4 required practical activity – Force and extension

AO1 and AO3

Standard and high Demand

AT 1.2

WS 2.5

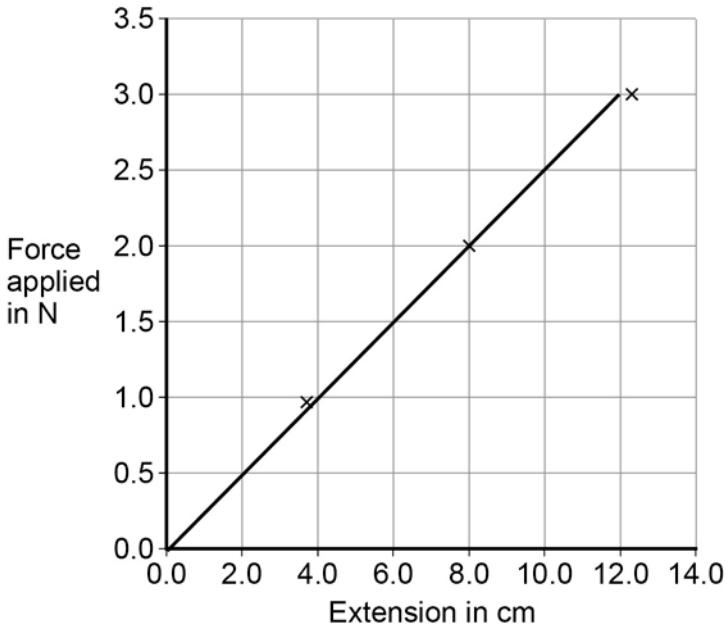
The questions require the students to interpret data given in graphical form. Maths skills are required to interpret the graph in order to read values and to identify the pattern in the data. Students are directed to use the graph in support of their answer.

Note that the range is the smallest and largest values, and **not** the difference between the two values.

0 4 A student changed the force applied to a spring by adding weights.

Figure 3 shows a graph of her results.

Figure 3



0 4 . 1 Write down the equation that links the force applied and extension for a spring.

[1 mark]

AO1

0 4 . 2 Identify the pattern shown in **Figure 3**.

Explain your answer.

[2 marks]

AO1 AO3

0 4 . 3 Give **one** way the student could improve her investigation.

[1 mark]

AO3

0 4 . 4 Describe the relationship between work done and elastic potential energy in stretching a spring.

[2 marks]

AO1

0 4 . 5 Draw a line on **Figure 3** to show the results for a stiffer spring.

Explain the reason for the line you have drawn.

[3 marks]

AO3

0 4 . 6 Explain what would happen to the spring if the student kept adding weights?

[2 marks]

AO1

Question	Answers	Extra information	Mark	AO/Spec. Ref.
04.1	force = spring constant x extension	accept f = ke	1	AO1/1 6.5.3
04.2	extension is directly proportional to the force applied because it is straight line through the origin		1 1	AO3/2a AO1/2 6.5.3
04.3	test a greater range of load **or** test more springs		1	AO3/3b 6.5.3 WS2.5
04.4	work done is equal to elastic potential energy as long as the spring does not go past the limit of proportionality		1 1	AO1/2 6.5.3
04.5	line extending with a greater gradient than existing line a stiffer spring has a greater spring constant (*k*) *k* = F/e		1 1 1	AO3/2a AO3/2b AO3/2b 6.5.3
04.6	the spring will be deformed because it has passed the elastic limit	accept not gone back to original shape	1 1	AO1/2 6.5.3

Physics1F question 5 required practical activity - resistance in a wire

AO1 and AO2

Low demand

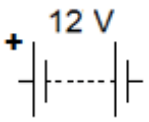
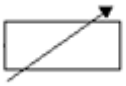
AT 1,6 and 7

WS 2.2, 2.3, 2.4, 3.2, 3.4

0 5 A student wants to investigate how the current through a filament lamp affects its resistance.

0 5 . 1 Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

[2 marks]

12 V battery	variable resistor	filament lamp	voltmeter	ammeter
				

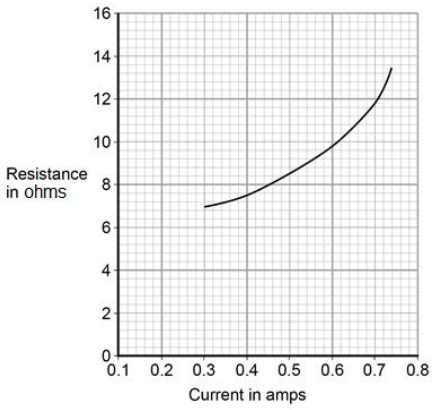
AO1

0 5 . 2 Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

[4 marks]

AO1

The student's results are shown in **Figure 6**.



