Pearson Edexcel

Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH12)
Paper 1: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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

January 2021
Publications Code WCH12_01_2101_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.

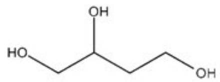
Section A

Question Number	Correct Answer	Mark
1	**The only correct answer is A** (X) ***B*** *is incorrect as Y represents the activation energy of the reverse reaction* ***C*** *is incorrect as X-Y is the enthalpy change for the reaction* ***D*** *is incorrect as X+Y is the sum of the activation energies*	**1**

Question Number	Correct Answer	Mark
2	**The only correct answer is C** ($CH_3C(CH_3)_2CH_2CH(CH_3)CH_3$) ***A*** *is incorrect as this structure has less branching* ***B*** *is incorrect as structure has less branching* ***D*** *is incorrect as structure has no branching*	**1**

Question Number	Correct Answer	Mark
3	**The only correct answer is C** (hydrogen fluoride, HF) ***A*** *is incorrect as it does not contain an O, N or F atom* ***B*** *is incorrect as it does not contain an electropositive H atom* ***D*** *is incorrect as it does not contain an O, N or F atom*	**1**

Question Number	Correct Answer	Mark
4	**The only correct answer is C** (trigonal pyramid, 107°) ***A*** *is incorrect as the hydroxonium ion has 3 bond pairs and one lone pair of electrons* ***B*** *is incorrect as the hydroxonium ion has 3 bond pairs and one lone pair of electrons* ***D*** *is incorrect as the hydroxonium ion has 3 bond pairs and one lone pair of electrons*	1

Question Number	Correct Answer	Mark
5	**The only correct answer is C** () ***A*** *is incorrect as the liquid only contains one OH group so less hydrogen bonding forms* ***B*** *is incorrect as the liquid only contains two OH groups so less hydrogen bonding forms* ***D*** *is incorrect as the liquid does not form hydrogen bonds*	1

Question Number	Correct Answer	Mark
6(a)	**The only correct answer is D** (dense white smoke) ***A*** *is incorrect as the reaction produces misty fumes of HI* ***B*** *is incorrect as the reaction produces the black solid* I_2 ***C*** *is incorrect as the reaction produces the yellow solid S*	1

Question Number	Correct Answer	Mark
6(b)	**The only correct answer is A** (−8) ***B*** *is incorrect as -6 is the change in oxidation number when S(s) forms* ***C*** *is incorrect as -2 is the oxidation number of S in* H_2S ***D*** *is incorrect as +6 is the oxidation number of S in* H_2SO_4	**1**

Question Number	Correct Answer	Mark
7	**The only correct answer is D** (2, 5, 10) ***A*** *is incorrect as charges and oxygen atoms do not balance* ***B*** *is incorrect as charges and oxygen atoms do not balance* ***C*** *is incorrect as charges, oxygen atoms and sulfur atoms do not balance*	**1**

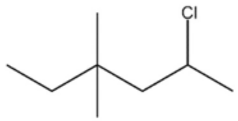
Question Number	Correct Answer	Mark
8	**The only correct answer is C** (hydrogen ions act as oxidising agents) ***A*** *is incorrect as magnesium atoms lose electrons* ***C*** *is incorrect as hydrogen molecules are a product* ***D*** *is incorrect as chloride ions do not gain or lose electrons*	**1**

Question Number	Correct Answer	Mark
9	**The only correct answer is C** (NH_4Cl) ***A*** *is incorrect as Ca^{2+} does not produce an alkaline gas when warmed with sodium hydroxide solution* ***B*** *is incorrect as Mg^{2+} does not produce an alkaline gas when warmed with sodium hydroxide solution* ***D*** *is incorrect as Be^{2+} does not produce an alkaline gas when warmed with sodium hydroxide solution*	1

Question Number	Correct Answer	Mark
10	**The only correct answer is B** (reducing ability of the halide ions) ***A*** *is incorrect as the oxidising ability of the molecular halogens decreases down the group* ***C*** *is incorrect as the electrostatic attraction between nucleus and outer shell of electrons decreases down the group* ***D*** *is incorrect as electronegativity decreases down the group*	1

Question Number	Correct Answer	Mark
11	**The only correct answer is D** (butane) ***A*** *is incorrect as it the standard enthalpy of combustion is −(16 x 55.6) kJ mol^{-1}* ***B*** *is incorrect as it the standard enthalpy of combustion is −(30 x 52.0) kJ mol^{-1}* ***C*** *is incorrect as it the standard enthalpy of combustion is −(44 x 50.4) kJ mol^{-1}*	1

Question Number	Correct Answer	Mark
12	**The only correct answer is B** (+1.2 kJ mol^{-1}) ***A*** *is incorrect as* +113.2 *is the value for* $CH_3COO^- + 2H_2O \rightarrow CH_3COOH + H^+ + 2OH^-$ ***C*** *is incorrect as* −1.2 *is the value for* $CH_3COO^- + H^+ \rightarrow CH_3COOH$ ***D*** *is incorrect as* −113.2 *is the value for* $CH_3COOH + H^+ + 2OH^- \rightarrow CH_3COO^- + 2H_2O$	1

Question Number	Correct Answer	Mark
13	**The only correct answer is B**  ***A*** *is incorrect as it is 2-chloro-5,5-dimethylhexane* ***C*** *is incorrect as it is 2-chloro-3,3-dimethylhexane* ***D*** *is incorrect as it is 1-chloro-3,3-dimethylcyclohexane*	1

Question Number	Correct Answer	Mark
14(a)	**The only correct answer is B** (elimination) ***A*** *is incorrect as alcohols do not have a double bond* ***C*** *is incorrect as water is a product not a reactant* ***D*** *is incorrect as C=C double bonds do not form via substitution reactions*	1

Question Number	Correct Answer	Mark
14(b)	**The only correct answer is C** (three) ***A*** *is incorrect as the OH group is not terminal or in a symmetrical alcohol* ***B*** *is incorrect as 4-methylpent-2-ene has E/Z isomers* ***D*** *is incorrect as 2-methylpent-2-ene does not have E/Z isomers*	**1**

Question Number	Correct Answer	Mark
15	**The only correct answer is B** (300 cm^3) ***A*** *is incorrect as it assumes the ratio of magnesium nitrate to gaseous products is 1:5* ***C*** *is incorrect as it assumes the only gaseous product is* NO_2 ***D*** *is incorrect as it assumes the ratio of magnesium nitrate to gaseous products is 1:1*	**1**

Question Number	Correct Answer	Mark
16	**The only correct answer is A** ((0.80 × 15.1) ÷ 60) ***B*** *is incorrect as mass does* ***not*** *equal density ÷ volume* ***C*** *is incorrect as moles does* ***not*** *equal* M_r *÷ mass* ***D*** *is incorrect as mass does* ***not*** *equal volume ÷ density*	**1**

Question Number	Correct Answer	Mark
17	**The only correct answer is D** (83.3 g) ***A*** *is incorrect as the scaling of the reacting amount to take into account the yield of 36% is incorrect (36/100)* ***B*** *is incorrect as the reacting amount has not been scaled to take into account the yield of 36%* ***C*** *is incorrect as the scaling of the reacting amount to take into account the yield of 36% in incorrect (136/100)*	**1**

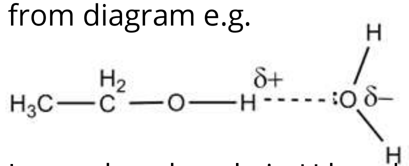
Question Number	Correct Answer	Mark
18	**The only correct answer is C** (300 cm^3) ***A*** *is incorrect as the stoichiometry has not been considered* ***B*** *is incorrect as the stoichiometry and the differences in concentration have not been considered* ***D*** *is incorrect as the stoichiometry has not been considered and the ratio of concentrations has been used the wrong way round*	**1**

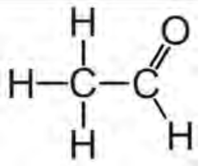
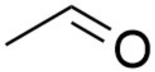
(Total for Section A = 20 marks)

Section B

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>19(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><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></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><td></td><td>Number of marks awarded for structure of answer and sustained lines of reasoning</td></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>
Indicative Points
</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 four 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 and overall score of 3 marks (3 marks for indicative content and zero marks for linkages).
Note – allow reverse arguments where appropriate e.g. IP1 and IP5
</td>
<td>6</td>
</tr>
</table>

	• **IP1** High temperature increases rate as more particles have E≥ E_a • **IP2** Catalyst increases rate by providing alternative mechanism / catalysts lower activation energy • **IP3** but high temperature reduces yield / moves eqm to LHS as reaction is exothermic • **IP4** so (high) temperature (of 300°) is a compromise (between rate and yield) • **IP5** high pressure increases the yield as reaction / equilibrium moves to side of fewest particles / high pressure increases rate as more particles in the same volume • **IP6** (low yield acceptable) as unconverted reactants can be recycled / passed through reactor again	May be shown on a labelled diagram Allow compromise between temperature or pressure and energy costs / equipment to withstand pressure/ costs to maintain temperature / costs to maintain pressure Allow (low yield acceptable) as ethanol is removed as it forms to move equilibrium to RHS Ignore any references to environmental effects / atom economy	

Question Number	Acceptable Answers	Additional Guidance	Mark
19(b)	An explanation that makes reference to the following points: • when they mix can form hydrogen bonds (to each other) **(1)** • as both compounds have hydrogen bonds (between their molecules) OR forces that form are similar in strength or stronger than hydrogen bonds in water / ethanol **(1)** • from the lone pair / slight negative charge on an oxygen (atom in one molecule) to a slightly positive hydrogen (atom in the other molecule) (on OH group or water) **(1)**	Ignore references to other intermolecular forces Allow ethanol-water forces can overcome ethanol-ethanol / water-water forces M1 and M3 can be awarded from diagram e.g.  Ignore bond angle in H bond diagram Ignore hydrocarbon structure on ethanol	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
19(c)(i)		Allow  Allow CH_3CHO Allow 'hybrid' structure e.g. skeletal but with some parts of the structure displayed Ignore bond angles Ignore correct molecular formulae Ignore attempts to write a balanced equation Ignore names even if incorrect Note Look out for structures drawn above the stem If 2 structures shown, e.g. skeletal and displayed, but one is incorrect then award 0 marks	1

Question Number	Acceptable Answers	Additional Guidance	Mark
19(c)(ii)	An answer that makes reference to the following points: • Y - Distil (off Y from reaction mixture as it forms) **(1)** • Ethanoic acid – (heat under) reflux **(1)**	Note if both answers given but the wrong way round allow 1 mark If no other mark is awarded, controlling the amount of oxidising agent in either case scores (1) Ignore temperatures if given	**2**

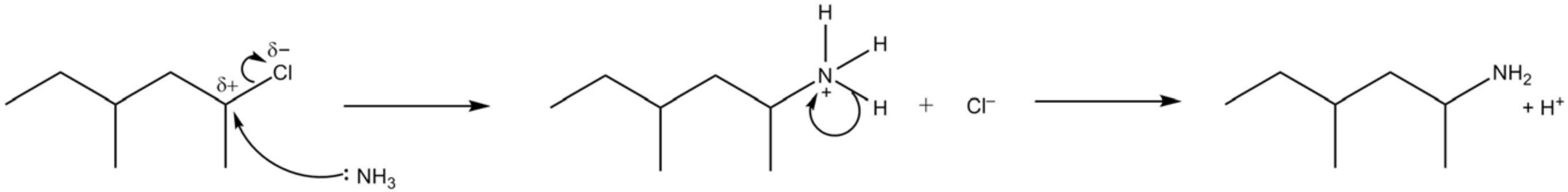
(Total for Question 19 = 12 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
20(a)(i)	• 4-methylhexan-2-ol	Allow 4-methyl-2-hexanol Allow 4-methylhexane-2-ol Ignore incorrect punctuation Do not award 4-methylhex-2-ol	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
20(a)(ii)	• PCl_5 / phosphorus(V) chloride / phosphorus pentachloride	Allow **concentrated** hydrochloric acid / conc.HCl or thionyl chloride / $SOCl_2$ Allow PCl_3 / phosphorus(III) chloride / phosphorus trichloride Allow conc.H_2SO_4 and KCl If name and the formula are given, both must be correct Ignore just HCl / hydrochloric acid	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
20(a)(iii)	A mechanism that includes the following points • arrow from lone pair on nitrogen atom in ammonia to carbon atom **(1)** • dipole shown and arrow from C–Cl bond to Cl or just beyond **(1)** • formula of intermediate including the + charge on the N atom **and** Cl^- **(1)** • arrow from N-H bond of the intermediate to N(+ and formulae of products) **(1)**	See example mechanism below M1 and M2 can be awarded if shown in 2 steps, via a carbocation Ignore any bases Ignore missing H^+ Ignore errors in hydrocarbon chain	**4**

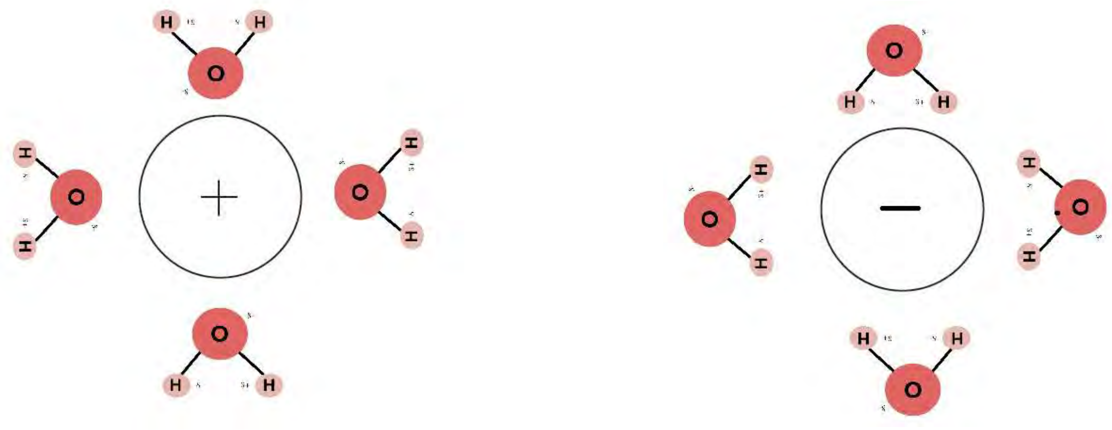
<u>Example of mechanism</u>



Question Number	Acceptable Answers	Additional Guidance	Mark
20(b)(i)	An explanation that makes reference to the following points: • (the bond formed is a) dative (covalent) / coordinate bond **(1)** • As the (lone) pair of electrons on the nitrogen (atom) **(1)** • (form the bond) as hydrogen (ion) has an empty orbital / no electrons **(1)**	Allow 'two electrons from the nitrogen' Ignore 'lone pair on the ammonia' Allow can be donated to / shared with the hydrogen (ion) Do not award hydrogen atom	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
20(b)(ii)	A diagram that includes the following points: • dipole on at least one of the water molecules **(1)** • DMAA ion is attracted to slightly negative oxygen atoms (in water) **(1)** • chloride ion is attracted to slightly positive hydrogen atoms (in water) **(1)**	must be at least 2 water molecules surrounding an ion Ignore lone pairs on oxygen Allow orientation showing only 1 H attracted to ion Allow slight positive charge shown on only 1 H atom Correct diagram but with missing dipoles loses M1 but can score M2 and M3 Ignore attempts to show 'force' or 'bond' e.g. with dashes / arrows Ignore any additions to the circles	**3**

Example of diagram for Q20bii



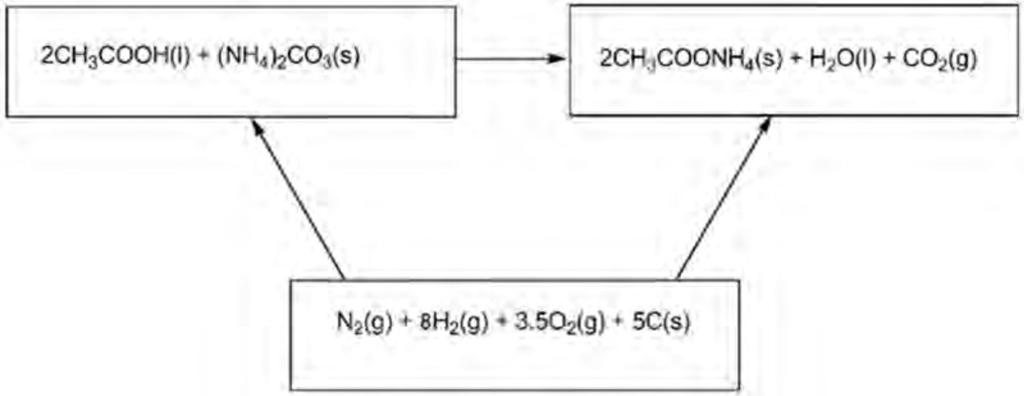
(Total for Question 20 = 12 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
21(a)	An answer that makes reference to the following points: • (white) solid / crystals / sodium carbonate dissolves **(1)** • (colourless) bubbles(of gas) / effervescence / fizzing **(1)**	Allow colourless solution forms Allow solid / sodium carbonate disappears Do not award just solid / sodium carbonate becomes smaller Do not award sodium dissolves / disappears Ignore incorrect formula for sodium carbonate Ignore just 'gas / carbon dioxide / CO_2 produced' Ignore limewater test on gas produced Do not award bubbles of an incorrect gas e.g. bubbles of oxygen Ignore 'heat is given off' Do not award 'solid melts' Do not award precipitate forms Do not award 'coloured solution forms' Apply list principle if more than 2 observations given	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
21(b)	• calculation of molar mass of hydrated sodium ethanoate **(1)** • calculation of moles of hydrated sodium ethanoate **(1)** • calculation of energy released **(1)** • calculation of ΔT **(1)** • calculation of final T **(1)**	Example of calculation 136 (g mol^{-1}) 20.1 ÷ 136 = 0.14779 (mol) 0. 14779 × 19700 = 2911.5 / 2.911 x 10^{3} (J) / 2.911 (kJ) 2911.54 ÷ (63.2 × 3.0) = 15.3562 (°C) 15.3562 + 5.0 = 20 / 20.4 (°C) Allow TE throughout but TE for M5 must give temperature of 50°C or less Ignore SF	**5**

Question Number	Acceptable Answers	Additional Guidance	Mark
21(c)	• top 2 boxes of Hess Cycle complete (reaction) **(1)** • bottom box of Hess Cycle complete (elements) **(1)** • inclusion of multiples of 2 for $\Delta_f H^{\ominus}$[CH_3COOH(l)] and $\Delta_f H^{\ominus}$[CH_3COONH_4(s)] **(1)** • evidence of correct manipulation of Hess Cycle to find $\Delta_r H^{\ominus}$(products – reactants) **(1)** • calculation of final answer **(1)**	<u>Example of calculation</u> See below for example of cycle Penalise incorrect / omission of state symbols once only in M1 and M2 Allow H_2CO_3(aq) in top right box (2 × −586.3) **and** (2 × −484.5) [(2 × −586.3) + (−285.8) + (−393.5)] – [(2 × −484.5) + (−939.9)] = (+) 57 kJ mol^{-1} Allow TE from M3 to M4 and M5 No TE from an incorrect Hess Cycle Correct answer with no working scores M3, M4 and M5 Lack of multiples in M3 gives (+) 158.8, which scores M4 and M5	**5**

Example of completed diagram



Question Number	Acceptable Answers	Additional Guidance	Mark
21(d)	• calculation of mass of ammonium carbonate in 1 dm^3 of solution **(1)** • calculation of concentration of solution **(1)** OR • Calculation of number of moles of ammonium carbonate **(1)** • calculation of concentration of solution **(1)**	<u>Example of calculation</u> 1.8 x 10 = 18 (g dm^{-3}) 18 ÷ 96 = 0.1875 (mol dm^{-3}) 1.8 ÷ 96 = 0.01875 (mol) 0.01875 ÷ 0.1 = 0.1875 (mol dm^{-3}) Correct answer no working scores 2 Ignore SF except 1 SF in final answer	**2**

(Total for Question 21 = 14 marks)
(Total for Section B = 38 marks)

Section C

Question Number	Acceptable Answers	Additional Guidance	Mark
22(a)(i)	$3Ca(OH)_2 + 3Cl_2 + KCl \rightarrow KClO_3 + 3CaCl_2 + 3H_2O$ OR $6Ca(OH)_2 + 6Cl_2 + 2KCl \rightarrow 2KClO_3 + 6CaCl_2 + 6H_2O$	Allow multiples If multiple used allow ‘$CaCl_2$ + 5$CaCl_2$’ Ignore state symbols	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
22(a)(ii)	• calculation of M_r of $KClO_3$ **(1)** • calculation of M_r of all products / reactants **(1)** • calculation of overall atom economy **(1)**	Example of calculation 39.1 + 35.5 + 48 (= 122.6) 122.6 + (3 ×18) + ((71+40.1) × 3) = 509.9 Value for M2 should be consistent with numerator of atom economy expression (122.6 ÷509.9) ×100 = 24.044 = 24.0 % Ignore SF except 1 SF Use of 39 for K or 40 for Ca is acceptable Allow TE from (a)(i) using either M_r of all products or reactants Allow TE throughout calculation But TE for M3 must give a value of less than 100 %	**3**

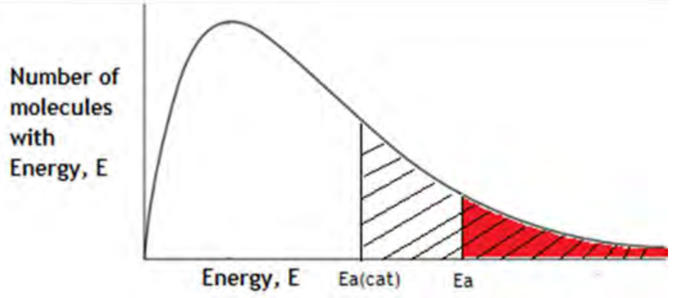
Question Number	Acceptable Answers	Additional Guidance	Mark
22(b)	An explanation that makes reference to the following points: • disproportionation reaction **(1)** • as chlorine (atoms) are oxidised from 0 (in chlorine) to (+) 5 (in calcium chlorate) **(1)** • and reduced (from 0) to −1 (in calcium chloride) **(1)**	Allow incorrect spellings of disproportionation if the word is recognisable and could not be confused with another chemical term Ignore redox Mark independently of M2 and M3 If initial oxidation state of 0 is not referenced at least once in either M2 or M3, then allow 1 for Cl is oxidised to +5 and reduced to -1 Changes in oxidation number can be shown above equation If no reference to oxidation and reduction then allow 1 mark for correct changes in oxidation number	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
22(c)(i)	An answer that makes reference to the following points: • add (dilute) nitric acid and silver nitrate (solution) **(1)** • white precipitate forms / precipitate forms whose colour is difficult to distinguish (between white and cream) **(1)** • which dissolves in dilute ammonia / dilute NH_3 / $NH_3(aq)$ **(1)**	Throughout the question if formulae are given they must be correct Allow acidified silver nitrate / $AgNO_3$ and H^+ Allow $AgNO_3$ Allow HNO_3 Do not award hydrochloric acid / sulfuric acid Allow white solid / white crystals / white ppt Allow aqueous ammonia Allow 'disappears' for dissolves Do not award **just** 'dissolves in concentrated NH_3' M2 and M3 dependent on reference to silver nitrate / $AgNO_3$	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
22(c)(ii)	• calculation of mass of oxygen **(1)** • calculation of moles of oxygen **(1)** • deduction of moles of potassium chlorate /calculation of mass of KCl **(1)** • calculation of mass of potassium chlorate in impure sample **(1)** • calculation of % purity of sample to 2 or 3 SF **(1)**	<u>Example of calculation</u> 1.52 − 1.02 = 0.50 (g) 0.50 ÷ 32 = 0.015625 (mol) 0.015625 × (2÷3) = 0.010417 (mol) / 0.015625 x (2/3) x 74.6 = 0.777 (g) 0.010417 × (39.1 + 35.5 + 48) = 1.2771 (g) / 0.777 + 0.5 = 1.277 (g) = (1.2771 ÷ 1.52) × 100 = 84.019 = 84 / 84.0 (%) Penalise incorrect rounding once only in M1-M4 Allow TE at each step, but TE for M5 must give a value less than 100% and based on 1.52 Allow alternative methods based on finding x where x = mass of impurity	**5**

Question Number	Acceptable Answers	Additional Guidance	Mark
22(d)(i)	potassium chlorate(VII) OR chlorate(VII) potassium	Allow pottassium chlorate(VII) Do not award just potassium chlorate	1

Question Number	Acceptable Answers	Additional Guidance	Mark
22(d)(ii)	An explanation that makes reference to any four of the following points: • heat to constant mass so all of the potassium chlorate(V) decomposes **(1)** • the solid product or potassium chloride dissolves (when the water is added) **(1)** • the rinsing removes potassium chloride (solution, which would otherwise add to the mass of the solid when it dries **(1)** • drying ensures the final mass recorded is only that of that catalyst **(1)** • the mass (of solid) recorded (at the end of the procedure) should be the same of that of the catalyst at the start **(1)**	Allow so all $KClO_3$ reacts / so reaction goes to completion Allow the catalyst does not dissolve (when the water is added) Ignore KCl reacts with the water / catalyst does not react with the water Allow to remove soluble impurities (from catalyst) Allow 'to remove water from the catalyst' / 'ensure the catalyst is dry' Allow 'to compare to the mass of catalyst' Allow 'to check the mass (of catalyst) hasn't changed'	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
22(e)	An explanation that makes reference to the following points: • activation energies shown and labelled for both catalysed and uncatalysed reaction **(1)** • number of molecules with $E > E_a$ shown on diagram **(1)**	 M2 can be awarded by written description	2

(Total for Question 22 = 22 marks)

(Total for Section C = 22 marks)

Total for Paper = 80 marks

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom