Mark Scheme (Results)

January 2021

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications website at http://qualifications.pearson.com/en/home.html for our BTEC qualifications.

Alternatively, you can get in touch with us using the details on our contact us page at http://qualifications.pearson.com/en/contact-us.html

If you have any subject specific questions about this specification that require the help of a subject specialist, you can speak directly to the subject team at Pearson. Their contact details can be found on this link:
http://qualifications.pearson.com/en/support/support-for-you/teachers.html

You can also use our online Ask the Expert service at https://www.edexcelonline.com
You will need an Edexcel Online username and password to access this service.

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your learners at: www.pearson.com/uk

January 2021
Publications Code 31619H_2101_MS
All the material in this publication is copyright
© Pearson Education Ltd 2021

Unit 3: Science Investigation Skills

General marking guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do, rather than be penalised for omissions.
- Examiners should mark according to the marking grid, not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks, if the learner's response is not rewardable according to the marking grid.
- Where judgement is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

Specific marking guidance

The marking grids have been designed to assess learner work holistically.
Rows in the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

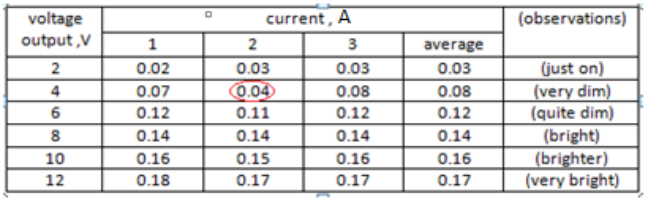
- Examiners should first make a holistic judgement on which band most closely matches the learner's response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer, in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band, depending on how they have evidenced each of the descriptor bullet points.

BTEC Next Generation Mark Scheme

Section 1

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>1 (a)</td><td>results table containing:

suitable headings with units (1)

 
<table>
<tr><td rowspan="2">voltage output ,V</td><td colspan="4">current , A</td><td rowspan="2">(observations)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>average</td></tr>
<tr><td>2</td><td>0.02</td><td>0.03</td><td>0.03</td><td>0.03</td><td>(just on)</td></tr>
<tr><td>4</td><td>0.07</td><td>0.04</td><td>0.08</td><td>0.08</td><td>(very dim)</td></tr>
<tr><td>6</td><td>0.12</td><td>0.11</td><td>0.12</td><td>0.12</td><td>(quite dim)</td></tr>
<tr><td>8</td><td>0.14</td><td>0.14</td><td>0.14</td><td>0.14</td><td>(bright)</td></tr>
<tr><td>10</td><td>0.16</td><td>0.15</td><td>0.16</td><td>0.16</td><td>(brighter)</td></tr>
<tr><td>12</td><td>0.18</td><td>0.17</td><td>0.17</td><td>0.17</td><td>(very bright)</td></tr>
</table>

raw measurements recorded to 2 decimal places, indication of anomaly (1)

repeats and averages calculated (1)

<table>
<tr><td>voltage output (V)</td><td>average current (A)</td></tr>
<tr><td>2</td><td>0.03</td></tr>
<tr><td>4</td><td>0.08 or 0.06</td></tr>
<tr><td>6</td><td>0.12</td></tr>
<tr><td>8</td><td>0.14</td></tr>
<tr><td>10</td><td>0.16</td></tr>
<tr><td>12</td><td>0.17</td></tr>
</table></td><td>voltage output setting/ supply/ voltage
unit volts/V
current, unit amps/ A

each current column with a current heading or covered by a current heading with units

observations are not required in the table but may be included

see table above for correct anomaly ringed

Average current must be to 2 decimal places.</td><td>3</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>1 (b)</td><td>labels and units for axes (1)

suitable scales (1)

all points plotted correctly, and curve of best fit drawn correctly (1)

<table>
<tr><th>voltage output (V)</th><th>average current to 2d.p (A)</th><th>average current to 3d.p (A)</th></tr>
<tr><td>2</td><td>0.03</td><td>0.027</td></tr>
<tr><td>4</td><td>0.08</td><td>0.075 or 0.063</td></tr>
<tr><td>6</td><td>0.12</td><td>0.117</td></tr>
<tr><td>8</td><td>0.14</td><td>0.140</td></tr>
<tr><td>10</td><td>0.16</td><td>0.157</td></tr>
<tr><td>12</td><td>0.17</td><td>0.173</td></tr>
</table>

Exemplar graph using current values to 2 d.p</td><td>allow axes either way around
voltage output, volts/V
current, amps/A
do not accept volts or amps as a label

spread of data covers half or more of the graph paper on both axes.
Scales must be linear

if numbers on the x or y axis are taken directly from the table for values of current in the order of the table then allow a maximum of 1 mark for the first marking point