0 5 . 3 Describe how the resistance of the filament lamp changes as the current through it increases.

[1 mark]

AO2

0 5 . 4 Use **Figure 6** to estimate the resistance of the filament lamp when a current of 0.10 A passes through the lamp.

[1 mark]

Resistance = _____ Ω

AO2

The current–potential difference graphs of three components are shown in **Figure 7**.

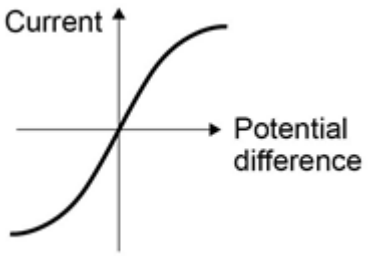
0 5 . 5 Use answers from the box to identify each component.

AO1

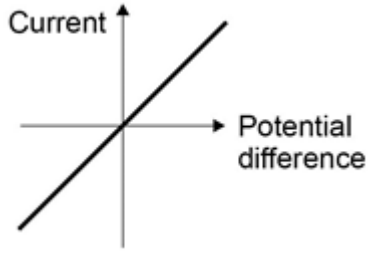
[3 marks]

diode	**filament lamp**	**light dependent resistor**
resistor at constant temperature		**thermistor**

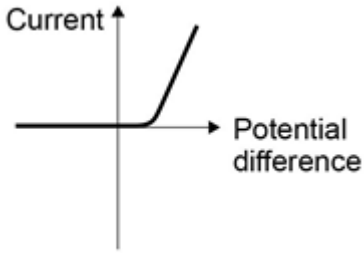
Graph A



Graph B



Graph C



Question	Answers	Extra information	Mark	AO/Spec. Ref.
05.1	battery, lamp and ammeter connected in series with variable resistor voltmeter in parallel with (filament) lamp		1 1	AO1/2 4.2.1.3

05.2	**Level 2:** A detailed and coherent description of a plan covering all the major steps is provided. The steps are set out in a logical manner that could be followed by another person to obtain valid results.	3–4	4	AO1/2 4.2.5.1
	Level 1: Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.	1–2		
	No relevant content	0		
	Indicative content • ammeter used to measure current • voltmeter used to measure potential difference • resistance of variable resistor altered to change current in circuit **or** change potential difference (across filament lamp) • resistance (of filament lamp) calculated **or** R=V/I statement • resistance calculated for a large enough range of different currents that would allow a valid conclusion about the relationship to be made			

05.3	(as current increases) resistance increases (at an increasing rate)		1	AO2/2 4.2.1.4 WS3

05.4	any value between 6.3 and 6.9 (Ω)		1	AO2/2 4.2.1.4 WS3

05.5	**A**: Filament lamp **B**: Resistor at constant temperature **C**: Diode		1 1 1	AO1/1 4.2.1.4

