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June 2022

International A Level Biology WBI16 01

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Introduction

In this qualification, candidates are expected to develop further the experimental skills and the knowledge and understanding of experimental techniques they acquired in units 1 and 2, by carrying out a range of practical experiments and investigations while they study units 4 and 5. This unit will assess candidates' knowledge and understanding of the experimental procedures and techniques that were developed in units 1, 2, 4 and 5.

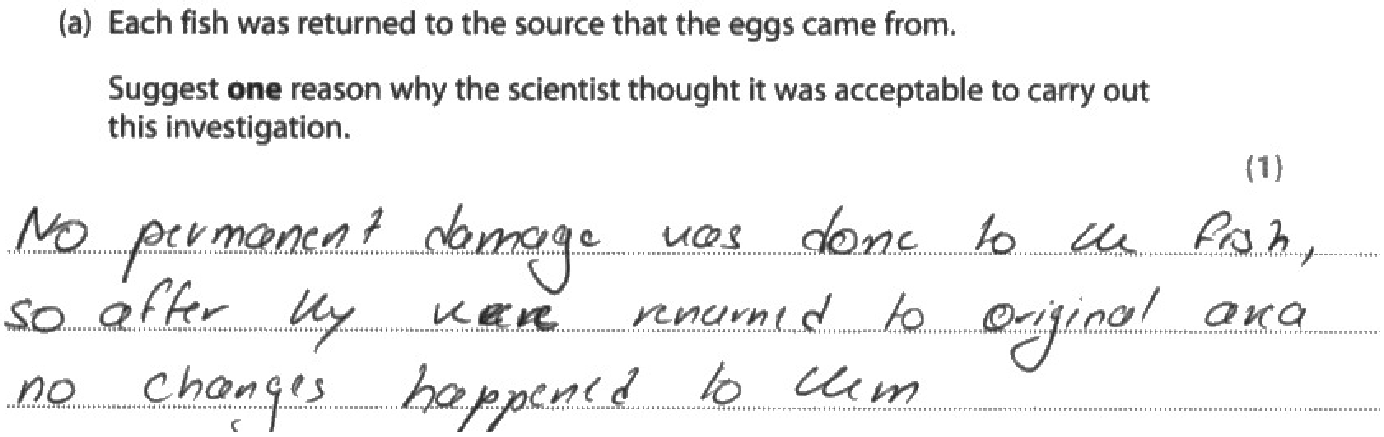
This paper includes short-open, open-response and calculation questions. This paper will include a minimum of 5 marks that target mathematics at Level 2 or above (see Appendix 6: Mathematical skills and exemplifications).

Candidates will be expected to apply their knowledge and understanding of practical skills to familiar and unfamiliar situations.

Question 1 (a)

In this question, candidates were given data related to an investigation that a scientist had carried out to determine the preference of zebrafish for different coloured areas of a T-maze, filled with water.

Candidates were asked for a reason as to why the scientist thought it acceptable to carry out this investigation.



(a) Each fish was returned to the source that the eggs came from.

Suggest **one** reason why the scientist thought it was acceptable to carry out this investigation.

(1)

No permanent damage was done to the fish, so after they were returned to original area no changes happened to them

ResultsPlus
Examiner Comments

This response was awarded the 1 mark for clearly suggesting that the fish were not harmed.

(a) Each fish was returned to the source that the eggs came from.

Suggest **one** reason why the scientist thought it was acceptable to carry out this investigation.

(1)

As zebra fish have a simple nervous system so they don't ~~feel~~ feel ~~most~~ much pain,

Examiner Comments

This is an example of a response that was awarded zero marks. The candidate has used information from the question to answer the question.

(a) Each fish was returned to the source that the eggs came from.

Suggest **one** reason why the scientist thought it was acceptable to carry out this investigation.

(1)

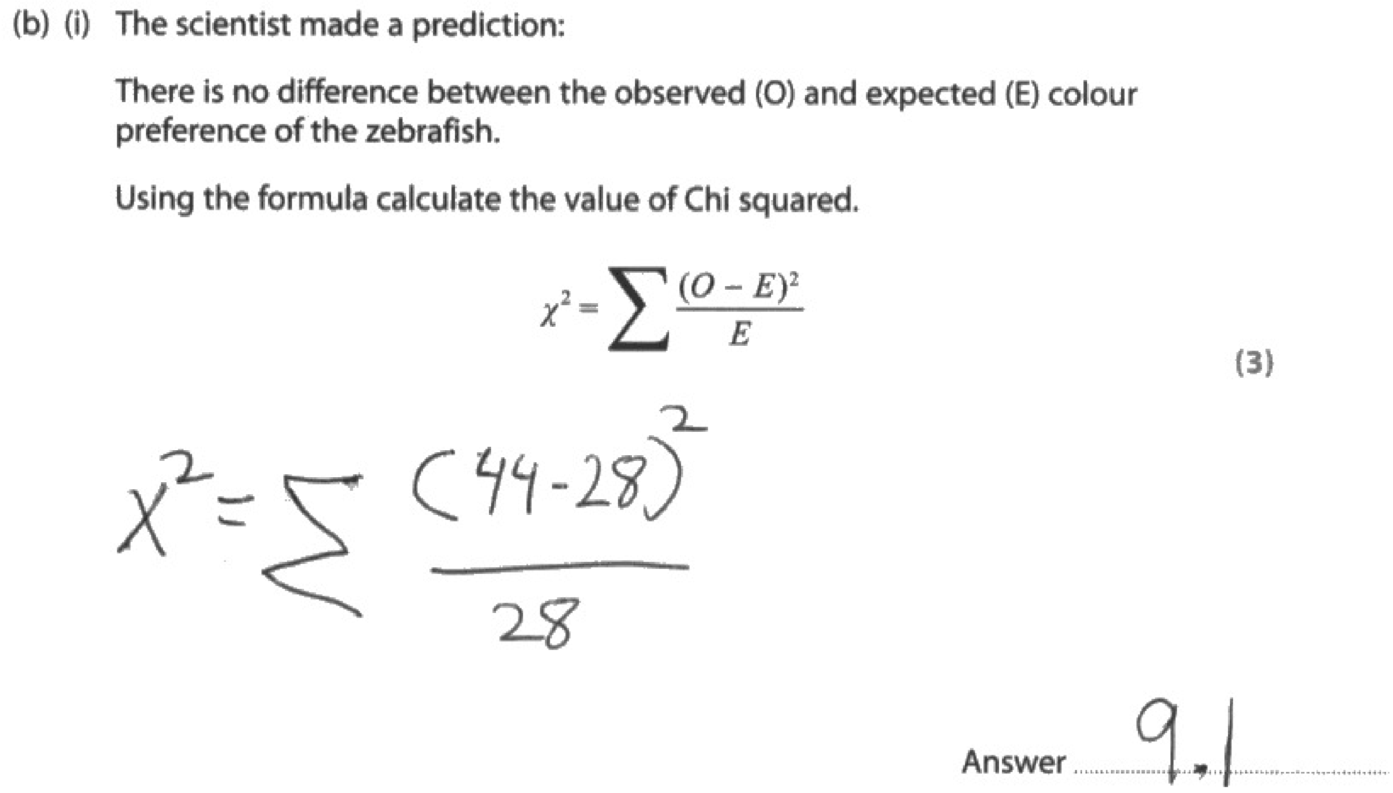
Because it is ethically acceptable, meaning no animals (zebra-fish) were harmed during this investigation.

Examiner Comments

This is a response that was awarded the 1 mark. However, the comment about being ethical was not relevant to this question.

Question 1 (b)(i)

In this calculation question, candidates were asked to use the formula given to calculate the value of Chi squared.



(b) (i) The scientist made a prediction:

There is no difference between the observed (O) and expected (E) colour preference of the zebrafish.

Using the formula calculate the value of Chi squared.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

(3)

$$\chi^2 = \sum \frac{(44-28)^2}{28}$$

Answer 9.1

ResultsPlus
Examiner Comments

This is an example of a response that was awarded zero marks. The candidate did not show any of the stages needed to gain marks.

ResultsPlus
Examiner Tip

Candidates need to perform this calculation by hand so they can answer this type of question under exam conditions.

(b) (i) The scientist made a prediction:

There is no difference between the observed (O) and expected (E) colour preference of the zebrafish.

Using the formula calculate the value of Chi squared.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

(3)

expected

green area	Red area
36	36

~~$\chi^2 = \Sigma$~~

$$\chi^2 = \frac{(44-36)^2}{36} + \frac{(28-36)^2}{36}$$

$$\chi^2 = \frac{16}{9} + \frac{16}{9} = \frac{32}{9} = 3.56$$

Answer 3.56

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate has given the calculation of 36 and then the correct use of the formula and a final answer.

in the care of the scientists ⇒ ~~[illegible]~~ ethical treatment of fish

(b) (i) The scientist made a prediction:

There is no difference between the observed (O) and expected (E) colour preference of the zebrafish.

1296

Using the formula calculate the value of Chi squared.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

(3)

$$x^2 = \sum \frac{(72-36)^2}{36} = \sum \frac{~~[illegible]~~\ 1296}{36} = 36$$

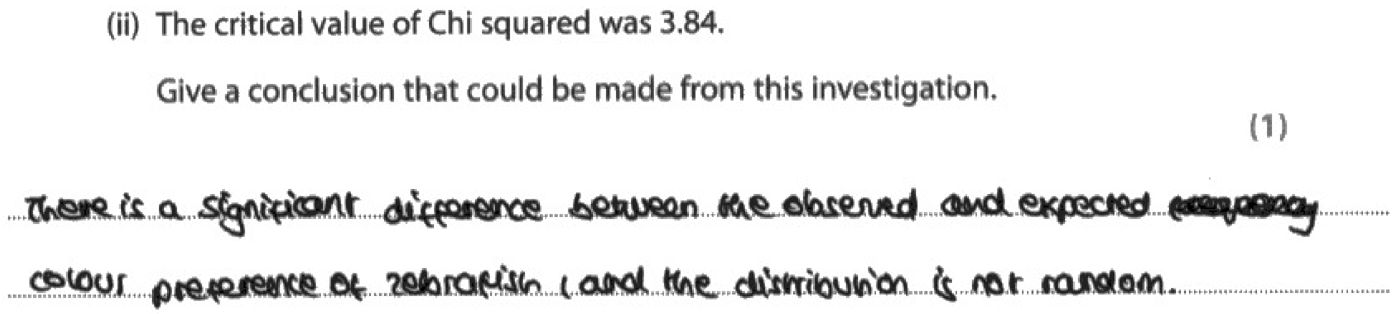
Answer 6^2

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. The candidate has gained a mark for showing evidence of calculating the expected value of 36.

Question 1 (b)(ii)

In this question, candidates were asked to give a suitable conclusion using the Chi squared value they calculated compared to the critical value.



(ii) The critical value of Chi squared was 3.84.

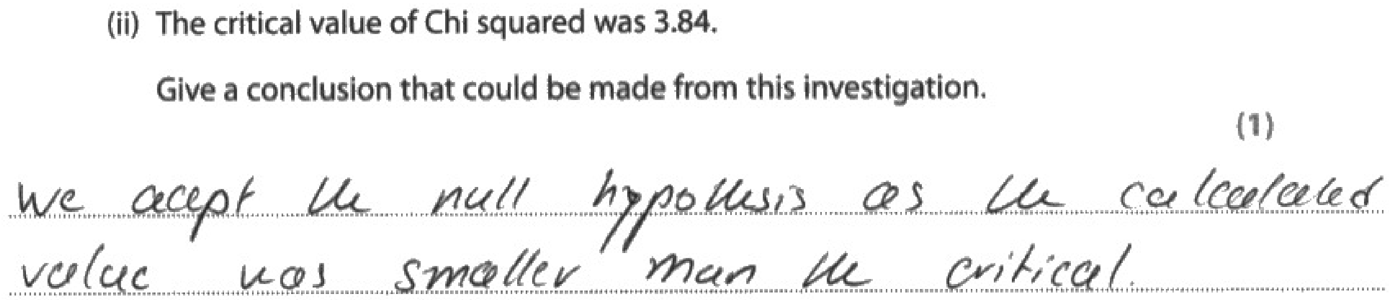
Give a conclusion that could be made from this investigation.

