BTEC

L3 Lead Examiner Report 1906

June 2019

L3 Qualification in Applied Science

Unit 3: Science Investigation Skills (31619H)

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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 (31619H)

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	9	19	30	42

Introduction

Science Investigation Skills Part B

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 Biology 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.

Introduction to the Overall Performance of the Unit

Science Investigation Skills Part A

This was the fifth time this paper was sat. Learners seemed to be gaining confidence in these papers and it was pleasing to see that the majority of learners are attempting all questions and not leaving blanks. The majority of learners had produced a good set of results from their experiments burning carbohydrate foods.

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 analyze their data. They were able to carry out calculations methodically, showing their working. Given new data they were also able to analyze and evaluate these.

Learners that did less well, did not always interact with questions sufficiently and therefore did not answer the questions posed appropriately.

Science Investigation Skills Part B

- Learners seem to be more familiar with the requirements of the section B questions, with more learners showing a clear structure to their response.
- Question 4 required the learners to plan a practical which would investigate the effect of light intensity on the rate of photosynthesis and most learners were able to attempt this question. However, a number of learners did not seem familiar with pond weed and did not use the information in the stem of the question about releasing bubbles of oxygen and gave a method about growing the pond weed from seed and measuring the mass or length of the plant. Some learners gave a correct hypothesis but then gave a practical which would not investigate that hypothesis. A common method describing growing plants on a windowsill and in a cupboard and this would investigate that light was needed for plant growth and not the effect of the light intensity on the rate of photosynthesis. Very few learners discussed how they would analyse their results.
- Question 5 required the learners to evaluate the method, results and conclusion of a practical. The practical was based on the growth of seeds in different pH conditions. Some learners were not able to attempt this question. Most learners were able to criticise the method and highlight several control variables which were not given and therefore the practical would be difficult to repeat and the results could be affected. Some learners highlighted that the lack of repeats, as only 1 seed was grown under each pH, meant that anomalous results could not be identified, and a mean could not be calculated. However, most learners agreed with the conclusion or suggested that it could be amended slightly as the seeds did grow at pH values other than pH7. Very few learners suggested that pH values between pH6 and pH7 could be investigated to find the optimum.
- The specification and sample assessment materials (SAMs) are located on the BTEC First qualification webpage located here.

Individual Questions

Science Investigation Skills Part A

Question 1a

Generally well answered with the majority of learners being able to tabulate their results with suitable headings and units and with all measurements recorded consistently, including repeats.

In general, learners performed well in question with many gaining full marks for correctly tabulating their data. The majority gave the correct units for their data. In some cases, learners lost marks as they did not show the average temperature of the water or the average mass of the carbohydrate food burned as asked in the question. Learners should be taught to read the question and ensure that they fully address it in their answer.

In this example the learner gained the full three marks available for their well-presented table.

Type of carbohydrate food	trial	mass (g)				temperature (°C)			
		initial	final	change	mean	initial	final	change	mean
maize puffs	1	0.4	0.0	0.4	0.4	25.0	40.0	15.0	15.3
	2	0.4	0.0	0.4		24.0	37.0	13.0	
	3	0.5	0.0	0.5		24.0	42.0	18.0	
marshmallows	1	8.0	7.4	0.6	0.8	24.0	38.0	14.0	18.0
	2	8.6	7.8	0.8		25.0	45.0	20.0	
	3	8.8	7.9	0.9		25.0	46.0	20.0	
popped popcorn	1	0.2	0.0	0.2	0.2	25.0	35.0	10.0	10.7
	2	0.2	0.0	0.2		25.0	37.0	12.0	
	3	0.2	0.0	0.2		25.0	35.0	10.0	
rice cakes	1	1.9	1.6	0.3	0.4	25.0	35.0	10.0	11.3
	2	1.9	1.4	0.5		26.0	37.0	12.0	
	3	2.0	1.6	0.4		26.0	38.0	12.0	

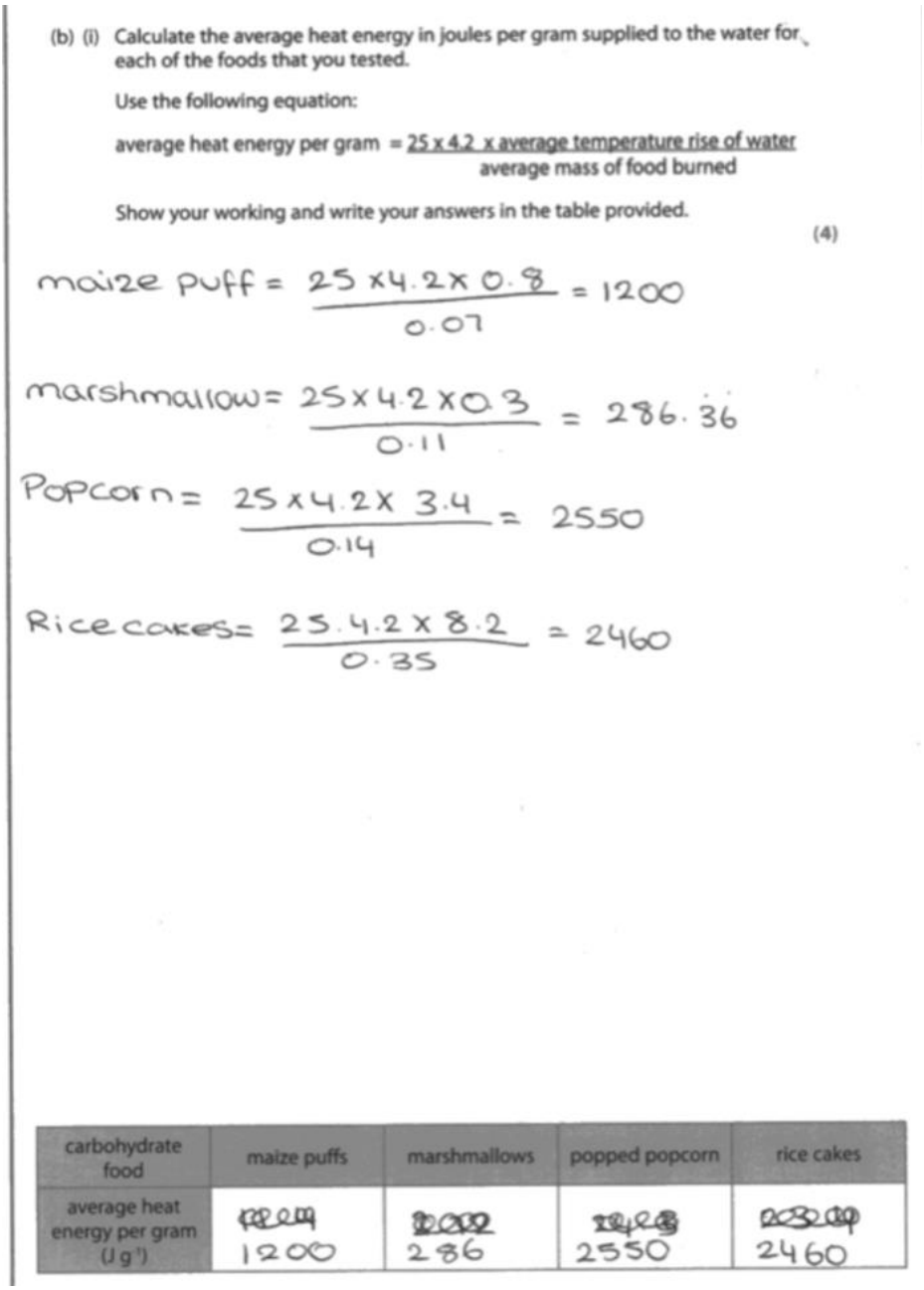
SECTION 1

1 (a) Record all your experimental results, including the average temperature change of water and the average mass of the carbohydrate food burned, in a suitable table using the space provided. Circle any anomalous results.

(3)

Question 1bi

Learners were asked to use their data to calculate the average heat energy per gram for each of the carbohydrate foods burned. The majority of learners completed this task well. Those that presented their table well in 1(a) often performed better in this question than those that presented confused tables. In this example, the learner set out their working well, calculated the values correctly and gained all four marks available.



(b) (i) Calculate the average heat energy in joules per gram supplied to the water for each of the foods that you tested.

Use the following equation:

$$\text{average heat energy per gram} = \frac{25 \times 4.2 \times \text{average temperature rise of water}}{\text{average mass of food burned}}$$

Show your working and write your answers in the table provided.

(4)

maize puff = $\frac{25 \times 4.2 \times 0.8}{0.07} = 1200$

marshmallow = $\frac{25 \times 4.2 \times 0.3}{0.11} = 286.36$

Popcorn = $\frac{25 \times 4.2 \times 3.4}{0.14} = 2550$

Rice cakes = $\frac{25.4.2 \times 8.2}{0.35} = 2460$

carbohydrate food	maize puffs	marshmallows	popped popcorn	rice cakes
average heat energy per gram ($J\,g^{-1}$)	1200	286	2550	2460

Question 1bii / 1biii

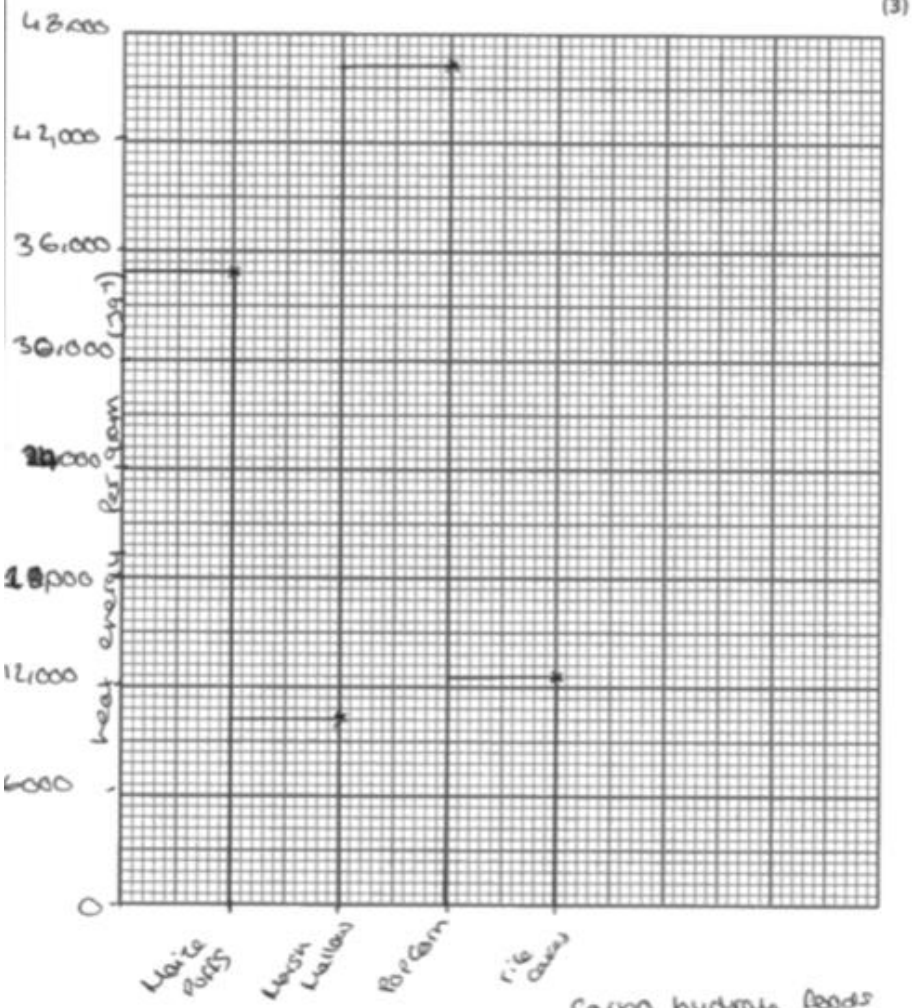
Part (ii) and (iii) of question 1b asked the learners to draw a bar chart of their results and describe these results. This question was answered with varying degrees of success.

