# L3 Lead Examiner Report 2001

January 2020

## L3 Qualification in Applied Science/Forensic and Criminal Investigation

### Unit 3: Science investigation Skills (31619H)

## Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications website at http://qualifications.pearson.com/en/home.html for our BTEC qualifications.

Alternatively, you can get in touch with us using the details on our contact us page at http://qualifications.pearson.com/en/contact-us.html

If you have any subject specific questions about this specification that require the help of a subject specialist, you can speak directly to the subject team at Pearson. Their contact details can be found on this link:
http://qualifications.pearson.com/en/support/support-for-you/teachers.html

You can also use our online Ask the Expert service at https://www.edexcelonline.com
You will need an Edexcel Online username and password to access this service.

**Pearson: helping people progress, everywhere**

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your learners at: www.pearson.com/uk

January 2020
Publications Code 31619H_2001_ER

# Grade Boundaries

## What is a grade boundary?

A grade boundary is where we set the level of achievement required to obtain a certain grade for the externally assessed unit. We set grade boundaries for each grade, at Distinction, Merit and Pass.

## Setting grade boundaries

When we set grade boundaries, we look at the performance of every learner who took the external assessment. When we can see the full picture of performance, our experts are then able to decide where best to place the grade boundaries – this means that they decide what the lowest possible mark is for a particular grade.

When our experts set the grade boundaries, they make sure that learners receive grades which reflect their ability. Awarding grade boundaries is conducted to ensure learners achieve the grade they deserve to achieve, irrespective of variation in the external assessment.

## Variations in external assessments

Each external assessment we set asks different questions and may assess different parts of the unit content outlined in the specification. It would be unfair to learners if we set the same grade boundaries for each assessment, because then it would not take accessibility into account.

Grade boundaries for this, and all other papers, are on the website via this link:

http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

### Unit 3: Science Investigation Skills

| Grade | Unclassified | Level 3 | | | |
|---|---|---|---|---|---|
| | | N | P | M | D |
| Boundary Mark | 0 | 10 | 20 | 31 | 42 |

# Introduction to the Overall Performance of the Unit

## Section 1: Physics

Section 2 of this paper consists of two questions which are taken from a different scientific discipline to the questions in section 1. In this paper, section 2 is based on the physics that is indicated in section H of the essential content of Unit 3. The questions are designed to test two parts of the specified content for the examination these being section A 'Planning a scientific Investigation' and section C 'Drawing conclusions and evaluating'

Question 4 tests the ability of the learner to plan a scientific investigation. This includes the development of a hypothesis, the selection and justification of equipment, techniques and standard procedures, health and safety and methods of data collection including, quantities to be measured, number and range of measurements to be taken, how the equipment is to be used, control variables and a brief method for data collection and analysis.

Question 5 gives a description of the method, results and conclusion of an investigation and tests the ability of learners to use this information to make recommendations to improve the method, determine possible sources of error, consider the reliability or otherwise of data and evaluate the conclusions given with respect to the results given for the investigation.

## Section 2: Chemistry

This was the sixth time this paper was sat. Learners were asked to carry out a practical investigation into the rate of diffusion of different temperature acid through agar. It was pleasing to see, from the results seen in question 1, hat the majority of learners were able to carry out the practical to get a meaningful set of results.

Learners that did well had obviously carried out their experiments in part A with due care and attention, paying consideration to how and why the method was carried out in the way it was. They were able to collect, present and analyse their data. They were able to carry out calculations methodically, showing their working. Given new data they were also able to analyse and evaluate this.

Learners that did less well, did not always interact with questions sufficiently and therefore did not answer the questions posed appropriately or gave vague or general answers and so which were not specific enough to gain credit. Key concepts of the unit such as the application and understanding of errors were often lacking.

# Individual Questions: Physics

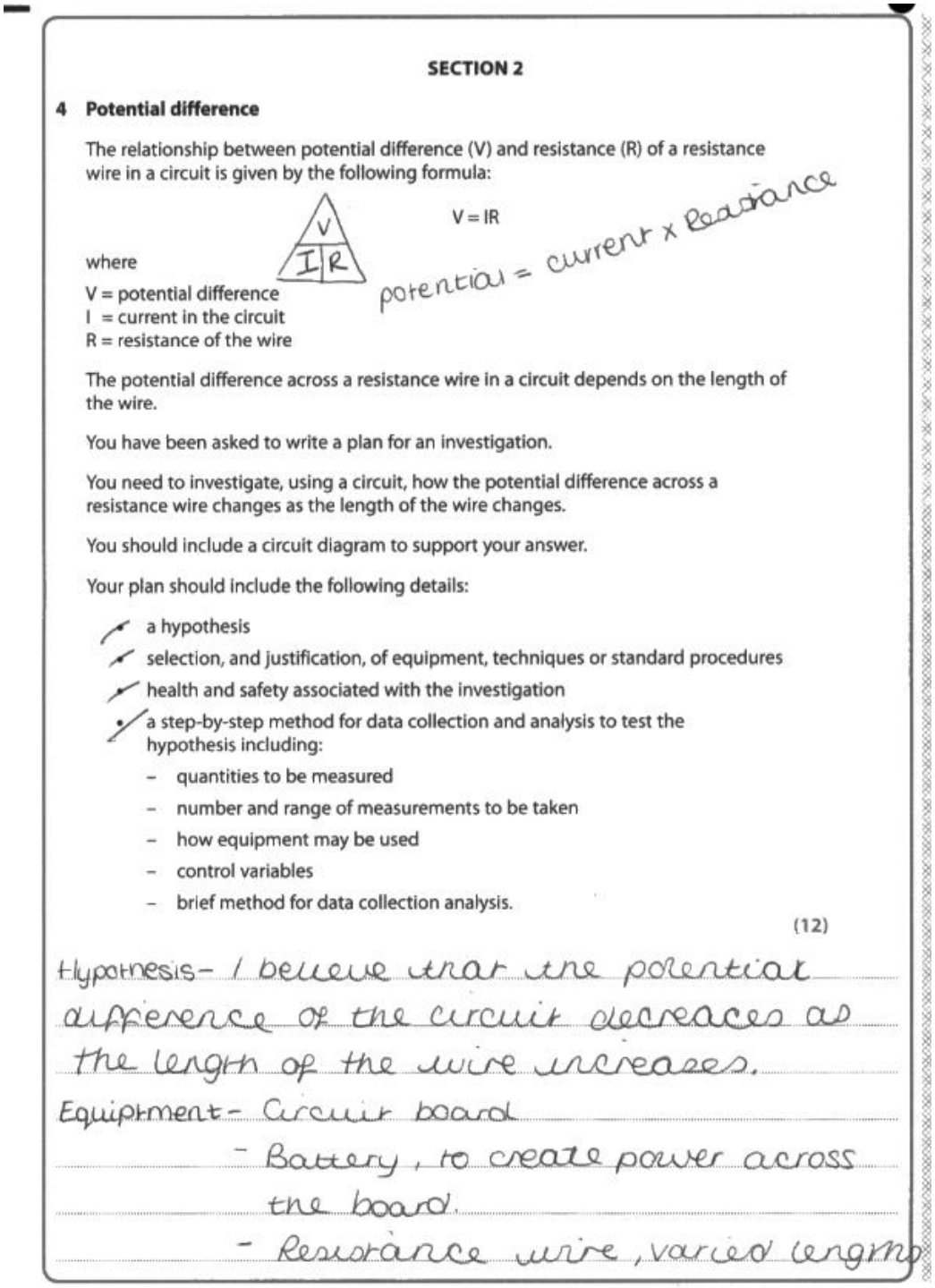
## Question 4

Learners were generally able to give a hypothesis, produce a plan and show how the data was collected but did not always relate these to the investigation that was required. The learners were required ' To investigate, using a circuit how the potential difference across a resistance changes as the length of the wire changes.' Many learners planned an investigation to find out how the resistance of a wire changes with the length of the wire.

The inclusion of 'Using a circuit' is to encourage learners to draw a circuit diagram showing a voltmeter in parallel with the resistance wire. There were very few correct circuit diagrams but many learners attempted descriptions of how the circuit should be set which were possible to follow with any certainty. Learners must draw circuits and show the correct placement of voltmeters (in parallel) and ammeters (in series). This would save time and be much more effective. However, drawing a circuit which has all the meters in series is not creditable as it is unlikely that any results would be obtained due to the high resistance of the voltmeter.
This investigation has virtually no risks and learners should realise this and state it. The only possible safety consideration would be that the wire may get hot. Generic laboratory safety rules and imagined dangers of using batteries or power packs gained no credit. Learners were quite often able to give the dependent and independent variables for the investigation they described but rarely noted that the current in the circuit should be maintained as constant in some way.

Level1 2 marks

The hypothesis selects the correct variables but relates them incorrectly./ Some relevant apparatus is given but the generic 'Health and Safety' paragraph gains no credit



**SECTION 2**

**4 Potential difference**

The relationship between potential difference (V) and resistance (R) of a resistance wire in a circuit is given by the following formula:




$V = IR$

potential = current x resistance

where

V = potential difference
I = current in the circuit
R = resistance of the wire

The potential difference across a resistance wire in a circuit depends on the length of the wire.

You have been asked to write a plan for an investigation.

You need to investigate, using a circuit, how the potential difference across a resistance wire changes as the length of the wire changes.

You should include a circuit diagram to support your answer.

Your plan should include the following details:

- a hypothesis
- selection, and justification, of equipment, techniques or standard procedures
- health and safety associated with the investigation
- a step-by-step method for data collection and analysis to test the hypothesis including:
  - quantities to be measured
  - number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)

Hypothesis- I believe that the potential difference of the circuit decreases as the length of the wire increases.

Equipment- Circuit board
- Battery, to create power across the board.
- Resistance wire, varied length

- a voltmeter, to record the volume of power going through the wires
- Book & pen, to record findings
-

Health & Safety - For this experiment you will need to make sure your workspace is clear, especially of liquids. If you have a live circit and you spill a liquid over it, you may damage the equipment or yourself, and your results will be inaccurate and unusable. Also you must make sure your ~~xxx~~ board is working correctly, as if there is a broken wire you could shock yourself when touching the board.

Method

1. collect all of your equipment listed above
2. make sure your work area is safe and hazard free.

Level 2 5 marks

In the example below the hypothesis relates length of wire and resistance , not potential difference and it incorrectly links the length and resistance The equipment listed would be used for the experiment to find out how the resistance of a wire varies with length and would get some results if the ohmmeter was used correctly but a battery would not be needed in the circuit. In the second equipment list a 'resister' is used to measure the resistance and under control variables' the same resistor' is used. The knowledge is adequate and shows an understanding of procedures, there is a rationale for the method and it may yield some results.

**SECTION 2**

**4 Potential difference**

The relationship between potential difference (V) and resistance (R) of a resistance wire in a circuit is given by the following formula:

$$V = IR$$

where

V = potential difference
I = current in the circuit
R = resistance of the wire

The potential difference across a resistance wire in a circuit depends on the length of the wire.

You have been asked to write a plan for an investigation.

You need to investigate, using a circuit, how the potential difference across a resistance wire changes as the length of the wire changes.

You should include a circuit diagram to support your answer.

Your plan should include the following details:

- a hypothesis
- selection, and justification, of equipment, techniques or standard procedures
- health and safety associated with the investigation
- a step-by-step method for data collection and analysis to test the hypothesis including:
  - quantities to be measured
  - number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

**(12)**

The longer the wire will be than the smaller the resistance would be.

