L3 Lead Examiner Report 1901

January 2019

L3 Qualification in Applied Science/Forensics and Criminal Investigations

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 2019
Publications Code 31619H_1901_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

This was the first time that the practical activity had been tested using the Section H Physics from the specification. From the tables that were produced it could be seen that learners were able to carry out the practical activity without difficulty. It was only in designing the table so that all columns were labelled and had units that problems arose. However, producing a graph to meet all the criteria was more challenging. Whilst most learners were able to label the axes and plot points correctly frequently the points did not cover half the graph paper and not enough care was taken in drawing lines or curves of best fit. Most learners were able to name the dependent and independent variables but found naming a control variable and giving a reason for controlling it more difficult. Most learners were able to describe the relationship between the number of lamps and the observed voltage but did not recognise their graph as being linear or non-linear. It was also surprising to find how few learners realised that opening the switch in a circuit stops the current.

The examination requires that learners have a calculator and a ruler. It was apparent that a ruler was not available in many cases as the extension of the line on the graph did not coincide with the original line or was at an angle to it. Taking readings from graphs also proved difficult for same learners rearrangement of equations requires more practice as does converting seconds to hours. Learners also need to learn the definitions of repeatability and reproducibility and consider, once they have carried out an investigation how it could be extended.

Section 2: Chemistry

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 chemistry part of the specification. 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 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.

Individual Questions: Physics

Q1a

The example below gained all 3 marks. The headings and units are correct, bulb is acceptable instead of lamp but voltmeter reading is not acceptable in place of voltage, the mean voltage has a unit and the averages are correct.

1 (a) Record all your experimental results, including the average voltage in a suitable table, using the space provided. Circle any anomalous results.

(3)

Number of Bulbs	voltage (v)			mean voltage (v)
	1	2	3	
1	2.97	2.96	2.95	2.96
2	2.59	2.54	2.60	2.58
3	2.44	2.44	2.43	2.44
4	2.31	2.27	2.24	2.27
5	1.98	1.97	1.98	1.98
6	1.90	1.90	1.91	1.90

The example below also gained all 3 marks. The table has correct headings with units. The 'voltage' heading and unit covers all the required columns. Repeats are shown, three is sufficient. All the results are given to a consistent number of decimal places. The averages are calculated to the same number of decimal places and an anomaly is ringed. The anomalous result is then not used to calculate the average for the sixth lamp

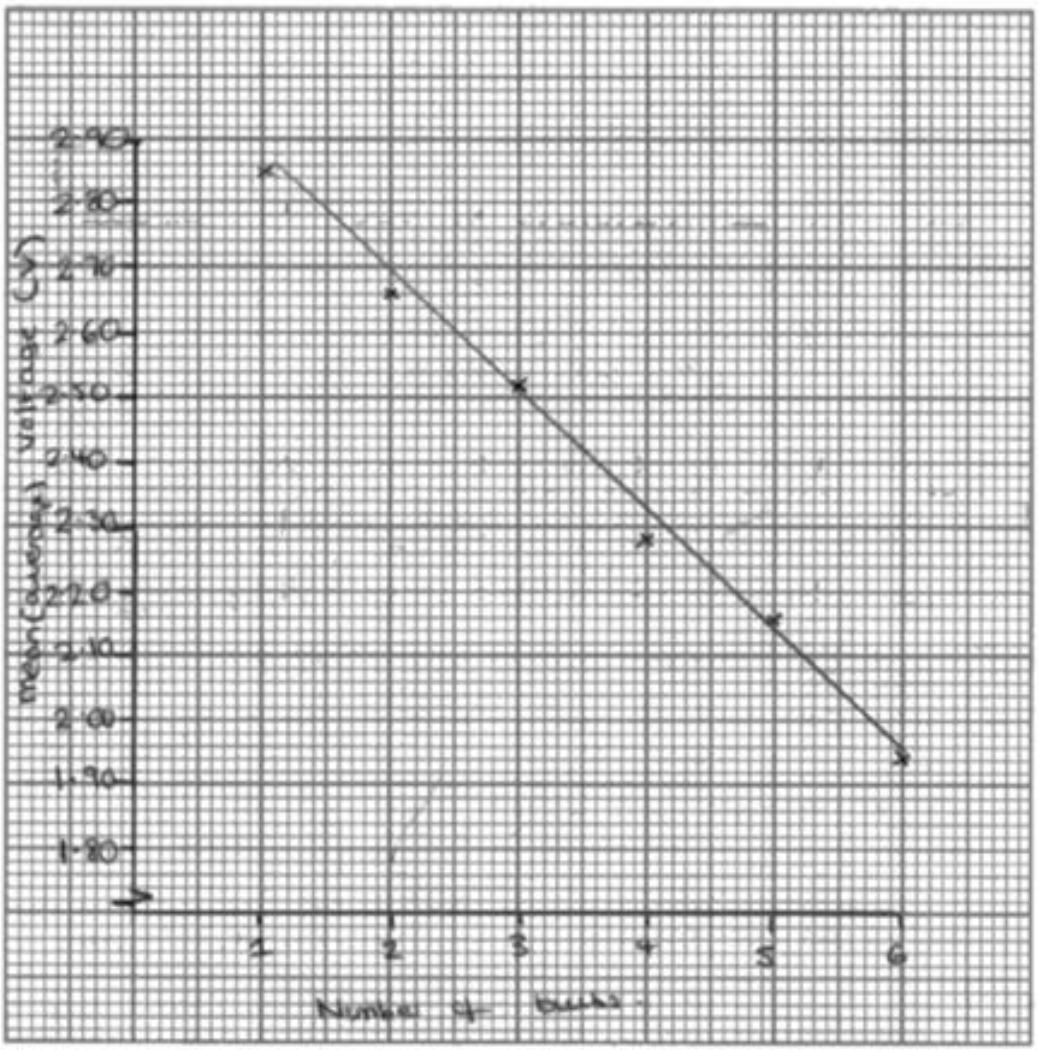
Number of Lamps	Voltage (V)			
	reading 1	reading 2	reading 3	mean
1	2.79	2.80	2.82	2.80
2	2.64	2.63	2.60	2.62
3	2.34	2.31	2.26	2.30
4	2.20	2.26	2.19	2.22
5	2.05	2.00	1.90	1.98
6	1.51	1.94	1.56	1.54

anomylous result

Q1b

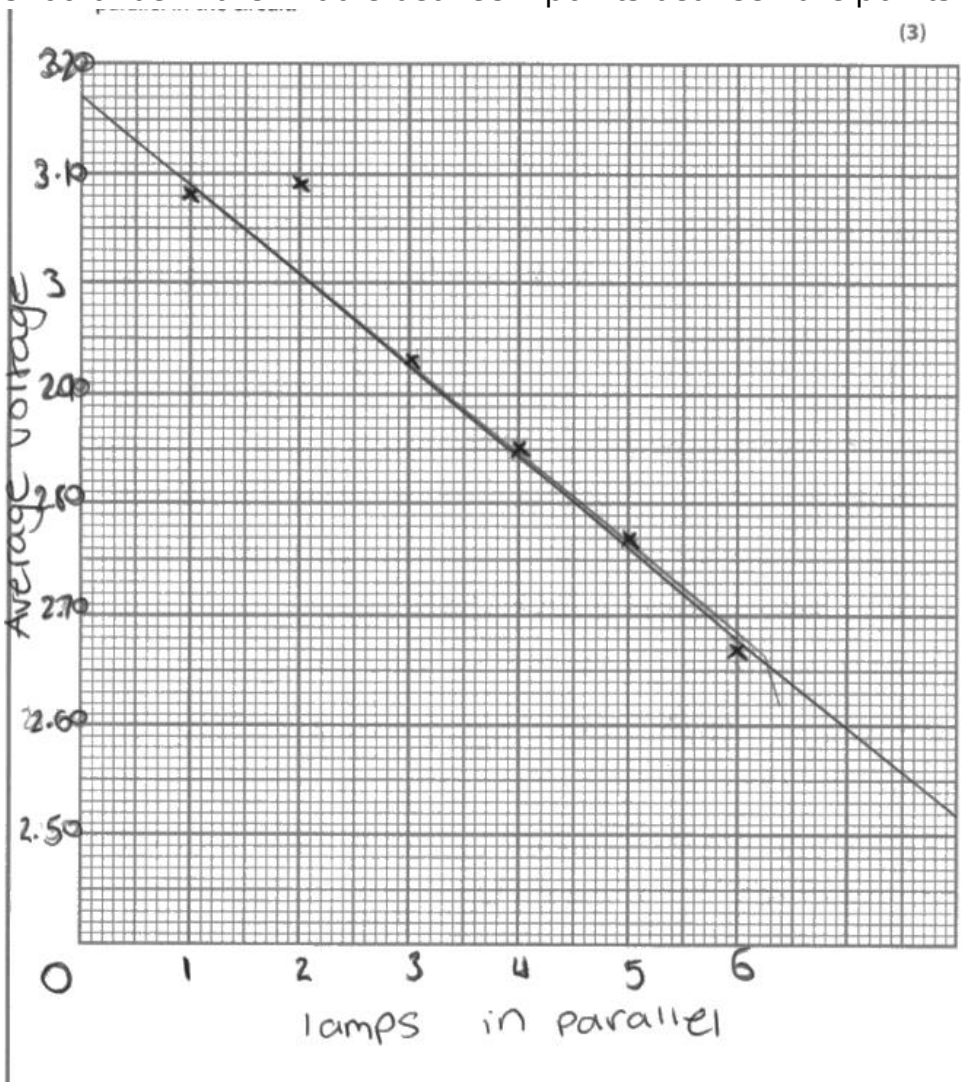
A maximum of 3 marks could be awarded for plotting the graph. Most learners were able to draw the axes and label the axes correctly with units. Producing a scale which allowed the spread of points to cover half of the graph paper was more challenging as most graphs to do this could not include the origin. Most learners could plot the graph points accurately but did not produce a smooth curve or a line of best fit which had points evenly distributed about the line. The example below was awarded 2 marks as the points are not evenly distributed about the line.