Physics required practical activity - Waves

Synergy – paper 1H, questions 09.1, 09.4

AO2

High demand

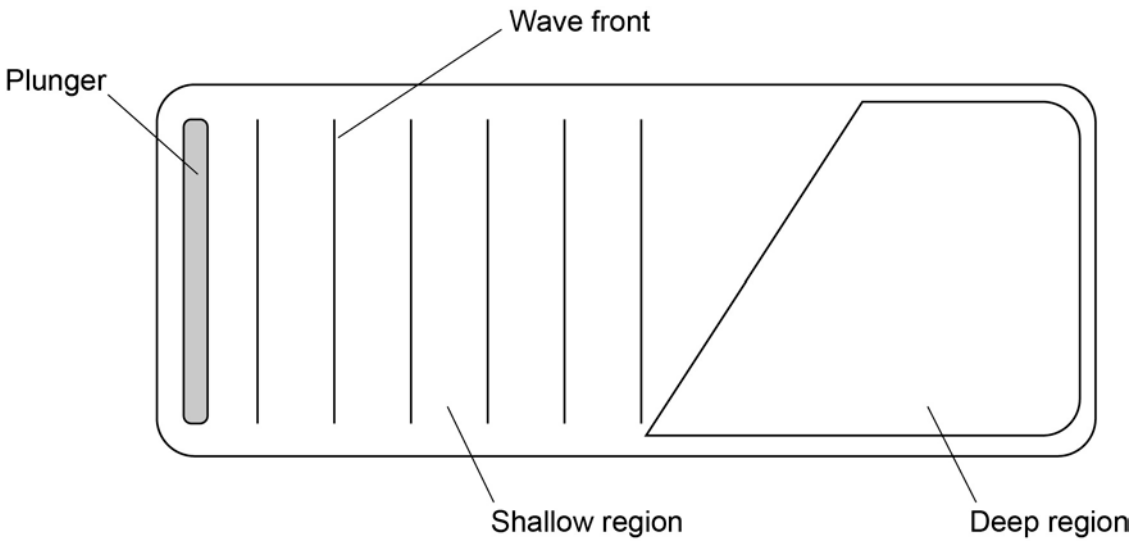
AT1, 4

WS 2.2, 3.1

0 9 Some students did an investigation to study the behaviour of waves.

Figure 8 shows a ripple tank that they used to model the behaviour of waves.

Figure 8



0 9 . 1 Complete the wave fronts on **Figure 8** to show how the wave is refracted as it passes from the shallow region into the deep region.

[1 mark]

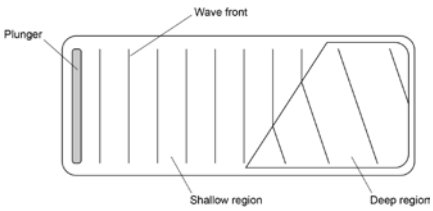
0 9 . 4 Some students investigate the properties of the waves generated in **Figure 8**.

Student **A** says 'the waves move water from one end of the tank to the other'.

Student **B** says 'that's wrong. Only the waves move, not the water'.

Suggest what the students could do to decide which of them is correct.

[2 marks]

Question	Answers	Extra information	Mark	AO/Spec. Ref.
09.1		lines should be further apart with the bottom of the wave fronts further to the right than the top	1	AO2 4.1.4.5
09.4	place a floating object/plastic duck on the surface of the water it will stay in the same place **or** only bob up and down if the water doesn't move		1 1	AO2 4.1.4.1

Physics paper 1H question 5

AO2 AO3

Standard demand

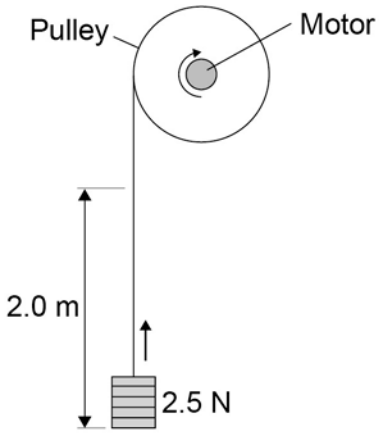
AT N/A

WS 2.2, 3.2, 3.4

The question is not based on a required practical activity. Students should be able to access the question without having performed the experiment as all the relevant information is provided in the question.

0 5 A student investigated the efficiency of a motor using the equipment in **Figure 4**.

Figure 4



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

0 5 . 1 Give **one** variable that the student controlled in his investigation.

[1 mark]

AO3

0 5 . 2 Give **two** reasons for taking repeat readings in an investigation.

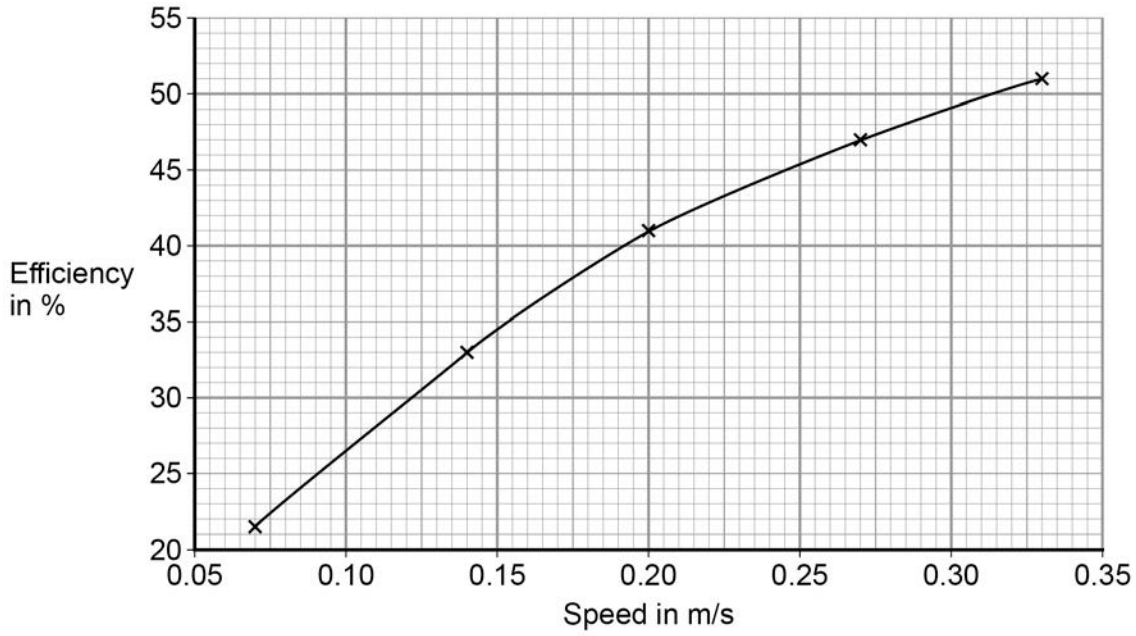
[2 marks]

1

2

Figure 5 shows a graph of the student's results.

Figure 5



0 5 . 3 Give **two** conclusions that could be made from the data in **Figure 5**?

[2 marks]

AO2

0 5 . 4 Give the main way that the motor is likely to waste energy.

[1 mark]

AO2

0 5 . 5 When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

[1 mark]

Efficiency = _____ %

AO2

Question	Answers	Extra information	Mark	AO/Spec. Ref.
05.1	water boils at the same temperature each time control starting temp by allowing enough time for water and kettle to reach room temperature		1 1	AO3/3a 6.1.1.5 WS2.2
05.2	uncertainty = (302 – 298)/2 uncertainty = ± 2 (s)	ignore missing ±	1 1	AO2/2 6.1.1.5 WS3.4
05.3	(Energy transferred = Power × time) E = 2.20 × 300 E = 660 (kJ)	 allow 660 (kJ) without working shown for **2** marks allow answer calculated using incorrect value for t (298 or 302) for **1** mark	 1 1	 AO2/1 AO2/1 6.1.1.5
05.4	(mass × change in temperature)/mass 80 (°C)	allow **1** mark for any correct pair of values from the table eg 20/0.25 allow 80 (°C) without working shown for **2** marks	1 1	AO2/2 6.1.1.4
05.5	four points plotted correctly accurate line drawn	allow **1** mark for three correctly plotted points ecf their 5.3 allow ± 1mm line should be straight and drawn with a ruler line must not go through the origin	2 1	AO2/2 6.1.1.4 WS3.2

Physics required practical – Specific heat capacity

Physics paper 1F question 12

AO1 AO2 AO3

Standard demand

AT 1 and 5

WS 2.3, 3.6, 3.7

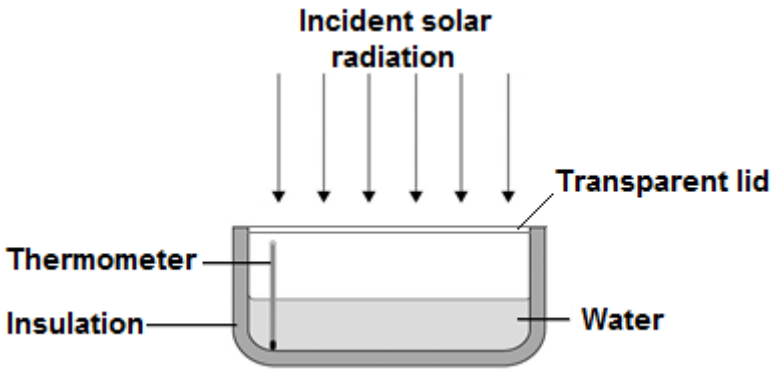
This question is set in the context of the required practical on specific heat capacity and assess related content from the specification along with working scientifically skills.

1 2 A student investigated how much energy from the Sun was incident on the Earth's surface at her location.

