



Pearson

Mark Scheme (Results)

Summer 2017

Pearson Edexcel GCE
in Chemistry (8CH0) Paper 2
Core Organic and Physical
Chemistry

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General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the mark scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense.

Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1	<p>1. The only correct answer is A</p> <p><i>B is not correct because fluorine is very electronegative and has a suitable lone pair of electrons for hydrogen bonding.</i></p> <p><i>C is not correct because has hydrogen bonding; compare with water.</i></p> <p><i>D is not correct because alcohols can hydrogen bond; compare with water.</i></p>	(1)

(Total for Question 1 = 1 mark)

Question Number	Answer	Mark
2	<p>2. The only correct answer is C</p> <p><i>A is not correct because it has a similar shape to water.</i></p> <p><i>B is not correct because it has a trigonal planar shape; resulting from the lone pair and two groups of electrons in the two double bonds.</i></p> <p><i>D is not correct because it is planar but not linear.</i></p>	(1)

(Total for Question 2 = 1 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)	<ul style="list-style-type: none"> <li data-bbox="367 533 1039 564">• moles of CO₂/moles of C (1) <li data-bbox="367 639 1039 671">• moles of H (1) <li data-bbox="367 783 1039 815">• empirical formula (1) <li data-bbox="367 1214 1039 1246">• calculates molecular formula C₆H₁₂ (1) 	<p data-bbox="1070 501 1406 533"><u>example of calculation</u></p> <p data-bbox="1070 536 1738 600">moles of CO₂ = 3.143/44 (= 0.07143/0.071) = moles of C</p> <p data-bbox="1070 639 1637 671">moles of H₂O = 1.284/18 (= 0.07133)</p> <p data-bbox="1070 703 1671 735">moles of H = 2 x moles of H₂O = 0.1427</p> <p data-bbox="1070 775 1509 807">C:H = 0.07143:0.1427 = 1:2</p> <p data-bbox="1070 839 1346 871">hence C₁H₂ or CH₂</p> <p data-bbox="1070 911 1653 975">allow TE from first and/or second mark point(s)</p> <p data-bbox="1070 983 1525 1015">Allow any workable calculation</p> <p data-bbox="1070 1054 1760 1086">Ignore SF in intermediate stages of calculation</p> <p data-bbox="1070 1126 1727 1190">Award 3 marks for correct C:H ratio, with or without working.</p> <p data-bbox="1070 1222 1585 1326">84/14 = 6 6 x CH₂ = C₆H₁₂ Mark independently of M1, M2, M3</p>	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(b)(i)	<ul style="list-style-type: none"> <li data-bbox="376 411 1115 448">• calculation of Q <li data-bbox="376 528 1115 564">• mass of hydrocarbon burnt and value of $\Delta_c H$ <li data-bbox="376 815 1115 852">• sign and significant figures 	<p data-bbox="1229 272 1568 309"><u>example of calculation</u></p> <p data-bbox="1229 316 1496 352">use of $Q = m c \Delta T$</p> <p data-bbox="1229 389 1590 456"> $Q = 250 \times 4.18 \times 8.2$ $= 8569 \text{ (J)} / 8.569 \text{ kJ}$ </p> <p data-bbox="1229 462 1653 499">ignore any sign at this stage</p> <p data-bbox="1229 531 1563 598"> $= 112.990 - 112.732$ $= 0.258 \text{ g}$ </p> <p data-bbox="1229 646 1697 754"> $\Delta_c H = (-) 8569 \times 84 / 0.258$ $= (-) 2789907 \text{ (J mol}^{-1}\text{)} / (-)$ $2789.907 \text{ (kJ mol}^{-1}\text{)}$ </p> <p data-bbox="1229 794 1675 903"> TE on incorrect value from M1 $= -2790 / -2800 \text{ (kJ mol}^{-1}\text{)}$ </p> <p data-bbox="1229 935 1738 1007"> allow $-2790000 / -2800000 \text{ J mol}^{-1}$ final answer to 2 or 3 sig figs only </p> <p data-bbox="1229 1042 1675 1114">Do not award M3 for incorrect method used in M2</p> <p data-bbox="1229 1153 1771 1216">correct final answer without working scores 3</p>	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(b)(ii)	an answer that makes reference to the following point: improved/better (thermal/heat) conduction	Allow copper is a good conductor (of heat) Allow reverse argument in terms of (thermal) insulators Ignore references to heat capacity/ heat lost to surroundings/ heat absorbed by container. Ignore any mention of glass breakage	(1)