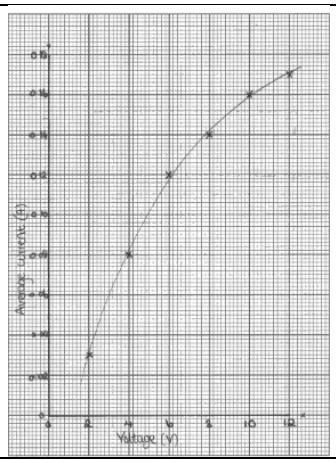
+/- 1 square for plotted points.
points are those calculated and given in the table.
accept points plotted to 3d.p if average given to 3d.p

curves drawn must be a smooth. Straight lines must be the lines of best fit for the points used.

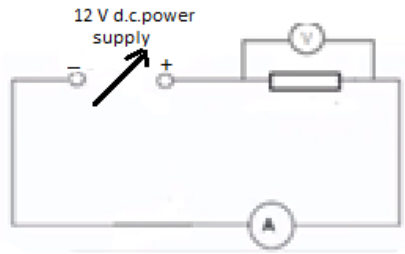
take ringed points as outliers

curve or lines must single lines not tramlines

no table given maximum of two marks, labels + units and suitable</td><td>3</td></tr>
</table>

			
1 (c)	A description including: current increases as the voltage (output) increases /positive correlation (1) any one from for a **curve** the gradient changes (1) the increase in current is at a decreasing rate (1) OR for a **straight line** constant gradient (1)	the correct description of an incorrect graph can gain both marks accept p.d (across lamp)/ e.m.f for voltage output. Do not accept volts for voltage or amps for current allow non-linear/begins to plateau/ evens out current and voltage are proportional gains two marks	2
1 (d)	(lamp) increased in brightness	(lamp) becomes hot(ter)	1
1 (e)	Any two from (same) ammeter (1) (same) lamp/bulb (1) (same) wires/switch/{lamp/bulb} holder (1) (same) power supply (1)	If no other mark awarded allow 1 mark for same equipment	2
1 (f)	**independent variable** voltage (output)/p.d./ potential difference V (1)	The answers must be in the correct order	2

	dependent variable current/ I		
1 (g)	*identification and expansion points can be included in either order depending on how the learner shapes their response* no current in the circuit/stops current/breaks the circuit (1) one from: allows lamp/connecting wires/ circuit to cool (1) prevents lamps/wires/circuit from overheating (1) ensures each reading taken is separate/ allows ammeter to return to zero/ allows (circuit) reset (1) prevents short circuit when not in use (1)		2
		Total	**15 marks**

Question Number	Answer	Additional guidance	Mark
2 (a)(i)		voltmeter must be across the fixed resistor can be above or below the fixed resistor accept curved/non-straight lines. ignore small gaps in joining wires	1
2 (a)(ii)	3.08 (V)		1
2 (a)(iii)	the potential difference increases as the current increases (1) increases at a constant rate/increase by the same amount every time (1)	ORA accept (the relationship is) linear/ potential difference and current are proportional (increases at} a rate of 0.44(V) every 0.2 (A) differences of 0.44 shown for voltage column on table For two marks (the relationship is) directly proportional OR doubling the pd, doubles the current	2
2 (a)(iv)	substitution (1) 1.32/0.6 evaluation (1) 2.2 (ohm)	2.2(ohms) with no working gains full marks. power of ten error gains 1 mark	2

2 (b)(i)	one from: zero error/zero not checked (1) wrongly calibrated/not calibrated (1) faulty ammeter (1)	 accept wrongly adjusted/ not adjusted/ wrongly set up /not set up accept bent needle/parallax error ignore the ammeter is old	1
2 (b)(ii)	substitution (1) (percentage error) = $\frac{0.01}{1.2}$ x 100 evaluation (1) 0.83(%)	0.8(%) with no working gains full marks accept use of 1.19 accept 0.8(%) Power of ten error gives 1 mark answers rounding to 0.008 gain 1 mark error using a factor of 2 giving 0.415% / 1.6% gains 1 mark	2
2 (c)(i)	 conversion (1) 25 mA =2.5 x 10^{-2}A or 0.025 A substitution (1) 0.075 = 2.5 x 10^{-2} x V rearrangement (1) (V) = $\frac{0.075}{2.5 \times 10^{-2}}$ evaluation (1) (V)=3.0(V)	answer 3.0(volts) accept 3 volts with no working shown gains full marks conversion, substitution and rearrangement in any order V = $\frac{P}{I}$ 3.0 to any other power of ten gains 3 marks 0.333 gains 3 marks to any other power of ten gains 2 marks 0.00187/0.0019 gains 3 marks to any other power of ten gains 2 marks	4
2 (c)(ii)	 substitution (1)		3

	0.075 = $\frac{\text{work done}}{300}$ rearrangement (1) (work done) =0.075 x 300 evaluation (1) 23 (J)	23 (J) with no working shown gains full marks Substitution and rearrangement in either order work done = power x time accept 22.5(J) power of 10 error gains 2 marks 0.00025 or 4000 gains 2 marks a power of ten error gains 1 mark using 5 mins giving value 0.375 gains 2 marks	
		Total	**16 marks**

Question Number	Answer	Additional guidance	Mark
3 (a)	Any two from: repeats/multiple readings were taken (1) includes a circuit diagram/image/picture (1) tests a good range of voltage outputs (1) used the same equipment throughout (1) same interval between readings (1)	accept any other valid strength in the method identified by the learner ignore opened the switch after each reading ignore comments related to safety or risk assessments	2
3 (b)	An explanation that makes reference to any two paired responses up to a maximum of four marks: only gives a trend/no specific values for the voltage/p.d for the lamp (1) measure the potential difference/voltage across the lamp (1) OR not possible to get interim values of voltage/smaller intervals of voltage (1) use a power supply with smaller increments (1) OR voltages are categoric/specific and not continuous (1) use a power supply/data logger with a continuous range (1) OR the method was limited to 12 volts (1) increase the range (above 12 V)/greater range (1) OR brightness only estimated (1) use a light meter (1)	ignore any references to repeats or data processing	4

3 (c)	A description that includes any three of the following: attempted/ tried by a colleague (1) same {method/standard procedure} used (1) new/ different set of equipment (1) different place/time (1) results compared /see if results are similar/ compare with known data (1)	Do not accept repeat experiment	3
		Total	**9 marks**

Section 2

Question Number	Indicative content

4	A plan that makes reference to:
	• a hypothesis/prediction
	  • *e.g. At its optimum temperature an enzyme will work at its fastest rate; at lower temperatures the rate of reaction will be slower and at higher temperatures there may be no reaction.*
	  • *e.g. As temperature increases so does the rate of an enzyme-controlled reaction, up to optimum temperature, and then the rate decreases (as the enzyme becomes denatured/active site shape is changed.)*
	• equipment, techniques and/or procedures
	  ○ *e.g. equipment*
	  ▪ *test tubes*
	  ▪ *starch solution/ specific concentration, same as the amylase*
	  ▪ *amylase solution at specific concentration*
	  ▪ *measuring cylinders/syringes/graduated pipettes and fillers*
	  ▪ *spotting tiles*
	  ▪ *iodine/KI solution*
	  ▪ *stop clock*
	  ▪ *water baths*
	  ▪ *(crushed) ice*
	  ▪ *thermometers*
	  ▪ *dropping pipettes*
	  ▪ *waterproof/ permanent pen for labelling*
	  ▪ *give credit for reasonable justification of choices*

	method > *have water baths set to specific temperatures, e.g. 10 °C, 20 °C, 30 °C, 40 °C, 50 °C. 60 °C, (ice required for 10 degree bath)* > *put a bottle of amylase solution into each water bath* > *leave for at least 5/10 mins so that the amylase is at the set temperature* > *measure a specific volume, e.g. 10ml of starch solution into each of the five test tubes* > *leave for at least 5/10 mins so that the starch is at the set temperature* > *label the test tubes with the temperature of its waterbath* > *put a drop of iodine/KI solution in each of the wells of a spotting tile* > *measure and add a specified volume, e.g.10 ml of the amylase solution to the starch solution at that temperature in the matching labelled test tube* > *put the test tubes in the matching temperature water bath* > *start the stop clock* > *using a pipette, after 1minute/ reasonable specified time interval take a sample from each test tube and add to a well on a spotting title* > *record the colour* > *repeat the sample every minute/reasonable specified time interval until the reaction mixture remains brown/yellow/orange instead of changing to blue black.* > *repeat experiment so that three full sets of results have been collected for each temperature.* > *reference to controlling other variables such as pH, concentration, volumes, throughout method* • risks and hazards ○ *e.g. iodine can be harmful* ▪ *wash hands and any exposed skin thoroughly after handling* ▪ *do not eat, drink or smoke when using it* ▪ *wear protective gloves/protective clothing/eye protection/face protection* ○ *report spillages* ○ *careful with high temperatures* • control variables ○ *e.g. volume and concentration of iodine/KI solution* ○ *concentration/ volume of starch solution* ○ *concentration/volume of amylase solution* ○ *pH* ○ *time at which sample is taken/time taken to transfer sample to spotting tile* • dependant variable- how it will be measured, units and the precision of measurements to be taken ○ *e.g. time it takes for starch to be broken down by amylase, in minutes, using a stop clock and testing samples every minute*

	• independent variable- the range of measurements/ categories to be used and how they will be measured, the intervals to take measurements ○ *e.g. temperature 10 °C, 20 °C, 30 °C, 40 °C, 50 °C* ▪ *measured with a thermometer or setting on a water bath* • data analysis ○ *e.g. collect results, in a list, in a table* ○ *highlight anomalous results and repeat if possible* ○ *calculate means, excluding anomalous results* ○ *convert time taken for amylase to digest starch to rate of reaction (1/time taken)* ○ *produce graph (rate of reaction v temperature)* ○ *draw conclusion against hypothesis – is it supported or not?*

Mark scheme (award up to 12 marks) Refer to the general marking guidance found in this document on how to apply levels-based mark schemes.		
Level	Mark	Descriptor
Level 0	0	No awardable content
Level 1	1-4	• Limited attempt at a hypothesis is made • Demonstrates limited knowledge and understanding of scientific concepts, procedures, processes and techniques with a basic description of the plan to investigate the scientific scenario given • Provides a rationale for the method suggested and generic statements may be presented rather than linkages being made so that lines of scientific reasoning are unsupported or unclear • The plan will not be logically ordered with significant gaps that will not lead to reliable results being collected
Level 2	4-6	• An explanation for the hypothesis is given which is partially supported by scientific understanding • Demonstrates adequate knowledge and understanding of scientific concepts, procedures, processes and techniques with a partial description of the plan to investigate the scientific scenario given • Provides a rationale for the method which has occasional linkages present so that lines of scientific reasoning are partially supported • The plan will generally be in a logical sequence and will yield some results
Level 3	7-9	• An explanation for the hypothesis is given which is supported by scientific understanding • Demonstrates good knowledge and understanding of scientific concepts, procedures, processes and techniques with a clear description of the plan to investigate the scientific scenario given • Provides a rationale for the method which has linkages present so that lines of scientific reasoning are supported • The plan will be in a logical sequence but with minor omissions of steps and will yield reliable results
Level 4	10-12	• An explanation for the hypothesis is given which is fully supported by scientific understanding • Demonstrates comprehensive knowledge and understanding of scientific concepts, procedures, processes and techniques with a step by step description of the plan to investigate the scientific scenario given • Provides a rationale for the method which has consistent linkages present so that lines of scientific reasoning are fully supported • The plan will be in a logical sequence and will lead to a reliable set of results being collected
		Total marks for Question 4= 12 marks

Question Number	Indicative content
5	An evaluation that makes reference to: method • *no indication that temperature is controlled* • *not stated volume of pH buffer solution* • *not stated volume or concentration of substrate* • *not stated volume or concentration of enzyme* • *not stated compatible substrate and enzyme* • *no reference to stirring* • *no description of what check/test will be carried out to confirm that the substrate has been completely broken down* • *no reference to the actual reaction being used* • *no reference to equipment or reagent used to take samples and test for substrate/products* • *no reference to using pH meter or how accurate timing achieved* results • *testing every minute could be difficult, results may not be accurate* • *testing every minute might not be sufficient as the reaction could be too quick* • *graph is plotted at intervals other than 60s* • *no repeats, so hard to tell if results are reliable/unable to spot anomalies* conclusion • *little difference between pH 1 and pH 2 – not valid* • *optimum could be between pH 1 and pH 3* • *lack of repeats means cannot assess reliability of results* • *intermediate values should be investigated*

Mark scheme (award up to 8 marks) Refer to the general marking guidance found in this document on how to apply levels-based mark schemes.		
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Adequate interpretation and analysis of the scientific information • Generic evaluative comments made with little linkage to supporting evidence/reference to context • A conclusion may be presented, but will lack focus and be superficial and underdeveloped
Level 2	3-5	• Good analysis and interpretation of the scientific information • Evaluative comments with supporting evidence/reference to context and a partially developed chain of reasoning • Conclusion will be mostly focussed and developed and draw upon some of the information presented before •
Level 3	6-8	• Comprehensive analysis and interpretation of all pieces of scientific information • Evaluative comments supported by relevant reasoning and appropriate reference to context • Conclusion will be clear and concise and well developed drawing upon the most relevant information presented before

Ofqual
Llywodraeth Cynulliad Cymru
Welsh Assembly Government
Rewarding Learning

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom