

Mark Scheme (Results)

Summer 2019

Pearson Edexcel Advanced Subsidiary Level In Chemistry (8CH0) Paper 02 Core Inorganic 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.

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- 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.

Question Number	Acceptable Answer	Additional Guidance	Mark
1(a)(i)	• hexane / $CH_3CH_2CH_2CH_2CH_2CH_3$	Allow displayed formula / skeletal formula Do not award hexene Ignore C_6H_{14}	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
1(a)(ii)	An explanation that makes reference to the following points: • isomers in petrol fraction have branched chains **(1)** • branched chains have a lower surface area / do not pack so closely together **(1)** • intermolecular forces / van der Waals' forces / London forces / dispersion forces / instantaneous dipole-induced dipole forces are weaker (so boiling temperature is lower) **(1)**	Unambiguous mention of breaking bonds within molecules can only score M1 Allow isomers can be secondary or tertiary Allow branched chains have lower boiling temperatures Ignore smaller molecule / smaller chain / shorter chain Do not award cyclic / geometric isomers / alkenes Allow branched chains have less points of contact Do not award unless clearly forces / bonds between molecules or 'intermolecular' is seen	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
1(b)	An explanation that makes reference to the following points: • shorter chain alkanes **and** alkenes formed **(1)** • Alkenes are useful starting materials in organic synthesis / used for making polymers / plastics **(1)** • Shorter chain alkanes are more in demand / higher value / can be used as fuel **(1)**	Answers only referring to hydrocarbons and not alkanes and / or alkenes can only score M3. Allow shorter chain hydrocarbons **and** alkenes formed Allow for a named product of synthesis, e.g. ethanol / alcohol / dihaloalkane etc.. Ignore just 'are more useful' Allow 'Shorter chain hydrocarbons are more in demand / higher value / are better fuels than longer chain hydrocarbons If M2 and M3 are not scored award 1 mark for 'to make polymers / plastics and fuels / higher value compounds' OWTTE.	**(3)**

Question Number	Answer	Mark
1(c)	**The only correct answer is D (increase / increase)** **A** *is not correct because both proportions increase* **B** *is not correct because the proportion of branched chain alkanes increases* **C** *is not correct because the proportion of cyclic hydrocarbons increases*	**(1)**

(Total for Question 1 = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)(i)	Award any **two** from the following: • they have the same general formula **(1)** • they / neighbouring compounds differ from each other by a $-CH_2-$ group **(1)** • they have the same functional group / display similar chemical properties **(1)** • they show a gradual change / trend in physical properties **(1)**	 Allow example of general formula, e.g alkanes are C_nH_{2n+2} Do not award 'the same formula / molecular formula / structural formula' Allow 'the same chemical properties' Ignore 'the same physical properties' or 'similar physical properties'. Trend must be stated or implied. Allow a stated property such as boiling temperature	**(2)**

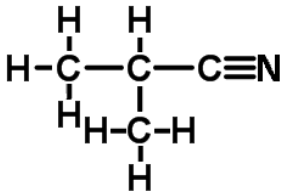
Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)(ii)	• alkene(s)	Do not award alkanes	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)(i)	• hydrogen chloride / HCl((g)) / H−Cl	Do not award hydrochloric acid / HCl(aq)	**(1)**

Question Number	Answer	Mark
2(b)(ii)	**The only correct answer is A (electrophilic addition)** **B** *is not correct because the reaction involves attack by an electrophile* **C** *is not correct because the reaction is an addition not a substitution* **D** *is not correct because the reaction is an addition involving attack by an electrophile*	**(1)**

Question Number	Answer	Mark
2(c)(i)	**The only correct answer is C (potassium cyanide)** **A** *is not correct because ammonia produces an amine* **B** *is not correct because there is no reaction with nitric acid* **D** *is not correct because silver nitrate makes silver chloride and an alcohol*	**(1)**

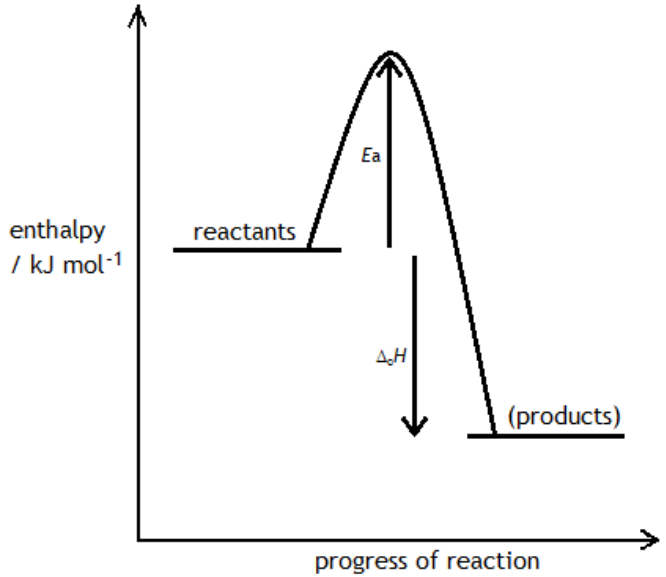
Question Number	Acceptable Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following points: • (Structural isomers are compounds with the) same molecular formula / C_4H_7N **(1)** • but different structural / displayed formula **(1)**	Do not award just 'formula' or just 'general formula' Ignore similar instead of same Allow different order or arrangement of atoms Ignore examples of isomers Do not award just 'different arrangement in space'	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
2(c)(iii)	 **(1)** • (2-)methyl(-1-)propan(e)nitrile **(1)**	All bonds must be shown Allow (2-)methylpropane(-1-)nitrile Do not award 2-cyanopropane M2 dependent on M1 or very near miss (such as correct structure not showing all bonds, or correct structure with H atoms not shown, or correct structure with nitrile with single or double bond)	**(2)**

(Total for Question 2 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following points: • (standard enthalpy change of combustion is the enthalpy change when) one mole of a substance burns completely (in oxygen) / burns in excess oxygen / fully combusts **(1)** • under standard conditions of 100 kPa and a stated temperature **(1)**	Accept energy released Ignore air Do not award one mole of atoms burns.... Do not award energy required / needed e.g $25^{O}C$ / 298 K / 273 K / 293 K Allow 101 kPa / 1 atm Do not award just 'under standard conditions' / rtp	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)(ii)	$C_8H_{18}(l) + 12½O_2(g) \rightarrow 8CO_2(g) + 9H_2O(l)$ • correct species **(1)** • balancing and state symbols **(1)**	Allow multiples only if one mole is not stated in (a)(i)	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)(iii)	 Line rising to a maximum then falling to products lower than reactants **(1)** Labelled arrows for E_a and $\Delta_c H^{\ominus}$ /-5 470 which touch or almost touch the maximum and be level or almost level with the product and reactant lines **(1)**	Do not award double headed arrows Do not award $-\Delta_c H^{\ominus}$ Do not award lines with no arrow heads Allow TE on an endothermic diagram	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(b)	• species and balanced **(1)** • arrows pointing downwards **(1)** • calculation of $\Delta_c H$ of reactants and show $\Delta_c H$ of product **(1)** • calculation of $\Delta_r H$ **(1)**	Ignore state symbols even if incorrect Ignore absence of oxygen alongside arrows <u>Example of calculation</u> $\Delta_c H_{reactants}$ = −394 + (2 x −286) (kJ mol^{-1}) = −966 (kJ mol^{-1}) $\Delta_c H_{products}$ = −890 (kJ mol^{-1}) $\Delta_r H$ = −394 + (2 x -286) − −890 = -76 (kJ mol^{-1}) Correct answer with no working scores final 2 Units not required, but if given must be correct Ignore SF Do not award kJ / mol^{-1} Allow TE on incorrect enthalpy of combustion calculation	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(i)	• calculation of mean C-H bond enthalpy	Example of calculation $\frac{-1652}{4} = -413$ (kJ mol^{-1}) Therefore bond enthalpy is (+)413 (kJ mol^{-1}) Correct answer with no working scores 1	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(ii)	• calculation of energy released when 8(C-H) bonds are formed in the formation of C_3H_8 **(1)** • calculation of mean C-C bond enthalpy **(1)**	Example of calculation 8 x -413 = -3304 (kJ mol^{-1}) $\frac{-3998 - -3304}{2} = -\frac{694}{2} = -347$ (kJ mol^{-1}) Therefore bond enthalpy is +347 (kJ mol^{-1}) Allow -347 (kJ mol^{-1}) if -413 given as answer in (i) for 2 marks Allow TE from (c)(i)	**(2)**

(Total for Question 3 = 13 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)	An answer which makes reference to the following points: • the concentration / amount of all components / of all reactants and products is constant **(1)** • the rate of the forward reaction is equal to the rate of the backward reaction **(1)**	 Allow concentration**s** remain constant Do not award the concentration / amount of reactants and products are equal / the same Ignore in a closed system	**(2)**

Question Number	Answer	Mark
4(b)(i)	**The only correct answer is B decrease/increase** **A** *is not correct because an increase in pressure results in an increase in yield* **C** *is not correct because an increase in temperature results in a decrease in yield* **D** *is not correct because an increase in temperature results in a decrease in yield*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4(b)(ii)	An explanation which makes reference to the following points: • (The yield of methanol decreases because a rise in temperature causes) the equilibrium shifts to the endothermic direction (which is the backward reaction) **(1)** • (The yield of methanol increases because) the equilibrium shifts to the side of fewer moles (of gas molecules) **(1)**	Allow TE on incorrect answers in (b)(i). e.g. if candidate gives forward reaction is endothermic allow increase in yield due to rise in temperature shifts the equilibrium to the endothermic direction can be awarded Allow the forward reaction is exothermic so the reaction favours the left hand side	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4(c)	An explanation which reference to the following points: • a catalyst increases the rate at which the reaction moves towards equilibrium / decreases the time a reaction takes to arrive at a particular yield of product / (provides a reaction pathway with) a lower activation energy **(1)** • allows milder conditions to be used (lowering cost) **(1)**	Allow a catalyst increases the rate of attainment of equilibrium / decreases the time a reaction takes to arrive at equilibrium Do not award just 'a catalyst increases the rate of reaction' Allow lower temperature and/or lower pressure and/or lower energy conditions Allow more product for the same energy Do not award just 'decreases the cost'	**(2)**

(Total for Question 4 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(a)	Returns / condenses volatile reactants / evaporated gases except but-1-ene back to the reaction mixture / so they are not lost Or Returns 1-bromobutane / water to the reaction mixture / so they are not lost Or Prevents loss of reactants so they have time to react Or Allows a higher temperature to be used without loss of reactants Or Prevents gases other than but-1-ene from entering the gas syringe	Ignore just cool down / condense the gases Do not award just condenses products Do not award condenses the but-1-ene / alkene Do not award for mention of condensing potassium gas or Br^- or potassium bromide or potassium hydroxide	**(1)**

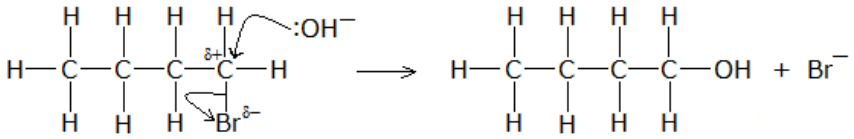
Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)	A description that makes reference to the following points: Either • (bubble the gas through) bromine water / aqueous bromine / Br_2(aq) / bromine in organic solvent **(1)** • goes (from (red-)brown / orange / yellow to) colourless **(1)** Or • (bubble the gas through) acidified **and** potassium manganate(VII) **(1)** • goes (from purple to) colourless **(1)**	Allow bromine / Br_2 Allow dissolve the gas in deionised / distilled water and add..... Allow decolorises Allow dissolve the gas in deionised / distilled water and add..... Allow decolorises or colour change in absence of acid in M1 Do not award positive results of incorrect tests e.g. Fehling's solution gives a red precipitate scores 0.	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(c)	• calculation of moles of but-1-ene **(1)** • calculation of percentage of 1-bromobutane converted **(1)** OR • calculation of volume of gas expected **(1)** • calculation of percentage of 1-bromobutane converted **(1)**	Example of calculation mol = $\frac{22}{24000}$ = 9.17×10^{-4} / 9.1667×10^{-4} $\frac{9.1667 \times 10^{-4}}{0.0080} \times 100$ = 11.5 / 11.458 % $0.008 \times 24 = 0.192\ dm^3$ / $0.008 \times 24000 = 192\ cm^3$ $\frac{22}{192} \times 100$ = 11.5 / 11.458 % Ignore SF except 1 SF Correct answer with no working scores 2	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(d)	• calculation of ratio of volumes before and after cooling **(1)** • calculation of temperature of warm syringe **(1)**	Example of calculation 24 = 1.091 / 1.0909... 22 1.0909 x 298 = 325 **K** / 325.09090909 **K** / 52**°C** Use of pV = nRT giving 325 K scores 2 Correct answer with no working scores 2 If candidate assumes P = 100000 / 101000 and uses pV = nRT to find T = 315 / 318 K award 1. Ignore SF except 1 SF	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(e)(i)	• substitution	Allow hydrolysis Ignore nucleophilic Do not award electrophilic Do not award displacement	**(1)**

Question Number	Answer	Mark
5(e)(ii)	**The only correct answer is D (phosphorus(V) chloride | steamy fumes)** **A** *is not correct because this is the result with an acid* **B** *is not correct because this will identify the functional group in the starting 1-bromobutane* **C** *is not correct because this will identify the product of oxidation of an alcohol, not the alcohol itself*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(e)(iii)	• curly arrow from **lone pair** of OH^- **(1)** • curly arrow from C-Br bond to, or just beyond, Br **(1)** • partial charges on C and Br **and** Br^- present as a product **(1)**	 Arrows may be shown on a transition state in an S_N2 mechanism. Allow S_N1 mechanism. For S_N1 must also have correct carbocation to score M3. Ignore K^+ on both sides or K^+ on the left and KBr on the right Ignore connectivity of OH group in product Do not award HBr as product on the right	**(3)**

Question Number	Answer	Mark
5(f)	**The only correct answer is C (3)** **A** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene* **B** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene* **D** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene*	**(1)**

(Total for Question 5 = 13 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(i)	• pipette	Allow graduated / volumetric pipette / glass pipette Do not award burette Comment Allow phonetic spelling of pipette	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(ii)	• (rinsed with) the sodium hydroxide solution / NaOH solution / aqueous sodium hydroxide / aqueous NaOH / NaOH(aq)	Allow (rinsed with) water then NaOH(aq), but not after Allow (rinsed with) sodium hydroxide concentration 0.235 mol dm^{-3} Allow just (rinsed with) NaOH solution without specifying which solution Do not award just '(rinsed with) sodium hydroxide / NaOH' Ignore details of how the rinsing happens Ignore clamping of burette Ignore references to setup of apparatus	**(1)**

Question Number	Answer	Mark
6(a)(iii)	**The only correct answer is C (from colourless to pink)** **A** *is not correct because this is the wrong colour change for methyl orange* **B** *is not correct because this is a colour change for methyl orange* **D** *is not correct because this is the colour change for an alkali titrated with an acid*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(iv)	• titration results that are within 0.2 (cm^3) of each other	Allow 'the same' or any values less than 0.2 (cm^3) Allow ± 0.1 (cm^3) Ignore 'similar' Do not award ± 0.2 (cm^3) Do not award use of cm	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(v)	• calculation of the mean titre **(1)** • calculation of the number of moles of NaOH **(1)** • calculation of moles of ethanoic acid / moles of ethanol oxidised **(1)** Either • calculation of concentration of acid **(1)** • calculation of percentage of ethanol oxidised to no more than 3 SF **(1)** Or • calculation of original moles of ethanol / max moles of ethanoic acid in 25 cm^3 **(1)**	Example of calculation $\frac{26.75 + 26.85}{2}$ = 26.80 (cm^3) $\frac{\text{Mean titre}}{1000} \times 0.235$ = 0.006298 / 6.298 x 10^{-3} (mol) NaOH:CH_3COOH:CH_3CH_2OH = 1:1:1 = 0.006298 / 6.298 x 10^{-3} (mol) May be stated, found in a table or used in further calculation Do not award if just moles of NaOH given or just calculation in M2 with no further evidence of use of ratio $c = \frac{n}{v} = \frac{0.006298}{25/1000}$ = 0.25192 / 2.5192 x 10^{-1} (mol dm^{-3}) $\% = \frac{0.25192}{2.50} \times 100 = 10.0768 = 10 / 10.1\%$ = 2.5 x 25 x 10^{-3} = 0.0625 (mol) Award this mark if seen, even if earlier marks have not been scored. $\% = \frac{0.06298}{0.0625} \times 100 = 10.0768 = 10 / 10.1\%$ Final answer must be to no more than 3 SF Correct answer with or without scores 5	**(5)**

	• calculation of percentage of ethanol oxidised to no more than 3 SF **(1)**	Allow TE throughout and correct alternative methods Mean of all three titres (27.16) gives 10.2% scores 4.	

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(vi)	• (The red colour of the red) wine would obscure the colour change (of the phenolphthalein)	Allow red wine is not colourless Allow the colour change cannot be seen	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)	• calculation of the concentration of ethanol in g dm^{-3} **(1)** • calculation of volume of ethanol in 1 dm^3 **(1)** • calculation of ABV **and** deduction of brand C **(1)**	Example of calculation 7.5 x 46 = 345(g dm^{-3}) $\frac{345}{0.79}$ = 436.7(08861) (cm^3) / 0.4367 dm^3 (units must be given if answer is 0.4367) $\frac{436.7}{1000}$ x 100 = 43.67% therefore C Correct value of ABV without working scores 2 Correct ABV without working and deduction of C scores 3 Ignore SF Allow TE throughout Allow correct alternative methods	**(3)**

(Total for Question 6 = 13 marks)

Question Number	Answer	Mark
7(a)	**The only correct answer is A (66.67/ 11.11 / 22.22)** **B** *is not correct because this calculation uses atomic number not mass* **C** *is not correct because this calculation ignores the number of each type of atom present* **D** *is not correct because this calculation ignores the mass of each atom and only uses the number*	**(1)**

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*7(b)</td>
<td>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.

<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<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>
</table>
</td>
<td>Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning.

For example, an answer with five indicative marking points, which 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).

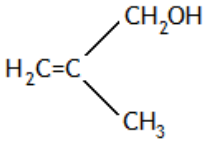
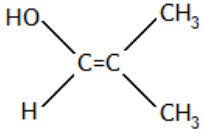
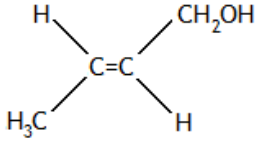
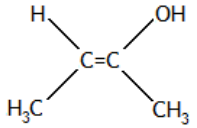
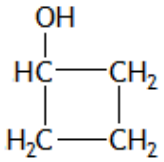
If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td>
<td>(6)</td>
</tr>
</table>

The following table shows how the marks should be awarded for structure and lines of reasoning.

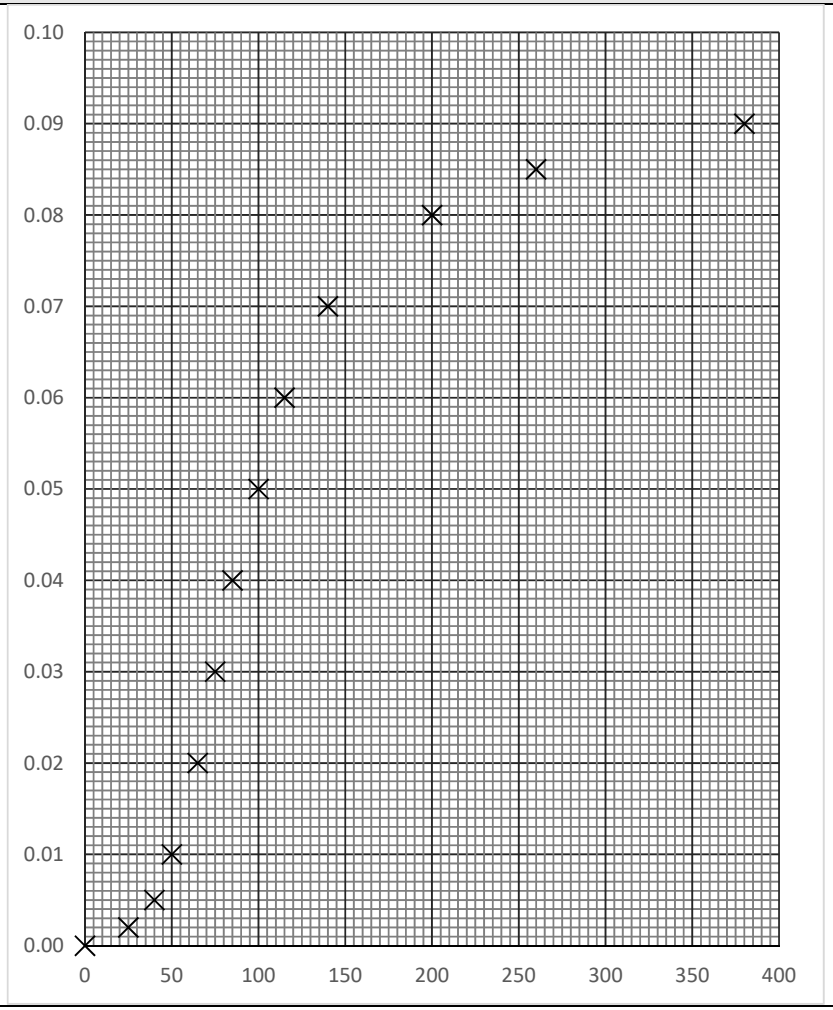
	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2
Answer is partially structured with some linkages and lines of reasoning.	1
Answer has no linkages between points and is unstructured.	0

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.

Reasoning marks may be reduced for extra incorrect chemistry

	Indicative content: IP1 • IR data shows that they all have an (alcohol) O−H and A and B have a C=C IP2 • B must have two different groups attached to each carbon of a double bond IP3 • C (has no double bond so) must be cyclic IP4 • A is  or  IP5 • B is  or  IP6 • C is 	Can be awarded as statements about all 3 together or separately Allow discussion of priority groups Allow double bond must be in the middle Allow statement that C does not have a C=C Do not award C has a C=O Allow 2-methyl-1-propen-1-ol / $CH_2 = C(CH_3)CH_2OH$ / skeletal formula Allow enol isomer (as shown) Allow *E*-but-2-ene-1-ol / skeletal formula and enol isomers (as shown) but must be an *E*-isomer Allow cyclobutanol / skeletal formula Allow methylcyclopropanol isomers with OH on any carbon	

(Total for Question 7 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)(i)	• five points plotted correctly Comment Ignore a sixth additional point **(1)** • smooth curve passing through all the points (to within 1 square) excluding any anomalous incorrectly plotted points **(1)**		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)(ii)	A description which refers to the following points: • take a tangent to the curve **(1)** • (tangent taken at) time = 0 (for the initial rate) / at the start **(1)** • (tangent taken at) at the steepest part of the curve (for the maximum rate) **(1)** • find the gradient (of the tangent by change in concentration over change in time) **(1)**	Marks may be scored by tangents on the graph Allow assume that the very first part of the graph is a straight line and extrapolate / extend (up to 25 s) Allow where the slope is closest to vertical / at about 100 s / 0.050 mol dm^{-3} Ignore just 'highest' Allow description of finding the gradient e.g. finding dy/dx / dy/dt Ignore just mol dm^{-3} / s	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)	An explanation which makes reference to the following points: • (the reaction is catalysed by hydrogen ions and the) concentration of hydrogen ions is initially very low **(1)** • hydrogen ions are formed by the reaction so the concentration of catalyst increases / rate of reaction increases **(1)**	Allow concentration of hydrogen ions is zero Allow initially the reaction is not catalysed (due to lack of hydrogen ions) Allow the reaction is autocatalytic Allow the reaction is exothermic so it heats up after the start (and so gets faster) for 1 mark If M1 and M2 are not scored allow a comment that hydrogen ions catalyse the reaction for 1 mark	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)	An answer which makes reference to the following point: • it is very difficult to judge where the tangent should be drawn for the initial rate compared to other points on the line	Allow comments about the tangent being difficult to measure initially or easier at the maximum rate	**(1)**

(Total for Question 8 = 9 marks)

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