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IAL Biology WBI13 01

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Introduction

This is the first unit three paper on the new specification, which began first teaching about a year ago. As the specimen materials for this paper showed, there have been major changes. The first of these is the loss of question 2, on the issue report. The second change is the increase in the number of marks awarded for this paper, going from 40 to 50. This has been accompanied by a reduction of 10 minutes in the length of the paper. The former is designed to increase the emphasis on the examination of practical work in a science subject. The latter change reflects the fact that candidates no longer have to read nearly 1000 words of text that they have never seen before.

Finally, there have been some changes in the emphasis of which practical skills are examined. The most important of these is the requirement for candidates to devise experimental procedures. These, as on this paper, will always grow out of core or recommended additional practicals, but will involve them having to think about how they will apply their understanding of the techniques used in the core practicals, together with that of the scientific method, to devise a procedure. On this paper there were two questions which used the command word 'devise 'and another used the phrase 'explain how to'. These questions proved to be quite low scoring but will also provide a lot of lessons to be learned for the future.

In other areas of the paper, candidates responded well, both to tasks that may be familiar to them from past papers on the old specification and on new tasks. Examples of the former are graph plotting and graphic interpretation skills and of the latter extracting information from a graph and presenting it in a suitable tabular form.

In terms of performance, question 1 proved to be the most accessible question, 2 the least so. It is clear that this paper was challenging for many candidates, especially in those skill areas which are new. No doubt this will improve over time.

Question 1 (a) (i)

Candidates were mostly successful in their attempts to answer this question. However, there are still some who confuse the IV and the DV as shown below.

1 The stigma of a flower secretes a solution of sucrose. Pollen grains germinate in this solution to produce pollen tubes.

The effect of sucrose concentration on the germination of pollen grains was investigated.

Pollen grains from a single flower were scraped into the cavity of a slide containing sucrose solution.

After one hour, the slide was viewed through the high power of a microscope.

The number of germinating pollen grains was counted together with the total number of grains in the field of view.

This procedure was repeated for each sucrose solution, using pollen grains from the same flower.

The percentage germination of pollen grains was calculated.

(a) (i) State the independent variable in this investigation.

(1)

germination of pollen grains

ResultsPlus
Examiner Comments

Here the IV and the DV are confused in the candidate's mind.

ResultsPlus
Examiner Tip

Be very careful to understand the difference between the types of variable found in any scientific experiment. The independent variable, which is the one you change, the dependent variable, which is the one that you measure and control variables, which are the ones you keep constant.

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The percentage germination of pollen grains was calculated.

(a) (i) State the independent variable in this investigation.

(1)

different sucrose ~~[illegible]~~ solutions

ResultsPlus
Examiner Comments

In this instance, some correct words have been used but the crucial one, concentration, is missing.

1 The stigma of a flower secretes a solution of sucrose. Pollen grains germinate in this solution to produce pollen tubes.

The effect of sucrose concentration on the germination of pollen grains was investigated.

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The percentage germination of pollen grains was calculated.

(a) (i) State the independent variable in this investigation.

(1)

Time

ResultsPlus
Examiner Comments

In some cases, as here, candidates had little idea of what to write.

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The percentage germination of pollen grains was calculated.

(a) (i) State the independent variable in this investigation.

(1)

Volume of
~~Solution of~~ sucrose solution

ResultsPlus Examiner Comments

Finally, some came very close but did not quite get there, volume is unacceptable.

Question 1 (a) (ii)

A rather worrying number of candidates quoted a biotic variable instead of the abiotic one that was asked for. It was appreciated when the paper was being set that the terms biotic and abiotic are not required on the AS specification and so the word environmental appeared in brackets. However, some still quoted a biotic variable.

.

(ii) State **one** abiotic (environmental) variable that should be controlled in this investigation.

(1)

The ~~type~~ species of flower

ResultsPlus
Examiner Comments

A biotic variable.

ResultsPlus
Examiner Tip

Make sure you understand the difference between environmental and biological variables.

(ii) State **one** abiotic (environmental) variable that should be controlled in this investigation.

(1)

~~Temperature~~ Humidity

ResultsPlus
Examiner Comments

Another kind of error is shown in this example. Humidity is the correct type of variable but is not relevant in an experiment where pollen grains are sitting in a sucrose solution.

ResultsPlus
Examiner Tip

Be careful to not just quote any variable, make sure that it is relevant in the situation you are considering.

Question 1 (a) (iii)

Sometimes it is unavoidable that questions will be linked. Candidates should be aware of this and try to choose an answer to the first one which they can do something with in the second. In this case, those who chose temperature were, at least sometimes, able to gain all three marks on the second. Those who chose other variables fared less well.

(iii) Explain why the results might have been affected if the variable you named in (a)(ii) had not been controlled.

(3)

Temperature affects the enzyme activity. At lower tempera-
-ture fewer collisions occurs due to less kinetic energes, so less
enzyme substrate complex form, resulting in less ~~germinati~~
germination of pollen grains. At higher temperature, enzyme
is denatured and losses its shape of active site as well,
thus less enzyme substrate complex form.

ResultsPlus
Examiner Comments

This is an example of a very good answer. The student demonstrates an understanding that enzymes may well be involved in pollen grain germination and then goes on to suggest how, through enzymatic involvement, temperature may affect germination.

(iii) Explain why the results might have been affected if the variable you named in (a)(ii) had not been controlled.

(3)

If the temperature is not controlled then the data could be not reliable or valid. If the temperature is too hot or cold the enzymes from the sucrose solution could have denatured. The standard deviation / error bars could over lap.

ResultsPlus
Examiner Comments

Many answers were of this kind. The student has not clearly understood that they are supposed to be talking about the effect of the lack of control of a variable on *the results*. The results in this are percentages pollen grains which germinate, but that is not mentioned anywhere in the answer. Enzymes and the effect of temperature on them are both mentioned and gain two marks. However, the answer is not rounded off with how all this might affect the results and fails to get the third mark.

ResultsPlus
Examiner Tip

One of the most common pieces of advice given to candidates in an exam is to carefully read the question. That certainly would have helped here.

