AQA Qualifications

AS-LEVEL

Chemistry

7404/2 Organic and Physical Chemistry
Mark scheme

7404
June 2016

Version: 1.0 Final

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 with 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 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 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 Extended responses

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.

3.5 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.

3.6 Oxidation states

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

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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, mark the replacement work and not the crossed out work.

3.12 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.

3.13 Organic structures

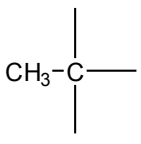
Where students are asked to draw organic structures, unless a specific type is required in the question and stated in the mark scheme, these may be given as displayed, structural or skeletal formulas or a combination of all three as long as the result unambiguous.

In general

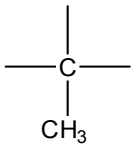
- Displayed formulae must show all of the bonds and all of the atoms in the molecule, but need not show correct bond angles.

- 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, e.g. 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, e.g 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.

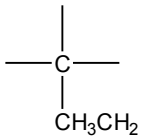
By way of illustration, the following would apply.



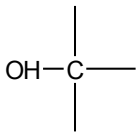
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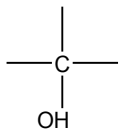
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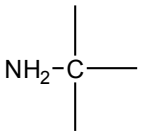
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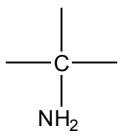
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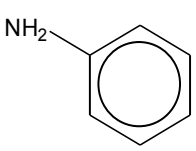
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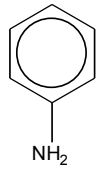
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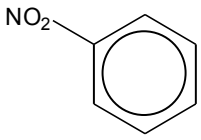
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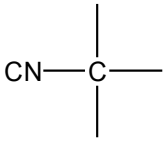
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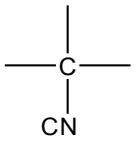
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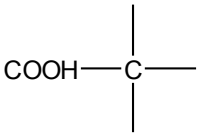
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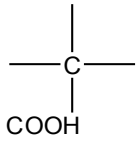
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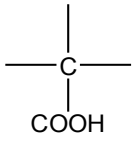
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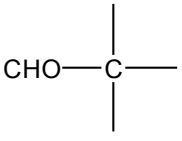
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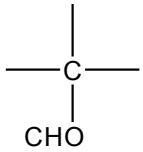
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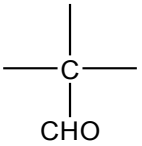
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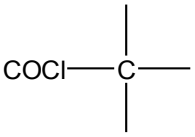
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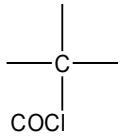
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- Representation of CH_2 by $C–H_2$ will be penalised
- Some examples are given here of **structures** for specific compounds that should **not** gain credit (but, exceptions may be made in the context of balancing equations)

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	ethane

- 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

3.14 Organic names

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

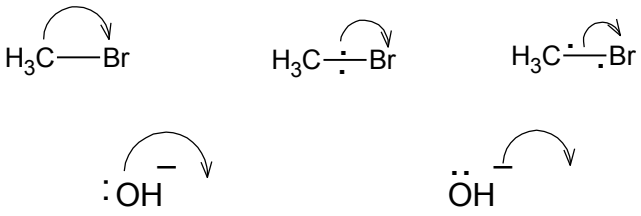
but-2-ol	should be **butan-2-ol**
2-hydroxybutane	should be **butan-2-ol**
butane-2-ol	should be **butan-2-ol**
2-butanol	should be **butan-2-ol**
ethan-1,2-diol	should be **ethane-1,2-diol**
2-methpropan-2-ol	should be **2-methylpropan-2-ol**
2-methylbutan-3-ol	should be **3-methylbutan-2-ol**
3-methylpentan	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**

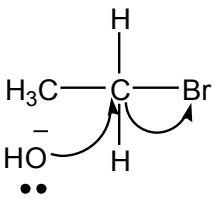
3.15 Organic reaction mechanisms

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.