In some cases, learners made the plotting of data their very difficult for themselves by using awkward (but still linear) scales, for example going up in 300 or 650 increments rather than 500, 100 or 1000 increments, this often meant that learners were then unable to use their scale properly and often lost a mark as they we unable to draw the bars to the correct place. Centers could spend more time teaching learners how to draw suitable graphs of different types of data. Another common issue when drawing the graph is where learners did not scale their graphs appropriately so that the data spread did not cover at least half of the paper.

The following example shows a good graph that scored the full 3 marks available. When describing the results the learner has correctly identified the foods that gave the highest and the lowest average heat energy per gram to gain both marks.

(ii) Draw a bar chart of average heat energy per gram for the carbohydrate foods.

(3)

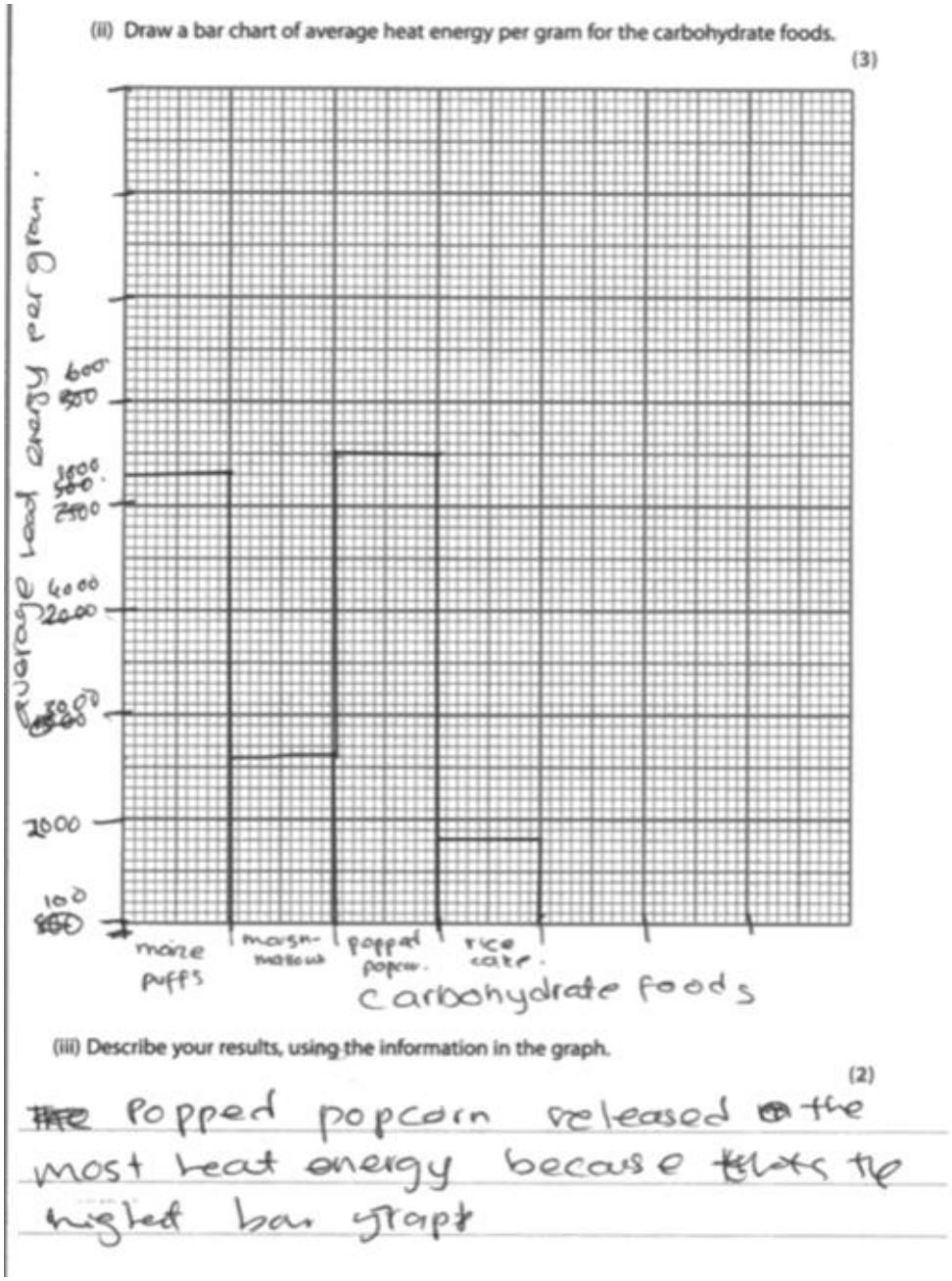


(iii) Describe your results, using the information in the graph.

(2)

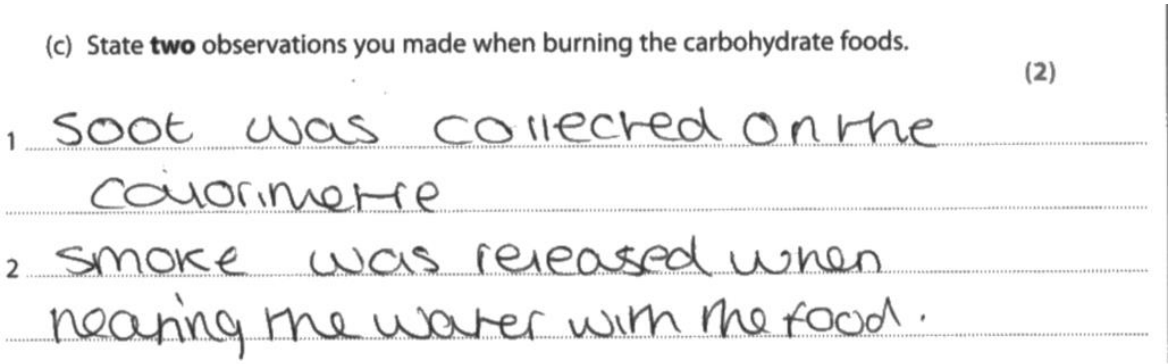
looking at my graph I can see that Popcorn had the highest average heat energy per gram and that the Marsh Mallow had the lowest. ~~the~~ This shows that the Popcorn had the most carbohydrates per gram.

In this example, unfortunately the learner gains no marks. The learner has given the correct labels but no unit for the heat energy so has lost the first mark. They have even drawn scales but the data spread does not cover half of the page, they have also made an error as the first value is 100 not 1000 and 600 for 6000 so loses the first mark. The marshmallow bar has been drawn incorrectly - all bars need to be correct for the plotting marks. Whilst the bar chart did not gain any marks, marks could still be awarded for a description of this graph with error carried forward. In this case, the learner gained 1 mark for correctly stating that the popped popcorn released the most heat energy.



Question 1c

Generally well answered with many learners scoring at least 1 of the 2 marks available for stating observations made when burning the carbohydrate foods. IN this example the learner states that soot and smoke was observed these are the same marking point and so just 1 mark was awarded.



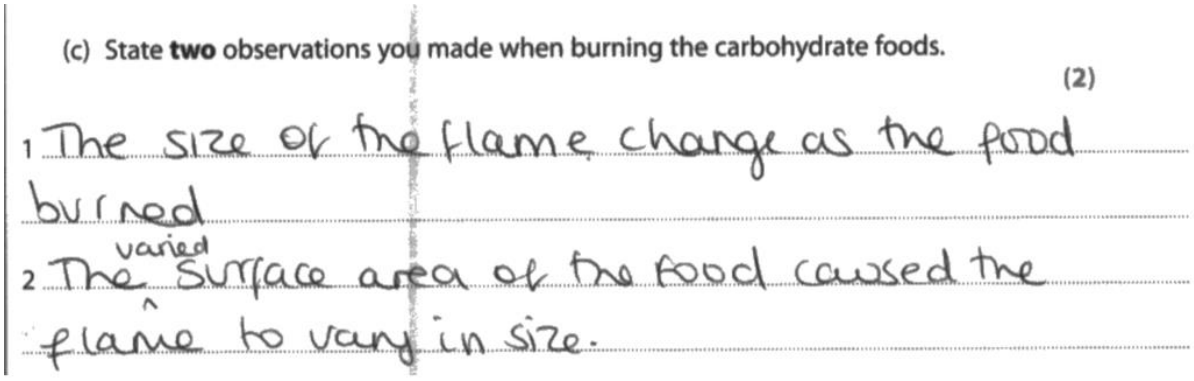
(c) State **two** observations you made when burning the carbohydrate foods.

(2)

1 soot was collected on the calorimeter

2 smoke was released when heating the water with the food.

Where learners lost marks it was often as they tried to give conclusions rather than observations. In this example, the learner gained 1 mark for stating that the size of the flame changed. The second comment they made is seen to be a conclusion and gained no marks. Learners should be taught that when being asked for observations they should be not be giving conclusions.



(c) State **two** observations you made when burning the carbohydrate foods.

(2)

1 The size of the flame change as the food burned

2 The varied surface area of the food caused the flame to vary in size.

Question 1d

It was pleasing to see that the majority of learners were able to recall how they used the pipette in their experiment accurately to measure the volume of water accurately as in this case that gained 2 marks.

(d) Describe how you used the pipette to measure the 25cm³ of water accurately.

(2)

I used the pipette by taking water out of a beaker and measuring up to the line. I made sure the line was at eye level and I used the bottom of the ~~rest~~ miniscus.

In some cases, learners lost marks as they described how they used the pipette rather than how they used it accurately. Although in this case, it is clear the learner had used a pipette and knew how to use a pipette there is no reference to draw the water up to the line, reading from the bottom of the meniscus, removing bubbles or any other procedural points that would ensure that the amount of water was accurate.

(d) Describe how you used the pipette to measure the 25cm³ of water accurately.

(2)

we used the Pipette by drawing water from a beaker by squeezing down the air ballon using the letter 'A' located on rop of the instrument, holding down the button 'S' to suck the water up and then you press down 'E' to empty.

Question 1e

Question 1(e) was well answered by learners with the majority understanding that the lid was present to reduce heat loss as in this example that gained the mark.

(e) Give **one** reason why a lid was used on the calorimeter.

(1)

So the heat is not able to escape to its sorrundings.

Where learners lost marks, it was often because they thought that the lid was to avoid water escaping from the calorimeter.

(e) Give **one** reason why a lid was used on the calorimeter.

(1)

To prevent water escaping in the form of steam.

Question 1fi / 1fii

Questions (f)(i) and (f)(ii) focused on the hazard and risks present in the experiment. It was clear from some of the learner's answers that they were not aware of the difference between the terms hazard and risk. Learners should be taught that the hazard is the object or substance that has the ability to do harm for example the Bunsen burner flame, hot food, sharp needled etc. With the risk being the implication to the user such as burns, scalds, cuts etc.

In this following example the learner has identified the hazard correctly as the flame, they have also stated that to minimize the risk from this hazard they would tie their hair back but they have not given the risk of the hair setting alight for the first marking point of (f)(ii).

(f) (i) State **one** hazard in your experiment.

(1)

Flame

(ii) Explain how you minimised **one** risk from the hazard in (f)(i).

(2)

Tied hair back.

In this example, the learner has given a risk rather than a hazard for part (i) and so does not gain this mark. However with error carried forward they were awarded 2 marks in part (ii) for stating that they would minimize the risk of getting burnt by placing the food on a skewer.

(f) (i) State **one** hazard in your experiment.

(1)

~~when~~ burning my hands trying to light the food.

(ii) Explain how you minimised **one** risk from the hazard in (f)(i).

(2)

I made sure that when I placed the skewer into the food, placed it near one end of it and my hand would be on the other side of the skewer to avoid getting burnt.

