Pearson

Mark Scheme (Results)

Summer 2026

Pearson Edexcel International Advanced Subsidiary Level In Chemistry
WCH12/01A

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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.

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 A** ($NaClO_2$) ***B*** *is incorrect because this chlorine has an oxidation number of (I)* ***C*** *is incorrect because this chlorine has an oxidation number of (V)* ***D*** *is incorrect because this chlorine has an oxidation number of (VII)*	**(1)**

Question Number	Answer	Mark
2(a)	**The only correct answer is A** (brown fumes) ***B*** *is incorrect because the brown nitrogen dioxide produced is a gas* ***C*** *is incorrect because this is not the observation made when nitrogen dioxide is produced* ***D*** *is incorrect because no hydrogen halide gas is produced*	**(1)**

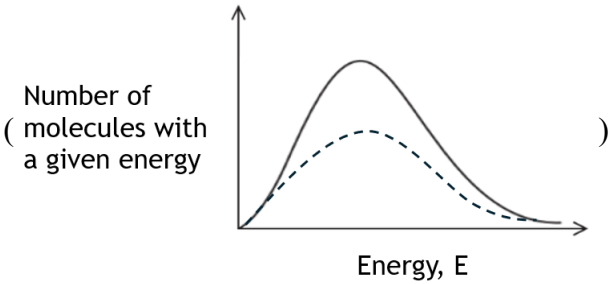
Question Number	Answer	Mark
2(b)	**The only correct answer is B** (relights a glowing splint) ***A*** *is incorrect because no hydrogen gas is produced* ***C*** *is incorrect because no ammonia or basic gas is produced* ***D*** *is incorrect because no acidic gas is produced*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** (green) ***A*** *is incorrect because this value is the colour given by sodium compounds* ***B*** *is incorrect because this is the colour given by strontium and lithium compounds* ***C*** *is incorrect because this is the colour given by potassium compounds*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is B** (I_2O_4) ***A*** *is incorrect because the ratio is inverted* ***C*** *is incorrect because the ratio is not 1:2* ***D*** *is incorrect because the ratio is not 1:2*	**(1)**

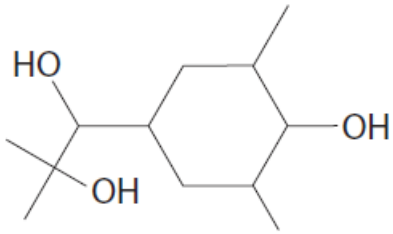
Question Number	Answer	Mark
5	**The only correct answer is B** (1.8) ***A*** *is incorrect because this is the volume of gas if the change was just due to the number of moles of propan-1-ol* ***C*** *is incorrect because this is the volume of carbon dioxide gas produced and does not account for the volume of oxygen gas used* ***D*** *is incorrect because this is the volume of oxygen gas used up but does not account for the volume of carbon dioxide made*	**(1)**

Question Number	Answer	Mark
6(a)	**The only correct answer is A** (Y) ***B*** *is incorrect because this is the difference between the increased number of molecules that can react in the presence of a catalyst and the number of molecules that can react without a catalyst* ***C*** *is incorrect because this is the total number of molecules that can react in the presence of a catalyst* ***D*** *is incorrect because this is the number of molecules that can react without a catalyst*	**(1)**

Question Number	Answer	Mark
6(b)	**The only correct answer is D** () *A is incorrect because this is the line if the temperature is increased* *B is incorrect because this is the line if the average energy of the molecules is halved* *C is incorrect because this is the line if the temperature is decreased*	**(1)**

Question Number	Answer	Mark
7(a)	**The only correct answer is C** (17.6%) *A is incorrect because this is the percentage calculated using one mole of hydrogen gas* *B is incorrect because this is the percentage calculated using three moles of hydrogen atoms* *D is incorrect because this is the percentage using the number of atoms*	**(1)**