She put an insulated pan of water in direct sunlight and measured the time it took for the temperature of the water to increase by 0.6 °C.

The apparatus she used is shown in **Figure 14**.

Figure 14



1 2 . 1 Choose the most appropriate resolution for the thermometer used by the student.

[1 mark]

Tick **one** box.

0.1 ºC ☐

0.5 ºC ☐

1.0 ºC ☐

The energy transferred to the water was 1050 J.

The time taken for the water temperature to increase by 0.6 °C was 5 minutes.

AO3 The specific heat capacity of water is 4200 J/kg °C.

1 2 . 2 Write down the equation which links energy transferred, power and time.

[1 mark]

AO1

1 2 . 3 Calculate the mean power supplied by the Sun to the water in the pan.

[2 marks]

AO2

1 2 . 4 Calculate the mass of water the student used in her investigation.

Use the correct equation from the Physics Equation Sheet.

[3 marks]

AO2 Mass = Kg

1 2 . 5 The student's results can only be used as an estimate of the mean power at her location.

Give **one** reason why.

[1 mark]

AO3

Question	Answers	Extra information	Mark	AO/Spec. Ref.
12.1	0.1 (ºC)		1	AO3/3a 4.1.1.3 WS2.3
12.2	power = energy transferred/time	allow P = E/t allow E = P x t	1	AO1/1 4.1.1.4
12.3	1050/300 3.5 (W)	 accept 3.5 (W) with no working shown for **2** marks	1 1	AO2/1 4.1.1.4
12.4	1050 = m x 4200 x 0.6 m = 1050/(4200 x 0.6) m = 0.417 (kg)	 accept 0.417 (kg) with no working shown for **3** marks	1 1 1	AO2/2 4.1.1.3
12.5	any **one** from: • energy used to heat metal pan (as well as the water) • energy transfer to the surroundings (through the insulation) • angle of solar radiation will have changed during investigation • intensity of solar radiation may have varied during investigation		1	AO3/3a 4.1.1.3 WS3

Physics – paper 1F, question 06.1

AO1

Low/Standard demand

AT N/A

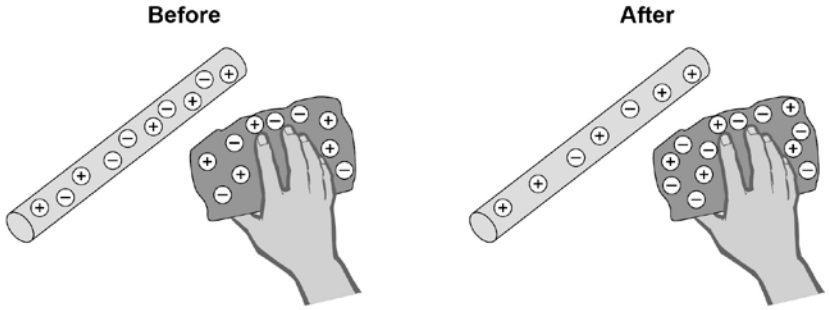
WS N/A

This is not a required practical activity, and the question is assessing the understanding of static charges. It is an extremely common activity that most students will experience but it is not essential that they have seen it first-hand.

0 6 A student rubs an acetate rod with a cloth.

Figure 8 shows the charges on the acetate rod and cloth before and after rubbing.

Figure 8



0 6 . 1 Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

[4 marks]

Question	Answers		Mark	AO/Spec. Ref.
06.1	**Level 2:** Clear description of negative charge transfer and net charge, with logical links	3–4	4	AO1 4.2.5.1
	Level 1: Description of negative charge transfer **or** net charge	1–2		
	No relevant content	0		
	Indicative content • friction (between cloth and rod causes) • electrons (to) move • from the acetate rod **or** to the cloth • (net) charge on cloth is negative and (net) charge on rod is positive			

Trilogy Physics 2H, questions 06.1, 06.2

AO1 AO2

High demand

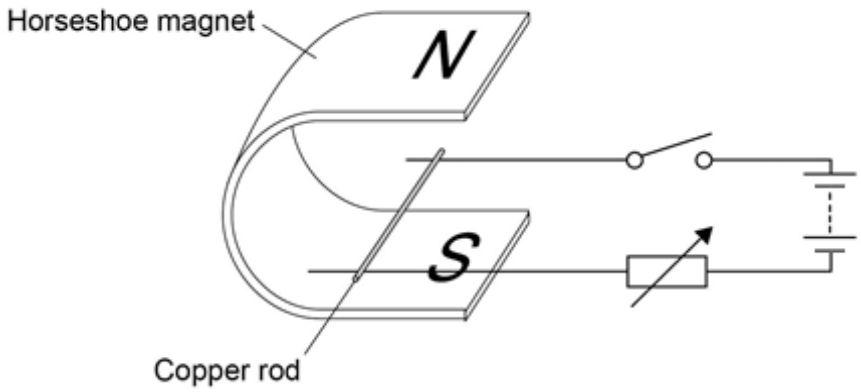
AT N/A

WS N/A

This is not a required practical activity. The context provides the background to the science concepts being assessed which are covered in the specification. It is not common for students to carry out this activity, but it would be likely that students would have seen the phenomenon demonstrated when this was taught.

0 6 A teacher used the equipment shown in **Figure 6**. to demonstrate the motor effect.

Figure 6



0 6 . 1 Describe how Fleming's left-hand rule can be used to determine the direction in which the rod will move when the switch is closed, and state the direction.

[4 marks]

AO1

0 6 . 2 Increasing the current can increase the force acting on the copper rod.

Give **one** other way in which the size of the force acting on the copper rod could be increased.

[1 mark]

AO2

0 6 . 3 The copper rod in **Figure 6** has a length of 7 cm and a mass of 4 $\times 10^{-4}$ kg.
When there is a current of 1.12 A the resultant force on the copper rod is 0 N.

Calculate the magnetic flux density.

Gravitational field strength = 9.8 N/kg

[5 marks]

AO2

Question	Answers	Extra information	Mark	AO/Spec. Ref.
06.1	thumb, index finger and third finger are held mutually at right angles		1 1	AO1/2 6.7.2.2
	index finger shows the direction of the magnetic field from North to South, third finger shows the direction of the current from positive to negative terminal		1	
	the thumb then shows the direction of the force acting on the copper rod		1	
	so the copper rod will move from left to right			
06.2	any **one** from: use a stronger magnet increase the magnetic flux density increase the length of the copper rod in the magnetic field coil the copper rod		1	AO2/2 6.7.2.2
06.3	$W = 9.8 \times 4 \times 10^{-4} = 3.92 \times 10^{-3}$ conversion of the length 7cm to 0.07m $3.92 \times 10^{-3} = B \times 1.12 \times 0.07$ $B = 3.92 \times 10^{-3}/0.0784$ B = 0.05 (T)	allow 0.05 (T) without working shown for the **5** calculation marks	1 1 1 1 1	AO2/2 6.5.1.3 6.7.2.2 WS4.5

Physics - paper 1F, question 04

AO3

Low demand

AT N/A

WS 3.7

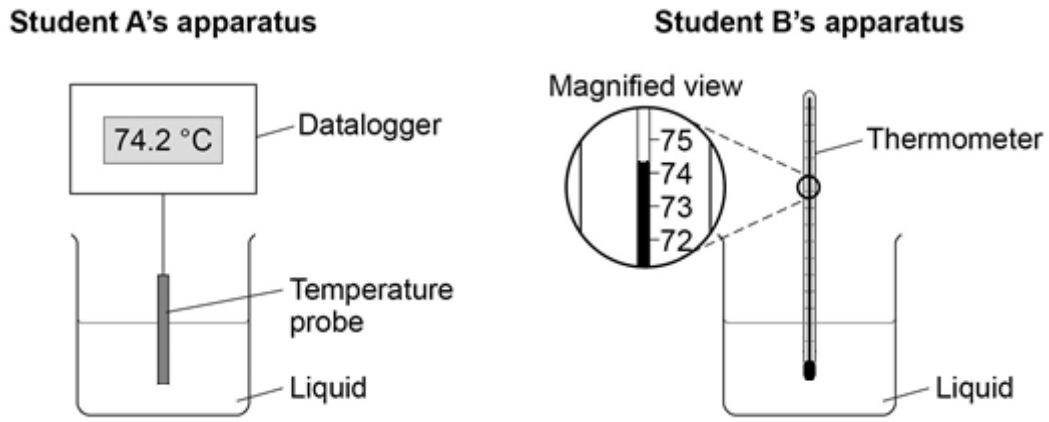
This is not a required practical and students do not need to have carried out the practical but when covering this part of the specification (4.3.1.2 and 4.3.2.3) it may have been referred to as a way of explaining the concepts. The question focuses on working scientifically skills and AO3

0 4 Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

Figure 4 shows the different apparatus the two students used.

Figure 4



0 4 . 1 Choose **two** advantages of using student **A**'s apparatus.

[2 marks]

Tick **two** boxes.

Student **A**'s apparatus made sure the test was fair. ☐

Student **B**'s apparatus only measured categoric variables. ☐

Student **A**'s measurements had a higher resolution. ☐

Student **B** was more likely to misread the temperature. ☐

AO1

0 4 . 2 Student **B** removed the thermometer from the liquid each time he took a temperature reading.

What type of error would this cause?

[1 mark]

Tick **one** box.

A systematic error ☐

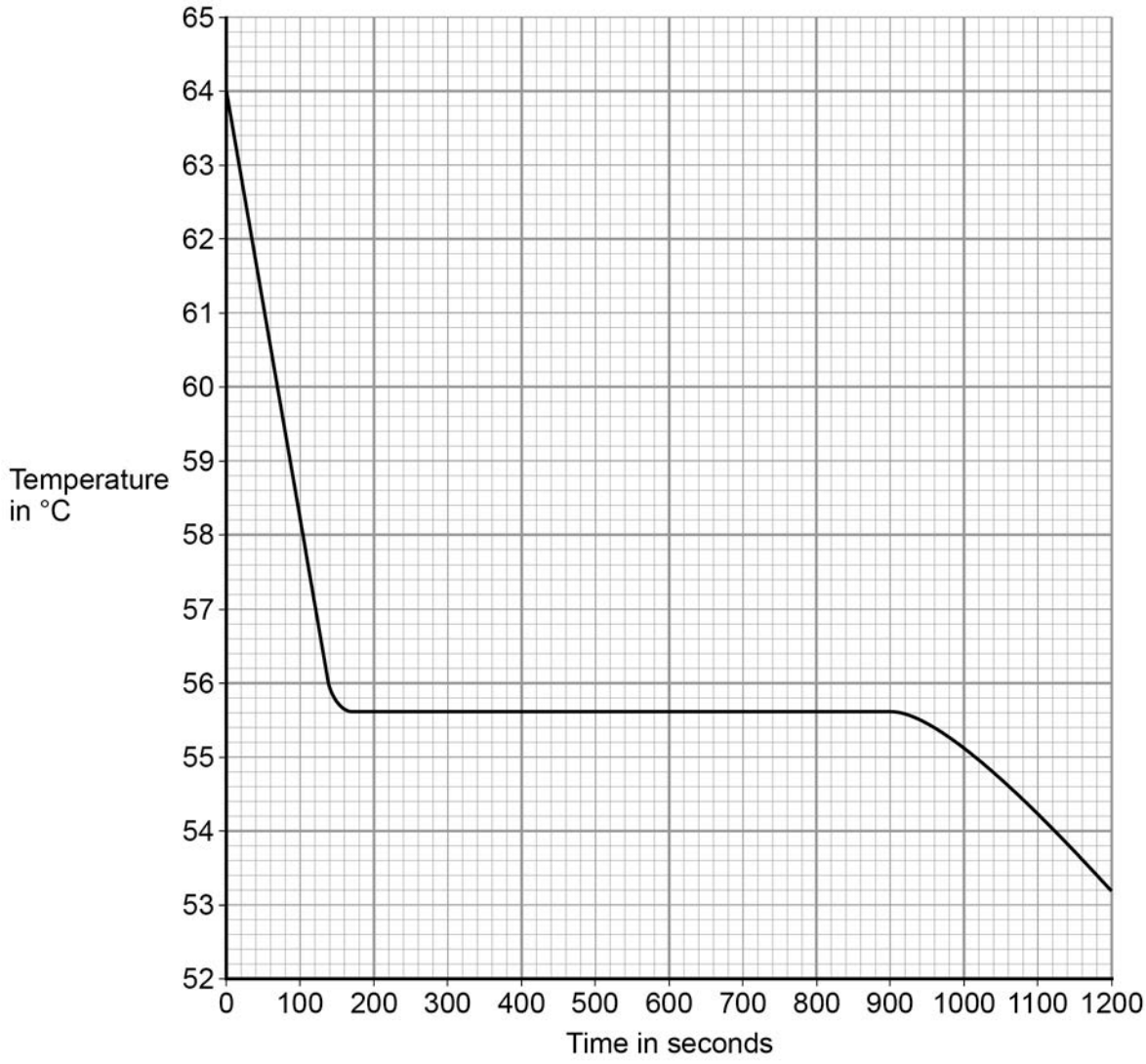
A random error ☐

A zero error ☐

AO3

Student **A**'s results are shown in **Figure 5**.

Figure 5



0 4 . 3 What was the decrease in temperature between 0 and 160 seconds?

[1 mark]

Tick **one** box.

8.2 °C	☐
8.4 °C	☐
53.2 °C	☐
55.6 °C	☐

AO3

0 4 . 4 Use **Figure 5** to determine the time taken for the stearic acid to change from a liquid to a solid.

[1 mark]

Time = _____ seconds

AO3

0 4 . 5 Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J/kg.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Energy = _____ J

AO2

0 4 . 6 After 1200 seconds the temperature of the stearic acid continued to decrease.
Explain why.

[2 marks]

AO3

Question	Answers	Extra information	Mark	AO/Spec. Ref.
04.1	Student A's measurements had a higher resolution Student B was more likely to misread the temperature		1 1	AO3/1b 4.3.1.3 WS3
04.2	a random error		1	AO3/3a 4.3.1.3 WS3
04.3	8.4 ˚C		1	AO3/2a 4.3.2.3
04.4	740 (seconds)	allow answers in the range 730 – 780	1	AO3/2a 4.3.2.3
04.5	0.40 x 199 000 79 600 (J)	accept 79 600 (J) with no working shown for **2** marks	1 1	AO2/1 4.3.2.3
04.6	stearic acid has a higher temperature than the surroundings temperature will decrease until stearic acid is the same as the room temperature/surroundings	accept stearic acid is hotter than the surroundings	1 1	AO3/2b 4.3.2.3

Synergy – paper 2H, (Physics) question 06.6

AO3

High demand

AT N/A

WS 2.7

Note that although this is not a required practical activity, it would be helpful to students if they were able to observe radioactive sources.

0 6 . 6 A teacher demonstrated an experiment to measure the count rate of a radioactive source.

Figure 8 shows how the teacher set up the apparatus.

Figure 8

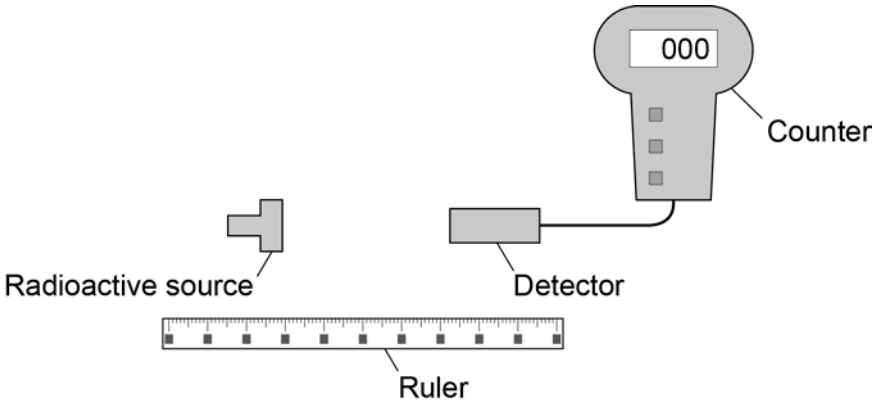


Table 4 shows the results.

Table 4

Distance in metres	Count rate in counts per minute
0.5	108
1.0	38
1.5	23
2.0	18

Suggest how the student could modify the experiment to determine the radiation type present in the source.

[4 mark]

Question	Answers	Mark	AO/Spec. Ref.
06.6	**Level 2:** A detailed and coherent plan covering all the major steps is provided. The steps are set out in a logical manner that could be followed by another person to determine the type of radioactivity.	3–4	AO3
	Level 1: Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to determine the type of radioactivity.	1–2	
	No relevant content.	0	
	Indicative content • move detector to within a few mm of source • insert thick paper and see whether the reading decreases • if so, could be alpha as paper absorbs this • repeat with thin aluminium • if reading falls then some beta radiation because absorbed by aluminium • if reading doesn't fall then must be gamma radiation		4.3.2.4