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Examiners' Report
June 2019

IAL Biology WBI06 01

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Introduction

This paper successfully differentiated between candidates and all questions seemed to be accessible. It was pleasing to see many candidates scoring high marks.

Candidates appeared to be very familiar with the method used to observe mitosis in plant cells and the bacterial inhibition practical techniques relevant to Q01 and Q03; with candidates providing high quality responses to these questions.

Most candidates had little difficulty in interpreting the data presented in Q02 and managed to construct an appropriate table and graph.

While some candidates continue to produce rather generic answers, it seemed that most candidates did attempt to answer the questions by giving responses which were specific to the relevant experimental contexts.

It is very encouraging to see this progress and it is hoped that future candidates will continue to think for themselves and demonstrate their understanding of the principles of experimental design.

Question 1 (a)

Nearly all candidates gave the correct numerical answer.

(a) Calculate the mitotic index for this variety of durum wheat.

(1)

$\frac{41}{121} \cdot 100 = 33.9$

Answer 33.9 %.

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Examiner Comments

This calculation is incorrect.

(a) Calculate the mitotic index for this variety of durum wheat.

(1)

ulu

do

oluidine

Answer 25.3

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Examiner Comments

Most candidates carried out the correct calculation and gave the answer 25.3 or 25.31.

Question 1 (b) (i)

Most candidates described some details of this investigation. The marks most frequently awarded were for sampling a stated part of the plant, using a suitable stain and two further details of the method used. Many candidates did not count the cells showing mitosis and the total number of cells.

(b) (i) **Describe an experiment to investigate the relationship between the mitotic index (MI) and the yield of grain of the three varieties of durum wheat.**

(5)

We first obtain three samples of the three varieties of durum wheat and make sure that each sample has the same weight. We will have to ~~enter~~ measure the time allowed for the plant to grow.

We must first isolate the plant sample to investigate its cells.

The temperature must ~~remain~~ ~~the~~ be controlled (by using a room with an AC) and so should the light intensity (by using bulbs/ or a constantly lit room) to have accurate comparisons. An electron microscope must be used to observe ~~the cells~~ if the cell is undergoing mitosis. The ~~higher~~ lower the mitotic index, a ~~the~~ big larger amount of cells are undergoing mitosis, and a larger yield will be produced.

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Examiner Comments

This candidate has not fully appreciated the context of the question. The answer given provides generic statements about growing plants under controlled conditions with a suggestion of measuring mitosis. If the candidate had gone on to provide relevant details about the mitotic index they could still have gained maximum marks.

First do the exp with 1 variety of durum wheat. Obtain an apical meristem. warm in HCl for 5 mins to break down the middle lamella. Add 2 drops of Toluidine blue to stain the chromosomes and make them more visible. Place the root tip on a microscopic slide and pass a cover slip on top of it. Place several sheets of filter paper and squash gently to get a single layer of cells. Warm the slide again to intensify staining. Repeat 3 more times with the 1st variety to get a mean. Repeat the exp with the other 2 two varieties using root tips of the same age. Compare mitosis btw the 3 different varieties. Calculate the mitotic index for each variety.

$$\text{Mitotic index} = \frac{\text{Number of cells in mitosis}}{\text{Total number of cells}} \times 100$$

The independent variable is the variety of durum wheat

The dependent variable is the number of cells in mitosis.

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Examiner Comments

This answer gained maximum marks. Sensible, practical details were given and the index formula was given credit as being equivalent to counting the cells in mitosis and the cells not in mitosis.

(5)

Independent variable is the variety of durum wheat and dependent variable is the mitotic index. Same mass and size of leaf is taken from ~~the~~ one type of the durum wheat. It is placed in dilute hydrochloric acid at 40°C for 5 minutes. It is removed using mounted needles. Hydrochloric acid causes the middle lamella to dissolve, separating the cells. Then it is placed on a ~~cover~~ slide and two droops of acetic orcein is added to make the chromosomes visible. Stage of mitosis is observed by the position of chromosomes. If chromosomes are present in a decondensed state, they would look visible which indicates mitosis in cells. It is placed on a cover slip and end of a mounted needle is used to press the cover slip to make it a thin layer. Mitotic index is calculated. Repeat two more times to get a mean ~~an average~~ value. Repeat for other ~~varii~~ two durum wheats. Temperature is controlled using thermostatically controlled water bath. Plot a graph.

ResultsPlus
Examiner Comments

The dependent variable was not correctly identified. The suitable stain was identified and two further details of the method. There was no indication of how yield would be measured or that cells in mitosis, and not in mitosis, should be counted.

Question 1 (b) (ii) - (iii)

At least one of the variables identified on the mark scheme was given by nearly all of the candidates.

In Q01(b)(ii), most candidates attempted to describe a control method for one of the variables stated in Q01(b)(i), and usually the description was sufficient to be awarded a mark. Some candidates commented that the results would not be valid if the stated variable was not controlled.

(ii) State **two** abiotic factors, other than temperature, that could affect the yield of grain.
(1)

① Light intensity

② Carbon dioxide concentration

(iii) Choose **one** of the factors you have identified in (ii). Explain how this factor could be controlled. Describe what effect it could have on the results if it is not controlled.
(2)

Abiotic factor Light intensity

How this factor could be controlled By ~~using~~ all plots at the same distance from the source of light.

Effect it could have on the results if it is not controlled Results are not valid, because this could affect the number of cells under mitosis.

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Examiner Comments

Many candidates identified two appropriate abiotic variables in Q01(b)(ii). The suggestion of how to control the abiotic factor of light intensity was just sufficient for the mark. 'If the variable is not controlled the results would not be valid', also gained a mark.