(1)

There is a significant difference between the observed and expected [illegible] colour preference of zebrafish (and the distribution is not random.

ResultsPlus
Examiner Comments

This response was awarded zero marks. The candidate does not indicate a comparison of the calculated and critical values.



(ii) The critical value of Chi squared was 3.84.

Give a conclusion that could be made from this investigation.

(1)

we acept the null hypothesis as the calculated value was smaller than the critical.

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Examiner Comments

This response was awarded the 1 mark.

Question 1 (c)

This was a two-part question. Candidates were required to identify a relevant abiotic variable, state how to control it and suggest what effect it might have if it was not controlled.

(c) (i) State **one** abiotic variable that could affect the results of this investigation.

(1)

Abiotic variable

food supply/availability

(ii) Describe how this abiotic variable could be controlled and the effect it could have on the results if it is not controlled.

(2)

Variable

food supply/availability

Describe how this variable is controlled

Equal masses of the same type of food should be placed in the green and red area

Describe the effect it could have on the results if it is not controlled.

The results would be invalid

ResultsPlus
Examiner Comments

This is a response that was awarded zero marks for part (i) and 1 mark for part (ii). The candidate did not select an abiotic variable for part (i). However, they did gain a mark for suggesting the results would not be valid for part (ii).

(c) (i) State **one** abiotic variable that could affect the results of this investigation.

(1)

Abiotic variable

Light intensity

(ii) Describe how this abiotic variable could be controlled and the effect it could have on the results if it is not controlled.

(2)

Variable

~~Block ambient~~ Light intensity

Describe how this variable is controlled

- Block ambient light and provide lamps on all sides

Describe the effect it could have on the results if it is not controlled.

- Results will not be valid
- Light being more intense on one side may cause zebrafish to prefer it.

ResultsPlus
Examiner Comments

This is a response that was awarded the mark for part (i) and 1 mark for part (ii). The candidate correctly identified light intensity as an abiotic variable for part (i). However the control was not clearly stated for part (ii).

(c) (i) State **one** abiotic variable that could affect the results of this investigation.

(1)

Abiotic variable

Temperature

(ii) Describe how this abiotic variable could be controlled and the effect it could have on the results if it is not controlled.

(2)

Variable

Temperature

Describe how this variable is controlled

Thermostatically controlled room or waterbath

Describe the effect it could have on the results if it is not controlled.

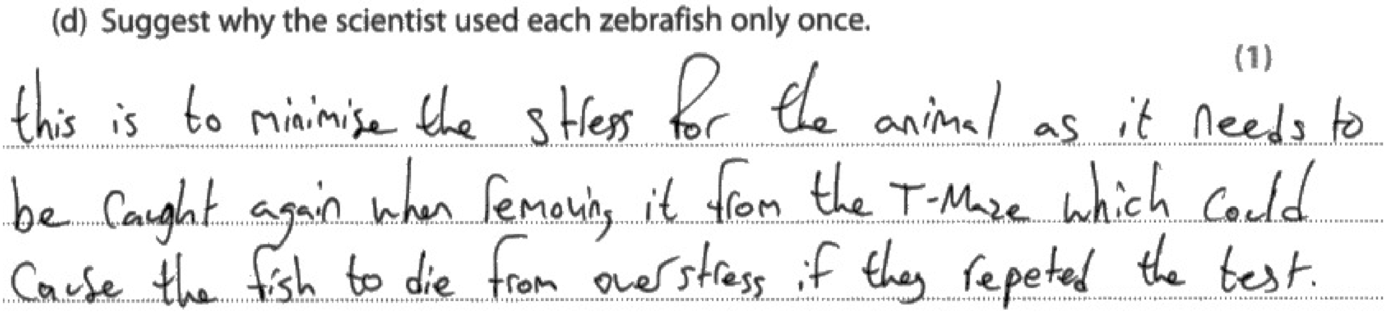
Results are not valid

ResultsPlus
Examiner Comments

This is a response that was awarded the full marks for part (i) and part (ii).

Question 1 (d)

Candidates were asked to suggest why each fish should only be used once in the choice chamber.



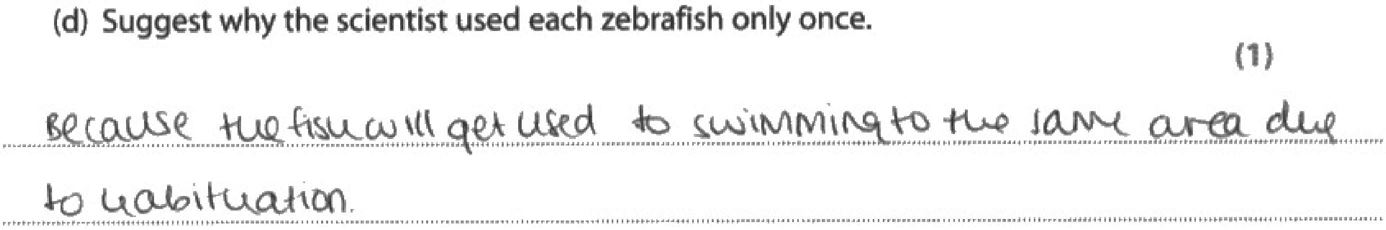
(d) Suggest why the scientist used each zebrafish only once.

(1)

this is to minimise the stress for the animal as it needs to be caught again when removing it from the T-Maze which could cause the fish to die from overstress if they repeted the test.

ResultsPlus
Examiner Comments

This response was awarded the 1 mark. The candidate correctly suggested the fish might become stressed if they were used more than once.



(d) Suggest why the scientist used each zebrafish only once.

(1)

Because the fish will get used to swimming to the same area due to habituation.

ResultsPlus
Examiner Comments

This response was awarded the 1 mark. The candidate correctly suggested the possibility of habituation.

of the 2 zones wouldn't be investigated

(d) Suggest why the scientist used each zebrafish only once.

(1)

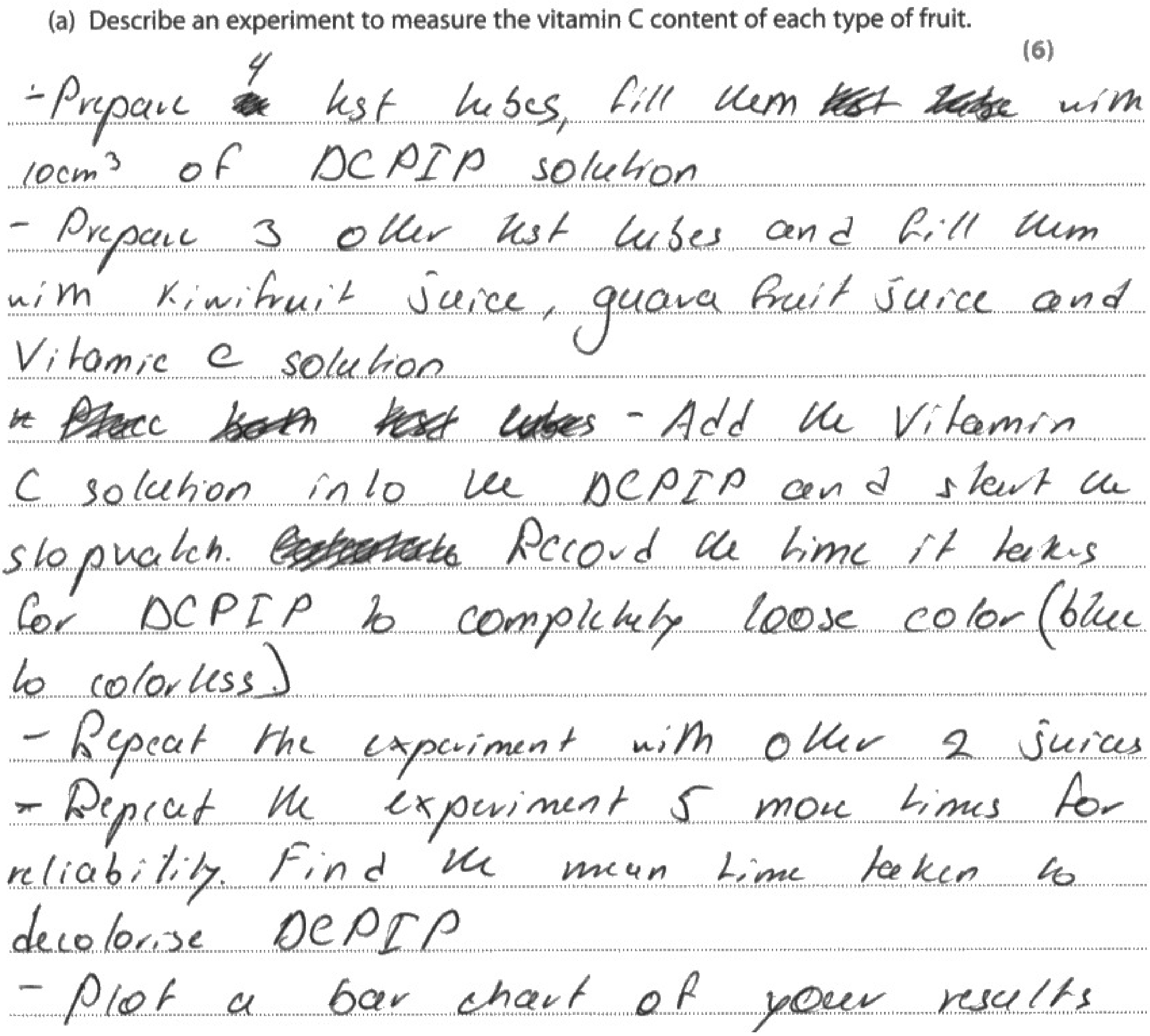
Because the fish may be able to memmorize where it went and in that way invalidate the results

ResultsPlus
Examiner Comments

This response was awarded the 1 mark. The candidates has correctly suggested learning might take place.

Question 2 (a)

In this question, candidates were told a student investigated the vitamin C content present in kiwifruits and guava fruits. Candidates were asked to describe an experiment to measure the vitamin C content of each type of fruit. Many candidates did not clearly state that DCPIP changes from blue to colourless with the addition of vitamin C. To just say DCPIP becomes colourless was not creditworthy.



(a) Describe an experiment to measure the vitamin C content of each type of fruit.

(6)

- Prepare ~~a~~ 4 test tubes, fill them ~~test tube~~ with $10cm^3$ of DCPIP solution
- Prepare 3 other test tubes and fill them with kiwifruit juice, guava fruit juice and Vitamin C solution
~~Place both test tubes~~ - Add the Vitamin C solution into the DCPIP and start the stopwatch. ~~[illegible]~~ Record the time it takes for DCPIP to completely loose color (blue to colorless)
- Repeat the experiment with other 2 juices
- Repeat the experiment 5 more times for reliability. Find the mean time taken to decolorise DCPIP
- Plot a bar chart of your results

ResultsPlus
Examiner Comments

This is a response that was awarded 3 marks.

(a) Describe an exemplary experiment to measure the vitamin C content of each type of fruit.