Question Number	Answer	Mark
7(b)	**The only correct answer is C** (increase in temperature) ***A*** *is incorrect because this will shift the equilibrium position to the left and decrease yield* ***B*** *is incorrect because this will shift the equilibrium position to the left and decrease yield* ***D*** *is incorrect because a catalyst does not shift the position of equilibrium*	**(1)**

Question Number	Answer	Mark
8	 **The only correct answer is D** (two secondary and one tertiary) ***A*** *is incorrect because the bottom left alcohol group is classified as tertiary* ***B*** *is incorrect because the upper left- and right-hand side alcohol groups are secondary and not tertiary* ***C*** *is incorrect because there are no primary alcohol groups*	**(1)**

Question Number	Answer	Mark
9(a)	**The only correct answer is B** (still head sealed around the thermometer) ***A*** *is incorrect because the thermometer bulb should be positioned directly opposite the condenser opening* ***C*** *is incorrect because the condenser entry and exit points should be open to allow water flow* ***D*** *is incorrect because there should be an opening or vent for gases to escape*	**(1)**

Question Number	Answer	Mark
9(b)	**The only correct answer is C** (C-H stretching at 2825 cm^{-1}) ***A*** *is incorrect because this is an absorption wavenumber value in the range for an O−H stretch in an alcohol but propanal does not have an O-H bond in its structure* ***B*** *is incorrect because this is an absorption wavenumber value in the range for an alkane C−H stretch which will be present in both propanal and propan-1-ol so cannot be used to confirm formation of the aldehyde* ***D*** *is incorrect because this is an absorption wavenumber value in the range for an alkyl ketone C=O stretch or a carboxylic acid C=O stretch and not an aldehyde*	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is D** (50% H_2SO_4(aq) and KBr(s)) ***A*** *is incorrect because aqueous bromine is used to react with alkenes and not alcohols* ***B*** *is incorrect because 50% sulfuric acid is required with solid potassium bromide to form bromoalkanes* ***C*** *is incorrect because this is not a suitable reagent to form bromoalkane*	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is C** (43) ***A*** *is incorrect because both isomers would be expected to produce a* CH_3^+ *fragment with* $m/z = 15$ ***B*** *is incorrect because both isomers would be expected to produce a* $C_2H_5^+$ *fragment with* $m/z = 29$ ***D*** *is incorrect because both isomers would be expected to produce a* $C_4H_9^+$ *fragment with* $m/z = 57$	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is C** (1.72 g) ***A*** *is incorrect because this mass ignores the molar ratios* ***B*** *is incorrect because this is the mass with a 100% yield and ignores the molar ratios* ***D*** *is incorrect because this is the mass with a 100% yield*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is B** (−196) ***A*** *is incorrect because this value is calculated from using one mole of hydrogen peroxide being formed instead of two* ***C*** *is incorrect because this value is calculated from using the formations of one mole of hydrogen peroxide and of one mole of water instead of two moles for both of them* ***D*** *is incorrect because this value is calculated from using one mole of water being formed instead of two*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is D** ($\frac{1}{3}O_3(g) \rightarrow O(g)$) ***A*** *is incorrect because this is the equation for 3 moles of oxygen atoms and not one mole* ***B*** *is incorrect because this equation forms molecular oxygen as well as oxygen atoms* ***C*** *is incorrect because this is the equation for the formation of molecular oxygen from ozone*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is C** (arrow L) ***A*** *is incorrect because arrow J indicates the enthalpy change for the reverse reaction* ***B*** *is incorrect because arrow K indicates the negative activation energy for the reaction* ***D*** *is incorrect because arrow M indicates the enthalpy change for the reaction*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is A** (4.0×10^{-6}) ***B*** *is incorrect because this is the rate in units of mol* dm^{-3} min^{-1} ***C*** *is incorrect because this value is the inverse of the rate value with the units of mol* dm^{-3} min^{-1} ***D*** *is incorrect because this value is the inverse of the rate value*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
16(a)	An answer that makes reference to two of the following points: • (Group 0 elements / noble gases are) monoatomic / exist as single atoms **(1)** • there are no electronegativity differences **(1)** • so there are no permanent dipoles for (permanent) dipole-dipole interactions OR so there are no permanent dipoles for hydrogen bonding OR there are no N/O/F bonded to hydrogen atoms for hydrogen bonding **(1)**	Allow non-molecular Allow non-polar Allow isn't a polar molecule Ignore "only London forces" Ignore no polar bonds / bonds are non-polar Any inference that Group 0 exist as molecules including "monomolecules" negates a mark	**(2)**

Question Number	Answer	Additional Guidance	Mark
16(b)	A description that makes reference to the following points: (Step 1) • (temporary) uneven distribution of **electrons** / (random) movement of **electrons** / fluctuation of **electrons** (in one helium atom) **(1)** • results in an (instantaneous/temporary) dipole **(1)** (Step 2) • which induces a dipole (in the second helium atom) **(1)** (Step 3) • (leading) to an (electrostatic) attraction between (opposite) dipoles (which is the London force) **(1)**	Allow the marking points linked to any step Ignore molecule Allow description e.g. momentary/fleeting imbalance in **electron** cloud, etc. Ignore positive and negative (dipoles) Allow polarises a neighbouring atom Allow a description of a dipole for M2 or M3 but the word dipole must be present for both marks to be awarded.	**(4)**

Question Number	Answer	Additional Guidance	Mark
16(c)	An explanation that makes reference to the following points: • increasing number of electrons results in increasing boiling temperatures **(1)** • (because the more electrons) the larger the (instantaneous) dipole (and the stronger the attraction giving a higher boiling temperature) **(1)**	Allow dipole is stronger / more powerful Ignore London forces are stronger Ignore more polar	**(2)**

Question Number	Answer	Additional Guidance	Mark
16(d)	An answer that makes reference to the following points: • H_2S to H_2Te show increasing boiling temperatures due to increasing London forces **(1)** • H_2O is an anomaly / (boiling temperature) is higher (than expected) / has the highest boiling temperature **(1)** • as it has hydrogen bonding which is stronger than London forces **(1)** • (and) requires more **energy** to break **(1)**	Accept Period 3 to Period 5 hydrides Allow S to Te hydrides Allow increasing boiling temperatures due to an increase in electrons Allow a comparison of two hydrides boiling temperatures Accept Period 2 hydride Accept H_2O would be expected to be below −60 (^oC) Allow H_2O does not follow the trend Allow hydrogen bonding is the strongest intermolecular force Ignore references to electronegativity Ignore reference to permanent dipole forces	**(4)**

(Total for Question 16 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
17(a)	An explanation that makes reference to the following points: • iodine reduced from 0 to −1 (in I^-) **(1)** • and (simultaneously) oxidised from 0 to (+)5 (in IO_3^-) **(1)**	Oxidation numbers can be written underneath equation Allow (1) for correct oxidation number changes if the terms oxidation and reduction are missing or mislabelled If no other mark awarded, then allow (1) for general definition of disproportionation i.e. oxidation and reduction of the same species (in a reaction)	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(b)	An answer that makes reference to the following points: • aqueous bromine and iodine can be brown/yellow **(1)** • iodine forms (a) purple upper layer / in cyclohexane / in organic solvent **(1)**	Allow aqueous iodine and bromine can look a similar colour Allow gives a clearer **colour** change/difference Allow helps to distinguish between I_2 and Br_2 Allow bromine in cyclohexane is brown Allow violet for purple Ignore pink Ignore references to solubility, rate of reaction and intermolecular forces	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(c)(i)	An answer that makes reference to the following points: • (test) ammonia (stopper / on a glass rod) **and** (result) white smoke	Do not award white fumes Ignore misty fumes Allow (damp blue) litmus turns red Allow (damp) pH indicator paper turns red	**(1)**

Question Number	Answer	Additional Guidance	Mark
17(c)(ii)	An answer that makes reference to the following points: • oxidation half-equation **(1)** • reduction half-equation **(1)**	$2I^- \rightarrow I_2 + 2e(^-)$ Allow multiples Allow $2I^- - 2e(^-) \rightarrow I_2$ $H_2SO_4 + 8e(^-) + 8H^+ \rightarrow H_2S + 4H_2O$ Allow (1) for both equations in the wrong order Ignore state symbols even if incorrect Note: Allow $SO_4^{2-} + 8e(^-) + 10H^+ \rightarrow H_2S + 4H_2O$	**(2)**

(Total for Question 17 = 7 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*18</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** mean bond enthalpy is the energy required to break (1 mol of) bonds (in the gaseous state) **IP2** carbon – halogen bonds require less energy to break from C−F to C−I **IP3** electronegativity is the ability of an atom to attract a bonding pair of electrons / electrons in a covalent bond **IP4** fluorine has greatest electronegativity of the (four) halogens and so results in the largest bond polarity / dipole **IP5** trend of increasing rate (of hydrolysis) C−F to C−I **IP6** because bond enthalpy (ultimately) determines the rate of hydrolysis (and this is more important than the electronegativity difference)	Ignore halide ions Accept reverse arguments Accept easier for require less energy Allow mean bond energy decreases from C−F to C−I Allow weaker bonds from C−F to C−I Allow down the group/table Allow electronegativity is the ability to attract a shared pair of electrons Accept description of trend of electronegativity decreasing linked to size of dipole decreasing Allow C−F bond is the most polar Allow C−F is more polar than C−I / C−Cl / C−Br Allow nucleophile is most attracted to carbon in C−F bond Allow down the group/table Allow C−Cl to C−I If no trend for IP2 and IP5 is given then 1IP can be awarded for two correct statements linking individual bonds strength to rate e.g. C−I rate is the fastest, C−I is the weakest	

(Total for Question 18 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
19(a)(i)	• calculation of mass dissolved **and** molar mass of $Sr(OH)_2$ **(1)** • calculation of number of moles of $Sr(OH)_2$ **(1)** • calculation of concentration in mol dm^{-3} **(1)**	Example of calculation m = (3.000 – 0.276) = 2.724 (g) 121.6 (g mol^{-1}) n = (2.724 ÷ 121.6 =) 0.022401 / 2.2401 × 10^{-2} (mol) c = (0.022401 ÷ 0.250 =) 0.089605 / 8.9605 × 10^{-2} (mol dm^{-3}) Ignore SF except 1SF TE throughout Correct answer with no working scores (3) Allow steps in any order: subtraction, division by M_r, division by volume	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	• calculation of moles of $Sr(OH)_2$ in 25.0 cm^3 **(1)** • calculation of number of moles of HCl needed **(1)** • volume of HCl required to nearest 0.05 cm^3 **(1)**	Example of calculation n = (0.089605 × 0.025 =) 0.0022401 / 2.2401 × 10^{-3} (mol) n = (0.0022401 × 2 =) 0.0044802 / 4.4802 × 10^{-3} (mol) V = (0.0044802 ÷ 0.155 =) 0.0289045 (dm^3) so V = 28.90 (cm^3) Do not award 28.9 for M3 Ignore SF except 1SF TE throughout Allow (3) for the value calculated using the concentration from 19(a)(i)	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(b)	• calculation of moles of $Ca(OH)_2$ **(1)** • calculation of number of moles of ions **(1)** • calculation of number of ions **(1)**	<u>Example of calculation</u> decrease in mass 1.47 – 1.15 = 0.32 (g) **and** n = (0.32 ÷ 74.1 =) 0.0043185 / 4.3185×10^{-3} (mol) n = (0.0043185×3 =) 0.012955 / 1.2955×10^{-2} (mol) n = ($0.0129555 \times 6.02 \times 10^{23}$ =) 7.7992×10^{21} Correct answer scores 3 marks TE throughout, except when a negative answer is given for M3 Ignore SF except 1SF Accept calculation with the steps done in a different order Steps required – subtraction, division by M_r, molar ratio and use of Avogadro constant Alternative M2: if moles are calculated before subtraction, then both 0.05951 and 0.04656 need to be shown	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(c)(i)	An answer that makes reference to the following point: • suitable equation	<u>Example of equation</u> $Mg(OH)_2(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + 2H_2O(l)$ Accept multiples	**(1)**

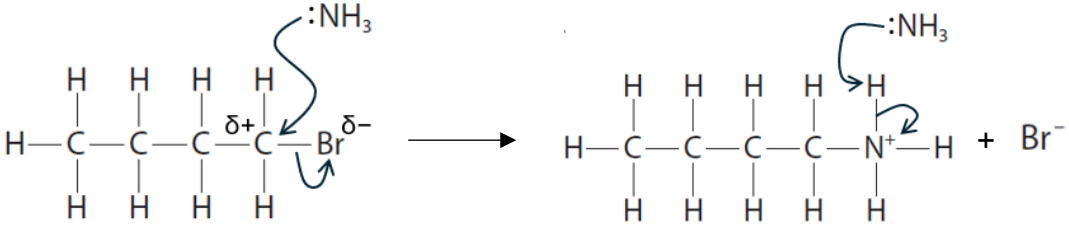
Question Number	Answer	Additional Guidance	Mark
19(c)(ii)	• calculation of mass of $Mg(OH)_2$ in adult bedtime dose **(1)** • calculation of number of moles of Mg^{2+} in adult bedtime dose **(1)** • calculation of mass of magnesium ions needed and in seawater **(1)** • calculation of volume of seawater that contains the adult bedtime dose of $Mg(OH)_2$ **(1)**	<u>Example of calculation</u> Mass in nine teaspoons = (4.00 × 10^2 × 9 ÷ 1000 =) 3.60 (g) n = (3.60 ÷ 58.3 =) 0.061750 / 6.1750 × 10^{-2} (mol) 6.1750 × 10^{-2} × 24.3 = 1.5005 (g) mass of magnesium ions **and** 1.262 (g) in 1.03 kg mass of magnesium ions in seawater (1.5005 ÷ 1.262) ÷ 1.03 = 1.1544 (dm^3) TE throughout Ignore SF except 1SF Correct answer with no working scores (4) Alternative MS: M1 as above M2 3.6 × $\frac{24.3}{58.3}$ = 1.5 g M3 1.5 ÷ 1262 × 10^{-6} = 1188.59 g M4 (1188.59 ÷ 1.03) ÷ 1000 = 1.15 dm^3	**(4)**

(Total for Question 19 = 14 marks)

TOTAL FOR SECTION B = 39 MARKS

Section C

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	An answer that makes reference to the following points: • dipole on C–Br bond • lone pair on (both) ammonia molecule(s) • curly arrow from the (lone pair of) N of first NH_3 to $C^{\delta+}$ • curly arrow from C–Br bond to, or just beyond, $Br^{\delta-}$ • curly arrow from the (lone pair of) N of second NH_3 to H (of N^+) • curly arrow from N–H bond to N^+	Ignore bromide ions Extra arrows or charges, or missing hydrogen atoms negate 1 point 6 points scores (4) 5 points scores (3) 3 or 4 points scores (2) 2 points scores (1) 1 point scores (0)	**(4)**

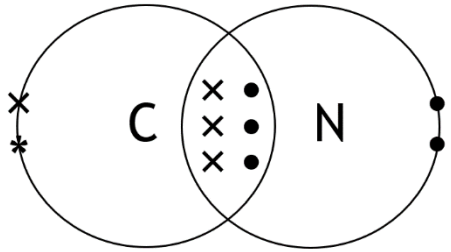
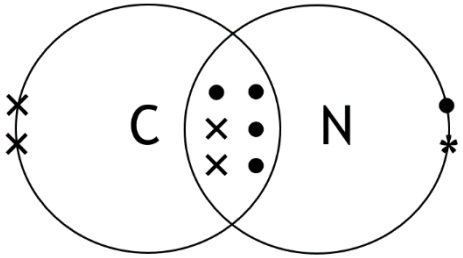


Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An answer that makes reference to the following point: • ammonia is volatile	Allow ammonia (gas) will escape Allow NH_3 evaporates Ignore NH_3 is a gas Ignore "to prevent gas escaping" Ignore general comments about yield increasing / equilibrium Ignore references to explosion / pressure	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	An answer that makes reference to the following points: • (product is) butan-1-ol / $CH_3CH_2CH_2CH_2OH$ **(1)** • because (in aqueous ammonia) the water acts as a nucleophile **(1)**	Accept any structural representation Allow product is butanol Allow reference to nucleophilic substitution Allow reference to hydroxide ions being present which act as a nucleophile Marks are independent	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following point: • pentanenitrile	Ignore any formulae	**(1)**

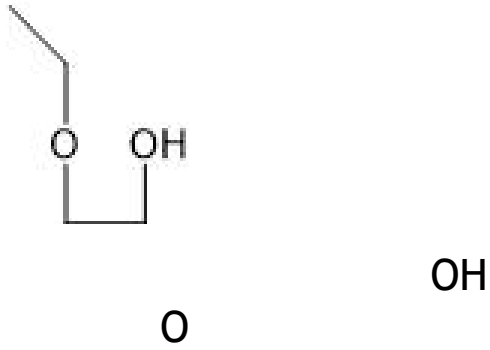
Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	An answer that makes reference to the following point: • the (carbon) chain (length) is extended	 Allow it increases the number of carbon atoms Allow it ascends the homologous series Allow adding a carbon	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(iii)	• suitable dot-and-cross diagram	<u>Example of diagram</u>  Allow  Do not award all dots or all crosses Do not award asterisk in the circle overlap area	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(iv)	An answer that makes reference to the following points: (Reason) • lone pair on the nitrogen atom can act as a nucleophile (in addition to the carbon) / be donated / attack **(1)** (Product) • suitable structure of isonitrile **(1)**	Allow the lone pair of the nitrogen atom bonds with the carbon Allow nitrogen can donate its lone pair to form a covalent bond Accept any combination of displayed / structural / skeletal formulae $CH_3CH_2CH_2CH_2NC$ Ignore structure of pentanenitrile	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(c)	An explanation that makes reference to the following points: • in Reaction 1 (the hydroxide is) acting as a nucleophile **(1)** • by donating a pair of electrons (and forming a bond with the carbon that was bonded to the chlorine atom) **(1)** • in Reaction 2 (the hydroxide is) acting as a base (and not as a nucleophile) **(1)** • by accepting a proton / in an elimination reaction **(1)**	Allow using a lone pair to attack the δ+ carbon (and replace the Cl) Ignore carbocation Allow removes a proton Ignore bonds with hydrogen	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(d)(i)	An answer that makes reference to the following points: • (not expected to be exothermic because) C−O and O−H bonds are both broken and made **(1)** • so no enthalpy change **(1)** • the epoxyethane C−O bonds are strained / (and likely to be) weaker / less endothermic / easier to break **(1)** • so more **energy** released on C−O formation in the alcohol/ethane-1,2-diol **(1)**	Allow the same bonds are broken and made Allow $\Delta_r H = 0$ Allow very small energy/enthalpy change Allow values of broken and formed are close/similar Ignore reference to endothermic Accept reference to the bond angle about the oxygen is about 60^o (and so strained) Allow the bonds in the ring/structure are easier to break Allow the C−O bonds are stronger in the product Allow more energy is released making bonds than taken in breaking the bonds (or reverse argument) If MP3 and MP4 are not awarded allow 1 mark for a comment on the product being more stable or epoxyethane being less stable	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(d)(ii)	• suitable skeletal formula	Examples of diagram  Ignore bond lengths / bond angles	**(1)**

(Total for Question 20 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS
TOTAL FOR PAPER = 80 MARKS