(Total for Question 3 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)	C ₁₀ H ₁₈ O	(1) Ignore C ₁₀ H ₁₇ OH	(2)
	154 (g mol ⁻¹)	(1) no TE on incorrect molecular formula except for C ₁₀ H ₁₇ OH	

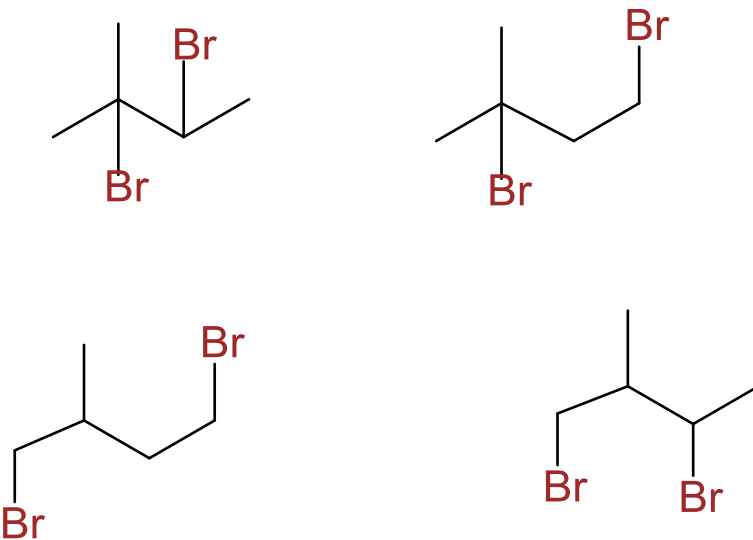
Question Number	Acceptable Answer	Additional Guidance	Mark
4(b)(i)	furthest peak to right/ highest $m/z = 154$	Ignore just 'highest peak' may be shown on spectrum alone provided 154 stated Allow parent ion/molecular ion/last peak at 154 Must see the figure 154 in text or on graph	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(b)(ii)	C ₅ H ₉ ⁺ / [C ₅ H ₉] ⁺	+ charge is essential, allow charge anywhere on the ion/ outside / inside brackets Allow displayed/structural/skeletal formula or any combination of these. Ignore name of ion even if incorrect (Correct name: 2-methylbut-2-ene ion)	(1)

Question Number	Answer Acceptable	Additional Guidance	Mark
4(c)	<p>alkene and C=C and (IR) peak between 1669 and 1645 (cm⁻¹)</p> <p>OR</p> <p>alkene and C-H and (IR) peak between 3095 and 3010 OR 3095 and 2995 (cm⁻¹) (1)</p> <p>alcohol and O-H and (IR) peak between 3750 and 3200 (cm⁻¹) (1)</p>	<p>can be in either order</p> <p>Allow CH (bond)</p> <p>Ignore any qualification of the wavenumber range eg isolated alcohol or phenol</p> <p>Allow Hydroxyl Do not award Hydroxide Allow OH (bond) Do not award -OH /-O-H</p> <p>If both bonds missing and everything else correct, award 1 mark</p> <p>Ignore all references to alkanes</p> <p>Allow single IR value or range within the data book range</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(d)	<p>An answer that makes reference to the following points:</p> <p>Alkene</p> <ul style="list-style-type: none"> • bromine water/Br₂(aq)/bromine • decolorised or orange/yellow/brown to colourless <p>Alcohol</p> <ul style="list-style-type: none"> • PCl₅/phosphorus pentachloride /phosphorus(V)chloride • Misty/steamy/white fumes 	<p>Allow alkene and alcohol in either order. No TE for other groups incorrectly identified in 4c or alkanes Result dependent on correct test for both functional groups</p> <p>(1) allow acidified potassium manganate/KMnO₄. (1) Decolourised (from purple)</p> <p>(1) allow (warm with) acidified Cr₂O₇²⁻ turns from orange to green / blue (1) If name and formula, both must be correct</p> <p>sodium (metal) effervescence OR any other workable test and correct result</p>	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(e)	<p>2</p> <p>number of C atoms in geraniol = 10, C atoms in isoprene = 5, (10/5 = 2)</p>	<p>(1)</p> <p>Note: this must be a whole number</p> <p>(1)</p> <p>Allow answers using C chain length ie isoprene = 4, geraniol = 8</p> <p>Ignore number of hydrogens in both isoprene and geraniol</p> <p>Do not award answers using M_r</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(f)	 <p>one mark for each structure</p>	<p>accept displayed/structural/skeletal formulae</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="1187 367 1478 542"> </div> <div data-bbox="1612 367 1926 542"> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div data-bbox="1187 638 1478 813"> </div> <div data-bbox="1612 638 1926 813"> </div> </div> <p>Allow 2 marks for 4 different and correct monobromo isomers Allow 1 mark for 2/3 different and correct monobromo isomers Zero for 1 monobromo isomer accept correct enantiomers (provided both C=C bond react) Deduct one mark only for use of HCl Deduct one mark for (any number of) missing hydrogens</p>	(4)