(ii) State **two** abiotic factors, other than temperature, that could affect the yield of grain.
(1)

Soil mineral content and soil pH

Light intensity

(iii) Choose **one** of the factors you have identified in (ii). Explain how this factor could be controlled. Describe what effect it could have on the results if it is not controlled.
(2)

Abiotic factor ~~pH~~ light intensity

How this factor could be controlled ~~using a buffering solution~~ using same area of cultivation, same wattage lightbulbs and same time of day.

Effect it could have on the results if it is not controlled ~~pH affect uptake of mineral~~ Light intensity affect rate of photosynthesis, thus, affect yield. More light means more yield. Not controlling it would mean results would not be valid.

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Examiner Comments

This answer gained maximum marks. The abiotic factor was clearly controlled and the effect, if not controlled, was well described.

(ii) State **two** abiotic factors, other than temperature, that could affect the yield of grain.
(1)

concentration of mineral ions and soil pH.

(iii) Choose **one** of the factors you have identified in (ii). Explain how this factor could be controlled. Describe what effect it could have on the results if it is not controlled.
(2)

Abiotic factor concentration of mineral ions

How this factor could be controlled Grow the plants ~~on~~ separately ~~of~~ in soil that has a known concentration of all mineral ions added to it, in a laboratory or a greenhouse.

Effect it could have on the results if it is not controlled results will not be valid as plants grown in soil with a higher concentration of mineral ions are more likely to have a better yield of grain than plants grown with a mineral ion deficiency.

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Examiner Comments

This answer gained maximum marks for clear and correct statements in Q01(b)(ii) and Q01(b)(iii).

Question 1 (c)

Candidates often gave answers which were only awarded the marks for saying that enzymes have a high optimum temperature; fibres containing cellulose and lignin. There were very few references to the other points on the mark scheme.

(c) Explain why some varieties of durum wheat can grow at high temperatures.

(3)

The high temperatures could be tolerated by these varieties of durum wheat due to presence of thermostable enzymes. These are enzymes that are adapted to very high temperatures and can adapt to any changes in temperature. So, these enzymes would increase rate of photosynthesis of these plants. Resulting in increase in rate of growth.

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Examiner Comments

This answer gained three marks as enzymes being thermostable was a credit worthy alternative to not being denatured. Marking point one and three were also given.

(c) Explain why some varieties of durum wheat can grow at high temperatures.

(3)

Some varieties of durum wheat may have huge water storage so they can maintain their temperature by transpiration. And their enzymes would use optimum temperature could be high so more enzyme substrate complex form at high temperature as kinetic energy increases so rate of reactions increase, as the metabolic rate increase they grow more.

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Examiner Comments

This candidate stated that the optimum temperature was high, however, there was no mention of enzymes not being denatured. Many candidates gave descriptions of enzyme substrate complex formation, which did not gain credit.

- Enzymes of the ~~durum~~ durum wheat have a high optimum temperature
- They will not be denatured.
- ~~More substrate~~ such as NADP
- Enzymes^ will still be able to catalyse reactions.
- ~~Gra~~ GALP is produced which provides glucose for growth.

ResultsPlus
Examiner Comments

This answer gained three marks as the first two marking points were clearly stated. The formation of GALP is part of photosynthesis, so mark point 3 was awarded as well.

Question 2 (a)

Most candidates gave clear statements which gained both marks.

Question 2 (b)

Most candidates provided a suitable table format with raw data and means entered correctly. There was, however, a tendency to provide incomplete headings for the table and this meant that the first marking point could not be awarded.

(b) Calculate the mean diameter of the inhibition zones for each type of bacteria.

Prepare a suitable table to display the **raw data** and your calculated **mean** for each type of bacteria.

(3)

Diameter of inhibition ~~zone~~ zone /mm	
Bacteria A	Bacteria B
37	21
26	25
30	32
37	32
25	18
22	17
33	28
36	31
35	29
36	30
37	31
22	17
22	16
30	25
25	20
Mean = 30.2	Mean = 24.8

ResultsPlus
Examiner Comments

Most candidates had little difficulty in presenting a table with complete headings, raw data and correctly calculated means for three marks.

(b) Calculate the mean diameter of the inhibition zones for each type of bacteria.

Prepare a suitable table to display the **raw data** and your calculated **mean** for each type of bacteria.

(3)

type of Bacteria	diameter of each inhibition zone /mm	mean diameter of inhibition zones /mm
A	37 , 26 30 , 37 25 , 22 33 , 36 35 , 36 37 , 22 22 , 30 25	30
B	21 , 25 32 , 32 18 , 17 28 31 29 , 30 31 , 17 16 , 25 20	25

ResultsPlus
Examiner Comments

The mean values rounded to the nearest whole number gained the mark in this question.

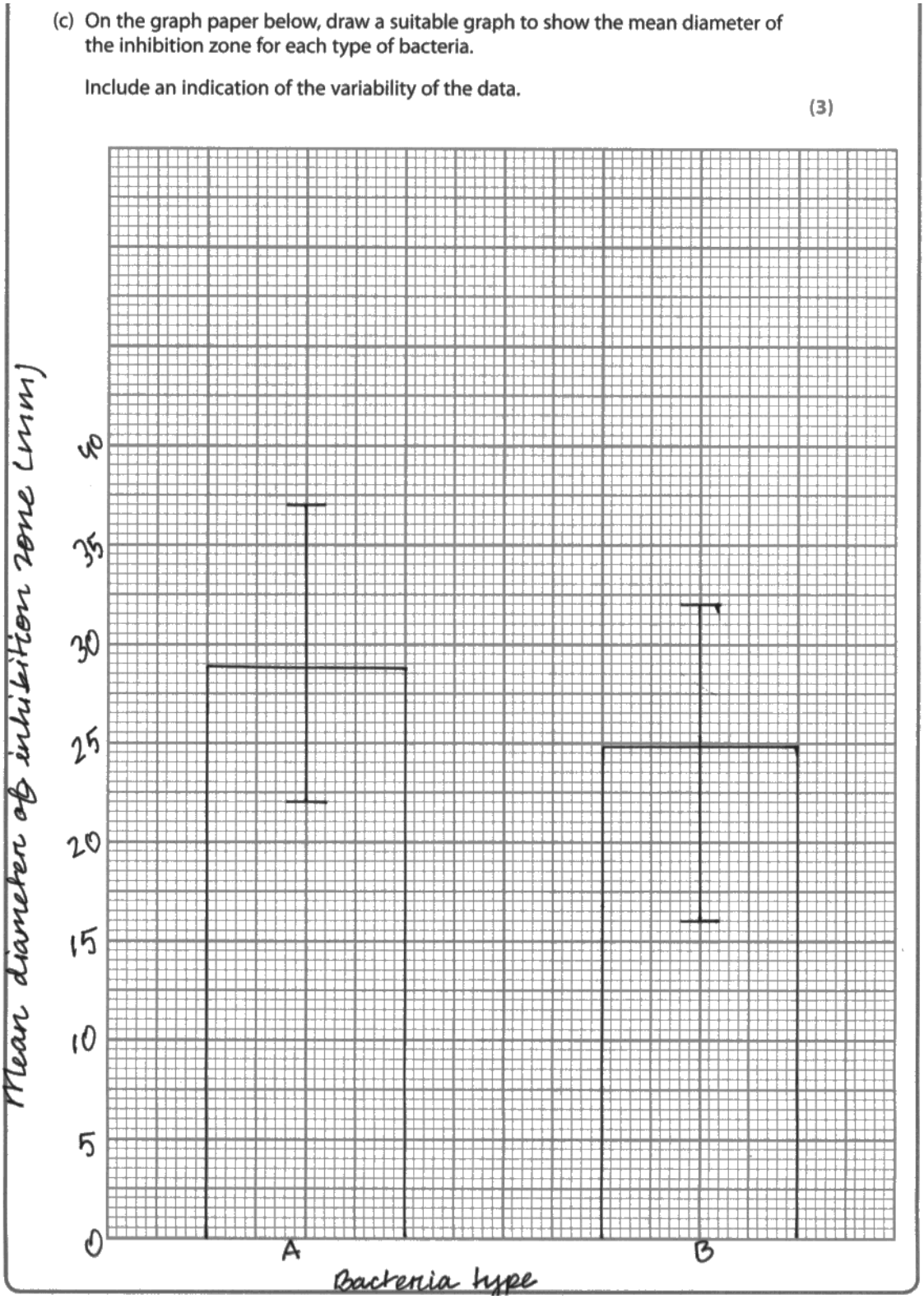
Question 2 (c)

Most graphs were awarded all three marks. Only a small number of candidates provided an incomplete label for the y axis or made an error in plotting the mean values or range bars.

(c) On the graph paper below, draw a suitable graph to show the mean diameter of the inhibition zone for each type of bacteria.

Include an indication of the variability of the data.

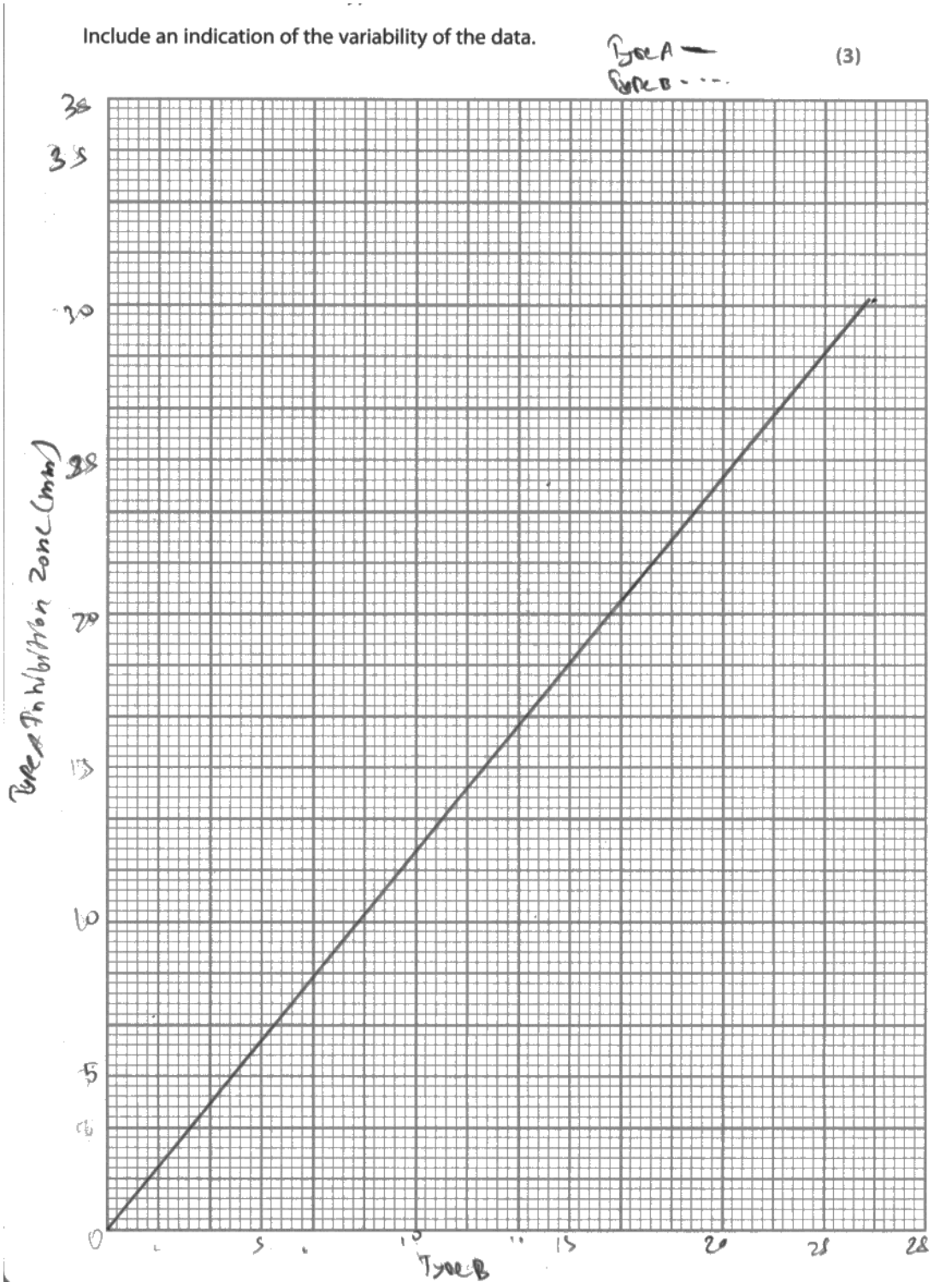
(3)