(Total for Question 1 = 20 marks)

Question 2a

The question focused on results from a colleague that repeated the investigation. In the first part of question 2, learners were asked to calculate the total percentage error for one of the trials that included two temperature measurements.

Learners found this quite difficult with only the best gaining full marks for the question as in this example.

2 (a) Your colleague repeated the investigation.

For one of the trials, they recorded an initial temperature of 23°C and a final temperature of 45°C.

They used a thermometer that measured in 1°C increments.

Calculate the total percentage error, using the initial and final readings, for this temperature rise.

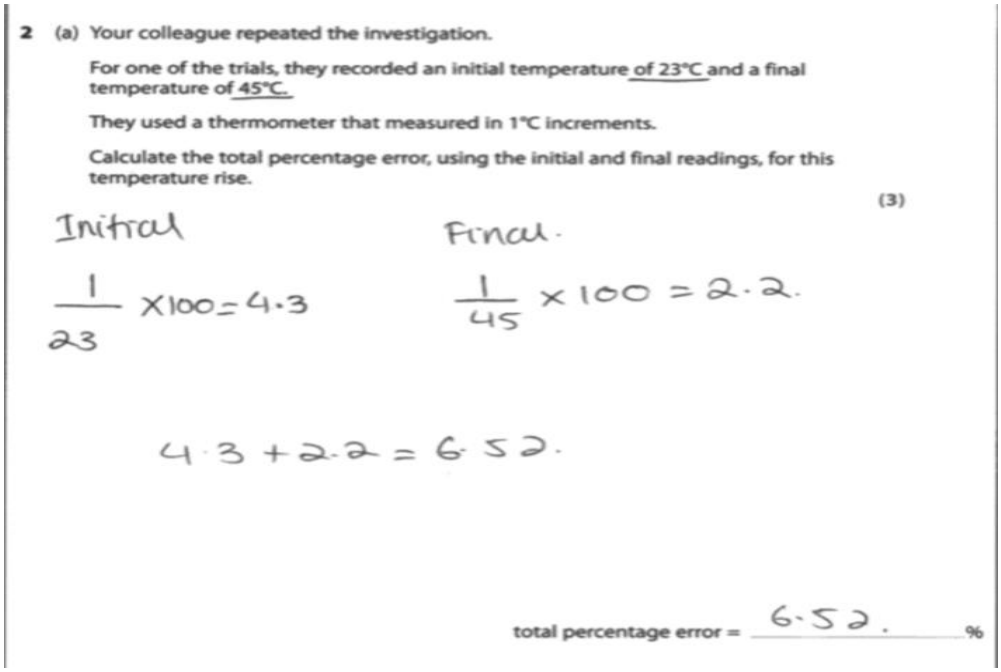
(3)

$\left(\frac{0.5}{23} + \frac{0.5}{45}\right) \times 100 = 3.285$

$= 3.29$

total percentage error = 3.29 %

In some cases, learners had the correct methodology by thought that the uncertainty was 1 rather than 0.5. In this case the learner scored 2 marks with error carried forward as in this example.



2 (a) Your colleague repeated the investigation.

For one of the trials, they recorded an initial temperature of 23°C and a final temperature of 45°C.

They used a thermometer that measured in 1°C increments.

Calculate the total percentage error, using the initial and final readings, for this temperature rise.

(3)

Initial

$\frac{1}{23} \times 100 = 4.3$

Final.

$\frac{1}{45} \times 100 = 2.2.$

$4.3 + 2.2 = 6.52.$

total percentage error = 6.52. %

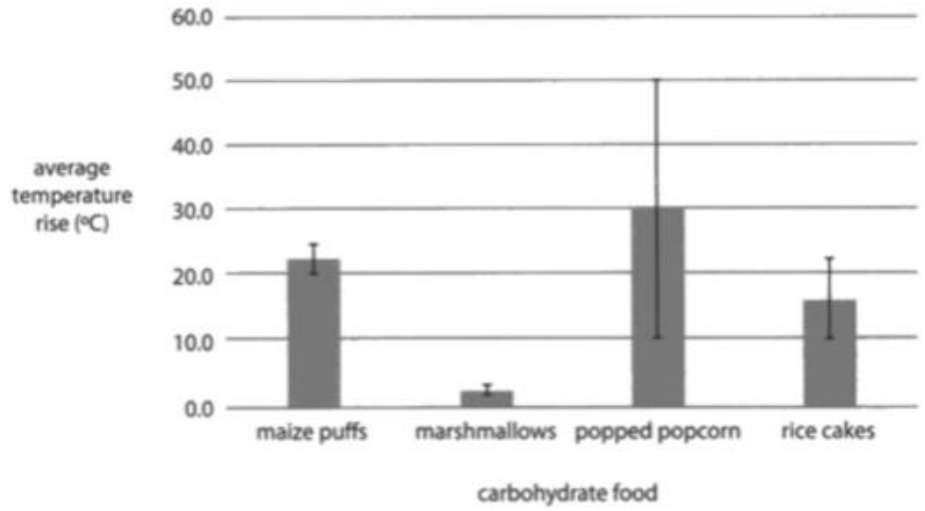
Question 2bi

Learners found the question difficult. In some cases, learners understood that there was a significant difference between the marshmallow and the other foods and there was no significant difference between the other foods, however they were then not able to correctly explain why.

The following answer gained the full four marks.

(b) Your colleague calculated the average and the standard deviation for the temperature rises.

They draw a graph of their results.



(i) Explain, using information from the graph, whether there is a significant difference between the average temperature rise for each of the carbohydrate foods.

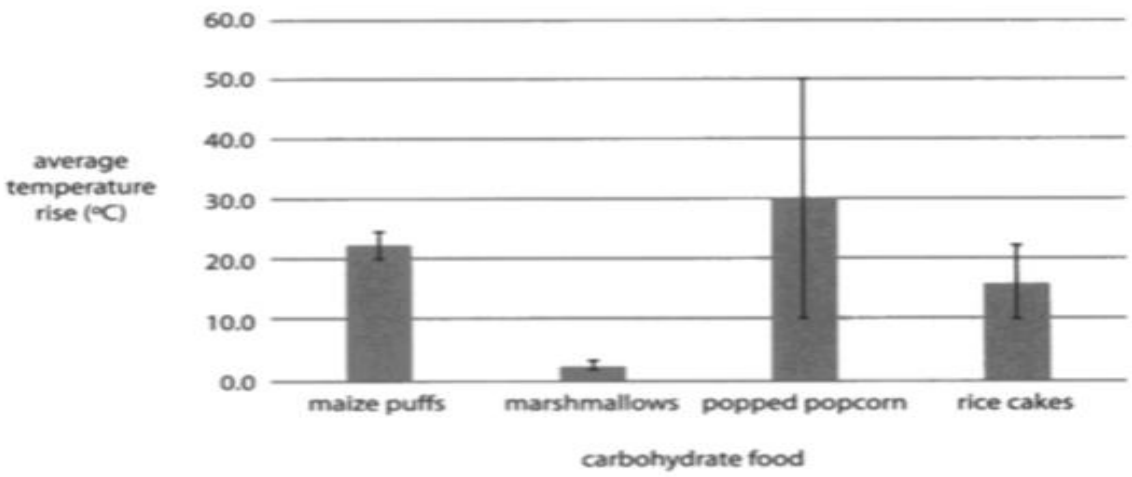
(4)

Both popped popcorn and rice have an overlap in their SD bars. Therefore between these two foods, there is no significant difference however maize puffs and mash mallows have no overlap in their bars so have a lot of significant difference among them. Popcorn has a massive error bar difference (40.0) which a highly significant temperature rise. Overall, I conclude that there is a significant difference of carbohydrates except popcorn and rice causes in average temperature rise.

This example gained 2 marks for this reason, they state that this is a significant difference between marshmallows and 'the rest' and that there is no significant difference between maize puffs and rice cakes.

(b) Your colleague calculated the average and the standard deviation for the temperature rises.

They draw a graph of their results.



(i) Explain, using information from the graph, whether there is a significant difference between the average temperature rise for each of the carbohydrate foods.

(4)

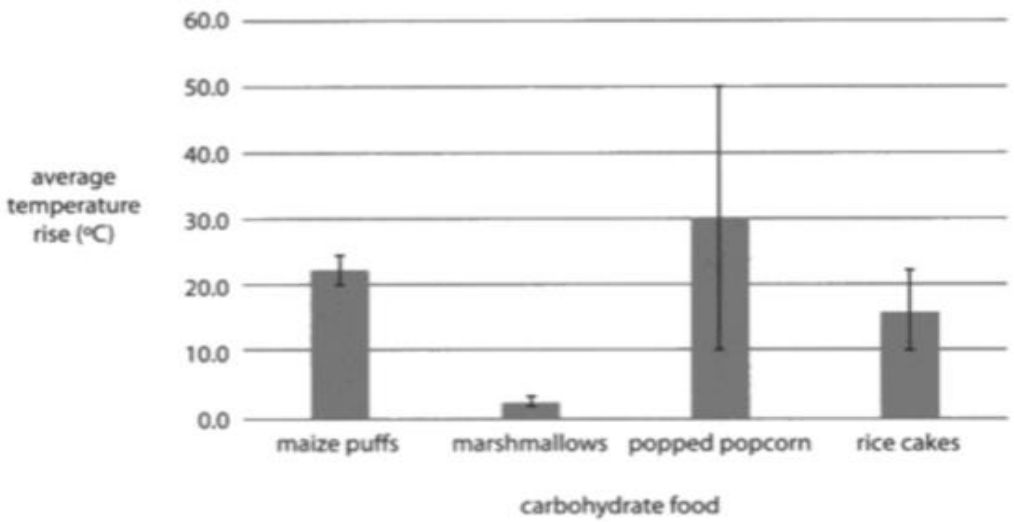
I believe there is a significant difference for popped popcorn. This is because it has a much higher reading than the rest. Also, Marshmallows have a significant difference as it is much smaller in number than the rest.

However I can understand that there is no significant difference between Maize puffs and Rice Cakes as they both share a similar value.

The following example, the learner has stated that there is no significant difference between the average temperature rise but has not stated between what and so marks were awarded.

(b) Your colleague calculated the average and the standard deviation for the temperature rises.

They draw a graph of their results.



(i) Explain, using information from the graph, whether there is a significant difference between the average temperature rise for each of the carbohydrate foods.

(4)

The graph shows that there is no significant difference between the average temperature rise and the food

Question 2bi / 2bii

In contract to part 2(b)(i), part 2(b)(ii) was generally well answered with the majority of learners being able to identify popcorn as the food that had the least reliable result, a good proportion of these were able to take this further and explain that this was because it had the highest standard deviation or error bar.

(ii) Explain, using information from the graph, which carbohydrate food has the least reliable results.

(2)

popped popcorn as it has the largest error bar (difference of 40°c).

A common error where learners lost marks was where they though that the marshmallow was the least reliable as it had the lowest reading, this did not gain credit.

(ii) Explain, using information from the graph, which carbohydrate food has the least reliable results.