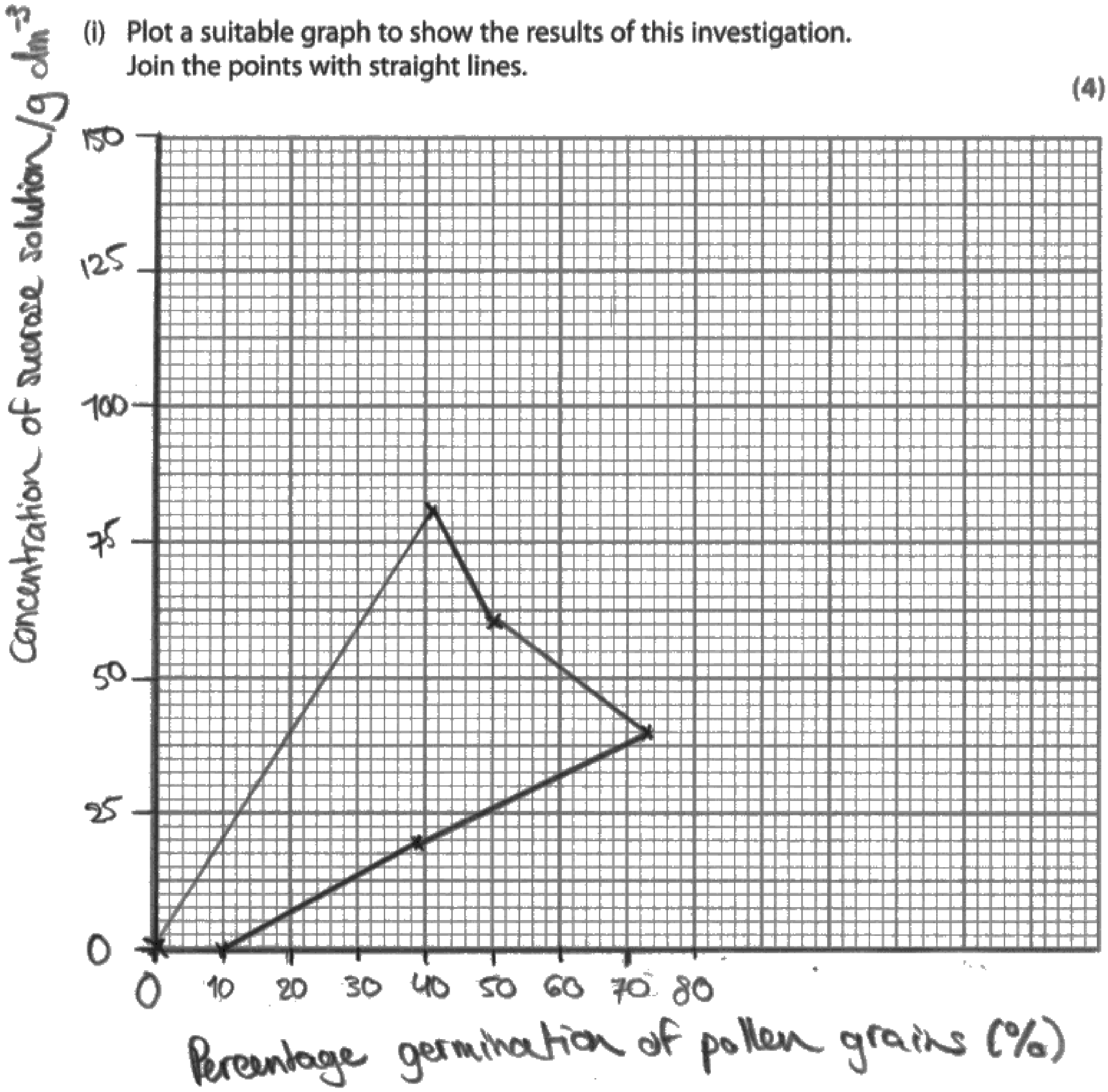
Question 1 (b) (i)

(b) The table shows the results of this investigation.

Concentration of sucrose solution / $g\,dm^{-3}$	Percentage germination of pollen grains (%)
0	10
20	39
40	73
60	50
80	41
100	0
120	0

(i) Plot a suitable graph to show the results of this investigation.
Join the points with straight lines.

(4)



ResultsPlus
Examiner Comments

Most candidates plot a very good graph and got high marks on this question. However, there are still some, as shown in this example, who find this exercise challenging. Regular graph plotting practise would serve such individuals well.

ResultsPlus
Examiner Tip

Make sure you understand which variable to put on which axis when plotting a graph and practice this skill regularly.

Question 1 (b) (ii)

(ii) These results suggest that the optimum concentration of sucrose for pollen grain germination is 40 g dm^{-3}.

Explain how the method could be modified to find the actual optimum concentration of sucrose.

(2)

→ By using a bigger variety of sucrose concentrations, for example (5, 10, 15, 20, 25 ---) this would provide the actual optimum concentration of sucrose, this could be done by diluting the sucrose concentrations.
→ By using the same volume of each of the sucrose concentration this could be done by measuring the volume of the concentrations with a measuring cylinder and making sure the volumes are the same.

ResultsPlus
Examiner Comments

It was not always very clear from student answers exactly what they intended to do. In this one, for example, the first line "using a bigger variety of sucrose concentrations" would not have gained the mark. When, on the next line, suggested sucrose concentrations were listed it is clear what the candidate means and the mark is awarded.

ResultsPlus
Examiner Tip

Try to make sure that the statements you make are not vague but that you use the correct word or phrase to say what you want to say. In this example, rather than a bigger variety the candidate means a narrower range, as shown by the example they have given in brackets.

Question 1 (c) (i)

(c) The table shows the results of an investigation into the effect of boric acid concentration, in a sucrose solution, on the growth of pollen tubes.

Boric acid concentration / parts per million (ppm)	Pollen tube length / µm
25	78
50	126
100	166
200	134
300	112
400	90

(i) Calculate the percentage increase in pollen tube length at 100 ppm compared with that at 25 ppm.

(2)

166 − 78 = 88

$\frac{88}{166} \times 100 = 53.01$

= 53%

Answer 53 %

ResultsPlus
Examiner Comments

In this example, the correct figures have been chosen from the table and these figures have been manipulated correctly to give the answer of 88. However, they then divide this by 166 rather than dividing 78 by 88.

ResultsPlus
Examiner Tip

Percentage calculations are frequently asked for on exam papers. Although they are relatively simple it is possible to go wrong, mainly by not being sure which number to divide by. A simple solution is to do a guesstimate of the likely correct answer. In this case, the length at 25 ppm is 78, about 80, at 100ppm it is 166, about 170. Twice 80 is 160 so that would be a 100% increase, so 170 is a little over 100%, but not much. Such reasoning would have told this candidate that the answer of 53% could not be right.

(c) The table shows the results of an investigation into the effect of boric acid concentration, in a sucrose solution, on the growth of pollen tubes.