(6)

dependant variable : the volume of fresh fruit juice needed to decolorise a DCPIP solution

begin the experiment by blending samples of Kiwifruit and guava fruit seperately, make sure the fruits are the same age, filter the solid part out to obtain fruit juice, use a syringe to add the juice's seperately to ~~2~~ two 5 cm^3 DCPIP solutions, noting the volume of juice needed to decolorise the solution from blue to colorless, keep the concentration and volume of DCPIP solution the same, keep the temperature the same using a thermostatically controlled water bath, afterwards use a standard solution of 1g dm^{-3} vitamin C solution ~~to decolorise~~ in a syringe and add it drop by drop to 5cm^3 of the DPIP solution, noting the volume needed to decolorise it, repeat each run (kiwi fruit, guava, Vitamin C solution) multiple times and calculate a mean, calculate the vitamin C content of each fruit by multiplying the concentration of the vitamin C solution by the volume needed to decolorise the DCPIP in dm^3, to obtain the mass of vitamin C in the vitamin C solution needed to decolorise 2cm^3 DCPIP, divide this by the volume of vitamin C solution used and multiply it by [illegible] each to obtain the vitamin C content of each juice per 100cm^3

ResultsPlus
Examiner Comments

This is a response that was awarded the full 6 marks. The candidate has given a clear and comprehensive answer.

(a) Describe an experiment to measure the vitamin C content of each type of fruit.

(6)

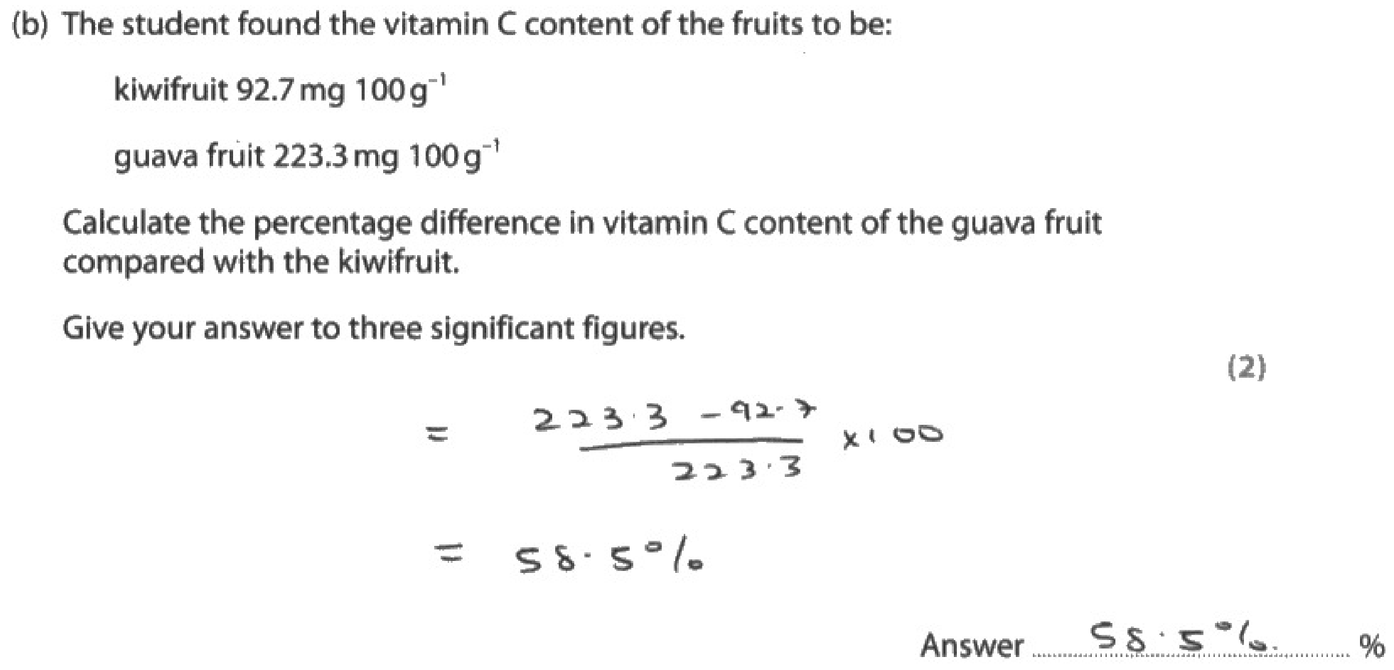
Crush the fruits using pestal and mortar and mix them with water to form a solution. use a Pippete to add DCPIP to the solution 1 drop at a time. ~~Measure~~ Note the volume of DCPIP added at which the solution turns from blue to colourless, repeat the experiment controlling the size of the fruits and calculate average, also repeat at different concentrations of DCPIP

ResultsPlus
Examiner Comments

This is a response that was awarded 4 marks.

Question 2 (b)

In this question, candidates were asked to calculate the percentage difference in vitamin C content of the guava fruit compared with the kiwifruit.



(b) The student found the vitamin C content of the fruits to be:

kiwifruit 92.7 mg $100\,g^{-1}$

guava fruit 223.3 mg $100\,g^{-1}$

Calculate the percentage difference in vitamin C content of the guava fruit compared with the kiwifruit.

Give your answer to three significant figures.

(2)

$$= \frac{223.3 - 92.7}{223.3} \times 100$$

$$= 58.5\%$$

Answer 58.5% %

ResultsPlus
Examiner Comments

This is an example of a response that was awarded the full 2 marks for a correct calculation.

(b) The student found the vitamin C content of the fruits to be:

kiwifruit 92.7 mg 100 g^{-1}

guava fruit 223.3 mg 100 g^{-1}

Calculate the percentage difference in vitamin C content of the guava fruit compared with the kiwifruit.

Give your answer to three significant figures.

(2)

$$\frac{223 \cdot 3 - 92 \cdot 7}{92 \cdot 7} \times 100$$

$$= \underline{\underline{140 \cdot 8}} \;\%$$

Answer ......141...... %

ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. The candidate has given an alternative calculation.

(b) The student found the vitamin C content of the fruits to be:

kiwifruit 92.7 mg 100 g^{-1}

guava fruit 223.3 mg 100 g^{-1}

Calculate the percentage difference in vitamin C content of the guava fruit compared with the kiwifruit.

Give your answer to three significant figures.

(2)

$$\frac{223.3}{92.7} \times 100 = 240.8 \ldots$$
$$= 249$$

Answer 241 %

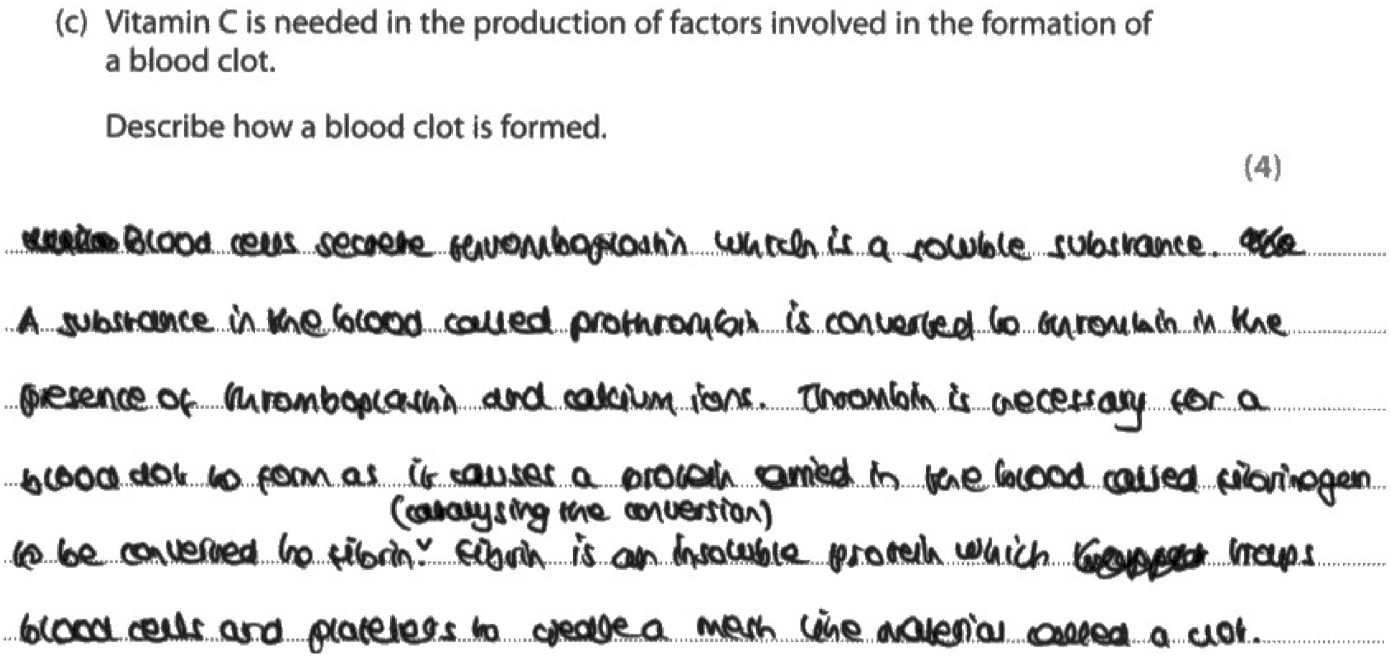
ResultsPlus
Examiner Comments

This is an example of a response that was awarded zero marks.

Question 2 (c)

In this question, candidates were asked to describe how a blood clot is formed.

The majority of candidates described the events in an appropriate order. However, many candidates did not identify the role of thromboplastin.



(c) Vitamin C is needed in the production of factors involved in the formation of a blood clot.

Describe how a blood clot is formed.

(4)

Blood cells secrete thromboplastin which is a soluble substance. A substance in the blood called prothrombin is converted to thrombin in the presence of thromboplastin and calcium ions. Thrombin is necessary for a blood clot to form as it causes a protein carried in the blood called fibrinogen to be converted to fibrin (catalysing the conversion). Fibrin is an insoluble protein which traps blood cells and platelets to create a mesh like material called a clot.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks.

(c) Vitamin C is needed in the production of factors involved in the formation of a blood clot.

Describe how a blood clot is formed.

(4)

Thromboplastin is an enzyme responsible for the conversion of prothrombin to thrombin. Thrombin then converts fibrinogen to fibrin which is what forms the mesh at wounds to stop blood loss. Platelets also gather to trap the plasma and blood cells. The fibrin mesh hardens to form a scab until new tissue is formed Calcium ions are also required for the conversion of prothrombin to thrombin.

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Examiner Comments

This is a response that was awarded 3 marks. The candidate mentioned thromboplastin but did not make it clear what was being trapped by the fibrin mesh.

(c) Vitamin C is needed in the production of factors involved in the formation of a blood clot.

Describe how a blood clot is formed.

(4)

released by Platelets

the biologically inactive prothrombin is converted into the enzyme thrombin catalysed by thromboplastin enzyme and Ca^{2+} ions, the enzyme thrombin catalyses the formation of insoluble fibrin from the soluble plasma protein fibrinogen, the fibrin forms a mesh trapping red blood cells and platelets forming the clot, the ~~these~~ fibrinogen binds to the active site of thrombin forming an enzyme substrate complex, lowering the activation energy for the conversion of fibrinogen into fibrin

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. The candidate has correctly trapped red blood cells in the mesh.

Question 3 (a)

In this question, candidates were asked to write a null hypothesis for an investigation that observed the effect that wind had on the bending of plants.

(a) State a suitable null hypothesis for this investigation.

(1)

There is no significant difference between the means of experimental group stem diameters and controll group.

ResultsPlus
Examiner Comments

This is an example of a response that was awarded the 1 mark for a clear nul hypothesis.

(a) State a suitable null hypothesis for this investigation.

(1)

There is no significant correlation between the bending of sunflowers and the diameters of their stem.