Equipment used:
- An ohmmeter - to find out the resistance of the wire in different lengths.
- Multiple lengths of wires - To find out if the resistance would be higher of lower depending on the length of the wire.
Battery / cell - To send electricity around the wires to find the resistance.
Ruler - Measure the wire length.
Technique -

I would start with the shortest wire, turn on the battery and record the resistance on a table. I would repeat these steps using 5-10 different length of wires; starting from 10cm, 20cm 30cm and so on going up in 10cm each time. I would also find the resistance 3-4 times on each length of wire to find an accurate average resistance.

Health and Safety-

- Don't be messing around as it could cause someone to get hurt.
- Goggles are not a nessescity but should be ~~[illegible]~~ woren as a ~~[illegible]~~ precaution.
- Don't over heat the battery by leave ~~[illegible]~~ it on for to long.

step by step method-

Quantaties to be measured is the ~~[illegible]~~ length of the wire in cm and the resistance ~~[illegible]~~ on a ohmmeter in Ω
Measurements for the wire would range from 10cm to 50cm as I would be using 5 different wires.

How equipment is used-

Battery/cell - to provide electricity to the circuit.
Resister - To measure the resistance.
wires - To see if resistance increases or decreases dependent on the wires length.

control varibles-

Things I would be keeping the same is, the same battery or cell and same resistor to make it fair for every length of the wire that is recorded.

Brief method for data collection-

I would be recording the data in a table, and draw a graph so I could find a best fit.

**(Total for Question 4 = 12 marks)**

Level 3  9 marks

The learner has given  a hypothesis which is correct but not the correct reasoning to support this. The independent and dependent variables are correct but the control variable does not mention keeping the current in the circuit constant. The method is clearly set out and the description of the circuit is supported by the circuit diagram which shows the voltmeter correctly placed in parallel with the resistance wire. The experimental method would give a set of results but as there is no way of controlling the current in the circuit the current would vary  for each different length of wire added to the circuit and therefore would not show the direct proportionality between the potential difference and the length of the resistance wire. This response shows good knowledge of concepts and processes, there is a rationale for the method and the plan will yield some reliable results.

## SECTION 2

**4 Potential difference**

The relationship between potential difference (V) and resistance (R) of a resistance wire in a circuit is given by the following formula:

$$V = IR$$

where

V = potential difference
I = current in the circuit
R = resistance of the wire

The potential difference across a resistance wire in a circuit depends on the length of the wire.

You have been asked to write a plan for an investigation.

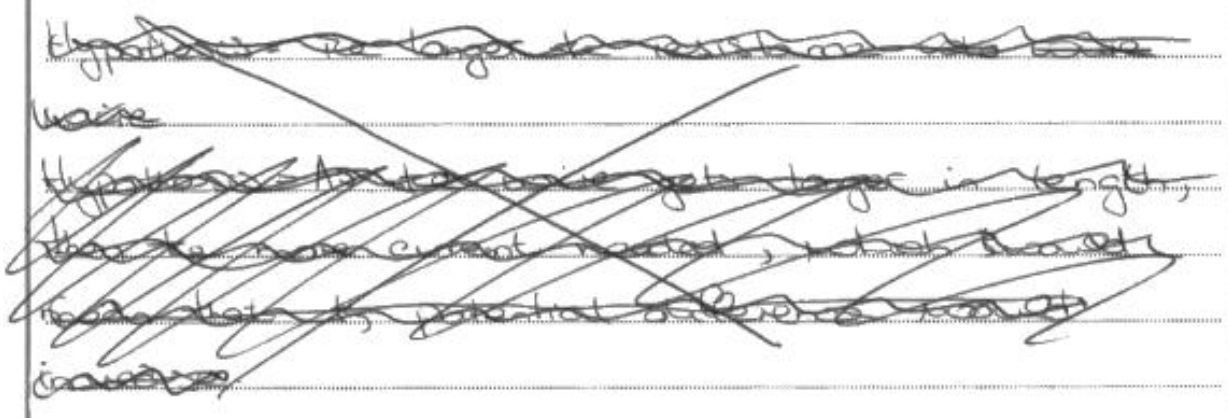
You need to investigate, using a circuit, how the potential difference across a resistance wire changes as the length of the wire changes.

You should include a circuit diagram to support your answer.

Your plan should include the following details:

- a hypothesis
- selection, and justification, of equipment, techniques or standard procedures
- health and safety associated with the investigation
- a step-by-step method for data collection and analysis to test the hypothesis including:
  - quantities to be measured
  - number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)



Null hypothesis = There would be no difference between the potential difference across a resistance wire and the length of the wire.
Hypothesis = The longer the length of the wire, the higher the potential difference would be. The reason for this would be because more current would be needed to flow through the circuit.

Equipment: Battery, voltmeter, resistance wire (steel), switch, wires + crocs. Resistance wire: 5cm, 10cm, 15cm and 20cm.
Independent variable = You will need to change the length of the resistance wire when you write down the potential difference of the first wire, so then later on you can compare the results.
Controlled variable = You need to be using the same voltmeter and the size of batteries across every round so that it is fair.
Dependent variable = We are measuring the potential difference of the different wires in length so then we could compare the different wires in length.

Equipments: We are using a voltmeter (V) to measure the potential difference. We are using different lengths of resistance wire in steel so we can see how it would affect the potential difference. We are using the cables and wires to connect the circuit together and we are using a battery to provide energy.

Health and safety: Make sure your hands are not wet otherwise you will get electrocuted.

Method:

1- Get all your equipments together, which is the wire, Battery, voltmeter and the resistance wire.

2- Connect all the equipments together.

3- Place the 5cm wire resistance of steel

4- Then record how much the voltmeter says

5- Repeat steps 3- 4 but with 10cm, 15cm and 20cm of the wire.

6- Produce a table with your findings and ~~hypothesis~~ repeat the ~~ex~~ experiment 3 times.

7- Produce a graph, ~~and~~ and a line of best fit.

Diagram:

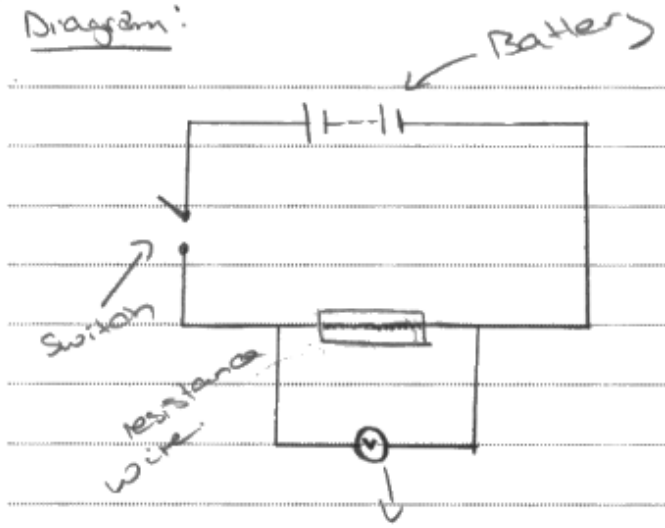



Table:

| IV | ΔV | | | |
|---|---|---|---|---|
| | 1 trial | 2 trial | 3 trial | mean |
| | | | | |
| | | | | |
| | | | | |

**(Total for Question 4 = 12 marks)**

## Level 4  12 marks

The learners has given the correct hypothesis and supported this by using the equation given in the question pointing out that the current in the circuit has to remain constant. All the necessary equipment is listed, the variables are correctly quoted and the circuit diagram shows the voltmeter in parallel with the wire. The procedure uses a wire of a constant length to keep the current constant and the voltmeter is connected across different lengths of this wire using crocodile clips. A method of collecting and recording the data is then given. This response demonstrates comprehensive knowledge of scientific concepts, procedures and techniques, provides a rationale for the method  and makes a plan which will lead to a reliable set of results being collected

## SECTION 2

**4 Potential difference**

The relationship between potential difference (V) and resistance (R) of a resistance wire in a circuit is given by the following formula:

$$V = IR$$

where

V = potential difference
I = current in the circuit
R = resistance of the wire

The potential difference across a resistance wire in a circuit depends on the length of the wire.

You have been asked to write a plan for an investigation.

You need to investigate, using a circuit, how the potential difference across a resistance wire changes as the length of the wire changes.

You should include a circuit diagram to support your answer. ✓

Your plan should include the following details:

- a hypothesis ✓
- selection, and justification, of equipment, techniques or standard procedures ✓
- health and safety associated with the investigation ✓
- a step-by-step method for data collection and analysis to test the hypothesis including:
  - quantities to be measured ✓
  - number and range of measurements to be taken ✓
  - how equipment may be used ✓
  - control variables ✓
  - brief method for data collection analysis. ✓

(12)

Hypothesis

The longer the wire, the more resistance is experienced within the circuits, and therefore there would be a higher voltage. This is because the longer the wire the more resistance as there is further for

the current to travel, And using the formula V = IR, If the current is constant and the resistance increases, so should the voltage.

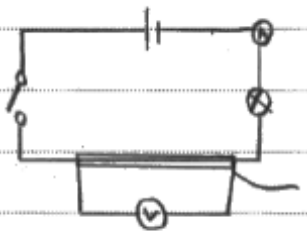
Equipment:

- Crocodile clips, to change the length of the wire.
- Power Battery: to supply the power to the circuit
- Bulb - to check that the circuit is working
- Resistance wire with a ruler underneath: to be able to measure the lengths of the wire
- Ammeter: to measure the current I. to keep it constant
- Voltmeter: to measure the voltage.
- Switch; to connect and disconnect the circuit when changing lengths.

Health and safety:

- Do not touch the resistance wire when the circuit is complete as there is risk of electrication. make sure the circuit is switched off when changing the lengths.

Diagram:




Variables:

Control: - the current (Amps)
- all the equipment in the circuit.

dependent: voltage

independent: length of wire

Method:

- Set up the equipment as shown in the diagram.
- move the crocodile clips so the length of the resistance wire in the circuit is 10cm
- turn on the circuit using the switch.
- make a note of the current so that you can make sure it has not changed thrught the experiment
- record the voltage across the wire. From the voltmeter
- Repeat these steps for lengths of 20cm, 30cm, 40cm, 50cm and 60cm.
- Then repeate the whole experiment motle- 2 times so that you have 3 voltages for each distance.
- Calculate a mean voltage

Results table

| length of wire | Voltage | | | |
|---|---|---|---|---|
| | Test 1 | Test 2 | test 3 | mean |
| 10cm | | | | |
| 20cm | | | | |
| 30cm | | | | |
| 40cm | | | | |
| 50cm | | | | |
| 60cm | | | | |

If my hypothesis is correct then the longer the length the higher the mean voltage.

**(Total for Question 4 = 12 marks)**

## Question 5

The investigation referred to in the question is to find out how the resistance of the thermistor varies with the temperature of the thermistor. No specific values were required it was only the trend that was being tested. Learners are then required to evaluate the method of the experiment, the results collected and the conclusion made. Knowing the initial temperature of the water or how much water is used is not essential to finding the trend. Although using sufficient water to cover the thermistor, stirring the water to ensure the thermometer and the thermistor are at the same temperature and keeping the thermistor off the base of the beaker are all important details which are not covered in the method or seen in the diagram. Many learners did not appreciate that the diagram was an important part of the method and showed how the value of the resistance of the thermistor was to be determined.

The majority of learners noted that there were no repeats or average shown or that the temperature values were not at equal intervals. However, there were very few comments on extending the range to see if the trend was still followed above and below the temperatures indicated. It was noted by some learners that the line on the graph was 'dot-to dot' and not as expected' a curve of best fit'.

