Pearson

Mark Scheme (Results)

October 2025

Pearson Edexcel International Advanced
Subsidiary Level in Chemistry
WCH12/01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

October 2025
Question Paper Log Number P78828A
Publication Code WCH12_01_2510_MS

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.

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.

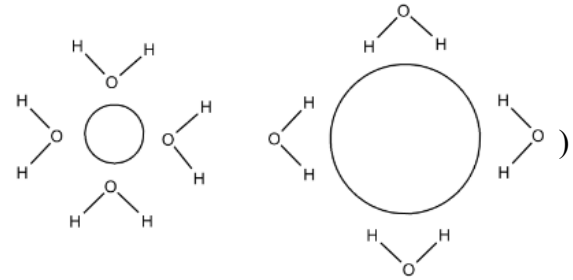
Section A

Question Number	Answer	Mark
1	**The only correct answer is C** (purple) ***A*** *is incorrect because brown is the colour of an aqueous solution of iodine in KI(aq)* ***B*** *is incorrect because grey is the colour of solid iodine* ***D*** *is incorrect because yellow is the colour of a very dilute aqueous solution of iodine in KI(aq)*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is A** (increases increases decreases) ***B*** *is incorrect because the solubility of hydroxides increases and the solubility of sulfates decreases* ***C*** *is incorrect because the reactivity increases* ***D*** *is incorrect because the reactivity increases, the solubility of hydroxides increases and the solubility of sulfates decreases*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** (no change) ***A*** *is incorrect because the equilibrium does not move to the left-hand side* ***B*** *is incorrect because the equilibrium does not move to the right-hand side* ***C*** *is incorrect because the equilibrium does not move to the left-hand side and then to the right-hand side*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is C** (2,2,3-trimethylbutane) ***A*** *is incorrect because 2,3-dimethylpentane has less branching so more area of contact, hence greater London forces* ***B*** *is incorrect because 3,3-dimethylpentane has less branching so more area of contact, hence greater London forces* ***D*** *is incorrect because heptane has no branching so more area of contact, hence greater London forces*	**(1)**

Question Number	Answer	Mark
5(a)	**The only correct answer is B** () ***A*** *is incorrect because the hydrogen atoms have a partial positive charge so would be repelled by the (smaller) sodium ion, and the oxygen atoms have a partial negative charge so would be repelled by the (larger) chloride ion* ***C*** *is incorrect because the oxygen atoms have a partial negative charge so would be repelled by the (larger) chloride ion* ***D*** *is incorrect because the hydrogen atoms have a partial positive charge so would be repelled by the (smaller) sodium ion*	**(1)**

Question Number	Answer	Mark
5(b)	**The only correct answer is D** (ion – permanent dipole) ***A*** *is incorrect because the sodium and chloride particles are ions* ***B*** *is incorrect because the sodium and chloride particles are ions* ***C*** *is incorrect because the sodium and chloride particles are ions*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is A** (P) ***B*** *is incorrect because the effect of hydrogen bonding on boiling temperature is much greater than shown* ***C*** *is incorrect because the trend only takes into account the steady increase in boiling temperature due to stronger London forces* ***D*** *is incorrect because the trend only takes into account the increase in boiling temperature due to stronger London forces*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is A** (67%) ***B*** *is incorrect because 56% is the percentage of ethanol by mass* ***C*** *is incorrect because 44% is the percentage of water by mass* ***D*** *is incorrect because 33% is the percentage of ethanol by moles*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is C** (0.48 dm^3) ***A*** *is incorrect because the stoichiometry of* $H_2O_2 : 2O_2$ *has been used* ***B*** *is incorrect because the stoichiometry of* $H_2O_2 : O_2$ *has been used* ***D*** *is incorrect because the stoichiometry of* $4H_2O_2 : O_2$ *has been used*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is B** (160 cm^3) ***A*** *is incorrect because the answer does not include the remaining oxygen* ***C*** *is incorrect because the answer includes* $4H_2O(g)$ ***D*** *is incorrect because the answer assumes no change in the volume of oxygen present*	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is C** (decreased by 3) ***A*** *is incorrect because it is the total change in oxidation number for all chromium atoms* ***B*** *is incorrect because it is the change for two chromium atoms* ***D*** *is incorrect because it is the change in charge for the ions containing chromium*	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is B** $(0.5 \times \frac{2}{3} \times 10)$ *A is incorrect because it uses the ratio* $3Cr_2O_7^{2-} : 2C_2H_5OH$ *which will not give the minimum volume* ***C*** *is incorrect because it uses the ratio* $3Cr_2O_7^{2-} : 2C_2H_5OH$ *and the equation, volume = moles × concentration to determine volume* ***D*** *is incorrect because it uses the equation, volume = moles × concentration to determine volume*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is B** (two of the statements) ***A*** *is incorrect because statement 3 is incorrect* ***C*** *is incorrect because statements 1 and 2 are correct* ***D*** *is incorrect because statements 1 and 2 are correct*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is D** (0.150) ***A*** *is incorrect because this is the inverse of the approximate gradient at 4 minutes* ***B*** *is incorrect because this is the inverse of the mean rate between 0 and 4 minutes* ***C*** *is incorrect because this is the mean rate between 0 and 4 minutes*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is B** (adding sodium carbonate solution to each liquid) ***A*** *is incorrect because only ethanol reacts with sodium metal* ***C*** *is incorrect because only ethanal reacts with Fehling's solution* ***D*** *is incorrect because only ethanol reacts with* PCl_5	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is B** (statements 1 and 3) ***A*** *is incorrect because statement 2 is incorrect, as C=O consists of a* σ *and a* π *bond* ***C*** *is incorrect because statement 2 is incorrect, as C=O consists of a* σ *and a* π *bond* ***D*** *is incorrect because statement 2 is incorrect, as C=O consists of a* σ *and a* π *bond*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is C** (structures 1 and 3 show the same compound) ***A*** *is incorrect because structure 2 has 10 carbon atoms, structures 1 and 3 have 9 carbon atoms* ***B*** *is incorrect because structure 2 has 10 carbon atoms, structure 3 has 9 carbon atoms* ***D*** *is incorrect because structures 1 and 3 are the same, as single bonds can rotate into different orientations*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** ($Sr(s) + F_2(g) \rightarrow SrF_2(s)$) ***A*** *is incorrect because both the elements are shown as ions* ***B*** *is incorrect because both the elements are shown as ions, and the state symbol for strontium is incorrect* ***D*** *is incorrect because the state symbol for strontium is incorrect*	**(1)**

Question Number	Answer	Mark
17	**The only correct answer is C** ($-4 \times \Delta_f H\ominus(H_2O(l))$) ***A*** *is incorrect because it does not take into account that 4 molecules of water are formed* ***B*** *is incorrect because it does not take into account that 4 molecules of water are formed and that the direction of the reaction is the opposite to that defined by* $\Delta_f H\ominus$ ***D*** *is incorrect because it does not take into account that the direction of the reaction is the opposite to that defined by* $\Delta_f H\ominus$	**(1)**

Question Number	Answer	Mark
18	**The only correct answer is A** (propan-1-ol, $CH_3CH_2CH_2OH$) ***B*** *is incorrect because a major peak is at 45* ***C*** *is incorrect because a major peak is at 29* ***D*** *is incorrect because a major peak is at 43*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
19(a)(i)	• balanced equation with state symbols	$2Ca(s) + O_2(g) \rightarrow 2CaO(s)$ Allow multiples	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	An answer that makes reference to the following point: • (brick) red / orange-red / yellow-red	Do not allow 'orange' or 'yellow' alone Do not allow any other shades of red e.g. scarlet or crimson	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(a)(iii)	An explanation that makes reference to the following points: • electrons are excited / promoted (by heat to higher energy levels) **(1)** • electrons fall back (from the excited state to the ground state) **(1)** • releasing light energy / photons / light waves / radiation (of a specific wavelength / frequency) **(1)**	Electrons only need to be mentioned once in M1 and M2 Allow move up / raised / jump as alternatives for excited Allow 'de-excited' Ignore 'emit a colour' Ignore 'emits light' without reference to energy or wave Allow 'energy' without reference to light Do not allow 'reflect a colour' Penalise atom / ion for electrons once only in M1 and M2	**(3)**

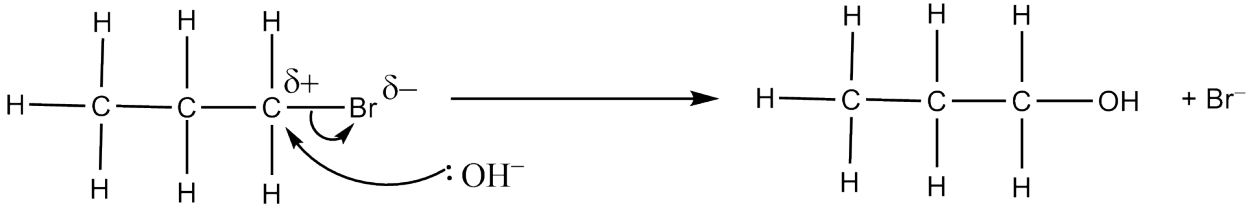
Question Number	Answer	Additional Guidance	Mark
19(b)	An answer that makes reference to the following point: • Ca_3N_2	Ignore any references to reactions with carbon dioxide	**(1)**

Question Number	Answer		Additional Guidance	Mark
19(c)	• calculation of moles of HCl used to react with CaO **and** calculation of moles of NaOH / HCl in titration	**(1)**	Example of calculation 200 ÷ 1000 × 1.00 = **0.200** (mol) 23.70 ÷ 1000 × 0.150 = **3.555 × 10^{-3}** (mol)	**(6)**
	• calculation of moles of excess HCl (mol NaOH/HCl in titration x 10)	**(1)**	3.555 × 10^{-3} × 10 = 3.555 × 10^{-2} / 0.03555 (mol)	
	• calculation of moles of hydrochloric acid that reacted with calcium oxide (subtraction)	**(1)**	0.200 – 0.03555 = 0.16445 (mol)	
	• calculation of moles of calcium oxide (division by 2)	**(1)**	0.16445 ÷ 2 = 0.082225 (mol)	
	• calculation of mass of calcium oxide (Multiply by 56.1)	**(1)**	0.082225 × 56.1 = 4.6128 (g)	
	• calculation of % purity of calcium oxide (Mass of CaO divided by 5.12 then multiplied by 100) Steps 4-6 must occur after the subtraction step if subtraction has been carried out.	**(1)**	4.6128 ÷ 5.12 × 100 = 90.094% = 90.1% Allow TE from M1 to M5 Allow TE to M6 if final answer is less than 100% Allow 90%, ignore SF and truncating errors Allow 89.96% obtained from using Mr of 56 Correct answer with no working scores (6)	

Question Number	Answer	Additional Guidance	Mark
19(d)	An answer that makes reference to the following points: • Error: calcium (ion) is polarised by the nitrate (ion) **and** Correction: nitrate (ion) is polarised by calcium (ion) **(1)** • Error: weakens the bond between the two ions/between calcium and nitrate (ions) **and** Correction: weakens the (covalent) bond(s) within the nitrate (ion) **(1)**	Allow the calcium (ion) is not polarised (by the nitrate ion) Allow it does not make the bond between the ions weaker Allows weakens the N−O bonds Allow 1 mark for both errors if no credit given for corrections	**(2)**

(Total for Question 19 = 14 marks)

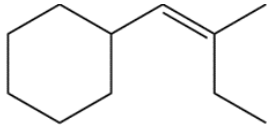
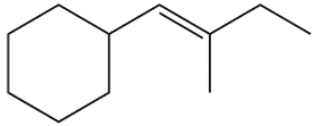
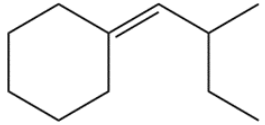
Question Number	Answer	Additional Guidance	Mark
20(a)	An answer that makes reference to the following points: • correct dipoles on C and Br atoms • curly arrow from C–Br bond to $Br^{(\delta-)}$ or just beyond • hydroxide ion with lone pair on oxygen • curly arrow from lone pair on oxygen to $C^{(\delta+)}$ 4 bullet points scores 2 marks 3 or 2 bullet points scores 1 mark 0 or 1 bullet points scores 0 marks	Penalise omission / incorrect placement of lone pair in bullet point 3 only. If lone pair not present, allow curly arrow to start anywhere on the hydroxide ion. For BP4, allow curly arrow from lone pair on oxygen to C+ if S_N1 mechanism given	**(2)**



Question Number	Answer	Additional Guidance	Mark
20(b)	An answer that makes reference to the following point: • to increase the length of a **carbon** chain / to extend the **carbon** chain	Accept to form a new **carbon-carbon** bond Allow to increase the number of **carbon** atoms (by one) Allow increase (hydro)**carbon** chain length / add to the **carbon** chain	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(c)	An answer that makes reference to the following point: • **heat** under pressure / **heat** in a sealed system	Ignore in ethanol / alcohol / alcoholic conditions Ignore excess ammonia Do not award reflux	**(1)**

Question Number	Answer		Additional Guidance	Mark
20(d)(i)	An explanation that makes reference to the following points:			**(2)**
	• to remove water (from the ethanol)	**(1)**	Allow to dry the ethanol /absorb water Allow drying agent Ignore source of the water Do not award dehydrate	
	• to prevent (nucleophilic) substitution from taking place	**(1)**	Accept to prevent formation of an alcohol Allow to prevent the hydroxide ion from behaving as a nucleophile	

Question Number	Answer	Additional Guidance	Mark
20(d)(ii)	•  **(1)** •  **(1)** •  **(1)**	Penalise non skeletal formulae once only Ignore bond angles and bond lengths	**(3)**

(Total for Question 20 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An explanation that makes reference to the following points: • disproportionation reaction **(1)** • as chlorine changes from 0 in Cl_2 to +5 in $NaClO_3$ so oxidation **(1)** • as chlorine changes from 0 in Cl_2 to –1 in NaCl so reduction **(1)**]	Stand alone mark Reference to oxidation number = 0 for Cl_2 required once only to score in both M2 and M3 Allow 1 mark from M2 and M3 for correct oxidation numbers of products if links to oxidation and reduction are omitted or not directly linked to each change Award credit for the correct oxidation numbers written on the species in the equation	**(3)**

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	• calculation of total relative mass of all reactants or calculation of total relative mass of all products **(1)** • calculation of percentage atom economy by mass **(1)**	<u>Example of calculation</u> $(6 \times 40) + (3 \times 71) = 453$ $(5 \times 58.5) + 106.5 + (3 \times 18) = 453$ $(106.5 \div 453) \times 100 = 23.510\% = 23.5\%$ Ignore SF except 1 SF Allow TE from M1 to M2 Penalise incorrect truncation / rounding in final answer Correct answer with no working scores (2)	**(2)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*21(b)</td>
<td>This question assesses the 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>
The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent 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>
</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, a response 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).

If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected that
5 or 6 indicative points would get 2 reasoning marks
3 or 4 indicative points would get 1 reasoning mark
0, 1 or 2 indicative points would get zero reasoning marks

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning</td>
<td>(6)</td>
</tr>
</table>

	Indicative content		
	IP1 misty fumes (that forms white smoke with NH_3) show formation of HCl and/or HI	Allow both halides form HX / hydrogen chloride and hydrogen iodide	
	IP2 purple vapour shows formation of I_2 / iodine		
	IP3 rotten egg smell shows formation of H_2S / hydrogen sulfide	Do not award SO_2	
	IP4 I^- changes from –1 to 0 (in I_2) / (S in) H_2SO_4 changes from +6 to –2	Allow iodine changes oxidation from −1 to 0 If SO_2 identified as giving the rotten egg smell, allow TE for oxidation number of S changing from +6 to +4	
	IP5 oxidation number of chlorine remains unchanged (in the reaction with sulfuric acid), so iodide (ion) is the stronger reducing agent or oxidation number of sulfur remains unchanged (in the reaction with chloride), so the iodide (ion) is the stronger reducing agent	Ignore iod**ine** is the stronger reducing agent	
	IP6 $8I^- + 8H^+ + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$	Accept $8I^- + 10H^+ + SO_4^{2-} \rightarrow 4I_2 + H_2S + 4H_2O$	

(Total for Question 21 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)	An answer that makes reference to five of the following points: • MP1: advantage of high temperature and/or pressure: increased rate of reaction **(1)** • MP2: increased temperature leads to more frequent successful collisions / particles increase in kinetic energy or increase in pressure means more particles per unit volume / more frequent successful collisions **(1)** • MP3: advantage of pressure: increases yield, as equilibrium moves to the right **and** this has the fewer gas molecules / particles / moles **(1)** • MP4: disadvantage of temperature: reduces yield as reaction is exothermic **and** equilibrium moves to left hand side **(1)** • MP5: disadvantage of high temperature: increases **energy** costs **(1)** • MP6: disadvantage of high pressure: increases costs of equipment to withstand high pressure **(1)** • MP7: high temperature and high pressure used as a compromise between advantages and disadvantages **(1)**	Accept reverse arguments Allow reference to time taken for reaction Do not award contradictory answers If number of moles given, it must be correct (5 to 3) Allow backward reaction is endothermic **and** equilibrium moves to the left Allow additional energy usage results in more CO_2 produced linked to global warming Allow increased cost as equipment needs thicker walls	**(5)**

Question Number	Answer	Additional Guidance	Mark
22(b)	An answer that makes reference to the following point: • reduces activation energy **and** provides alternative route / mechanism	Allow E_a for activation energy Ignore a catalyst is not used up during the reaction	**(1)**

(Total for Question 22 = 6 marks)

TOTAL FOR SECTION B = 40 MARKS

Section C

Question Number	Answer	Additional Guidance	Mark
23(a)	An answer that makes reference to the following point: • the carbon (atom) attached to the OH group is attached to two other carbon (atoms)/ alkyl groups	Allow alcohol / hydroxyl / hydroxy for OH group Allow R groups for alkyl groups Allow the carbon (atom) attached to the OH group is attached to one hydrogen (atom) Do not award hydroxide group / OH^- for OH group Do not award any mention of carbocation	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	An answer that makes reference to the following point: • (reflux / Liebig) condenser	Ignore references to adaptor / connector Ignore condensation tube Do not award an answer that indicates a sealed system	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(ii)	An answer that makes reference to the following point: • orange to green	Allow orange to blue Ignore adjectives	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(iii)	A description that makes reference to the following points: • peak at 3750-3200 (cm^{-1} O−H) would diminish **(1)** • peak at 1720-1700 (cm^{-1} C=O) would appear **(1)** • fingerprint region would change (shape) or peak due to C−O would diminish **(1)**	For M1 and M2 allow any range or specific wavenumber within the given range	**(3)**

Question Number	Answer	Additional Guidance	Mark
23(c)(i)	• calculation of mass of 2000 dm^3 of propanone multiply by 0.784, and multiply by 1000 **(1)** • calculation of moles of propanone divide by 58 **(1)** • calculation of moles of benzene required, taking into account % yield divide by 0.85 **(1)** • calculation of mass of benzene in kg multiply by 78, then divide by 1000 **(1)** 1792.4 scores (3) for inversion of yield calculation 2480 (kg) scores (4) 1844.7 scores (2) for M1 and M3 2108.7 scores (3) for omission of step 3	<u>Example of calculation</u> $0.784 \times 2000 \times 1000 = 1\,568\,000$ (g) / 1.568×10^6 $1\,568\,000 \div 58 = 27\,034.5$ (mol) / 2.70345×10^4 $27\,034.5 \times 100 \div 85 = 31\,805.3$ (mol) / 3.18053×10^4 $(31\,805.3 \times 78 = 2\,480\,811$ g) 2480.8 (kg) / 2.4808×10^3 Allow TE at each step Mathematical operations can be seen in any order Ignore SF except 1 SF Correct answer with no working scores (4)	**(4)**

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	An answer that makes reference to the following point: • phenol is a useful / desired product	Allow 'there is a market for phenol' / 'the phenol can be sold' / both products are useful Ignore phenol can be re-used or recycled	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(d)	An answer that makes reference to the following points: • (both soluble in water) as they can both form hydrogen bonds to **water** **(1)** • propan-2-ol (has a higher boiling temperature than propanone, as it) forms hydrogen bonds **(1)** • but propanone (only) forms (London forces and) (permanent) dipole-dipole attractions **(1)** • hydrogen bonds are the strongest intermolecular force / are stronger than dipole-dipole attractions, therefore require more energy to break **(1)**	Allow a comparison to London forces if (permanent) dipole - dipole forces are not mentioned	**(4)**

Question Number	Answer	Additional Guidance	Mark
23(e)(i)	• calculation of moles of biopropanol **(1)** • calculation of energy released by biopropanol multiply by 2021 **(1)** • evaluate ΔT by the conversion of energy to joules and re-arrangement of $Q = mc\Delta T$ multiply M2 by 1000, then divide by (200 x 4.18) **(1)** • final temperature in °C add 20 **(1)** 62.5 scores (3) for use of 58 as M_r 41.1 scores (3) for failure to add 20 20.04 scores (3) for failure to convert kJ to J 22.4 scores (2) for missing steps 1 and 2	<u>Example of calculation</u> n = 1.02 ÷ 60 = 0.017 (mol) Q = 2021 × 0.017 = 34.357 (kJ) ΔT = 34 357 ÷ (200 × 4.18) = 41.097 = 41.1 (°C), final temp = 61.1 (°C) Correct answer with no working scores (4) Allow TE for M2 and M3 Allow TE for M4 provided final temperature change is positive Ignore SF except 1 SF Ignore sign in M2	**(4)**

Question Number	Answer	Additional Guidance	Mark
23(e)(ii)	An answer that makes reference to the following point: • reforming	Allow reformation Do not award: formation / forming	**(1)**

(Total for Question 23 = 20 marks)

TOTAL FOR SECTION C = 20 MARKS
TOTAL FOR PAPER = 80 MARKS