



**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

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

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

## Subject-specific Marking Instructions

### INTRODUCTION

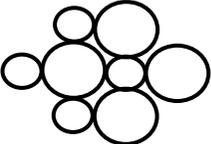
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

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

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

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Question			Answer	Marks	Guidance
2	(a)	(i)	$C_2H_3^+$ ✓ $C^{13}C_2H_6^+$ ✓	2	<b>ALLOW</b> structure, eg $CH_2=CH^+$ or $CH_2CH^+$ or $CH_3C^+$ <b>ALLOW</b> other unambiguous representations Award one mark for both correct species without plus sign <b>ALLOW</b> 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)	<b>Any two from:</b> IR : propene would have alkene C=C ✓ at 1620-1680 ✓ <b>OR</b> alkene C-H ✓ at 3000 – 3100 ✓  CNMR: propene would have 3 peaks ✓ cyclopropane would have 1 ✓ <b>OR</b> propene would have (two) peak(s) at 110-160 ✓ C=C ✓  HNMR: propene would have 3 peaks ✓, cyclopropane would have 1 ✓ <b>OR</b> propene would have (two) peak(s) at 4.5 – 6 ✓ H-C=C ✓	4	<b>IF</b> only <b>one</b> method chosen, a <b>maximum</b> of two marks can be awarded. No marks available for identification of methods that can be used, all marks are for the reasons provided.  <b>ALLOW</b> environments for peaks for both types of NMR  <b>ALLOW</b> propene has multiplet ✓ from central CH ✓
2	(b)	(i)	$\sigma$ bonds: 8 <b>and</b> $\pi$ bonds 1	1	
2	(b)	(ii)	$120(^{\circ})$	1	

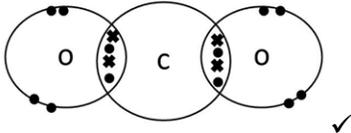
Question			Answer	Marks	Guidance
2	(c)	(i)	$C_9H_{20} \rightarrow 2C_3H_6 + C_3H_8$	1	<b>IGNORE</b> state symbols
2	(c)	(ii)	<p><b>FIRST CHECK ANSWER ON ANSWER LINE</b>  <b>If answer = 8.4 (kg) award 2 marks</b></p> <p>(amount nonane) = <math>15000/128</math> <b>OR</b> <math>117(\dots)</math> (mol) ✓</p> <p>mass propene (= <math>2 \times 117 \times 0.85 \times 42/1000</math>)            = 8.4 (kg) ✓</p>	2	<p><b>ALLOW</b> 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><b>ALLOW</b> <math>15/128 = 0.117</math> for MP1</p>
2	(d)		<pre>       H             H H-C-H           — C — C —                   H   H           </pre>	1	<b>IGNORE</b> brackets and 'n' must be full structural with 'spare' bonds.
2	(e)	(i)	<p><b>Any three from:</b>            enthalpy change of hydrogenation of benzene is <b>less</b> (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><b>ALLOW</b> points made on a diagram</p> <p><b>ALLOW</b> any appropriate comment relating to delocalisation in benzene</p>

Question	Answer	Marks	Guidance
2 (e) (ii)	<p>Refer to marking instructions on page 6 of mark scheme for guidance on marking this question.</p> <p><b>Level 3 (5 – 6 marks)</b> A detailed comparison that identifies products and reaction conditions for both reactions. <b>AND</b> Correctly identifies <b>both</b> 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><b>Level 2 (3 – 4 marks)</b> Partial comparison of both reactions. <b>AND</b> Correctly identifies <b>both</b> reaction types. <b>OR</b> Detailed explanation of the one reaction. <b>AND</b> Correctly identifies <b>ONE</b> 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><b>Level 1 (1 – 2 marks)</b> Partial comparison of both reactions. <b>AND</b> Attempts to identify the reaction types. <b>OR</b> Discusses <b>both</b> 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><b>Level 0</b> <i>No response or no response worthy of credit.</i></p>	6	<p><b>Indicative scientific points include:</b></p> <p><b>AO2.1 application of knowledge and understanding of cyclohexene reaction</b></p> <ul style="list-style-type: none"> <li>product 1,2 dibromohexane</li> <li>formula;</li> <li>Br<sub>2</sub> decolourises</li> <li>at room temp</li> </ul> <p><b>AO2.1 application of knowledge and understanding of benzene reaction</b></p> <ul style="list-style-type: none"> <li>product bromobenzene</li> <li>formula;</li> <li>HBr as a product</li> <li>needs reflux</li> <li>halogen carrier</li> <li>Fe/FeBr<sub>3</sub> catalyst</li> </ul> <p>May be given by use of appropriate equation(s)</p> <p><b>AO3.2 Conclusions about reaction types</b></p> <p><i>cyclohexene:</i></p> <ul style="list-style-type: none"> <li>Electrophilic</li> <li>addition</li> </ul> <p><i>benzene:</i></p> <ul style="list-style-type: none"> <li>electrophilic</li> <li>substitution;</li> <li>maintains delocalisation</li> </ul>
	<b>Total</b>	<b>23</b>	

Question		Answer	Marks	Guidance
3	(a)	<p><b>Any three from:</b> Active site has complementary shape to hydrogen peroxide (molecule) ✓</p> <p>H<sub>2</sub>O<sub>2</sub> binds/fits to active site ✓</p> <p>bonds broken more easily ✓</p> <p>E<sub>a</sub> lowered ✓.</p>	3	<p><b>ALLOW</b> 'substrate' for H<sub>2</sub>O<sub>2</sub> throughout</p> <p><b>ALLOW</b> forms enzyme-substrate complex</p>
3	(b)	Oxidation	1	<b>ALLOW</b> 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><b>Level 3 (5 – 6 marks)</b> Detailed procedure with most <b>key</b> variables identified and includes some relevant fine detail (may or may not include a diagram). <b>AND</b> 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><b>Level 2 (3 – 4 marks)</b> Workable procedure with <b>some</b> variables identified may include some relevant fine detail (may or may not include a diagram). <b>AND</b> 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><b>Indicative scientific points include:</b> <b>AO3.3 Development of a practical procedure by analysing information</b> <i>Key variables may include:</i></p> <ul style="list-style-type: none"> <li>• flask with peroxide;</li> <li>• same volume of peroxide solutions</li> <li>• keep concentration (and volume) of catalase</li> <li>• constant</li> <li>• vary peroxide concentration;</li> <li>• volume of oxygen measured in gas syringe or over water;</li> </ul> <p><i>Fine detail may include:</i></p> <ul style="list-style-type: none"> <li>• means of adding catalase / starting reaction;</li> <li>• time for certain volume of oxygen to be produced</li> <li>• record volume of oxygen produced at fixed time intervals</li> <li>• suitable apparatus for measuring volumes of solutions</li> <li>• suggests appropriate volume of gas to be collected</li> <li>• suggests appropriate time intervals for measuring volume of gas</li> </ul>

Question			Answer	Marks	Guidance																
			<p><b>Level 1 (1 – 2 marks)</b> Outline of procedure with <b>some</b> variables given (may or may not include a diagram). <b>OR</b> 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><b>Level 0</b> <i>No response or no response worthy of credit.</i></p>		<p><b>AO3.1 Processing results</b> <i>Makes reference to</i> (plots) graph of volume of oxygen produced</p> <ul style="list-style-type: none"> <li>• against time;</li> <li>• measures slope at the origin / time <math>t = 0</math>;</li> <li>• rate proportional to 1/time for a small volume of oxygen to be produced</li> <li>• uses rate = vol of oxygen/time</li> <li>• use of smallest rate value to calculate relative rates</li> </ul> <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>[H<sub>2</sub>O<sub>2</sub>]/ mol dm<sup>-3</sup></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 <sub>2</sub> O <sub>2</sub> ]/ mol dm <sup>-3</sup>	(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). <b>ALLOW</b> 'concentration of H<sub>2</sub>O<sub>2</sub>' for [H<sub>2</sub>O<sub>2</sub>], 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><b>IGNORE</b> inclusion of temperature</p>
[H <sub>2</sub> O <sub>2</sub> ]/ mol dm <sup>-3</sup>	(relative) rate																				
0.05	1.0																				
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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><b>ALLOW</b> +/- 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	<b>ALLOW</b> [enzyme] for [catalase], (must have 'rate =' at start of their expression) <b>ALLOW</b> units in any order
3	(e)	(ii)	peroxide: first order <b>initially</b> ✓ then zero order ✓ catalase: no evidence since concentration not changed (AW)✓	3	<b>ALLOW</b> concentration of catalase kept constant
3	(f)		<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 4.2 award 3 marks</b> $(0.35/2 = ) 0.175$ mol oxygen per $\text{dm}^3$ peroxide ✓ volume strength $(= 24 \times 0.175) = 4.2$ ✓ answer to 2sf ✓	3	<b>If answer = 8.4 award 2 marks</b> for candidate failing to convert 0.35 to 0.175 <b>ALLOW</b> ecf from incorrect calculation of number of moles Any calculated value to 2sf scores 1 mark.
3	(g)		<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 120 (<math>\text{cm}^3</math>) award 2 marks</b> $(\text{total volume} =) 20 \times 0.35/0.05$ <b>OR</b> $140 (\text{cm}^3)$ ✓ volume to add = $120 (\text{cm}^3)$ ✓	2	<b>ALLOW</b> $140(\text{cm}^3)$ even on the answer line for 1 mark
				26	

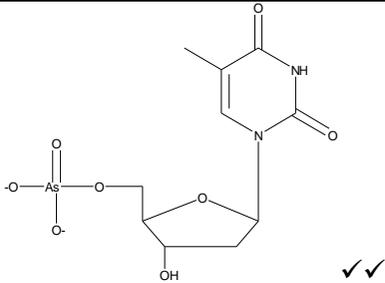
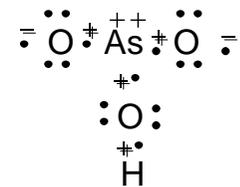
Question			Answer	Marks	Guidance
4	(a)	(i)	hydrogen carbonate	1	<b>ALLOW</b> 'hydrogencarbonate'/hydrogen carbonate(IV) but no other oxidation states <b>IGNORE</b> bicarbonate
4	(a)	(ii)	$\text{CO}_3^{2-}$	1	<b>IGNORE</b> 'carbonate'
4	(b)	(i)	 <p>linear ✓</p>	2	
4	(b)	(ii)	(C–O) bonds are polar because of different electronegativities (of C and O) ✓ dipoles cancel (AW) ✓	2	allow $\text{C}^{\delta+}\text{O}^{\delta-}$ instead of 'different electronegativities' <b>ALLOW</b> centre of negative charge cancelled by centre of positive charge
4	(c)		water can form (some) hydrogen bonds with $\text{CO}_2$ ✓ lone pair on the oxygen (of $\text{CO}_2$ ) attracted to $\delta^+\text{H}$ (of water molecule) ✓	2	<b>MUST</b> be clear that the lone pair from O is from $\text{CO}_2$ molecule otherwise MP2 cannot be scored <b>ALLOW</b> both marks from a correctly drawn diagram
4	(d)	(i)	<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 3.79 award 2 marks</b>  $[\text{H}^+] = \sqrt{(3.3 \times 10^{-2} \times 7.9 \times 10^{-7})}$ OR $1.6(1..) \times 10^{-4}$ ✓ $\text{pH} = 3.79(19\dots)$ ✓	2	An answer rounding to 3.8 scores 2  <b>ALLOW</b> ecf from incorrect $[\text{H}^+]$
4	(d)	(ii)	$([\text{H}^+] = [\text{HCl}] =) 1.6(14\dots) \times 10^{-4}$ ✓	1	<b>ALLOW</b> ecf from any value from pH 3 – 6 in 4d(i) eg pH3.8 gives $[\text{H}^+] = 1.58 \times 10^{-4}$

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Question			Answer	Marks	Guidance
4	(e)	(i)	<p><b>FIRST CHECK ANSWER ON ANSWER LINE</b>  <b>If answer = 19.8 award 2 marks</b></p> <p><math>[H^+] = 3.98 \times 10^{-8} \checkmark</math>  <math>[HCO_3^-]/[CO_2] = (7.9 \times 10^{-7} / 3.98 \times 10^{-8}) = 19.8(5) \checkmark</math></p>	2	<p><b>ALLOW</b> answer rounding to 20 for 2 marks</p> <p><b>ALLOW</b> ecf from incorrect <math>[H^+]</math></p>
4	(e)	(ii)	<p>Student is correct since blood contains too much <math>H^+</math> / is too acidic <math>\checkmark</math></p> <p>Adding <math>HCO_3^-</math> will move equilibrium (position in 4.1) to left / increases pH <math>\checkmark</math></p>	2	
4	(f)		<p><b>FIRST CHECK ANSWER ON ANSWER LINE</b>  <b>If answer = 11.4 award 3 marks</b></p> <p>amount NaOH (remaining) = <math>1 \times 10^{-4}</math> mol <math>\checkmark</math>  in <math>40 \text{ cm}^3</math>, so <math>[OH^-] = 1 \times 10^{-4} \times 1000/40</math> OR <math>2.5 \times 10^{-3}</math> <math>\checkmark</math>  pH (= <math>14 - pOH = 14 - 2.6</math>) = 11.4 <math>\checkmark</math></p>	3	<p><b>ALLOW</b> 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	<b>ALLOW</b> idea that As interferes with sulfur bridges / S-S bonds in the protein
5	(b)		2	<b>ALLOW</b> 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 $\text{As}_2\text{S}_3$ ✓	2	
5	(d) (i)	generating flask containing zinc, sulfuric acid and $\text{As}_2\text{O}_3$ ✓ heated tube leaving flask ✓ silvery-black film / Arsenic (metal) labelled ✓	3	<b>ALLOW</b> 'sample' for $\text{As}_2\text{O}_3$ <b>IGNORE</b> closed tube
5	(d) (ii)	$\text{As}_2\text{O}_3 + 6\text{H}_2 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O}$ ✓ $2\text{AsH}_3 \rightarrow 2\text{As} + 3\text{H}_2$ ✓	2	<b>ALLOW</b> $\text{As}_2\text{O}_3 + 6\text{Zn} + 6\text{H}_2\text{SO}_4 \rightarrow 2\text{AsH}_3 + 3\text{H}_2\text{O} + 6\text{ZnSO}_4$ for equation 1 <b>IGNORE</b> state symbols
5	(e) (i)	 8 electrons around As atom ✓ completely correct including lone pair on As ✓	2	<b>ALLOW</b> 'spare' electrons on oxygen as different symbol or the same as others on that oxygen <b>IGNORE</b> overall charge of 2-

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5	(e)	(ii)	$\text{Cu}^{2+}$ (ion) ✓	1	<b>ALLOW</b> 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	<b>ALLOW</b> 107 – 108  <b>ALLOW</b> '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)		<b>Any three from:</b> 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	<b>ALLOW</b> (wallpaper) linked to Gosio's Disease
				20	

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