AQA

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AS
CHEMISTRY
7404/2

Paper 2 Organic and Physical Chemistry

Mark scheme

June 2020

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206A74042/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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AS and A-Level Chemistry
Mark Scheme Instructions for Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information in the 'Comments' column is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

You should mark according to the contents of the mark scheme. If you are in any doubt about applying the mark scheme to a particular response, consult your Team Leader.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which might confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

The use of M1, M2, M3 etc in the right-hand column refers to the marking points in the order in which they appear in the mark scheme. So, M1 refers to the first marking point, M2 the second marking point etc.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **OR**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general 'List' principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

For example, in a question requiring 2 answers for 2 marks:

Correct answers	Incorrect answers (i.e. incorrect rather than neutral)	Mark (2)	Comment
1	0	1	
1	1	1	They have not exceeded the maximum number of responses so there is no penalty.
1	2	0	They have exceeded the maximum number of responses so the extra incorrect response cancels the correct one.
2	0	2	
2	1	1	
2	2	0	
3	0	2	The maximum mark is 2
3	1	1	The incorrect response cancels out one of the two correct responses that gained credit.
3	2	0	Two incorrect responses cancel out the two marks gained.
3	3	0	

3.2 Marking procedure for calculations

Full marks should be awarded for a correct numerical answer, without any working shown, unless the question states 'Show your working' or 'justify your answer'. In this case, the mark scheme will clearly indicate what is required to gain full credit.

If an answer to a calculation is incorrect and working is shown, process mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.4 Equations

In questions requiring students to write equations, state symbols are generally ignored unless otherwise stated in the 'Comments' column.

Examiners should also credit correct equations using multiples and fractions unless otherwise stated in the 'Comments' column.

3.5 Oxidation states

In general, the sign for an oxidation state will be assumed to be positive unless specifically shown to be negative.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.7 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term or if the question requires correct IUPAC nomenclature.

3.8 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.9 Ignore / Insufficient / Do <u>not</u> allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.10 Marking crossed out work

Crossed out work that **has not been** replaced should be marked as if it were not crossed out, if possible. Where crossed out work **has been** replaced, the replacement work and not the crossed out work should be marked.

3.11 Reagents

The command word "Identify", allows the student to choose to use **either** the name or the formula of a reagent in their answer. In some circumstances, the list principle may apply when both the name and the formula are used. Specific details will be given in mark schemes.

The guiding principle is that a reagent is a chemical which can be taken out of a bottle or container. Failure to identify complete reagents **will be penalised**, but follow-on marks (e.g. for a subsequent equation or observation) can be scored from an incorrect attempt (possibly an incomplete reagent) at the correct reagent. Specific details will be given in mark schemes.

For example, **no credit** would be given for

- the cyanide ion or CN^- when the reagent should be potassium cyanide or KCN;
- the hydroxide ion or OH^- when the reagent should be sodium hydroxide or NaOH;

- the $Ag(NH_3)_2^+$ ion when the reagent should be Tollens' reagent (or ammoniacal silver nitrate). In this example, no credit is given for the ion, but credit could be given for a correct observation following on from the use of the ion. Specific details will be given in mark schemes.

In the event that a student provides, for example, **both** KCN and cyanide ion, it would be usual to ignore the reference to the cyanide ion (because this is not contradictory) and credit the KCN. Specific details will be given in mark schemes.

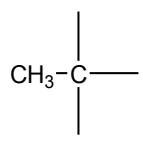
3.12 Organic structures

Where students are asked to draw organic structures, unless a specific type is required in the question and stated in the mark scheme, these may be given as displayed, structural or skeletal formulas or a combination of all three as long as the result is unambiguous.

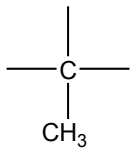
In general

- Displayed formulae must show all of the bonds and all of the atoms in the molecule, but need not show correct bond angles.
- Skeletal formulae must show carbon atoms by an angle or suitable intersection in the skeleton chain. Functional groups must be shown and it is essential that all atoms other than C atoms are shown in these (except H atoms in the functional groups of aldehydes, secondary amines and N-substituted amides which do not need to be shown).
- Structures must not be ambiguous, eg 1-bromopropane should be shown as $CH_3CH_2CH_2Br$ and not as the molecular formula C_3H_7Br which could also represent the isomeric 2-bromopropane.
- Bonds should be drawn correctly between the relevant atoms. This principle applies in all cases where the attached functional group contains a carbon atom, eg nitrile, carboxylic acid, aldehyde and acid chloride. The carbon-carbon bond should be clearly shown. Wrongly bonded atoms will be penalised **on every occasion**. (see the examples below)
- The same principle should also be applied to the structure of alcohols. For example, if students show the alcohol functional group as C ─ HO, they should be penalised **on every occasion**.
- Latitude should be given to the representation of C ─ C bonds in alkyl groups, given that CH_3─ is considered to be interchangeable with H_3C─ even though the latter would be preferred.
- Similar latitude should be given to the representation of amines where NH_2─ C will be allowed, although H_2N─ C would be preferred.
- Poor presentation of vertical C ─ CH_3 bonds or vertical C ─ NH_2 bonds should **not** be penalised. For other functional groups, such as ─ OH and ─ CN, the limit of tolerance is the half-way position between the vertical bond and the relevant atoms in the attached group.

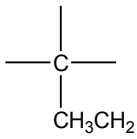
By way of illustration, the following would apply.



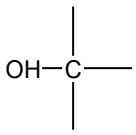
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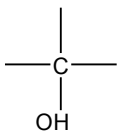
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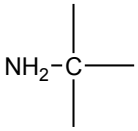
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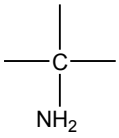
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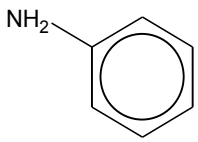
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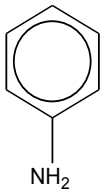
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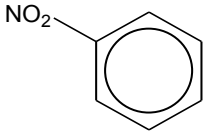
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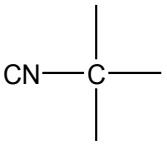
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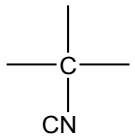
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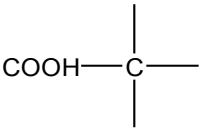
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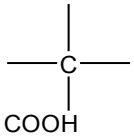
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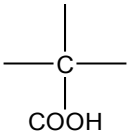
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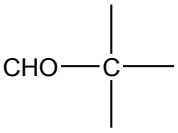
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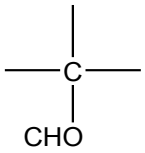
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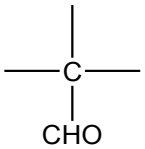
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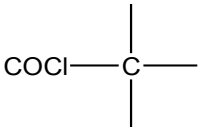
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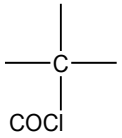
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- Representation of CH_2 by $C–H_2$ will be penalised
- Some examples are given here of **structures** for specific compounds that should **not** gain credit (but, exceptions may be made in the context of balancing equations)

CH_3COH	for	ethanal
CH_3CH_2HO	for	ethanol
$OHCH_2CH_3$	for	ethanol
C_2H_6O	for	ethanol
CH_2CH_2	for	ethene
$CH_2.CH_2$	for	ethene
$CH_2:CH_2$	for	ethene

- Each of the following **should gain credit** as alternatives to correct representations of the structures.

$CH_2 = CH_2$	for	ethene, $H_2C=CH_2$
$CH_3CHOHCH_3$	for	propan-2-ol, $CH_3CH(OH)CH_3$

- In most cases, the use of "sticks" to represent C ─ H bonds in a structure should **not** be penalised. The exceptions to this when "sticks" will be penalised include
    - structures in mechanisms where the C ─ H bond is essential (e.g. elimination reactions in halogenoalkanes and alcohols)
    - when a displayed formula is required
    - when a skeletal structure is required or has been drawn by the candidate

3.13 Organic names

As a general principle, non-IUPAC names or incorrect spelling or incomplete names should **not** gain credit. Some illustrations are given here.

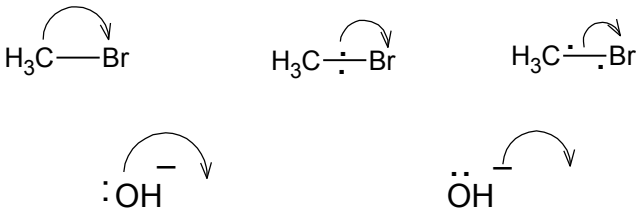
Unnecessary but not wrong numbers will **not** be penalised such as the number '2' in 2-methylpropane or the number '1' in 2-chlorobutan-1-oic acid.

but-2-ol	should be **butan-2-ol**
2-hydroxybutane	should be **butan-2-ol**
butane-2-ol	should be **butan-2-ol**
2-butanol	should be **butan-2-ol**
ethan-1,2-diol	should be **ethane-1,2-diol**
2-methpropan-2-ol	should be **2-methylpropan-2-ol**
2-methylbutan-3-ol	should be **3-methylbutan-2-ol**
3-methylpentan	should be **3-methylpentane**
3-mythylpentane	should be **3-methylpentane**
3-methypentane	should be **3-methylpentane**
propanitrile	should be **propanenitrile**
aminethane	should be **ethylamine** (although aminoethane can gain credit)
2-methyl-3-bromobutane	should be **2-bromo-3-methylbutane**
3-bromo-2-methylbutane	should be **2-bromo-3-methylbutane**
3-methyl-2-bromobutane	should be **2-bromo-3-methylbutane**
2-methylbut-3-ene	should be **3-methylbut-1-ene**
difluorodichloromethane	should be **dichlorodifluoromethane**

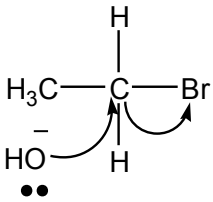
3.14 Organic reaction mechanisms

Curly arrows should originate either from a lone pair of electrons or from a bond.

The following representations should not gain credit **and will be penalised each time** within a clip.



For example, the following would score zero marks



When the curly arrow is showing the formation of a bond to an atom, the arrow can go directly to the relevant atom, alongside the relevant atom or **more than half-way** towards the relevant atom.

In free-radical substitution

- the absence of a radical dot should be penalised **once only** within a clip.
- the use of half-headed arrows is not required, but the use of double-headed arrows or the incorrect use of half-headed arrows in free-radical mechanisms should be penalised **once only** within a clip

The correct use of skeletal formulae in mechanisms is acceptable, but where a C-H bond breaks, both the bond and the H must be drawn to gain credit.

3.15 Extended responses

For questions marked using a 'Levels of Response' mark scheme:

Level of response mark schemes are broken down into three levels, each of which has a descriptor. Each descriptor contains two statements. The first statement is the Chemistry content statement and the second statement is the communication statement.

Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the Chemistry content descriptor for that level. The descriptor for the level indicates the qualities that might be seen in the student's answer for that level. If it meets the lowest level, then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Once the level has been decided, the mark within the level is determined by the communication statement:

- If the answer completely matches the communication descriptor, award the higher mark within the level.
- If the answer does not completely match the communication descriptor, award the lower mark within the level.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an exemplar in the standardising materials which will correspond with each level of the mark scheme and for each mark within each level. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the exemplar to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the exemplar.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other chemically valid points. Students may not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme. The mark scheme will state how much chemical content is required for the highest level.

An answer which contains nothing of relevance to the question must be awarded no marks.

For other extended response answers:

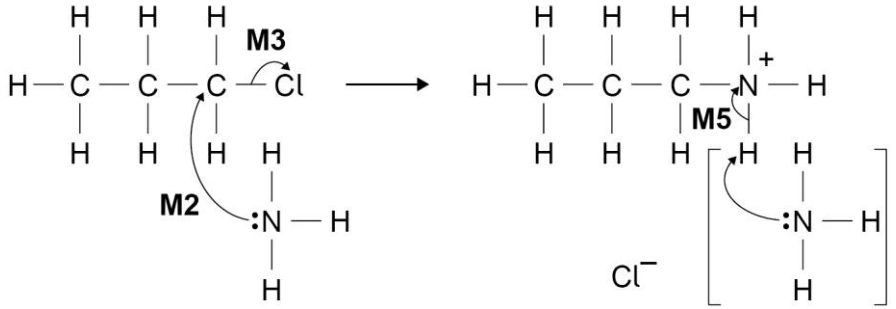
Where a mark scheme includes linkage words (such as 'therefore', 'so', 'because' etc), these are optional. However, a student's marks for the question may be limited if they do not demonstrate the ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. In particular answers in the form of bullet pointed lists may not be awarded full marks if there is no indication of logical flow between each point or if points are in an illogical order.

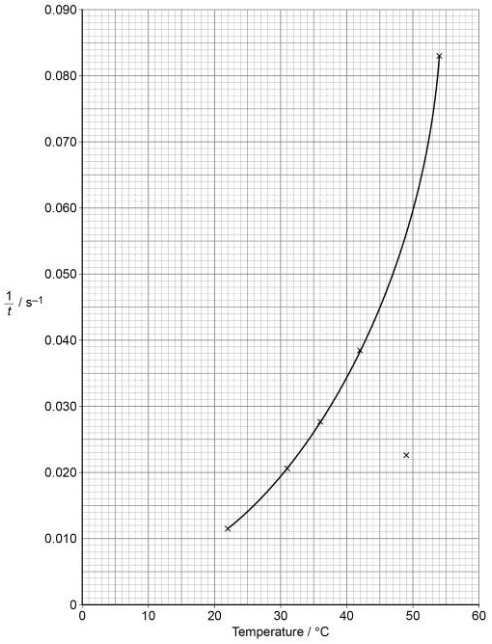
The mark schemes for some questions state that the maximum mark available for an extended response answer is limited if the answer is not coherent, relevant, substantiated and logically structured. During the standardisation process, the Lead Examiner will provide marked exemplar material to demonstrate answers which have not met these criteria. You should use these exemplars as a comparison when marking student answers.

Question	Marking guidance	Additional Comments/Guidelines	Mark
01.1	**M1** The <u>enthalpy / heat energy change</u> when 1 mol (of a substance / compound / product) is formed from its (constituent) elements **M2** with (all) reactants and products / <u>all</u> substances in standard states	**M1** energy change is not sufficient – must refer to enthalpy change or heat energy change **M2** or with (all) reactants and products / substances in normal states under standard conditions / 100 kPa and any specified temperature (usually 298 K) Ignore reference to 1 atmosphere If enthalpy of combustion given rather than formation, then mark **M1** and **M2** independently, and **M2** could score.	1 1
01.2	**M1** ΔH = [sum $\Delta_f H$ products] – [sum $\Delta_f H$ reactants] **or** –114 = [3(–130) – 972] – [3X – 339] **or** 3X = 3(–130) – 972 + 339 + 114 **M2** 3X = –909 **M3** X = –303 (kJ mol^{-1})	–303 scores 3 marks (+303 scores 2 marks) –909 scores 2 marks (+909 scores 1 mark) ignore units **M2** No ECF from **M1 (**except +909 or arithmetic error) **M3** ECF from **M2**, ie **M3** ÷ 3	1 1 1

01.3	**M1** provides energy to break (covalent) bond in chlorine / Cl_2 or to form chlorine free radicals **M2** $CH_3CH_2CH_3 + {\bullet}Cl \rightarrow {\bullet}CH_2CH_2CH_3 + HCl$ **M3** ${\bullet}CH_2CH_2CH_3 + Cl_2 \rightarrow ClCH_2CH_2CH_3 + {\bullet}Cl$	**M2** and **M3**: • must show structure of ${\bullet}CH_2CH_2CH_3$ in at least one of the equations to score both marks (dot must be on or around the end CH_2 group), but only penalise ${\bullet}C_3H_7$ once across both equations if both equations otherwise correct • on this occasion, molecular formula of propane can be allowed for **M2** • on this occasion, molecular formula of 1-chloropropane can be allowed for **M3** • penalise absence of radical dots once • allow equations in either order	1 1 1

01.4	the ability/power of atom to attract/withdraw the <u>2/pair</u> of electrons in a covalent bond	allow nucleus in place of atom	1

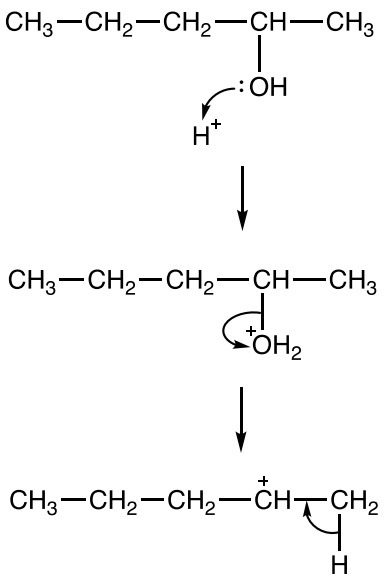
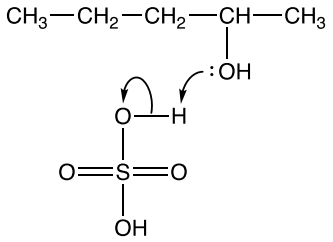
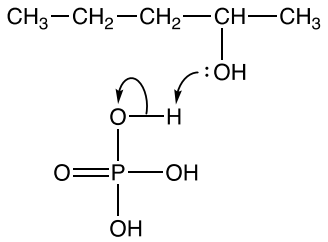
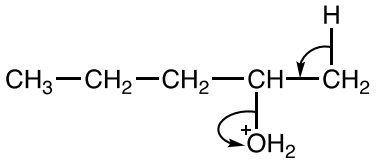
01.5	**M1** nucleophilic substitution **M4 Structure**  **M2** curly arrow from lone pair on N of NH_3 to the correct C atom **M3** must show the movement of a pair of electrons from the C−Cl bond to the Cl atom; mark **M3** independently provided it is from <u>their original molecule</u> **M4** is for the structure of the alkylammonium ion, which could be a condensed formula; a positive charge must be shown on, or close to, the N atom **M5** is for an arrow from the N−H bond to the N atom	For the mechanism Penalise **M2** if negative charge on ammonia Penalise **M3** for formal charge on C and/or Cl of C–Cl or incorrect partial charges on C–Cl; ignore other partial charges on uncharged atoms penalise **M3** for any additional arrow(s) to/from the Cl to/from anything else the second molecule of NH_3 is not essential for **M5**, but penalise **M5** if used incorrectly (but only penalise once in **M2** and **M5** for negative charge on ammonia) <u>SN1 mechanism alternative</u> (loss of Cl first followed by attack by NH_3) : **M2** curly arrow from C–Cl bond to the Cl **M3** curly arrow from lone pair of NH_3 to correct C on the correct carbocation	1 1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
02.1	Idea that it is hard to judge to the nearest 0.01 second *or* Idea that it is hard to judge the exact moment (that it becomes too cloudy / the cross disappears) *or* the idea of reaction time	Ignore ideas relating to accuracy (unless qualified)	1
02.2	0.083(3….)		1
02.3	**M1** points plotted correctly (allow ±1/2 small square for each) **M2** suitable best fit curve that misses point at 49°C and passes within one small square of the other five points 	If any points plotted incorrectly: best fit line based on their plotted points which may need to be more than one square away from some points If no value calculated in 2.2, then **M1** and **M2** based on the other points (except the fifth anomalous point). A straight line may be allowed for **M2** for the first four points. If incorrect value calculated in 2.2: **M1** based on all values being plotted correctly; **M2** based on suitable best fit line for the plotted points (except the fifth anomalous point). Penalise **M2** if best fit line goes to 0,0.	2

02.4	$\frac{1}{\text{value from their best fit line at 40°C}}$	eg $\frac{1}{0.0345}$ = 29 (s) Ignore units	1
02.5	as it forms a toxic gas or SO_2 is toxic/poisonous or to limit amount of SO_2 formed	Ignore reference to SO_2 being harmful Ignore reference to acid rain / pollutant	1
02.6	reaction would take too long / too slow / take a long time / very slow	Ignore reaction may not occur Allow idea that it makes judging the moment when the cross disappears more difficult	1

Question	Marking guidance	Additional Comments/Guidelines	Mark
03	**Percentage yield** **M1** reactant moles = $\frac{1.00}{116.0}$ (= 0.00862) **M2** product moles = $\frac{0.552}{72.0}$ (= 0.00767) **M3** % yield = $\left(\frac{0.00767}{0.00862} x\ 100\right)$ = 88.9(3) or 89% **M4** idea of getting as much product as possible in the reaction / idea of efficient conversion of reactants to products **Atom economy** **M5** $\left(\frac{72.0}{74.0+34.0} x\ 100\right)$ = $\left(\frac{72.0}{108.0} x\ 100\right)$ = 66.7% **M6** idea of maximising the mass of reactants / atoms that ends up in desired product or idea of minimising the amount of by-products	Correct **M3** scores **M1-3** Numerical answers to at least 2sf Allow ECF in **M1-M3** **Alternative for M2/3** **M2** expected mass of product = 0.00862 x 72.0 (= 0.621 g) **M3** % yield = $\left(\frac{0.552}{0.621} x\ 100\right)$ = 88.9(3) or 89% **Alternative for M5:** $\left(\frac{72.0}{72.0+36.0} x\ 100\right)$	1 1 1 1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
04.1	**M1** idea that pentan-2-ol has stronger intermolecular forces **M2** pent-1-ene has van der Waals' forces (only) **M3** pentan-2-ol (also) has hydrogen bonds	**M1** idea that hydrogen bonds are stronger than van der Waals' forces Penalise **M1** for any reference to idea of breaking covalent bonds **M2** allow London forces or temporary/induced dipole forces or vdW forces for van der Waals' forces **M3** Ignore reference to dipole-dipole forces in pentan-2-ol	1 1 1
04.2	**M1** reagent = <u>conc</u> sulfuric acid or <u>conc</u> phosphoric acid **M2** condition = hot / temperature in range 150-200°(C)	**M1** penalise incorrect name or formula (even if both name and formula are given) **M2** allow high temperature **M2** reagent must indicate an acid in some way in order for **M2** to be awarded **M1/2** allow 1 mark if H_2SO_4/H_3PO_4 given as reagent and conc(entrated) given as condition	1 1

04.2 (cont)	 **M3** curly arrow from lone pair on alcohol O to H^+ **M4** curly arrow from C-O bond to O on correct intermediate **M5** arrow from C-H bond on C1 to C-C bond between C1 and C2 on correct carbocation	**M3-5** penalise **M3/4/5** for any additional arrow(s) in addition to the correct one at each stage If incorrect reactant (or product if shown), maximum 2 marks of **M3-5** **Alternatives for M3**  or  allow **M4** and **M5** concurrent: 	1 1 1

<table>
<tr><th>Question</th><th>Marking guidance</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr>
<td>05</td>
<td>
This question is marked using levels of response.
Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.
<table>
<tr><td>Level 3
(5-6 marks)</td><td>All stages are covered and each stage is generally correct and virtually complete.

(6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.</td></tr>
<tr><td>Level 2
(3-4 marks)</td><td>All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR

two stages are covered and are generally correct and virtually complete

(4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.</td></tr>
<tr><td>Level 1
(1-2 marks)</td><td>Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR

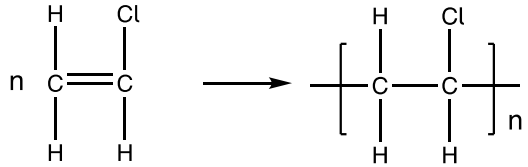
only one stage is covered but is generally correct and virtually complete

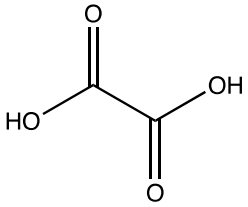
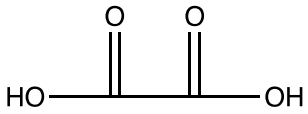
(2 v 1) Answer includes statements which are presented in a logical order and/or linked.</td></tr>
<tr><td>0 marks</td><td>Insufficient correct chemistry to warrant a mark.</td></tr>
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<td>
Indicative chemistry

Stage 1
Difference between structural & stereoisomers
1a structural isomers = molecules with same molecular formula but different structure
1b stereoisomers = molecules with same structural formula but different arrangement of atoms in space

Stage 2
Stereoisomers
2a lack of rotation around C=C
2b structures of E- and Z-but-2-ene
2c correct identity of E and Z isomers

Stage 3
Structural isomers
3a different C chain, e.g. methylpropene & but-1-ene / but-2-ene
3b different position of functional group e.g. but-1-ene & but-2-ene
3c different functional group, e.g. cyclobutane & but-1-ene / but-2-ene / methylpropene
</td>
<td>6</td>
</tr>
</table>

Question	Marking guidance	Additional Comments/Guidelines	Mark
06.1	**M1** structure of chloroethene **M2** structure of PVC **M3** correct use of n on both sides of equation 	Allow any correct structural representations of monomer and polymer **M2** allow correct repeating unit, but penalise incorrect use of bracket in **M3** **M2** and **M3** could score as ECF from incorrect **M1**	1 1 1
06.2	**M1** no reaction / yellow-orange **M2** polymer is saturated / does not contain double bond(s)	**M1** ignore brown; ignore red; ignore 'nothing'; ignore 'no observation'	1 1
06.3	**M1** $C_{24}H_{38}O_4$ **M2** makes it more flexible	**M2** allow make less brittle; ignore making more elastic	1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.1		Any correct skeletal representation, but alcohol H's should be shown and C atoms should not be shown 	1
07.2	**M1** acidified potassium dichromate(VI) or sulfuric acid & potassium dichromate(VI) **M2** reflux	**M1** H_2SO_4 and $K_2Cr_2O_7$ or H^+ and $K_2Cr_2O_7$ do not need (VI), but if oxidation state given it must be correct allow other strong acids **M2** need an attempt at an oxidising agent in **M1**	1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.3	**M1** amount of $H_2C_2O_4$ = $0.400 \times \frac{10}{1000}$ = 0.004 mol **NaOH in excess** **M2** amount of NaOH = $0.200 \times \frac{50}{1000}$ = 0.010 mol **M3** amount of NaOH needed for reaction = 0.008 mol or amount of left over NaOH needed for reaction = 0.002 mol or 0.005 mol of $H_2C_2O_4$ needed for all NaOH to react **Yield** **M4** amount of $Na_2C_2O_4$ formed = 0.004 mol **M5** mass of $Na_2C_2O_4$ = 134.0 x 0.004 = 0.536 g = 536 mg	**NaOH in excess:** allow ECF from **M1/2** to **M3** as long as the amounts do have NaOH in excess **M3** Allow any reasoned justification using moles to show that NaOH is in excess (it must take into account the 2:1 ratio in some way) **Yield:** allow ECF from **M1** to **M4**, and from **M4** to **M5** 536 mg scores **M1,4,5** 0.536 g scores **M1,4**	1 1 1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.1	**M1** $\frac{[CO]^2\,[H_2]^4}{[C_2H_5OH]\,[H_2O]}$ **M2** $mol^4\ dm^{-12}$	**M2** allow for units that are consequential on **M1**	1 1

08.2	**M1** clear attempt made to divide moles by volume to find concentrations **M2** $\frac{[\frac{0.110}{0.750}]^2\ [\frac{0.220}{0.750}]^4}{[\frac{0.075}{0.750}]\ [\frac{0.156}{0.750}]}$ **M3** 7.66×10^{-3}	7.66×10^{-3} scores **M1,2,3** 7.66×10^{-15} scores **M1,3** **M1** can use 0.750 or 750 (or 75, 7.5, 0.075, 0.0075, etc) **M2** $\frac{(0.147)^2\ (0.293)^4}{(0.100)\ (0.208)}$ or $\frac{(0.0215)\ (0.00740)}{(0.100)\ (0.208)}$ for **M2** volume used must be 0.750 or 750 (if use V at this stage, then must be one of these values of V used later on) **M3** ignore units **If moles are used in place of concentration** penalise **M1**, but **M2** and **M3** could score for ECF **M2** $\frac{(0.110)^2\ (0.220)^4}{(0.075)\ (0.156)}$ **M3** = 2.42×10^{-3} **Allow ECF if incorrect expression for K_c is used**	1 1 1

08.3	**M1** yield would decrease **M2** equilibrium (position) moves left / shifts left / in direction of reverse reaction to oppose increase in pressure / to reduce pressure **M3** fewer moles/molecules of gas on left hand side / fewer moles/molecules of gaseous reactants **M4** no effect on K_c	mark each point independently **M2** need both parts; ignore favours reverse reaction for the first part **M3** 2 moles/molecules (of gas) on left hand side v 6 moles/molecules (of gas) on right hand side	1 1 1 1

Question	Marking Guidance	Mark	Comments
9	C	1	C-C bonds are broken
10	C	1	Its decomposition is catalysed by chlorine molecules
11	C	1	3-fluoro-2,2-dimethylpentane
12	D	1	3-bromo-3-methylpentane
13	B	1	Fingerprint region of infrared spectrum
14	D	1	CH_3Cl and HCl
15	D	1	Ethene with concentrated sulfuric acid
16	C	1	C_3H_4
17	C	1	Propanenitrile
18	B	1	Biofuel ethanol is purified by fractional distillation
19	B	1	14.8 cm^3
20	B	1	At a given temperature their average kinetic energy is constant
21	D	1	+947
22	D	1	7.7%
23	A	1	$-\frac{c\ w\ \Delta T\ M_r}{b}$