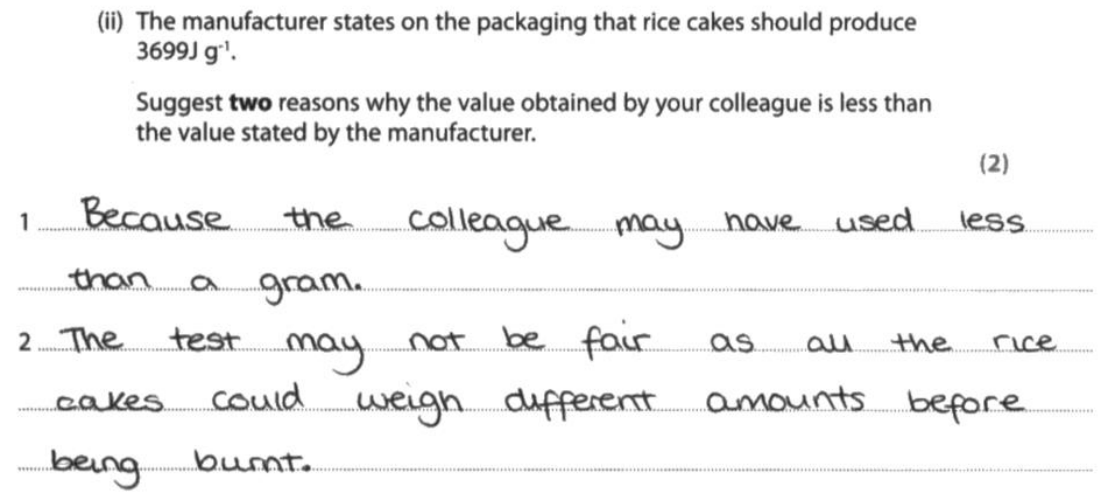
(2)

The marsh mallows has the least reliable result because the temprature rise was very low and it could be because they started melting and the fire did not stay on for long.

Question 2cii

In question 2(c)(ii) most learner scored at least 1 mark here, this was usually for stating that there may have been heat loss. Many learners lost marks as they thought that the difference is due to a smaller piece of food being used, showing a misunderstanding of heat energy per gram. Some simply stated that the colleagues' results were incorrect or there was human error which was not sufficient for credit.

This example gained no credit.



(ii) The manufacturer states on the packaging that rice cakes should produce 3699J g^{-1}.

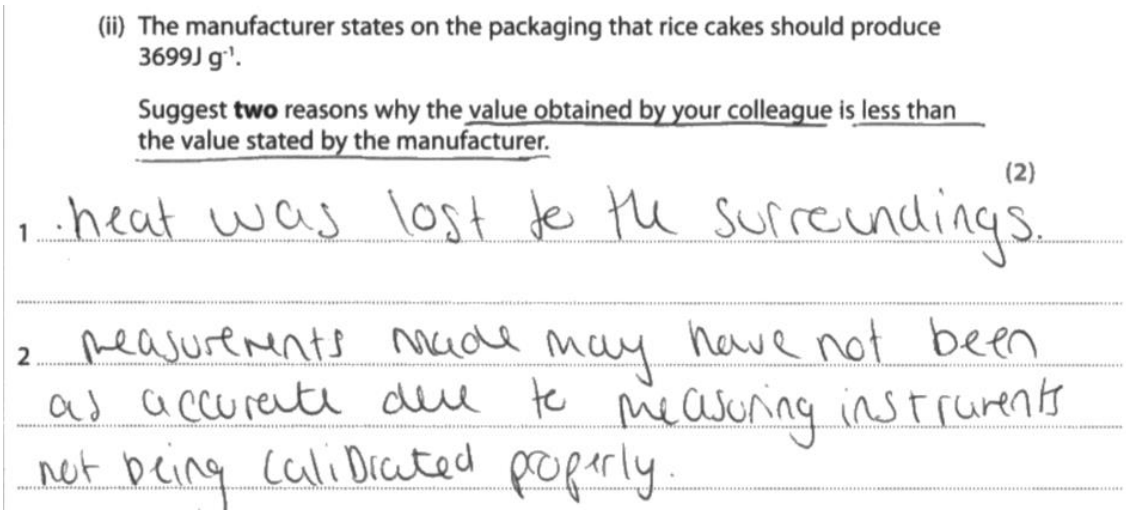
Suggest **two** reasons why the value obtained by your colleague is less than the value stated by the manufacturer.

(2)

1 Because the colleague may have used less than a gram.

2 The test may not be fair as all the rice cakes could weigh different amounts before being burnt.

The following example gained 2 marks for heat loss to the surroundings and for an understanding that the colleagues equipment may not have been as accurate.



(ii) The manufacturer states on the packaging that rice cakes should produce 3699J g^{-1}.

Suggest **two** reasons why the value obtained by your colleague is less than the value stated by the manufacturer.

(2)

1 .heat was lost to the surroundings.

2 measurements made may have not been as accurate due to measuring instruments not being calibrated properly.

Question 3a

Question 3, focuses back on the learners investigation. Part (a) of question 3 asked learners to state two variable other than the material of the calorimeter that they controlled in their investigation. In general, learners performed well in this question, with the majority stating the volume of water and the distance the food was held from the bottom of the calorimeter were controlled to gain both marks.

3 (a) The material the calorimeter was made from was one of the variables that you controlled in your investigation.

State **two** other variables you controlled in your investigation.

(2)

1 The amount of water measured and used

2 The 1cm distance between the calorimeter and the burning carbohydrate food.

In some cases, learners stated that the mass of the food was controlled which is incorrect and did not gain credit.

3 (a) The material the calorimeter was made from was one of the variables that you controlled in your investigation.

State **two** other variables you controlled in your investigation.

(2)

1 The mass of the carbohydrate foods.

2 The amount of water in the metal calorimeter had to be 25 cm^3.

Some learners just stated that the water and needle size was controlled, rather than the volume of water or distance of food from calorimeter, as these answers were not specific enough no credit was awarded. Learners should be taught to be specific and not ambiguous with their answers.

3 (a) The material the calorimeter was made from was one of the variables that you controlled in your investigation.

State **two** other variables you controlled in your investigation.

(2)

1 water.

2 Needle size.

Question 3b

Question 3(b) tested the learners understanding of why the mass of the carbohydrate was measure before and after burning. A good proportion of learners could state that this was find the change in the mass or to see how much food had actually burnt, fewer were then able to explain that this was so that the heat energy per gram could be calculated. The follow exemplar answer scored 2 marks.

(b) Explain why the mass of the carbohydrate food was recorded before and after burning in your investigation.

(2)

So that I could see the difference in mass which would tell me how much was burnt so that I could calculate the average heat energy per gram.

This next answer scored 1 mark for showing an understanding that the mass was recorded before and after to see how much food was burned. They have not linked this to finding the energy released per gram of the food.

(b) Explain why the mass of the carbohydrate food was recorded before and after burning in your investigation.

(2)

To see how much of the food was burned to help calculate the amount of energy the food produces

Some learners were not specific and just stated that it was to see how much energy was used, this was not sufficient for credit and gained no marks.

(b) Explain why the mass of the carbohydrate food was recorded before and after burning in your investigation.

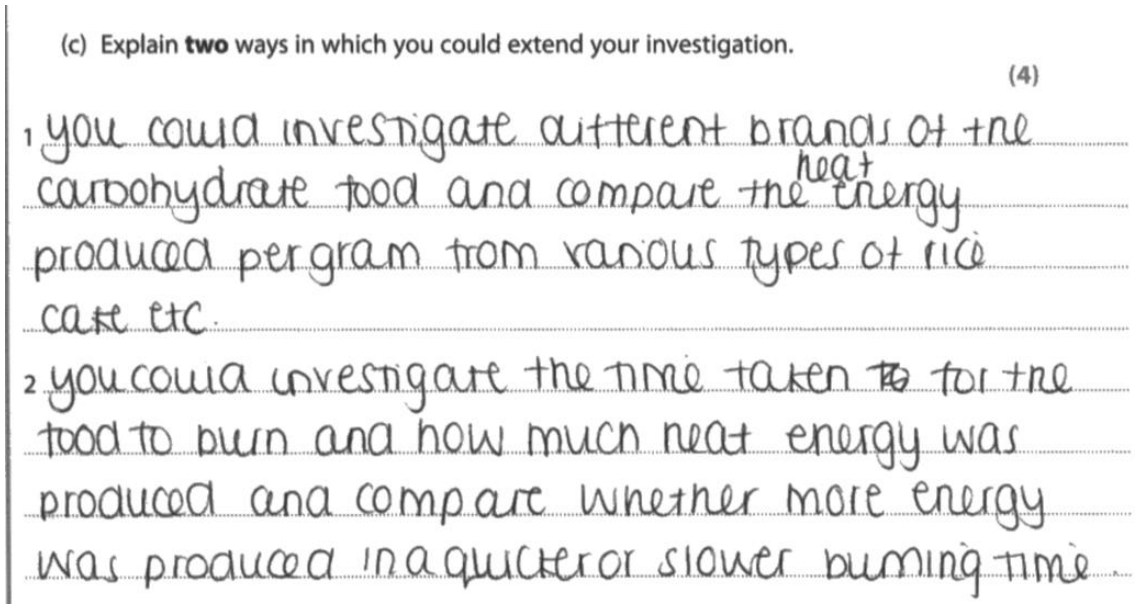
(2)

Too see how much energy was used to heat the water up.

Question 3c

In the last question of section A of the paper on their investigation, question 3(c) learners were asked to explain how ways to extend their investigation. Many learners did not do well in this question as they did not understand what is meant by the term extend. Many learners referred to repeating or improving their investigation. Those that did understand the question often did well.

In this example the learner has explained two extensions, trying different brands of foods comparing the energy produced per gram or timing how long the energy was produced to find out how quickly the energy was released. This answer gained 4 marks.



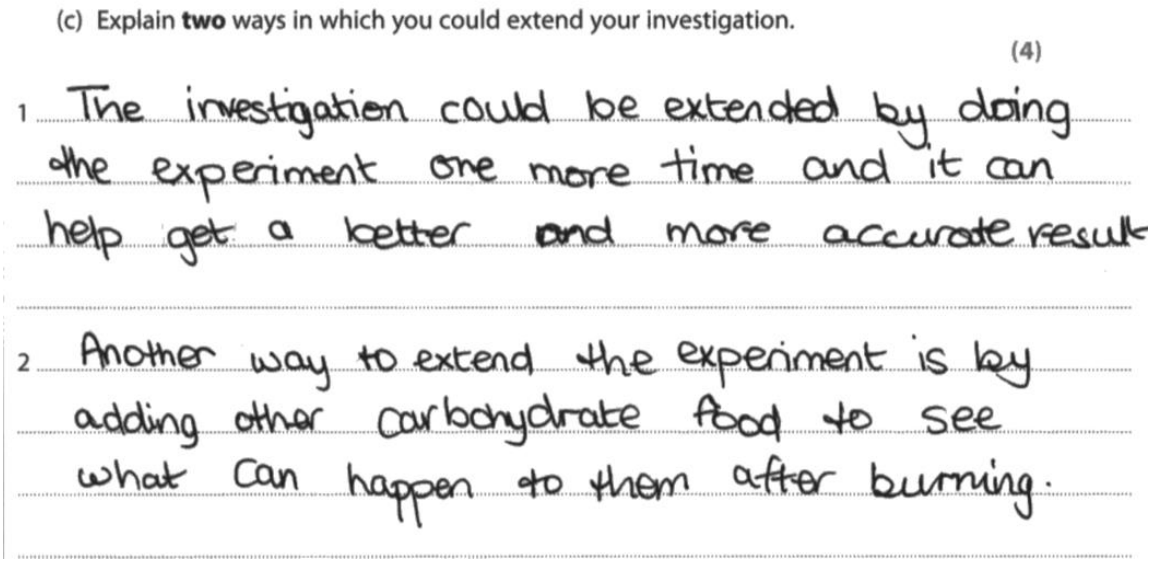
(c) Explain **two** ways in which you could extend your investigation.

(4)

1 you could investigate different brands of the carbohydrate food and compare the heat energy produced per gram from various types of rice cake etc.

2 you could investigate the time taken ~~to~~ for the food to burn and how much heat energy was produced and compare whether more energy was produced in a quicker or slower burning time.

This example gained 1 mark as the learner suggests adding other carbohydrate foods, however there is credit for the explanation to see what happens to them after burning is not sufficient for the mark. There was no credit for ideas about repeating or making the experiment more accurate.



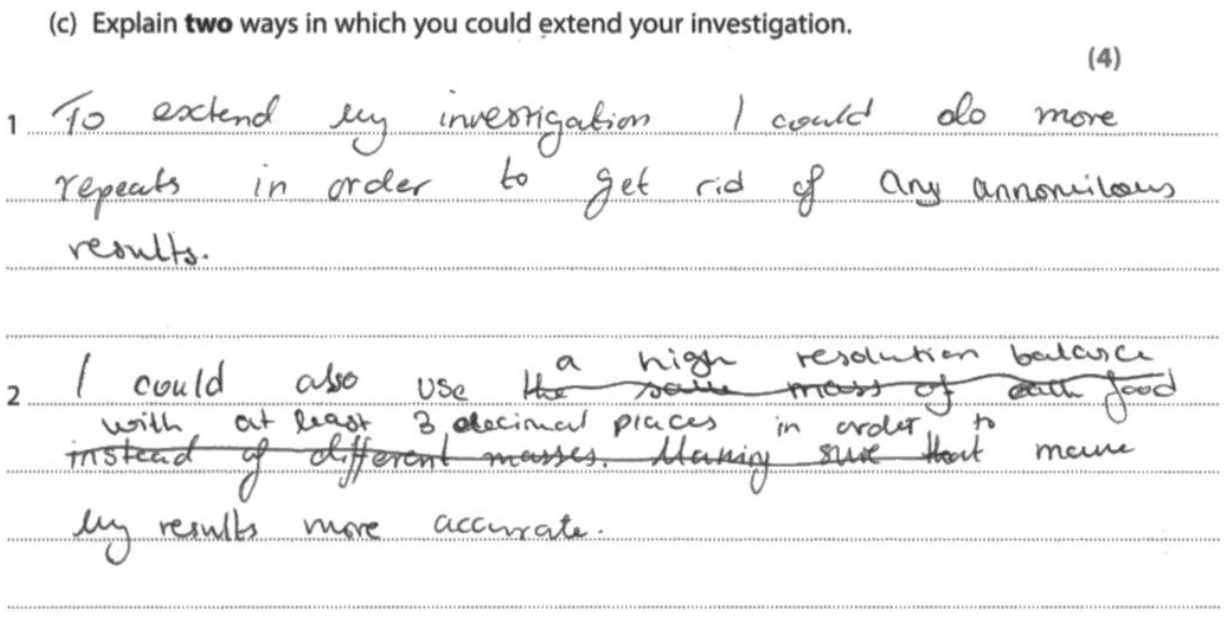
(c) Explain **two** ways in which you could extend your investigation.

(4)

1 The investigation could be extended by doing the experiment one more time and it can help get a better and more accurate result

2 Another way to extend the experiment is by adding other carbohydrate food to see what can happen to them after burning.

In this last example, the learner has suggested repeating the experiment, this is not an extension to the experiment and gained no credit. They also suggest using a higher resolution balanced, this is not an extension to the experiment but an improvement and so gained no marks.



(c) Explain **two** ways in which you could extend your investigation.

(4)

1 To extend my investigation I could do more repeats in order to get rid of any annomilous results.

2 I could also use ~~the~~ a high resolution balance ~~same mass of each food~~ with at least 3 decimal places in order to ~~instead of different masses. Making sure that~~ make my results more accurate.

Science Investigation Skills Part B

Question 4

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 light intensity on the rate of photosynthesis. Learners were given the information that pond weed releases bubbles of oxygen during photosynthesis.

The majority of learners were able to achieve Level 2 and Level 3, demonstrating adequate to good levels of knowledge and understanding. A number of learners demonstrated excellent knowledge and understanding and were able to clearly and logically plan and justify the investigation. Quite a few learners appeared to have run out of time and therefore answers were incomplete. There were quite a few scripts seen where the learner had provided an excellent hypothesis, equipment list, variable and risk assessment but then did not include a method/procedure.

Those answers that scored highly showed a clear line of logic and rationale throughout the answer, a focus on the important details, and an understanding of which elements of the plan were most significant in terms of addressing their hypothesis

On the whole, the learners tended to struggle with the hypothesis which was generally very poorly done. Learners tended to give a very brief hypothesis which was not supported with sufficient scientific knowledge.

A significant number of learners failed to include a method as a part of their answer, severely limiting them in terms of marks that could be awarded, especially in some cases where it was clear that the candidate understood the practical and showed good scientific knowledge.

Among those that did provide a method, many of the plans were unrealistic in regard to timescales for collecting data (some suggesting that bubbles be counted over a period of 24 hours) and how and where this should be carried out (one suggesting that a diver be required to count bubbles in the pond weed's natural habitat).

Common errors in the method included mistaking the wavelength of light for intensity and so including coloured filters, giving too little detail about key points to the practical such as values of the controls and how they would actually be controlled. A

high proportion of learners didn't use the information provided in the stem about visible oxygen bubbles and instead gave methods which measured plant growth.

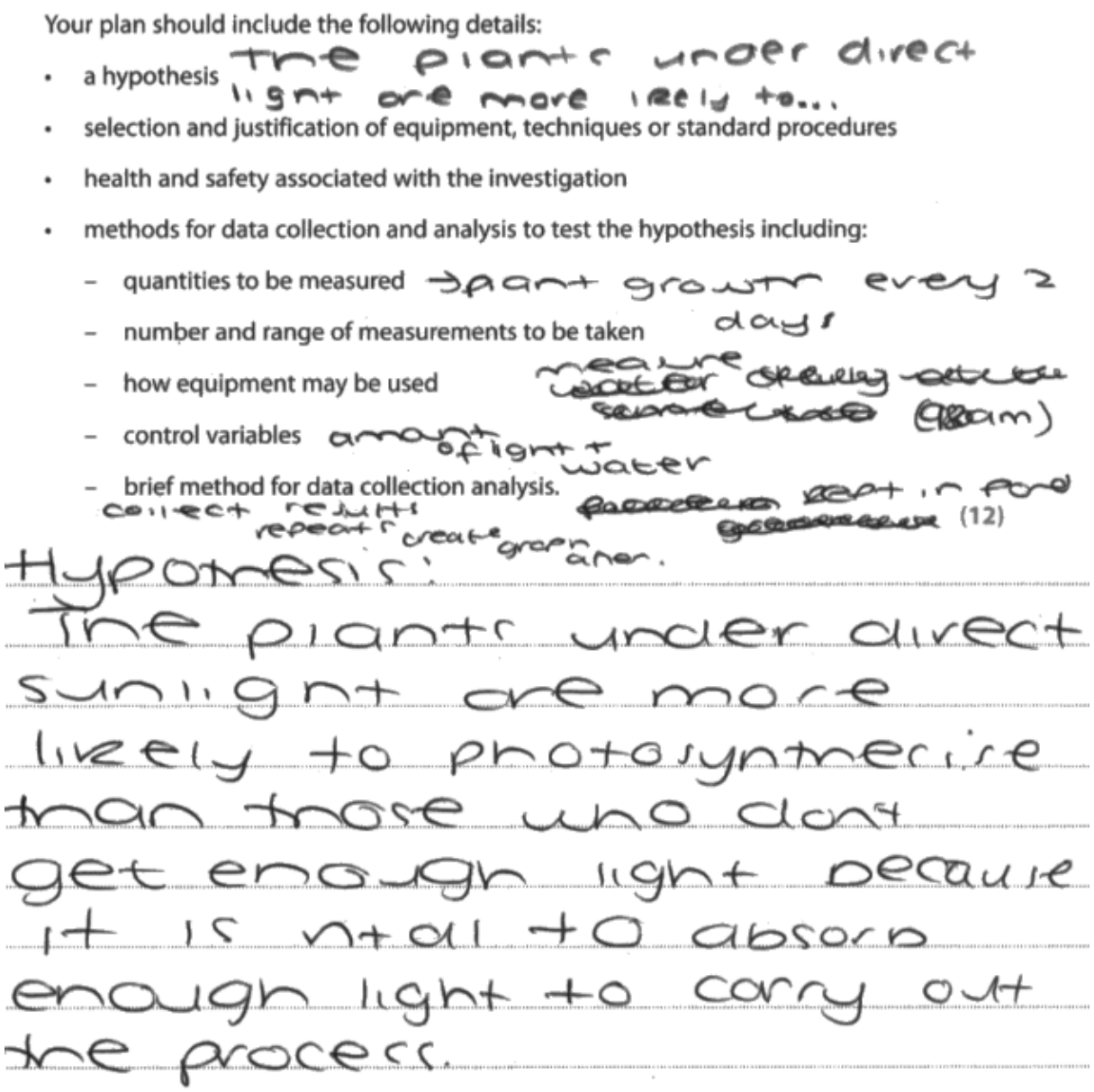
Despite this, a significant number of learners produced extremely creditworthy methods, especially among those who had clearly carried out the practical themselves, with several candidates including details such as allowing the pond weed to acclimatise to the light, limiting the variation in the light but darkening the room so that the lamp was the only source of light and using a filter between the lamp and the pond weed to ensure a constant temperature of the water, which demonstrated a deeper understanding of the topic.

Safety was also answered well and some risk assessments had been produced.

Data analysis and processing was quite poor, with only around half the learners including this area in their answer. The concept of performing repeats was mentioned frequently, but more often than not without indication of their purpose or how they could be used to increase the accuracy of the experiment. A significant number of learners were unable to draw a quantitative conclusion from their experiment, having used vague measures of light intensity such as 'daylight', 'shade' or 'cupboard' using light intensity levels of "daylight", "shade", "cupboard" etc. which wouldn't allow any mathematical analysis to be performed.

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

This response achieved a Level 1 and was awarded 2 Marks



Your plan should include the following details:

- a hypothesis the plants under direct light are more likely to...
- 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:
  - quantities to be measured plant growth every 2 days
  - number and range of measurements to be taken
  - how equipment may be used measure water (beam)
  - control variables amount of light + water
  - brief method for data collection analysis. collect results repeats create graph ane. (12)

Hypothesis:
The plants under direct sunlight are more likely to photosynthesise than those who dont get enough light because it is ntall to absorb enough light to carry out the process.

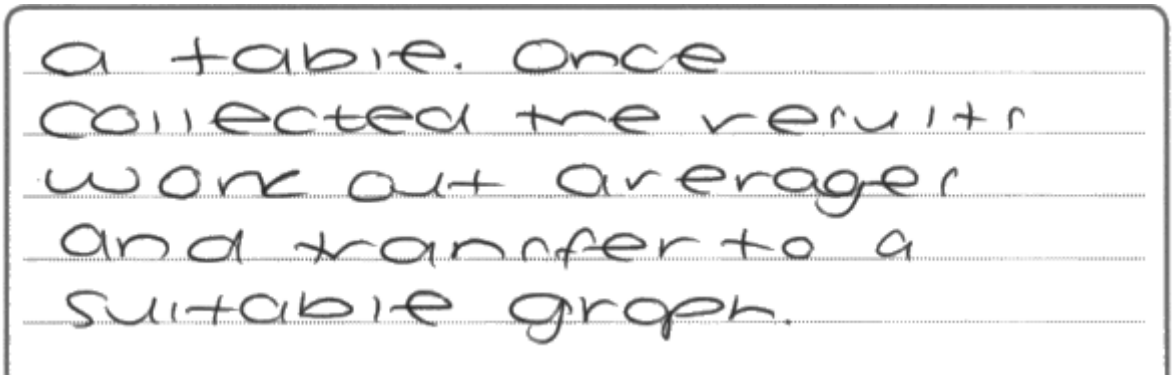
Health and safety:
- wear gloves to protect hand from anything on the pond weed when measuring.
- wear suitable clothing when around the pond.

method for data collection:
- continue this for 2 weeks.
- measure plant growth every 2 days at 9:30 am and write down the measurement taken in (cm) recorded in (mm)

control variables:
- the amount of light absorbed.
- controlling the time of when to measure the plant.
- where it is kept.

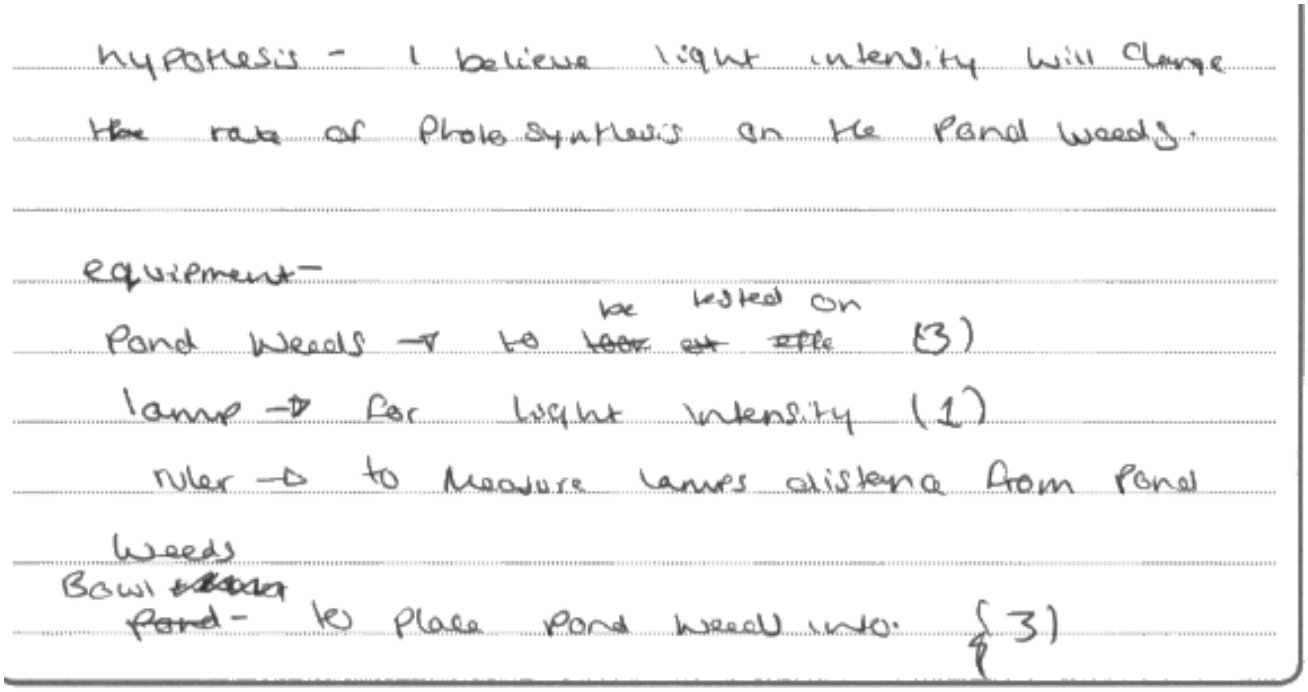
collect the results in

12


a table. Once
collected the results
work out averages
and transfer to a
suitable graph.

The learner has given some constants, but have not mentioned any variables and have not given an equipment list. The learner's hypothesis demonstrates a lack of scientific understanding of photosynthesis. The method is confused with the suggestion of measuring plant growth, but there is no mention of light intensity. They have given some health and safety points. There is a minor comment on data analysis about calculating averages, even though there is no mention of carrying out repeats. Overall this is just the middle of level 1 and awarded 2 marks.

The response achieved a Level 2 and was awarded 4 Marks


hypothesis - I believe light intensity will change
the rate of Photosynthesis on the Pond weeds.

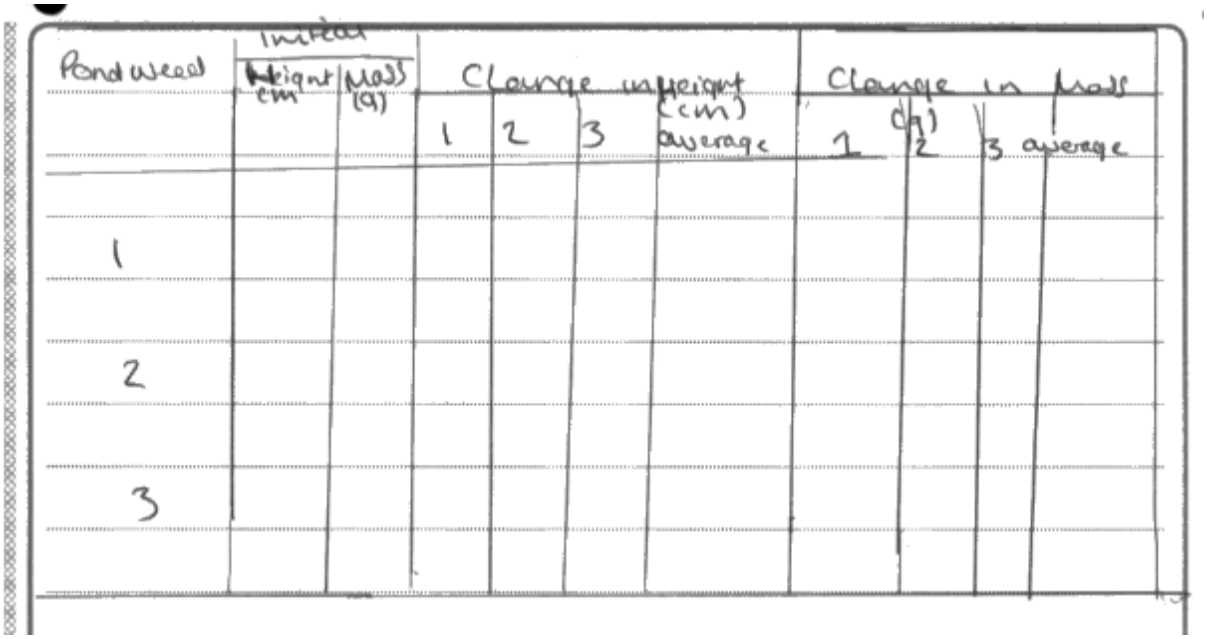
equipment-
Pond Weeds → to be tested on (3)
lamp → for light intensity (1)
ruler → to measure lamps distance from Pond
weeds
Bowl
Pond - to place Pond weeds into. (3)

~~Health and Safety~~ - Beaker → to add water
Water → Clean up Spillages to bowl
water → to place pond
Health and Safety - weeds into (1 L)
Water → clean up spillages
glass ware → if dropped clean up with
dustpan and Brush

~~Method~~ Method -
- Place 1 litre of water into bucket and add a Pond Weed & repeat 2 more times
- to place a lamp down and using a ruler place Buckets holding Plants at 30 cm, 45cm and 60 cm away from the lamp
- Measure initial height and weight
- turn the lamp on and leave plants for 7 days ~~and~~ then
- Measure final weight and height.

Controlled Variables -
- amount of water in each bucket
- temperature

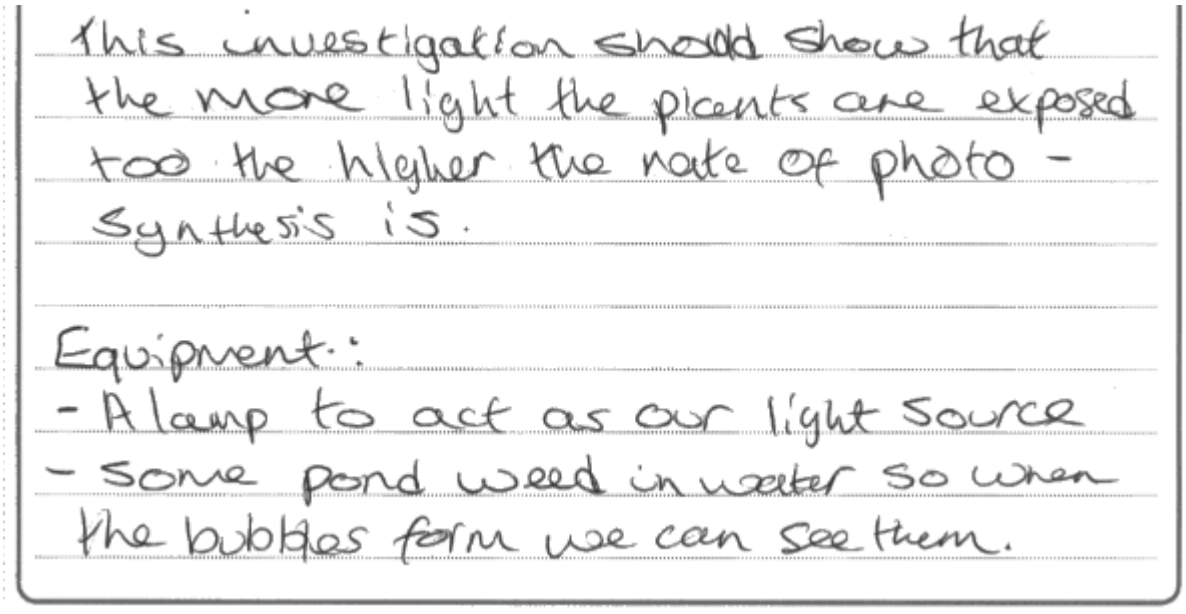
Independant Variable -
distance Pond weeds are from lamp.



Pond weed	Initial height (cm)	Initial Mass (g)	Change in height (cm) 1	2	3	average	Change in Mass (g) 1	2	3	average
1										
2										
3										

The learner has given an independent variable and attempted to give a dependent variable and one constant. The equipment list is not extensive but is sufficient for level 2 as the learner has given some justification. The hypothesis is quite basic and, as it is not supported by scientific theory or reasoning, can only achieve a Level 1. The method describes an unrealistic time scale and measuring the weight and height of the plant is unfeasible. The learner has given some health and safety points. There is a results table for data analysis which includes repeats and averages. Overall this is the bottom of Level 2 and awarded 4 marks.

This response achieved a Level 3 and was awarded 7 Marks



This investigation should show that the more light the plants are exposed too the higher the rate of photo-synthesis is.

Equipment:
- A lamp to act as our light source
- some pond weed in water so when the bubbles form we can see them.

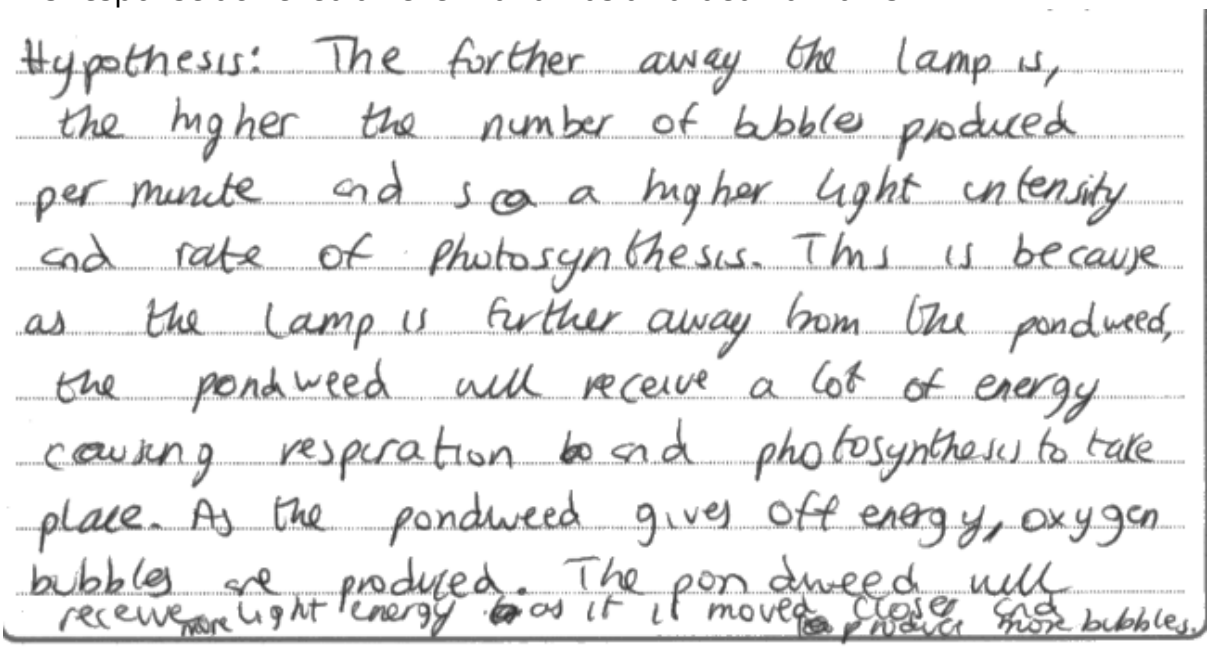
- A tape messure to measure the distances of the light from the plant.
- a stop watch to time how many bubbles are produced in a certain amount of time.

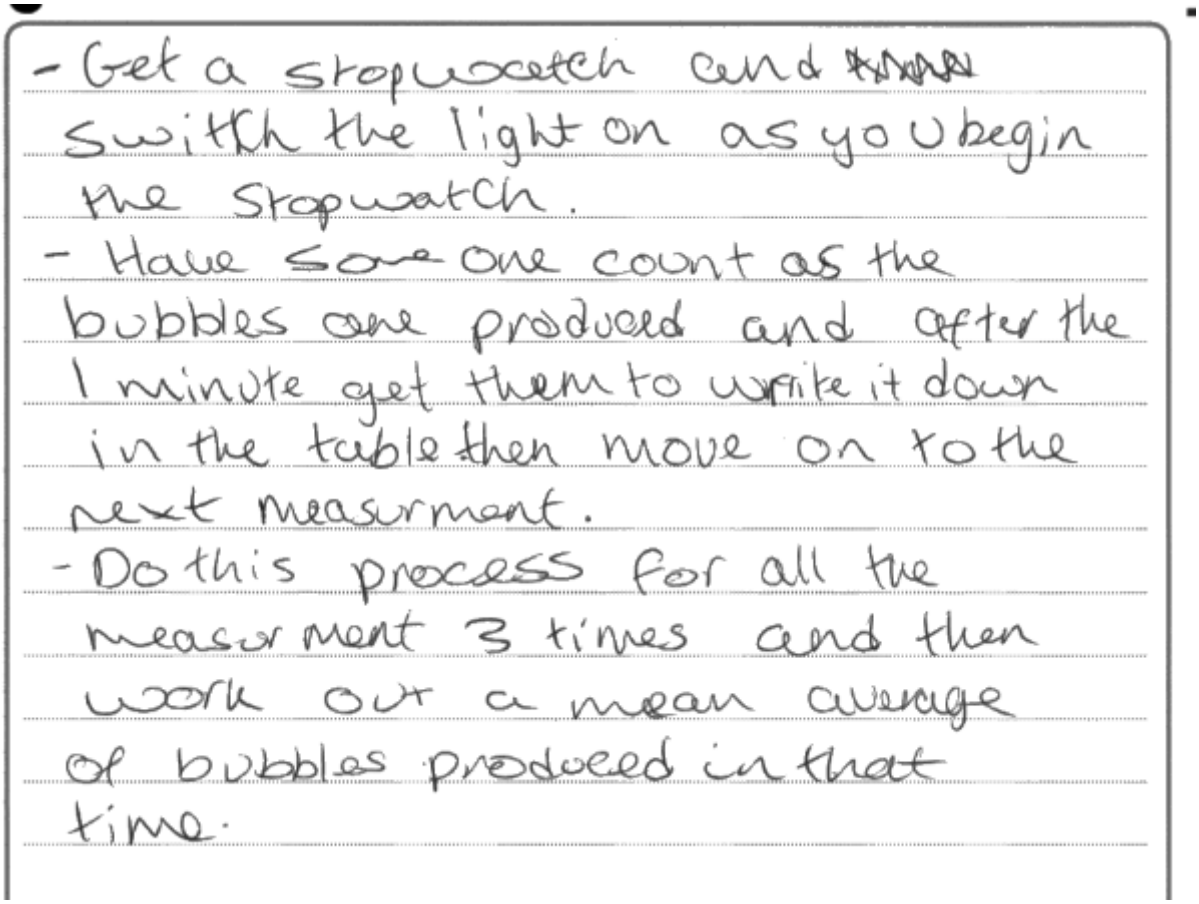
Health and safety
- turn the light off when not in use because ~~it~~ bulbs get hot overtime
- Check the plug to make sure it is safe and the wire
- Becareful using water around electronics ~~appliances~~.

Method -
- Draw ~~3~~ 5 tables with have 3 repeats in. ~~Inclu~~ the tables will be for 1m, ~~25cm, 50cm~~ 0.75m, 0.50m, and 0.25m and 0m.
- There will also be a section in the table for amount of bubbles produced in 1 ~~minute~~ minute.
- set up the lamp so it is 1 meter away from the pond weed

The learner has implied the constants as well as the independent and dependent variables through the method and as such is creditworthy as the type of variable does not need to be identified. The method is otherwise logically ordered but vague in places. The equipment list is not extensive but is sufficient and includes comments on the purpose of each piece of equipment. They have given some health and safety points.
The hypothesis is quite basic and, as it is not supported by scientific theory or reasoning, can only achieve a Level 1. The learner has suggested that the experiment would be repeated 3 times and mentioned data analysis, such as producing tables and averages.
Overall this is the bottom of level 3 and awarded 7 marks.

This response achieved a Level 4 and was awarded 10 Marks


Hypothesis: The further away the lamp is, the higher the number of bubble produced per minute and so a higher light intensity and rate of photosynthesis. This is because as the lamp is further away from the pondweed, the pondweed will receive a lot of energy causing respiration to and photosynthesis to take place. As the pondweed gives off energy, oxygen bubbles are produced. The pondweed will receive more light energy as if it moved closer and more bubbles.



- Get a stopwatch and switch the light on as you begin the stopwatch.
- Have someone count as the bubbles are produced and after the 1 minute get them to write it down in the table then move on to the next measurment.
- Do this process for all the measurment 3 times and then work out a mean average of bubbles produced in that time.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Variables

Independent - distance from the light source (lamp).

Dependent - number of oxygen bubbles produced in one minute.

Control - volume of water, size ~~of pondweed~~ and surface area of pondweed, lamp, temperature, carbon dioxide concentration

Equipment list and their justification

250 cm^3 beaker - to have 200 cm^3 of water in.

Conical flask - to put in the pondweed inside it.

Test tube - to observe the number of bubbles given off per minute.

Lamp with set light intensity - to shine light on the beaker with pondweed.

Stopwatch (±0.01 s) - to time 60 seconds (1 minute).

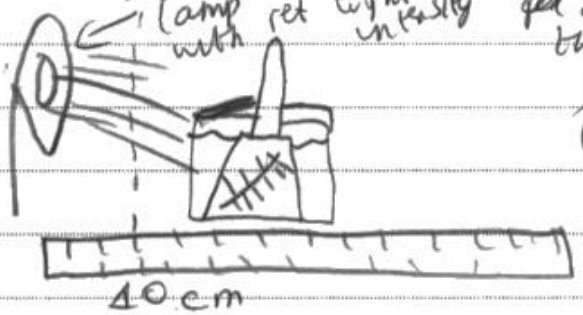
Ruler (m) - to measure distance from the light source to the beaker containing pondweed.

Distilled water - to add 250 cm^3 of this into the beaker. ~~Scissors - to cut the pondweed~~

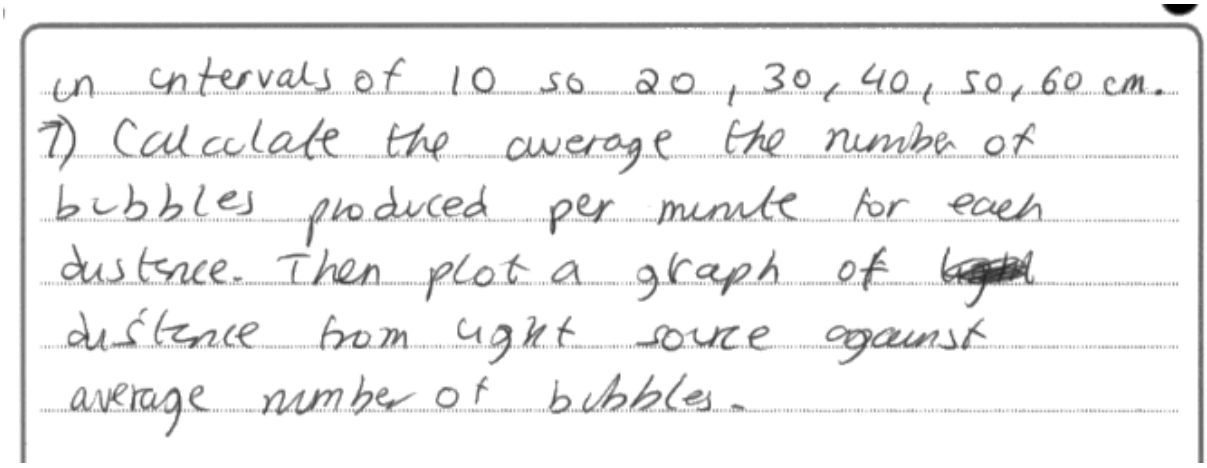
~~Health and Safety~~

~~Broken glassware could occur so you can get cuts so place the equipment at the centre of the table.~~

Scissors - to cut the pondweed
Pondweed - to place this into the beaker of water and this needs to be the same size.
Health and Safety
Broken glassware - you could get cuts so place it on the middle of the table.
Ensure you cut the pondweed carefully without allowing the scissor to touch your skin.
Method
1) Set up the apparatus as shown below. including adding 250 cm3 of water into the beaker, attachem the tube to the flask placing pondweed underneath the conical flask.



2) Ensure the length between the lamp and beaker is 10cm.
3) Leave it up to 5 minutes so that the pondweed accimilitases to the lamp's light intensity.
4) After that, start the stopwatch for one minute and count the number of bubbles given off in this one minute.
5) Repeat steps 2 - 4 two more times.
6) Repeats steps 2 - 5 for different distances


in intervals of 10 so 20, 30, 40, 50, 60 cm.
7) Calculate the average the number of bubbles produced per minute for each distance. Then plot a graph of ~~light~~ distance from light source against average number of bubbles.

The learner's hypothesis demonstrates a lack of scientific knowledge or understanding of photosynthesis even for a level 1 hypothesis. However, the rest of the response is level 4 and so holistically the learner can still be awarded a mark in level 4. The learner has given an independent and dependent variable and some controls. The equipment list is good, and some items have been justified. The method is clear, well illustrated, and provides reference to allowing the plant to adjust to the light source. The learner has suggested that the experiment would be repeated with different light intensities. They have given some health and safety points. There are some comments about data analysis, about calculating the average and plotting a graph. Overall this is the bottom of level 4 and awarded 10 marks.

Question 5

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 growth of cress from seed in different pH solutions. 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 majority of learners achieved a Level 2 on this question and generally focused entirely on the "mistakes" made in the method. Most learners accurately noted no measurements for pH solution given, no repeats performed, unspecified growing times, no explanation of how often to water/how much to use. There was, however, a general lack of explanation of why these "errors" were significant or how they may potentially affect the results. Consideration of these factors was only seen in the answers given by the highest performing candidates on this question.

The amount, dimensions, and arrangement of the cotton wool was a focus for a large number of learners, as was the size and capacity of the beakers used indicating a lack of understanding regarding why variables must be controlled.

A significant number of learners were able to link the idea of only using one seed to the potential for anomalous results, however many candidates did this by incorrectly identifying the lack of growth at pHs 8 and 9 as examples of a possible anomaly.

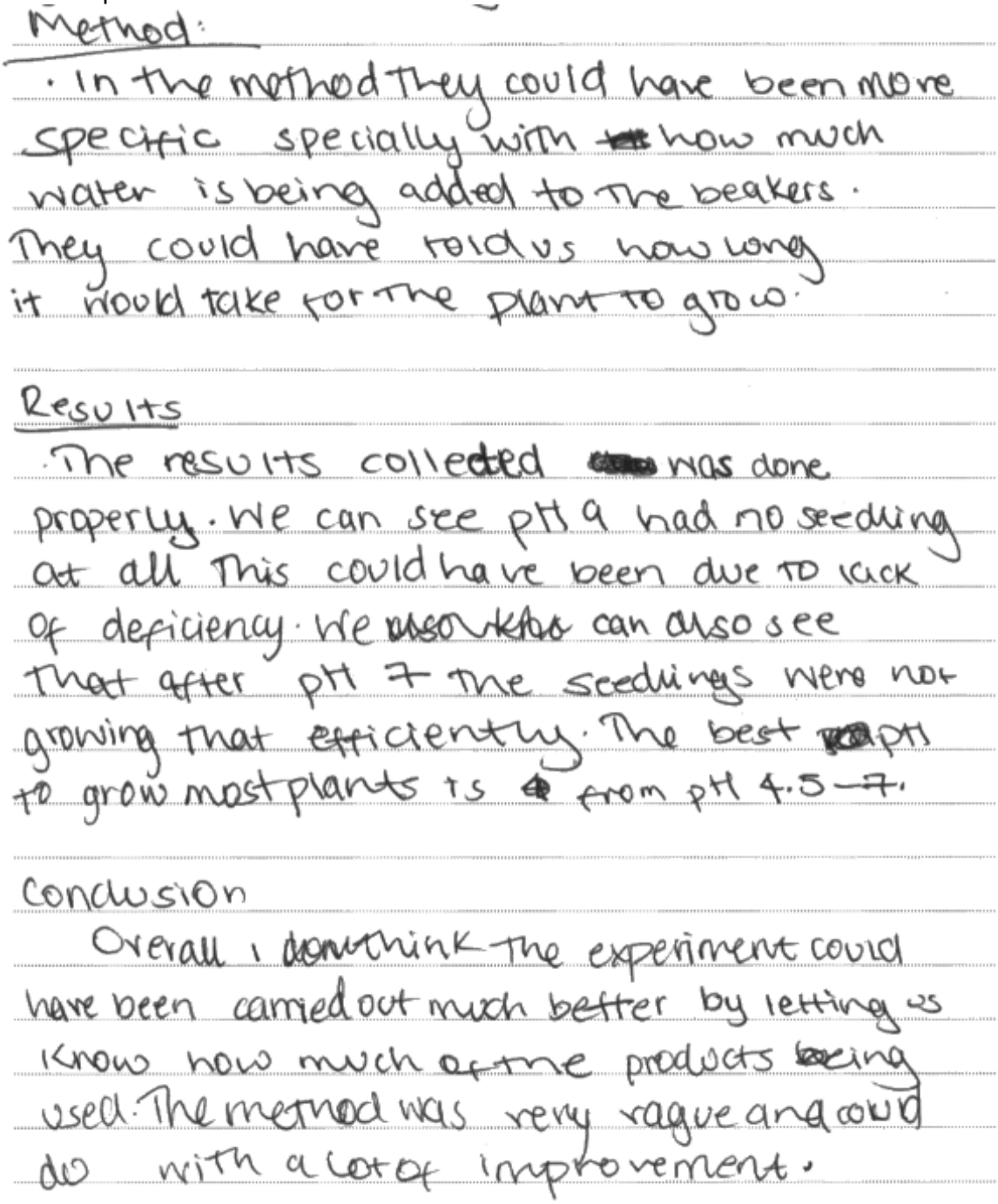
The idea that the candidate should test all pH from 1-14 was fairly common as a suggested improvement and the highest scoring learners identified that smaller intervals between pH values would allow a more reliable conclusion to be drawn from their results. Soil was mentioned as a more suitable replacement for cotton wool by a number of learners, as was the idea of testing pH values outside the given range.

Many of the responses were unfinished, indicating that a large number of learners ran out of time during this question.

Of the lower-scoring responses, many learners provided a commentary of how the practical was carried out rather than an evaluation with little mention of ways to improve the method. Where there was a discussion of the results, learners often focused on the formatting of the graph or the choice of graph, labelling, titles, etc rather than discussing lack of repeats, whether the results supported the conclusions, etc.

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

This response achieved a Level 1 and was awarded 2 Marks



Method:

· In the method they could have been more specific specially with how much water is being added to the beakers. They could have told us how long it would take for the plant to grow.

Results

The results collected was done properly. We can see pH 9 had no seedling at all This could have been due to lack of deficiency. We can also see that after pH 7 the seedlings were not growing that efficiently. The best pH to grow most plants is from pH 4.5–7.

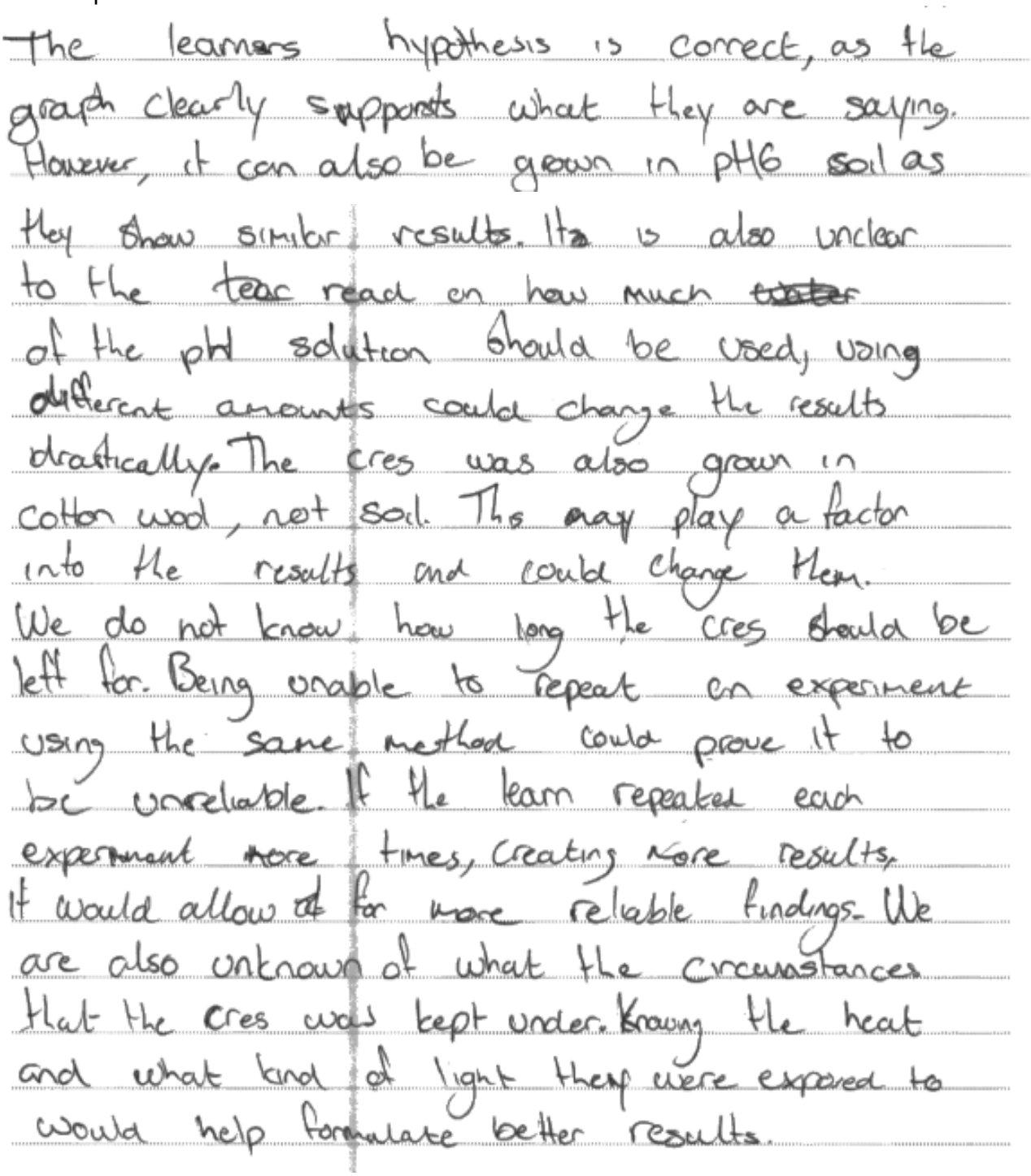
Conclusion

Overall I think the experiment could have been carried out much better by letting us know how much of the products being used. The method was very vague and could do with a lot of improvement.

The learner has made creditworthy comments regarding the control variables and aspects of the method including the amount of water and time grown being unknown.

They have made some reference to the results and conclusion but have failed to mention the lack of repeats or further investigation to find the optimum pH value.

This response achieved a Level 2 and was awarded 5 Marks


The learners hypothesis is correct, as the graph clearly supports what they are saying. However, it can also be grown in pH6 soil as they show similar results. Its is also unclear to the teac read on how much ~~water~~ of the pH solution should be used, using different amounts could change the results drastically. The cres was also grown in cotton wool, not soil. This may play a factor into the results and could change them. We do not know how long the cres should be left for. Being unable to repeat an experiment using the same method could prove it to be unreliable. If the learn repeated each experiment more times, creating more results, it would allow of for more reliable findings. We are also unknown of what the circumstances that the cres was kept under. Knowing the heat and what kind of light they were exposed to would help formulate better results.

The learner has confused conclusion with hypothesis, but in their comments regarding the seeds growing at pH6 have shown the start of an idea to investigate in between the pH values.
They have suggested that the amount of pH solution, the difference cotton wool makes, the length of time it grows for, the number of repeats and the conditions, such as heat and light should have been included in the method and so this is a level 2 response.

This response achieved a Level 3 and was awarded 7 Marks

Method - First of all, the learner didn't state what measurement of beaker to use and the size of cotton to be used. Then, also there are no measurements taken on how much solution is needed, therefore this can make the results collected inaccurate and affects the reliability of the data. Then, we don't exactly know the time limit, so then to measure the height of the cress seedling. Therefore, the method is unproducible and unaccurate.

Results Collected - Since we didn't see any repeated trials, it will be very hard to give a judgement on the results collected. Also, not having at least three trials makes it difficult to see if there are any anomalies, which they need to be ignored when calculating mean value. Therefore, this result is unreliable.

Conclusion - Even though, the learner made a true judgement based on the graph showing cress seedling grow better in soil at pH 7, however adding ranges by starting from acidic level, which is pH 1, can give us a clear results, and will be easier to see. As there are sometimes plants grow in a very acidic soil. Therefore, not repeated results and a brief method with no measurement given makes this experiment unreliable.

The learner has made comments regarding the amounts of solution, the time limit and the effect these have on reliability. Their comments on the results collected is creditworthy at Level 3 as they have mentioned repeats and identified anomalies, even discussing the effect such errors would have on calculating averages. The learner has referred to the idea of looking outside the range to ensure the correct conclusion has been given. Had they also suggested investigating results between the pH values this would have been 8 marks.
Overall 7 marks have been awarded.

Summary

Science Investigation Skills Part B

- Learners should consider their time management during the examination to ensure that they can attempt section B.
- Familiarization with practical methods and the format of written practical methods is beneficial
- Learners should support their hypothesis with scientific knowledge.
- Learners should try to give logical methods with specific values for the independent, dependent and control variables.
- Learners should consider why control variables need to be controlled and how this can be done.
- Learners should justify their equipment choices
- Learners can consider the use of annotated diagrams to support their response.

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