Boric acid concentration / parts per million (ppm)	Pollen tube length / μm
25	78
50	126
100	166
200	134
300	112
400	90

(i) Calculate the percentage increase in pollen tube length at 100 ppm compared with that at 25 ppm.

(2)

percentage increase in pollen tube length = $\frac{166\ \mu m + 78\ \mu m}{78\ \mu m} \times 100$

= 312.8 %

Answer 312.8 %

ResultsPlus
Examiner Comments

To work out a percentage change one number will be subtracted from another. If the change is down then this subtraction will give a negative result, such as 30 down to 20; -10. If it is up, then the answer will be positive, 30-20, 10. A percentage change calculation will never involve adding two numbers, as has been done here.

Question 1 (c) (ii)

This was the best answered of the three devise type questions on the paper. The biggest reason for the loss of marks was a failure to measure growth but instead to look at germination. This is very surprising considering that the effect of pH on germination had already been described in the earlier part of the question. In addition, an account of an experiment in which length was used as a measure of growth had just been described. Where candidates did discuss measurement of length, few knew how it could be done.

(ii) You are provided with a solution containing 500 g dm^{-3} of sucrose.

Devise a procedure to investigate the effect of different concentrations of sucrose on the rate of growth of pollen tubes, using this sucrose solution.

(5)

~~Take two plastice plastine rings of diameter 2 cm and place it on a microscope slid Onto the centre of the Dilute the Add~~ Dilute the 500 gdm^{-3} of sucrose by adding distilled water and filter to get the sucrose solutions of 400 gdm^{-3}, 300 gdm^{-3}, 200 gdm^{-3}, 100 gdm^{-3}, and 50 gdm^{-3} concentrations. Take two ~~plastine~~ plasticine rings of diameter 2 mm and place it on a microscope slide. Place ~~the~~ 1 cm^3 of 500 gdm^{-3} sucrose solution in the centre of a coverslip using a dropper ~~Carefully~~ and ~~blow~~ dust some pollen into the sucrose solution. Carefully invert the coverslip which is placed on top of the plasticine rings. ~~After Record the time taken for a pollen tube to appear, It use a mi calibrate the eyepiece~~ After ~~one~~ three hours measure the length of the pollen tube using the eyepiece graticule. First calibrate the eyepiece graticule using a stage micrometer, for a given objective lens. Rate of pollen tube growth is equal to; Initial length of pollen tube − Final length of pollen tube / three ~~one~~ hours

~~Keep variables such as~~ Repeat the entire procedure for

(Total for Question 1 = 18 marks)

sucrose concentrations of 400 gdm^{-3}, 300 gdm^{-3}, 200 gdm^{-3}, 100 gdm^{-3} and 50 gdm^{-3}. Repeat ~~the~~ four more times for each concentration. Keep variables such as temperature, humidity, availability of oxygen ~~and age of pol~~ the same throughout experiment. Temperature is controlled by conducting experiment in a thermostatically controlled room, ~~and humidity is controlled~~

ResultsPlus Examiner Comments

This is quite a rare full mark answer.

In the first few lines are the first 2 marking points, create at least sucrose solutions and do this by diluting with water. Then comes the suggestion to measure using a graticule after 3 hours, this gets marking points 6 and then 5. Right at the end variables which should be controlled are listed for marking point 3.

(ii) You are provided with a solution containing 500 g dm^{-3} of sucrose.

Devise a procedure to investigate the effect of different concentrations of sucrose on the rate of growth of pollen tubes, using this sucrose solution.

(5)

Use multiple pollen tubes with same age and ~~surface~~ volume. In a room with same temperature and light intensity. Add the pollen grains onto agar plate. Put in different concentrations but same amount of ~~concen~~ sucrose solution. Leave it for 10 days. Repeat the experiment more than once. Observe the results.

ResultsPlus
Examiner Comments

There were 2 marks here for a list of relevant variables (mp3) and a suggested time scale. A weak statement such as observe the results will never be enough.

ResultsPlus
Examiner Tip

Nearly all experiments you will do or think and read about should involve the measurement of something and that is the DV. So, the results of experiments will almost always be numbers.

(ii) You are provided with a solution containing 500 g dm^{-3} of sucrose.

Devise a procedure to investigate the effect of different concentrations of sucrose on the rate of growth of pollen tubes, using this sucrose solution.

(5)

~~Use 500 g dm^{-3} stock sucrose solution to make · Example 100g/200 g dm^{-3}, 350 g dm^{-3} and 50 g dm^{-3} sucrose solution with different sucrose soluti sucrose concentrations. Label the six test tubes with waterproof mark. Find the concentration of the sucrose in 500 g dm^{-3} then make diffre~~

- Use 500 g dm^{-3} stock solution to make different concentration of sucrose by serial dilution. Use syringes and distilled water keep the temperature and pH of water same. Use Give ~~them~~ provide pollen the needed conditions like water, nutrients and warm temperature then measure the length of pollen tubes before and after the experiment. Use a test tube containing only pollen tubes with no sucrose solution as control.

ResultsPlus
Examiner Comments

Here the idea of serial dilution gained a mark and the suggestion that temperature should remain constant gained another mark. However, vague suggestions such as measure the pollen grain, although the correct variable, are too imprecise to gain the mark.

Question 2 (a) (i)

This should have been a relatively simple question, as it is based on GCSE learning. However, many candidates were able to obtain only one mark because they forgot that Benedict's reagent, and other similar alternatives, need some heat applied for the reaction to occur. A worrying minority had no idea at all which test is involved.

2 An investigation was carried out to determine the relative concentration of reducing sugars in a range of foods.

In each case, some food was ground up with distilled water. The resulting liquid was filtered to give an extract.

This extract was then tested for the presence of reducing sugars using a reagent.

(a) (i) Describe how a test for reducing sugars is carried out.

(2)

We use iodine ~~or benedict solution~~ to the food that we want to test on reducing sugar it will change ~~from blue to black~~ to form blue

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Examiner Comments

The sugar test really ought to be known from GCSE and semi-quantitative testing for reducing sugars is one of the core practicals on the specification. Iodine does not test for reducing sugars.

ResultsPlus
Examiner Tip

Try to make sure you know the basic materials from GCSE, such as the standard food tests. Also, it is vital that you know the details of all the core and recommended additional practicals on the AS specification.

2 An investigation was carried out to determine the relative concentration of reducing sugars in a range of foods.

In each case, some food was ground up with distilled water. The resulting liquid was filtered to give an extract.

This extract was then tested for the presence of reducing sugars using a reagent.

(a) (i) Describe how a test for reducing sugars is carried out.

(2)

You would place drops of liquid extract into a known solution of blue DCPIP and see how many drops in ml it takes ~~to decolourise~~ change the DCPIP ~~from blue to transparent to brick red~~. until no change of colour is presented, leaving a blue, green, yellow, orange or brick red colour

ResultsPlus
Examiner Comments

Another example where the wrong test has been chosen.

2 An investigation was carried out to determine the relative concentration of reducing sugars in a range of foods.

In each case, some food was ground up with distilled water. The resulting liquid was filtered to give an extract.

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(a) (i) Describe how a test for reducing sugars is carried out.

(2)

The food extract is mixed with the reagent and the change in colour and concentration of reagent and food extract is ~~[illegible]~~ also recorded. The results are placed on a colour chart.

ResultsPlus
Examiner Comments

No marks will be awarded on an A-level paper for vague statements such as 'the reagent'.

2 An investigation was carried out to determine the relative concentration of reducing sugars in a range of foods.

In each case, some food was ground up with distilled water. The resulting liquid was filtered to give an extract.

This extract was then tested for the presence of reducing sugars using a reagent.

(a) (i) Describe how a test for reducing sugars is carried out.

(2)

Use Benedict's solution with some concentration to the extract which are going to tested heat them gently to observe colour change from blue to orange.

ResultsPlus
Examiner Comments

A relatively clear and correct answer.

Question 2 (a) (ii)

This question is based on core practical one and so it was rather alarming to see a very large number of zero scores with full marks being a rarity. The main problem is that, although candidates are aware of the basics they were not able to give enough specific detail to gain the marking points.

(ii) Explain how this investigation should be carried out to give a semi-quantitative estimate of the concentration of the reducing sugars by comparing the colour of the precipitate with a colour chart.

(3)

Prepare a range of reducing sugar solutions with concentrations 0%, 0·1%, 0·5%, 1%, 5%. Equal volumes of the 0·1% solution ~~is add~~ and benedict's solution are added into a test tube and boiled in a water bath. this procedure is repeated to all the other concentrations, to obtain colour standards.

Concentration	0%	0·1%	0·5%	1%	5%
Colour	blue	green	yellow	orange	red

test for reducing sugars in a juice or food extract with unknown concentration of reducing sugars, then compare the colour of the solution with colour standards to estimate the concentration of reducing sugars.

ResultsPlus
Examiner Comments

A very uncommon three mark answer in which the candidate has generated colour standards, standardised the Benedict's test and used a stated volume to test.

(ii) Explain how this investigation should be carried out to give a semi-quantitative estimate of the concentration of the reducing sugars by comparing the colour of the precipitate with a colour chart.

(3)

Heat several test tubes with different reducing sugars and concentration in a water bath with a known volume of Benedict's solution for several minutes until there is a colour change. Place each test tube on the rack and place a white tile behind so colour is more visible and clearly distinguishable. Compare each colour to that of the colour chart and observe which colour closely resembles the one in the test tube to find the range of possible concentrations. Make sure the room is well lit with daylight.

ResultsPlus
Examiner Comments

In this example, no food is tested and only 1 mark can be awarded for the idea of a standardised test, mp 3.

Question 2 (a) (iii)

This was a very challenging question and few saw the solution. It highlights a need for candidates to be tutored in the art of applying what they know to novel situations, a feature of the new paper. The overwhelming majority got no marks. Many tried to answer with the stock "repeat it many times" type of answer. A few did realise that something needed to be tested for sugar after the initial test but were often unclear about what that should be. Others thought looking at a food label would do the trick.

(iii) It was assumed that the extract contained all the reducing sugars from the food sample.

Suggest how this assumption could be tested.

(2)

The concentration of the solution would be obtained from comparison ~~bette~~ with the colour chart. and then it could be ~~test~~ compared with the information given on the label of food sample's packaging.

ResultsPlus
Examiner Comments

A very vague answer for no marks.

(iii) It was assumed that the extract contained all the reducing sugars from the food sample.

Suggest how this assumption could be tested.

(2)

This assumption could be tested by taking the remains of the ground up food and testing them using the reagent. If the reagent stays blue then there are no reducing sugars in the remains and all reducing sugars are in the extract. If it doesn't stay blue then there are some reducing sugars within the remains and not all reducing sugars are in the extract.

ResultsPlus
Examiner Comments

A good answer, although very simple. It is all that was needed. Test the residue in the filter paper and see if there is any sugar in it. The term residue was, of course, not needed. This candidate uses the phrase "remains of the ground up food". The only slight issue is that they fail to name Benedict's reagent, but the reagent was accepted.

(iii) It was assumed that the extract contained all the reducing sugars from the food sample.

Suggest how this assumption could be tested.

(2)

This assumption could be tested by placing a few drops of bennidicts solution onto the ground up food that had been filtered off and seeing if there is a colourchange, if there is, then not all the reducing sugars were extracted.

ResultsPlus
Examiner Comments

Here, although the description of how the test is done is incorrect, the two ideas are OK for both marks.

Question 2 (b)

A significant number of candidates misread the question and listed the sequence of colours produced by the test as sugar concentration rises.

(b) The table shows the results of the investigation. from food samples.

Food	Colour of precipitate
apple	brick red
bread	green
cashew nut	no precipitate
potato	yellow
sweet potato	orange

Complete the table below by writing the names of the foods in order from the highest concentration of reducing sugars to the lowest concentration.

(2)

highest ──────────────────────────► lowest

orange	yellow	~~brick red~~ green	~~green~~ brick red	no pecipitate

*iii) - add benedict solution to food sample
- add benedict solution to extract
- observe colour of pecipitate if same - compare on colour chart means all reducing sugar is from food sample

ResultsPlus
Examiner Comments

In this case, this sequence is not correct. However, many did quote the correct sequence but did not use this knowledge to get the marks.

Question 2 (c) (i)

This question was pleasingly well answered. Most candidates put apple and went on to talk about its high reducing sugar content and the most copper ions reduced. However, some candidates did not gain further marks because their expression was too imprecise, saying things such as 'a lot of sugar' or 'many copper ions'.

(c) The reagent used to test for reducing sugars is a blue solution containing soluble copper ions. Reducing sugars react with the copper to form an insoluble precipitate.

After testing, the precipitate formed can be removed. This leaves a solution that is less blue.

(i) Explain which food extract would leave the least blue solution when the precipitate is removed.

(3)

Apple

• The reducing sugars present in the extract of apple reacts with the soluble copper ions and reduces them. The food extract which has the highest percentage of reducing sugars reduces most of the copper ions reducing the intensity of the blue colour.

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Examiner Comments

Having said apple, this candidate jumps the first hurdle with the phrase "(apple) has the highest percentage of reducing sugar". They then jump the second with the phrase "reduces most of the copper ions" to get 3 marks.

Question 2 (c) (ii)

This question gave a good spread of marks but 1 and 2 were the most common.

(ii) Devise a procedure to determine the concentration of reducing sugars in a sweet potato.

(4)

→ A sweet potato sample is cut and then again ground with a mortar and pestle. The sample is then added to distilled water. The reaction mixture is swirled to allow the reducing sugar present in the potato to dissolve in the water. The whole mixture is then filtered and the residue is squizzed, transferring the solution to the prepared extract.

→ Volume of extract is measured using a measuring cylinder, V.

→ Then using a syringe blue Benedict's reagent is added to the extract and the reaction mixture is stirred using the needle of the syringe.

→ Excess [illegible] Benedict's reagent is added until blue solution does not disappear any further.

→ The precipitate that has formed is removed by filtration and dried. The mass of precipitate is measured and mole number is calculated. From this we can find out mole number of reducing sugar in the extract sample. → Concentration of sugar = $\frac{\text{mole no.}}{\text{Volm, V}}$

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Examiner Comments

One of the very few 4 mark answers we saw. Most others who score marks got 1 or 2 for the easier parts of taking a known volume of the material to be tested and doing Benedict's test on it. They then simply repeated what was done in an earlier question and compared with a colour standard. The two routes forward were to weigh the precipitate or do colorimetry on the remaining blue solution, but very few saw this.

Question 3 (a) (i)

This question gave a good spread of marks, but few gained all 4.

3 The enzyme urease catalyses the following reaction:

urea → ammonia + carbon dioxide

The effect of pH on this reaction was investigated using the following method.

- One test tube containing 5 cm^3 of urease solution was placed in a water bath at 40 °C and left for 10 minutes.
- Another test tube containing 5 cm^3 of urea solution in a buffer at pH 3.0 was placed in the same water bath and left for 10 minutes.
- After 10 minutes, the contents of both tubes were mixed together in one test tube.
- This test tube was replaced in the water bath.
- The concentration of ammonia was measured after 15 minutes and again after 60 minutes.
- The procedure was repeated for pH values of 4.0, 6.5, 6.8, 7.3, 8.0 and 9.0.

(a) (i) Explain why the urease solution and the urea solution were kept in the water bath at 40 °C before and after being mixed.

(4)

Temperature is variable ~~that~~ may affect the rate of reaction. Since pH is our independent variable temperature must be constant. So this ensures any difference seen is due to pH. keeping in the water bath ensures both test tubes reach a steady ~~to~~ temperature of 40 °C ~~so~~. This is done to equilibrate with 40 °C as they may be in different temperatures. 40 °C is chosen as it is the optimum temperature of urease. The rate of reaction is highest as shape of active site is complementary with urea and is not denatured. Particles can collide with enough activation energy for a reaction to happen. It is also kept after mixing to ensure reaction goes on at 40 °C as heat losses may occur. So rate of collision is same.

ResultsPlus
Examiner Comments

This is a 4 mark answer. It deals with the idea that only pH can vary in an experiment where pH is the IV. It then goes on to talk about equilibration, where many candidates called it acclimatisation, which is not the same thing. Thirdly, it discusses why 40^{o}C was chosen, suggesting that it is the optimum for urease. Finally, it makes points which all add up to saying that temperature affected the reaction rate.

3 The enzyme urease catalyses the following reaction:

$$\text{urea} \xrightarrow{\text{urease}} \text{ammonia} + \text{carbon dioxide}$$

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- After 10 minutes, the contents of both tubes were mixed together in one test tube.
- This test tube was replaced in the water bath.
- The concentration of ammonia was measured after 15 minutes and again after 60 minutes.
- The procedure was repeated for pH values of 4.0, 6.5, 6.8, 7.3, 8.0 and 9.0.

(a) (i) Explain why the urease solution and the urea solution were kept in the water bath at 40 °C before and after being mixed.

(4)

This is to equate the temperature of both the urease solution and urea solution. The temperatures must be equal before being mixed to increase validity as temperature should be controlled to truly see the effect of pH on the reaction. Also 40°C may be the optimum temperature of the enzyme to ensure quickest reaction without denaturing the protein (enzyme). They are kept in the water bath even after to maintain this equated temperature throughout so the results are valid and pH's effect can be clearly seen.

ResultsPlus
Examiner Comments

This is another good answer, but this time gets 3. It discusses the idea of equilibration but uses the word equate, which was accepted in context. It then talks about how 40°C might be the optimum and says that only pH can be allowed to vary.

Notice that discussion of how various procedures can make results valid, reliable, accurate, are very unlikely to gain any marks unless it is clear that the candidate knows what these terms mean.

Question 3 (a) (ii)

Fully correct answers to this question were very rare.

(ii) Explain how you could determine suitable concentrations of urea and urease solutions to use in this investigation.

(2)

by repeating the experiment using different concentrations of both urea and urease solutions and checking the suitable ones and use them where the reaction is not too fast but not too slow

ResultsPlus
Examiner Comments

In this example, both marks are gained. Many suggested the idea of doing the experiment at a range of urea and urease concentrations, as here. However, hardly any made the suggestion seen in this answer, to select those which gave a rate which is neither too fast nor too slow.

ResultsPlus
Examiner Tip

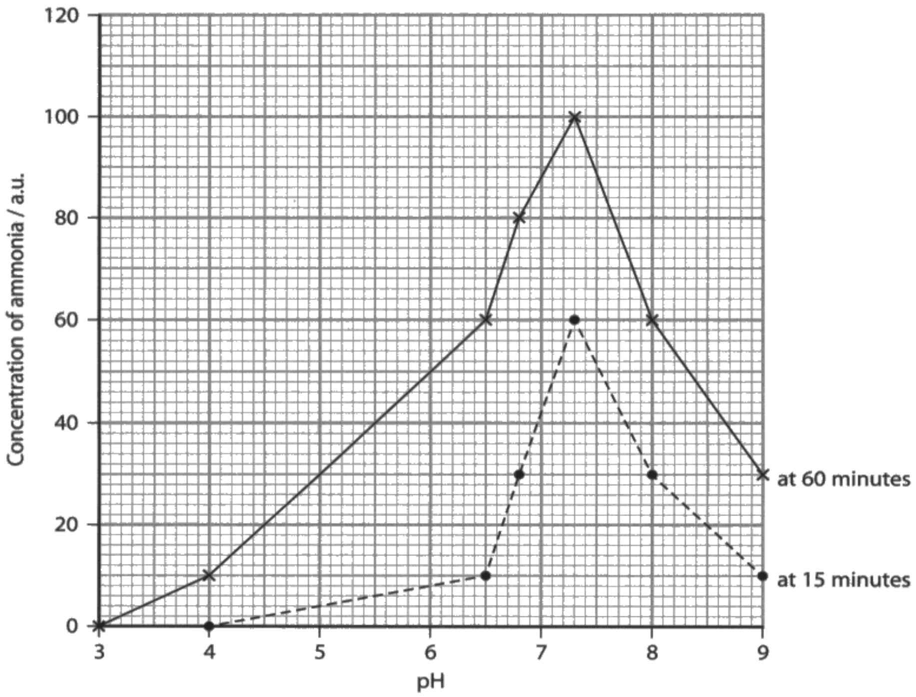
In all true experiments, there will be three kinds of variable, the IV and the DV. And the third type, the control variables. You must think about what these might be AND about how to decide what values to set them at. In a class practical you may be told what to set them at, but someone had to decide. You should always think about how you would go about this for all the CVs.

In this case, many said, "choose the fastest one". But this might be too fast. If you have seen catalase acting on hydrogen peroxide, you will know how fast enzyme catalysed reactions can be.

Question 3 (b) (i)

A large majority found this one of the most accessible questions on the paper. However marks were still lost by some.

(b) The graph shows the results of this investigation.



(i) Draw a suitable table to include the results for the experiment at 60 minutes.

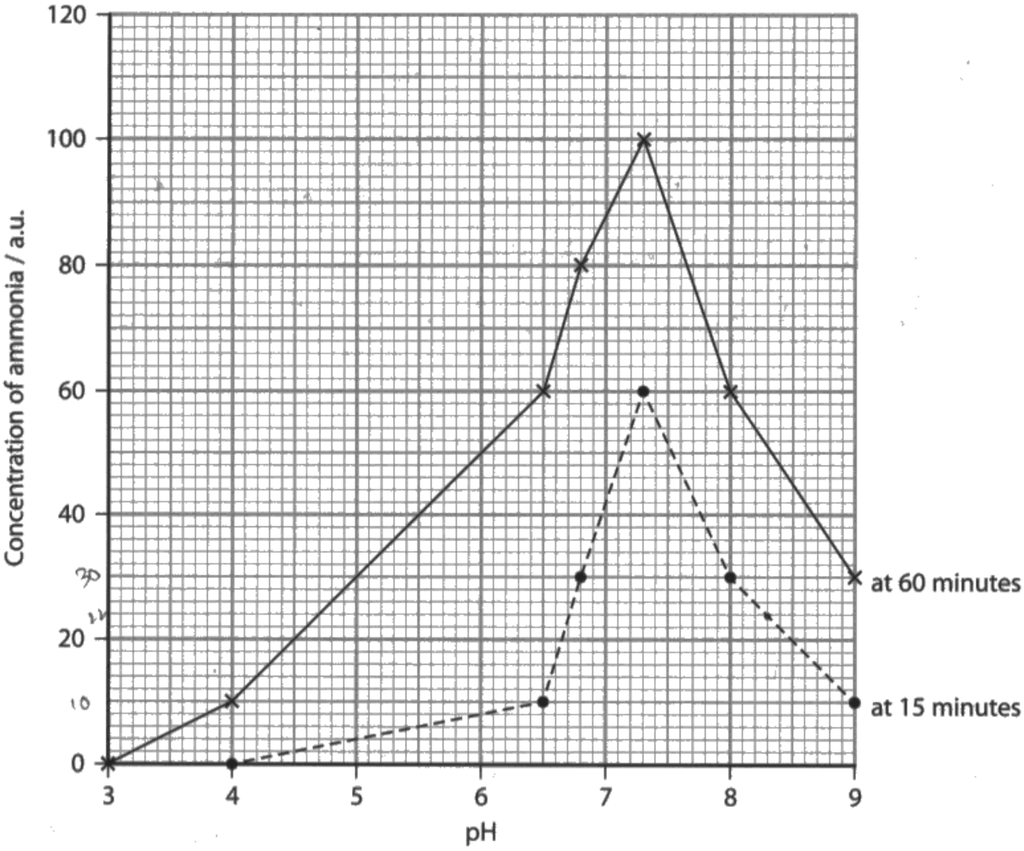
(4)

PH	Results at 60 minutes
3	0
4	10
5	
6.5	60
6.8	80
7.3	100
8	60
9	30

ResultsPlus
Examiner Comments

In this example 2 marks were lost for an inappropriate RH column heading. It would never be appropriate to head a results table column with results and, in addition, there are no units.

(b) The graph shows the results of this investigation.



(i) Draw a suitable table to include the results for the experiment at 60 minutes.

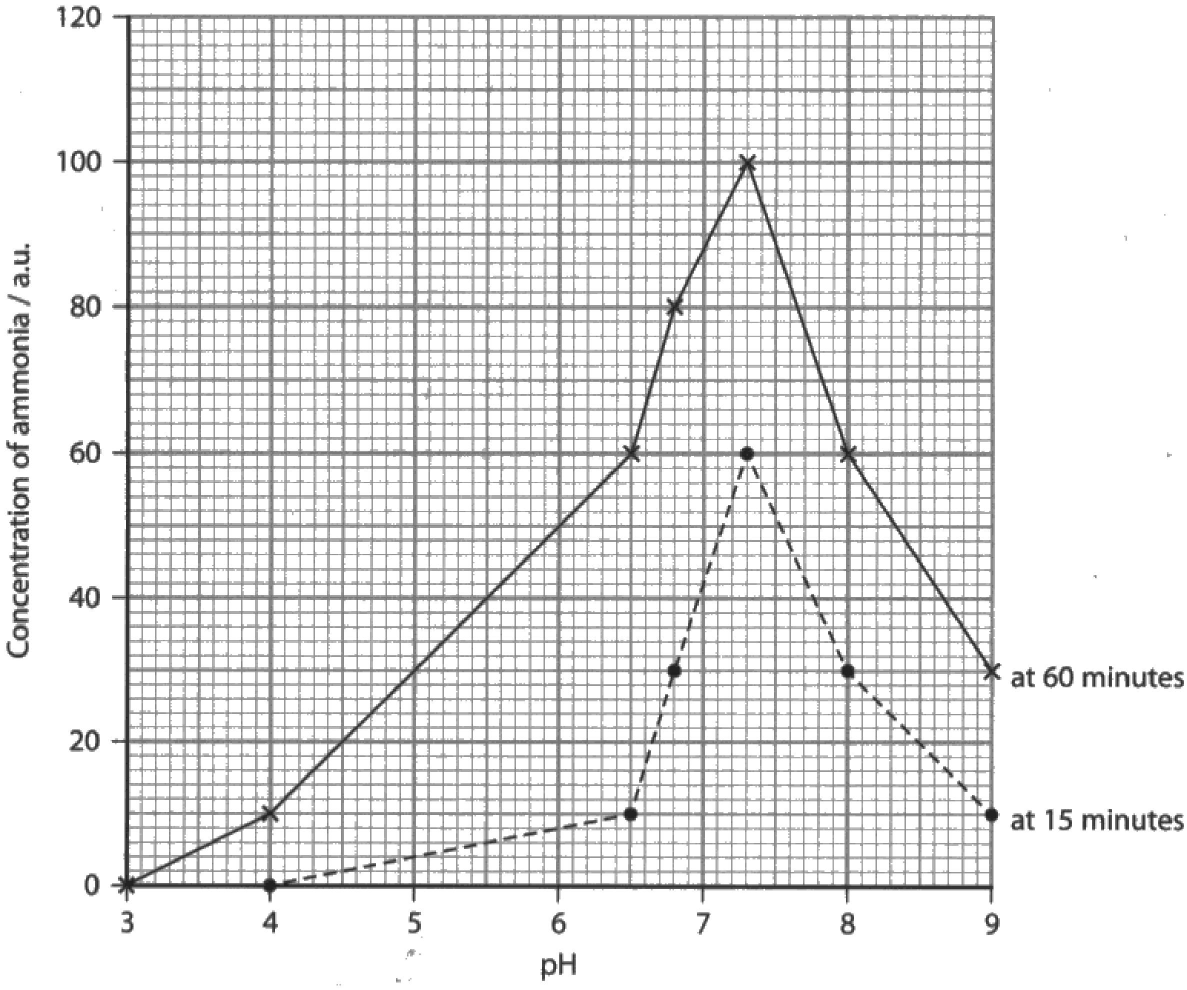
(4)

pH	Concentration of ammonia / a.u.	
	15 minutes	60 minutes
3.0	0	0
4.0	0	10
6.5	10	60
6.8	30	80
7.3	60	100
8.0	30	60
9.0	10	30

ResultsPlus
Examiner Comments

Four clear marks.

(b) The graph shows the results of this investigation.



(i) Draw a suitable table to include the results for the experiment at 60 minutes.

(4)

pH	Concentration of ammonia / a.u
3	0
4	10
5	30
6	50
7	88
8	60
9	30

ResultsPlus
Examiner Comments

A common reason for the loss of a mark was candidates who decided to not answer the question set, which asked for a table of the *results*. Instead, they made a hybrid table of some results and some data which was derived from the graph.

ResultsPlus
Examiner Tip

The results of an experiment are raw results, not a mixture of raw results and ones derived from a graph, as in this answer. Such results are inferred.

Question 3 (b) (ii)

This was a relatively easy calculation, and the correct answer was given by a majority of candidates. However, some lost a mark due to a lack of units or the use of incorrect units.

(ii) Calculate the rate of reaction at a pH of 7.3 during the first 15 minutes of this investigation.

Include appropriate units with your answer.

(2)

$\frac{60}{15} = 4$

Answer ......4......

ResultsPlus Examiner Comments

This answer gained only 1 of the 2 marks available as there are no units given.

ResultsPlus Examiner Tip

As a general rule, if there are no units supplied at the end of the answer line, you must supply them.

Question 3 (b) (iii)

In compare and contrast questions similarities and differences must be given. Full marks will never be available for giving only similarities or only differences.

(iii) Compare and contrast the results shown in the graph at 60 minutes with those at 15 minutes.

(3)

In both graphs concentration increases as pH increases upto a pH of 7·3 . At 60 minutes, at a pH of 4 there is a concentration of 10 a.u where as in 15 minutes it is zero. At a pH of 7·3 the concentration at 60 minutes is higher than at 15 minutes. The increase in concentration is greater at 60 minutes from pH (4-6·5) as seen by a steeper gradient. The concentration drops after a pH of 7·3 on both graph

ResultsPlus
Examiner Comments

This answer effectively repeats the same point, that 7.3 is the optimum for both 15 and 60 minutes, a number of times.

ResultsPlus
Examiner Tip

Look at the number of marks available and make that number of *different* points in your answer to any question.

(iii) Compare and contrast the results shown in the graph at 60 minutes with those at 15 minutes.

(3)

Overall concentration of ammonia was higher at 60mins, but at both times the highest ammonia conc was at pH 7.3. Both graphs have a rise in conc from 3 (at 60mins) & at 4 (at 15mins) pH rising up at pH 7.3. The rise at 60mins was from 0 up to 100 a.u, but at 15 it was from 0 to 60 a.u (ammonia conc rise). Then for both times the conc of ammonia drops gradualy from 100 to 30 (for 60 mins) & from 60 down to 10 a.u (for 15mins) when the pH increased from 7.3 upto 9 pH.

For the line for 15 mins, the rise was smaller from 4 - 6.5 pH, because at 60mins the rise was very steep. For 15 mins the rise of conc was small after 4 - 6.5 pH rise - from 0 to 10 a.u, 10 a.u difference compare to 60 mins the rise was from 10 to 60 a.u - 50 a.u difference. Then both lines rose for con at 7.3 pH.