The conclusion given in the question was 'The resistance decreases at a greater rate when the temperature is high'. It is this conclusion which learners should have evaluated and this was incorrect. However, either from not understanding the reference to rate or from misreading the conclusion many learners produced a conclusion from the graph which showed 'the resistance decreases as the temperature increases' this was credited as a conclusion as it drew on evidence from the information presented. However, it should be noted that a comment is expected on the 'learner's conclusion' as given in the question.

Leve1 2 marks

This response has comments on method result and conclusion. The first paragraph deals with the conclusion and incorrectly states the conclusion is right. The evaluation of the method does not require use of equipment to be justified as the diagram shows how the equipment is used. The resistance of the thermistor before it is put into the water is irrelevant. The amount of water is not relevant on its own but only that it is necessary to cover the thermistor. An average is mentioned as not being included but there is no mention of repeats or what is to be repeated. The temperature of the hot plate is also irrelevant. This is an adequate interpretation of the information given with little linkage to supporting evidence.

**5** A thermistor is one type of temperature dependent resistor.

A learner sets up a circuit to investigate how the resistance of the thermistor varies with the temperature of the thermistor.

Figure 2 shows the equipment used.

A hot plate is used to heat and control the temperature of the water in the beaker.

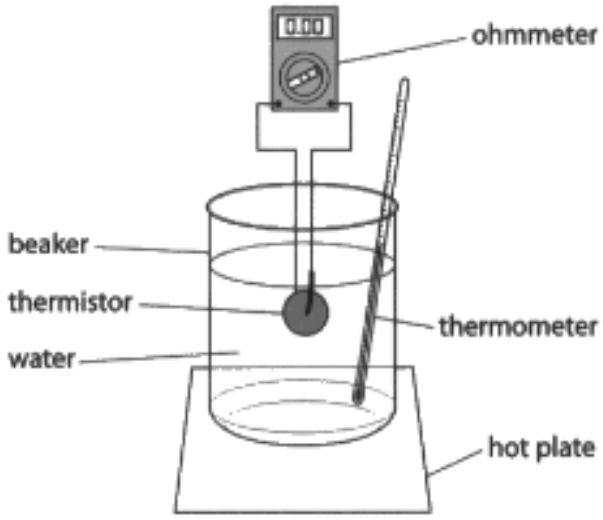



**Figure 2**

Here is the learner's method:

- put the thermistor into cold water
- measure the resistance with an ohmmeter
- switch on the hot plate
- measure the resistance at different temperatures.

The results of the learner's investigation are shown in Figure 3.

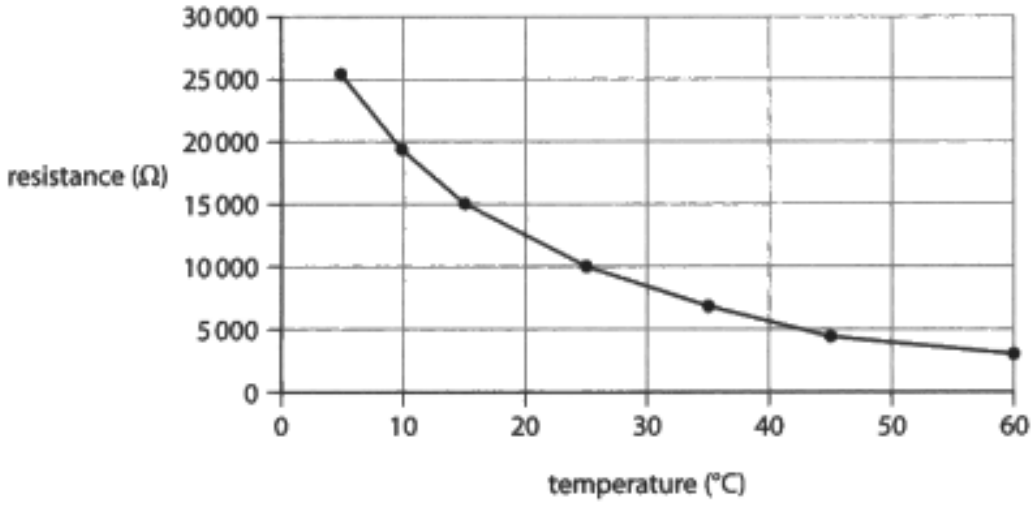



**Figure 3**

The learner concludes that:

'The resistance decreases at a greater rate when the temperature is high.'

Evaluate the learner's investigation.

Your answer should include reference to the:

- method of the experiment
- results collected
- conclusion made.

(8)

The learners conclusion is right at concluding that resistance decreases at greater rate when the temperature is high, this is proven by the figure 3.
The learner has not justified why each equipment should be used, e.g. It has not made clear what the thermister needs to be at (which number) and before put into water.
It hasn't mentioned how much the water needs to be, there is no average table where size the beaker needs to be, hasn't been mentioned, what temperature is not right.

## Level 2 5 marks

This response starts by considering results and states that without completing repeats, anomalies could not be identified. The learner also mentions lack of regular intervals of temperature.

The use of a consistent volume of water is not relevant as time is not a control in this investigation. However, sufficient water to cover the thermistor is necessary and would be useful to mention.

The learner states in the last paragraph that the conclusion is correct having probably misread or not understood the conclusion given. However, a correct version of a conclusion that can be drawn from the graph is given and this does use information from the evidence presented and is accepted as a creditable conclusion.

**5** A thermistor is one type of temperature dependent resistor.

A learner sets up a circuit to investigate how the resistance of the thermistor varies with the temperature of the thermistor.

Figure 2 shows the equipment used.

A hot plate is used to heat and control the temperature of the water in the beaker.

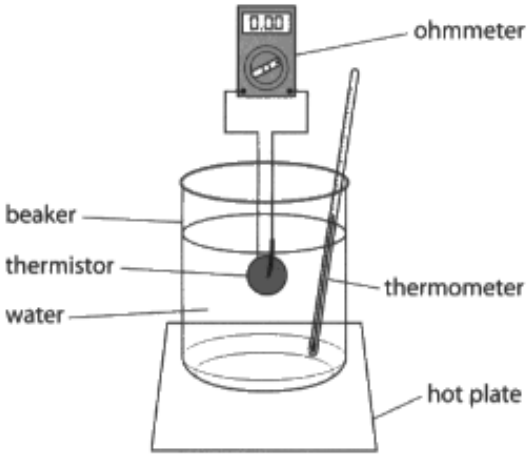



**Figure 2**

Here is the learner's method:

- put the thermistor into cold water
- measure the resistance with an ohmmeter
- switch on the hot plate
- measure the resistance at different temperatures.

The results of the learner's investigation are shown in Figure 3.

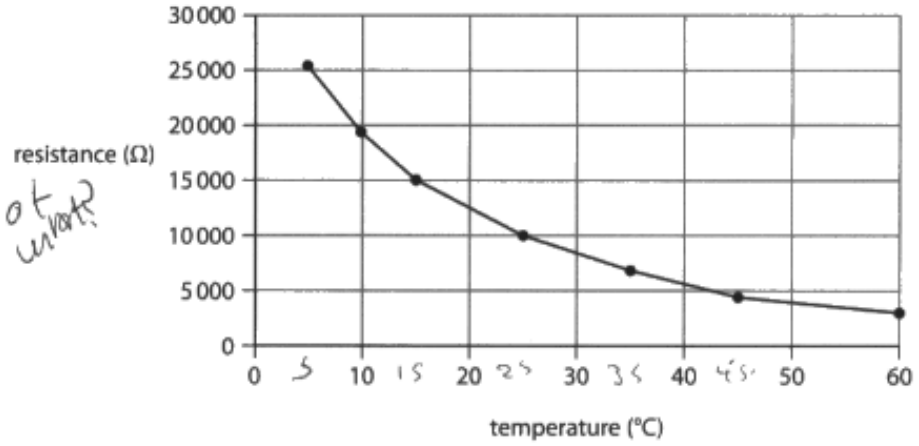



**Figure 3**

The learner concludes that:

'The resistance decreases at a greater rate when the temperature is high.'

Evaluate the learner's investigation.

Your answer should include reference to the:

- method of the experiment
- results collected
- conclusion made.

(8)

Firstly, the most important part of any experiment is repeats. The learner has not stated to repeat the method 3x. Without repeats anomalies can arise and this will lead to inaccurate results therefore each variable (10, 20, 30, 40, 50, 60) is in need of being repeated 3 times. Additionally the method does not state which variables to use. Although, plotted on the graph, 5 variables are needed of different temperatures. The learner has not made it clear what these are and these variables should be at regular intervals. For example; 10, 20, 30, 40, 50(°C). Furthermore, the learner has not included the volume of water needed. A specific volume is needed as a larger volume of water will take longer to heat hence if the volume is not kept the same results will be inaccurate.

Moreover, the learner has not specified when to take measurements and measure the resistance. As the thermometer will not instantly measure the temperature. It would be necessary to measure the resistance after 2 minutes when the water and thermometer and thermistor are in the water. The results collected were also dependant on 1 attempt of the investigation. so it is likely the displayed graph is incorrect. In conclusion the method given was not great. It lacked simple instructions and needed to be more specific. As well as this the learners conclusion is in fact wrong. Correct The resistance of a thermistor decreases as the temperature increases. Therefore, his statement can be seen as correct.

Level 3 8 marks

This response mentions the volume of water and also the need to stir the water as the evaluation of the method. The learners has noted that there are no repeats and therefore no mean and that the intervals between temperature are uneven. This is sufficient for the evaluation of the results. It has been stated that the conclusion is incorrect and the corrected version has been given.

**5** A thermistor is one type of temperature dependent resistor.

A learner sets up a circuit to investigate how the resistance of the thermistor varies with the temperature of the thermistor.

Figure 2 shows the equipment used.

A hot plate is used to heat and control the temperature of the water in the beaker.

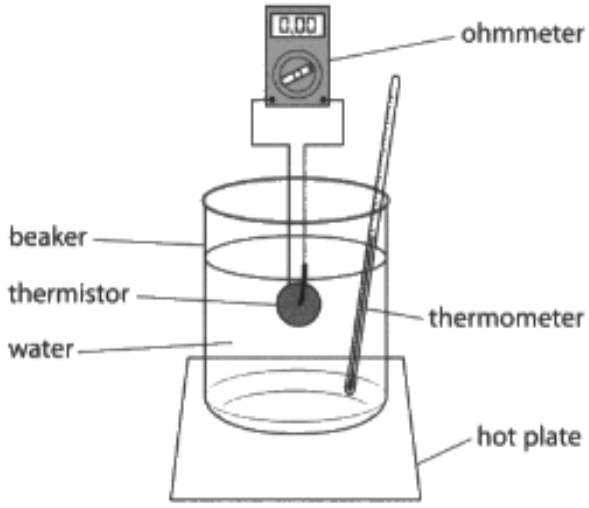



**Figure 2**

Here is the learner's method:

- put the thermistor into cold water
- measure the resistance with an ohmmeter
- switch on the hot plate
- measure the resistance at different temperatures.

The results of the learner's investigation are shown in Figure 3.