(3)


2·90
2·80
2·70
2·60
2·50
2·40
2·30
2·20
2·10
2·00
1·90
1·80
Mean (closed) Voltage (V)
1
2
3
4
5
6
Number of bulbs

The graph below was only awarded 1 mark. There is no unit on average voltage. However the scale enables points to cover more than half of the graph paper and this gains a mark.

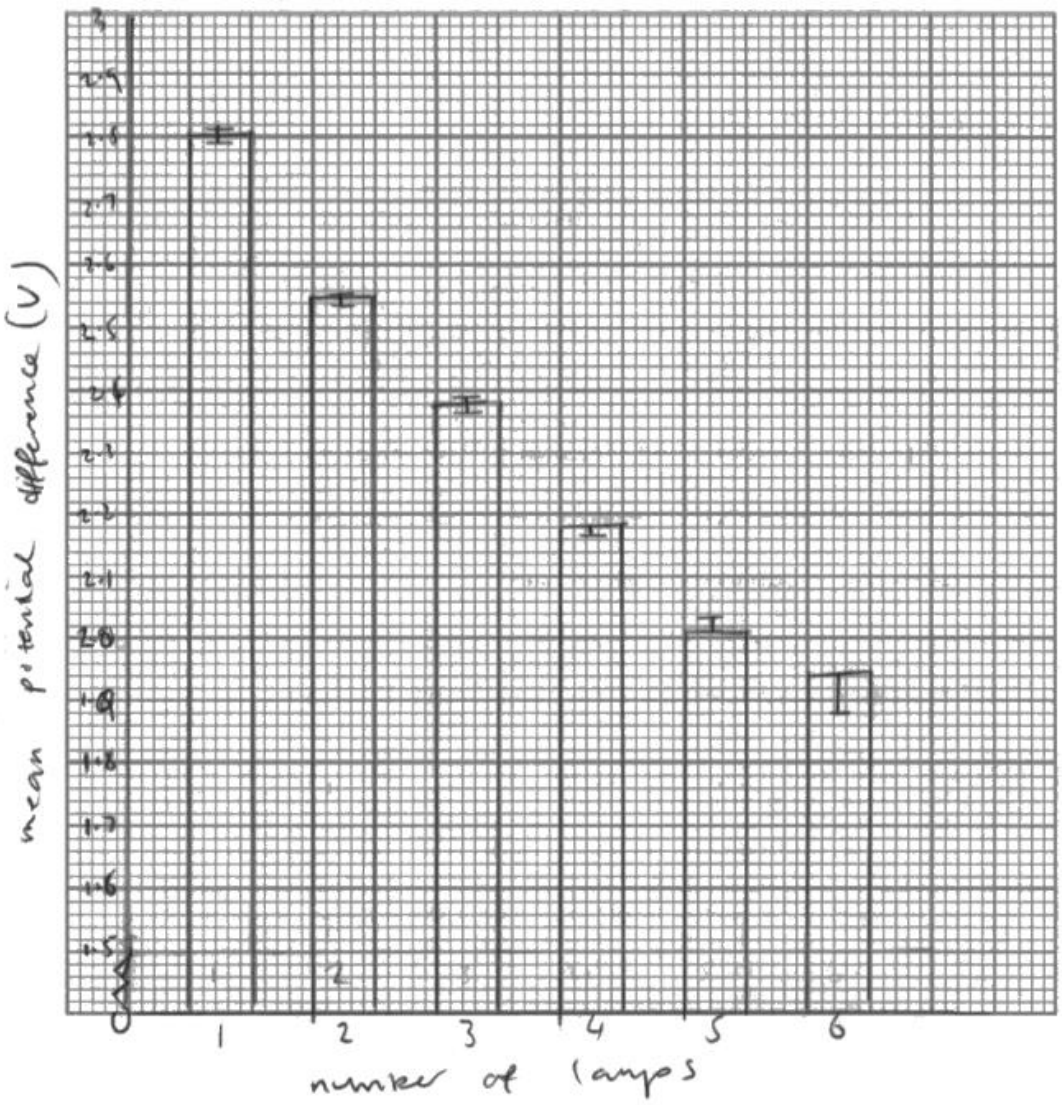
The tramlines on a graph do not get the final mark and the line drawn is not the best straight line through the points Either the point for the second lamp should be ringed as an anomaly and also noted as an anomaly on the table or the line should be in the middle between points between the points for lamps 1 and 2.



The example below shows a bar chart that was produced from the results, this gained 3 marks as it showed the correct labels on the axes , sufficient coverage of points and correctly plotted points.

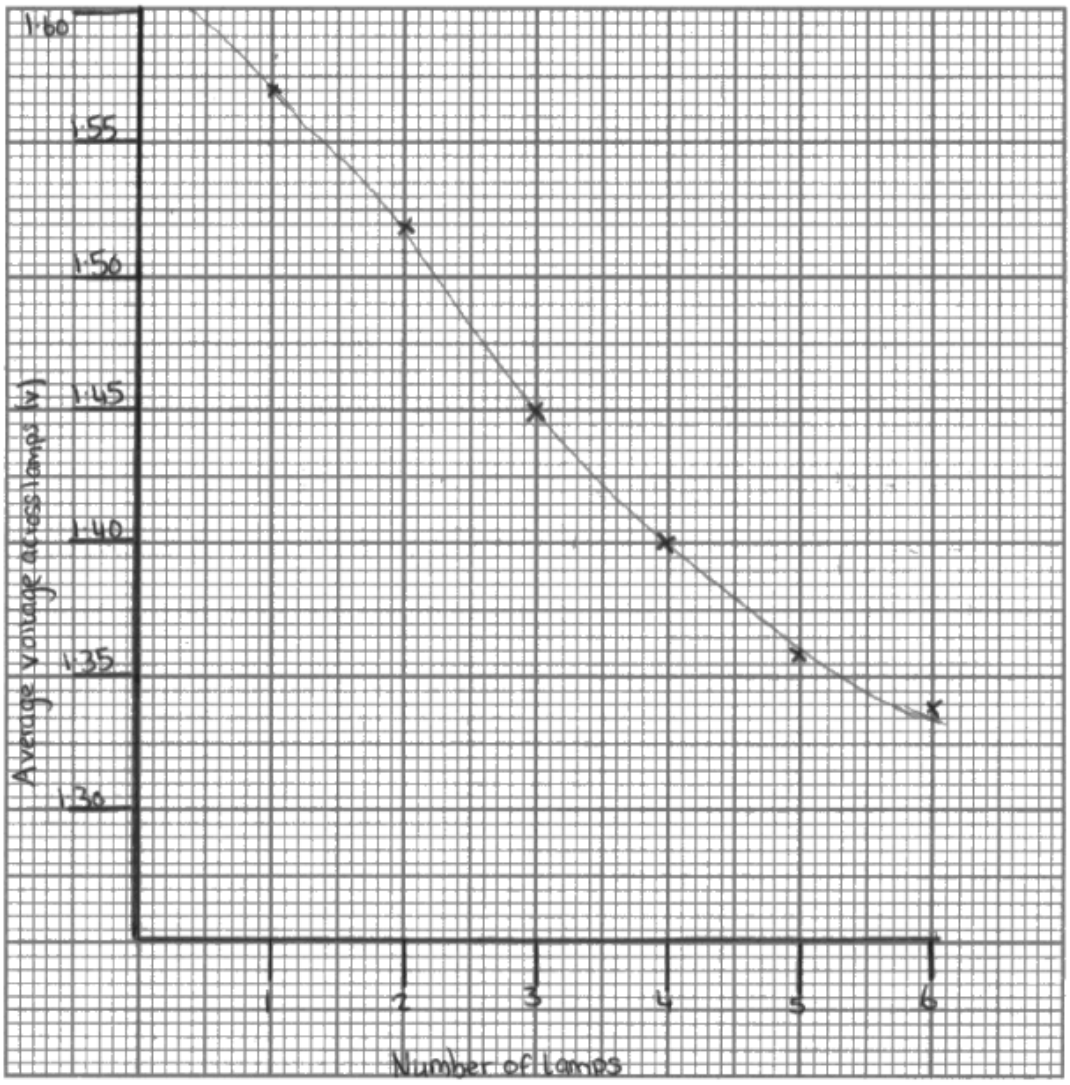
(b) Plot a graph of average voltage across the lamps against number of lamps in parallel in the circuit.

(3)



The response below gained three marks, the curve was just smooth enough to gain the third mark

(3)



Q1ci and Q1cii

Most learners were able to identify the independent variable as the number of lamps/bulbs and the dependent variable as the voltage/ potential difference.

Q1d

The most common answer that was that as the number of lamps increased the voltage decreased and this was consistent with the graph that was plotted. Negative correlation was also accepted although this should also be related the variables. The graph did not show direct proportionality or inverse proportionality but the relationship can be described as 'linear' for a straight line or 'non-linear' for a curve.

The response below gained two marks as the accompanying graph showed a straight line.

(d) Describe, using information from your graph, the relationship between the voltage across the lamps and the number of lamps in parallel.

(2)

As more lamps are added the potential difference across the lamps decreases with a linear relationship

Q1e

Many learners were able to make the observation that 'the more lamps that were added the lights got dimmer'. Repeating this statement in reverse did not gain the second mark. The second mark was awarded for the learner noticing that all the lamps in a set of lamps were at the same brightness.

The response below gained 2 marks.

(e) State **two** observations you made about the brightness of the lamps.

(2)

1 The more lamps there were in the circuit the less bright the lamps were.

2 All the lamps had the same brightness in each circuit, the brightness was shared.

Q1f

Surprising few learners realised that opening the switch in a circuit will stop the current/breaks the circuit. More learners gained a mark for an expansion without identifying the reason. The most common acceptable answer was to allow the cells/batteries /lamps/ equipment to cool down.

The example below has both marks awarded.

(f) Explain why it was necessary to open the switch in between taking voltmeter readings.

(2)

It is necessary to open the switch because it stops the current from flowing thus enabling the equipment to cool down.

Q2ai, Q2aii, Q2bi, Q2bii and Q2bii

This combination of questions, tested the learners' ability to read information from a graph and then use those readings to calculate the gradient of the graph.

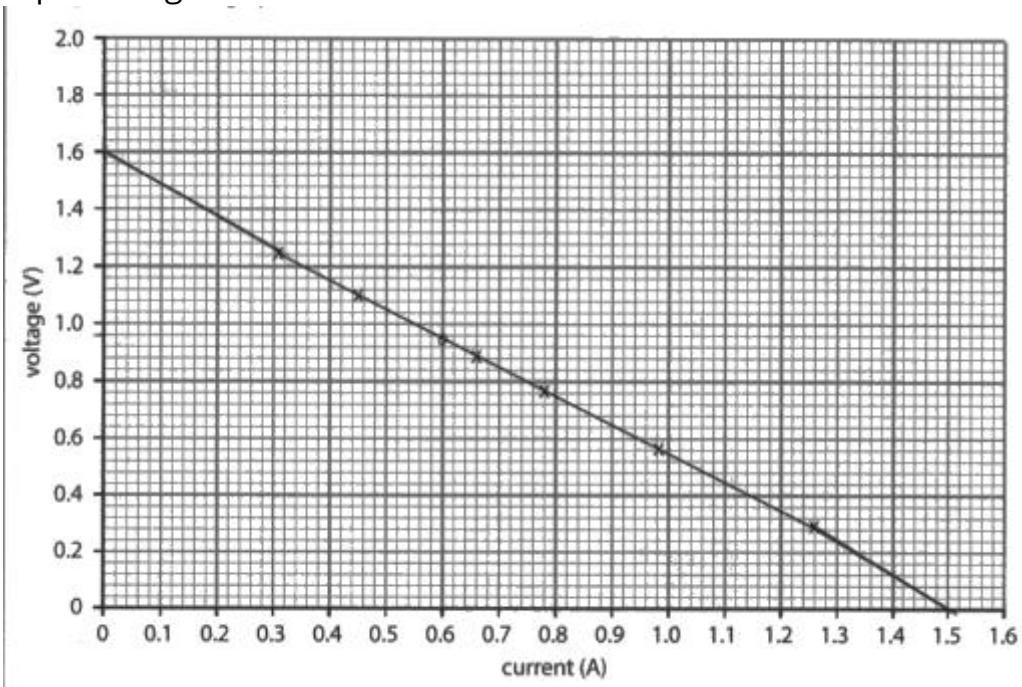
Q2ai

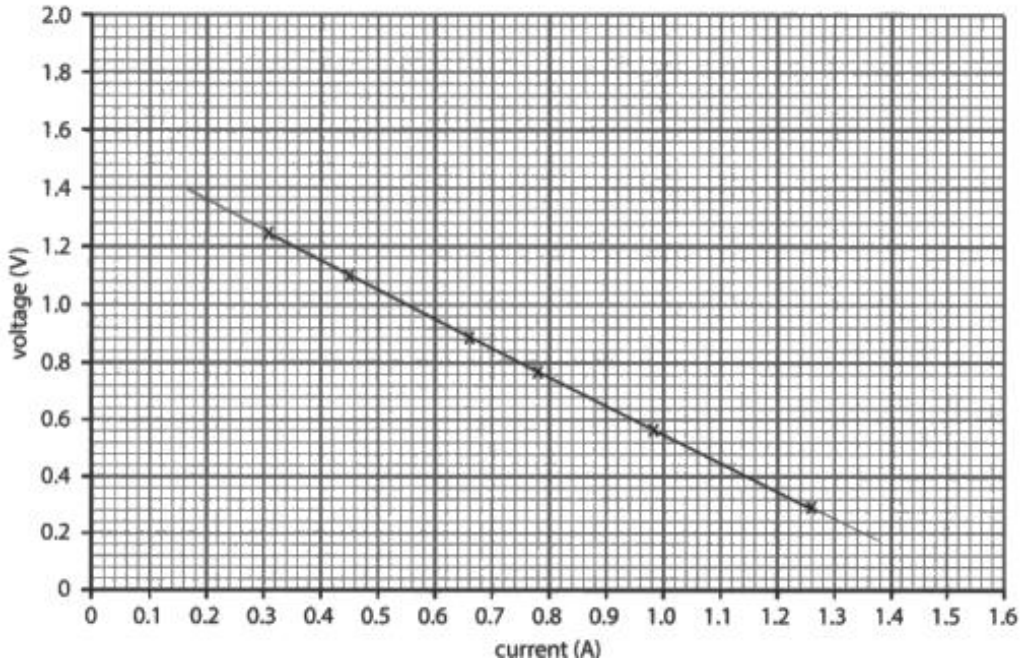
Most learners were able to identify voltage for the current of 0.6 A using the graph.

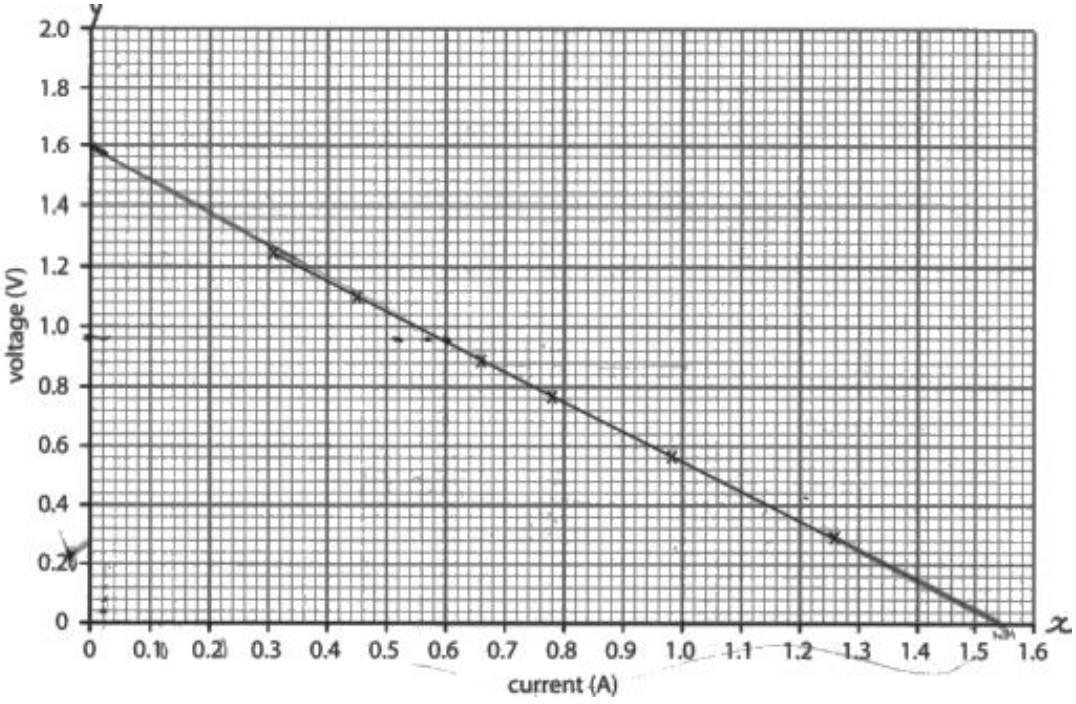
Q2aii

The continuation of a straight line to cut both the x and y axes presented some difficulty especially to those learners without a ruler. (It should be noted that having a ruler is a requirement of the examination).

Below are examples of extension of the straight line that did not score a mark. The first example the two ends ore off line. The second example the extensions do not cut the axis and the third example the top extension does not start at the top of the given line.







Q2bi, Q2bii and Q2biii

Once the line had been extended then most learners were able to estimate the intercepts and obtain a value for the gradient. The example below shows Q2bi and Q2bii in tolerance and the correct calculation to obtain a value for the gradient which is also in tolerance.

(b) The equation of the line is given by $y = -mx + c$.

(i) c is the value of the intercept on the y-axis.

Estimate the value of c.

(1)

c = 1·58 V

(ii) Estimate the value of the intercept on the x-axis.

(1)

intercept on x-axis = 1·54 A

(iii) -m is the gradient of the line.

Calculate m.

Use the equation

$$m = \frac{c}{\text{(x-axis intercept)}}$$

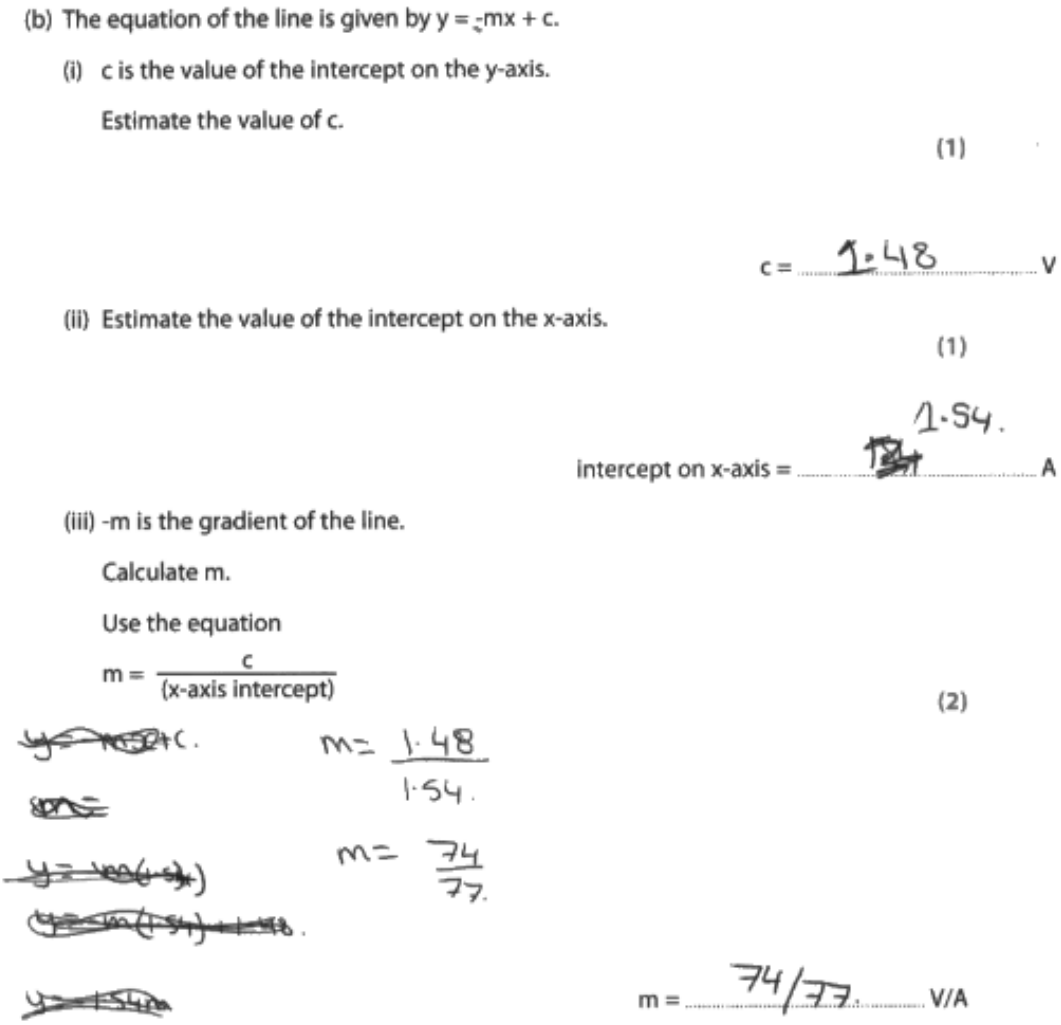
(2)

$$\frac{1·58}{1·54} = 1·025$$

$$= 1·03$$

m = 1·03 V/A

The second example shows 2bi out of tolerance 2bii in tolerance, 2biii would have gained both marks but the answer must be calculated and not left as a fraction.


(b) The equation of the line is given by $y = -mx + c$.

(i) c is the value of the intercept on the y-axis.

Estimate the value of c.

(1)

c = 1.48 V

(ii) Estimate the value of the intercept on the x-axis.

(1)

intercept on x-axis = 1.54. A

(iii) -m is the gradient of the line.

Calculate m.

Use the equation

$m = \frac{c}{\text{(x-axis intercept)}}$

(2)

$m = \frac{1.48}{1.54}$

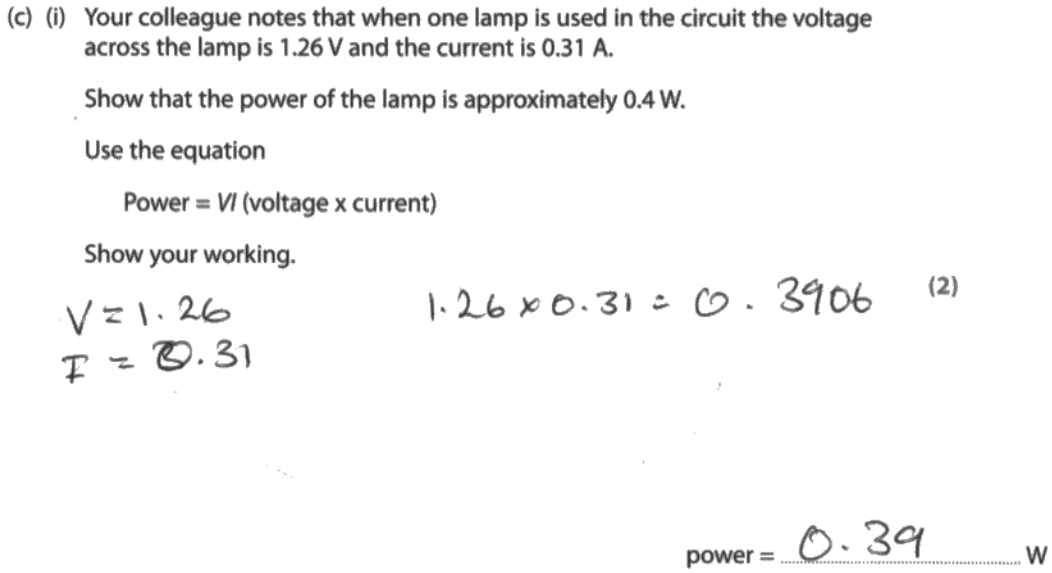
$m = \frac{74}{77}$

m = 74/77. V/A

Q2ci

Most learners were able to substitute and showed their working and then evaluated to 0.39W. This is a 'show that', therefore the answer must be seen to be at least one decimal place more than the answer given in the question.

The example below gained both marks and gave 0.39 in the answer line.


(c) (i) Your colleague notes that when one lamp is used in the circuit the voltage across the lamp is 1.26 V and the current is 0.31 A.

Show that the power of the lamp is approximately 0.4 W.

Use the equation

Power = *VI* (voltage x current)

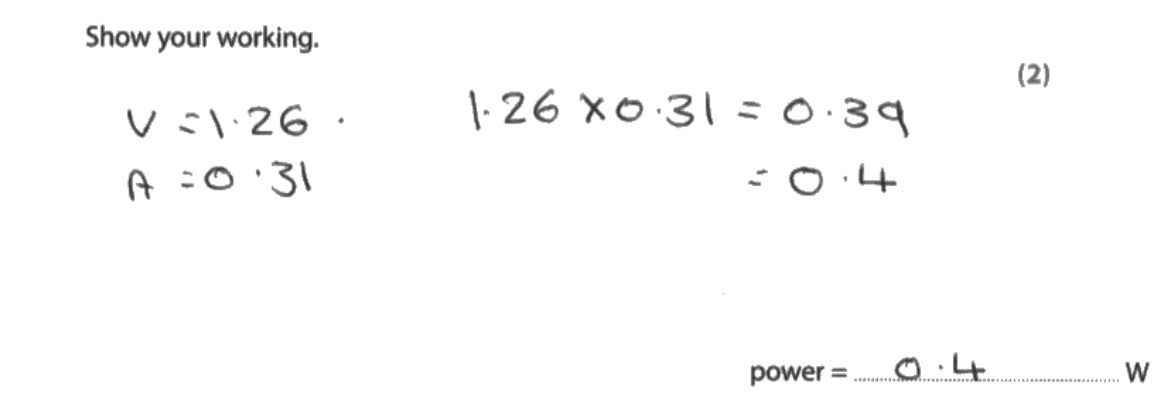
Show your working.

V = 1.26
I = 0.31

1.26 x 0.31 = 0.3906 (2)

power = 0.39 W

The response below also gains 2 marks but this is only because 0.39 can be seen in the calculation it is not necessary to round this to the value given in the question. Without seeing the calculation this answer on its own would not gain any marks.


Show your working.

V = 1·26
A = 0·31

1·26 x 0·31 = 0·39
= 0·4

(2)

power = 0·4 W

Q2cii

Almost all learners wrote the equation and showed their working. Many learners gained 3 marks for their answer because the conversion of seconds to hours had not been carried out or the conversion was to minutes, not hours.

The example below gained all four marks.

Your colleague finds out that the energy stored by a cell is 9360 J.

Assume the power output of the lamp is a constant 0.4 W.

Calculate the time in hours that the cell would deliver current to the lamp.

Use the equation

$$\text{power} = \frac{\text{work done}}{\text{time}}$$

Show your working.

Time = Energy / Power

$\frac{9360\text{J}}{0.4\text{W}} = 23400\text{seconds}$

23400 ÷ 60 (4)
= 390 minutes
390 ÷ 60 = 6.5

time for lamp to keep working = 6.5 hours

3 marks were awarded for the example below as it shows an incorrect conversion to hours.

Show your working.

(4)

~~0.39 =~~

$0.4 = \frac{9360\text{J}}{\text{time.}}$

work done ÷ Power
9360 ÷ 0.4 = 23400 minutes.

time for lamp to keep working = 390. hours

23400 minutes in hours. = 390

2 marks were awarded for the next example this shows a correct substitution and rearrangement but the learner has converted the energy into kilojoules , this was seen a number of times with no apparent reason giving an incorrect evaluation.

Show your working.

(4)

Time = work done / power

9360 / 0.4 9360J = 9.36kJ

9.36 / 0.4 = 23.4

time for lamp to keep working = 23.4 hours

Q2d

The majority of learners were able to complete this calculation and gain 2 marks. Only occasionally was the % multiplied by 100 for the second time and although the maximum uncertainty was given a few learners divided this by 2 and then did the calculation. The answer should be given to two decimal places as both values are to two decimal places but 0.9% was accepted.

(d) Your colleague used a voltmeter that had a maximum error (uncertainty) of 0.01 V when the measured value was 1.11 V.

Calculate the percentage error in the measurement.

(2)

Use the equation

percentage error = $\frac{\text{maximum error}}{\text{measured value}}$ x 100

$P = \frac{0.01}{1.11} \times 100$

$P = 0.900900$

percentage error = 0.90 %

Q2e

Many learners added to the table given in the question and used this as a basis for their answer. The examples below gives a correct conclusion supported by evidence and using the table.

(e) Your colleague finds some data about how the current varies with the number of lamps in a parallel circuit. Figure 2 shows the data.

Number of lamps	Current in the circuit (A)
1	0.62
2	1.08
3	1.50
4	1.88
5	2.22
6	2.52

Figure 2

Your colleague predicts

'When seven lamps are added in parallel the current will be 2.98 A.'

Comment on whether you think their prediction is correct.

Use your colleague's results to support your answer.

(2)

The prediction is incorrect the current goes in 0.4 increments e.g. 0.62 → 1.08 = 0.46 then minus 0.4 = 1.08 → 1.50 = 0.42 meaning the current for 7 lamps would be 2.78.

AS from 2.22 − 2.52 it increases by 0.30 it would increase by 0.26 for the next result for 7 lamps which then becomes 2.52 + 0.26 = 2.78.

(Total for Question 2 = 16 marks)

(e) Your colleague finds some data about how the current varies with the number of lamps in a parallel circuit. Figure 2 shows the data.

Number of lamps	Current in the circuit (A)
1	0.62
2	1.08
3	1.50
4	1.88
5	2.22
6	2.52

)0·46
)0·42
)0·38
)0·34
)0·3
: 0·38

Figure 2

Your colleague predicts

'When seven lamps are added in parallel the current will be 2.98 A.'

Comment on whether you think their prediction is correct.

Use your colleague's results to support your answer.

(2)

the results suggest that with every bulb that's added, the current increases by around 0·38 (average). 2·52 + 0·38 = 2·90, An increase in 0·46 is probably too high as the increase decreases at each lamp.

(Total for Question 2 = 16 marks)

Q3a

Only a few learners were able to gain 2 marks on this question. Learners were sometimes able to give another control such as 'use the same lamps or cells', but were unable to explain why this should be done.

Below is an example of a response which gained two marks.

3 (a) You used the same voltmeter throughout your investigation.

Explain how **one** other variable was controlled.

(2)

I used the types of bulbs with the same power rating of 3V as different bulbs would have different power ratings and resistance which could affect the results.

However the majority of response were similar to the response shown below which gained 1 mark as the learner recognised that the same cell should be used.

3 (a) You used the same voltmeter throughout your investigation.

Explain how **one** other variable was controlled.

(2)

Using the same cell, which was controlled to prevent using older or weaker cells which would have negatively affected our results.

The response below was not awarded a mark, however a significant number of learners believed that the switch was something to control.

3 (a) You used the same voltmeter throughout your investigation.

Explain how **one** other variable was controlled.

(2)

I used the same switch, some switches are stiffer or tighter than others. This allowed me to apply the same amount of pressure to the switch as fairly as possible.

Q3b

This question referred to two ways of testing reliability but did not state that the first comment had to be on repeatability and the second on reproducibility and was worth 4 marks.

Below is an example of a 4 mark answer.

(b) Repeatability and reproducibility can be used to test the reliability of an investigation.

Explain these **two** ways in which the reliability of your data could be tested.

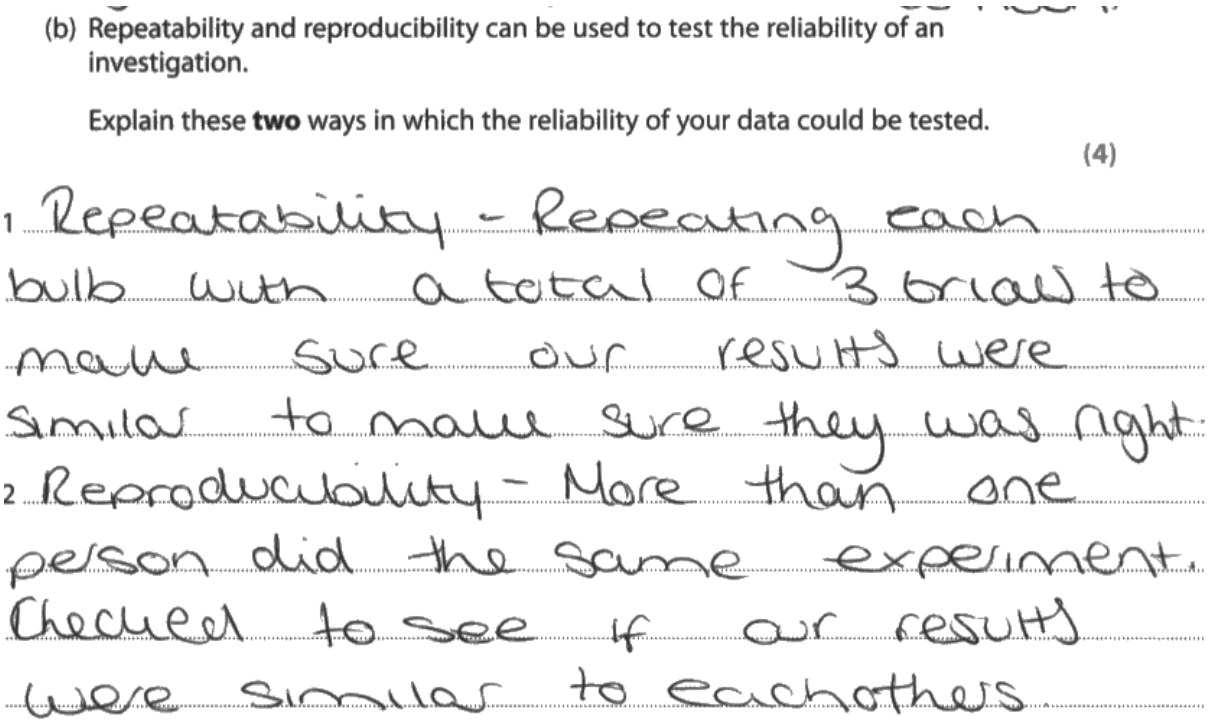
(4)

1 I could compare my data with that of others doing the same experiment to see if we get the same pattern in our results

2 we can repeat the experiment several times with the same method and equipment, to see if we get the same results.

Many learners where able to gain one mark usually for repeating the experiment but did not gain the second mark for 'using the same apparatus'. Repeatability and reproducibility are definitions which need to be learned.

Below is an example of a 3 mark answer.



(b) Repeatability and reproducibility can be used to test the reliability of an investigation.

Explain these **two** ways in which the reliability of your data could be tested.

(4)

1 Repeatability - Repeating each bulb with a total of 3 trials to make sure our results were similar to make sure they was right.

2 Reproducibility - More than one person did the same experiment. Checked to see if our results were similar to eachothers.

Q3c

This was again a four mark question but most learners were only able to gain two marks.as the answer required 'linked pairs'.

Learners quite frequently gave the extension as 'adding more cells' and the reason 'increase the range of readings' but then adding more lamps for the same reason does not gain any additional marks.

Below is an example of a four mark answer, giving two possible extensions with two different reasons.

(c) One way of extending your investigation is by using an ammeter to measure the current in the circuit.

Explain **two** other ways your investigation could be extended.

(4)

1 We could have used a series circuit and to see how the voltage and current differ from that of a parallel to circuit.

2 We could have used 6v bulbs and 12v bulbs to get more readings and to compare with eachother.

Below are examples of two mark answers the first mentions repeats, this is not an extension and the second add different components twice.

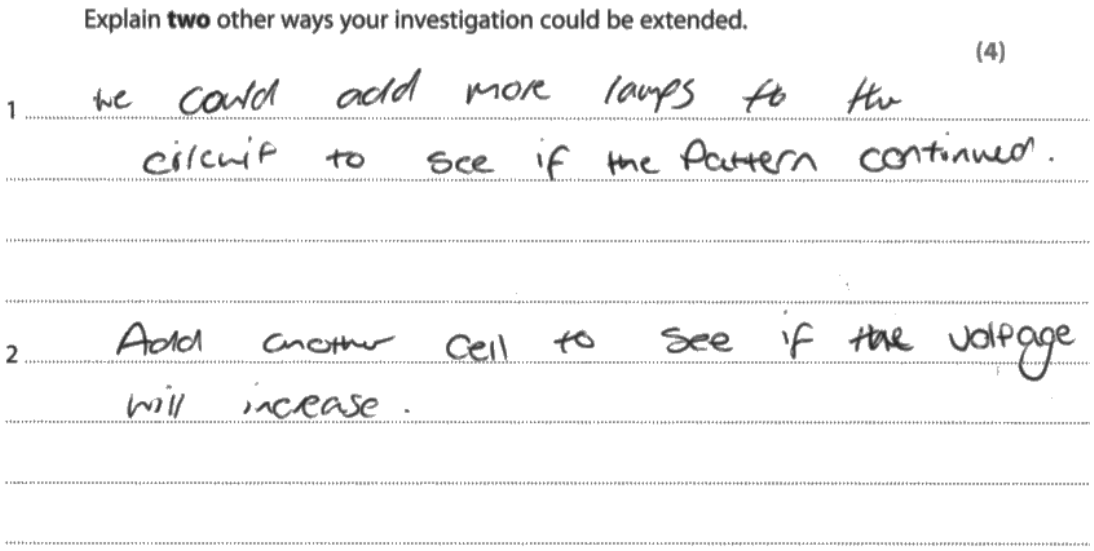
(c) One way of extending your investigation is by using an ammeter to measure the current in the circuit.

Explain **two** other ways your investigation could be extended.

(4)

1 Repeat the experiment to get more results and create an average.

2 Adding more bulbs to get a wider range of results.


Explain **two** other ways your investigation could be extended.

(4)

1 we could add more lamps to the circuit to see if the pattern continued.

2 Add another cell to see if the voltage will increase.

Individual Questions: Chemistry

Q4

Question 4 is a level based question using four levels of attainment. For each level there is a range of three marks and once the level is decided looking at the work as a whole, the quality of work presented within that level is assessed. The four levels of attainment are described by the generic mark scheme with a mark out of 12.

The investigation that learners had to plan a method for is the effect of surface area on the rate of diffusion of sulfuric acid through agar containing sodium hydroxide and phenolphthalein. Learners were given the information that sulfuric acid reacts with sodium hydroxide in a neutralisation reaction and that phenolphthalein is an indicator that is pink in alkaline conditions and colourless in acidic conditions. They are asked to plan an investigation into how the rate of diffusion of sulfuric acid into a cube of agar containing sodium hydroxide and phenolphthalein changes with changing surface area.

The following are examples or responses at each of the four levels that can be awarded.

In this, first, example the learner has a written a confused hypothesis involving three variables, they have given some equipment with some attempts to justify them and there are some generic statements about health and safety. However, there has been no attempt at writing a method. The answer was given a mark of 2 in level 1.

4 Diffusion is the random movement of particles from an area of high concentration to an area of low concentration.

The rate of diffusion of sulfuric acid into a cube of agar is being investigated. The agar contains a mixture of sodium hydroxide with phenolphthalein.

Sulfuric acid reacts with sodium hydroxide in a neutralisation reaction.

Phenolphthalein is an indicator that is pink in alkaline conditions and colourless in acidic conditions.

You have been asked to write a plan for an investigation into the effect of surface area on the rate of diffusion of sulfuric acid through agar containing sodium hydroxide and phenolphthalein.

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
- methods for data collection and analysis to test the hypothesis including
  - the quantities to be measured
  - the number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)

↳ HYPOTHESIS:

The effect of surface area on the rate of diffusion is depend on the amount of concentration agar used.

↳ SELECTION & JUSTIFICATION OF EQUIPMENT, TECHNIQUES.

✓ Petri dishes - for the agar.

✓ Beakers - for measuring the Sulfuric acid and sodium hydroxide.

~~✓ Protective~~

✓ Personal Protective Equipment - such as gloves to protect the hand, laboratory coat to protect the skin from physical injury, goggle

to protect the eye and nose mask to prevent one from inhaling.

✓ Clips - for picking up agar.

✓ Ruler - for measurement.

✓ Beaker rack - to hold all beakers.

↳ NUMBER AND RANGE OF MEASUREMENT TO BE TAKEN.

Must be repeated 3-4 times. Measurement should be taken before and after.

↳

↳ CONTROL VARIABLES.

✓ Concentration of sulfuric acid is independent variable

✓ The agar containing a mixture of sodium hydroxide is a dependent variable

↳ BRIEF METHOD OF DATA COLLECTION:

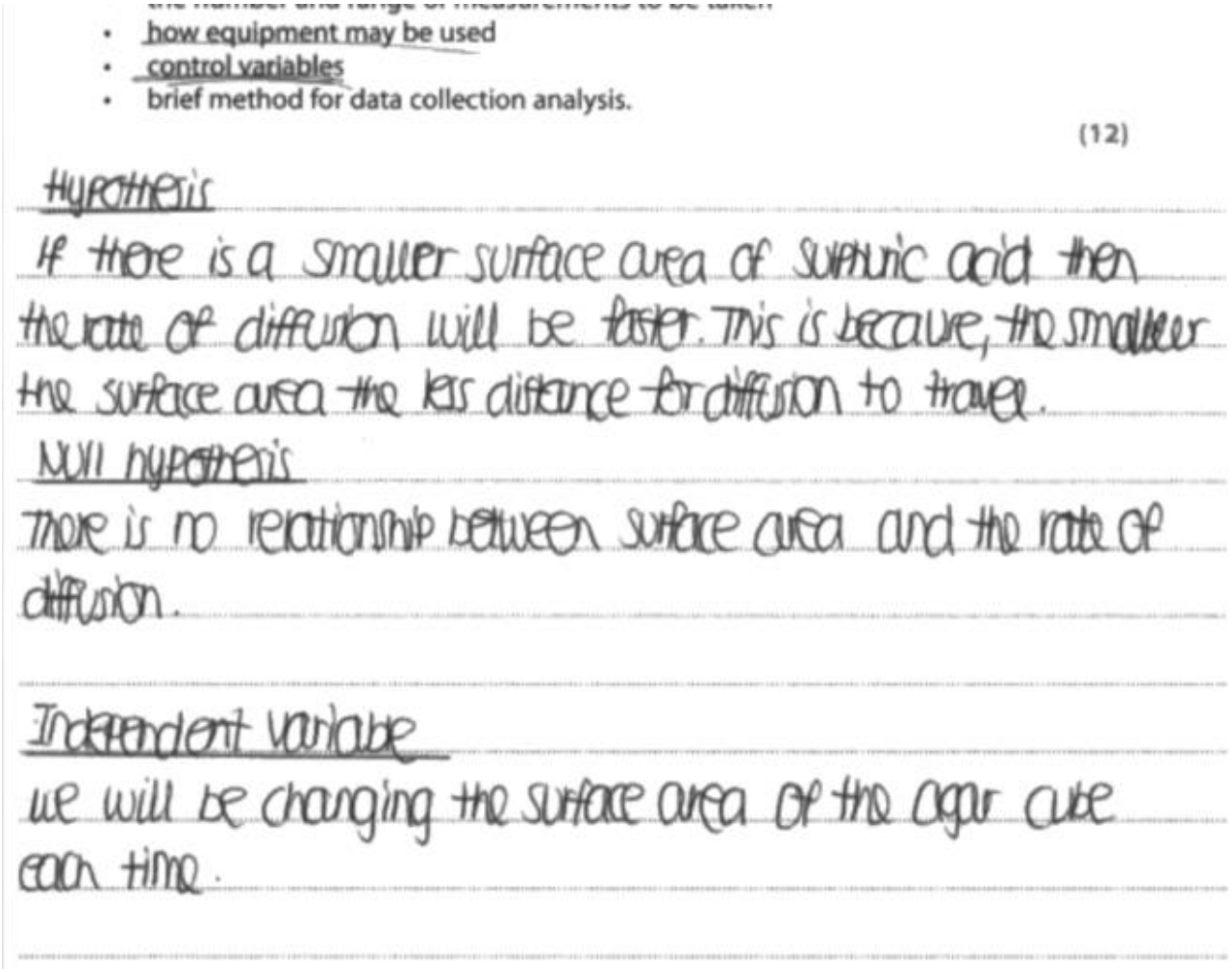
* All ~~data~~ measurements must be recorded on the sheet.

↳ Collect ~~data~~ the mean or average of data.

✓ Circle out anomalous results.

✓ Plot on graph.

In this second example, the learner has given attempted a hypothesis which addresses surface area and attempted a relationship, however there is no attempt to explain it. They have stated the independent variable and given an equipment list with some pieces of equipment justified and some relevant safety. A method has been given with some controls, but unfortunately although they have used cubes of agar, it does not work as they have cut the same sized hole in each cube. Showing a lack of appreciation of how to change the surface area. The answer was given a mark of 6 in level 2.



- how equipment may be used
- control variables
- brief method for data collection analysis.

(12)

Hypothesis

If there is a smaller surface area of sulfuric acid then the rate of diffusion will be faster. This is because, the smaller the surface area the less distance for diffusion to travel.

Null hypothesis

There is no relationship between surface area and the rate of diffusion.

Independent variable

we will be changing the surface area of the agar cube each time.

dependent variable

~~the~~ measuring the ~~time taken~~ distance for the diffusion of sulphuric acid to take place.

~~control~~ Equipment list:

- agar ~~cube~~ cube in petri dish (2cm, 4cm, 6cm & 8cm) containing sodium hydroxide & phenolphthalein.
- cork borer (5mm) - To make the well. (calibrated 5mm)
- cocktail stick. - To remove excess agar jelly.
- ~~phenolphthalein~~
- sulphuric acid
- Ruler - To measure the distance travelled (±0.1 error)
- ~~stop clock. - to record~~
- Syringe - to measure out ~~the~~ 1 dm³ of sulphuric acid (±0.01)

Risk assessment.

Risk	Hazard	Occurance	Prevention	Severity if occurred
sulphuric acid	may spill on the hands and can irritate the skin; could cause burns or eyes.	if this has occured immediately rinse under cold water. ~~die~~ depending on the severity, seek medical attention.	wear goggles to prevent eye damage and wear gloves if necessary.	medium.

Control:

- same cork borer
- same concentration of sulphuric acid used.

Method:

1) Gather the equipment needed using the equipment list.

2) Begin by measuring 3 equal Places using a cm³ ruler in the taking the smallest (2cm) cube ↓ agar cube.

3) Then taking a 5mm cork borer, use it to make holes in the agar cube.

4) Next, take the cocktail stick and remove the discs ~~and the~~ to form wells in the cube

5) ~~# After~~, begin the measure ~~25ml~~ ~~0.1dm³~~ 0.1dm³ of sulphuric acid using a ~~P pipette~~ syringe and ~~to~~ Place into the 3 wells in the agar cube.

6) Repeat steps 2 - 5 for the other cubes ~~and remember to use~~

7) Start the stop ~~watch~~ watch and after every minute, ~~record~~ measure the distance of the sulphuric acid travelled using a ruler and record this into a suitable results table.

~~8) To carry out the average distance~~

8) once ~~the~~ data has been collected, repeat the experiment at least 3 times in order to eliminate anomalies ↓ to give reliable results.

9) Take out an average on the distance travelled and ~~to~~ Plot it on a ~~graph~~ graph: distance travelled against the surface area cube used

In this example the learner has given a correct hypothesis, they have described the equipment to be used and has and justified it in terms of use and accuracy, health and safety has been discussed although it is weak in places. A method has been given with two controls and includes key points to make the experiment more valid, such as using tweezers to ensure that agar does not react to the skin. However, there are some issues, for example there is no reference how big the cubes should be. There are references to repeats and calculating an average and plotting a graph but does not state of what. The answer was given a mark of 8 in level 3.

- brief method for data collection analysis.

(12)

As the surface area increases for the agar cubes the rate of diffusion should also increase.

You will need a beaker to carry the solution in. Also a 10cm³ measuring cylinder, for the sulfuric acid. We don't use a 100cm³ measuring cylinder to reduce measurement error. A white tile is needed to place the agar cubes on, so that we could clearly see the

effects. ~~sulfu~~

Goggles and gloves need to be worn, because sulfuric acid is dangerous and irritant to skin. This acid could spill and react with your skin or even fall in your eye if you touch it with your hands and rub your eyes. To prevent spillage hold it with care and place it in the middle of the table. If it does fall on your skin, wash your skin thoroughly with cold water and call a teacher for help.

Also the beaker could fall and glass could go into your skin or your eyes. This is why you should where goggles. If this does happen use the eye wash or wash the blood with cold water. Once again call the teacher for further help.

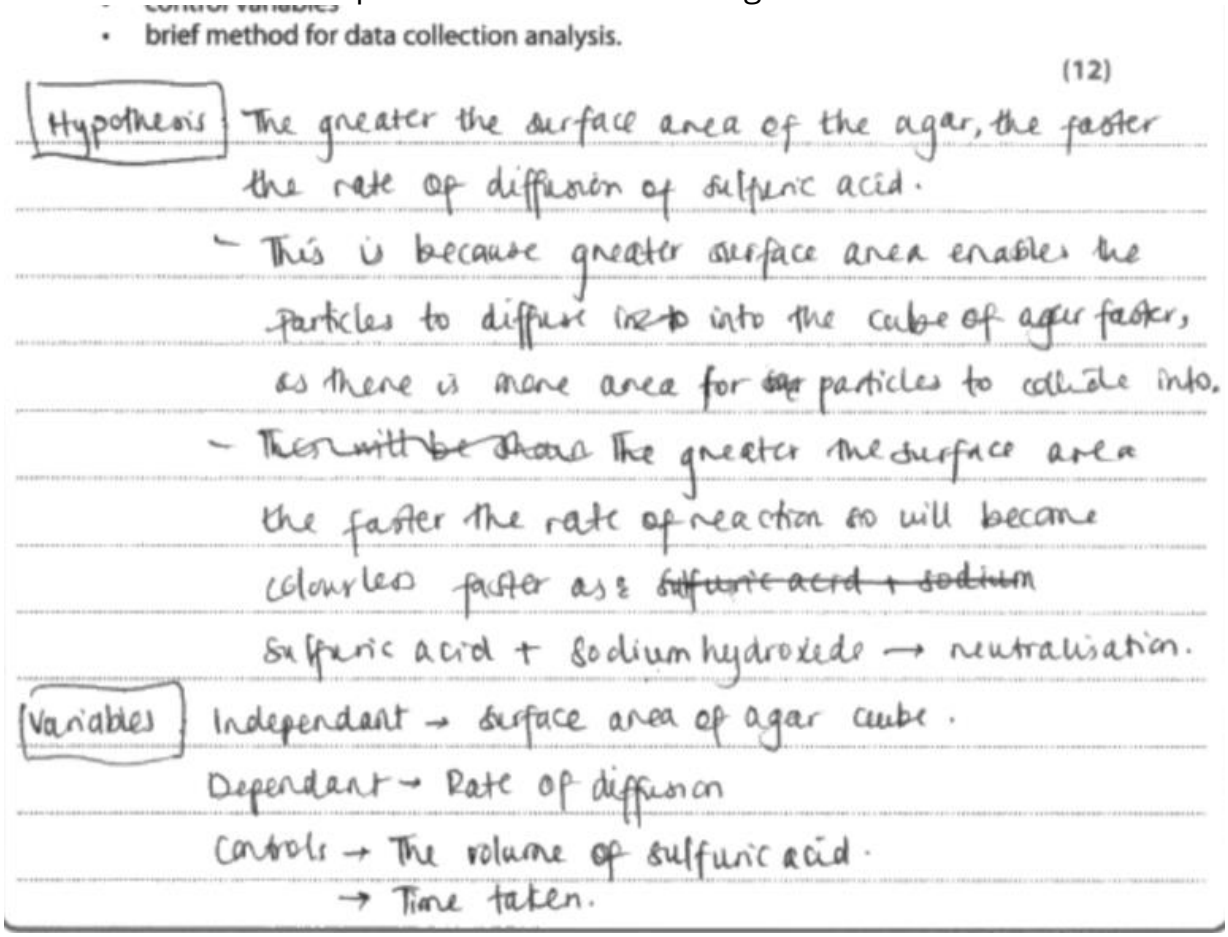
Get three or four different size of agar cubes and measure each of their surface area using a ruler. Handle the agar with tweezers so that the alkali doesn't react with your skin.

Place one of the cubes into the beaker. Then using the measuring cylinder put 10cm3 of sulfuric acid into the beaker with the agar cube. Start a stopwatch straight away and leave it for two minutes. Once the two minutes are over stop the timer and get the agar cube out using the tweezer and place it on the white tile. Using the scalpel cut the agar cube in half. You will observe that ~~the~~ some of the agar has changed colour from pink to colourless. This is the acid spreading into the agar cube. Using a ruler measure the length of the colourless part. This is the diffusion distance. Repeat this with the other three cubes and note down the diffusion path. Repeat the whole test three times. ~~Or~~ Once you got the results calculate an average and plot a graph.

You must control the ~~amount~~ concentration of sulfuric acid because if it is increased or decreased it will effect the results and the results will be unreliable. Control the time also for two minutes as time is also a factor that will effect the results.

(Total for Question 4 = 12 marks)

In this, last example, the learner has given a hypothesis and attempted to explain it. They have listed the correct dependent and independent variables and a control variable. A list of equipment has been given, with some justified. They have mentioned safety although there are some errors such as the flammable sulphuric acid. A correct, workable method has been given which would give results, includes a range, repeats and controls. There is a table for results and states what should be plotted. The answer was given a mark of 10 in level 4.



- brief method for data collection analysis.

(12)

Hypothesis: The greater the surface area of the agar, the faster the rate of diffusion of sulfuric acid.

– This is because greater surface area enables the particles to diffuse ~~in~~ into the cube of agar faster, as there is more area for particles to collide into.

– ~~There will be shown~~ The greater the surface area the faster the rate of reaction so will became colourless faster as: ~~Sulfuric acid + sodium~~ Sulfuric acid + Sodium hydroxide → neutralisation.

Variables: Independant → Surface area of agar cube.

Dependant → Rate of diffusion

Controls → The volume of sulfuric acid.

→ Time taken.

Health and safety:

① Sulfuric acid → Acidic, flammable → Use small amounts, avoid spillages. use gloves ~~when~~ + goggles when handling.

② Breaking glass → Can cause cut → Keep test tubes away from the edge. Do not ~~directly~~ use hands to clear it up. Clean any cut. Use goggles to avoid anything going into the eye.

~~Method~~:

Equipment

- Sulfuric acid ~~(glass)~~ (300 ml in total) - ~~20~~ 20ml per test and trial.
- Agar - 5 cubes :- ① whole ② halves (cut into) ③ Quarters (cut into) ④ Fifths (cut into) ⑤ Sixths (cut into)
  - ↳ NOTE - ensure it is cut evenly per trial.
- ~~To~~ measuring cylinder to measure 20 ml of Sulfuric acid.
- test tube ~~pentagon~~ (5) - for agar
- Timer

Method

① Pour out 20 ml of Sulfuric acid in the measuring cylinder.

② ~~In the first~~ Take ~~the~~ the first agar variation. (cube) and place in a test tube.

③ Pour in the Sulfuric acid whilst simultaneously ~~pressing~~ ~~and~~ pressing the timer.

④ to soon as ~~it~~ it turns colourless stop the timer and record

the time.

⑤ Repeat steps 1-4 for all the variations of the agar.

⑥ Complete three trials per variation to test reliability of the rate being recorded and replicability of the method.

Recording results + Data analysis.

① Record results in a table.

	Agar	Time (m) 1	2	3	Average rate of reaction (g/s)
1	Whole				
2	Halves				
3	Quarters				
4	Fifths				
5	Sixths				

② Using the averages plot the data into the graph. This will allow a clear pattern to emerge.

Q5

Question 5 is a level based question, with marks awarded across three levels. The question requires learners to evaluate the method, results and conclusion of a given experiment. In this case the experiment is investigating the effect of temperature of the rate of diffusion in liquids. A method, results in the form of a graph and a conclusion is given for the learners consideration. Learners are asked to evaluate the method of the experiment, the results collected and the conclusions made.

The following are examples of responses at each of the three levels that can be awarded.

In this example, the learner has not made an attempt to interpret the results or the conclusion, they have recognised that a measuring cylinder has not been used and that a water bath has not been referred to indicating that the method does not state how the water has been heated.
The learner has noted that the temperature has not gone up in even increments.
The answer was given a mark of 2 in level 1.

5 A learner investigates the effect of temperature on the rate of diffusion in liquids.

This is the learner's method:

- collect a beaker of water
- add one drop of food colouring to the edge of the beaker
- start a stopwatch
- stop the stopwatch when the colour has spread throughout the whole beaker
- repeat the experiment with water at 30°C, 50°C, 60°C and 100°C.

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

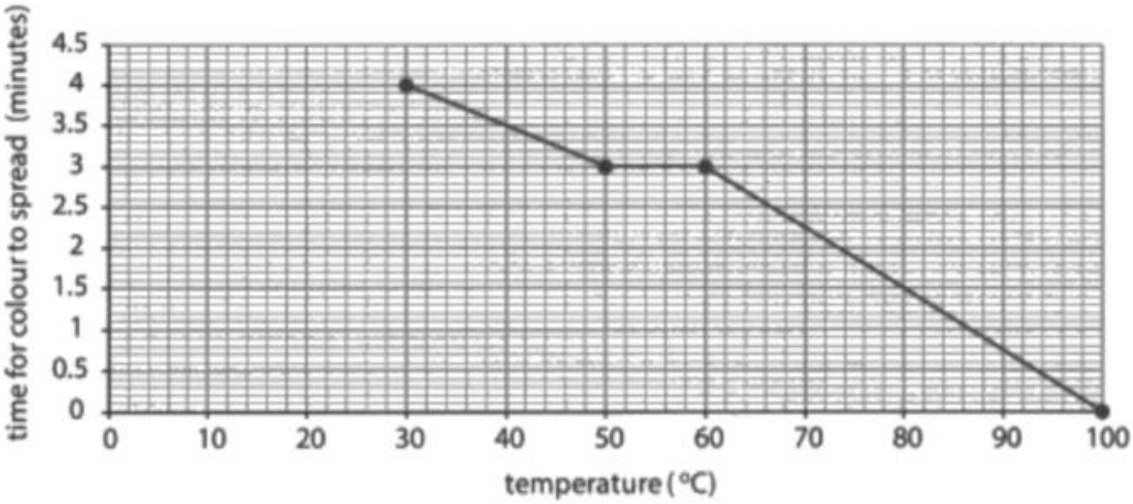


Figure 3

The learner concludes that the rate of diffusion of food colouring through water increases with increasing temperature.

Evaluate the learner's investigation.

Your answer should include reference to:

- the method of the experiment and the equipment used
- the results collected
- the conclusion made.

(8)

Errors she made are clear, as measuring cylinder was not used, hence she will not be sure of how 'have reliable' results.

In conclusion, her results are not reliable or reproducible as we have not recieved the time taken in e.g hrs, sec or mins.

- Also, we have not been told if she used a water bath.
- Temperature she used is incorrect, as they should be going up in equal intervals e.g. 2, 4, 6, 8.
- Also, it does not state what interval she used, ie every 30 mins or seconds.

In this example, the learner has noted that the temperature has not gone up in constant how much water has been used and has stated that this should have been controlled, there are also comments on repeatability and reproducibility. They state that the conclusion is correct but acknowledges that the same results at 50 and 60°C undermine the conclusion. The answer was given a mark of 5 in level 2.

The learner concludes that the rate of diffusion of food colouring through water increases with increasing temperature.

Evaluate the learner's investigation.

Your answer should include reference to:

- the method of the experiment and the equipment used
- the results collected
- the conclusion made.

(8)

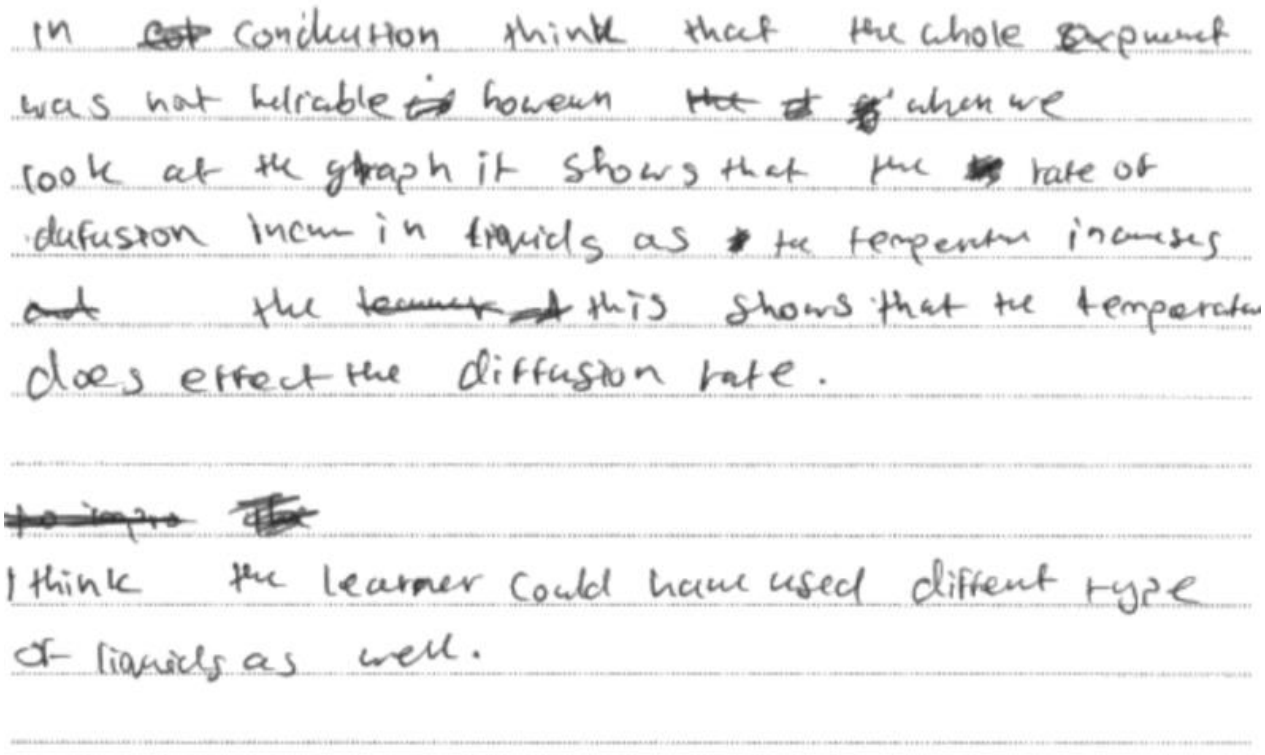
The learner's investigation on the effect of the temperature on the rate of diffusion in liquids was carried in different temperature as stated however the temperatures of the water did not ~~the~~ have the exite amoet of temporatue differts as you can see it went ~~of~~ from 30°C-50°C the 50°C-60°C then ~~to~~ 60°C-100°C

This shows that the temperature different was not kept constant. if any ~~was~~ ~~he~~ asked to find out he ~~the~~ time ~~he~~ it will take dissolve in 10°C or 20°C it will hard ~~for~~ he ~~the~~ it's not ~~constant~~.

Secondly the learner is using a beaker of water thats his first step and ~~I~~ I think it's not accurate as it not measure. also the beaker can be in different size such as 50ml, 100ml, 200ml ~~then~~ for it not clear also ~~the~~ this shows that he amount of ~~sugar~~ water used wasn't ~~clear~~ ~~accurate~~ accurate, kept constant or ~~not~~ controlled.

The learner has ont used repeatably or reproducibility in his experiment therefore the results and the experiment is not heliable.

The learner ~~must~~ concluded that the rate of diffusion of food coluring through water ~~with~~ inchess with ~~the temperature~~ increasing temperature. ~~his~~ ~~how~~ I agree with his colution however when we look at his graph at 50°C the time it ~~for~~ en to ~~the~~ desolve was 3minutes ~~and~~ it was also 3minutes ~~when he te~~ at 60°C there was his data is not 100% supporting his condution.



In this last example, the learner has mentioned omissions in the method such as the size of the beaker, the amount of water, lack of equipment, a means to heat the water consistently, the same food colouring type and detail for the experiment to be reproduced. The learner has commented that the experiment has not been repeated because it says time taken rather than average and explained how they know this. They make an attempt to evaluate the conclusion, saying that the conclusion is brief but correct but do not take this any further. The graph has been annotated with "not a line of best fit" and explains this in the text, they then go on to say that this makes that line of best fit inaccurate and unreliable. They have also said that the results may be inaccurate (they are not averaged) and therefore would not know if there are any anomalous results. The learner has evaluated all three traits.

The answer was given a mark of 7 in level 3.

The learner concludes that the rate of diffusion of food colouring through water increases with increasing temperature. → no evidence provided

Evaluate the learner's investigation.

Your answer should include reference to:

- the method of the experiment and the equipment used
- the results collected
- the conclusion made.

(8)

The learner provides a basic method for their experiment. It begins with not stating what size beaker should be used or the amount of water to start with. Furthermore, there is no beginning temperature. The next step does say to add one drop of colouring but doesn't say whether or not to stir it. The method doesn't mention all the equipment that should be used. For example, a thermometer to measure the temperature or to use a bunsen burner or kettle to warm the water up.

It does say the dependent variable, time taken, and the ~~dep~~ independent, the ~~water~~ temperatures but doesn't say anything about the control variables. For example, using the same food colouring or same size beaker.

The graph indicates that the learner did no repeats because it says time taken rather than average time taken therefore, the results may be inaccurate because the learner doesn't know if there are any anomalous results. Also, the line of best fit on the graph is incorrect because it is all joined together rather than a straight line that passes through most the points.

The conclusion is also very brief. It is correct in what it is saying but doesn't offer any explanation or any evidence from the graph to support it.

In conclusion, this learners investigation is too brief and rushed. It doesn't give in depth detail for someone to reproduce it if they wanted to. Some details such as the line of best fit is inaccurate, therefore is not reliable. On the otherhand, the conclusion made was correct but didn't have enough detail.

Summary - Physics

To improve their mark for this paper learners should:-

- Learn how to put correct headings on a table of results.
- Check scales used will give sufficient coverage of the graph paper.
- Practice drawing lines and curves of best fit.
- Take a ruler into the examination room.
- Always show the substitution into an equation.
- If working in fractions remember to convert to decimal for the answer line.
- Learn the definitions of repeatability and reproducibility.
- In a 'show that' question always quote your answer to one more decimal place than the value given in the question.
- Learn to convert seconds to hours.
- Read the questions carefully and note units to be used in the answer line.

Summary - Chemistry

To improve on section 2 of the paper learners should:-

- Ensure that they read the questions and information given in the stem completely.

In Question 4

- Produce a hypothesis using the variables
- Decide how the variables are to be measured
- Ensure that they give a method
- Ensure that when they are giving measurements in the method that they are realistic in terms of size or concentrations.
- When giving health and safety considerations, ensure that these are relevant to the method posed, rather than generic lab rules.
- Plan their time so that they do not spend a long time on the hypothesis, equipment or health and safety, leaving no time for the method or further questions.

In Question 5

- Use the bullet points in the question stem to ensure that address all areas of the question in their evaluation.
- Ensure that they evaluate the method, not write another method, in the style of question 4 but for the scenario given in question 5.

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