ResultsPlus
Examiner Comments

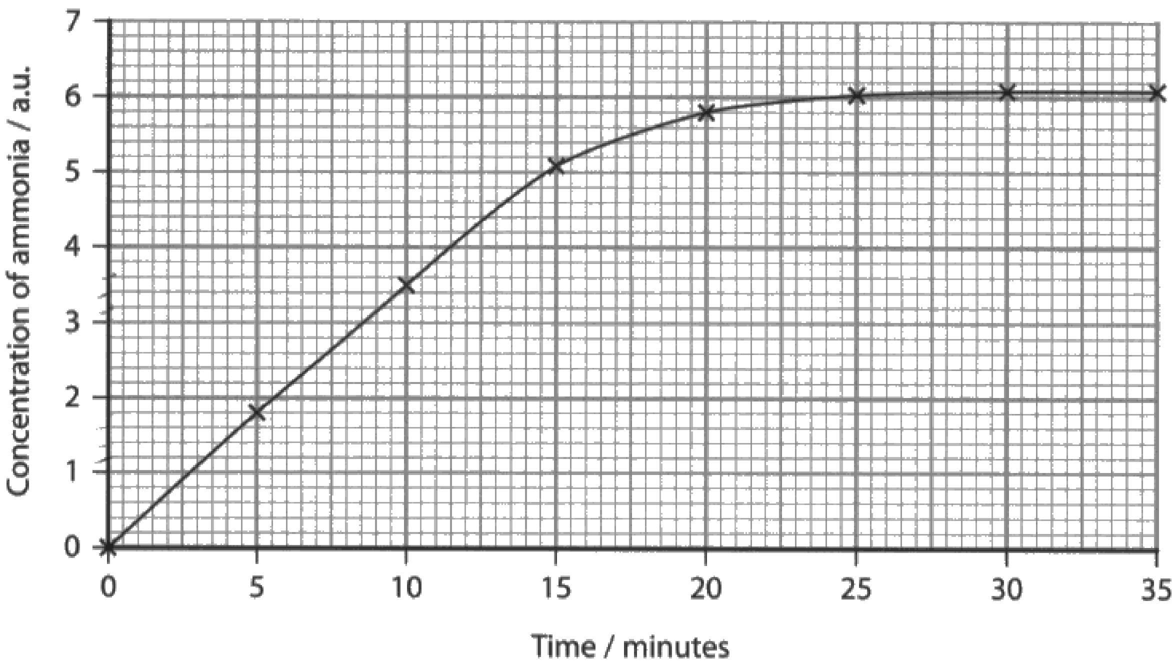
This approach is generally not going to be highly mark yielding. It just quotes numbers at the examiner but does not attempt to draw any general points from all the numbers. It got 2 and these were in the first two lines.

Question 3 (c)

Some leeway was given because the numbers for the calculation had to be obtained from the graph. Finding the initial rate should be a standard procedure for students on this course (from Core Practical 4) and indeed this was answered well. However, some lost the mark because they did not put the units or did not put the correct units. There were various ways of expressing the rate (per second, per minute) and so units were needed for the mark.

(c) In another investigation, the concentration of ammonia was recorded every 5 minutes for 35 minutes, at a pH of 6.0.

The graph shows the results of this investigation.



Calculate the initial rate of this reaction.

Include appropriate units with your answer.

(1)

$\frac{1.8}{5} = 0.36$

$\frac{3.5}{10} = 0.35$

$\frac{5.5}{15} = 0.37$

Answer 0.37

ResultsPlus
Examiner Comments

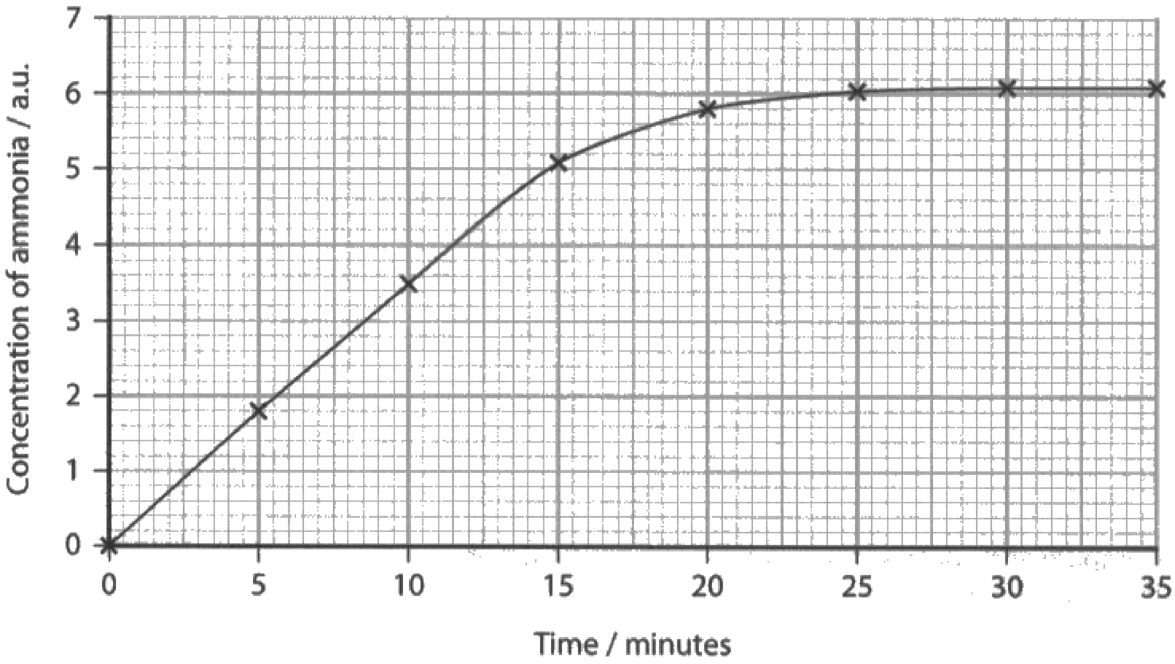
A correct answer but no mark as there are no units given.

ResultsPlus
Examiner Tip

Remember to put units on the results of numerical calculations if they are not supplied for you at the end of the answer line.

(c) In another investigation, the concentration of ammonia was recorded every 5 minutes for 35 minutes, at a pH of 6.0.

The graph shows the results of this investigation.



Calculate the initial rate of this reaction.

Include appropriate units with your answer.

(1)

1.8 au. ⟶ 5 min

$\frac{1.8 au}{5} = \frac{x}{1}$

$= \frac{1.8 \times 1}{5} = \frac{1.8}{5} = 0.36$ au /mi

Answer 0.36 a.u. /min

ResultsPlus
Examiner Comments

A carefully set out and correct answer.

Paper Summary

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

1. Make sure you are very familiar with every aspect of each of the 9 core practicals and the 5 recommended practicals, any of these may form the context for questions on this paper.

2. For each practical, you should consider the variables involved. The DV, the IV, and the CVs. How is the DV measured? What range of values would be appropriate for the IV? What values would be chosen for the CVs and how would they be determined? These, amongst others, are questions which you may be required to think about in the examination.

3. Try to think about how you might design experiments to answer all sorts of questions and get used to this way of thinking. In all experiments, you change a variable, the IV, and look at the effect of these changes on another variable, the IV. All other variables which may affect the DV are kept constant, these are the CVs.

Grade Boundaries

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