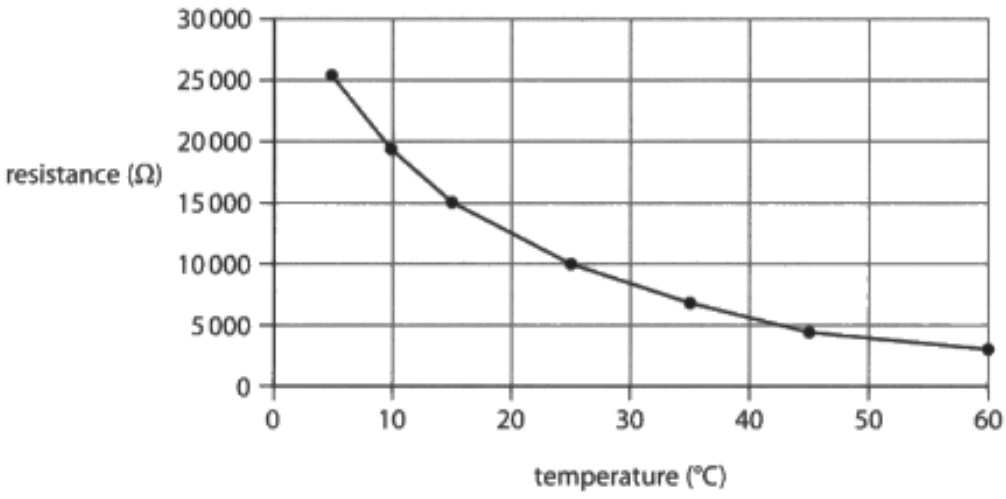



**Figure 3**

The learner concludes that:

'The resistance decreases at a greater rate when the temperature is high.'

Evaluate the learner's investigation.

Your answer should include reference to the:

- method of the experiment
- results collected
- conclusion made.

(8)

To improve the method, the learner should have said to stir the water after the hot plate is turned on otherwise the hot water will stay at the bottom and the cold will stay at the top. Furthermore, the learner has not said how much cold water to place in the beaker.

To improve the results, the learner should have said to repeat the method and calculate a mean so that they are accurate. Furthermore, the results are unevenly spread out so you should do the temperature every 5°C rather than 10°C.

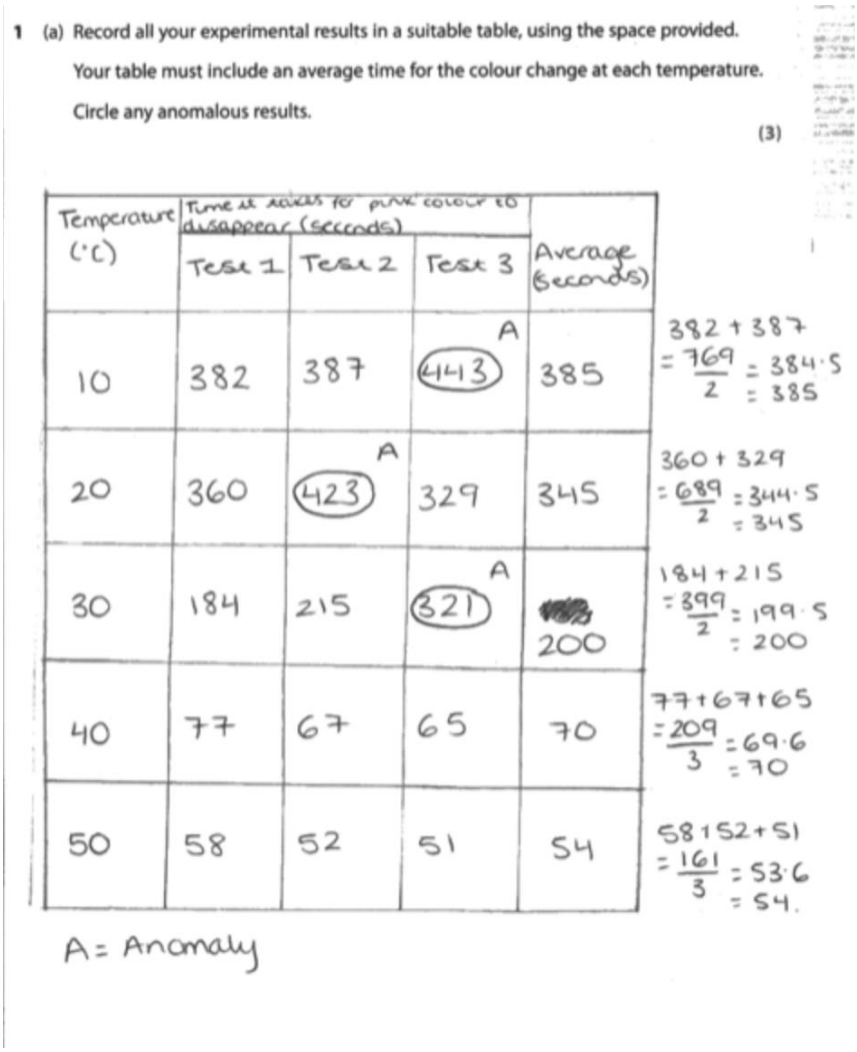
Finally, the conclusion the learner has made is wrong, it should be the resistance increases at a greater rate when the temperature is low.

## Individual questions: Chemistry

The first question on the paper required learners to present the results of their experiment in a table with suitable headings and units and with all measurements recorded consistently. Learners were also asked to record their average and to circle any anomalous results.

It was pleasing to that the majority of those that found that they had anomalous results generally remembered to omit these results from their average.

The majority of learners performed well in this question, with many gaining the full 3 marks available as in this example.



1 (a) Record all your experimental results in a suitable table, using the space provided.
Your table must include an average time for the colour change at each temperature.
Circle any anomalous results.
(3)

| Temperature (°C) | Time it takes for pink colour to disappear (seconds) | | | Average (seconds) |
|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | |
| 10 | 382 | 387 | (443) A | 385 |
| 20 | 360 | (423) A | 329 | 345 |
| 30 | 184 | 215 | (321) A | 200 |
| 40 | 77 | 67 | 65 | 70 |
| 50 | 58 | 52 | 51 | 54 |

382 + 387 = 769/2 = 384·5 = 385
360 + 329 = 689/2 = 344·5 = 345
184 + 215 = 399/2 = 199·5 = 200
77 + 67 + 65 = 209/3 = 69·6 = 70
58 + 52 + 51 = 161/3 = 53·6 = 54

A = Anomaly

Those learners that did not gain the full 3 marks available, often loss marks as they did not include appropriate headings for their tables or did not give appropriate units. Learners should be careful when using the unit for time of minutes as often what they are giving is time in minutes and seconds rather than minutes alone.

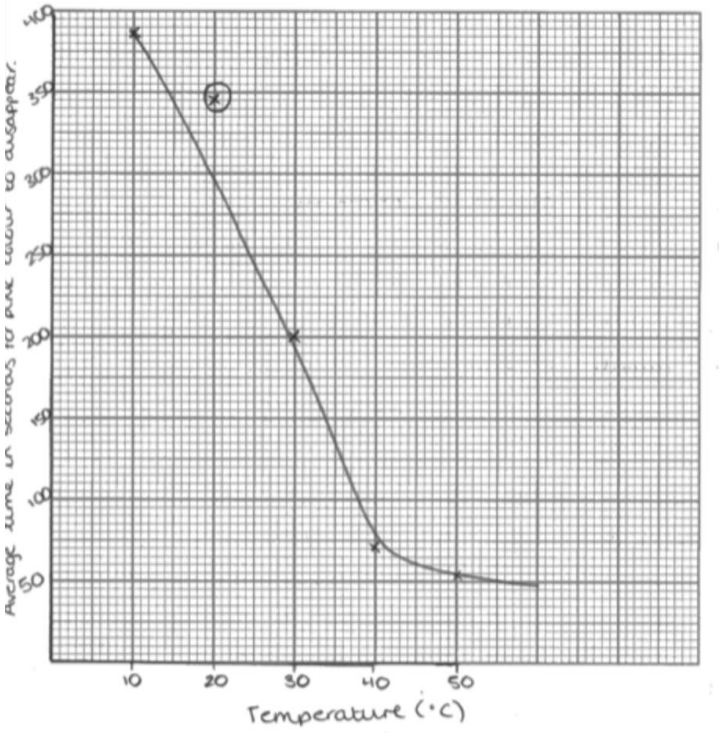
In part (b) of question 1, learners were asked to plot a graph of the results of their experiment and to include a line of best fit.

A good proportion of learners were able to gain all three marks for correctly labelling their axes including the units, for drawing appropriate scales and for plotting their points and drawing a suitable line of best fit. As in this example.

(b) Plot a graph of the average time for the colour change against the temperature of the hydrochloric acid.

You should include a line of best fit.

(3)

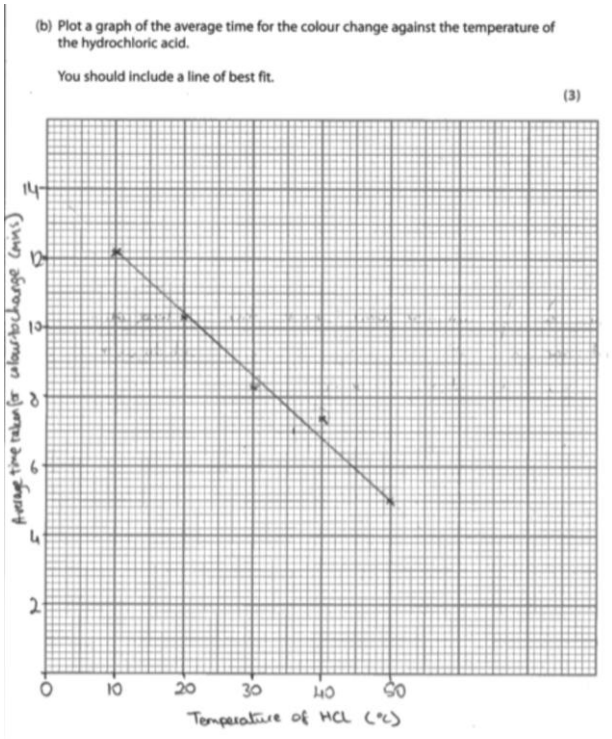


Where learners did not score full marks, it was often because the scale that they used meant that their data spread covered less than half of the graph paper.

This example scored 2 marks for the axes labels and plotted points with a line of best fit.

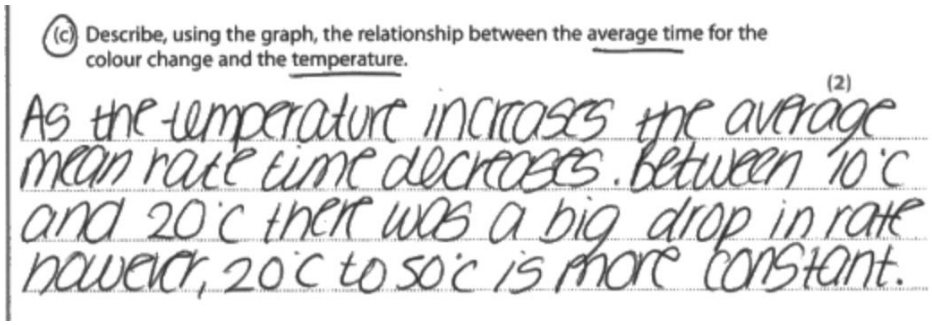
Where errors in units were penalised in part (a) this was not penalised again in part (b).

Learners should be taught to scale their axes so that their data spread covers at least half of the graph paper provided.




Part (c) of question 1 asked learners to describe the relationship shown by their graph. The majority of learners could correctly describe the trend shown in their graph. However, there was sometimes some confusion between rate and time. Whilst a correct description given in terms of rate or of in time was accepted, in some cases learners confused themselves by mixing the two and often contradicted themselves within their answer.

