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Mark Scheme (Results)

January 2022

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH12)
Paper 01: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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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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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.

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Section A

Question Number	Answer	Mark
1	**The only correct answer is D** (exothermic, neutralisation) ***A*** *is incorrect because the reaction is exothermic and is not formation* ***B*** *is incorrect because the reaction is exothermic* ***C*** *is incorrect because the equation does not show formation*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is B** ($Cl_2(g) \rightarrow 2Cl(g)$) ***A*** *is incorrect because this is the standard enthalpy change of atomisation of magnesium* ***C*** *is incorrect because this is the standard enthalpy change of atomisation of oxygen* ***D*** *is incorrect because this is the standard enthalpy change of atomisation of mercury*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is B** ($-16.6\ kJ\ mol^{-1}$) ***A*** *is incorrect because this is the energy change divided by the* M_r ***C*** *is incorrect because this is the energy change divided by the* M_r *and multiplied by the mass* ***D*** *is incorrect because this is the energy change but has not been correctly converted into kilojoules*	**(1)**

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Question Number	Answer	Mark
4	**The only correct answer is A** (623 kJ mol^{-1}) ***B*** *is incorrect because this is the C=O bond in CO_2 added to an O–H bond minus 591* ***C*** *is incorrect because this is the value for C=O in CO_2* ***D*** *is incorrect because this is the value when only one of the two C-H bonds is taken into account*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is D** ($CH_4 < Cl_2 < Br_2 < H_2O$) ***A*** *is incorrect because the sequence is reversed* ***B*** *is incorrect because methane has the lowest boiling temperature* ***C*** *is incorrect because methane has the lowest boiling temperature*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is C** (the H−O−H bond angle is the same in ice and in water) ***A*** *is incorrect because ice does have a lower density than water* ***B*** *is incorrect because H_2O molecules are further apart in ice than in water* ***D*** *is incorrect because the molecules in ice are held together by hydrogen bonds*	**(1)**

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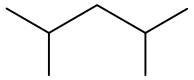
Question Number	Answer	Mark
7	**The only correct answer is D** (hydrogen bonding, permanent dipole-permanent dipole forces and London forces) ***A*** *is incorrect because there are also permanent dipole-permanent dipole interactions* ***B*** *is incorrect because there are also London forces* ***C*** *is incorrect because there are also hydrogen bonds*	**(1)**

Question Number	Answer	Mark
8(a)	**The only correct answer is B** (hexane) ***A*** *is incorrect because this has a shorter chain length* ***C*** *is incorrect because this has a shorter chain length* ***D*** *is incorrect because this has a shorter chain length*	**(1)**

Question Number	Answer	Mark
8(b)	**The only correct answer is A** () ***B*** *is incorrect because this only has one branch* ***C*** *is incorrect because this only has one branch* ***D*** *is incorrect because this is unbranched*	**(1)**

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Question Number	Answer	Mark
9	**The only correct answer is C** (hexane) ***A*** *is incorrect because butan-1-ol contains polar bonds* ***B*** *is incorrect because ethanoic acid contains polar bonds* ***D*** *is incorrect because water contains polar bonds*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** (concentrated phosphoric acid) ***A*** *is incorrect because this would oxidise the alcohol* ***B*** *is incorrect because this is a drying agent* ***D*** *is incorrect because this produces an alkene from a halogenoalkane*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is C** (sulfate(VI)) ***A*** *is incorrect because the oxidation number of sulfur is +6* ***B*** *is incorrect because the oxidation number of sulfur is +6* ***D*** *is incorrect because the oxidation number of sulfur is +6*	**(1)**

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Question Number	Answer	Mark
12	**The only correct answer is A** ($Ca(NO_3)_2$) ***B*** *is incorrect because the oxidation number of nitrogen is -3* ***C*** *is incorrect because the oxidation number of nitrogen is +3* ***D*** *is incorrect because the oxidation number of nitrogen is +3*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is A** ($Cu^{2+} + 2Ag \rightarrow 2Ag^{+} + Cu$) ***B*** *is incorrect because the oxidation number of the copper is unchanged* ***C*** *is incorrect because this is a reaction where copper is oxidised* ***D*** *is incorrect because this is a reaction where copper is oxidised*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is C** ($3Cu + 2NO_3^- + 8H^+ \rightarrow 3Cu^{2+} + 2NO + 4H_2O$) ***A*** *is incorrect because the charges have not been balanced* ***B*** *is incorrect because the charges have not been balanced* ***D*** *is incorrect because the charges have not been balanced*	**(1)**

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Question Number	Answer	Mark
15	**The only correct answer is B** (± 0.75 %) ***A*** *is incorrect because only one of the readings has been taken into account* ***C*** *is incorrect because both the uncertainty and the number of readings have been doubled* ***D*** *is incorrect because the value has been multiplied by 1000 instead of 100*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is A** ($Ba^{2+}(aq) + 2OH^{-}(aq) + 2H^{+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$) ***B*** *is incorrect because it only shows the precipitation reaction* ***C*** *is incorrect because it only shows the neutralisation reaction* ***D*** *is incorrect because it shows the barium sulfate ions as separated*	**(1)**

Question Number	Answer	Mark
17	**The only correct answer is D** (3 and 4) ***A*** *is incorrect because a flame test will not positively identify ammonium ions and barium nitrate will not positively identify chloride ions* ***B*** *is incorrect because a flame test will not positively identify ammonium ions* ***C*** *is incorrect because barium nitrate will not positively identify chloride ions*	**(1)**

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Question Number	Answer	Mark
18	**The only correct answer is B** (high temperature, low pressure) ***A*** *is incorrect because high pressure would favour the back reaction* ***C*** *is incorrect because both these conditions would favour the back reaction* ***D*** *is incorrect because low temperature would favour the back reaction*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is C** (darker and then lighter) ***A*** *is incorrect because when the equilibrium is re-established the mixture becomes lighter* ***B*** *is incorrect because when the mixture is compressed it initially becomes darker* ***D*** *is incorrect because the colour change is reversed*	**(1)**

Total for Section A = 20 marks

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Section B

Question Number	Answer	Additional Guidance	Mark
20(a)	An answer that makes reference to the following point: • nucleophilic **(1)** • substitution **(1)**		**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following points: • lone pair on the **nitrogen** / N **(1)** • delta +/δ+/partial positive (charge) on the **carbon** (attached to the chlorine) **(1)**	The answers may be shown on the diagram Ignore "pairs" if only one lone pair shown on diagram Ignore "lone pair on the ammonia/NH_3" Do not award ammonium Ignore "positive dipole" alone Ignore any references to missing dipoles on ammonia molecule NOTE: The specific carbon does not need to be referenced but if annotated on diagram must be correct Use the list principle for extra comments	**(2)**

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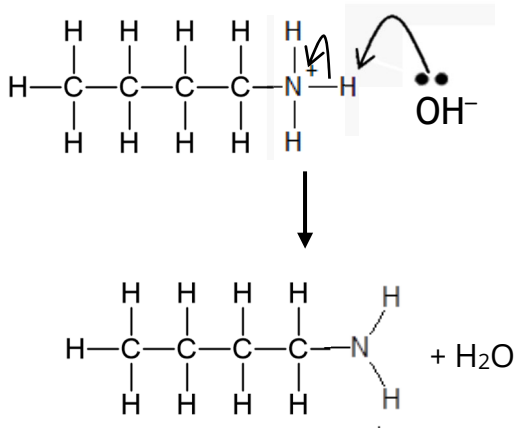
Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	A correctly drawn mechanism showing: • curly arrow from the lone pair on the oxygen going to the hydrogen **(1)** • curly arrow from the same N-H bond to N atom or + **(1)** • correct products **(1)**	An example of a mechanism:  Assume arrows drawn are curly Ignore spectator ions Penalise the use of ammonia once only i.e. M3 can be awarded for the correct products of reaction with further ammonia Covalent bonding in sodium hydroxide loses M1 Missing negative charge on OH^- loses M1 Allow structural formulae for M3	**(3)**

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Question Number	Answer	Additional Guidance	Mark
20(c)	An answer that makes reference to the following points: • the rate of reaction will be slower for 1-chlorobutane **(1)** • C–Cl has a higher bond enthalpy (than C–Br) **(1)** • 1-chlorobutane is a primary halogenoalkane (rather than a tertiary halogenoalkane) **(1)**	Allow reverse answers Allow less / decreased Allow reference to bond strength Allow C–Cl requires more energy to break Allow 1-chlorobutane is 1° / 2-bromo-2-methylpropane is 3° Allow reference to methyl stabilisation of (partial) positive charge(s) on carbon atom(s) Allow reference to stability of carbocations Do not award alcohol Do not award secondary / 2° M2 is dependent on M1 M3 is independent	**(3)**

(Total for Question 20 = 10 marks)

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Question Number	Answer	Additional Guidance	Mark
21(a)(i)	• mass change = 0.57(g) **and** temperature change = 45.8(ºC)	Accept –0.57(g) Do not award – 45.8 Ignore extra SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An answer that makes reference to the following points: • M_r calculated correctly for 2-methylpropan-2-ol **(1)** • moles calculated correctly **(1)** • correct use of $\Delta H = mc\Delta T$ **(1)** • answer with units **(1)** **and** minus sign	Example answer: $M_r = 74$ $0.57 \div 74 = 0.0077027$ mol / 7.7027×10^{-3} mol $\Delta H = 75 \times 4.18 \times 45.8 = 14358$ (J) $\Delta H = \frac{-(75 \times 4.18 \times 45.8)}{0.0077027} = \frac{-14358}{0.0077027}$ $\Delta H = -1\,864\,100 / -1.8641 \times 10^6$ J mol^{-1} OR $\Delta H = -1864.1$ kJ mol^{-1} / -1900 kJ mol^{-1} Ignore extra M_r calculations Ignore SF except 1 SF TE throughout including from 21(a)(i) Correct answer with some working scores (4)	**(4)**

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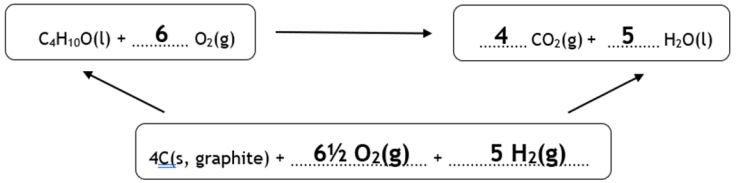
Question Number	Answer	Additional Guidance	Mark
21(b)(i)	• oxygen is an element **and** in its standard state	Allow description of standard state of an element Allow oxygen is an element and gas in standard conditions Allow because ($\Delta_f H^\ominus$) value for an element is 0	**(1)**

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following points: • balanced reactants and products **(1)** • balanced elements with state symbols **(1)**	An example of a completed cycle:  Accept elements in any order Allow top heavy fractions throughout	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(b)(iii)	An answer that makes reference to the following points: • expression for calculation of enthalpy change of combustion **(1)** • answer **and** negative sign **(1)**	<u>Example of calculation</u>: ΔH = – Δ_fH reactants + Δ_fH products OR = − (−359) + (4 × −394) + (5 × −286) = **−**2647 (kJ mol^{-1}) Ignore SF except 1 SF Ignore units even if incorrect TE from balancing in 21(b)(ii)	**(2)**

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Question Number	Answer	Additional Guidance	Mark
21(c)	An answer that makes reference to any two of the following points: • heat is lost (in the enthalpy experiment) OR no account has been taken of the heat capacity of the beaker **(1)** • incomplete combustion (of alcohol) **(1)** • some alcohol evaporates **(1)**	Allow energy lost Allow heat transfer Ignore heat lost/transferred to the thermometer Ignore incomplete burning Do not award references to time Ignore evaporation of water / mass change Allow "no stirrer so temperature is not uniform" for 1 of the marks Ignore human error Ignore non-standard conditions	**(2)**

(Total for Question 21 = 12 marks)

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Question Number	Answer	Additional Guidance	Mark
22(a)	An answer that makes reference to the following points: • (dark) grey / black **and** solid	Ignore shiny / metallic	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	• the ability of an atom to attract a bonding/shared pair of electrons (in a covalent bond)	Allow "ability of an atom to attract electron**s** in a covalent bond"	**(1)**

Question Number	Answer		Additional Guidance	Mark
22(b)(ii)	An explanation that makes reference to the following points:			**(2)**
	• elements become less electronegative (down the group)	**(1)**	Allow decreases Allow descriptions using names of elements	
	• the outer electron(s)/shell is further away from the (positive) nucleus (so the bonding electrons are less strongly attracted)	**(1)**	Allow increased repulsion (from inner electrons) Allow more shielding (by inner electrons) Allow more (inner) shells of electrons Allow effective nuclear charge is lower Ignore other comments about nuclear charge Ignore size/radius of atom increases Allow reverse argument Marks are independent	

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<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>22 (c)*</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>

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	Indicative content: **IP1** all are disproportionation reactions (because chlorine is both oxidised and reduced) **IP2** chlorine changes/is reduced from 0 to –1 (in Cl^- in all reactions) **IP3** $Cl_2 + H_2O \rightleftharpoons HCl + HOCl$ **IP4** $Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$ **IP5** $3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$ **IP6** chlorine oxidised to +1, +1 and +5 shown in the appropriate reaction	Allow for a description, including the name, of disproportionation if a reaction type is not given for all three equations Allow disproportional/disproportion reaction Allow $Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$ Allow single arrow instead of equilibrium sign Allow HClO or ClOH Allow $Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$ Allow $3Cl_2 + 6OH^- \rightarrow ClO_3^- + 5Cl^- + 3H_2O$ Allow oxidation numbers shown next to a combination of correct names and formulae even if the equations are not balanced Ignore state symbols even if incorrect	

Total for Question 22 = 10 marks)

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Question Number	Answer	Additional Guidance	Mark
23 (a)(i)	• **carbon monoxide** / **CO** is (a) toxic (gas)	Allow explanations of toxicity in terms of reaction with haemoglobin Allow poisonous Ignore "fumes are toxic" Ignore harmful Ignore "it is toxic" Do not award corrosive	**(1)**

Question Number	Answer	Additional Guidance	Mark
23 (a)(ii)	An answer that makes reference to the following points: • M_r of MgC_2O_4 and $MgCO_3$ **(1)** • mass of MgC_2O_4 that reacts **(1)** • mass of $MgCO_3$ that is formed **(1)** • mass of MgC_2O_4 remaining **and** total solid	Example calculation: M_r MgC_2O_4 = 112.3 and M_r $MgCO_3$ = 84.3 6.0 × 0.7 = 4.2 (g) **OR** 6.0 × 0.3 = 1.8 (g) (4.2 ÷ 112.3) × 84.3 = 3.15 (g) (6.0 – 4.2 = 1.8 (g)) 3.15 + 1.8 = 4.95 (g) Alternative method: (moles oxalate calculated) 6 ÷ 112.3 = 0.05343 (moles carbon monoxide calculated) 0.7 × 0.05343 = 0.03740 (mass carbon monoxide calculated) 0.03740 × 28 = 1.0472 (g) mass of solid remaining 6.0 – 1.0472 = 4.95(28) (g) Ignore SF except 1SF Allow use of Magnesium as 24 to get 4.96 (g) Correct answer with some working scores (4)	**(4)**

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Question Number	Answer		Additional Guidance	Mark
23 (b)	An answer that makes reference to the following points:			**(3)**
	• the temperature of decomposition of carbonates / thermal stability increases (down the group)	**(1)**	Ignore references to rate Ignore "decomposition decreases down the group" Allow amount of heat energy needed to decompose increases down the group	
	• the size of the **cation** increases (but has the same charge)	**(1)**	Accept reference to the metal ion size/radius Allow charge density of (cat)ion decreases Ignore "ion size decreases" Do not award atomic radius	
	• (so) polarises the anion / carbonate (ion) less	**(1)**	Allow polarises electron cloud less Allow weakens the carbon oxygen bond	

(Total for Question 23 = 8 marks)

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Section C

Question Number	Answer	Additional Guidance	Mark
24(a)	An answer that makes reference to the following points: • urea forms hydrogen bonds **(1)** • urea forms (permanent) dipole-dipole forces **(1)** • these forces are stronger than London forces **(1)**	Ignore references to number of hydrogen bonds Allow a correct diagram Allow hydrogen bonds are the strong**est** intermolecular forces Allow dispersion forces/van der Waals for London forces Do not award M3 if breaking covalent bonds is referenced	**(3)**

Question Number	Answer	Additional Guidance	Mark
24(b)	An answer that makes reference to the following points: • M_r of urea **(1)** OR moles of urea • mass of urea required **(1)**	M_r = 60 (9.07 ÷ 1000) × 150 = 1.36(05) (9.07 ÷ 1000) × 150 × 60 = 81.63 (g) / 81.6 (g) Ignore SF except 1 SF Correct answer scores (2) No M2 if units other than grams are used	**(2)**

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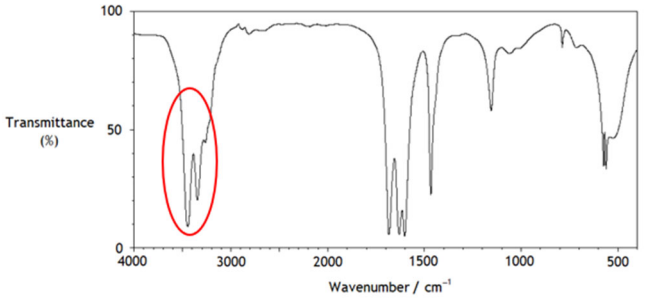
Question Number	Answer	Additional Guidance	Mark
24(c)	An answer that makes reference to the following point: • (oxides of nitrogen lead to the formation of) acid rain	Allow formation of photochemical smog Allow "NO can react with ozone" Allow descriptions of acid rain formation e.g. forms HNO_3 Do not award greenhouse effect / global warming Do not award depletes the ozone layer without reference to nitrogen(II) oxide/NO	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(d)(i)	An answer that makes reference to the following point • correct peak circled	Example of completed spectra:  Allow any number of the three peaks in the region to be circled individually Extra circles negate the mark	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(d)(ii)	An answer that makes reference to the following point • C=O		**(1)**

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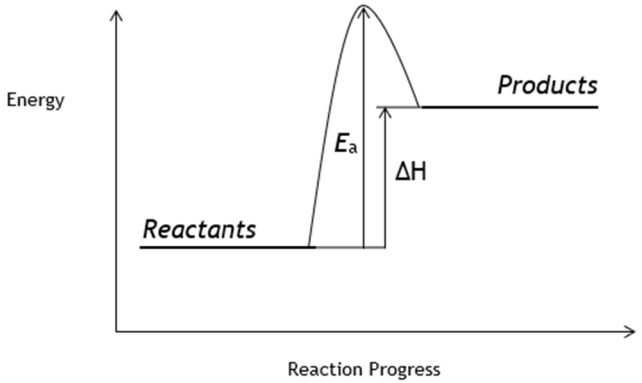
Question Number	Answer	Additional Guidance	Mark
24(e)(i)	An answer that makes reference to the following points • products **and** reversible arrow	Example of balanced equation: $\rightleftharpoons 2NH_3 + CO_2$ Accept products in any order Allow multiples if equation is balanced Allow 2 full headed arrows, one in either direction	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(e)(ii)	An answer that makes reference to the following points: • line labelled products higher than line labelled reactants and to the right **(1)** • Δ*H* labelled correctly **(1)** • E_a labelled correctly **(1)**	 Accept actual reactants and products labelled on diagram (even if slightly incorrect names or formulae are used) Ignore state symbols even if incorrect Allow ΔH given as +133 Double-headed arrows penalised once only Arrows in wrong direction or missing heads penalised each time M2 and M3 can be given as a TE on exothermic reaction if arrows are consistent	**(3)**

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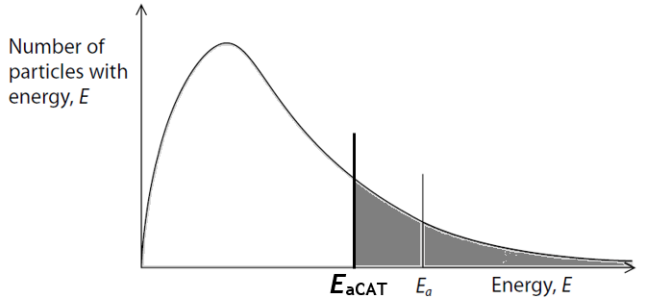
Question Number	Answer	Additional Guidance	Mark
24(f)(i)	An explanation that makes reference to the following points: • the urea is a reactant and forms a new product (that leaves the catalytic converter)	Allow "catalysts are not used up in the reaction" Allow "urea is used up in the reaction" Allow "the amount/mass of urea changed" Allow "urea is not reformed" Allow "the catalyst is a metal oxide" Ignore references to activation energy / rate / reusable Do not award "catalysts do not react"	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(f)(ii)	An explanation that makes reference to the following points: • catalyst decreases the activation energy required **(1)** • more particles have the energy required for the reaction to take place **(1)** • increases the number of successful collisions per unit time / frequency of successful collisions **(1)**	Example of a completed diagram  Accept M1 shown on the diagram Allow "Ea moves to the left" Allow area under the curve above Ea increases for M2 NOTE: Shading is not required, but incorrect shading would negate M2	**(3)**

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Question Number	Answer	Additional Guidance	Mark
24(g)(i)	• hot gases from the engine warm up the catalytic converter	Allow uses the (heat) energy from the engine Allow energy from combustion of fuel Allow the reactions that occur in the catalytic converter are exothermic	**(1)**

Question Number	Answer		Additional Guidance	Mark
24(g)(ii)	• conversion of m^3 to dm^3	**(1)**	<u>An example of a calculation:</u> 89.3 × 1000 = 89300 dm^3	**(3)**
	• moles of nitrogen	**(1)**	89300 ÷ 51.1 = 1747.6 / 1748 mol	
	• number of molecules of nitrogen	**(1)**	1748 × 6.02 × 10^{23} = 1.052 ×10^{27} / 1.05 ×10^{27} / 1.1 ×10^{27} Allow TE throughout Ignore SF except 1SF Ignore units even if incorrect 1.052 ×10^{24} / 1.05 ×10^{24} / 1.1 ×10^{24} scores 2 1.052 ×10^{21} / 1.05 ×10^{21} / 1.1 ×10^{21} scores 2 2.747 ×10^{30} / 2.75 ×10^{30} / 2.8 ×10^{30} scores 2 Correct answer with some working scores (3)	

(Total for Question 24 = 20 marks)

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

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