Pearson

Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced Subsidiary Level in Chemistry
Paper 01A: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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.

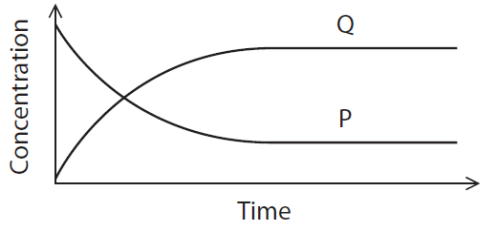
Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

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**  ***B*** *is not correct because it shows the concentration of both reactants and products decreasing* ***C*** *is not correct because both concentration of reactants and products are still changing* ***D*** *is not correct because concentrations of P and Q remain unchanged*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is A** (The rates of the forward and backward reactions are equal) ***B*** *is not correct because the concentrations of reactants and products are unlikely to be equal* ***C*** *is not correct because the forward and backward reactions still occur* ***D*** *is not correct because catalysts do not affect the position of equilibrium*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** ($2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$) ***A*** *is not correct because the equilibrium will move to the left hand side (more molecules)* ***B*** *is not correct because the equilibrium will not change as both sides have the same number of molecules* ***C*** *is not correct because the equilibrium will move to the left hand side (more molecules)*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is A** (solid potassium hydroxide) ***B*** *is not correct because the equilibrium would move to the left* ***C*** *is not correct because the equilibrium would move to the left* ***D*** *is not correct because the position of equilibrium would remain unchanged*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** (0.717) ***A*** *is not correct because the formula of the precipitate is AgCl, not* $Ca(NO_3)_2$ ***C*** *is not correct because the formula of the precipitate is AgCl, not* $AgCl_2$ ***D*** *is not correct because 0.005 mol, and not 0.01 mol, of precipitate is formed*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is C** (+6) ***A*** *is not correct because the oxidation number of S in a compound is not always −2* ***B*** *is not correct because this is the value for the* SO_3^{2-} *ion* ***D*** *is not correct because the sum of all the oxidation states should be equal to the charge on the ion, not 0*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is B** ($6NaOH + 3Br_2 \rightarrow 5NaBr + NaBrO_3 + 3H_2O$) ***A*** *is not correct because it is a neutralisation reaction* ***C*** *is not correct because only Al is oxidised and only H is reduced* ***D*** *is not correct because no oxidation numbers change*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is B** ($2HCl(aq) + Ba(OH)_2(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$) ***A*** *is not correct because it is a redox reaction* ***C*** *is not correct because it is a redox reaction* ***D*** *is not correct because it is a redox reaction*	**(1)**

Question Number	Answer	Mark
9(a)	**The only correct answer is C** (5:3:8) ***A*** *is not correct because y is wrong* ***B*** *is not correct because x and z are wrong* ***D*** *is not correct because x, y and z are wrong*	**(1)**

Question Number	Answer	Mark
9(b)	**The only correct answer is B** ($C_2O_4^{2-}$) ***A*** *is not correct because the oxidation number of H has not changed* ***C*** *is not correct because it is the oxidising agent* ***D*** *is not correct because the oxidation numbers of S and O have not changed*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is D** (Hydrogen unchanged, Oxygen oxidised and reduced) ***A*** *is incorrect because hydrogen is unchanged and oxygen is both oxidised and reduced* ***B*** *is incorrect because hydrogen is unchanged and oxygen is both oxidised and reduced* ***C*** *is incorrect because hydrogen is unchanged and oxygen is both oxidised and reduced*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is D** (Exothermic, Enthalpy change of neutralisation) ***A*** *is incorrect because the reaction is exothermic and is not the formation* ***B*** *is incorrect because the reaction is exothermic and is not the formation* ***C*** *is incorrect because the equation does not show formation from elements in their standard states*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is D** ($\Delta_r H$) ***A*** *is incorrect because this is not an enthalpy of atomisation* ***B*** *is incorrect because carbon monoxide is not the final combustion product of carbon* ***C*** *is incorrect because two moles of carbon monoxide are formed*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is C** (+25.0 kJ mol^{-1}) ***A*** *is incorrect because this is the enthalpy change per mole in J* mol^{-1} ***B*** *is incorrect because this is the energy change divided by the mass of potassium hydrogencarbonate* ***D*** *is incorrect because this is the energy change divided by the product of the* M_r *and the mass of potassium hydrogencarbonate*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is B** (–75) ***A*** *is not correct because the 2 equations have been added together* ***C*** *is not correct because the second equation has been subtracted from the first equation* ***D*** *is not correct because both equations have been reversed and added together*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is B** (–122) ***A*** *is not correct because it is the sum of formation of all product and reactant bonds* ***C*** *is not correct because the energy to break the bonds is less than the energy released when the new bonds form* ***D*** *is not correct because it is the sum of breaking all product and reactant bonds*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** ($\frac{1}{2}Br_2(l) \rightarrow Br(g)$) ***A*** *is not correct because 2 moles of Br atoms form and* Br_2 *is in gaseous state* ***B*** *is not correct because 2 moles of Br atoms form* ***D*** *is not correct because* Br_2 *is in gaseous state*	**(1)**

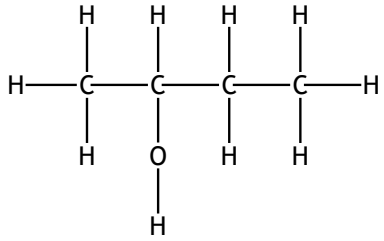
Question Number	Answer	Mark
17	**The only correct answer is A** (*an increase of 6.6*°C) ***B*** *is not correct because neutralisation reactions are exothermic, so temperature will rise not fall* ***C*** *is not correct because the total volume of solution is 50 cm^3, not 25 cm^3* ***D*** *is not correct because neutralisation reactions are exothermic, so temperature will rise not fall and because the total volume of solution is 50 cm^3, not 25 cm^3*	**(1)**

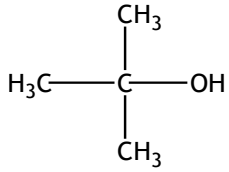
Question Number	Answer	Mark
18	**The only correct answer is D** (highest mass/charge ratio) ***A*** *is not correct because the molecular ion does not always have the greatest abundance* ***B*** *is not correct because the molecular ion does not always have the greatest stability* ***C*** *is not correct because the molecular ion cannot have a higher charge than the other ions*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is D** (propanone) ***B*** *is not correct because there would be a molecular ion peak at m/z = 44* ***C*** *is not correct because there would be a molecular ion peak at m/z = 60* ***D*** *is not correct because there would be a molecular ion peak at m/z = 60*	**(1)**

(Total for Section A = 20 marks)

Section B

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	• displayed formula of butan-2-ol	Example of displayed formula  Ignore bond lengths and bond angles Do not award −OH Do not award ─H─O Do not award other types of formulae	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	• structure of 2-methylpropan-2-ol	Example of structure  / $(CH_3)_3C(OH)$ Allow displayed / skeletal or hybrid formula Ignore incorrect vertical connectivity on ─O─H Do not award CH_3─ If 2 formulae given, both must be correct	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	• (2)-methylpropan-1-ol	Allow methylpropan-1-ol	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	• primary / 1° (alcohol)	Do not award first / 1 / 1st	**(1)**

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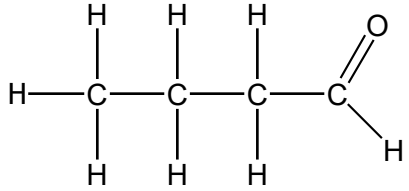
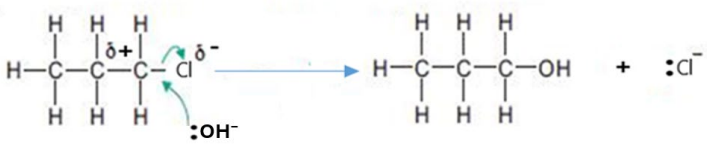
Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	• structural formula of butanoic acid	Example of formula $CH_3CH_2CH_2COOH$ Allow $CH_3CH_2CH_2CO_2H$ Allow skeletal/displayed/hybrid formulae Do not award C_3H_7COOH	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(iii)	• displayed formula of butanal	Example of formula  Only penalise incorrect number of carbons once in b(ii) and b(iii) Allow structural/skeletal/hybrid formulae	**(1)**

(Total for Question 20 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An answer that makes reference to the following point: • time taken for the precipitate (of silver halide) to form	Allow ppt / ppte / solid Allow time for silver halide (AgCl / AgBr / AgI) to form Allow time to go cloudy Allow how fast/ how quickly for time taken Accept speed at which the precipitate forms Ignore rate at which precipitate forms	**(1)**

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An explanation that makes reference to the following points: • (1)-iodopropane **(1)** • **C−I** bond weakest **(1)**	Allow any correct formula Allow less energy needed to break C-I bond Allow C-I bond has the lowest bond enthalpy Accept C-I bond more easily broken Ignore just C-I bond is weak Do not award for simply saying the iodine /1-iodopropane bond is weakest M2 dependent on M1 or near miss Allow reverse argument Ignore references to electronegativity/ reactivity	**(2)**

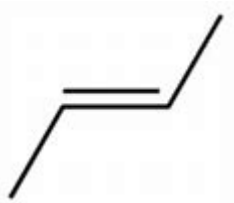
Question Number	Answer	Additional Guidance	Mark
21(b)	• dipole on C−Cl bond • curly arrow from bond to Cl or just beyond • lone pair on oxygen of hydroxide **ion** • curly arrow from (lone pair) to carbon (δ+) All 4 points scores (2) 2-3 points scores (1) 1 point scores (0)	<u>Example of mechanism</u>  Ignore S_N2 transition state Ignore products Ignore missing lone pair on the leaving group Lone pair must be fully on the O atom of the hydroxide **ion** Penalise use of half arrows once only Comment If S_N1 mechanism used, all scoring points are available but intermediate must be correct. The arrow goes C+ for M4	**(2)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>21(c)</td>
<td>An answer that makes reference to the following points:

• row 1 correct (1)

• row 2 correct (1)

• row 3 correct (1)</td>
<td>Example of skeletal formulae:

<table>
<tr><th>Skeletal formula</th><th>Name</th></tr>
<tr><td>  </td><td>Z – but-2-ene</td></tr>
<tr><td>  </td><td>E – but-2-ene</td></tr>
<tr><td>  </td><td>but-1-ene</td></tr>
</table>

If E and Z names are reversed, score (1) for M1 and M2
If no other marks awarded, award (1) for 3 correct skeletal formulae in any order

Allow rows in any order
Allow cis for Z and trans for E

Penalise non-skeletal formulae once only
No TE of name on incorrect formula</td>
<td>(3)</td>
</tr>
</table>

(Total for Question 21 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)(i)	• Green	Allow any shade of green eg pale green, apple green Ignore initial colour eg changes **from** blue **to** green Do not award any other colour in combination with green eg yellow-green	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(a)(ii)	An explanation that makes reference to the following points: • electrons excited/promoted to a higher (energy) level/shell by absorbing (thermal) energy /heat (from (Bunsen) flame) **(1)** • (promoted) electrons fall /drop to a lower energy level /(sub)shell/ orbital or electrons return to ground state **(1)** • emitting light /photons (in the visible region) **(1)**	Read the whole answer before awarding marks. If no mention of electrons only M3 may be awarded Accept "jump back to lower energy level Allow de-excites Allow release for emitting Ignore just colour emitted / released. Ignore unqualified references to wavelength/ frequency	**(3)**

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	• $2NaNO_3 \rightarrow 2NaNO_2 + O_2$	Allow multiples Ignore state symbols, even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	• $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$	Allow multiples Ignore state symbols, even if incorrect Ignore water of crystallisation	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(c)	An explanation that makes reference to the following points: (First mark – charge) • magnesium **ion** has a greater /higher charge (than sodium ion) or magnesium is Mg^{2+} **and** sodium is Na^{+} **(1)** (Second mark – size) • magnesium ion is smaller (than sodium ion) or sodium ion is larger (than magnesium ion) **(1)** (Third mark – comparison of polarisation) • magnesium / Mg^{2+}/cation /smaller ion causes more polarisation / distortion **or** sodium / Na^{+}/cation /larger ion causes less polarisation / distortion **(1)** (Fourth mark – what is being polarised) • C–O bonds / C=O bonds **(1)**	Allow magnesium **ion** has a higher charge density Do not award atoms These may be seen subsumed in other scoring points Allow magnesium is smaller than sodium or reverse argument if ion is stated for first mark Allow magnesium has a smaller ionic radius Do not award atomic radius Allow "polarising power" Allow "more polarising" Allow carbonate (ion)/CO_3^{2-}/anion/negative ion	**(4)**

Question Number	Answer	Additional Guidance	Mark
22(d)(i)	• calculation of moles of HCl **(1)** • calculation of moles of mol Na_2CO_3 in 25 cm^3 **(1)** • calculation of moles of mol Na_2CO_3 in 250 cm^3 **(1)**	<u>Example of calculation</u> n = ((10.75 ÷ 1000) x 0.150 =) 1.6125 x 10^{-3} (mol) n = (1.6125 x 10^{-3} ÷ 2 =) 8.0625 x 10^{-4} (mol) n = (8.0625 x 10^{-4} x 10 =) 8.0625 x 10^{-3} (mol) Ignore SF except 1SF TE at each stage Correct answer with no working scores (3)	**(3)**

Question Number	Answer		Additional Guidance	Mark
22(d)(ii)	• calculation of molar mass of $Na_2CO_3.xH_2O$	**(1)**	<u>Example of calculation</u> *M*r = (1.00 ÷ 8.0625 x 10^{-3} =) 124 (g mol^{-1})	**(2)**
	• calculation of x or • calculation of mass of Na_2CO_3 **and** calculation of mass of water	**(1)**	*x* = ((124 – 106) ÷ 18 =) 1 *m* = (8.0625 x 10^{-3} x 106 =) 0.8546 (g) *m* = (1-0.14538 =) 0.14538 (g)	
	• calculation of mole ratio and statement of x	**(1)**	*n* = (8.0625 x 10^{-3} : (0.14538 ÷ 18) =) 1:1 x = 1	
		(1)	Ignore SF Allow TE for M2 provided answer is an integer Allow TE from (b)(i) unless *M*r of hydrate < 106	

Question Number	Answer	Additional Guidance	Mark
22(d)(iii)	An answer that makes reference to the following points: (First error) • not washing the weighing bottle (with deionised water) or not re-weighing the weighing bottle **(1)** (First Effect with reason) • the titration volume is less and because lower/decreased concentration / more dilute **(1)** (Second error) • not shaking/inverting/mixing the solution in the volumetric flask **(1)** (Second effect with reason) • titres inconsistent/varied and because non-homogeneous solution **(1)** or • titre volumes may be smaller and in parts of the solution where the concentration is lower **(1)**	Two matching pairs in either order. The effect on titration volumes is **conditional** on the error. Allow rinsing for washing Allow not adding washing to volumetric flask Allow some solid could be left in the weighing bottle / not transferred to the flask Allow any suggestion that there is no agitation of the solution in the volumetric flask Ignore references to how to make up to the mark. Ignore references to dissolving solid in a beaker first. Allow reverse argument M2 dependent on M1 or near miss M4 dependent on M3 or near miss Comment For M1 award any reference to not ensuring that all the solid is removed from the weighing bottle.	**(4)**

(Total for Question 22 = 19 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>23(a)*</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.

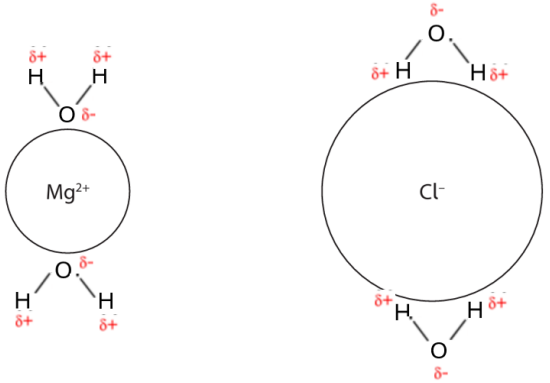
The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some 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, 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.

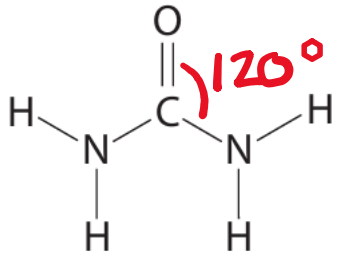
If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).
Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.
</td>
<td>(6)</td>
</tr>
</table>

	Indicative content: • IP1: fluorine has (only) London forces (instantaneous dipole-induced dipole) (as it has a symmetrical electron cloud/is a symmetrical/non-polar molecule) • IP2: hydrogen sulphide is a polar molecule or sulfur is more electronegative than hydrogen / the S─H bond is polar • IP3: H_2S forms permanent dipole-(permanent) dipole interactions (in addition to London forces) • IP4: methanol can form hydrogen bonds (because it contains a hydrogen attached to a small electronegative element so) • IP5: hydrogen bonds are strong**est** intermolecular forces / take more energy to break • IP6: London forces are the weak**est** intermolecular forces so fluorine has the lowest boiling temperature	Allow dispersion forces / van der Waals forces Allow all molecules have London Forces / similar London Forces Allow both for all Ignore LDF Accept there is an electronegativity difference Accept permanent dipole interactions between molecules Ignore just dipole-dipole / pd-pd interactions Allow H bonds Do not award just H bonds are strong Accept low**est** / small**est** / great**est** for IP 5 and 6 Ignore references to differences in strength of London Forces IP 5 and 6 can be seen as a comparator with the other forces rather than as a specific statement Comment Allow VdW	

Question Number	Answer	Additional Guidance	Mark
23(b)	An answer that makes reference to the following points: • negative dipole on the oxygen closest to the magnesium ion **(1)** • positive dipoles on the hydrogens closest to the chloride ion **(1)**	<u>Example of diagram</u>  Allow 1 (or more) water molecules bridging both ions Allow dipole shown just on relevant atom adjacent to the ion Accept just 1 water molecule per ion Ignore relative sizes of H and O atoms Ignore lone pairs on oxygen atom Ignore any attempts to show bonds between dipoles and ions Ignore variations in distance between molecules and ions If no dipoles are shown, max (1) If full rather than partial charges shown on the water molecule, max (1) Comment If O_2H used max (1)	**(2)**

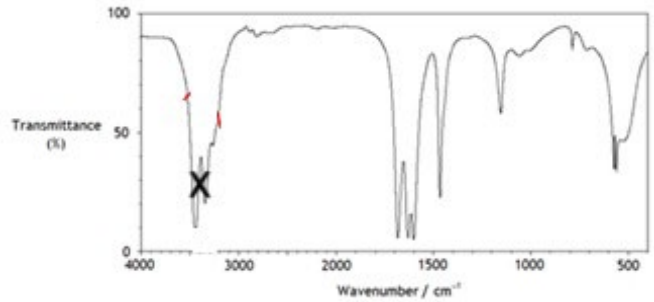
(Total for Question 23 = 8 marks)
(Total for Section B = 41 marks)

Section C

Question Number	Answer	Additional Guidance	Mark
24(a)	An answer that makes reference to the following points: • C angle of 120(°) **(1)** • trigonal planar **(1)**	Example of diagram  Ignore additional angles even if incorrect Do not award correct bond angle not shown on the diagram Any position of the bond angle around the C can be awarded	**(2)**

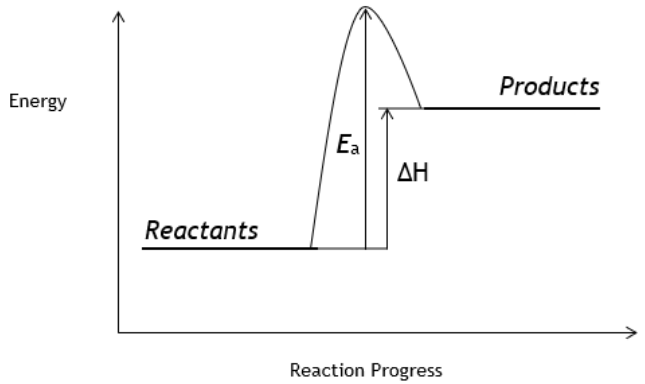
Question Number	Answer	Additional Guidance	Mark
24(b)	• M_r of urea **(1)** • mass of urea required **(1)** or • moles of urea **(1)** • mass of urea required **(1)**	<u>Example of calculation</u> $M_r = 60$ m = (18.0 ÷ 1000) × 125 × 60 =) 135 (g) n = (18.0 x (125 ÷ 1000) =) 2.25 (mol) m = (2.25 x 60 =) 135(g) Ignore missing units for M2 unless incorrect Ignore SF except 1 SF Correct answer with no working scores 2 TE from M1 for either met	**(2)**

Question Number	Answer	Additional Guidance	Mark
24(c)	An answer that makes reference to the following point: • oxides of nitrogen lead to the formation of acid rain	Allow effect on plants and animals / formation of photochemical smog Ignore toxic / harmful / corrosive Ignore references to global warming Ignore references to ozone / the ozone layer	**(1)**

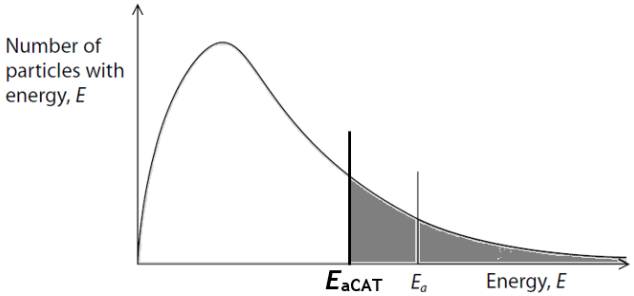
Question Number	Answer	Additional Guidance	Mark
24(d)(i)	An answer that makes reference to the following point • correct peak annotated with a cross	Example of completed spectra:  Allow any of the three peaks in the region to be individually annotated with a cross Allow more than one cross in the correct region. Do not award if additional crosses added in an incorrect region.	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(d)(ii)	An answer that makes reference to the following point • C=O	Ignore “carbonyl” Ignore just CO Do not award C─O	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(e)(i)	An answer that makes reference to the following points • products **and** reversible arrow	Example of balanced equation: $\rightleftharpoons 2NH_3 + CO_2$ Allow multiples if equation is balanced	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(e)(ii)	An answer that makes reference to the following points: • reactant line below product line • reactant and product lines labelled • activation energy "hump" drawn correctly • *E*a arrows pointing upwards starting and finishing at reactant (or extrapolated) line and the top of the hump • ΔH arrow pointing upwards starting and finishing at reactant and product lines (or extrapolated) • both arrows labelled correctly 6 points scores 3 4-5 points scores 2 2-3 points scores 1	Example of sketch:  Accept actual reactants and products labelled on diagram Allow +133 for Δ*H* Ignore state symbols even if incorrect Penalise lines rather than arrows once only Penalise double-headed arrows once only Award (1) for exothermic diagram with *E*a labelled correctly and ΔH correctly labelled with -133 kJ mol^{-1}.	**(3)**

Question Number	Answer	Additional Guidance	Mark
24(f)(i)	An explanation that makes reference to the following points: • the urea is used up / is not reformed (in the reaction)	 Allow urea mass reduces / amount reduces / reacts to form other products Allow "catalysts are not used up in the reaction" Ignore just urea is a reactant. Ignore references to effect on Ea / reaction pathways	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(f)(ii)	An answer that makes reference to the following points: • the catalyst decreases the activation energy required **(1)** • this means more particles have the energy required for the reaction to take place **(1)** • this increases the number of **successful** collisions per second **(1)**	Example of a completed diagram  Accept M1 shown on the diagram Accept more particles have energy (at or) above Ea Allow increased frequency of successful collisions Accept "effective" for "successful" collisions Ignore just increased frequency of collisions Ignore just more successful collisions Ignore just "more chance" of successful collisions Ignore references to alternative reaction pathways	**(3)**

		Comment Accept molecules for particles	

Question Number	Answer	Additional Guidance	Mark
24(g)(i)	• The hot gases from the engine warm up the catalytic converter	Allow warmed up by heat produced from combustion Allow just warmed up by / heat from the engine Allow just hot gases Allow the reaction is exothermic Do not award energy from the reaction between urea and water	**(1)**

Question Number	Answer		Additional Guidance	Mark
24(g)(ii)	• conversion of m^3 to dm^3	**(1)**	Example of calculation $V = (90.0 \times 1000 =) 90000$ (dm^3)	**(3)**
	• moles of nitrogen	**(1)**	$n = (90000 \div 55.2 =) 1630.4 / 1630$ (mol)	
	• number of molecules of nitrogen	**(1)**	$N = (1630.4 \times 6.02 \times 10^{23} =) 9.8152 \times 10^{26} / 9.82 \times 10^{26}$ Ignore SF except 1 SF	

		TE from M1 Correct answer with no working scores 3	

(Total for Question 24 = 19 marks)
(Total for Section C = 19 marks)
TOTAL FOR PAPER = 80 MARKS