

COMPONENT 4 – Applications In Science**HIGHER TIER****MARK SCHEME****GENERAL INSTRUCTIONS**Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response questions).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

SECTION A

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		2 H ₂ O (1) + CO ₂ (1)	2			2		
		(ii)	I	100 × 21 (1) = 2 100 [kg CO ₂ eq] (1)		2		2	1	
			II	Carbon dioxide produced by burning has a greenhouse contribution of 275 [kg CO ₂ eq] (1) Which is less than that of methane (1)			2	2		
	(b)	(i)	I	Doesn't burn fossil fuels / produce CO ₂		1		1		
			II	280 × 27 (1) 7 560 [g] (1)		2		2	2	
		(ii)		32 × 0.45 (1) = 14.4 [kg] (1)		2		2	2	
		(iii)		Ignores carbon dioxide produced during charging (1) Which is equivalent to 72 g/km (1)			2	2		
	(c)			They are then cheaper so encourages us to buy electric vehicles (1) Meets [government] targets on CO ₂ production / decrease carbon footprint of user (1)	2			2		
				Question 1 total	4	7	4	15	5	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		CO ₂ (1) Anaerobic respiration (1) Of glucose (1) Glucose → ethanol and carbon dioxide (1)	4			4		
		(ii)		<i>S. cerevisiae</i> (1) Higher the rate of fermentation the higher the rate of CO ₂ production (1) And therefore ethanol production (1)		1	1	3		3
	(iii)	I		To exclude air (1) And therefore prevent aerobic respiration (1)	2			2		2
		II		To prevent contamination with wild/other strains of yeasts	1			1		1
	(iv)	I		(43.2 - 41.7) (1) 60-45 =0.1 (1)		2		2	2	
		II		Yeast being poisoned by ethanol (1) Glucose becoming depleted (1)		2		2		2
	(b)			Failure to isolate controlled variables will compromise the validity of the investigation	1			1		1
					Question 3 total	8	5	2	15	2

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Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		The amount of energy per kg (1) Required to change ice to water (1) Without change in temperature (1)	3			3		
	(b)		Determination that mass of melted ice = 0.036 kg (1) Conversion to 36 g (1) $\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{36}{0.92}$ = 39.1 [cm ³] (1)		3		3	3	3
	(c)	(i)	Recall of: $P = V \times I$ (1) Substitution: $P = 3.8 \times 10 = 38$ [W] (1) Energy supplied = $P \times t = 38 \times 300$ (1-conversion of minutes) = 11 400 [J] (1)	1 1		1 1	4	3	4
		(ii)	Substitution into $Q = mL$ i.e. $11\,400 = 0.036 \times L$ (1) Manipulation: (1) i.e. $L = \frac{11400(\text{ecf})}{0.036(\text{ecf})}$ $L = 3.2 \times 10^5$ [J/kg] (1)	1		1 1	3	3	3
		(iii)	Greater mass of ice melts for the same amount of heat supplied by the heater (1) L calculated from this experiment would be smaller than the actual value (1)				2		2
			Question 4 total	6	7	2	15	9	12

Question		Marking details		Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Neutralisation reaction (1) in which salt, carbon dioxide and water are formed (1)	2			2		2
	(b)		11.65 (first box), 11.60 (second box) Do not accept 11.6 Mean = 11.63 [cm ³]		1		1		1
	(c)		moles HCl = 11.63 (ecf) $\times \frac{0.25}{1000}$ = 0.0029 mol (1) moles CaCO ₃ = 2 \times 0.0029 (ecf) = 0.0058 [mol] (1)		2		2	2	2
	(d)		mass CaCO ₃ = 0.0058 (ecf) \times 40 = 0.232 / 0.23 g (1) % = 0.232 (ecf) $\times \frac{100}{0.54}$ = 42.9/43 [%] (1)		2		2	2	2
	(e)		Reading of burette scale / parallax errors (1) Adding too much acid / passing the endpoint (1)			2	2		2
			Question 5 total	2	5	2	9	4	9

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Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)	Total resistance = $20 + 15 + 10 = 45 \text{ } (\Omega)$ (1) Recall $V = IR$ (1) $I = V/R = 6/45$ rearrange and substitute (1) = 0.13A (1) Both number + unit for mark (1) Allow ecf.	1	1		4	2	3
		(ii)	Correct symbol for voltmeter in parallel with the $15 \text{ } \Omega$ (or R_2) resistor	1			1		1
		(iii)	Correct symbol for ammeter in series with the $15 \text{ } \Omega$ resistor	1			1		1
		(iv)	$20 \times 0.13 = 2.6 \text{ [V]}$		1		1	1	1
		(b)	Two or three resistors must be shown in parallel in completed circuit. (1) By placing resistors in parallel there are more branches for current to flow through. (1) So decreasing total resistance. (1)			3		3	2
			Question 6 total	3	7	0	10	5	9

Question		Marking details		Marks Available						
				AO1	AO2	AO3	Total	Maths	Prac	
7	(a)			Simplest whole number (1) Ratio of atoms/ions in compound (1)	2			2		
	(b)			Mass Mg = 20.28 - 20.04 = 0.24 [g] Mass oxygen reacted = 20.44 - 20.28 = 0.16 [g] Both correct for a mark (1) $\text{Moles} = \frac{\text{mass}}{\text{molar mass}} \text{ (1)}$ $\text{Mg} = \frac{0.48}{0.24(\text{ecf})} = 0.02 \text{ [mol]} \text{ and } \text{O} = \frac{0.16(\text{ecf})}{16} = 0.01 \text{ [mol]} \text{ (1)}$ Empirical formula: i.e. Mg ₂ O (1) Allow ecf Workings must be shown to obtain marks. If the correct empirical formula is given without workings award 1 mark only	1	1		4		
	(c)			Not all the magnesium reacted (1) therefore amount of oxygen underestimated (1)			2	2		2
				Question 7 total	3	2	3	8	2	6

Question		Marking details		Marks available								
				AO1	AO2	AO3	Total	Maths	Prac			
8	(a)			<p>Indicative content:</p> <p>AO1 allocation - Visking tubing gives a model of selectively permeable membrane which allows diffusion of molecules based upon size. Small molecules can diffuse through but not larger ones. Starch can be thought of as a chain of glucose molecules</p> <p>AO3 allocation - Starch is too large to diffuse across the membrane and so is not detected in the beaker. In first 15 minutes there is no glucose in water but after 15 minutes glucose is detected. After 15 minutes the concentration of the glucose increases up to 30 minutes. The only source of glucose is from the digestion of starch. The enzyme carbohydrase must break down starch into glucose molecules once it is added.</p> <p>5 – 6 marks Clear understanding of the idea of selective diffusion based upon size of molecules across the Visking tubing. Clearly states similarities (structure of glucose as chain of glucose molecules) and differences (size of molecules) between starch and glucose. Clearly explains the change in glucose concentration in terms of action of enzyme and subsequent diffusion of smaller molecule across membrane. <i>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The information included in the response is relevant to the argument.</i></p> <p>3 – 4 marks Appreciates that Visking tubing is a selective membrane which allows smaller molecules (glucose) to pass through. Starch does not pass through because of larger size. Understands that glucose is only formed after the addition of carbohydrase and so only starts diffusing after the enzyme is added. <i>There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument.</i></p>			3		3	6		6

			<p>1 – 2 marks An appreciation of the relative sizes of the molecules and that smaller molecule can diffuse across the Visking tubing. Glucose is the smaller molecule which diffuses after 15 minutes only after carbohydrase has been added. <i>There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument.</i></p> <p>0 marks <i>No attempt made or no response worthy of credit.</i></p>						
	(b)		<p>Water added to iodine solution (1) Stayed brown therefore no starch present (1) Water added to Benedict's solution and heated strongly (1) Went orange/red/brick red therefore glucose present (1)</p>	4			4		4
			Question 8 total	7	0	3	10	0	10

COMPONENT 4 – Applications in Science**HIGHER TIER****SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES**

	Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A	1	4	7	4	15	5	0
Section B	2	3	3	2	8	2	8
	3	8	5	2	15	2	9
	4	6	7	2	15	9	12
	5	2	5	2	9	4	9
	6	3	7	0	10	5	9
	7	3	2	3	8	2	6
	8	7	0	3	10	0	10
	TOTAL	36	36	18	90	29	63