Pearson BTEC

Examiners' Report
Lead Examiner Feedback

January 2021

Pearson BTEC Nationals
In Applied Science (31619H)
Unit 3: Science Investigation Skills

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Introduction

Section 1 - Physics

This examination originally tested the skills of learners in using a given method (Part A) to set up an investigation and then processing the results obtained. Part B Section 1 used questions to test processing, analysis and interpretation of data either from the investigation or from related topics. Section 2 was in this series a Biology topic which covered planning an investigation and evaluation of results.

As it was not possible for learners to carry out investigations due to government restrictions and reduced time available during the pandemic, Part A of the examination was changed. The Part A in the January 2021 series gave a method for an investigation with a circuit diagram, a pictorial representation of the apparatus and results. Learners were given Part A to study and make notes for 45 minutes before starting Part B. Part B Section 1 started with the same two questions as on previous papers, but learners were given a set of results to put into a table, the results were processed to produce a graph.

Introduction to the Overall Performance of the Unit

Learners adjusted well to the difference in format but still found it difficult to produce a properly organised table of results from which a graph could be plotted. Learners usually showed working for calculations and were often able to successfully rearrange an equation. Giving limitations of the method and suggesting improvements proved to be challenging but learners were generally able to describe at least two of the requirements needed to test reproducibility.

Introduction

Section 2 - Biology

Section 2 of this paper consists of two questions which are taken from a different scientific discipline to the questions in Section 1.
In this paper, Section 2 is based on the Biology that is indicated in section D: enzymes in action of the essential content of Unit 3, focussing on D3 Factors that can affect enzyme activity. The questions are designed to test two parts of the specified content for the examination these being section A 'Planning a scientific Investigation' and section C 'Drawing conclusions and evaluating'.

Introduction to the Overall Performance of the Unit

Question 4 tests the ability of the learner to plan a scientific investigation. This includes the development of a hypothesis, the selection and justification of equipment, techniques and standard procedures, health and safety and methods of data collection including, quantities to be measured, number and range of measurements to be taken, how the equipment is to be used, control variables and a brief method for data collection and analysis. Unfortunately, the majority of the learners did not seem familiar with the practical and designed their plan to use iodine as an indicator similar to Universal Indicator or phenolphthalein where a colour change could be observed over time. However learners were able to give independent and dependant variables and justification of their selected equipment and so marks could be awarded holistically for the response and practical knowledge could be credited.

Question 5 gives a description of the method, results and conclusion of an investigation and tests the ability of learners to use this information to make recommendations to improve the method, determine possible sources of error, consider the reliability or otherwise of data and evaluate the conclusions given with respect to the results given for the investigation. Most learners commented on the lack of detail in the given method and gave sensible suggestions to improve the repeatability and reliability of the experiment. Most learners commented on the need for repeats. Some suggested that the result at pH 2 could have been anomalous and suggested repeating this reading. Fewer learners questioned the accuracy of the conclusion and those that did suggested investigating values between pH 1 and 3 to find a more accurate optimum. The vast majority of learners were able to attempt this question, suggesting an improvement with time management throughout the paper, as previously a number of scripts did not include a response to Q5.

Individual Questions

Physics

Q1a

An acceptable form of the table is shown below.

voltage output ,V	current , A			
	1	2	3	average
2	0.02	0.03	0.03	0.03
4	0.07	0.04	0.08	0.08
6	0.12	0.11	0.12	0.12
8	0.14	0.14	0.14	0.14
10	0.16	0.15	0.16	0.16
12	0.18	0.17	0.17	0.17

However, there are several ways of completing the table which would still gain 3 marks, one of these is shown below.

(V) Voltage	Lamp Brightness	Current (A)			Average Current (A)
		1	2	3	
2	Just on	0.02	0.03	0.03	0.03
4	very dim	0.07	anomoly 0.04	0.08	0.08
6	Quite dim	0.12	0.11	0.12	0.12
8	Bright	0.14	0.14	0.14	0.14
10	Brighter	0.16	0.15	0.16	0.16
12	very bright	0.18	0.17	0.17	0.17

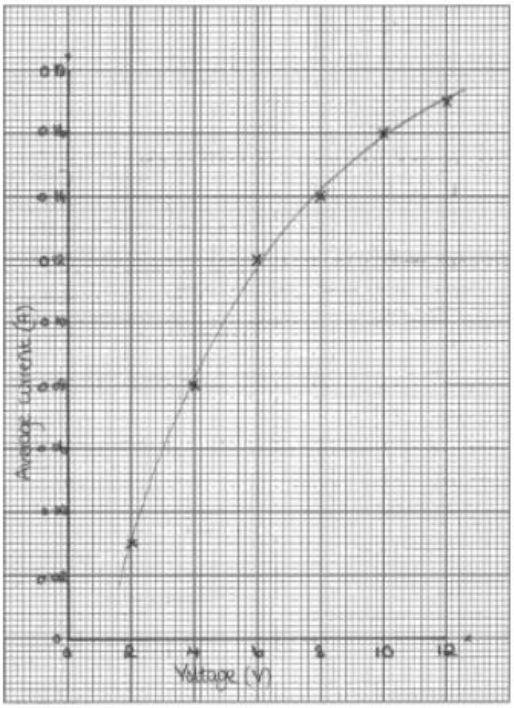
The following tables only gained two marks. The first because the averages of the current were given to three decimal places. As the results are to two decimal places the averages should also be to two decimal places. The second table because there is no overall heading of current or a unit of current. The inclusion of the unit of voltage after each reading, but not in the heading for the column is acceptable.

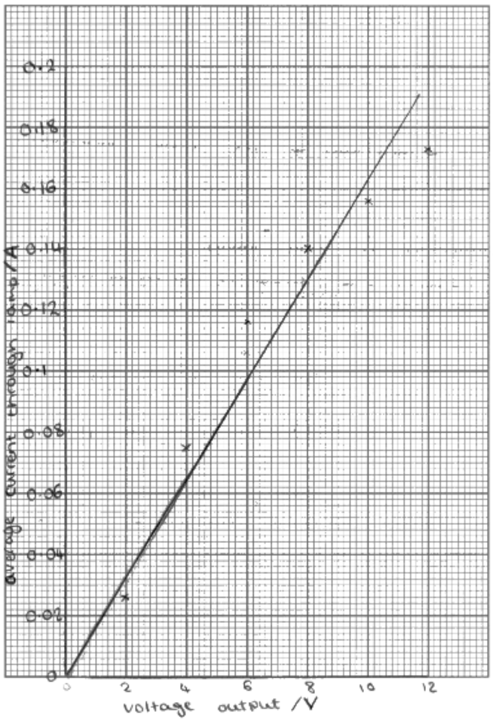
Voltage output (V)	Current (A)			
	1	2	3	average
2	0.02	0.03	0.03	0.027
4	0.07	0.04	0.08	0.075
6	0.12	0.11	0.12	0.117
8	0.14	0.14	0.14	0.14
10	0.16	0.15	0.16	0.157
12	0.18	0.17	0.17	0.177

Voltage setting	1	2	3	Avg
2v	0.02	0.03	0.03	0.03
4v	0.07	0.04	0.08	0.08
6v	0.12	0.11	0.12	0.12
8v	0.14	0.14	0.14	0.14
10v	0.16	0.15	0.16	0.16
12v	0.18	0.17	0.17	0.17

Q1b

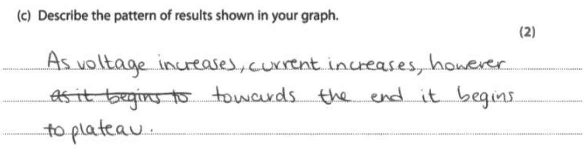
For the graph a scale should be chosen so that plotted points cover more than half the grid both horizontally and vertically. An example of a graph that gained 3 marks is shown below. This shows a suitable scale with the axes labelled with quantities and units, correctly plotted points with the current taken to two decimal places and a curve of best fit which shows an even spread of points on either side of the curve. The second graph also gains 3 marks as the scale is correct and there are correct axes labelled and units. The plots are also correct when three decimal places are used for the average. The learner has assumed the graph should pass through the origin, which is ignored and then drawn the best straight line through the points, with the points evenly distributed about the line.



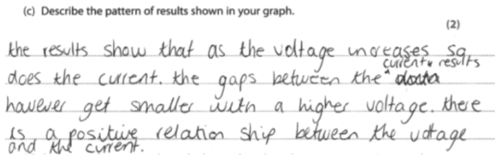


Q1c

The majority of learners could describe the trend of the line drawn on the graph which would gain a mark. However, it should be noted that for the curve the gradient changes or that the current increases at a decreasing rate or the change is non-linear to give the second mark. If the learner showed a straight line as the graph, then it should be noted that the gradient is constant to gain the second mark. Below are two examples of responses that gained 2 marks for describing the curve.


(c) Describe the pattern of results shown in your graph. (2)

As voltage increases, current increases, however ~~as it begins to~~ towards the end it begins to plateau.


(c) Describe the pattern of results shown in your graph. (2)

the results show that as the voltage increases so does the current. the gaps between the current results ~~data~~ however get smaller with a higher voltage. there is a positive relation ship between the voltage and the current.

Q1d

Almost all learners were able to identify that the lamp got brighter during the investigation.

Q1e

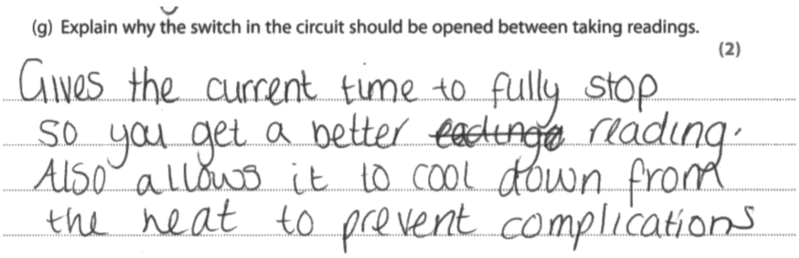
Most learners were able to identify one control variable and a significant proportion identified the lamp, ammeter or power supply to gain both marks.

Q1f

Many learners were able to identify the independent variable as the voltage output and the dependent variable as the current through the lamp.

Q1g

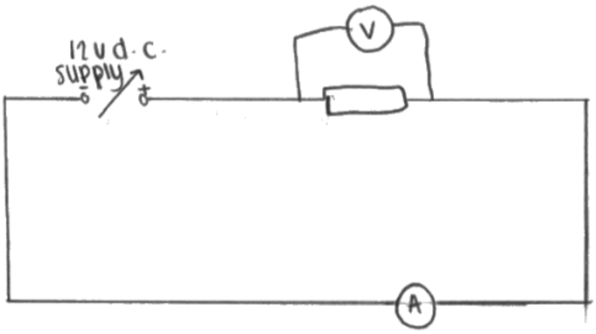
Only a few learners were able to gain two marks for the answer to this question. Learners were generally not able to identify that the switch being open leaves a gap in the circuit and therefore there is no current in the circuit. However, many learners did give the expansion point that this prevents overheating of apparatus in the circuit. Below is an example of response that gained two marks.


(g) Explain why the switch in the circuit should be opened between taking readings. (2)

Gives the current time to fully stop so you get a better ~~reading~~ reading. Also allows it to cool down from the heat to prevent complications

Q2ai

A significant number of learners were unable to draw a voltmeter placed in parallel with the resistor in the circuit. Either due to not recognising the circuit symbol for a fixed resistor or not knowing how to show a voltmeter in parallel in a circuit diagram. A correct response is shown below.

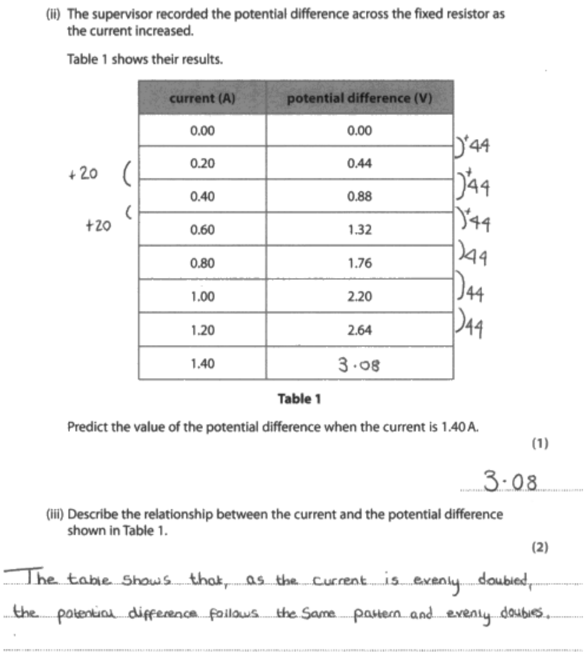


Q2aii

Most learners were able to predict the potential difference to complete the table and found it to be 3.08 V.

Q2aiii

The relationship between current and potential difference was described as 'the potential difference increases as the current increases' or 'current and potential difference are proportional' by many learners and this gained one mark. This needed to be extended to gain the second mark as for example 'the increase is constant' or for both marks 'the potential difference increases by 0.44 V for every increase in current of 0.2 A'. Two marks were also given for stating that the relationship is **directly** proportional. This can be seen as current and potential difference are proportional and both start at zero. Below are two examples of responses that gained two marks.



(ii) The supervisor recorded the potential difference across the fixed resistor as the current increased.

Table 1 shows their results.

current (A)	potential difference (V)
0.00	0.00
0.20	0.44
0.40	0.88
0.60	1.32
0.80	1.76
1.00	2.20
1.20	2.64
1.40	3·08

Table 1

Predict the value of the potential difference when the current is 1.40 A.

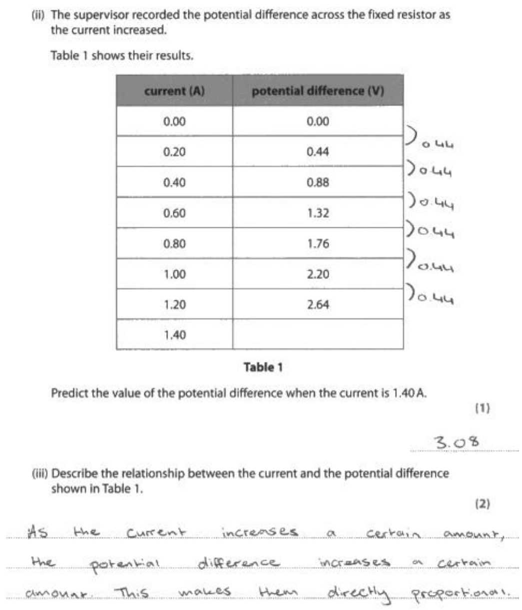
(1)

3·08

(iii) Describe the relationship between the current and the potential difference shown in Table 1.

(2)

The table shows that, as the current is evenly doubled, the potential difference follows the same pattern and evenly doubles.



(ii) The supervisor recorded the potential difference across the fixed resistor as the current increased.

Table 1 shows their results.

current (A)	potential difference (V)
0.00	0.00
0.20	0.44
0.40	0.88
0.60	1.32
0.80	1.76
1.00	2.20
1.20	2.64
1.40	

Table 1

Predict the value of the potential difference when the current is 1.40 A.

(1)

3.08

(iii) Describe the relationship between the current and the potential difference shown in Table 1.

(2)

As the current increases a certain amount, the potential difference increases a certain amount. This makes them directly proportional.

Q2aiv

Most learners showed their working but were not able to gain both marks for this calculation because they did not select the correct potential difference from the table. An example with the correct evaluation is shown below.

(iv) Calculate the resistance (R) when the current is 0.60 A as shown in Table 1. (2)

Use the equation: $R = \frac{V}{I}$

where V is potential difference and I is current.

Show your working.

$R = \frac{1.32}{0.60}$

resistance = 2.20 ohms

Q2bi

Many learners were not able to suggest that the most likely reason for a systematic error in a meter was that it was either not calibrated, wrongly calibrated or that there was a zero error.

Q2bii

A considerable number of learners were not able to calculate a percentage error in the meter reading correctly and even using the correct values. There were many power of ten errors in the final evaluation. Below is an example of a correct calculation.

(ii) Calculate the percentage error in the 1.20 A reading that this error of 0.01 A causes. (2)

Show your working.

$\frac{0.01}{1.20} \times 100$

percentage error = 0.83 %

Q2ci

For this calculation the equation was given but milliamps had to be changed to amps and the equation had to be rearranged to find the voltage. Most learners showed their working so marks could be awarded for correct substitution even if the units had not been changed. The most common mark was 3 out of 4 because learners had substituted, rearranged the equation correctly, but not converted milliamps to amps, giving a power of ten error. Below is an example of a correct calculation that gained four marks.

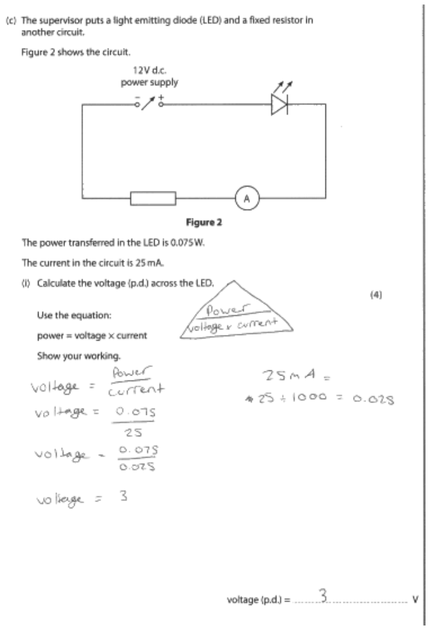

(c) The supervisor puts a light emitting diode (LED) and a fixed resistor in another circuit.

Figure 2 shows the circuit.

Figure 2

The power transferred in the LED is 0.075 W.

The current in the circuit is 25 mA.

(i) Calculate the voltage (p.d.) across the LED. (4)

Use the equation:

power = voltage × current

Show your working.

voltage = power / current

voltage = 0.075 / 25

voltage = 0.075 / 0.025

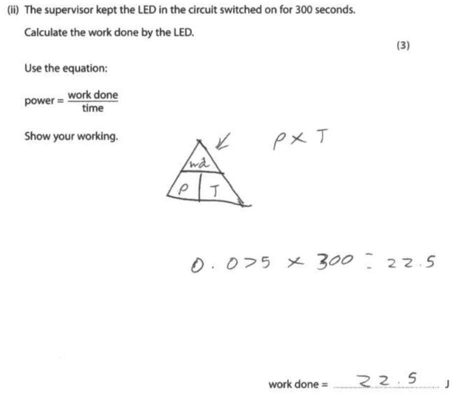
voltage = 3

25 mA = 25 ÷ 1000 = 0.025

voltage (p.d.) = 3 V

Q2cii

For this calculation again the equation was given, and it did not require units to be changed. Many learners were able to gain one mark for correct substitution and if only the rearrangement was incorrect and the evaluation from that point was correct two marks were given. Below is an example of a correct calculation that gained three marks.


(ii) The supervisor kept the LED in the circuit switched on for 300 seconds.

Calculate the work done by the LED. (3)

Use the equation:

power = work done / time

Show your working.

P × T

0.075 × 300 = 22.5

work done = 22.5 J

Q3

All the parts of this question refer back to the investigation which was detailed in Part A of the paper.

Q3a

Learners were generally able to give one strength of the method. This was usually that repeats were taken or occasionally that there was a good range of voltage outputs or the use of a circuit diagram was included. Below is an example of a learner response that gained two marks.

3 (a) The trainee technician used a method to collect data.

Identify **two** strengths of the trainee technician's method.

(2)

strength 1

They used repeats to identify a mean and to increase the precision

strength 2

A wide range of voltages was used to gain a large accurate set of results

Q3b

The majority of learners were only able to gain one mark for this question giving the limitation as 'the readings were only taken to 12 V' or 'the readings were only taken every 2V' but learners did not continue and give the possible improvement. The example below shows a learner response which gained four marks.

(b) Explain how **two** limitations in the trainee technician's investigation could be improved.

(4)

limitation 1

The brightness is measured in subjective terms like "bright" and "very bright" meaning it could mean something different for someone else. To prevent this, use an objective measure of brightness, use a light sensor.

limitation 2

The ~~experim~~ investigation includes no data for beyond 12 V meaning the bulb could potentially operate beyond 12V, not meeting production standards. A solution is to get readings for 14 V and 16V.

Q3b

Many learners were able to gain a mark for knowing that to test for reproducibility the experiment must be carried out by another person and then the results compared, but were less familiar with the idea that the same method must be used or a different set of apparatus. The response below gives all the main points in the mark scheme and gains three marks.

(c) Reproducibility and repeatability are measures of precision.

Describe how the reproducibility of the trainee technician's data could be tested.

(3)

If Someone were to do their experiment using their own equipment Somewhere else following their method to See if they get the Same or Slightly different results as theirs were fairly accurate

To improve their mark on Section 1 Part 1 of this paper learners should:

- practice completing a table to show quantities, units and averages to the same number of decimal places as the raw data
- practice putting scales on graph paper to ensure, the points plotted cover at least half of the graph paper vertically and horizontally
- practice drawing curves of best fit
- learn how to completely describe relationship between two quantities on a graph or in a table
- learn the symbols used in circuit diagrams and how to put meters in parallel and series.
- learn to calculate percentage errors
- learn the possible causes of systematic and random errors
- learn how to convert units e.g. milliamps to amps
- practice rearranging equations

Individual Questions

Section 2 - Biology

Question 4

This was a 12 mark extended open response question.

This question required the learners to write a plan with a hypothesis, equipment, health and safety, method, variables and data analysis. The vast majority were able to provide a plan with all the required sections, but the responses are taken holistically. For example, the control variables can be included in the step by step method and so do not necessarily have to be listed separately.

Learners were generally able to give a basic hypothesis, the majority identifying that the rate of reaction would increase with increasing temperature, very few references to the optimum temperature or denaturation were seen unless part of a band 4 response. Stronger learners included details of higher energy levels and higher temperatures, more successful collisions, more enzyme substrate complexes, denaturation of the enzyme at higher temperatures.

Where an equipment list was present, the majority of learners were able to justify use. It was evident that the majority of learners had not had the opportunity to experience this practical, or similar, and so the majority of the responses implied that iodine could be used as an indicator and a colour change would be observed, similar to Universal Indictor for pH, rather than describing the need to take samples of the enzyme-substrate mixture at intervals for testing.

Most candidates gave a method which mixed amylase and starch before heating (iodine was commonly added here as well). Several responses were seen where learners had mixed only two of these and were looking for a colour change. Very few used a spotting tile to test samples from the enzyme/substrate mixture. A large number of learners were timing until the iodine turned blue/black. Leaners provided a range of methods to describe the breakdown of starch which included different foods with carbohydrates present, i.e. potatoes. In this this case learners would often get a bit confused and also change the concentration/size of the starch as well as the temperature. The majority used Bunsen burners instead of water baths to obtain a temperature higher than room temperature. The majority used the

Bunsen to directly heat test tubes containing enzyme, or substrate, or iodine, or all three.

Most of the learners provided a brief risk assessment to the practical, some including generic and non-relevant risks such as electric shock. Better answers tended to have health and safety in a table format with details of hazard, risk and precaution. Most were able to discuss care when using hot water and Iodine.

The majority of learners, including the weaker students, were able to correctly state the variables involved, but a few mentioned controlling the temperature as a control variable not realising that this was the IV.

Despite being unfamiliar with the expected method, the vast majority made an attempt finishing with doing repeats of the method and at different temperatures. Most learners had a table with room for repeats and an average and those that drew a graph drew an 'n-shape' graph.

In spite of the lack of knowledge of the expected method, a lot of learners were still able to produce a well-presented plan.

Level 1: 3 marks

The learner has given the very basic hypothesis without reference to optimum or the ideas of denaturing at high temperatures. They have given an equipment list, but without justification. Health and safety are brief and there is a list of quantities to measure without specific details. The range of temperatures has been given. The method is brief with major omissions - as iodine is not included and so the end point would not be determined. An incorrect control variable has been given - as temperature is the independent variable.

Overall, this is a level 1 response, with 3 marks awarded.

Hypothesis: The higher the temperature, the ~~fas~~ quicker it takes ~~the starch~~ for amylase enzyme to break down starch.

Equipment: Thermometer, test tube, ~~busum burner~~ bunsum burner, three starch solution, and enzyme amylase, goggles Stopwatch for measurment of time, ~~and~~ kettle

Health and Safety: Possible risk of solution in contact with eyes
So goggles should be worn, ~~and~~ an apron,
gloves, ~~sta~~ Hot water burning skin

quantities to measure: The temperature difference and its effect.
• digestion of starch ~~to~~
• How long it takes = Stop watch
• Temperature of starch

number and range measurements: 10°c, 20°c, 30°C, 40°C, 50°C,
~~for each attempt~~ ~~for~~ of temperature

~~You turn on bunsen burner, get a solution of~~ You heat up
kettle to 10°C, get a solution of starch and amylase enzyme,
~~place~~ measure temperature, so its 10°c, then place test tube with
starch and amylase in the water, with thermometer inside, ~~start~~ stop
watch to measure change of solution and how long it digests

Control Variable: Controlling temperature change
. Starch and amylase enzyme solution

Level 2: 6 marks

The learner has followed the bullet points given in the question- and may have ran out of time or space with their response as it does start well but does not include a method for data collection. However, the level descriptors in the mark scheme have several bullet points and so the response should be considered holistically. The learner could frame their response in a number of ways - including diagrams - and marks can be awarded - they do not have to follow the bullet points in the question - i.e. we may have to look for details in their method for number and range of measurements or consider a list of measurements as detail about their step by step method.
Here the learner has provided a hypothesis and does hint at the knowledge of an optimum.' A range of temperatures to cover and equipment to be used has been given. The justification of the equipment and how the equipment may be used provides some insight into the plan that would yield some results - the independent variable, a suggestion of a control variable, 3 repeats, calculating an average, use of iodine and the importance of controlling some variables ("could affect the results") can be seen in the response.

Therefore, this is a 6 mark response.

Hypothesis:
My hypothesis is the more present that amylase is present in the solution the solution will turn from brown to blue/black. In addition I think that the colder the temperature will make the reaction be slower however, having a hot temperature will kill the amylase solution

So, the temperature has to be just right for this experiment so, i would suggest doing a range of temperatures such as 20°C, 40°C and 60°C or 30°C, 40°C or 50°C.

Equipment needed:

Beaker Thermometer
Test tube
Startch Solution Syringe (mls ones)
Amylase
Syringe
kettle
measuring cylinder

Justifaction of equipment:

The equipment listed above will be needed as if we are recording different temperatures then, you are going to want to measure the water that you are going to surround your amause in and you want your temperature to be what you have written down. The technique that will be used for this experiment is that you'll be trying to see by collecting results and Putting them in a table

If the hypothesis that I have made is right or wrong.

Health and Saftey:

The Health and Saftey of any experiment is there to keep you safe and from preventing you getting ill or getting hurt. The health and saftey of this experiment is to stand up when performing this experiment to ensure nothing spills on you, wear eye protection to protect your eyes and if you are using hot water wear protected eye wear / gloves so nothing splashes in your eyes but, if the water in the beaker is hot for you to touch with you bare hands use gloves to poor it down the sink or wait till it cools down before pouring it away.

Step by Step method:

For the purpose of this experiment I think it has a great purpose to do the experiment three times for each temperature which then allows for an average temperature to be calculated.

How equipment may be used:

The beaker will be used to put the water in which will show us if temperature affects the results and the thermometer will be used to check the temperature of the water

control variable a syrnge will also be used to accuratley ~~record~~ measure the solution for the test tube.

The control variable for this experiment is that you would have to add the same amount of the startch solution, amylase and the same amount of iodine as, if you add slightly more or less it could affect the results in the slightest

(Total for Question 4 = 12 marks)

Level 3: 9 marks

The learner has given an incomplete hypothesis - there is no reference to optimum. Suggestions of volumes have been given which indicates the investigation could be repeatable and is a description of parts of their method. The learner has given health and safety information for their practical. The learner has given a logical method that is likely to yield results - but with some errors/omissions- this is a level 3 step by step method. The amylase, starch and iodine have been mixed together and then the learner is timing for the colour change, but they have said they will wait for the blue/black colour and so are unclear about iodine. Learners would not be expected to know that the iodine would affect the enzyme action and so we are not "penalising" their response for this idea - they are using the iodine as an indicator. The learner has given correct variables, indicated a range of temperatures ("increase the temperature of the water bath by 10oC") and indicated that there will be 3 repeats, with a mean calculated and anomalies considered. Overall, 9 marks can be awarded.

Hypothesis:

The higher the temperature, the higher the rate of digestion of starch by the enzyme amylase. This is as temperature is a catalyst and speeds up enzymes and substrates during the lock and key theory. This is when the enzyme and substrate together and release a product.

Equipment list:

- 3x pippettes
- Starch solution - 25 ml
- Amylase solution - 25ml
- 5x test tubes
- Test tube rack
- Iodine solution
- ~~Measuring cylinder with graduations for every ml~~
- Water bath
- Stop watch.

Risk assesment:

I made sure to wear goggles as iodine and other chemicals are irritants to the skin and eyes when they come into contact. Furthermore I made sure to tuck chairs in and bags as this is a tripping hazard and can damage glass ware. When broken glass comes into contact with skin it causes cuts. If anything hazardous occurs I would get the technicians help. Furthermore when using the water bath we would use test tube racks so the test tubes could be moved or touched without touching the water. This is as water which is high in temperature leaves burns to the skin when it comes into contact.

Method:

1) Make sure the water bath is filled with water to the recommen' level. If not add the recommended amount and plug the water bath into a plug socket. Make sure to set the water bath to 10°C
2) Place the test tube rack into the water bath with the 5 test tubes in the test tube rack.
3) Now add 5ml of Amylase into one of the test tubes using the graduations on the pipette.
4) Then add 5ml of starch solution to the same test tube and add 2 drops of iodine solution and start the stopwatch.
5) When the solution turns to a blue or black colour, stop the stop watch and record the time in seconds.
6) Repeat steps 3, 4, 5 increasing the temperature in the water bath by 10°C.
7) Record these readings into a suitable table.

Variables:

Control - Amount of Amylose and starch solution
Independent - Temperature of the water bath
Dependent - Time taken for the Amylose and starch solution to react.

Evaluation

If all steps have been taken accurately the hypothesis should be accepted and there should be a visible correlation between the higher the temperature the faster the reaction. In this experiment I used a water bath instead of a bunsen burner and thermometer as thermo- are often inaccurate as bunsen burners often heat up only specific areas of the solution which could give a biased reading of temperature. Furthermore I could've used a measuring cylinder to measure out the amylase and starch solution however due to the amounts of solutions needed being small volumes a pipette is also appropriate. Furthermore I used a different test tube and pipette for each reading as they can be precipitated from previous experiments or readings. This gave the most accurate results.

~~At the end of the experiment I would also calculate~~
To further expand this investigation I would repeat readings for the same temperature to get a mean average. This would get the most accurate results, whilst ruling out anomalies.

Level 4: 11 marks

The learner has supported their hypothesis with scientific understanding - this is a level 4 feature. The equipment list gives some justification of the use and some details of temperatures and volumes. The method also included details, covering a range of temperatures, in a logical sequence and could lead to a set of results being collected. The only "omission" really is to wait for a colour change in the whole enzyme-substrate mixture, rather than taking samples and testing with iodine at time intervals. It seems this practical has not been completed this year by the learners and so iodine is being used as an indicator - we are not heavily penalising this idea. The learner has indicated that they will carry out repeats and analyse their data with a results table and expected graph (which further supports their understanding in the hypothesis). The variables are given and correct, and safety is considered. This is a good level 4 style response and 11 marks have been awarded.

Hypothesis: The warmer the enzyme amylase becomes, the faster the rate of digestion will be. But this will only work up until an certain point as if the enzyme becomes to warm, it will denature. So the rate of digestion will increase with temperature increase up until an certain point

Equipment: - Potato as potatos contain starch
- Enzyme Amylase to react with the potatos starch
- Iodine solution to identify starch

- water baths to warm up the potato at set temps
- freezer to cool / freeze the potato at set temps
- test tubes to ~~..~~ hold the potato and amalaye
- Knife to cut the potato - thermometer to measure temp of potato
- Chopping board to have the potato cut onto it
- mass balance to weigh the potato
- ~~Measuring cylinder /~~ syringe (10ml) to measure of the amylase
- Stop watch ~~.~~ to measure the time - white paper / tile to accurately see in colour change

A syringe was used over an measuring cyclinder as they are more accurate for smaller volumes.

Method: 1. Cut up the potato using the knife on the chopping and using the mass balance, create 6 piles that weight the same amount and then place them into their own test tubes

2. Place an test tube in to the freeze with its temp set at 0°c using an thermometer as help

3. Place the others in to different water baths at temps of 10°, 20°, 30°, 40° and 50° respectively with an thermometer

4. ~~After~~ While the test tubes are in the water baths / freezer measure out 15ml using the 10ml syringe while being careful of the miniuscus into an beaker

5. After 20 mins of the ~~..~~ potato being in the freezer, take it out and pace 2-3 drops of iodene solution on it and place an white tile / paper under it

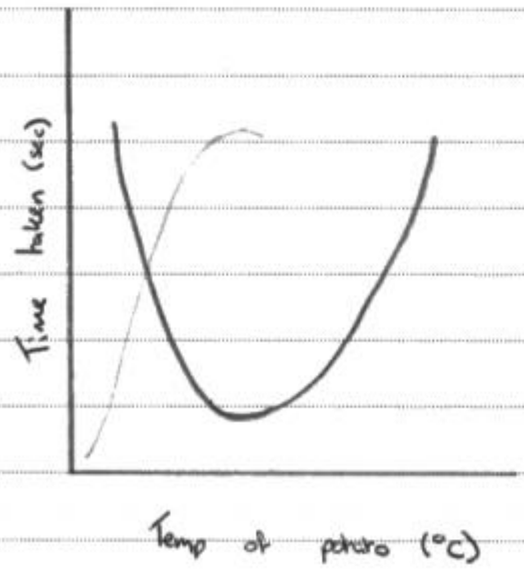
6. time how long it takes for the iodenes solutions colour to disapear

7. Repeat this with all the rest of the potatos at the different temp but one at an time as so they dont cool down / warm up to room temp
8. Repeat each one 3 times in total as to ~~complete~~ gathe an mean for the results making sure the mass of potato was kept the same as before

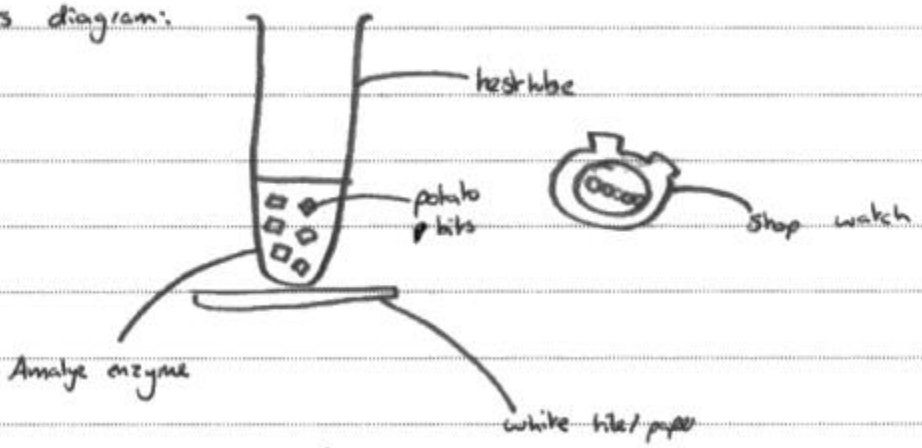
Example table:

Temperature of potato °C	Time taken for iodenes colour to disapear (sec) 1	2	3	Mean
0				
10				
20				
30				
40				
50				

Example graph:



Experiments diagram:



Independant varible: The temp of the potatos bits measured by an thermometer in °C to an accuracy of 0.05°C

Dependant varible: Time taken for the colouring of the iodien solution to disapear + measured using an stop watch in seconds to an accuracy of 1/100 of an second

Controled varibles: - The amount of potato as with more, that is a large surface area so may go faster
- Amount of amalyse " "
- The time taken in the frezer / water bath as with less time, the potato may not be at the right temp yet

Safety: - Wore goggles as of amalye getting into the eyes or when cutting the potato, its liquids may as well
- Be extra careful when cutting with the knife as of fingers getting cut + wear gloves so cuts don't happen

(Total for Question 4 = 12 marks)

Question 5

This was an 8 mark extended open response question. The experiment referred to in the question investigated the effect of pH on enzyme reaction.

The majority of learners were able to identify at least some of the problems in the method. The most commonly highlighted points observed were the lack of stated volumes in regard to the buffer/enzyme/substrate and the absence of a stopwatch. However, some learners were able to link these to the flaws in the conclusion. Higher level learners were able to discuss intervals between pH 1-2 and refer to specific pieces of equipment e.g. pipettes and even using indicator to show that the substrate had broken down. Some learners discussed the lack of a hypothesis, variables and health and safety procedures. Only a small number referred to the fact that the enzyme and substrate had not been identified.

Many learners identified the need for repeat readings, and some discussed the idea of repeatability would be difficult due to the lack of detail in the method. Many learners were able to identify the need for repeat readings to get an average and ignore any anomalies. A common response was to suggest that a line of best fit should have been drawn on the graph- which for this data is incorrect as a dot to dot line should be used. A significant number of learners suggested that a results table should have been included as it was difficult to get an accurate reading.

Learners who scored well on this question generally referred to the optimum pH being between 1-3 and went on to state that more readings were needed around these pH values – poorer responses tended to want to extend the pH range beyond 5. Learners commonly stated that the given conclusion was correct as that was the lowest time in the graph. A few learners stated that pH2 was anomalous as it didn’t match the “linear” hypothesis.

Considering this was the last question there were few ‘blank’ answers, suggesting that time management has improved since the previous series in which several learners had left this question blank.

Level 1: 2 marks

The learner starts well giving a brief evaluation of the method. They state that the method lacks the detail of "how much" pH buffer solution, substrate and enzyme is added. They also highlight that the method doesn't tell us how to determine when all the substrate is broken down. After this the response becomes generic and vague. The lack of title isn't really an evaluation of the graph as the labelled axes indicate what the graph represents. The fact that the conclusion doesn't contain an explanation is also insufficient to be fully creditworthy. Therefore, overall, this is a level 1 response with 2 marks awarded.

> The learner's method is not detailed. They do not explain how much PH buffer solution to add or how much substrate and enzyme. The learner also doesn't tell us how to determine when all of the substrate has been broken down.
>
> The learner's results ~~table~~ graph doesn't have a title to explain what the graph shows. ~~As well~~ The learners conclusion also doesn't tell us how they came to that conclusion.

Level 3: 6 Marks

The learner has provided relevant comments about the method, results and conclusion. However, some key points have been missed about the conclusion. The learner has stated that the method doesn't specify "how much" (i.e. volumes) buffer, substrate of enzyme are used. They have commented that the method is brief and lacks detail, such as using a stop clock. The learners comment about checking every minute which could mean that they miss the time the substrate has been broken down, is a good evaluation point about this method. The learner implies that the results are accurate as there is a relationship between pH and time taken to break down. The learner has also suggested that to make the results more reliable they should be repeated. Overall, this can be awarded 6 marks.

The learner doesnt specify how much pH buffer solution, substrate or enzyme they are using in their experiment.
The method he used is very breif and doesnt say if you do all 5 at once or seperately. It should be done seperatly to get more accurate readings.
He doesnt specify if hes using a stop clock or not.
He was only checking on it every minute where he should be checking on it constantly so he doesnt miss the time when the substrate has been broken down.
It seems like his results are accurate as as the pH goes up so does the time taken for it to breakdown.
Using his results hes right by concluding that the enzyme works best at pH 2 as

that took the shortest time to breakdown although we dont know how reliable his results are as he didnt repeat them.

Level 3: 8 marks

The learner has given a number of points about the method - they have talked about time intervals and calibration to check the pH. They have included reference to volumes. They have suggested that the experiment should be repeated to calculate an average. A description of getting a more precise conclusion by using pH1.5 and 2.5 is given. They have used the graph to support the conclusion and so have missed some points from the indicative mark scheme that there is little difference between pH 1 and 2 - but not all points need to be covered for maximum marks to be given. Each response should be considered against the levels in the mark scheme and this is an 8 mark response.

The learners Method:

- the learner hasn't included how much pH buffer solution to add to each beaker. This means each pH could be slightly inaccurate. They could record the actual pH after adding the buffer by using a calibrated pH meter.
- The learner hasn't specified what substrate or enzyme they are going to use, and how much of each. This means their method cannot be reproduceable and tested by another person. It could also effect the time taken to break the substrate down as the amount is unknown so can't be compared.
- Checking every minute is a large interval. A smaller interval such as 30 seconds could be used which would provide more accurate time taken for each beaker.
- People may view the substrate broken down at different points so the results cannot be reliable.

Results:

The learner only did the experiment once. Instead it should be repeated 2 more times so then an average time taken can be worked out. This would provide them with an 'average to plot on the graph, making their results more reliable.

They used pH's at integers, so to get a more precise conclusion on how the pH can affect time taken they could use intermediate pH's such as pH1.5, 2.5 etc.

Their results show as pH is increased, then the time for the substrate to be fully brokendown takes longer. Therefore, their conclusion is correct from their results shown by the graph as at pH 2 it takes the shortest time, 50 seconds. However the enzyme may actually work best at pH 1.5 or pH 2.5 but they don't have any data to support that.

Summary

To improve their mark for this section of Unit 3 learners should:

Question 4

- Establish the correct hypothesis from the information in the question and where possible support the hypothesis with scientific knowledge
- State when the investigation has minimal risks or give a detailed risk assessment
- Give a step by step method that would produce valid results
- Consider the repeatability of the investigation by including detail such as volumes, temperatures. This would also indicate the control variables which are being considered
- State if repeats would be needed and why repeats can be useful, for example highlighting anomalous results, which would then be discarded for the mean or repeated
- Give suggestions for data analysis - such as calculating means, plotting a graph, any statistically analysis that could be carried out

Question 5

- Comment on any positives or good practice given in the method or evident in the results
- Note if the investigation is looking for a trend or specific results
- Consider the information any graph, table or diagram provides as well as the text
- Look to see if the results could be extended if there is correlation or if smaller increments of the independent variable would enable an optimum to be found
- Evaluate the conclusion which is given - by stating if they think the conclusion is correct, incorrect or partially supported

The specification and/or sample assessment materials (SAMs) located on the BTEC Nationals qualification webpage located here.

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