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Question	Marking Guidance	Mark	Comments
01.1	M1 $(K_c =) \frac{[CH_3CH_2OH]}{[CH_2{=}CH_2][H_2O]}$ M2 $mol^{-1}\ dm^3$	1 1	M1 penalise missing brackets or use of (); allow correct molecular formulae in correct expression (and allow CH_2CH_2); ignore powers shown as 1 M2 units must be in simplest form on one line (or $dm^3\ mol^{-1}$) M2 units are consequential on expression in M1 ($mol^{-1}\ dm^3$ only scores if it is the units for the expression in M1)
01.2	M1 $\frac{[\frac{4.40}{2.00}]}{[\frac{0.70}{2.00}]\times[\frac{1.20}{2.00}]}$ or $\frac{2.20}{0.35 \times 0.60}$ or $\frac{4.40}{0.70 \times 1.20} \times 2.00$ M2 10.5 (must be 3sf)	1 1	10.5 (3sf) scores both marks; correct value to 2sf (10) or 4sf or more (10.476…) scores 1 mark Volume not used is CE=0 If use incorrect expression for K_c in 1.2 then no marks in 1.2 If a value from the question is copied incorrectly into the expression, could still score M2 if then used correctly in calculation (AE -1) Ignore units

Question	Marking Guidance	Mark	Comments
02.1	M1 (q = mcΔT = 100 x 4.18 x 38(.0)) = 15 884 / 15 880 / 15 900 / 16 000 (J) (OR 15.884 / 15.88 / 15.9 / 16 (kJ)) M2 Moles (methanol = 1.65 / 32.0) = 0.0516 or 0.052 M3 Heat change per moles = M1/M2 (15 884 / 0.0516 / 1000 = 308 (kJ mol^{-1}) (allow 305 to 310) M4 Answer = −308 (kJ mol^{-1}) (allow −305 to −310)	1 1 1 1	Award full marks for correct answer M1 mark is for value not expression (at least 2sf); penalise incorrect units here only if M1 is the only potential scoring point in M1-M3 M2 at least 2sf M3 at least 2sf; answer must be in kJ mol^{-1} M4 this mark is for – sign (mark independently)
02.2	Heating up copper / calorimeter / container / thermometer / heat capacity of copper / calorimeter / thermometer not taken into account OR Evaporation of alcohol/methanol OR Experiment not done under standard conditions	1	Not human errors (e.g. misreading scales) Not impure methanol Allow evaporation of water
02.3	(100 x 0.5 / 38 =) 1.3 or 1.32 or 1.316% (minimum 2 sf)	1	Allow correct answer to at least 2sf; Allow 1.31 or 1.315%
02.4	Idea that heat loss is more significant issue OR Idea that temperature change/rise is (significantly / much) bigger than uncertainty	1	One of these two ideas only and each one must involve a comparison

02.5	M1 Mass of ethanol = 500 x 0.789 (= 394.5 or 395 (g)) M2 Moles of ethanol = M1 / 46.0 (= 8.576 or 8.58) M3 Heat released = M2 x 1371 = 11800 (kJ) must be 3 sf	1 1 1	Correct answer to 3sf scores 3; correct value to 2sf or more than 3sf scores 2 Answers that are a factor of 10^x out score 2 if given to 3sf or 1 if given to a different number of sf M3 ignore units, but penalise incorrect units M3 ignore sign M2 and M3 – allow consequential marking

Question	Marking Guidance	Mark	Comments
03.1	2,2,4-trimethylpentane	1	This answer only but ignore punctuation
03.2	M1 (fractional or simple) distillation M2 idea that isooctane / the one with the lower boiling point boils (first) (or reaches top of column first) M3 idea that isooctane <u>condenses / liquefies</u> and <u>collected</u> (where collected = idea that it is separated / collected (away from the octane))	1 1 1	Incorrect process in M1 CE=0 If M1 blank, mark on for M2 and M3 (ignore boiling, condensing) Ignore reference to octane boiling and being collected at higher temperature If temperature referred to, should be between 99 and 124°C "it" refers to isooctane M2 – allow vaporises/evaporates first Penalise M2 and M3 if octane boils first In M2 and M3 – if no specific reference to individual alkanes, could score one mark for M2 + M3 combined if M2 and M3 both otherwise correct M2 and M3 must refer laboratory apparatus (not to an industrial process)
03.3	$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$	1	Accept multiples; ignore state symbols Accept any correct structural representation of isooctane

03.4	M1 Alternative route/mechanism/pathway M2 With lower <u>activation energy</u>	1 1	 Accept E_a for activation energy

03.5	$2CO + 2NO \rightarrow 2CO_2 + N_2$	1	Accept multiples; ignore state symbols

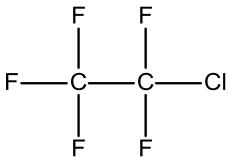
03.6	M1 to reduce amount of metals needed / small amount of metal needed M2 Increase / maximise / produce large surface area or to give catalyst a larger surface area: volume ratio or so that high(er) proportion of atoms/metal is on surface	1 1	M1 relates to low amount of metal M2 is related to large surface area

03.7	M1 bromine (water or in organic solvent or CCl_4) / Br_2 (aq) / Br_2 M2 (orange/yellow to) colourless / decolourised / loses its colour	1 1	M1 no reagent or an incorrect reagent (e.g. bromide), CE=0; penalise Br (or incorrect formula of other correct reagent) but mark on for M2 it must be a whole reagent and/or correct formula If oxidation state given in name, it must be correct. If 'manganate' or 'manganate(IV)' or incorrect formula, penalise M1 but mark on. ignore 'acidified' M2 ignore goes clear ignore brown/red, but penalise other incorrect colours *Alternatives:* M1 = potassium manganate(VII), M2 = colourless M1 = <u>conc</u> sulfuric acid, M2 = brown M1 = iodine, M2 = colourless

Question	Marking Guidance	Mark	Comments
04.1	M1 have the same molecular formula or are C_3H_6O or both have the same number/amount of each type of atom or same amount of each element or are isomers M2 identical / exactly the same / same precise (relative) molecular mass / formula mass / M_r	1 1	M1 not just the same atoms; M2 same (relative) molecular mass / formula mass / M_r is NOT enough got score M2 M2 allow same accurate (relative) molecular mass / formula mass / M_r M2 ignore reference to number of decimal places
04.2	M1 prop-2-en-1-ol M2 O(-)H (alcohol) and 3230–3550 (cm^{-1}), or C=C and 1620–1680 (cm^{-1})	1 1	M1 must refer to this compound clearly by name or structure (not to alcohol alone); ignore minor slips in name/structure M2 marked independently from M1 could score from bond labelled on correct signal on spectrum allow any value within these ranges if additional incorrect signals given penalise M2 ignore signals below 1500 cm^{-1} and C-H signals

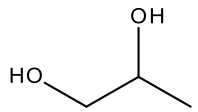
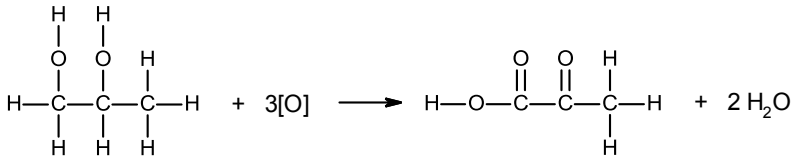
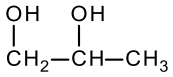
<table>
<tr><td>04.3</td><td colspan="3">a) Determine the level by looking at the chemical content. (NB - If there is clear breakage of covalent bonds then max level 2 (max 3 marks).
b) The mark within that level is then determined by looking at how coherent and logical the answer is and by use of terminology; start at the higher mark and penalise poor terminology/explanation; examples of terminology that would reduce the mark to the lower one:
• reference to van der Waals ‘bonds’ or dipole-dipole ‘bonds in relevant compounds that are being credited
• uncertainty about whether hydrogen bonds are the O-H bonds within or are forces/bonds between molecules (if the alcohol is being credited)
• use of ‘vdw’ or ‘dip-dip’ unless these terms ‘van der Waals’ for ‘dipole-dipole’ have been used elsewhere in answer (note that IMF and H-bond would not be penalised)
c) If the answer does not achieve level 1, then 1 mark maximum could be scored for any correct point from the list of indicative content</td></tr>
<tr><td></td><td>Level 3
(5-6 marks)</td><td>• Relative order of boiling points of all three compounds
• Strongest intermolecular force of all three compounds identified
• Answer explains this coherently and logically and uses correct terminology for all three compounds</td><td rowspan="4">Indicative chemistry content:
• Correct order (highest to lowest) = prop-2-en-1-ol > propanal > butane
• Prop-2-en-1-ol has hydrogen bonds
• Propanal has (permanent) dipole-dipole forces
• Butane has van der Waals’ forces
• Strength of intermolecular forces: hydrogen bonds > dipole-dipole > van der Waals

(Note - actual values for reference are prop-2-en-1-ol 97°C, propanal 46°C and butane -1°C)</td></tr>
<tr><td></td><td>Level 2
(3-4 marks)</td><td>• Relative boiling points of two compounds correctly compared
• Strongest intermolecular force for these two compounds correctly identified
• Answer explains this coherently and logically and uses correct terminology for these two compounds</td></tr>
<tr><td></td><td>Level 1
(1-2 marks)</td><td>• One compound with the highest or lowest boiling point is correctly identified
• Strongest intermolecular force for that one compound identified
• Answer explains this coherently and logically and uses correct terminology for this one compound
• allow 1 mark for individual correct point from indicative content on the right if no other mark scored</td></tr>
<tr><td></td><td>Level 0
(0 marks)</td><td>None of the indicative chemistry content given.</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
05.1	M1 $\bullet Cl + O_3 \rightarrow \bullet ClO + O_2$ M2 $\bullet ClO + O_3 \rightarrow \bullet Cl + 2O_2$	1 1	M1 and M2 could be in either order. Credit the dot anywhere on the radical. Penalise absence of dot once only. Individual multiples acceptable but both need to be doubled if two marks are to be awarded. Ignore state symbols
05.2		1	Must be displayed formula
05.3	Does not contain Cl or does not release Cl (atoms/radicals) or no C-Cl bonds or C-F bond(s) strong / does not break / no F (atom/radicals) released	1	
05.4	M1 $CHF_2CH_3 + \bullet F \rightarrow \bullet CF_2CH_3 + HF$ M2 $\bullet CF_2CH_3 + F_2 \rightarrow CF_3CH_3 + \bullet F$	1 1	M1 and M2 could be in either order. Credit the dot anywhere on the radical. Penalise absence of dot once only.

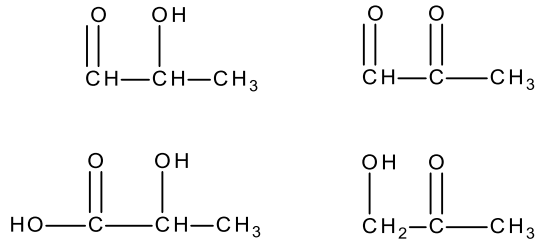
05.5	M1 moles CF_3CH_3 = 1410/84(.0) (=16.8, 16.79 mol) M2 molecules = M1 x 6.022×10^{23} = 1.01×10^{25} (3sf only)	1 1	Correct answer scores both marks Allow M2 for M1 x Avogadro with answer to 3 sf (but must have attempted to calculate moles for M1) Ignore incorrect units

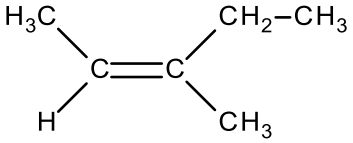
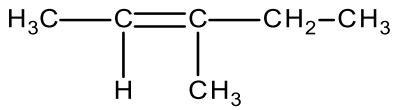
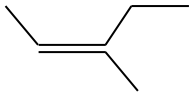
05.6	(bonds) vibrate/stretch/bend OR (as bonds) are polar	1	NOT polar molecules; 'they' = bonds

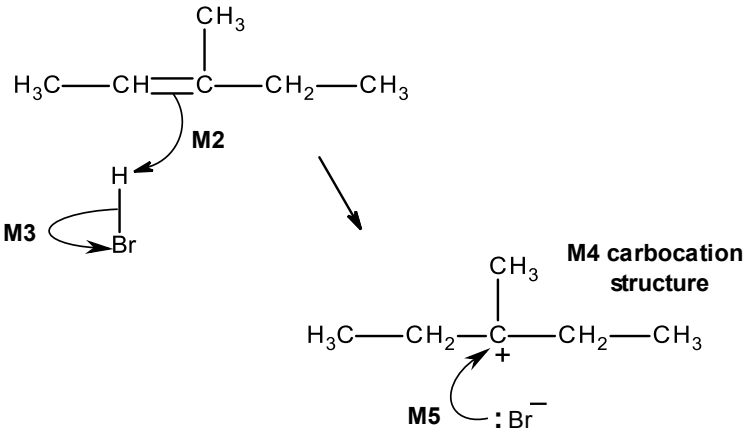
Question	Marking Guidance	Mark	Comments
06.1		1	Any correct skeletal formula (both OH groups must be shown)
06.2	M1 Displayed formula of correct product M2 Balanced equation   $CH_2OHCHOHCH_3$ $C_3H_8O_2$	1 1	Incorrect organic product CE=0 M1 must be displayed formula but can be shown separately or in the equation. M2 allow any correct structural formula (or molecular formula $C_3H_4O_3$) for product in balanced equation allow any correct formula of propane-1,2-diol (including its molecular formula $C_3H_8O_2$)

06.3	M1 flask with condenser vertically above it (without gaps between flask and condenser) M2 flask and condenser labelled	1 1	Distillation diagram CE = 0 M1 condenser must have outer tube for water that is sealed at top and bottom; condenser must have two openings for water in/out (that are open, although these openings do not need to be labelled) M1 penalise M1 if apparatus is sealed (a continuous line across the top and/or bottom of the condenser is penalised) M2 allow condensing tube for condenser label

06.4	form small(er) bubbles or prevent large bubbles	1	

06.5	Any one of these four structures: 	1	Allow any correct structural / displayed / skeletal formula For reference: Carbon 1 – Carbon 2 aldehyde – alcohol carboxylic acid – alcohol aldehyde – ketone alcohol – ketone

Question	Marking Guidance	Mark	Comments
07.1		1	Must show all 4 groups bonded to C=C Allow CH_3- for methyl group; allow C_2H_5 for ethyl group Allow correct structure of the style  Allow correct skeletal structure 

07.2	M1 <u>electrophilic addition</u>  NB the arrows here are double-headed M2 must show an arrow from the double bond towards the H atom of the H-Br molecule M3 must show the breaking of the H-Br bond M4 is for the structure of the tertiary carbocation M5 must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged atom (of either a secondary or) of a tertiary carbocation M6 3-bromo-3-methylpentane is <u>formed from 3^{y} carbocation</u> OR 2-bromo-3-methylpentane is <u>formed from 2^{y} carbocation</u> M7 <u>3^{y} carbocation more stable than 2^{y}</u>	1 1 1 1 1 1 1	**M2-M5** Penalise one mark from their total if half-headed arrows are used **M2** Ignore partial negative charge on the double bond **M3** Penalise incorrect partial charges on H-Br bond and penalise formal charges Penalise **M4** if there is a bond drawn to the positive charge Penalise only once in any part of the mechanism for a line and two dots to show a bond **Max 3 of any 4 marks (M2-5)** for wrong organic reactant or wrong organic product (if shown) or secondary carbocation **Max 2 of any 4 marks in the mechanism** for use of bromine Do not penalise the “correct” use of “sticks” For **M5**, credit attack on a partially positively charged carbocation structure but penalise **M4** **M6 is high demand and must refer to product being formed from/via correct class of carbocation** **M7 is high demand and must be clear answer refers to stability of carbocations (intermediates) not products** **Candidate that states that products are carbocations would lose M6 and M7** **M6,7** allow carbonium ion in place of carbocation; or a description of carbocation in terms of alkyl groups/ number of

			carbon atoms joined to a positive C
			When asked to outline a mechanism, candidates are **expected** to draw a mechanism with curly arrows (specification 3.3.1.2). On this occasion only we would allow a detailed description as shown. M2 must the describe the movement of a pair of electrons / curly arrow from the C=C towards the H atom of the H-Br molecule M3 must describe the breaking of the H-Br bond with the bonding pair of electrons moving to the Br / curly arrow from H-Br bond to Br M4 is for the structure of the tertiary carbocation (i.e. positive C bonded to one methyl and two ethyl groups) M5 must describe the movement of a pair of electrons from the Br^- ion to the positive C atom of the carbocation / curly arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged C atom (of either a secondary or) of a tertiary carbocation

Question	Marking Guidance	Mark	Comments
08.1	**Method 1** M1 Moles of Mg = 0.396/24.3 = 0.0163 M2 Moles of CH_3COOH = 0.600 x 30.0/1000 = 0.018 M3 Mark for showing Mg is in excess: either 0.018 mol of CH_3COOH reacts with 0.009 mol of Mg OR 0.0163 mol of Mg reacts with 0.0326 mol of CH_3COOH OR 0.0073 mol of Mg is in excess **Method 2** M1 Moles of CH_3COOH = 0.600 x 30.0/1000 = 0.018 M2 Moles of Mg that would react with this = 0.009 M3 Mass of Mg needed = 24.3 x 0.009 = 0.219 g which is less than 0.396 g OR Moles of Mg = 0.0163 which is more than 0.009 required **Method 3** M1 Moles of Mg = 0.396/24.3 = 0.0163 M2 Moles of CH_3COOH that would react with this = 0.0326 M3 Volume of CH_3COOH needed = 0.0326 / 0.60 = 0.0543 dm^3 (54.3 cm^3) which is more than 0.030 dm^3 (30 cm^3)	1 1 1	Allow working throughout to 2sf If candidate gets 16.3 mol (as not converted mg to g) in method 1 or 3 then can only score 1 mark maximum (M2) Accept other valid calculations that show the Mg is in excess
08.2	M1 Line starts at origin and is steeper M2 (moles CH_3COOH = 0.800 x 20/1000 = 0.016) line levels out on 8th line up (line below the original 9th line)	1 1	 M2 for line on 8th line on grid (original on 9th line) – allow some leniency so long as clear it ends at (or very close to) the 8th line; and line does not significantly wobble

Question	Marking Guidance	Mark	Comments
09	C	1	
10	D	1	
11	D	1	
12	A	1	
13	B	1	
14	B	1	
15	D	1	
16	C	1	
17	A	1	
18	B	1	
19	C	1	
20	D	1	
21	C	1	
22	B	1	
23	C	1	