ResultsPlus
Examiner Comments

This is an example of a response that was awarded zero marks. Reference to a correlation was incorrect.

(a) State a suitable null hypothesis for this investigation.

(1)

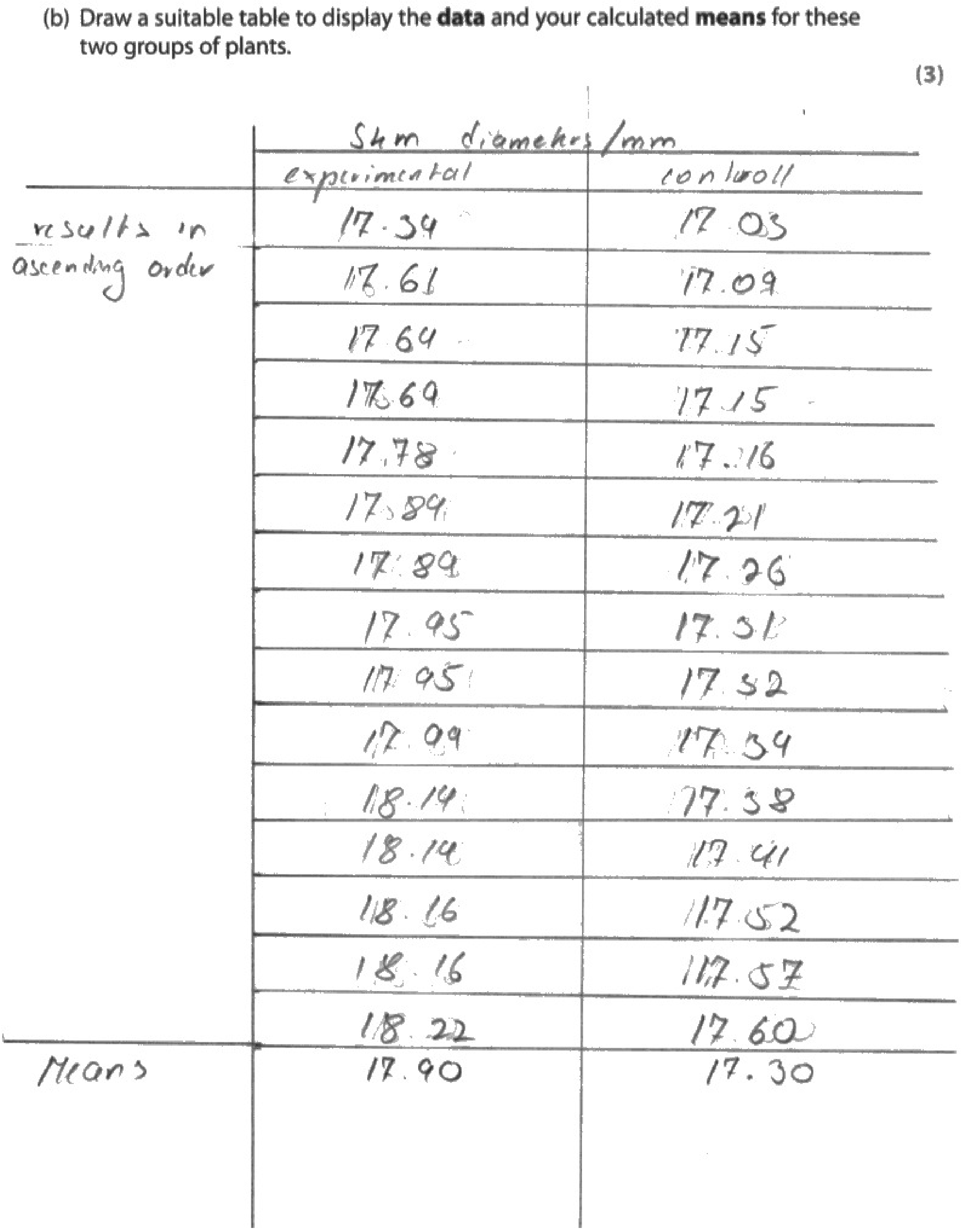
There is no significant difference between diameters of the stem in experimental group and control group.

ResultsPlus
Examiner Comments

This is a response that was awarded the 1 mark for a correct statement.

Question 3 (b)(c)

In this two-part question, candidates were asked to tabulate data in part (b) and then draw a suitable graph in part (c).



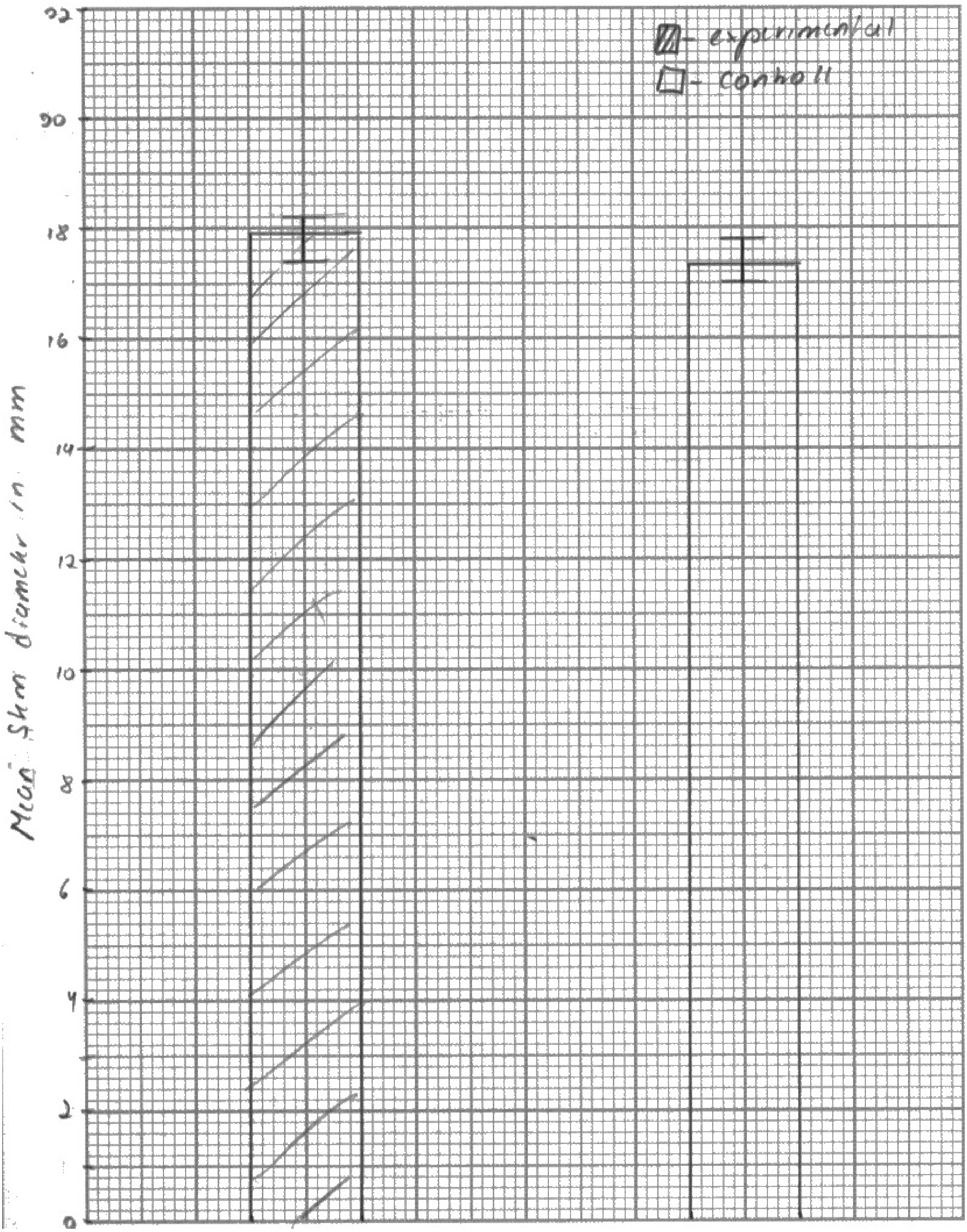
(b) Draw a suitable table to display the **data** and your calculated **means** for these two groups of plants.

(3)

	Stem diameters / mm	
	experimental	controll
results in ascending order	17.34	17.03
	17.61	17.09
	17.64	17.15
	17.69	17.15
	17.78	17.16
	17.89	17.21
	17.89	17.26
	17.95	17.31
	17.95	17.32
	17.99	17.34
	18.14	17.38
	18.14	17.41
	18.16	17.52
	18.16	17.57
	18.22	17.60
Means	17.90	17.30

(c) Plot a suitable graph to show the mean diameter of the stems for each group of plants. Include an indication of the variability of these data.

(3)



ResultsPlus
Examiner Comments

This response was awarded the full 3 marks for part (b) and 2 marks for part (c). The data was tabulated correctly, and the means calculated. The graph was the correct format but one of the error bars was not correctly plotted.

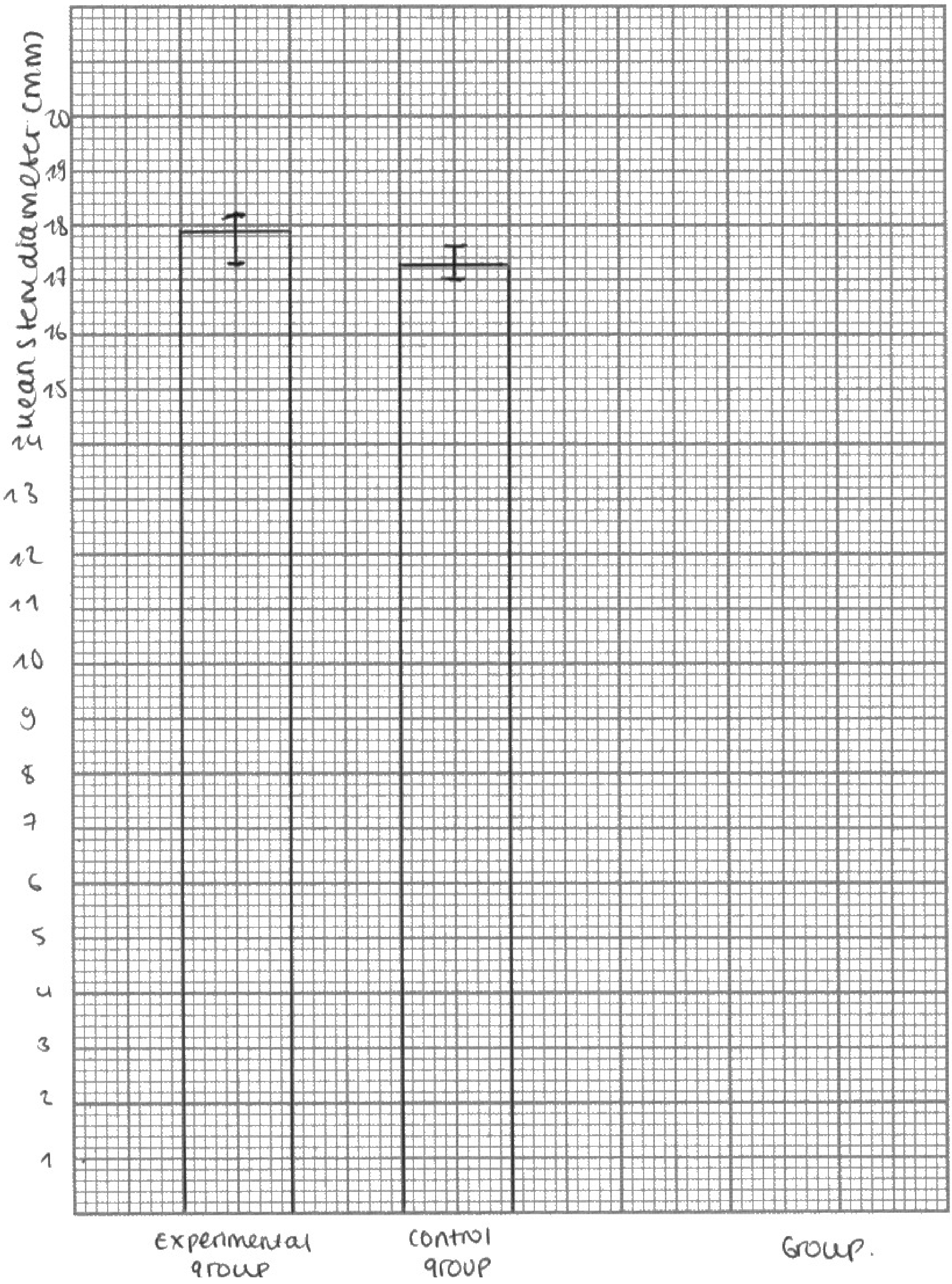
(b) Draw a suitable table to display the **data** and your calculated **means** for these two groups of plants.

(3)

	Experimental group stem diameter (mm)	control group stem diameters (mm)
	17,34	17,15
	18,16	17,52
	17,61	17,57
	18,14	17,03
	17,64	17,26
	18,14	17,31
	17,95	17,09
	17,78	17,38
	17,69	17,41
	17,84	17,21
	17,99	17,34
	17,95	17,16
	17,89	17,15
	18,16	17,32
	18,22	17,6.
Mean	17,9	17,3

(c) Plot a suitable graph to show the mean diameter of the stems for each group of plants. Include an indication of the variability of these data.

(3)



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Examiner Comments

This is a response that was awarded the full 3 marks for both part (b) and part (c) for a clear table and graph.

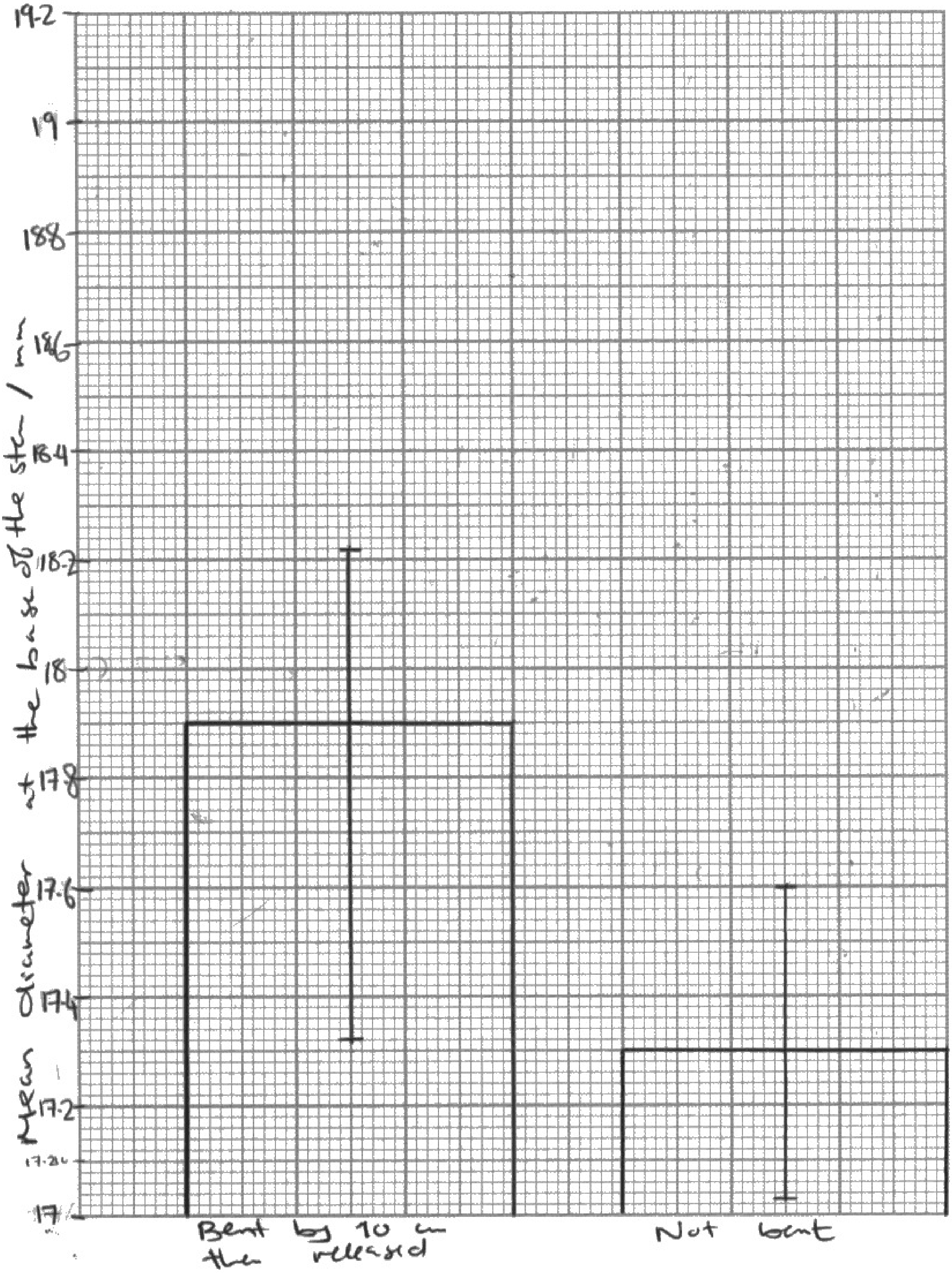
(b) Draw a suitable table to display the **data** and your calculated **means** for these two groups of plants.

(3)

Condition	diameter of the stem at the base/mm	
	For each plant	Mean
bent by 10 cm then released	17.34 17.69 18.16 17.84 17.61 17.99 18.14 17.95 17.64 17.89 18.14 18.16 17.95 18.22 17.78	17.90
Not bent	17.38 17.66 17.09 17.32 17.31 17.15 17.26 17.16 17.03 17.34 17.57 17.21 17.52 17.41 17.15	17.30

(c) Plot a suitable graph to show the mean diameter of the stems for each group of plants. Include an indication of the variability of these data.

(3)



ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks for part (b) and 2 marks for part (c). The graph did not start the y axis at zero.

ResultsPlus
Examiner Tip

Bar graphs should always have a linear scale on the y axis starting at zero.

Question 3 (d)(i)

In this question, candidates were asked to calculate the value of *t* using the formula.

(d) The student analysed this data with a *t* test using the formula:

$$t = \frac{(\bar{x}_A - \bar{x}_B)}{\sqrt{\frac{(S_A)^2}{n_A} + \frac{(S_B)^2}{n_B}}}$$

where:

$\bar{x}$ is the mean value for each group of plants

n is the number of samples for each group of plants

$(S_A)^2 = 0.03$ and $(S_B)^2 = 0.06$

(i) Calculate the value of *t*.

(2)

$$t = \frac{17.9 - 17.3}{\sqrt{\frac{0.03^2}{15} + \frac{0.06^2}{15}}} = 34.64$$

Answer 34.64

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Examiner Comments

This is a response that was awarded 1 mark. The values given were already squared and the candidate squared them again. However, the formula was correctly applied.

(d) The student analysed this data with a t test using the formula:

$$t = \frac{(\bar{x}_A - \bar{x}_B)}{\sqrt{\frac{(S_A)^2}{n_A} + \frac{(S_B)^2}{n_B}}}$$

where:

$\bar{x}$ is the mean value for each group of plants

n is the number of samples for each group of plants

$(S_A)^2 = 0.03$ and $(S_B)^2 = 0.06$

(i) Calculate the value of t.

(2)

$$\frac{(17.3 - 17.9)}{\sqrt{\frac{0.03}{15} + \frac{0.06}{15}}}$$

$$\frac{-0.6}{\sqrt{\frac{0.09}{15}}} \qquad \frac{-0.6}{\sqrt{0.006}}$$

Answer 7.75

0.066

0.077.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. The candidate correctly applied the formula to the data given.

(d) The student analysed this data with a *t* test using the formula:

$$t = \frac{(\bar{x}_A - \bar{x}_B)}{\sqrt{\frac{(S_A)^2}{n_A} + \frac{(S_B)^2}{n_B}}}$$

where:

$\bar{x}$ is the mean value for each group of plants

n is the number of samples for each group of plants

$(S_A)^2 = 0.03$ and $(S_B)^2 = 0.06$

(i) Calculate the value of *t*.

(2)

$$t = \frac{(17.90 - 17.30)}{\sqrt{\frac{0.03}{15} + \frac{0.06}{15}}} = 7.7$$

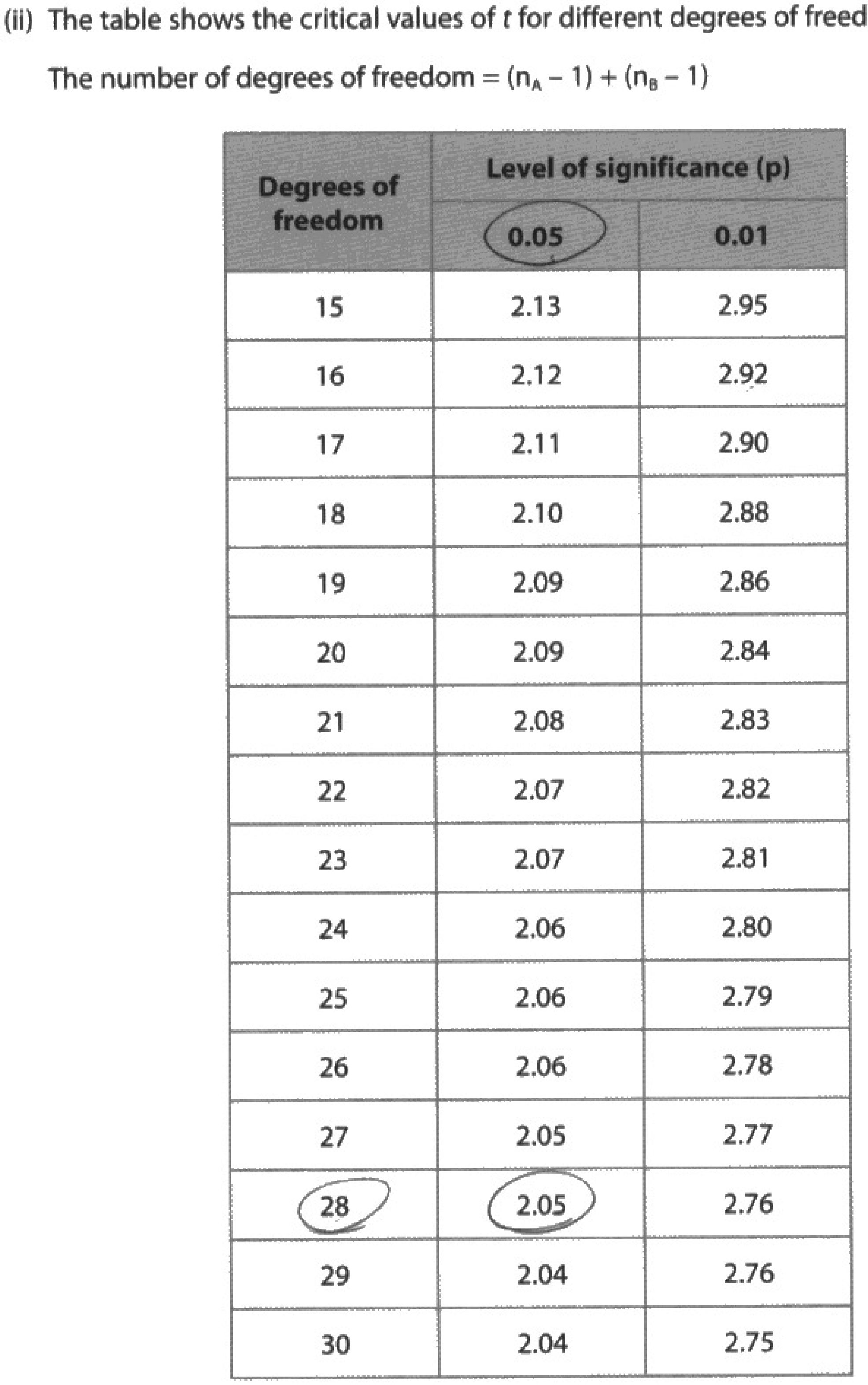
Answer 7.7

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. The formula was correctly applied. However, the values of *t* are always given to two places. The mark was given for the calculation.

Question 3 (d)(ii)

Candidates were asked to use the information given, and their calculated value of *t*, to give a suitable conclusion to this investigation.



(ii) The table shows the critical values of *t* for different degrees of freedom.

The number of degrees of freedom = $(n_A - 1) + (n_B - 1)$

Degrees of freedom	**Level of significance (p)**	
	0.05	**0.01**
15	2.13	2.95
16	2.12	2.92
17	2.11	2.90
18	2.10	2.88
19	2.09	2.86
20	2.09	2.84
21	2.08	2.83
22	2.07	2.82
23	2.07	2.81
24	2.06	2.80
25	2.06	2.79
26	2.06	2.78
27	2.05	2.77
28	2.05	2.76
29	2.04	2.76
30	2.04	2.75

Deduce the conclusions that can be drawn from this investigation.
Use your graph and the information in the table to support your answer.

(2)

I reject the null hypothesis as the ~~th~~obtained value of 7.75 is higher than the critical value of 2.05 which means ther is a significant difference between the mean diameter of stems between both groups

ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. The candidate selected the correct critical value. Candidates could either identify it on the table or state it in their written answers. This candidate made the correct deduction.

(ii) The table shows the critical values of *t* for different degrees of freedom.

The number of degrees of freedom = $(n_A - 1) + (n_B - 1)$

Degrees of freedom	Level of significance (p)	
	0.05	0.01
15	2.13	2.95
16	2.12	2.92
17	2.11	2.90
18	2.10	2.88
19	2.09	2.86
20	2.09	2.84
21	2.08	2.83
22	2.07	2.82
23	2.07	2.81
24	2.06	2.80
25	2.06	2.79
26	2.06	2.78
27	2.05	2.77
28	2.05	2.76
29	2.04	2.76
30	2.04	2.75

Deduce the conclusions that can be drawn from this investigation.
Use your graph and the information in the table to support your answer.

(2)

There is a significant difference between the control and experimental group as the value of T test is 7.75 which is higher than p at 28 for 0.05 (2.05), therefore the results are significant. The experimental group had larger diameter than the control group.

ResultsPlus
Examiner Comments

This response was awarded 1 mark. The candidate did not reject the null hypothesis so only one mark could be gained.

Question 3 (e)

In this question, candidates were asked to suggest reasons why conclusions drawn from this investigation might not be valid.

(e) Explain why it may **not** be reasonable to draw valid conclusions from the results of this investigation.

(2)

~~Hot~~ results may be due to abiotic factors and the stems bend to reach light or due to plant hormones IAA or giberellin.
Different ages. Not enough valid data
Accuracy of 10cm bend may not be accurate due to human bias.

ResultsPlus
Examiner Comments

This is a response that was awarded zero marks. The candidate did not identify any reasons as to why it may not be possible to draw valid conclusion from the investigation.

(e) Explain why it may **not** be reasonable to draw valid conclusions from the results of this investigation.

(2)

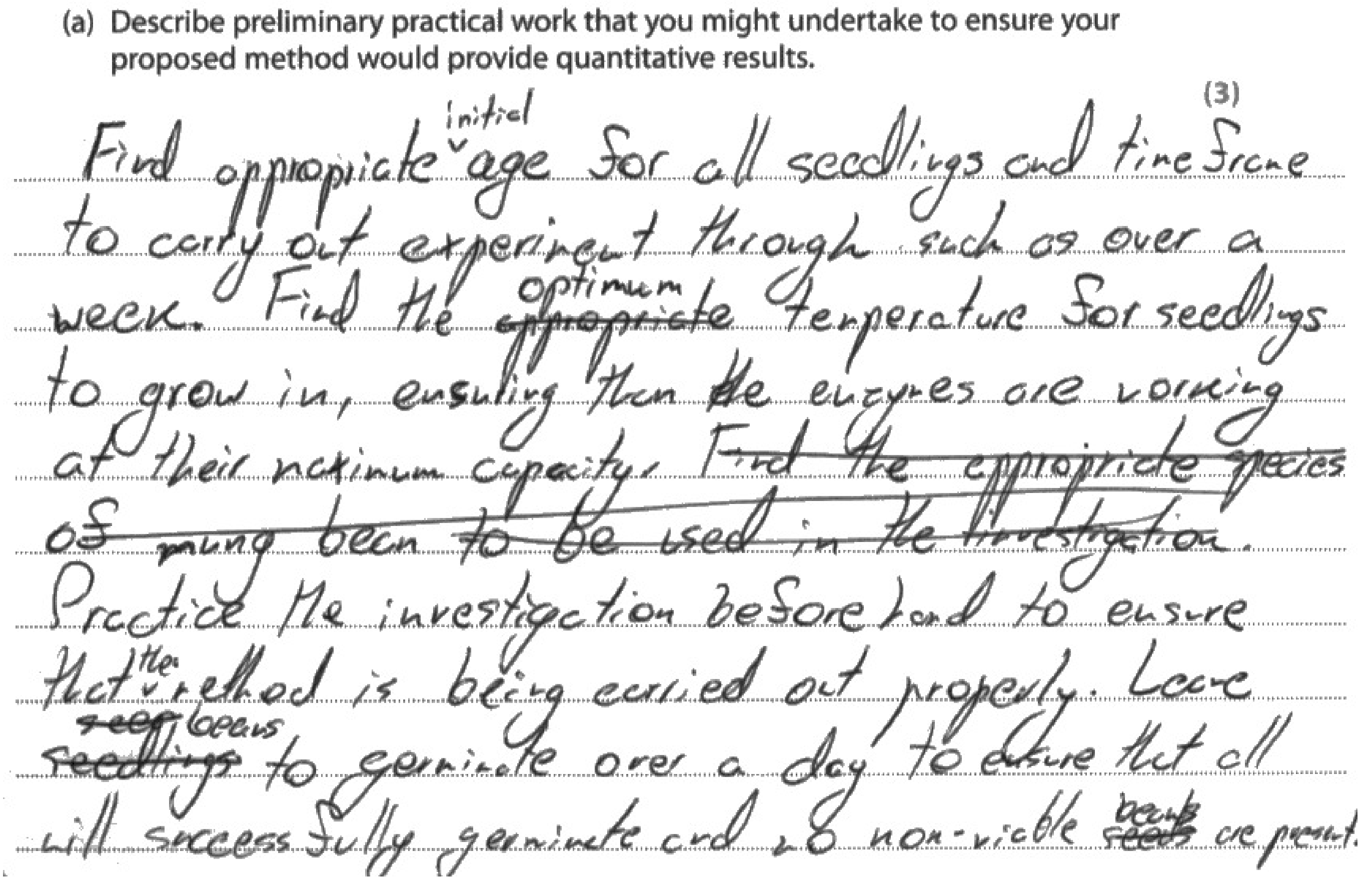
Since there was a small sample size use
and the SD Bars overlap

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. It is an example of the most frequent method of gaining one mark. The small sample size is not relevant because the sample size was large enough to carry out a statistical test.

Question 4 (a)

In this question, candidates were asked to describe suitable preliminary practical work that should be done before embarking on the main investigation to support or reject the hypothesis that, "*as mung bean seedlings age, their respiratory quotient (RQ) decreases*".



(a) Describe preliminary practical work that you might undertake to ensure your proposed method would provide quantitative results.

(3)

Find appropiate initial age for all seedlings and time frame to carry out experiment through such as over a week. Find the ~~appropriate~~ optimum temperature for seedlings to grow in, ensuring then the enzymes are working at their maximum capacity. ~~Find the appropriate species of mung bean to be used in the investigation.~~ Practice the investigation beforehand to ensure that the method is being carried out properly. Leave ~~seeds~~ beans ~~seedlings~~ to germinate over a day to ensure that all will successfully germinate and no non-viable ~~seeds~~ beans are present.

ResultsPlus
Examiner Comments

This is a response that was awarded 2 marks. The candidate described two aspects of preliminary work that were relevant to this investigation.

ResultsPlus
Examiner Tip

Candidates should avoid giving short generic answers such as, '*find a suitable temperature*', without suggesting why this is needed.

(a) Describe preliminary practical work that you might undertake to ensure your proposed method would provide quantitative results.

(3)

Find a suitable number of seedlings to use, and find the time taken for a certain amount of ~~oxygen to be relea~~ carbon dioxide to be released. Find a way to measure the growth of the seedlings. Find the right age of the seedlings to start with. Practie the method to see if it will work.

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. The comment about finding the time to produce carbon dioxide was creditworthy.

(a) Describe preliminary practical work that you might undertake to ensure your proposed method would provide quantitative results.

(3)

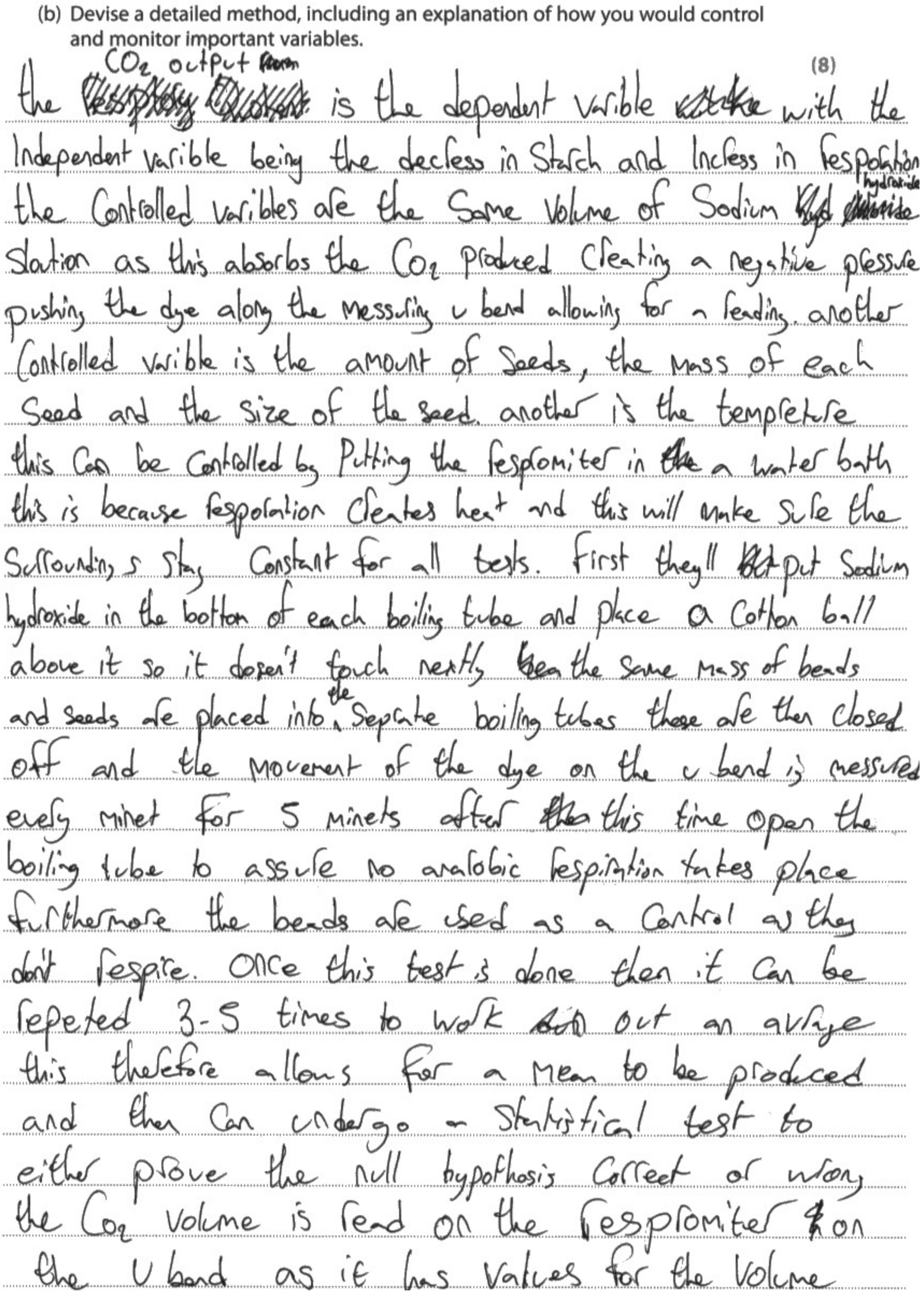
firstly ~~so~~ they might Vary the Seeds in each respomiter this is to fine tune the ~~sam~~ Suttible number of Seeds allowed in which anaobic respiration dosen't take place further more once fine tuned they Can ~~f~~ do more trials to find the optimum ~~Respiration Rate~~ templete for respiration to occur. this Can be further developed as of they Could find beads the Same size and Mass as the Seeds for the experiment.

ResultsPlus
Examiner Comments

This is a response that was awarded 2 marks. The optimum temperature for respiration to take place and find a suitable number of seeds was creditworthy.

Question 4 (b)

In this question, candidates were asked to describe a detailed method, including an explanation, of how they would control and monitor important variables. If labelled diagrams were included, these frequently aided the awarding of marks.



(b) Devise a detailed method, including an explanation of how you would control and monitor important variables.

(8)

the ~~Respitory Quotient~~ CO$_2$ output from is the dependent varible ~~[illegible]~~ with the Independent varible being the decress in Starch and Incress in respiration the Controlled varibles are the Same Volume of Sodium ~~hyd chloride~~ hydroxide slution as this absorbs the CO$_2$ Produced Creating a negative pressure pushing the dye along the messuring u bend allowing for a reading. another Controlled varible is the amount of Seeds, the Mass of each Seed and the Size of the seed. another is the temprature this Can be Controlled by Putting the respromiter in ~~the~~ a water bath this is because respiration Creates heat and this will make sure the Surroundings stay Constant for all tests. First they'll ~~but~~ put Sodium hydroxide in the botton of each boiling tube and place a Cotton ball above it so it doesn't touch nextly ~~then~~ the Same Mass of beads and seeds are placed into the seperate boiling tubes these are then closed off and the Movement of the dye on the u bend is messured every minet for 5 minets after ~~the~~ this time open the boiling tube to assure no anarobic respiration takes place furthermore the beads are used as a Control as they don't respire. Once this test is done then it Can be repeted 3-5 times to work ~~out~~ out an avrige this therefore allows for a Mean to be produced and then Can undergo a Statistical test to either prove the null hypothosis Correct or wrong the CO$_2$ volume is read on the respromiter ~~to~~ on the U band as it has Values for the Volume produced limiting the calculations needed to calculate the RQ, its O_2 intake ÷ CO_2 output

ResultsPlus
Examiner Comments

This is a response that was awarded 3 marks. The description of the method was easy to follow but lacked the details needed to gain more marks.

(b) Devise a detailed method, including an explanation of how you would control and monitor important variables.

(8)

- The dependant variable is the RQ (the vol. of CO_2 released with the vol. of O_2 absorbed)
- Use a respirometer that has 2 tubes ~~separated by a~~ connected by a thin tube with a visible dyed liquid ~~and~~ against a cm scale.
- Add soda lime at the bottom of each tube to absorb the CO_2 produced by the beans. Place cotton wool above the soda lime and add a suitable number/mass of mung beans. ~~on~~ in one tube with the same mass of glass beads in the other tube to act as a control.
- Set the gas taps at the top of each tube to set the liquid at the starting point of 0cm.
- Use the same mass of soda lime ~~for~~ in each tube by measuring it first on electrical weights.
- Start the stopwatch when the gas taps are opened to allow O_2 to enter the tubes. Every 2 mins record

the distance moved by the liquid towards the mung beans against the scale.

- After ~~15~~ 20 mins stop the stopwatch and close the gas taps. Record the furthest distance the liquid travelled towards the mung beans.
- Divide the ~~dista~~ max. distance travelled by the liquid with the time it took (20 mins) to find the rate of respiration.
- Find the RQ by: ~~dividing~~

$$\frac{\text{Volume of } CO_2 \text{ produced}}{\text{Vol. of } O_2 \text{ absorbed.}}$$

~~The~~ - Find the vol. of O_2 ~~produced~~ absorbed by calculating the distance the liquid travelled. ~~by~~

~~Vol of CO_2 produced absorbed is found by~~

- Repeat this experiment for different mung bean ages, 3 times for each age group to find the mean RQ for each age group.

~~Keep the~~ - Control the room temp by using an AC and control the ~~rooms~~ humidity by using a dehumidifier.

ResultsPlus
Examiner Comments

This is a response that was awarded 6 marks. The candidate has written a good answer, only missing a small amount of detail.

(b) Devise a detailed method, including an explanation of how you would control and monitor important variables.

(8)

~~We would For tt~~ The dependent variable is the amount of CO_2 produced, ~~and~~ which would be measured using a respirometer. The independent variable would be the age of the ~~seed~~ germinating beans, starting from 1 day old, until 7 days old. ~~The bens beans we~~ The same amount of beans, of the same species will be used. Before the experiment, and the germination of any of the beans, they will be sterilised, to prevent any microorganisms from affecting the results. The same temperature ~~will~~ ~~be~~ and humidity (water content) will be used in all 7 test tubes containing the beans and in the control tube, without beans. The beans will be placed in a gauze platform on each of the test tubes, over soda lime which would absorb the ~~oxygen~~ carbon dioxide produced. The test tube containing the beans will be attached to a respirometer using a bung, to prevent any air from entering the test tube. For ~~a~~ each different age of bean, the amount of oxygen used up will be found every ~~10~~ 10 minutes for an hour, and a average will be calculated. The amount of oxygen used up will be found using a bubble which was inserted in ~~the~~ a capillary tube connected to the respirometer. The change in volume will give the amount of oxygen used per unit time. ~~This could be repeated~~ to use to find the respiration quotient. The practical could be repeated at least 3 times for reliable results.

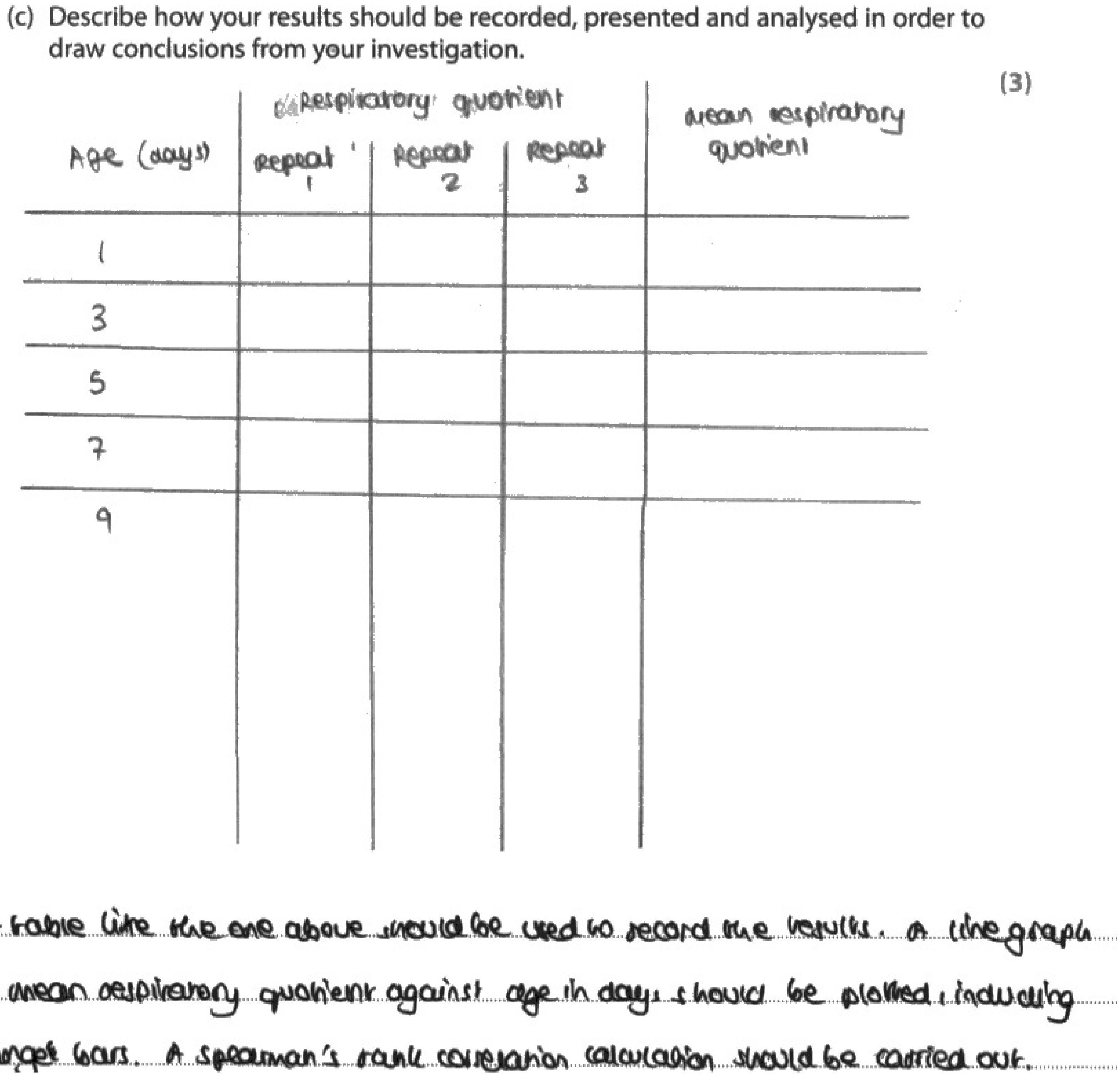
ResultsPlus
Examiner Comments

This is a response that was awarded 4 marks. The candidate has given a method which lacks some clarity and missed some important marking points.

Question 4 (c)

This question asks about how to process data. Candidates were asked to describe how their results should be recorded, presented and analysed in order to draw conclusions from their investigation

Many candidates chose to draw and label tables and graphs. However, maximum marks can still be gained from detailed descriptions alone.



(c) Describe how your results should be recorded, presented and analysed in order to draw conclusions from your investigation.

(3)

Age (days)	Respiratory quotient			mean respiratory quotient
	Repeat 1	Repeat 2	Repeat 3	
1				
3				
5				
7				
9				

A table like the one above should be used to record the results. A line graph of mean respiratory quotient against age in days should be plotted, including range bars. A spearman's rank correlation calculation should be carried out.

ResultsPlus
Examiner Comments

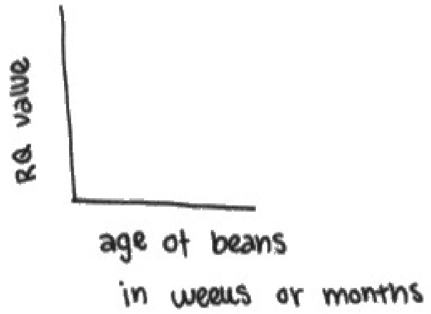
This is a response that was awarded 3 marks. The candidate has given a table with units, an appropriate description of a line graph and a suitable statistical test for the type of data indicated in the table.

ResultsPlus
Examiner Tip

In this question it must be clear either from a sketch or a statement that a line or scatter graph is going to be used.

(c) Describe how your results should be recorded, presented and analysed in order to draw conclusions from your investigation.

(3)



The table that I would produce would have headings such as the RQ value, the age of the beans (in weeks or months) and present this data.

we could use a correlation statistical test such as the spearman's rank correlation coefficient.

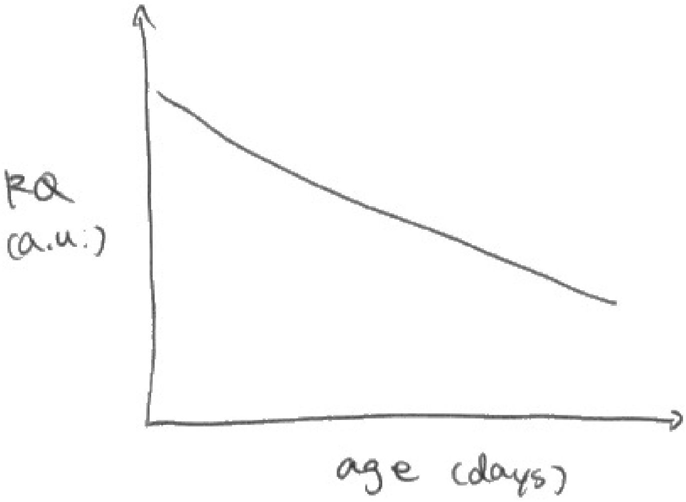
ResultsPlus Examiner Comments

This response is awarded 1 mark. This response did not gain credit for the sketch graph as it is not clear if it is a bar or line graph.

(c) Describe how your results should be recorded, presented and analysed in order to draw conclusions from your investigation.

(3)

age (~~years~~ days)	RQ (a.u.)				mean



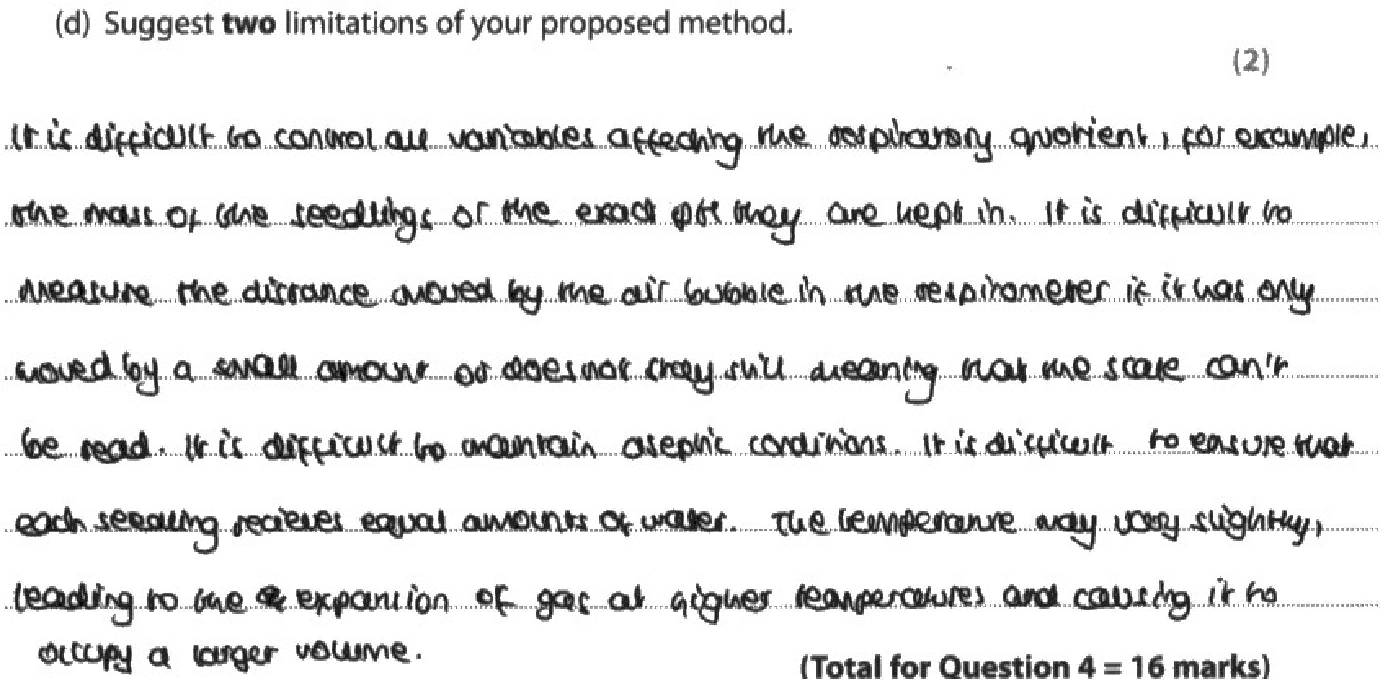
Use spearman's test to see if There is significant correlation between the age of the ~~bean~~ beans and RQ values.

ResultsPlus
Examiner Comments

This is a response that was awarded 3 marks.

Question 4 (d)

In this question, candidates were asked to suggest two limitations of their proposed method.



(d) Suggest **two** limitations of your proposed method.

(2)

It is difficult to control all variables affecting the respiratory quotient, for example, the mass of the seedlings or the exact pH they are kept in. It is difficult to measure the distance moved by the air bubble in the respirometer if it was only moved by a small amount or does not stay still meaning that the scale can't be read. It is difficult to maintain aseptic conditions. It is difficult to ensure that each seedling receives equal amounts of water. The temperature may vary slightly, leading to the expansion of gas at higher temperatures and causing it to occupy a larger volume.

(Total for Question 4 = 16 marks)

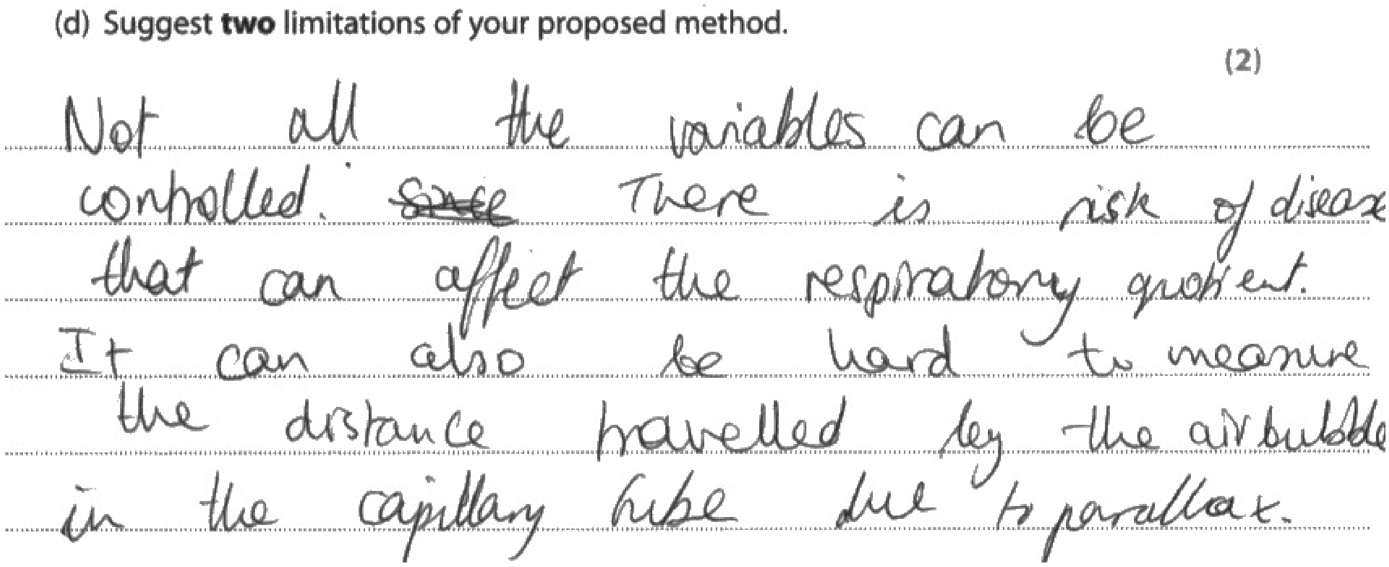
ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. The candidate clearly addresses the problems and limitations of the investigation.

ResultsPlus
Examiner Tip

Candidates should think carefully about the method they describe and select the most important limitations that apply to the method.

Avoid making generic comments about limitations without relating them to the specific context.



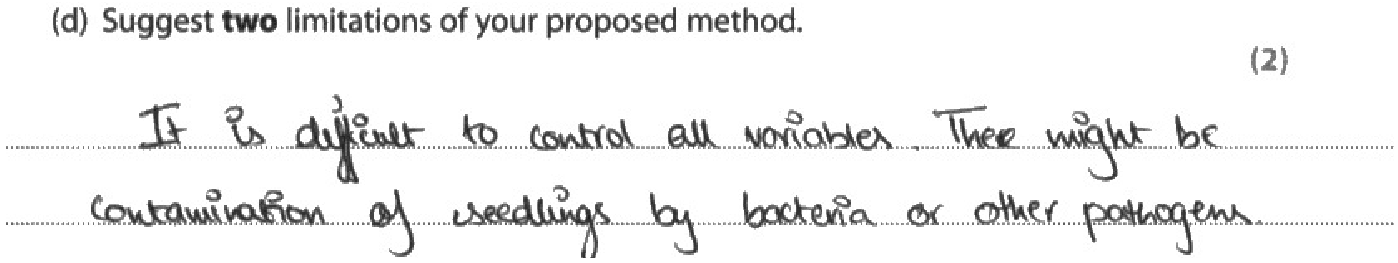
(d) Suggest **two** limitations of your proposed method.

(2)

Not all the variables can be controlled. ~~Since~~ There is risk of disease that can affect the respiratory quotient. It can also be hard to measure the distance travelled by the air bubble in the capillary tube due to parallax.

ResultsPlus
Examiner Comments

This is another example that was awarded the full 2 marks.



(d) Suggest **two** limitations of your proposed method.

(2)

It is difficult to control all variables. There might be contamination of seedlings by bacteria or other pathogens.

ResultsPlus
Examiner Comments

This response was awarded 1 mark. The response gained the mark for suggesting the possibility of contamination.

Paper Summary

Advice for students:

- Read the whole question before you start to answer, and check that your answer covers everything the question asks for.
- Make sure your answer relates to the specific context of the question.
- When studying core practicals, think about what the techniques might be used for and the types of scientific question they might help to answer.
- Carry out every core practical for yourself, so you understand how it works and any difficulties that might be encountered.
- If you are given the procedure for a practical technique, put yourself in the shoes of the person writing the procedure: how would they have worked out the details (such as volumes, concentrations and times)? They will have used preliminary practical work.
- Consider the strengths and limitations of each core practical technique.
- Practice writing null hypotheses for experiments you carry out, even if you will not necessarily be applying a statistical test

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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