

GCE

Chemistry B

Unit **H433/02**: Scientific literacy in chemistry

Advanced GCE

Mark Scheme for June 2018

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.




All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BID	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NEOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

Subject-specific Marking Instructions**INTRODUCTION**

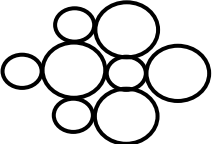
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question			Answer	Marks	Guidance
1	(a)	(i)	+4 (kJmol ⁻¹)	1	ALLOW '4' but NOT -4, if units are evident they must be correct
1	(a)	(ii)	At least one large ion labelled 'Cl ⁻ ' and one small ion labelled 'Na ⁺ ' ✓ three ions added that continue to demonstrate the ordered arrangement of ions ✓  ✓	2	DO NOT ALLOW if two large ions are touching or if two small ions are touching IGNORE extra correct ions added ALLOW other correct diagrams eg as shown
1	(b)		FIRST CHECK ANSWER ON ANSWER LINE If answer = 39(%) award 2 marks <i>M_r</i> values MgCO ₃ ·3H ₂ O 138.3 and 3H ₂ O 54 ✓ % loss = 5400/138.3 = 39(%) ✓	2	If answer rounds to 39(%) award 2 marks ALLOW ecf from incorrect calculation of <i>M_r</i> values ALLOW calculation of MgCO ₃ / MgCO ₃ ·3H ₂ O = 61% (% retained) for 1 mark
1	(c)		FIRST CHECK ANSWER ON ANSWER LINE If answer = 0.69 (g) award 3 marks (rearranges ideal gas equation) $n = PV/RT$ ✓ (substitution of values into rearranged equation) $n = 99000 \times 200 \times 10^{-6} / 8.314 \times 290$ (= 8.212 x 10 ⁻³ mol) ✓ (Uses $m = n \times M_r$ to calculate mass of Magnesium Carbonate) mass = (84.3 x 8.212 x 10 ⁻³) = 0.69(2...) (g) ✓	3	ALLOW ecf (If gas equation is inverted and values substituted correctly and evaluated the answer arrived at is 10265, award 2 marks) (If final answer rounds to 690(g) award 2 marks as

Question			Answer	Marks	Guidance
					candidate has failed to convert 200cm ³ correctly but has done everything else appropriately)
1	(d)	(i)	Mg(g) → Mg ⁺ (g) + e ⁻ ✓	1	ALLOW Mg(g) – e ⁻ → Mg ⁺ (g)
	(d)	(ii)	Electron in Mg is nearer nucleus (ora) ✓ Stronger attraction (ora) (AW) ✓	2	ALLOW less shielding in Mg (ora) / fewer electron shells in Mg / smaller atomic radius IGNORE 'charge density' IGNORE 'held more strongly'
1	(e)	(i)	hydrochloric (acid) / HCl ✓	1	IGNORE 'dil' / 'conc'
	(e)	(ii)	barium (carbonate) ✓	1	ALLOW BaCO ₃ but NOT Ba on its own
				13	

Question			Answer	Marks	Guidance
2	(a)	(i)	$C_2H_3^+$ ✓ $C^{13}C_2H_6^+$ ✓	2	ALLOW structure, eg $CH_2=CH^+$ or CH_2CH^+ or CH_3C^+ ALLOW other unambiguous representations Award one mark for both correct species without plus sign ALLOW formula with comment that ONE of the C atoms is a ^{13}C isotope for MP2
2	(a)	(ii)	Both have same type and number of atoms / same molecular formula ✓ Sum of accurate atomic masses would be the same (AW) / same M_r ✓	2	
2	(a)	(ii)i	Any two from: IR : propene would have alkene C=C ✓ at 1620-1680 ✓ OR alkene C-H ✓ at 3000 – 3100 ✓ CNMR: propene would have 3 peaks ✓ cyclopropane would have 1 ✓ OR propene would have (two) peak(s) at 110-160 ✓ C=C ✓ HNMR: propene would have 3 peaks ✓, cyclopropane would have 1 ✓ OR propene would have (two) peak(s) at 4.5 – 6 ✓ H-C=C ✓	4	IF only one method chosen, a maximum of two marks can be awarded. No marks available for identification of methods that can be used, all marks are for the reasons provided. ALLOW environments for peaks for both types of NMR ALLOW propene has multiplet ✓ from central CH ✓
2	(b)	(i)	σ bonds: 8 and π bonds 1	1	
2	(b)	(ii)	120°	1	

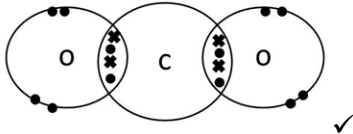
Question			Answer	Marks	Guidance
2	(c)	(i)	$C_9H_{20} \rightarrow 2C_3H_6 + C_3H_8$	1	IGNORE state symbols
2	(c)	(ii)	<p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 8.4 (kg) award 2 marks</p> <p>(amount nonane) = $15000/128$ OR $117(\dots)$ (mol) ✓</p> <p>mass propene (= $2 \times 117 \times 0.85 \times 42/1000$) = 8.4 (kg) ✓</p>	2	<p>ALLOW ecf from incorrect equation in c(i) eg if one propene molecule as a product, then 4.2 on the answer line scores 2 marks.</p> <p>ALLOW $15/128 = 0.117$ for MP1</p>
2	(d)		<pre> H H H-C-H — C — C — H H </pre>	1	IGNORE brackets and 'n' must be full structural with 'spare' bonds.
2	(e)	(i)	<p>Any three from: enthalpy change of hydrogenation of benzene is less (exothermic) than 3 x enthalpy change of hydrogenation of cyclohexene ✓</p> <p>(therefore) bonding in benzene is not 3 (C=C) double bonds (and 3 C—C bonds) / benzene does not have alternating single and double bonds between the carbon atoms ✓</p> <p>benzene is more stable ✓</p> <p>benzene has delocalised electrons / structure ✓</p>	3	<p>ALLOW points made on a diagram</p> <p>ALLOW any appropriate comment relating to delocalisation in benzene</p>

Question	Answer	Marks	Guidance
2 (e) (ii)	<p><i>Refer to marking instructions on page 6 of mark scheme for guidance on marking this question.</i></p> <p>Level 3 (5 – 6 marks) A detailed comparison that identifies products and reaction conditions for both reactions. AND Correctly identifies both reaction types. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3 – 4 marks) Partial comparison of both reactions. AND Correctly identifies both reaction types. OR Detailed explanation of the one reaction. AND Correctly identifies ONE reaction type. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence</i></p> <p>Level 1 (1 – 2 marks) Partial comparison of both reactions. AND Attempts to identify the reaction types. OR Discusses both reaction types. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>Level 0 <i>No response or no response worthy of credit.</i></p>	6	<p>Indicative scientific points include:</p> <p>AO2.1 application of knowledge and understanding of cyclohexene reaction</p> <ul style="list-style-type: none"> • product 1,2 dibromohexane • formula; • Br₂ decolourises • at room temp <p>AO2.1 application of knowledge and understanding of benzene reaction</p> <ul style="list-style-type: none"> • product bromobenzene • formula; • HBr as a product • needs reflux • halogen carrier • Fe/FeBr₃ catalyst <p>May be given by use of appropriate equation(s)</p> <p>AO3.2 Conclusions about reaction types</p> <p><i>cyclohexene:</i></p> <ul style="list-style-type: none"> • Electrophilic • addition <p><i>benzene:</i></p> <ul style="list-style-type: none"> • electrophilic • substitution; • maintains delocalisation
	Total	23	

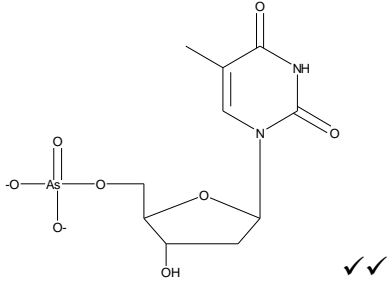
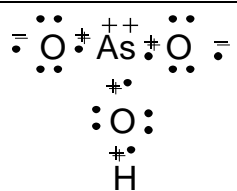
Question		Answer	Marks	Guidance
3	(a)	<p>Any three from: Active site has complementary shape to hydrogen peroxide (molecule) ✓</p> <p>H₂O₂ binds/fits to active site ✓</p> <p>bonds broken more easily ✓</p> <p>E_a lowered ✓.</p>	3	<p>ALLOW 'substrate' for H₂O₂ throughout</p> <p>ALLOW forms enzyme-substrate complex</p>
3	(b)	Oxidation	1	ALLOW redox
3	(c)	<p><i>Please refer to the marking instructions on page 6 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5 – 6 marks) Detailed procedure with most key variables identified and includes some relevant fine detail (may or may not include a diagram). AND Explains clearly how to process results.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3 – 4 marks) Workable procedure with some variables identified may include some relevant fine detail (may or may not include a diagram). AND Attempts to explain how to process results.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p>	6	<p>Indicative scientific points include: AO3.3 Development of a practical procedure by analysing information <i>Key variables may include:</i></p> <ul style="list-style-type: none"> flask with peroxide; same volume of peroxide solutions keep concentration (and volume) of catalase constant vary peroxide concentration; volume of oxygen measured in gas syringe or over water; <p><i>Fine detail may include:</i></p> <ul style="list-style-type: none"> means of adding catalase / starting reaction; time for certain volume of oxygen to be produced record volume of oxygen produced at fixed time intervals suitable apparatus for measuring volumes of solutions suggests appropriate volume of gas to be collected suggests appropriate time intervals for measuring volume of gas

Question			Answer	Marks	Guidance																
			<p>Level 1 (1 – 2 marks) Outline of procedure with some variables given (may or may not include a diagram). OR Attempts to explain how to process results.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>Level 0 <i>No response or no response worthy of credit.</i></p>		<p>AO3.1 Processing results <i>Makes reference to</i> (plots) graph of volume of oxygen produced</p> <ul style="list-style-type: none"> • against time; • measures slope at the origin / time $t = 0$; • rate proportional to 1/time for a small volume of oxygen to be produced • uses rate = vol of oxygen/time • use of smallest rate value to calculate relative rates <p>NB: Some of the above indicative science may be addressed as part of a labelled diagram – accept any relevant diagram even if poorly drawn. Allow sketch graph labelled as evidence of method used to process experimental data collected.</p>																
3	(d)	(i)	<table border="1"> <thead> <tr> <th>[H₂O₂]/ mol dm⁻³</th> <th>(relative) rate</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>1.0</td> </tr> <tr> <td>0.10</td> <td>2.1</td> </tr> <tr> <td>0.15</td> <td>3.0</td> </tr> <tr> <td>0.20</td> <td>3.8</td> </tr> <tr> <td>0.25</td> <td>4.0</td> </tr> <tr> <td>0.30</td> <td>4.1</td> </tr> <tr> <td>0.35</td> <td>4.1</td> </tr> </tbody> </table>	[H ₂ O ₂]/ mol dm ⁻³	(relative) rate	0.05	1.0	0.10	2.1	0.15	3.0	0.20	3.8	0.25	4.0	0.30	4.1	0.35	4.1	2	<p>First mark for labelled columns (or rows). ALLOW 'concentration of H₂O₂' for [H₂O₂], Evidence of units required for Hydrogen peroxide. Accept 'au/arb' for relative rate but no other units allowed. Other units = CON</p> <p>Second mark for correct values, all concentration values to 2 dp, rate values to 1dp.</p> <p>IGNORE inclusion of temperature</p>
[H ₂ O ₂]/ mol dm ⁻³	(relative) rate																				
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0.35	4.1																				
3	(d)	(ii)	<p>labelled axes (ignore units) with rate as y-axis ✓ plot points correctly ✓ draws best fit line ✓ (must go through the origin) each scale chosen to take up more than half axis ✓</p>	4	<p>ALLOW +/- ½ small square</p> <p>Line should pass through at least 5 points / pass within 1 small square of their plotted points</p>																

Question			Answer	Marks	Guidance
3	(e)	(i)	Rate = $k[\text{H}_2\text{O}_2][\text{catalase}]$ ✓ $\text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$ ✓	2	ALLOW [enzyme] for [catalase], (must have 'rate =' at start of their expression) ALLOW units in any order
3	(e)	(ii)	peroxide: first order initially ✓ then zero order ✓ catalase: no evidence since concentration not changed (AW)✓	3	ALLOW concentration of catalase kept constant
3	(f)		FIRST CHECK ANSWER ON ANSWER LINE If answer = 4.2 award 3 marks $(0.35/2 =) 0.175$ mol oxygen per dm^3 peroxide ✓ volume strength $(= 24 \times 0.175) = 4.2$ ✓ answer to 2sf ✓	3	If answer = 8.4 award 2 marks for candidate failing to convert 0.35 to 0.175 ALLOW ecf from incorrect calculation of number of moles Any calculated value to 2sf scores 1 mark.
3	(g)		FIRST CHECK ANSWER ON ANSWER LINE If answer = 120 (cm^3) award 2 marks (total volume =) $20 \times 0.35/0.05$ OR $140 (\text{cm}^3)$ ✓ volume to add = $120 (\text{cm}^3)$ ✓	2	ALLOW $140(\text{cm}^3)$ even on the answer line for 1 mark
				26	

Question			Answer	Marks	Guidance
4	(a)	(i)	hydrogen carbonate	1	ALLOW 'hydrogencarbonate'/hydrogen carbonate(IV) but no other oxidation states IGNORE bicarbonate
4	(a)	(ii)	CO_3^{2-}	1	IGNORE 'carbonate'
4	(b)	(i)	 <p>linear ✓</p>	2	
4	(b)	(ii)	(C–O) bonds are polar because of different electronegativities (of C and O) ✓ dipoles cancel (AW) ✓	2	allow $\text{C}^{\delta+}\text{O}^{\delta-}$ instead of 'different electronegativities' ALLOW centre of negative charge cancelled by centre of positive charge
4	(c)		water can form (some) hydrogen bonds with CO_2 ✓ lone pair on the oxygen (of CO_2) attracted to $\delta^+\text{H}$ (of water molecule) ✓	2	MUST be clear that the lone pair from O is from CO_2 molecule otherwise MP2 cannot be scored ALLOW both marks from a correctly drawn diagram
4	(d)	(i)	FIRST CHECK ANSWER ON ANSWER LINE If answer = 3.79 award 2 marks $[\text{H}^+] = \sqrt{(3.3 \times 10^{-2} \times 7.9 \times 10^{-7})}$ OR $1.6(1..) \times 10^{-4}$ ✓ $\text{pH} = 3.79(19..)$ ✓	2	An answer rounding to 3.8 scores 2 ALLOW ecf from incorrect $[\text{H}^+]$
4	(d)	(ii)	$([\text{H}^+] = [\text{HCl}] =) 1.6(14..) \times 10^{-4}$ ✓	1	ALLOW ecf from any value from pH 3 – 6 in 4d(i) eg pH3.8 gives $[\text{H}^+] = 1.58 \times 10^{-4}$

Question			Answer	Marks	Guidance
4	(e)	(i)	<p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 19.8 award 2 marks</p> <p>$[H^+] = 3.98 \times 10^{-8} \checkmark$ $[HCO_3^-]/[CO_2] = (7.9 \times 10^{-7} / 3.98 \times 10^{-8}) = 19.8(5) \checkmark$</p>	2	<p>ALLOW answer rounding to 20 for 2 marks</p> <p>ALLOW ecf from incorrect $[H^+]$</p>
4	(e)	(ii)	<p>Student is correct since blood contains too much H^+ / is too acidic \checkmark</p> <p>Adding HCO_3^- will move equilibrium (position in 4.1) to left / increases pH \checkmark</p>	2	
4	(f)		<p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 11.4 award 3 marks</p> <p>amount NaOH (remaining) = 1×10^{-4} mol \checkmark in 40 cm^3, so $[OH^-] = 1 \times 10^{-4} \times 1000/40$ OR 2.5×10^{-3} \checkmark pH (= $14 - pOH = 14 - 2.6$) = 11.4 \checkmark</p>	3	<p>ALLOW ecf</p> <p>Final answer must be to at least 1dp</p>
				18	

Question		Answer	Marks	Guidance
5	(a)	will not allow formation of S-S bonds	1	ALLOW idea that As interferes with sulfur bridges / S-S bonds in the protein
5	(b)		2	ALLOW arsenate group partially, or fully protonated bonded to either OH group on the ribose ring for 2 marks Correct structure with one error scores 1 mark.
5	(c)	$2\text{As}^{3+}(\text{aq}) + 3\text{H}_2\text{S}(\text{g})/(\text{aq}) \rightarrow \text{As}_2\text{S}_3(\text{s}) + 6\text{H}^+(\text{aq})$ balanced equation ✓ Correct state symbol for As_2S_3 ✓	2	
5	(d) (i)	generating flask containing zinc, sulfuric acid and As_2O_3 ✓ heated tube leaving flask ✓ silvery-black film / Arsenic (metal) labelled ✓	3	ALLOW 'sample' for As_2O_3 IGNORE closed tube
5	(d) (ii)	$\text{As}_2\text{O}_3 + 6\text{H}_2 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O} \checkmark$ $2\text{AsH}_3 \rightarrow 2\text{As} + 3\text{H}_2 \checkmark$	2	ALLOW $\text{As}_2\text{O}_3 + 6\text{Zn} + 6\text{H}_2\text{SO}_4 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O} + 6\text{ZnSO}_4$ for equation 1 IGNORE state symbols
5	(e) (i)	 8 electrons around As atom ✓ completely correct including lone pair on As ✓	2	ALLOW 'spare' electrons on oxygen as different symbol or the same as others on that oxygen IGNORE overall charge of 2-

Question			Answer	Marks	Guidance
5	(e)	(ii)	Cu^{2+} (ion) ✓	1	ALLOW Copper(II) / copper ion
5	(f)		107.5 (°) ✓ Four pairs of electrons (around As) ✓ Repel and get as far away as possible / move apart to minimise repulsion ✓ Lone pair : bond pair repulsion > bond pair : bond pair repulsion / lone pair repels more (than bond pair) / lone pair takes up more room (AW) ✓	4	ALLOW 107 – 108 ALLOW 'areas of electron density'/'groups of electrons' for 'pairs of electrons' / 3 bonding pairs AND 1 lone pair must be clear that it is electrons repelling to score third mark
5	(g)		Any three from: arsenic found in Napoleon's hair ✓ wallpaper (might have) contained arsenic /contained Scheele's Green ✓ Dampness / mould on the wallpaper released toxic arsenic vapours ✓ wallpaper poisoned others ✓	3	ALLOW (wallpaper) linked to Gosio's Disease
				20	

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