Mark Scheme (Results)

January 2020

Pearson BTEC Level 3 – Applied Science / Forensic and Criminal Investigation

Unit 3: Science Investigation Skills (31619H)

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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.

Applied Science Unit 3 Science Final

Question Number	Answer	Additional guidance	Mark
1 (a)	results table containing: • suitable headings with units (1) • measurements consistently recorded to the same number of decimal places (1) • repeats and means calculated (1)		3
1 (b)	• labels and units for axes (1) • suitable scales (1) • points plotted correctly and line of best fit (1)	allow axes either way around allow axis break spread of data covers half graph paper allow +/- 1 small square if numbers on the x or y axis are taken directly from the table in the order of the table then allow a maximum of 1 mark for the first marking point	3
1 (c)	as temperature increased, the time decreased / negative correlation (1) comment on the {proportionality / gradient relationship /shape of curve} between temperature and time taken for colour change consistent with their results (1)	relationship should be consistent with findings from graph allow rate increases/positive correlation allow there was no pattern to my results.	2

1 (d)	{irritation / burns} to skin (1) from (warm) acid / agar cylinder (containing sodium hydroxide) / hot water (1) wear gloves / {use spatula / spoon} when handling the cylinder (1) OR {irritation / burns} to eyes (1) from (warm) acid / agar / (agar containing) sodium hydroxide / phenolphthalein (1) wear goggles (1)	way to minimise risk must link to hazard or risk given allow from hot glassware allow use tongs ignore references to broken glassware	3
1 (e)	an explanation linking: use a pipette/burette (1) (because it has a) smaller {scale / percentage error / diameter tube} / lower uncertainty (1)	 allow syringe ignore scales ignore because it is more accurate / precise allow exact volume can be **transferred**	2
		Total	13 marks

Question Number	Answer	Additional guidance	Mark
2 (a)(i)	(more than 90°C) is hazardous / acid would start to boil / acid could start to evaporate / agar could start to {disintegrate / melt}	allow 110°C is above the boiling point of water / cannot get the acid to 110°C (with water bath) ignore 'the water would boil' alone	1
2 (a)(ii)	less than 10°C would mean that diffusion would be too slow / acid could freeze / agar would freeze /	allow -10°C is below the freezing point of water / cannot get the acid to -10°C (with water bath) ignore water would freeze	1

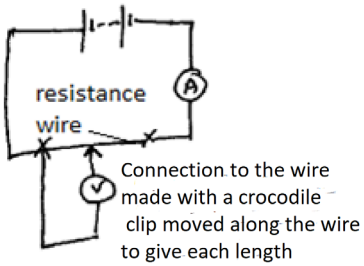
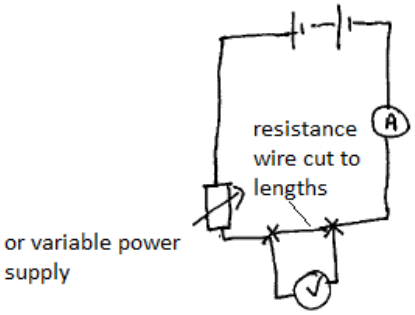
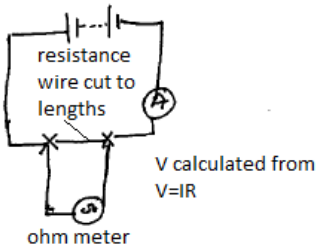
2 (b)	Allow any 2 from: diffusion happened {slower / took longer} (1) acid colder (than in attempt 1 or 3) (1) transferred to the boiling tube too slowly (1) OR diffusion took longer (1) different sized boiling tube / not enough acid / agar tube too big (1) {less agar covered / less surface area covered} (by the acid) (1) OR diffusion took longer (1) left over water from rinsing boiling tube (1) acid less concentrated (1) OR diffusion took longer (1) used a lower concentration acid (1) fewer acid particles to diffuse (1) accept any feasible suggestion	allow particles have less energy if no other mark scored allow timer stopped too late / started too early for 1 mark	2
2 (c)(i)	430	allow any value between 420-440	1

2(c)(ii)	Substitution (1) $\frac{1}{430}$ Evaluation (1) 0.00232(558) Standard form (1) 2.33×10^{-3}	allow ECF from 2(c)(i) allow full marks for answer of 2.33×10^{-3} without working allow 1 mark for incorrect answer with relevant working in standard form.	3
2 (d)(i)	4/5 error bars correctly drawn (2) 2/3 error bars correctly drawn (1)	ignore bars drawn horizontally	2
2 (d)(ii)	$10^{o}C$ (1) it has the greatest standard deviation (1)	allow largest error bar allow greatest range	2
2 (e)(i)	rearrangement (1) $\text{average time} = \frac{1}{\text{average rate}}$ substitution (1) $\text{average time} = \frac{1}{8.29 \times 10^{-3}}$ evaluation (1) average time = 120.627262	allow full marks for answer of 120.63 without working allow 120.6 allow 121	3
2 (e)(ii)	(the rate of diffusion) increases	allow ORA - rate of diffusion is slower **with hydrochloric acid**	1
		Total	16 marks

Question Number	Answer	additional guidance	Mark
3 (a)(i)	same size (shape / cylinder)	allow same {height / length / diameter} (cylinder) / cork borer ignore same volume / mass	1
3 (a)(ii)	Award **one** mark for an identification and **one** additional mark for an appropriate expansion <u>identification</u> (overall) rate would increase (1) and more surface area for particles to diffuse across (1) OR (so) more particles can diffuse at the same time (1) OR more contact between agar and acid (1)	ignore particles move faster ignore surface area alone allow diffusion would happen quicker	2

3 (b)	any two linked pairs from : the concentration of the acid (1) by using 1M / {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 volume of acid (1) by using 10 cm^3 / use a measuring cylinder /pipette (1) OR type of agar (1) by using same batch of agar (1) OR concentration of the {phenolphthalein /indicator/sodium hydroxide} in the agar (1) by using same batch/bottle (1) OR point at which experiment has finished (1) e.g same person judges when colour has disappeared / use a white tile to observe when agar cylinder is completely colourless (1)	ignore references to surface area and temperature allow strength for concentration allow amount for volume	4

3 (c)	Any two linked pairs : use different acids (1) e.g. nitric acid (1) OR use a different indicator (1) e.g. use methyl orange OR use a different alkali in the agar (1) e.g. use ammonia (1) OR try a different substrate for diffusion (1) e.g. use gelatin (1) OR try {different shapes /sizes / surface areas} of agar (1) e.g. use cubes / different sized borer (1) OR use different volumes of acid (1) e.g. 20 cm^3 (1) OR use different concentrations of acid (1) e.g. 2M (1) OR use different concentration of alkali (in agar) (1) e.g. 1M (1)	ignore references to temperature allow strength for concentration allow amount for volume ignore hydrochloric acid ignore phenolphthalein ignore sodium hydroxide ignore amount of agar ignore $10cm^3$ ignore 1M ignore 0.01M	4
		Total	11 marks

Question number	Indicative content
4	A plan that makes reference to: **Check question page for any relevant comments** • **a hypothesis:** ○ as the length of the resistance wire increases, the potential difference increases ○ the resistance of the wire will be directly proportional to the length ○ potential difference and resistance are directly proportional. ○ • **equipment, techniques or standard procedures/method:** ○ circuit diagram or description of circuit set up.  Also accept the following circuits   ○ a voltmeter in the circuit must be in parallel with resistance wire ○ voltmeter/multi-meter connected to one end of wire put across increasing lengths of wire to measure potential difference across each measured length of wire ○ accept lengths of wire cut, using variable powerpack or resistor to control current and either voltmeter or ohmmeter in parallel with wire ○ resistance wire attached to ruler (meter rule or half meter rule) ○ allow wire to cool between measurements ○ repeat measurements and take average ○ repeat for different materials/thicknesses of wires. • **health and safety associated with the investigation:** ○ minimal risks associated with this investigation ○ possible heating of wire if circuit left connected can result in burns if wire touched • **control variables:** ○ a constant source of potential difference for the circuit ○ use of ammeter to confirm constant current through the wire

	○ wire of constant cross sectional area ○ same type of resistance wire ○ constant temperature of wire. • **dependent variable** ○ potential difference for each length of resistance wire ○ measured using a voltmeter in parallel with resistance wire. • **independent variable:** ○ length of resistance wire ○ lengths of wire,range of lengths, for example, 10 20 30 40 50 cm accept any suitable range or interval with at least four readings. • **data analysis:** ○ tabulate results ○ plot a graph of potential difference (across resistance wire) against length (of resistance wire) ○ graph to be a straight line through the origin showing potential difference is directly proportional to the length of the resistance wire.

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 that 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.

Question number	**Indicative content**
5	An evaluation that makes reference to: **Check diagram and graph for any relevant comments** **Method** • note the temperature of the(cold/hot) water • need sufficient water to cover thermistor/amount of water not specified. • stir the water • put the thermistor and thermometer closer together/move thermometer up from the bottom of the beaker • indicate the temperatures at which resistance is to be measured • waterbath/thermostat • take a second set of results (by cooling the water) • extend the temperature range using oil instead of water • extend the range by adding ice. **Results** • take measurements at regular temperature intervals • take results at smaller intervals of temperature • graph axis should be labelled i.e. temperature of thermistor ($^{\circ}$C) and resistance of thermistor, should have title • no repeat and average • no anomalies • the graph should be a continuous curve not be shown as dot to dot **Conclusion** • Resistance decreases as temperature increases or reverse argument taken from the graph • results give a negative correlation/ all results follow a similar trend • the gradient/slope of the graph represents the rate of change of resistance with temperature • the gradient/slope of graph is less at higher temperatures compared to lower temperatures (may be shown on the graph) • the relationship is non-linear • the (written) conclusion is incorrect as the rate at which the resistance decreases is greater at lower not higher temperatures • the conclusion is incorrect as the gradient/slope at low temperatures is much steeper than the gradient/slope at high temperatures.
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: 8 marks

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