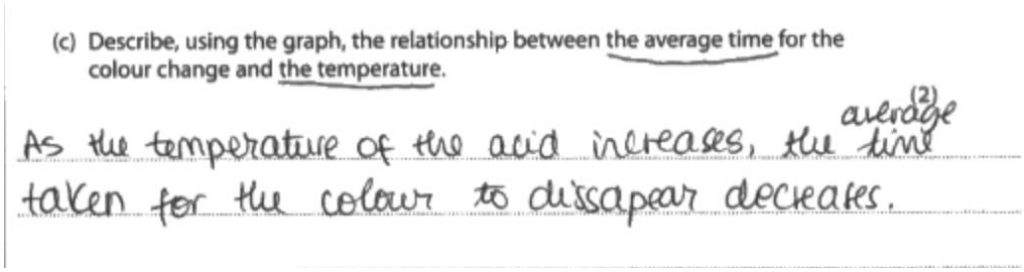
The second mark was very rarely scored with few learners being able to describe in further detail the proportionality of their graphs, shape or varying gradients within their data. The following example however, scored two marks.


(c) Describe, using the graph, the relationship between the average time for the colour change and the temperature.

(2)

As the temperature increases the average mean rate time decreases. Between 10°C and 20°C there was a big drop in rate however, 20°C to 50°C is more constant.

This example scored just 1 mark for stating that the average time take decreases.

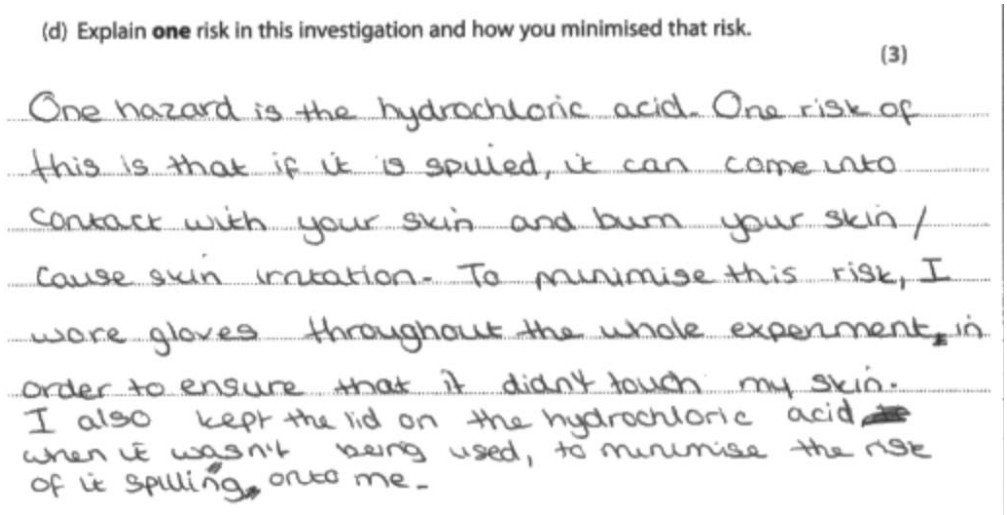

(c) Describe, using the graph, the relationship between the average time for the colour change and the temperature.

(2)

As the temperature of the acid increases, the average time taken for the colour to dissapear decreases.

Learners performed better in part (d) of question 1, the majority scoring at least one mark and a good proportion scoring the full 3 marks available.

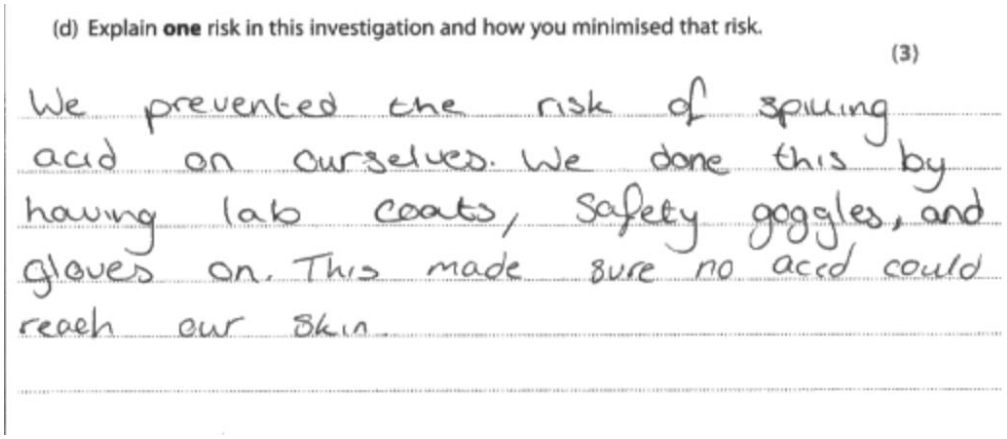
In this example, the learner scored the full 3 marks available for understanding that the risk is that the skin could be burned or irritated by the acid. They understand that the hazard is the hydrochloric acid and that the way to minimise the risk would be to wear gloves.


(d) Explain **one** risk in this investigation and how you minimised that risk.

(3)

One hazard is the hydrochloric acid. One risk of this is that if it is spilled, it can come into contact with your skin and burn your skin / cause skin irritation. To minimise this risk, I wore gloves throughout the whole experiment, in order to ensure that it didn't touch my skin. I also kept the lid on the hydrochloric acid when it wasn't being used, to minimise the risk of it spilling onto me.

In this next example, the learner scored 2 marks, although they have understood that there is an acid which is a hazard and that they should wear gloves to protect themselves no actual risk has been identified to gain the first marking point.


(d) Explain **one** risk in this investigation and how you minimised that risk.

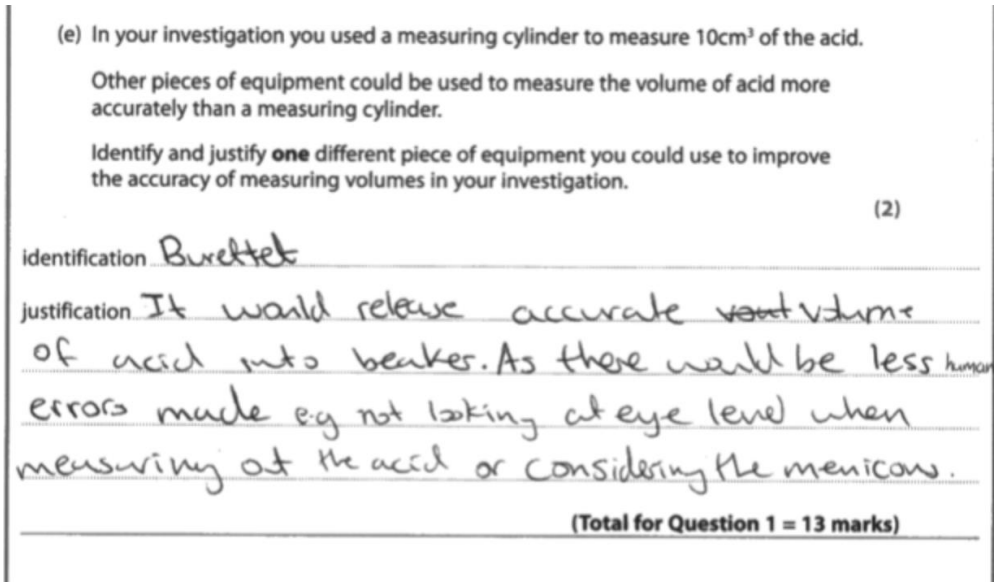
**(3)**

We prevented the risk of spilling acid on ourselves. We done this by having lab coats, safety goggles, and gloves on. This made sure no acid could reach our skin.

Learners should be taught that general laboratory rules and examples of poor laboratory practice are not sufficient when assessing risks in practical's and will gain no credit.

Another common incorrect answer seen was when learners misunderstood the question and thought risk was an experimental feature to improve results and gave examples of measures to reduce cooling and how to avoid contamination for example. Learners that stated that the acid was dangerous or harmful did not gain the first mark.

In the final part of question 1, part (e,) learners were asked to identify and justify a piece of equipment that would improve the accuracy of measuring volumes rather than the measuring cylinder used. A large proportion of learners were able to score at least one mark for understanding that a pipette or a burette would be more accurate, fewer however were able to give an appropriate justification for this. Many repeated the stem and said that it was more accurate or it meant less human error, this did not score.



(e) In your investigation you used a measuring cylinder to measure 10cm³ of the acid.

Other pieces of equipment could be used to measure the volume of acid more accurately than a measuring cylinder.

Identify and justify **one** different piece of equipment you could use to improve the accuracy of measuring volumes in your investigation.

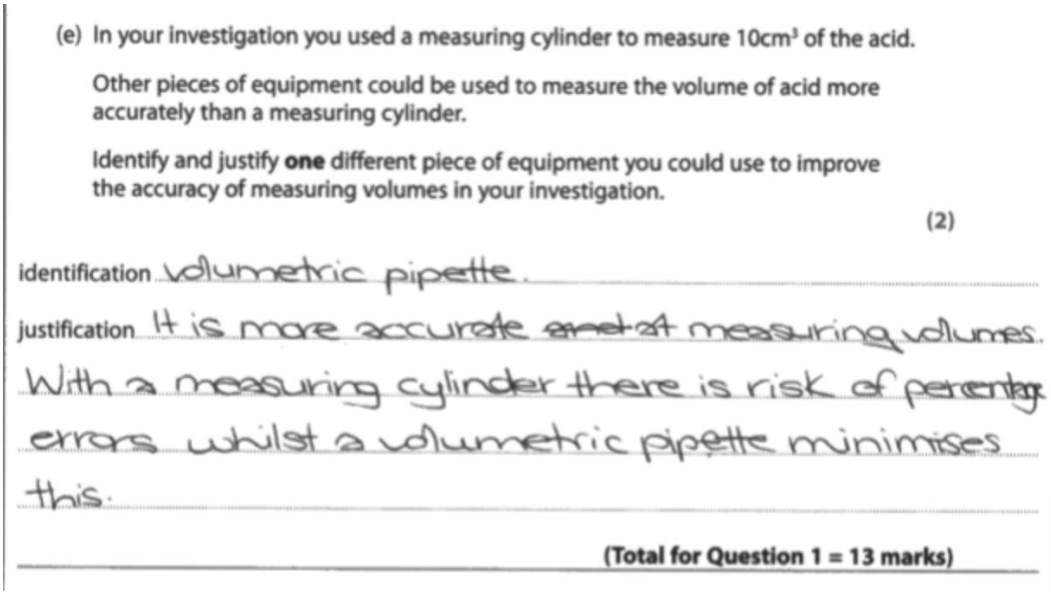
(2)

identification Burette

justification It would release accurate ~~vol~~ volume of acid into beaker. As there would be less human errors made e.g not looking at eye level when measuring of the acid or considering the meniscus.

**(Total for Question 1 = 13 marks)**

This next example scored 2 marks for stating that the volumetric pipette would minimise the percentage error.



(e) In your investigation you used a measuring cylinder to measure 10cm³ of the acid.

Other pieces of equipment could be used to measure the volume of acid more accurately than a measuring cylinder.

Identify and justify **one** different piece of equipment you could use to improve the accuracy of measuring volumes in your investigation.

(2)

identification volumetric pipette.

justification It is more accurate ~~at~~ at measuring volumes. With a measuring cylinder there is risk of percentage errors whilst a volumetric pipette minimises this.

**(Total for Question 1 = 13 marks)**

Question 2 focused on analysing some data from another source.

In part (a)(i), around half of all learners were able to give a reason why the colleague did not use a temperature higher than 90$^{O}$C.

Of those that scored the mark, they often did so as they understood that this would have been hazardous or unsafe.

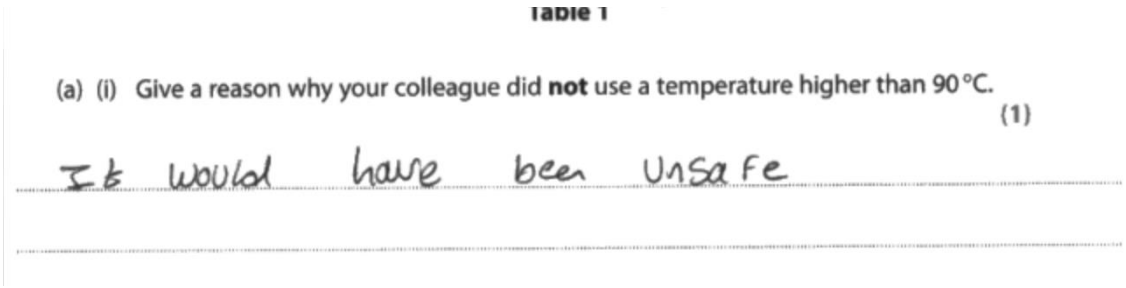


Table 1

(a) (i) Give a reason why your colleague did **not** use a temperature higher than 90 °C.

(1)

It would have been unsafe

Some learners understood that going up in the 20°C intervals would take the temperature above the boiling point of water and so would not be achievable.

In some cases, the learners were not specific enough and just stated that the water would boil, which was not accepted.

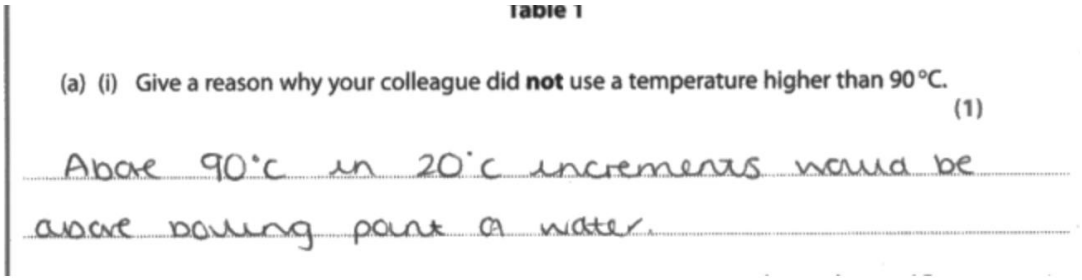


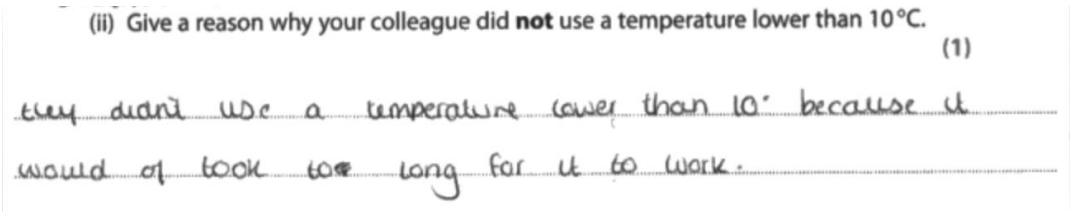
Table 1

(a) (i) Give a reason why your colleague did **not** use a temperature higher than 90 °C.

(1)

Above 90°C in 20°C increments would be above boiling point of water.

A similar number of learners were also able to explain why the colleague did not use a temperature lower than 10°C, with many stating that the diffusion would be too slow or that the acid or agar might freeze. Some learners were very vague with their answer and just stated that the experiment would not work, this did not gain credit. Some weaker responses mentioned that the thermometer would not go that low.


(ii) Give a reason why your colleague did **not** use a temperature lower than 10 °C.

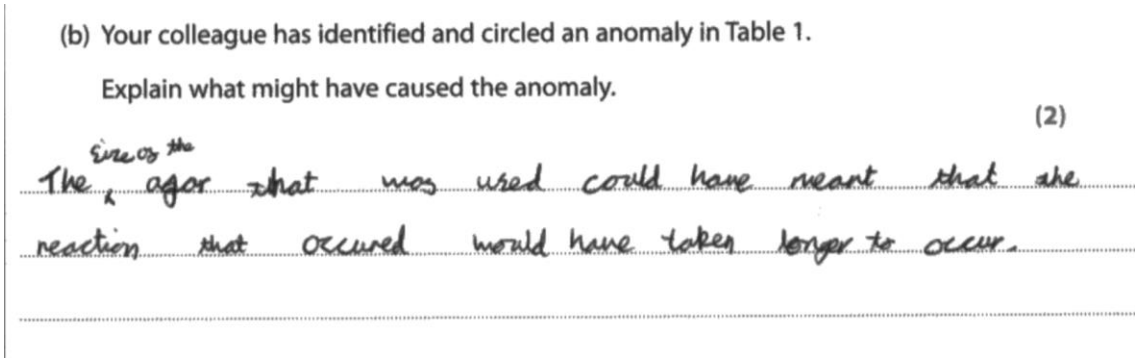
(1)

they didn't use a temperature lower than 10° because it would of took too long for it to work.

In part (b) of question 2, learners were asked to explain what might have caused an anomaly circled in the table of data collected by the colleague. A good proportion of learners were able to analyse the data to conclude that the anomaly meant that the diffusion had appeared to take longer than the others or that it happened slower. Of those that knew that the anomaly appeared to make the

diffusion take longer around half to give an explanation as to why this may have happened.

This example gained 1 mark for stating that the reaction takes longer to occur, the learner tried to explain that this was because the size of the agar, but as they have not stated that the agar was too big or less agar may have been covered then the second mark was not scored. Learners should be taught to be specific with their answers as vague responses are unlikely to gain credit.

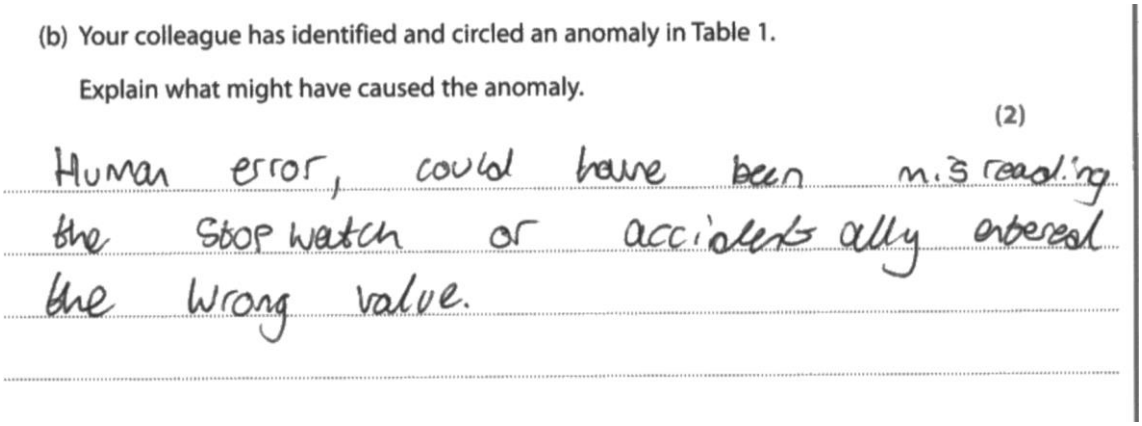

(b) Your colleague has identified and circled an anomaly in Table 1.

Explain what might have caused the anomaly.

(2)

The size of the agar that was used could have meant that the reaction that occured would have taken longer to occur.

Learners should be taught that answers regarding 'human error' alone are unlikely to score, if they had been more specific as to what the human error may have been for example, the stopwatch may have been started to early then this could have scored.


(b) Your colleague has identified and circled an anomaly in Table 1.

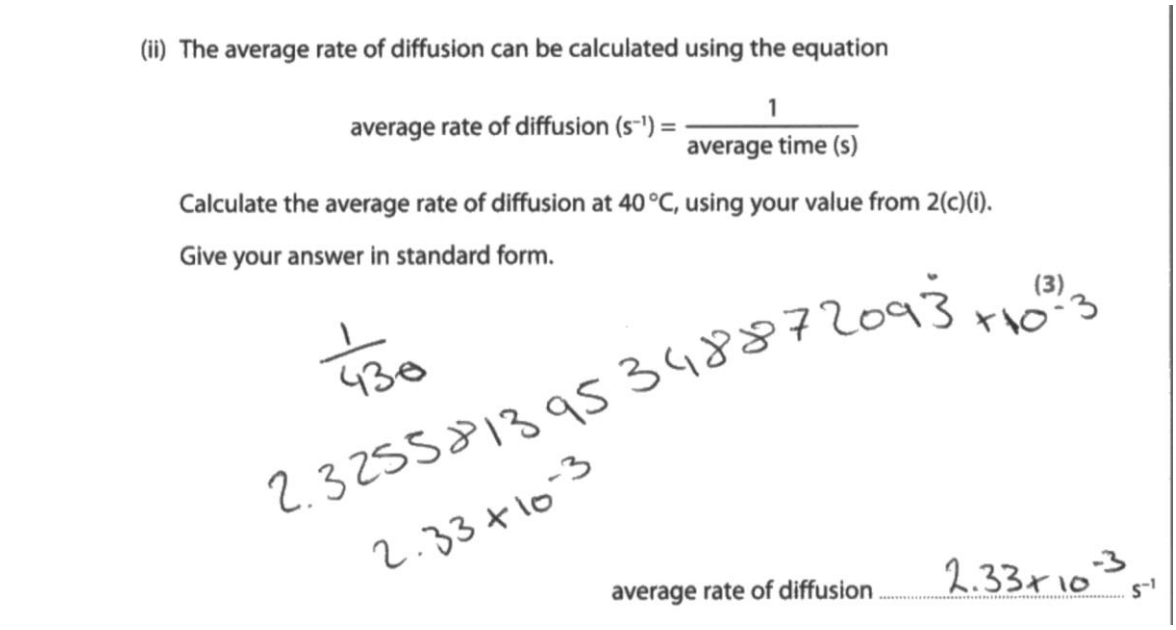
Explain what might have caused the anomaly.

(2)

Human error, could have been mis reading the stop watch or accidents ally entered the wrong value.

Part (c) of question 2 focused on a graph of the colleagues data. In part (i) the vast majority of learners were able to use the graph to find the average time taken for the acid to diffuse at 40°C.

In part (ii) a large proportion of learners were able to calculate the average rate of diffusion at 40°C, using their value from part (i) to gain the full 3 marks as shown in this example.



(ii) The average rate of diffusion can be calculated using the equation

$$\text{average rate of diffusion } (s^{-1}) = \frac{1}{\text{average time (s)}}$$

Calculate the average rate of diffusion at 40 °C, using your value from 2(c)(i).

Give your answer in standard form.

(3)

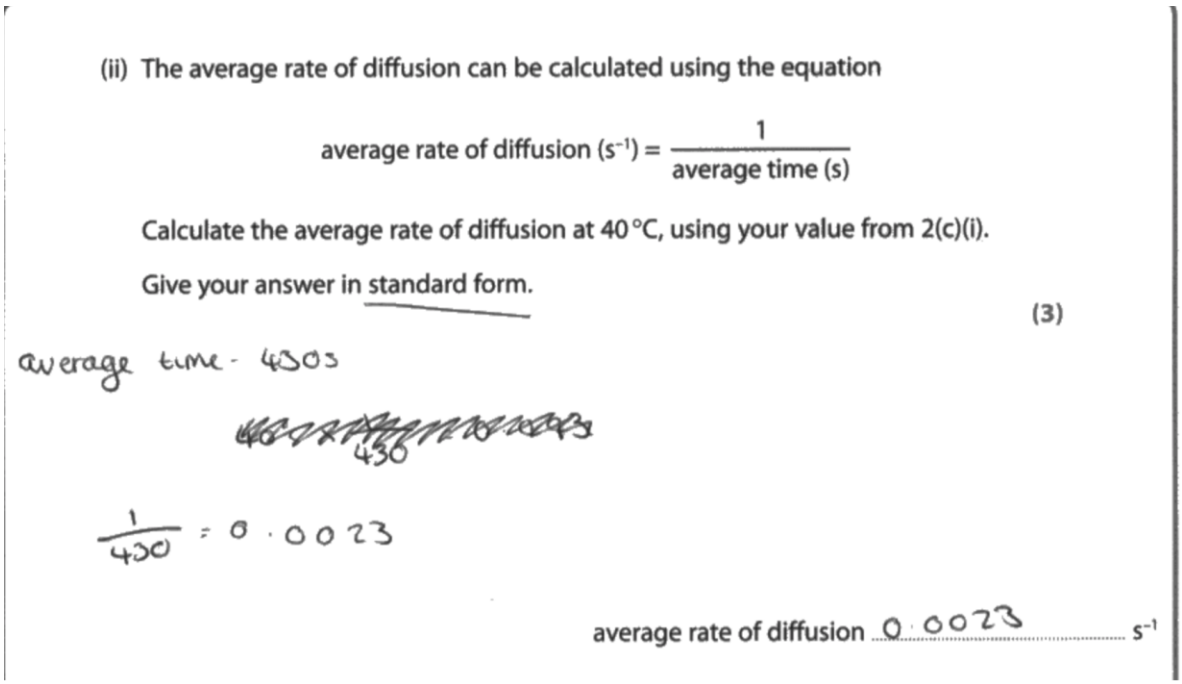
$\frac{1}{430}$

$2.325581395348872093 \times 10^{-3}$

$2.33 \times 10^{-3}$

average rate of diffusion $2.33 \times 10^{-3}$ $s^{-1}$

Of those that scored, around one third were able to complete the calculation correctly but were not able to give their answer in standard form so scored 2 of the 3 marks available.



(ii) The average rate of diffusion can be calculated using the equation

$$\text{average rate of diffusion } (s^{-1}) = \frac{1}{\text{average time (s)}}$$

Calculate the average rate of diffusion at 40 °C, using your value from 2(c)(i).

Give your answer in standard form.

(3)

average time = 430s

$\frac{1}{430}$

$\frac{1}{430} = 0.0023$

average rate of diffusion 0.0023 $s^{-1}$

Learners found it difficult to draw error bars in question (d) (i) with few learners gaining 1 mark and fewer still gaining both marks. This was the only question on the paper where there were a significant number of 'no responses'. Only the most able seemed to be able to show some understanding of what error bars are. Some common errors seen when drawing the error bars were: to circle points, to drawn lines from each point to both x and y axes, error bars that were well in excess of the standard deviation, error bars in only one direction, error bars with very dramatic asymmetry and error bars that were all the same size.

The following example scored 2 marks for 5 correct errors bars, symmetrical in both directions. Where learners had only drawn 2 or 3 error bars correctly just 1 mark was awarded.

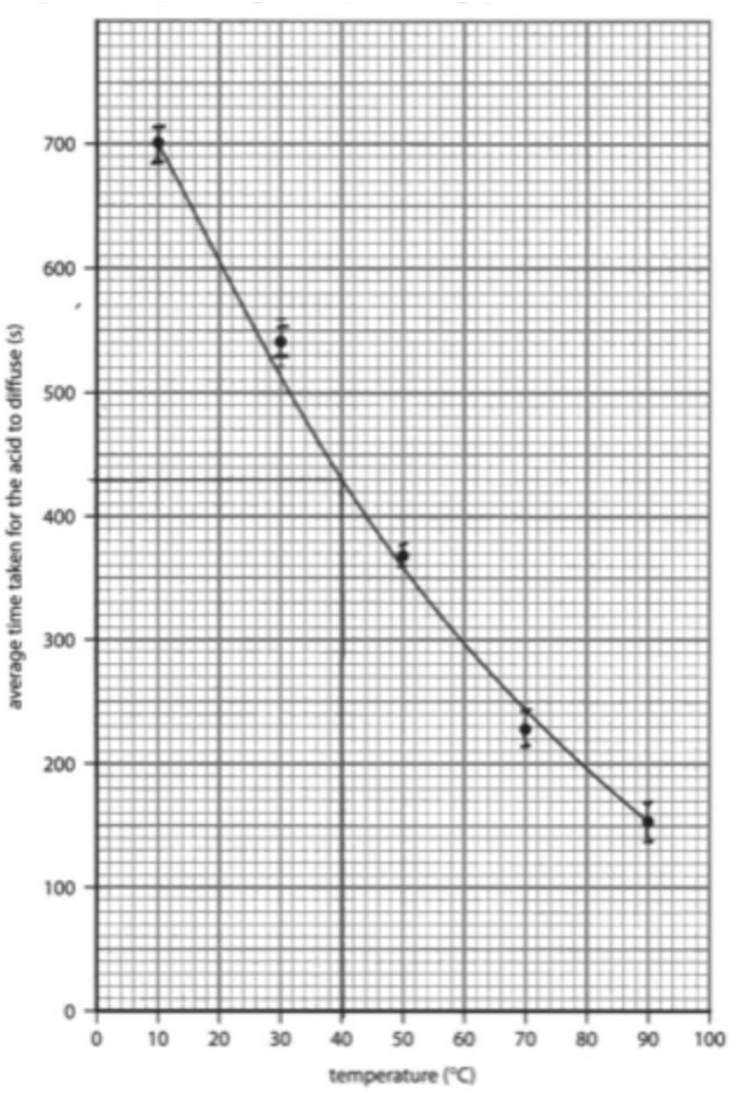
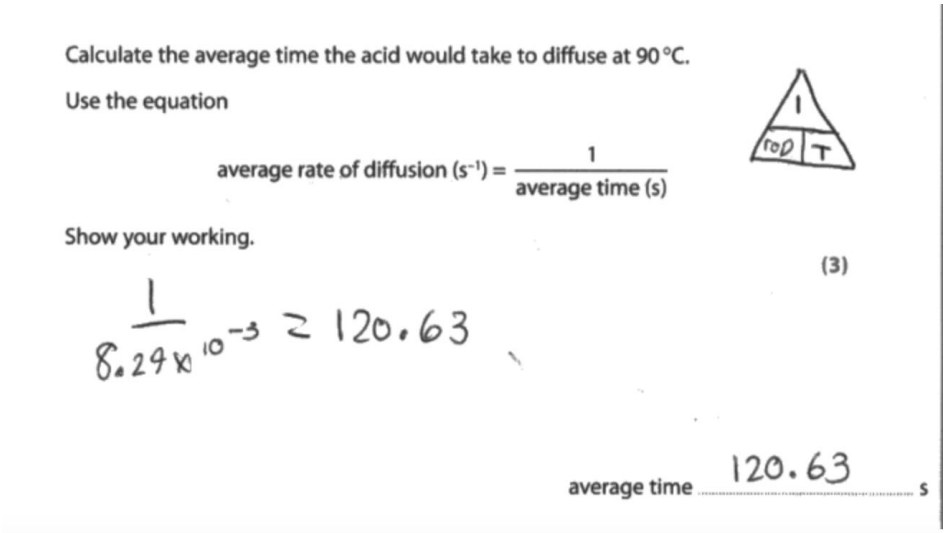



**Figure 1**

Question 2 part (d)(ii) asked learners to explain which temperature in figure 1, had the least reliable set of results, most of those that showed the understanding that 10°C had the least reliable set of results were then able to follow this up and explain that this was because it had the largest error bar to score the 2 marks available.

Learners performed well in the second calculation on the paper in question 2(e)(ii) with the majority scoring the full 3 marks available as in this example.


Calculate the average time the acid would take to diffuse at 90 °C.

Use the equation

$$\text{average rate of diffusion } (s^{-1}) = \frac{1}{\text{average time (s)}}$$

Show your working.

(3)

$\frac{1}{8.29 \times 10^{-3}} = 120.63$

average time 120.63 s

In some cases, learners had shown the correct methodology but did not evaluate their calculation correctly, this example shows the importance of learners showing their working in their answer. If the answer of 112.48 was given on the answer line with no working, then no marks would be awarded. However, as the learner has the correct methodology, with only the evaluation incorrect, 2 marks were awarded.

In some cases, learners lost marks for incorrect rounding, often their methodology was correct and so 2 marks could be awarded but as they rounded their answer incorrectly for example rounding to 120.62 rather than 120.63, the evaluation mark could not be scored.

The last question of question 2 asked learners to state the effect of using sulfuric acid instead of hydrochloric acid had on the average rate of diffusion, a good proportion of learners gained the mark for correctly stating that the rate of diffusion increases when using sulfuric acid rather than hydrochloric. Some learners stated that the rate of diffusion was higher which was accepted.

(ii) State what effect using sulfuric acid instead of hydrochloric acid had on the average rate of diffusion.

(1)

The average rate of diffusion was higher

**(Total for Question 2 = 16 marks)**

Where learners lost marks, it was often because they were vague with their answers and just stated that the hydrochloric acid gave better results, this did not gain credit.

(ii) State what effect using sulfuric acid instead of hydrochloric acid had on the average rate of diffusion.

(1)

Sulfuric acid is more concentrated than hydrochloric acid, giving better results.

**(Total for Question 2 = 16 marks)**

Question 3 focussed learners back on their own investigation with part (a)(i) asking how the surface area of the agar cylinder was controlled, in the main this was well answered with many learners understanding that the surface area was controlled by keeping the size of the cylinder the same, some stated that it was controlled by using the same size cork borer or tool which was also accepted.

3 In your investigation, the surface area of the agar cylinder was controlled.

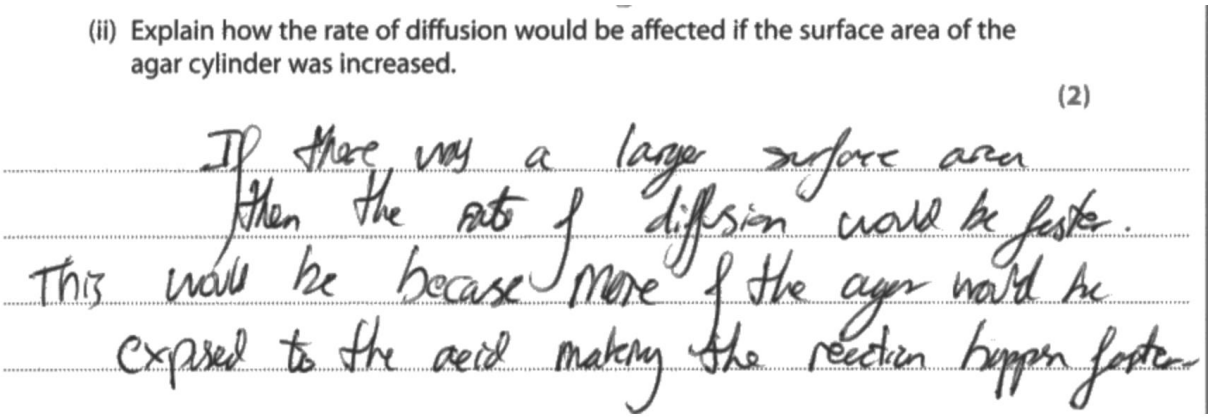
(a) (i) State how the surface area of the agar cylinder was controlled.

(1)

They were cut by the same tool to the same size.

In some cases, learners lost marks as they stated simply that they measured the cylinder but there was no reference to ensuring that they were the same to gain the mark.

In part (ii) learners found it more difficult to explain how the rate of diffusion would be affected if the surface area of the cylinder was increased. This example scored 2 marks for showing the understanding that the rate of diffusion would be faster and that this is because more of the agar would be exposed.

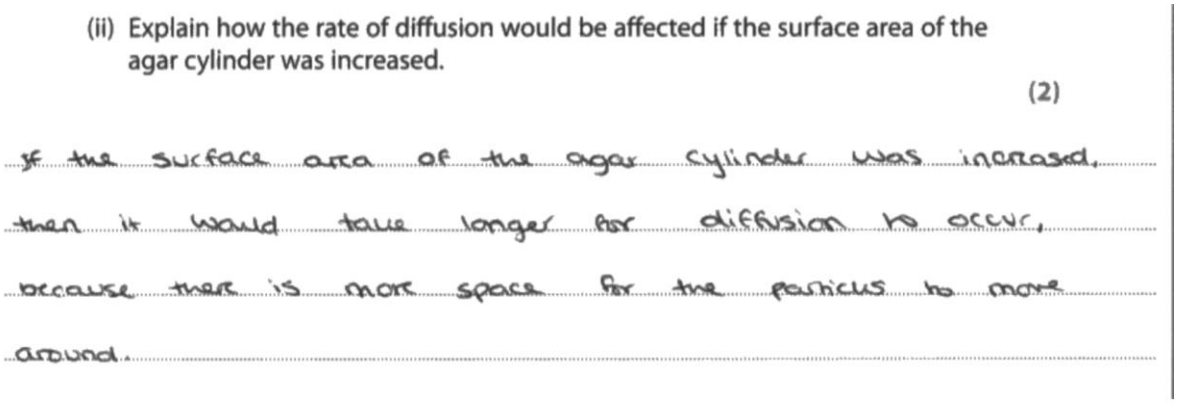


(ii) Explain how the rate of diffusion would be affected if the surface area of the agar cylinder was increased.

(2)

If there was a large surface area then the rate of diffusion would be faster. This would be because more of the agar would be exposed to the acid making the reaction happen faster.

A common misconception was that if the surface area was increased that it would take longer for diffusion to occur, this answer scored 0 marks.



(ii) Explain how the rate of diffusion would be affected if the surface area of the agar cylinder was increased.

(2)

if the surface area of the agar cylinder was increased, then it would take longer for diffusion to occur, because there is more space for the particles to move around.

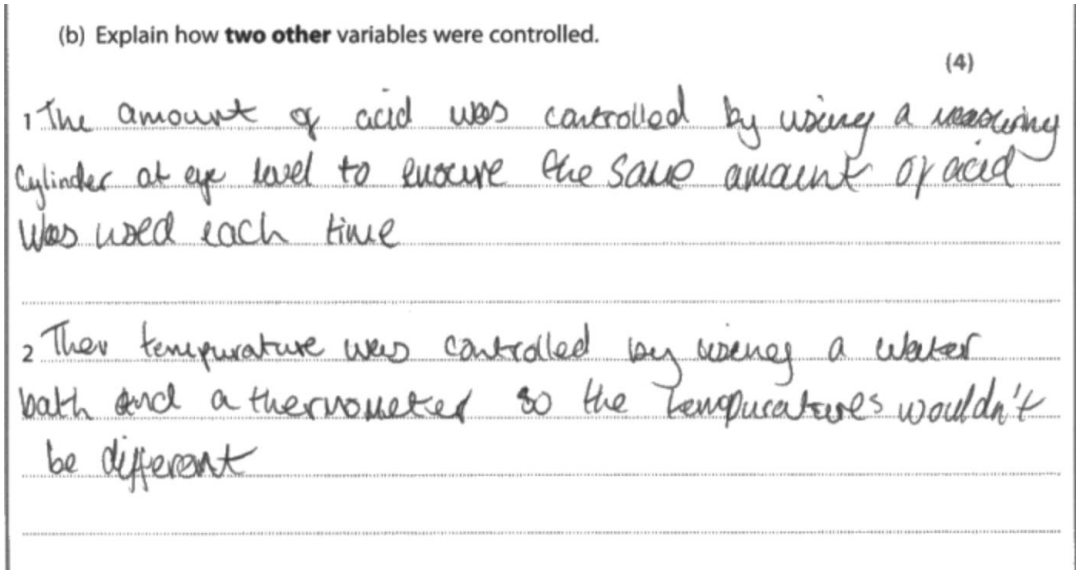
Many learners gave a correct answer and then directly contradicted themselves, this was often around confusion between time and rate eg “the rate would increase so it would take longer to diffuse” or “the time taken would decrease, rate of diffusion would decrease” – this prevented them from being awarded the first marking point.

There were several common misconceptions that were used to explain a learners identified trend such as : particles would have more energy / would move faster,

particles would need to travel through more agar or particles would have more room to move around.

Learners found part (b) easier with the vast majority being able to score at least 1 mark. The most common score on this question was 2 with many learners being able to give two variables but fewer being able to explain how these variables were controlled or only one variable was explained.

In this example, the learner has stated the amount of acid was controlled by using a measuring cylinder. A common misconception was to think that temperature was a variable that was controlled, this gained no credit.



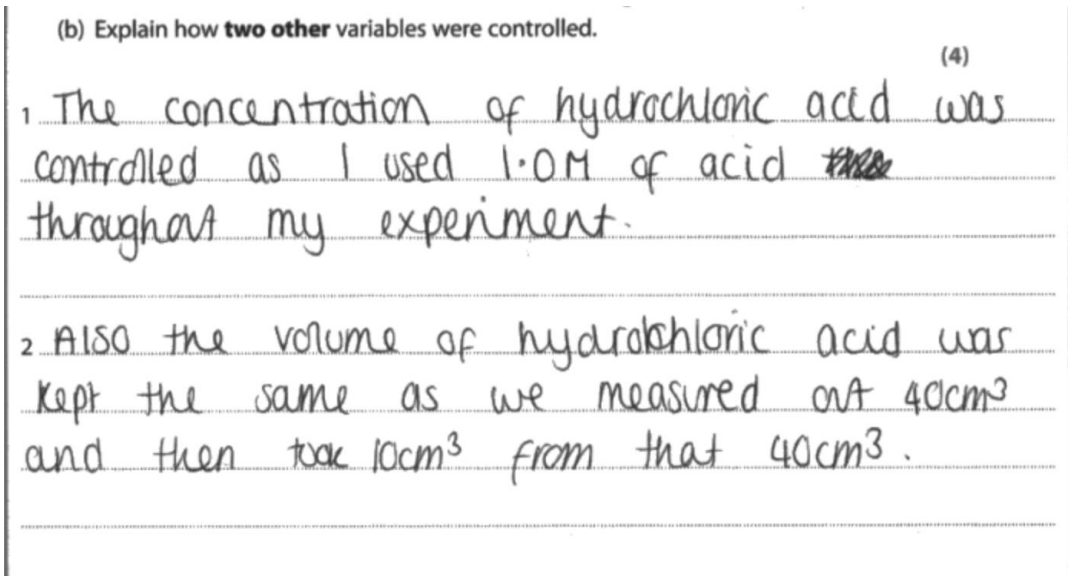
(b) Explain how **two other** variables were controlled.

(4)

1 The amount of acid was controlled by using a measuring cylinder at eye level to ensure the same amount of acid was used each time

2 The temperature was controlled by using a water bath and a thermometer so the temperatures wouldn't be different

The most able learners were are to explain two variables that were controlled as in this example that scored 4 marks for the two variables, concentration of acid and volume of acid and then their explanations that 1.0M was used throughout and that 10cm$^3$ was used each time.



(b) Explain how **two other** variables were controlled.

(4)

1 The concentration of hydrochloric acid was controlled as I used 1·0M of acid throughout my experiment.

2 Also the volume of hydrochloric acid was kept the same as we measured out 40cm$^3$ and then took 10cm$^3$ from that 40cm$^3$.

In some cases, learners did not engage with the command correctly and tried to explain why variables were controlled rather than how variables were controlled. Learners should be taught the difference between the commands explain how and explain why.

In the last question on the section A of the paper, learners were asked to describe two ways, other than trying different temperatures, that their investigation could be extended. Here again, the most common score on this question was 2 with many learners being able to give two ways to extend the investigation but fewer being able to describe in further details the way in which this would be done.

(c) One way to extend your investigation would be to try different temperatures e.g. 15 °C and 25 °C.

Describe **two other** ways you could extend your investigation.

**(4)**

1 Having different concentration could be another way of extending the experiment. e.g a higher level of concentrated HCL or a lower concentrated amount.

2 Another way of extending my investigation is having a different size agar. eg one much bigger or smaller than the agar cylinder now.

**(Total for Question 3 = 11 marks)**

In this example, the learner states that the they could try different concentrations or different sizes of agar but just stating higher or lower or bigger or smaller was not sufficient for the second mark point for each extension so the answer scored just 2 marks.

(c) One way to extend your investigation would be to try different temperatures e.g. 15 °C and 25 °C.

Describe **two other** ways you could extend your investigation.

**(4)**

1 I could have used other acids, for example Sulfuric acid. So I could have 10°C of Sulfuric acid and 10°C of hydrochloric acid in another test tube.

2 I could have used different sizes of the agar cylinder. For example one agar cylinder could be 5cm and another agar cylinder could be 10cm. Then I could compare the results

**(Total for Question 3 = 11 marks)**

The following example scored 4 marks.

Learners should be taught that simply repeating the same experiment is not acceptable for an extension to the investigation. This response gained just 1 mark for using a larger surface area if jelly.

(c) One way to extend your investigation would be to try different temperatures e.g. 15 °C and 25 °C.

Describe **two other** ways you could extend your investigation.

**(4)**

1 we could also extend the amount of trials we did to get a more accurate average time taken.

2 we could of used a larger surface area of agar jelly to see if time taken to dissolve would change.

**(Total for Question 3 = 11 marks)**

## Summary

## Physics

To improve their mark for this section of Unit 3 learners should:-

In Q4,

- Establish the correct hypothesis from the information in the question.
- State when the investigation has minimal risks
- Learn the correct positioning of voltmeters and ammeters in circuits.
- Remember to draw a circuit diagram when using an electrical circuit.

In Q5.

- Note if the investigation is looking for a trend or specific results
- Consider the information the diagram gives
- Comment on good practice in carrying out an investigation, such as stirring the water.
- Look to see if the results could be extended
- Evaluate the conclusion which is given

## Summary

## Chemistry

To improve in future series, learners should Ensure that they understand basic mathematic principles such as writing answers in standard form and rounding of answers and drawing and analysing error bars. They should practice drawing graphs, ensuring that they label axes, including units and that they use linear scales that are appropriate so that their data spread takes up at least half of the paper that they are using. Learners should practice plotting data and then drawing the best fit line or curve, if appropriate, through that data.

Learners should continue to practice exam technique, ensuring that they know what is required by specific command words and know the difference in what is required from commands such as explain how and explain why. Learners should ensure that they are specific with their answers rather than giving vague or general answers.

Learners should be practising practical's and past papers and sample assessment materials located on the BTEC First qualification webpage located here.

For more information on Pearson qualifications, please visit
http://qualifications.pearson.com/en/home.html

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE