Mark Scheme

January 2018

Pearson BTEC Level 3 – Applied Science

Unit 3: Science Investigation Skills

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Publications Code xxxxxxxx*

Unit 3: Science Investigation Skills – sample marking grid

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.

Question number	Correct Answer	Additional guidance	Mark
1a	suitable headings with units (1) measurements consistently recorded to the same precision (1) three or more repeats (1)	allow M/m/molar/moles/mol/mdm^{-3} for concentration allow seconds/sec/s/minutes/min/m/for time	**(3)**

1 (b)	An explanation that makes reference to two linked pairs from white {tile/paper} **(1)** to see colour change/end point **(1)** OR (used a) stopwatch/stop clock/timer (1) to give results to milliseconds (1) OR read from bottom of meniscus (1) to get the true/exact value of the volume of acid (1) OR eye level (1) to get the true/exact value of the volume of acid (1) OR time taken in seconds not minutes (1) to give a true/exact value for time of diffusion (1) OR use {clean/washed/new} equipment for each test (1) so there is no contamination (1) OR keep agar in container / keep lid on agar (1) to prevent {early reactions/colour change} with (carbon dioxide in the air) (1)	do not allow answers that relate to controls ignore same equipment allow any appropriate small increment	**(4)**

1(c)	all 5 substituted correctly (1) 3 or 4 evaluated correctly (1)	 allow different numbers of sig figs	**(2)**
1 (d)	labels and units for axes (1) suitable scales (1) all points plotted correctly and suitable line of best fit for learner's data **(1)**	maximum 2 marks if time, rather than rate has been plotted – do not award label mark point allow reversed axes spread of plots covers half of graph paper +/- 1 small square do not allow tramlines	**(3)**
1 (e)	 as concentration increased rate of diffusion increased (1) comment on the proportionality/gradient relationship between concentration and rate of diffusion (1)	Answer consistent with result from graph or table allow positive/negative correlation allow correct comment regarding levelling off of data	**(2)**
		Total marks	**(14)**

Question number	**Correct Answer**	**Additional guidance**	**Mark**
2 (a)	any number between 0.0016 and 0.0047		**(1)**
2(bi)	Mean calculated correctly 0.0085 (s^{-1})	allow 8.5 x 10^{-3}	**(1)**

2(bii)	For each number subtract the mean **(1)** and square the result **(1)** Add up these values (1) and divide by one less than the sample number **(1)** Square root this number to get the standard deviation **(1)**	0.0084-0.0085 = (-)0.0001 -0.0001^2= 0.00000001 0.0083-0.0085 = (-)0.0002 -0.0002^2= 0.00000004 0.0088-0.0085 = 0.0003 0.0003^2= 0.00000009 $\frac{0.00000001+0.00000004+0.00000009}{(3-1)}$ = 0.00000007 √0.00000007 = 0.00026458 Allow any stage/answer in standard form 2.6×10^{-4} or 0.00026 allow ECF at any stage correct answer on answer line scores 5 marks	**(5)**

2 (ci)	Any three from: (same/different) shape/ {size/surface area/volume } cylinder (1) (same/different) {density/type} of agar (1) (same/different) amount of {sodium hydroxide/phenolphthalein} in cylinder (1) (same/different) concentration of sodium hydroxide in cylinder (1) (same/different) type of alkali (1) (same/different) temperature (1) (same/different) type of indicator (1) same concentrations of acid 0.1-2M (1) different concentration of 2.5M/wider range of concentrations used (1) different pH of {acid/alkali} (1)	accept any suitable reasons based on own results ignore type of acid allow different sized cork borer ignore volume	**(3)**
2 (cii)	An explanation that makes reference to the following points: (2.5M sulfuric) acid is very concentrated / high in concentration (1) {dissolves/reacts/corrodes/dehydrates} the agar cylinder (1)	allow contains more molecules/particles of acid allow more corrosive	

2(d)	An explanation that makes reference to two linked pairs from no evidence for concentrations above 2.5M in (either set of) results (1) so cannot say for certain (1) OR uses data to show that rate increases as concentration increases e.g at 0.1 is it 0.0003 but at 2.0 it is 0.0072 (1) so no reason for pattern not to continue (1) OR agar {shrinks/dissolves/reacts/corrodes} at 2.5m (1) pattern might not continue / cannot say for certain (1)	no marks for comment correct or incorrect allow rates of diffusion might plateau	**4**
		Total	**16 marks**

Q	Correct Answer	Additional guidance	Mark
3 (a)	An explanation that makes reference to two linked pairs from surface area of the cylinder (1) by using same {size/shape/volume} cylinder/cut with the same size cork borer (1) OR the concentration of the sodium hydroxide (1) by using {clean/fresh/washed} equipment for each test OR ensure all agar is covered by the same amount (1) by keeping the size of {boiling tube/ test tube} the same (1) OR same volume of acid (1) by using 10ml/use a measuring cylinder /pipette (1) OR same type of agar (1) by using same batch of agar (1) OR same concentration of the {phenolphthalein /indicator/sodium hydroxide} in the agar (1) by using same batch/bottle (1) OR temperature (1) by using a water-bath (1)	ignore temperature ignore concentration of acid allow length/width/diameter for size allow amount for volume ignore staying in the same laboratory	**(4)**

3 (b)	An explanation that makes reference to any two the following points: higher temperature provides more energy (to acid particles) (1) so acid particles will move faster (1) more collisions (in a given time) (1) {diffusion/reaction} will happen faster	 allow ORA allow average rate is faster	**(2)**
3 (c)	An explanation that makes reference to two linked pairs from repeat the experiment for different acid/alkalis (1) e.g use nitric acid (1) OR use different substrate (1) e.g gelatin (1) OR use different {shape/size/volume of} agar (1) e.g use a different size cork borer/cube (1) OR use different temperatures (1) e.g use an ice bath/waterbath to cool/ warm acid (1) OR use different volumes of acid (1) e.g. 20ml and 25ml (1)	ignore large range of concentrations allow any named acid allow other named substance allow any shape given allow any temperatures stated allow any stated volumes	**(4)**
		Total marks	**10**

Question number	Indicative content
4	A plan that makes reference to: • a hypothesis • equipment techniques and /or procedures • risks • control variables • dependent variables – how it will be measured, units and the precision of measurements to be taken • independent variable – the range of measurements/categories to be used and how they will be measured, the intervals to take measurements • data analysis.
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	1-3	• 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 that 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 that 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 thatis 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 12		

Potential learner hypothesis

'the diode will not conduct at all in one direction regardless of what potential difference is applied and in the other direction it will conduct but only after the potential difference rises above a certain value'

Question number	Indicative content
5	An evaluation that makes reference to: Method • ensure the same starting temperature for the water • ensure the volume of water remains constant for each power value • heat the water for the same amount of time • identify a means of controlling the current and/or the potential difference • a reference to the beaker not being insulated so there is considerable heat loss • identifying a means of measuring the power, e.g. using an ammeter to measure the current and a voltmeter to measure the potential difference across the resistor • mechanisms of heat loss should be considered when deciding on the type of insulation to be used • water is not stirred Results • no repeat readings are taken • smaller intervals should be used • the range of results could be increased • increase the number of data points Conclusion • above 36W the temperature change is no longer linear, more measurements of temperature are needed from 36W to 48W to see if this is a trend or an anomaly • a graph can be drawn of the power supplied against the rise in temperature to identify the trend more clearly, more data points would help confirm this • the data supports the conclusion • use of quantitative values • the evidence to support the conclusion is weak because there is only one set of data/no repeats
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 focused and developed and draw on 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
		Total marks 8