(Total for Question 4 = 16 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)	an answer that makes reference to the following point: volume/space occupied by one mole of a gas at a specified temperature and pressure/rtp/stp/standard conditions	temp and pressure need not be s.t.p. or r.t.p. ignore just reference to 22.4 or 24 dm ³ Ignore units of volume, if given.	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(i)	(% volume uncertainty =)1% (1) (% mass uncertainty =)1/1.1/1.09/1.08696 % (1)	<u>example of calculation</u> 0.5 cm ³ in 50 cm ³ % uncertainty = $\frac{0.5}{50} \times 100 = 1\%$ mass of gas = 107.655 – 107.563 = 0.092 g uncertainty = 0.0005 x 2 0.001 g in 0.092 g % uncertainty = $\frac{0.001}{0.092} \times 100$ = 1/1.1/1.09/1.08696 % Ignore uncertainties added together Do not award calculation of uncertainty in each mass <u>reading</u> (often added together +1) eg 0.0004644 + 0.0004648 + 1 = 1.000928	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(ii)	<p>an answer that makes reference to the following points:</p> <p>halves the % volume uncertainty / 0.5 cm^3 in $100 \text{ cm}^3 = 0.5\%$ (1)</p> <p>(volume of gas is doubled so mass of gas doubles), % mass uncertainty (also) halves. (1)</p>	<p>TE for answer to (b)(i) $\div 2$</p> <p>TE for answer to (b)(i) $\div 2$</p> <p>Allow 1 mark for both uncertainties decrease</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(iii)	<ul style="list-style-type: none"> mass of gas and expression for molar mass (1) molar mass to 2 or 3 SF and correct units (1) 	<p><u>example of calculation</u></p> <p>mass of gas = $107.655 - 107.563 = 0.092 \text{ g}$ and molar mass = $0.092 \times 24000 / 50$ = 44.16</p> <p>Allow any other correct alternative calculation</p> <p>TE from M1 to M2 for incorrect mass only</p> <p>44.2/44 g mol⁻¹ Correct answer to 2/3 SF with/without working gets 2 marks</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(iv)	<p>an explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> plunger does not return (to zero/original position) when released (1) molar mass will decrease because 'air' has a lower molar mass (than 44/carbon dioxide) (1) 	<p>Mark independently</p> <p>There must be some reference to air</p>	(2)

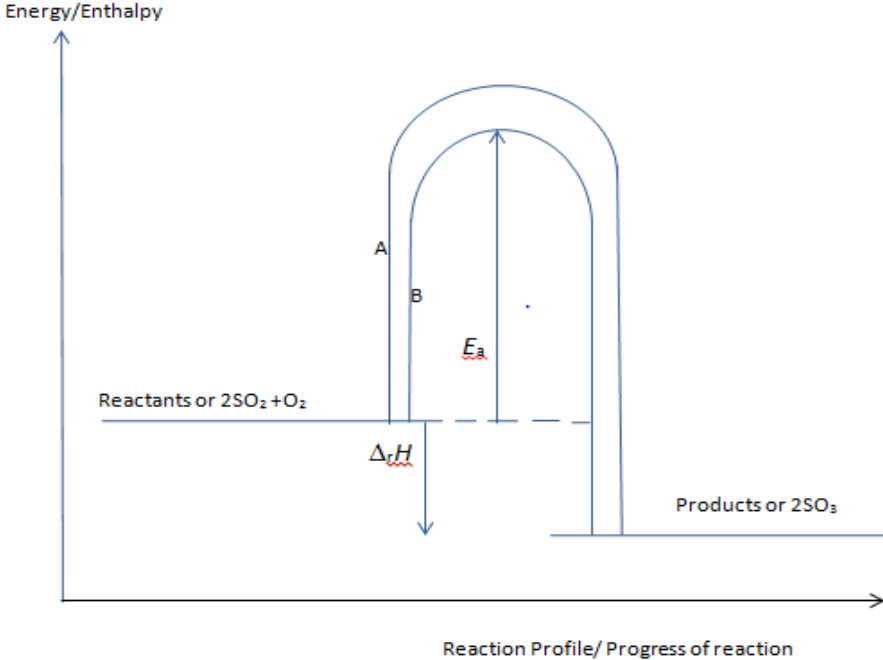
Question Number	Acceptable Answer	Additional Guidance	Mark
5(c)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> the calculated molar mass would be greater (1) at a lower temperature there would be more molecules/moles/mass in the same volume /density is greater. (1) 	<p>Points to be marked independently</p> <p>Standalone mark</p> <p>Do not award for answers that refer to smaller volume</p> <p>Ignore smaller molar volume</p> <p>Ignore particles/molecules/atoms closer together</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(d)	an answer that makes reference to the following point: water (vapour) would decrease/affect molar mass OR gas is now a mixture so would decrease/affect molar mass	Ignore gas may dissolve in water Do not award water may react with gas in syringe Do not award wet gas is heavier Ignore answers that refer to molar volume	(1)

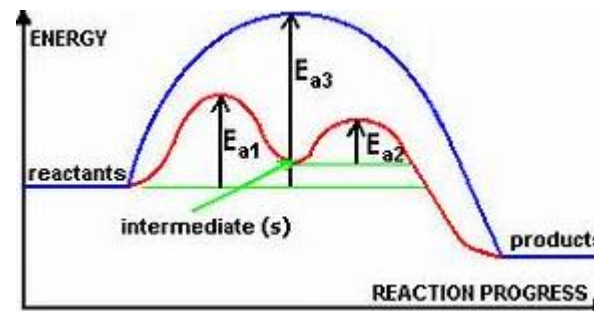
(Total for Question 5 = 12 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark																				
*6(a)	<p>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="367 517 1189 788"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>4</td> </tr> <tr> <td>5-4</td> <td>3</td> </tr> <tr> <td>3-2</td> <td>2</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> </tr> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table border="1" data-bbox="367 895 1189 1358"> <thead> <tr> <th></th> <th>Number of marks awarded for structure and sustained lines of reasoning</th> </tr> </thead> <tbody> <tr> <td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td> <td>2</td> </tr> <tr> <td>Answer is partially structured with some linkages and lines of reasoning.</td> <td>1</td> </tr> <tr> <td>Answer has no linkages between points and is unstructured.</td> <td>0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0		Number of marks awarded for structure and sustained lines of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2	Answer is partially structured with some linkages and lines of reasoning.	1	Answer has no linkages between points and is unstructured.	0	<p>Guidance on how the mark scheme should be applied:</p> <p>The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</p> <p>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.</p> <p>If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).</p> <p>Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points																						
6	4																						
5-4	3																						
3-2	2																						
1	1																						
0	0																						
	Number of marks awarded for structure and sustained lines of reasoning																						
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2																						
Answer is partially structured with some linkages and lines of reasoning.	1																						
Answer has no linkages between points and is unstructured.	0																						

<p>*6(a)</p>	<p>Indicative content:</p> <ul style="list-style-type: none"> • IP1 increase in temperature will increase rate • IP2 (but) increase in temperature will decrease yield/move the equilibrium to the LHS/ produce less SO₃ because it is an exothermic reaction (in the forward direction) • IP3 increase in temperature increases energy costs • IP4 increase in pressure has no effect on rate (because all the active sites are already occupied on a heterogeneous catalyst). OR increase in pressure will increase rate (of reaction) • IP5 increase in pressure will move position of eqm to RHS/increase yield because there are less moles/molecules (of gas) on the RHS • IP6 but increased pressure increases (construction and running) costs/reduces economic viability 	<p>Decreased yield with no reference to exothermic reaction does not get IP2.</p> <p>Allow increases yield of reactants/SO₂ and O₂ (with reference to exothermic reaction)</p> <p>Increased yield with no reference to number of moles does not get IP5.</p> <p>Award one mark for IP2 and IP5 if correct references to yield in both but reasons not given</p> <p>Allow IP3 and IP6 if increased costs of higher temperature and pressure are mentioned together provided that the temperature costs are linked to energy costs. Otherwise only IP6 can be awarded.</p> <p>Ignore any reference to catalyst</p>	
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Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(i)	<ul style="list-style-type: none"> <li data-bbox="367 991 725 1058">vertical axis labelled: H/enthalpy/energy/E (1) <li data-bbox="367 1203 972 1270">level of reactants / $2\text{SO}_2 + \text{O}_2$ above level of products / 2SO_3 (1) 	 <p data-bbox="1032 308 1196 328">Energy/Enthalpy</p> <p data-bbox="1128 699 1339 719">Reactants or $2\text{SO}_2 + \text{O}_2$</p> <p data-bbox="1704 804 1868 825">Products or 2SO_3</p> <p data-bbox="1397 746 1451 767">ΔH</p> <p data-bbox="1487 948 1823 968">Reaction Profile/ Progress of reaction</p> <p data-bbox="1025 1023 1279 1043">Do not award ΔH</p> <p data-bbox="1025 1098 1429 1161">Ignore horizontal axis label Ignore units if given</p> <p data-bbox="1025 1203 1585 1224">ignore state symbols even if incorrect</p>	(3)

	<ul style="list-style-type: none"> correct profile for uncatalysed reaction labelled A <p>and</p> <p>peak lower for catalysed reaction labelled B</p> <p style="text-align: right;">(1)</p>	<p>allow vertical lines for catalysed and uncatalysed reactions to run together</p> <p>allow double hump profile</p>	
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Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(ii)	<p>enthalpy change, $\Delta_r H / \Delta H / (-)197(\text{kJ mol}^{-1})$, shown correctly</p> <p style="text-align: right;">(1)</p> <p>activation energy, E_a, shown correctly (upper diagram)</p> <p style="text-align: right;">(1)</p>	<p>Ignore presence/absence of arrowheads</p> <p>Allow a degree of imprecision in the start/finish points of the lines for ΔH and E_a</p> <p>E_a shown on double hump profile - shown in this diagram as E_{a1}</p> <p>Ignore E_{a2} if also shown</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(c)(i)	$(K_c =) \frac{[\text{SO}_3]^2}{[\text{O}_2][\text{SO}_2]^2}$	Do not award just K or K_p . must be square brackets do not accept partial pressures ignore units or lack of units ignore state symbols Allow \times sign in the denominator but not $+$	(1)

Question Number	Answer	Mark
6(c)(ii)	<p>6(c)(ii). The only correct answer is B</p> <p><i>A is not correct because it refers to the inverted expression for K_c</i></p> <p><i>C is not correct because units do not cancel for concentration²/concentration³</i></p> <p><i>D is not correct because it refers to concentration³/concentration or similar ratio of powers</i></p>	(1)

(Total for Question 6 = 13 marks)

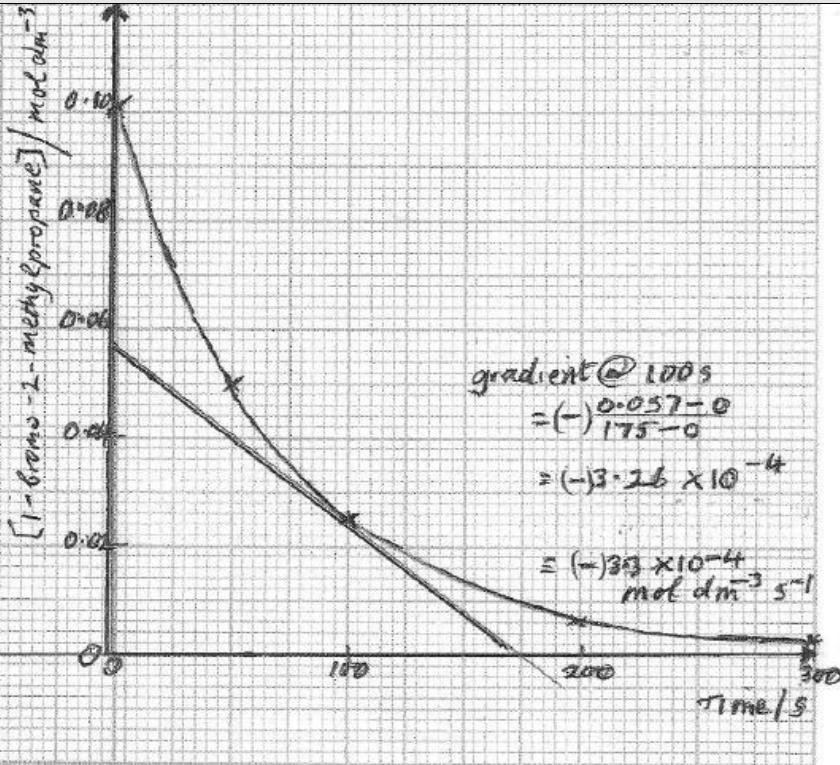
Question Number	Answer	Mark
7(a)(i)	<p>7(a)(i). The only correct answer is B</p> <p><i>A is not correct because X,Y,Z is chloro/bromo/iodo, and would be for increasing rate not time taken</i></p> <p><i>C is not correct because Y,X,Z is bromo/chloro/iodo, ie incorrect for rate or time taken</i></p> <p><i>D is not correct because Z,X,Y is iodo/chloro/bromo, also incorrect for either rate or time taken</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(ii)	to increase the solubility of / dissolves the halogenoalkane /reactants / so that reactants are miscible	<p>Do not award just 'as a good solvent'</p> <p>Allow cosolvent / as a (good) solvent for both reactants</p> <p>Ignore 'stop formation of layers'</p> <p>Ignore 'to allow mixing'</p> <p>Comment Water, aqueous silver nitrate and just silver nitrate are all acceptable alternatives for the other reactant</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(iii)	to allow the solutions to equilibrate / reach the same temperature /reach 50°C/reach the required temperature	<p>Do not award to keep temperature constant</p> <p>Ignore references to reaction rates</p> <p>Ignore reference to fair test</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(iv)	<p>an explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> (the halogenoalkane is) hydrolysed by water (1) C- Hal bond breaks (heterolytically producing ions) (1) 	<p>reward recognition of reaction with water Do not award reaction with OH⁻</p> <p>Comment Must be clear that the C-Hal bond is breaking. Allow statements like 'the halogen ion / halide breaks off'</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(v)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$	<p>Ignore previous workings. Mark the final equation. Do not award uncancelled spectator ions</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(i)	<p>Graph: both axes labelled and graph covering at least half the grid in both directions. (1)</p>	 <p>Do not award 1-bromo-2-methylpropane without [] Do not award just 'concentration/mol dm⁻³' Allow 'concentration of 1-bromo-2-methylpropane/mol dm⁻³' Units required on both axes Accept / between label and mol dm⁻³ or (mol dm⁻³)</p> <p>Non-linear scale on either axis loses M1 and M2 but can get M3 for a smooth curve based on their points</p>	(1)

	points plotted correctly (1) smooth line of best fit (1)	Reversed axes loses M1 only Accuracy $\pm \frac{1}{2}$ small square Do not award dot-to-dot lines	
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Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(ii)	line drawn as tangent to curve at time 100 s. (1) gradient= $(-)\text{3.3} \times 10^{-4}$ (allow range $(-)\text{2.5} \times 10^{-4}$ to $(-)\text{4.5} \times 10^{-4}$) (1) mol dm ⁻³ s ⁻¹ (1)	ignore missing negative sign. Allow any SF except 1 Do not award answers that use only the one point at 100s Example $0.0250/100 = 2.5 \times 10^{-4}$ Do not award for gradient of a straight line graph Do not award for gradient as a fraction Allow mol dm ⁻³ /s	(3)

Question Number	Answer	Mark
7(c)(i)	<p data-bbox="365 268 880 304">1. The only correct answer is D</p> <p data-bbox="365 347 1615 384"><i>A is not correct because the OH^- ion is consumed, therefore not acting as a catalyst</i></p> <p data-bbox="365 427 1711 464"><i>B is not correct because the OH^- ion has negative charge and will not act as an electrophile</i></p> <p data-bbox="365 507 1805 584"><i>C is not correct because the OH^- ion does not have a single unpaired electron therefore not a free radical</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(c)(ii)	<p>correct structure of 1-bromo-2-methylpropane (1)</p> <p>dipole on C - Br bond, i.e. $\delta+$ and $\delta-$ (1)</p> <p>lone pair shown on OH^- and curly arrow from lone pair on OH^- to correct carbon (1)</p> <p>curly arrow from C-Br bond to Br and correct products (1)</p>	<p>$\text{S}_{\text{N}}2$ mechanism M1, M2 and M4 still available for $\text{S}_{\text{N}}1$ mechanism</p> <p>TE for any other halogenoalkane, M2, M3 and M4 still available</p> <p>Lone pair must be located (anywhere) on the O atom of the hydroxide ion</p>	(4)

Question Number	Acceptable Answer	Mark
7(c)(iii)	<p>7(c)(ii). The only correct answer is D</p> <p><i>A is not correct because addition involves the joining together of two molecules to make a bigger one</i></p> <p><i>B is not correct because elimination involves the loss of a small molecule during the reaction</i></p> <p><i>C is not correct because there are no changes in oxidation number</i></p>	1

(Total for Question 7 = 18 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)	<p>CH₂OHCH₂CH₂OH/</p> <pre> H H H H—C—C—C—H O H O H H </pre> <p>CH₂OHCHOHCH₃/</p> <pre> H H H H—C—C—C—H O O H H H </pre>	<p>(1)</p> <p>allow displayed / skeletal formula allow OH undisplayed If more than one formula given for a molecule, both must be correct</p> <p>Penalise C–H–O only once Do not penalise bond to H of pendent OH Do not award C</p> <pre> H O </pre> <p>(1)</p> <p>Ignore names even if incorrect Penalise missing alkane H once only Do not award missing H from OH</p> <p>Allow formulae of propane-1,1-diol or propane-2,2-diol</p> <p>Do not award for other diols</p>	(2)

Question Number	Acceptable Answer	Mark
8(b)(i)	<p>8(b)(i). The only correct answer is A</p> <p><i>B is not correct because hydrogen chloride would be lost during heating</i></p> <p><i>C is not correct because reflux is required to ensure complete oxidation</i></p> <p><i>D is not correct because reflux is required to ensure complete oxidation</i></p>	(1)

Question Number	Acceptable Answer	Mark
8(b)(ii)	<p>8(b)(ii). The only correct answer is B</p> <p><i>A is not correct because the correct colour change is reversed</i></p> <p><i>C is not correct because the orange dichromate(VI) ions are reduced to green chromium(III) ions</i></p> <p><i>D is not correct because the orange dichromate (VI) ions are reduced to green chromium(III) ions</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(i)	<p>moles of NaOH $18.45 \times 0.400 / 1000 = 7.38 \times 10^{-3} / 0.00738$ (1)</p> <p>moles of propanedioic acid $7.38 \times 10^{-3} / 2 = 3.69 \times 10^{-3} / 0.00369$ (1)</p>	TE: moles of NaOH/2	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(ii)	<p>moles of propanedioic acid in 250 cm³ (1)</p> <p>mass of propanedioic acid in 250 cm³ (1)</p>	<p><u>example of calculation</u></p> <p>moles of propanedioic acid 25 x answer to (c)(i) = 25 x 3.69 x 10⁻³ = 0.09225</p> <p>0.09225 x 104 = 9.6/9.59/9.594 (g)</p> <p>Allow calculation in either order e.g. calculate mass propanedioic acid in 10.0 cm³ first then x 25</p> <p>Allow TE from c(i) eg 0.00738 gives 19.188 (g)</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(iii)	<p>theoretical yield</p> <p>% yield</p>	<p><u>example of calculation</u></p> <p>(1) theoretical yield $15.2 \times 104/76 = 20.8 \text{ g}$</p> <p>(1) % yield answer to c(ii) $\times 100/20.8$ $9.594 \times 100/20.8 =$ $46/46.1/46.12/46.13/46.125 \text{ (\%)}$</p> <p>use of 9.6 gives 46.15385</p> <p>allow any number of sig figs except one</p> <p>Correct answer with or without working scores 2 marks TE on incorrect theoretical yield and answer to c(ii)</p> <p>Both marks will be lost for use of 15.2 as theoretical yield (gives 63.1%)</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(iv)	an answer that makes reference to one of the following points: <ul style="list-style-type: none"> • transfer losses • incomplete reaction/oxidation/ formation of aldehyde • side reaction(s) 	Ignore spillage/impure reactants/incompetence/references to uncertainties Ignore other products formed/loss by evaporation Penalise additional incorrect reasons ie +1 -1 = zero	(1)

(Total for Question 8 = 11 marks)

TOTAL FOR PAPER = 80 MARKS

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