ResultsPlus
Examiner Comments

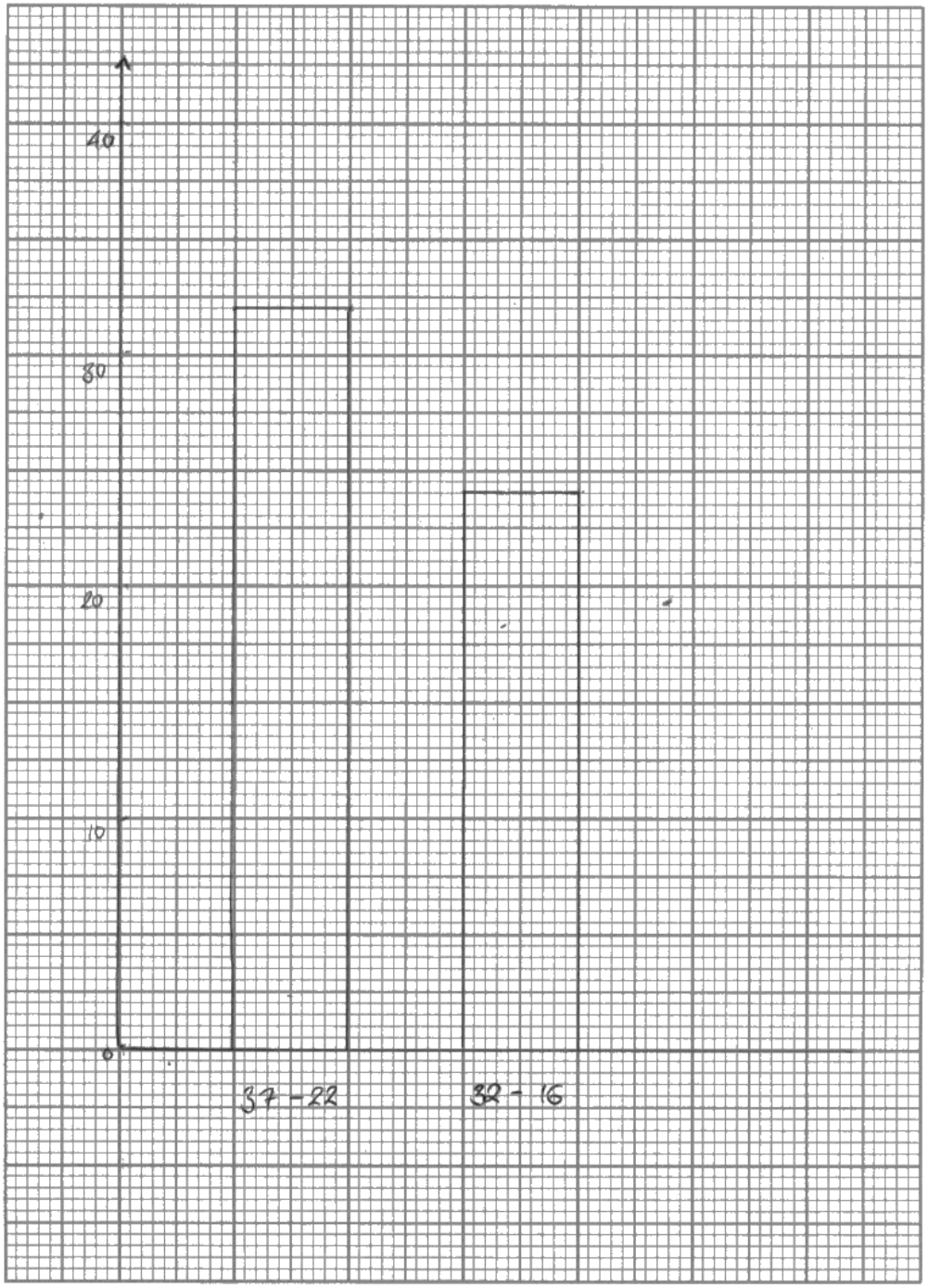
This candidate provided complete axis labels, as well as correctly plotted means and range bars. This answer was awarded maximum marks.

Include an indication of the variability of the data. (3)



ResultsPlus
Examiner Comments

Nearly all candidates drew graphs in an appropriate format. However, this candidate has tried to present a scatter graph so could not gain any marks.



ResultsPlus
Examiner Comments

This candidate could have still gained two marks by labelling both axes and plotting the range bars. Note that the type B mean is incorrectly plotted. The examiners would have allowed an error carried forward if the mean in Q02(b) had been incorrectly stated as 24.

Question 2 (d)

Most candidates selected the correct critical value of 2.05 from the table provided and then completed their answer as shown on the mark scheme.

(d) The scientist applied a *t* test to the data. A value of $t = 2.44$ was calculated.

The table below shows critical values of *t* for different degrees of freedom at different levels of significance.

The number of degrees of freedom is calculated using the formula

$$\text{degrees of freedom} = (n_1 - 1) + (n_2 - 1)$$

$(15-1) + (15-1) = 14 + 14 = 28$

where n_1 and n_2 represent the size of each sample.

degrees of freedom	p = 0.05	p = 0.01	p = 0.005
11	2.20	3.11	3.50
12	2.18	3.05	3.43
13	2.16	3.01	3.37
14	2.14	2.98	3.33
15	2.13	2.95	3.29
16	2.12	2.92	3.25
17	2.11	2.90	3.22
18	2.10	2.88	3.20
19	2.09	2.86	3.17
20	2.09	2.84	3.15
21	2.08	2.83	3.14
22	2.07	2.82	3.12
23	2.07	2.81	3.10
24	2.06	2.80	3.09
25	2.06	2.79	3.08
26	2.06	2.78	3.07
27	2.05	2.77	3.06
28	2.05	2.76	3.05
29	2.04	2.76	3.04
30	2.04	2.75	3.03

What conclusions can be drawn from this investigation?

Use your graph and the information in the table to explain your answer.

(4)

According to the graph, the mean diameter of clear zone for bacterial ~~species~~ type A is higher than for bacterial type B.

The ~~calculated~~ critical value for 28 degrees of freedom is 2.05.

The calculated value is greater than the critical value at the 95% confidence level therefore the null hypothesis ~~is~~ is rejected. There is a significant difference in the mean diameter of clear zone between bacterial types A and B.

The diameter of clear zone of bacterial type ~~B~~ A is significantly higher than B.

~~The~~ Both error bars are long signifying a large variability of data for both species. Error bars overlap

ResultsPlus
Examiner Comments

This candidate was careful to state that there was a significant difference between the mean diameters of the clear zone. Again, all the marking points were given so maximum marks were awarded.

(d) The scientist applied a *t* test to the data. A value of $t = 2.44$ was calculated.

The table below shows critical values of *t* for different degrees of freedom at different levels of significance.

The number of degrees of freedom is calculated using the formula

$$\text{degrees of freedom} = (n_1 - 1) + (n_2 - 1)$$

where n_1 and n_2 represent the size of each sample.

degrees of freedom	p = 0.05	p = 0.01	p = 0.005
11	2.20	3.11	3.50
12	2.18	3.05	3.43
13	2.16	3.01	3.37
14	2.14	2.98	3.33
15	2.13	2.95	3.29
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19	2.09	2.86	3.17
20	2.09	2.84	3.15
21	2.08	2.83	3.14
22	2.07	2.82	3.12
23	2.07	2.81	3.10
24	2.06	2.80	3.09
25	2.06	2.79	3.08
26	2.06	2.78	3.07
27	2.05	2.77	3.06
28	2.05	2.76	3.05
29	2.04	2.76	3.04
30	2.04	2.75	3.03

What conclusions can be drawn from this investigation?

Use your graph and the information in the table to explain your answer.

(4)

From the graph the mean diameter of inhibition zone is greater in bacteria type A than type B. For degrees of freedom (15+1)+(15-1) = 28 the critical value is 2.05. Since the calculated value of t is greater than the critical value (2.44>2.05) at the 95% confidence level, the null hypothesis is rejected. That means that there is a significant difference in the mean diameter of zone of inhibition between bacteria type A and type B. Therefore the mean diameter of zone of inhibition is significantly greater for type A than type B, so ~~lino~~ lincomycin is significantly more effective on type A than type B. The error bars are large so there is large variability in data so the results are not very reliable.

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Examiner Comments

This candidate identified the critical value on the table and gave a clear response containing every point on the mark scheme; they gained maximum marks.

(d) The scientist applied a *t* test to the data. A value of $t = 2.44$ was calculated.

The table below shows critical values of *t* for different degrees of freedom at different levels of significance.

The number of degrees of freedom is calculated using the formula

$$\text{degrees of freedom} = (n_1 - 1) + (n_2 - 1)$$

where n_1 and n_2 represent the size of each sample.

degrees of freedom	p = 0.05	p = 0.01	p = 0.005
11	2.20	3.11	3.50
12	2.18	3.05	3.43
13	2.16	3.01	3.37
14	2.14	2.98	3.33
15	2.13	2.95	3.29
16	2.12	2.92	3.25
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23	2.07	2.81	3.10
24	2.06	2.80	3.09
25	2.06	2.79	3.08
26	2.06	2.78	3.07
27	2.05	2.77	3.06
28	2.05	2.76	3.05
29	2.04	2.76	3.04
30	2.04	2.75	3.03

What conclusions can be drawn from this investigation?

Use your graph and the information in the table to explain your answer.

(4)

Error bars overlap so less variability in data.
Null hypothesis can be accepted.
There is no significant difference between the diameter of inhibition zone of Type A and Type B bacteria.
Difference in mean value is small
30.2 − 24.8 = 5.4mm

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Examiner Comments

Most candidates gave appropriate answers that gained most, or all, of the available marks, however, a small number of responses such as this one were seen. Only the mark on the variability of data could be awarded in this case.

Question 2 (e)

This question proved to be challenging for some candidates. All of the marking points were seen, however, only the candidates who thought carefully about the context of the investigation gained 3 or 4 marks.

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

(4)

Other variables affect the effect of antibiotics not ~~controlled~~ taken into consideration, for example uneven spread of bacteria, ~~size of paper disc~~ concentration of bacteria. Other variables affecting the antibiotics not controlled, for example size of paper disc, concentration of antibiotics. Range bar overlaps from the graph. Experiment only done on one source of lichen, not representive. Method of extracting bacteria may also affect the result. Difficult to measure diameter of inhibition zone, as it may not be circular. Trend may not be followed for bacteria taken from other lichens.

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Examiner Comments

This candidate fully appreciated the context of the investigation and gave five reasons why the conclusions might not be valid.

- small sample size - uncontrolled - V - uneven spread of bact - not standardise how - lab ≠ natural - good growing cond of bact

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

(4)

The investigation only involved a small sample size of bacteria extracted from the lichen sample. There are also factors not being controlled such as the strain of bacteria used and light intensity. ~~and the amount~~ There is a wide variability of data and large overlapping in the range bars that decrease the validity of the investigation. There may be the uneven spread of bacteria in the beginning, causing conclusions ~~not~~ to be not valid. The investigation also did not ~~spec~~ standardise the method of applying the antibiotic on the agar. The agar jel also ~~enables~~ creates a good growing condition of bacteria by providing nutrient and water causing unwanted microorganisms and bacteria to be produced and ~~for~~ decrease the validity of the investigation. The laboratory conditions may be different than the natural conditions where the bacteria infects ~~the~~ the lichen.

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Examiner Comments

This candidate commented on the variability of the data, the uneven spread of the cultured bacteria, and the possible contamination of samples by other bacteria.

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

(4)

The sample size is ~~sample~~ small so. The range of the two types of bacteria overlap in the graph. Other factors such as concentration of antibiotic, humidity pH of agar plates were not taken into account. These bacteria do not represent the entire population of bacteria.

ResultsPlus
Examiner Comments

A significant number of candidates provided answers such as this one. The wide variability of results was identified, however, other suggestions were too vague to gain credit in the context of this investigation.

Question 3 (a)

Nearly all candidates identified one risk to safety. General comments about goggles and lab coats did not gain credit.

3 Some people with illnesses secrete fewer digestive enzymes from the pancreas than healthy people.

One of the enzymes secreted by the pancreas is protease.

Protease is an enzyme that hydrolyses proteins to form amino acids.

The activity of protease can be investigated using a solution of the protein casein as a substrate. This solution changes from white to colourless as the protein is hydrolysed.

A student formed the following hypothesis:

> The greater the concentration of protease the faster the rate of hydrolysis of casein.

Plan an investigation to provide evidence to support or reject this hypothesis.

Your answer should give details under the following headings.

(a) A consideration of whether there are any safety issues you would need to take into account.

(2)

The enzyme may cause irritation so gloves and glasses should be worn. There is possibility of burn on hand from hot water bath.

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Examiner Comments

Most candidates recognised the risk of casein being an irritant or an allergen, as shown here. The other risks associated with high temperatures or glassware were not frequently identified. This candidate gained both marks.

~~• S Protease solution may squirt~~

• Solutions may squirt into eyes. Wear goggles to avoid that

• Glass apparatus may break, wear gloves and safety boots to avoid injuries.

• Allergic reactions due to protease or casein.

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Examiner Comments

A significant number of candidates provided generic answers concerning goggles, laboratory coats and gloves without linking these to a specific risk. This candidate did manage to gain two marks for observing the potential risks of apparatus breaking and allergic reaction.

Protease could be incitant to the skin, so the use ~~of Globes~~ of gloves will be needed.

Casein will need to be cut so, with a knife, so the person doing the experiment needs to be concious about this.

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Examiner Comments

This candidate did not gain credit for identifying the risk involved when using a sharp knife. This question requires risks to be identified which are relevant to the method being used in the investigation.

Question 3 (b)

Candidates frequently suggested some sensible preliminary work which was relevant to the main investigation. There were few generic answers given by candidates.

Question 3 (c)

Nearly all the candidates gave very detailed, logically ordered accounts, which suggests they had carried out this type of investigation in a laboratory.

(c) A detailed method, including an explanation of how important variables are to be controlled or monitored.

(10)

[2 marks are available in this section for the quality of written communication.]

independent variable is the concentration of protease enzyme and the dependent variable is the rate of hydrolysis of casein.

~~Plan increasing volumes of protease~~

Place 5 cm^3 of the casein solution in 5 test tubes.

In 4 different test tubes, place increasing volumes of protease enzyme. Pour ~~the~~ it $1cm^3$, $2cm^3$, $3cm^3$, $4cm^3$ and add distilled water to make all the volumes upto $4cm^3$. In the last test tube, add distilled water which acts as a control.

Pour the protease enzyme into casein solution and start the stop watch immediately. Measure the time it takes for the solution to turn colourless and record it. Repeat the same for all concentrations.

Repeat the experiment at least 3 three times for all concentrations and obtain mean values.

The rate of hydrolysis is calculated by the formula:

$$\text{rate} = \frac{\text{volume of solution}}{\text{time taken}}$$

Other variables needed to be constant include temperature which affects the rate of hydrolysis and it can be controlled by using a thermostatically controlled waterbath.

Moreover, the volume of the casein solution must be constant including the concentration. This can be controlled by using 5 grams of milk powder with 10 cm^3 of distilled water. The resulting solution is well stirred and used to pour 5 cm^3 of the solution in each test tube.

The pH should be monitored ~~and~~ since it will affect the rate at which protease enzyme will work.

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Examiner Comments

The dependent variable was not clearly identified by many candidates. However, this candidate gave eight other marking points and two marks were awarded for a clear, logical answer.

the independant variable is the concentration of protease used and it is measured using measuring cylinders

the dependant variable is the ~~rate of reaction~~ time taken for the solution to become colourless i.e rate of reaction is measured using a stopwatch.

~~make up~~ take place 4 different concentration of protease ~~in a 4 different~~ i.e $1cm^3$, $2cm^3$, $3cm^3$ and $4cm^3$ into 4 different test tube. ~~make up~~ pre add distilled water to each of the ~~testube~~ testtube until each solution was a total volume of $4cm^3$. place another testtube with $4cm^3$ of distilled water to act as a control. ~~to each~~ place each of the test tube in a water bath to maintain a constant temperature. place at 35°C. Add to each testtube $1cm^3$ of caesin ~~in~~ and start the stop watch. ~~measure the time taken for each solution~~ Record the time taken for the solution to change it's colour from white to colourless. Repeat the experiment ~~3 t 8x 4 times to obtain~~ 5 times. ~~to obtain an mean~~ this to calculate an average mean to observe reliability.

variables to be controlled are:

volume of the enzyme: ensure the volume of the enzyme are as stated above. ~~this is to~~ the volume is measured using a measuring cylinder.

volume of the substrate: ensure you measure $1cm^3$ of substrate caesin accurately using a measuring cylinder.

temperature: temperature should be ~~controlled and monitored using~~ ~~a thermometer~~ remain constant using a water bath. to measure the temperature use a thermometer.

pH: use a buffer to control pH.

~~to an~~ to measure A reliable way to measure ~~enzyme concentration~~ ~~of protease~~. the time taken for the solution to become colourless use a stop watch and repeat the experiment. calculate a mean and ~~the~~ show variability of data using error bars.

Observations made the greater the concentration of ~~an~~ protease the greater the rate of reaction. therefore more ~~enzyme-temp~~ enzyme-substrate complexes are formed.

ResultsPlus
Examiner Comments

This candidate clearly identified the dependent variable and gave an answer worthy of maximum marks.

The independent variable in this investigation is the concentration of protease used. The dependent variable is the rate of disappearance of casein. The ~~varia~~ variables that are going to be controlled are temperature and concentration and volume of casein.

~~For~~ First, in 5 seperate clean beakers pour casein of $5cm^3$ of $1 mol dm^{-3}$. Put these beakers in a water bath at 25°C. After letting these solutions acclimatise to the temperature label each beaker with 0, 1, 3, 6 and 9 $mol dm^{-3}$. Ensuring this is done at the same time, put 0, 1, 3, 6 and 9 ~~mole~~ $mol dm^{-3}$ of protease solution after setting up a stop coatch fore each beaker.

Measure the time in seconds it takes fore each casein solution to go colourless. ~~Ma~~ Record your results in a table of concentration of ~~casein~~ protease and time it takes for the solution to go colourless. The rate can also be ~~measured~~ calculated as ~~X~~ 1 divided by the time, in seconds, it takes for the solution to go colourless.

Repeat this procedure a total of 5 times, excluding anomalies and finding averages to make the investigation reliable.

Ethical issues to consider may be where the protease enzyme was obtained from. Ensure that it did not alter the organism's lifestyle, nor cause harm nor pain to it

To ensure safety, wear gloves, goggles and a labcoat. Also wash your ~~on~~ hands after the procedure.

ResultsPlus
Examiner Comments

This candidate did not clearly identify the dependent variable, however, they did provide six marking points and the quality of the response gained a further two marks.

Question 3 (d)

Most candidates presented tables in an appropriate format, however, some tables were not given headings with units, or the heading was not appropriate for tabulating raw data. A table does need to show that repeats can be recorded. The majority of candidates did suggest an appropriate statistical test.

(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation.

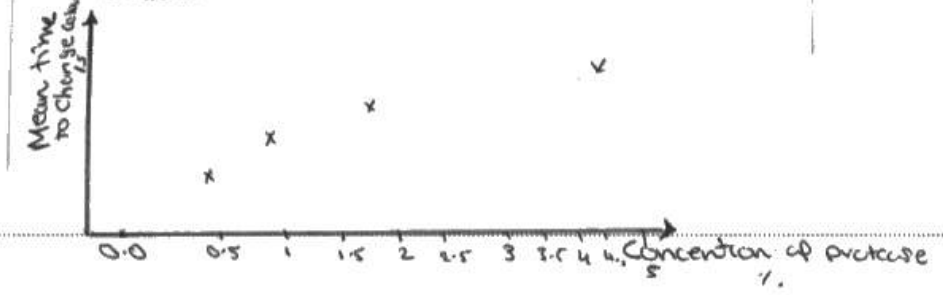
(4)

Record in a suitable table such as the table shown below.

Calculate mean by $\frac{\text{Sum of result}}{3}$

Concentration of protease %	Time to Change Colour of Solution / s			Mean time to change colour / s
	1	2	3	
0.0				
0.5				
1.0				
2.0				
5.0				

present in a scatter graph such as the graph shown below.



Analysed by using a Statistical test such as Spearman Rank test to assess the Significance ~~Calculation~~ Correlation between the concentration of protease and the mean time took to change the Solution colour from white to colourless.

ResultsPlus
Examiner Comments

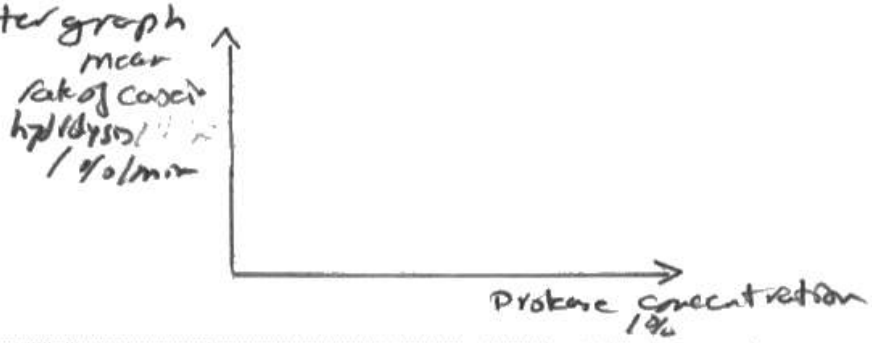
This candidate gave a clear answer which gained maximum marks.

(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation. (4)

Data is recorded in a table and mean is calculated by sum of results / 3

Protease concentration / %	Rate of hydrolysis of casein / % / min			
	1	2	3	mean
0				
1				
2				
3				
4				
5				

Data is presented in a scatter graph



Data is analysed using an appropriate statistical test such as Spearman rank correlation test to asses the significance of the correlation between protease concentration and mean rate of hydrolysis of casein.

ResultsPlus
Examiner Comments

The heading of 'rate of hydrolysis' was not appropriate for a table of raw data, however, the remaining three marking points were awarded.

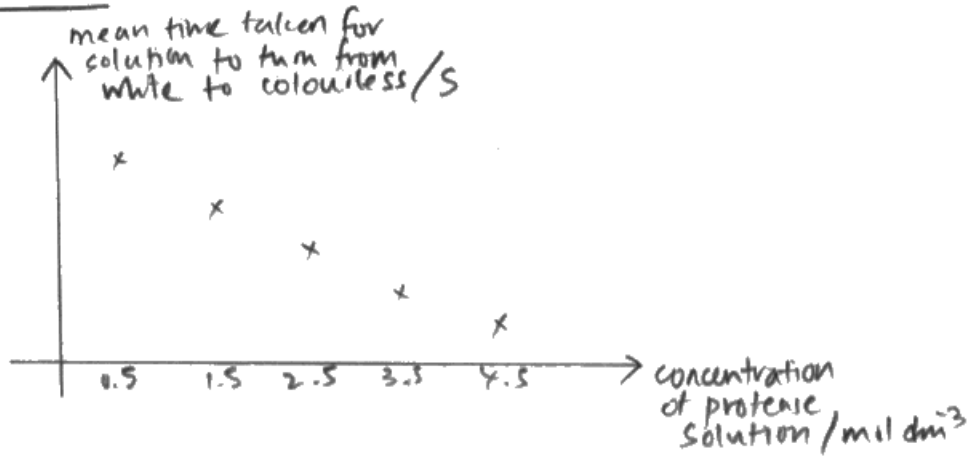
(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation

(4)

Table

Concentration of protease solution / mol dm^{-3}	Time taken for solution to turn from white to colourless / s			Mean / s
	1	2	3	
0.5				
1.5				
2.5				
3.5				
4.5				

Graph



Test

- use correlation test to find significant correlation between the concentration of protense solution and mean time taken for solution to turn from white to colourless.

ResultsPlus
Examiner Comments

A clear answer with a detailed sketch graph. This candidate was awarded four marks.

Question 3 (e)

There were far less generic responses this year. All marking points, except the last, were seen regularly in candidates' responses.

(e) The limitations of your proposed method.

(3)

It may be difficult to control all variables that could affect the activity of proteases.

It may be difficult to see the colour change from white to colourless.

It may be difficult to judge when the exact ending of hydrolysis has occured.

ResultsPlus
Examiner Comments

This candidate suggested that it was difficult to control all the variables which affected the rate of reaction and it would be difficult to judge the end point.

It is difficult to control all the factors affecting time taken for casein to decolourise. It can be difficult to accurately judge the exact end-point by eye. ~~Only~~ Type of ~~protease~~ enzyme and source of ~~protease~~ enzyme can affect the time for casein to decolourise. Only 1 source of protease used, should use more as it may not be an accurate representation of all protease. Also only 1 type of substrate used, should use more.

ResultsPlus
Examiner Comments

This candidate commented on control variables, the end point, and the source of substrate in order to gain three marks.

Hard to control all variables ~~affing~~ affecting the rate of protein hydrolysis (digestion) Its difficult to judge the end point of reaction Not all variables controlled, such as surface area of the protein which would affect reaction rate Another variable may be limiting the effects of protease, such as temperature.

ResultsPlus
Examiner Comments

This candidate gave four ideas worthy of credit as given on the mark scheme, thus achieving maximum marks.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Read the question carefully before providing an answer.
- Carefully check all calculations and rounding up of values.
- Draw neat, fully labelled tables and graphs.
- Use subject specific terms to help support an answer.
- Plan descriptions of investigations first, before you start writing.

Grade Boundaries

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

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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