AQA

AS-LEVEL
Chemistry

AS Paper 2
Mark scheme

7404/2
June 2017

Version: 1.0 Final

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 Assessment Writer.

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.

Further copies of this mark scheme are available from aqa.org

AS-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

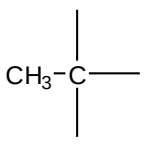
Where students are asked to draw organic structures, unless a specific type is required in the question and stated in the mark scheme, these may be given as displayed, structural or skeletal formulas or a combination of all three as long as the result unambiguous.

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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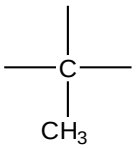

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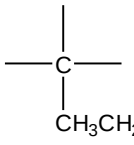

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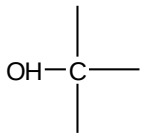

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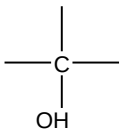

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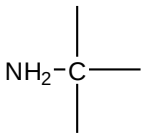

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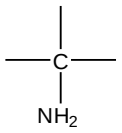

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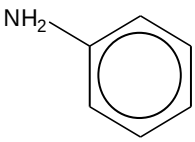

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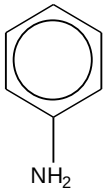

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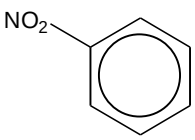

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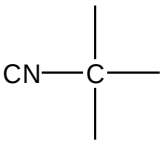

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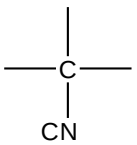

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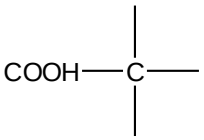

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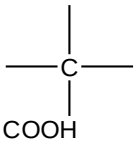

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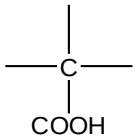

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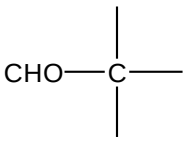

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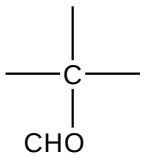

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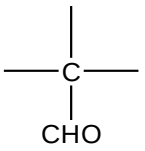

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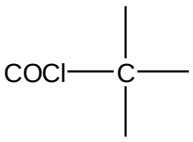

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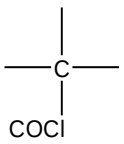

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- Representation of CH_2 by C–H_2 will be penalised
- Some examples are given here of **structures** for specific compounds that should **not** gain credit (but, exceptions may be made in the context of balancing equations)

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

3.14 Organic names

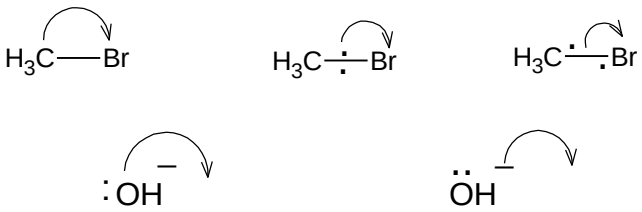
As a general principle, non-IUPAC names or incorrect spelling or incomplete names should **not** gain credit. Some illustrations are given here.

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**

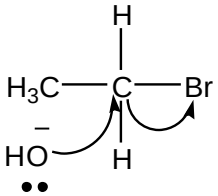
3.15 Organic reaction mechanisms

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.

Question	Marking Guidance	Mark	Comments
01.1	energy	1	Ignore reference to • any units (e.g. J, kJ, J mol^{-1}, kJ mol^{-1}) • particles • molecules • kinetic **NOT** mean energy or average energy **NOT** E
01.2	**M1** maximum peak height is lower and displaced to the right of the original	1	
	M2 all of the following • starts at the origin but does not follow the original line • shows separation as soon as possible from the original line • crosses the original curve once only • similar area to original curve • an attempt has been made to draw the new curve correctly towards the energy axis above the original curve but not to touch the original curve (or axis)	1	

Question	Marking Guidance	Mark	Comments
01.3	**M1** an increase in the number/amount/proportion/fraction of molecules with $E \geq E_a$ / with activation energy **or** more molecules have $E \geq E_a$ / with activation energy **or** more molecules have enough / sufficient energy (to react)	1	**M1** Ignore - Molecules have more energy - More energetic collisions - More collisions Allow $E > E_a$ in place of $E \geq E_a$
	M2 more successful / effective / productive collisions in a given time / period **or** higher rate of successful / effective / productive collisions **or** higher frequency of successful / effective / productive collisions	1	Credit particles for molecules (but not atoms) Penalise for **M1** reference to increased activation energy **M2** Must refer to <u>both</u> idea of successful/effective/productive collisions and the rate/frequency of collisions Ignore 'chance of collision'

Question	Marking Guidance	Mark	Comments
02.1	**Stage 1** **M1** $n = \frac{PV}{RT}$ **M2** $= \frac{102\ x\ 10^3\ \ x\ \ 72\ x\ 10^{-6}}{8.31\ x\ 373}$ **M3** $= 0.0024 / 0.00237 / 0.002369 / 0.0023693$ .. **Stage 2** **M4** $M_r\ (= \frac{mass}{moles}) = \frac{0.194}{\mathbf{M3}}$ **M5** = 82 (**2sf only**)	1 1 1 1 1	As this is an extended response question, each separate step of correct working is required in **M1**-**M5** Correct answer with no working scores 2 marks **M1** - If expression not written out, **M1** could score from a correct expression for **M2** (even if unit conversions are not correct for **M2**) **M2** – allow an expression that gives correct value for **M3** **M3** should be at least 2sf (do not allow 0.0023 but do allow 0.00236) **M4** must show 0.194 or 194 x 10^{-3} in working to score **M5** must be 2sf ECF: • No ECF within either stage 1 or stage 2 (except for transcription errors) • Allow ECF from stage 1 into stage 2, i.e for **M4** and **M5** based on incorrect **M3,** (but if expression for **M4** is inverted, cannot score **M5**) • (Note that if 72 x 10^{-3} used in **M2**, then **M3** = 2.4, **M5** = 0.082) Ignore units for **M3** and **M5** Note that if T = 273 + 373 = 646, **M5** = 140 (2sf)

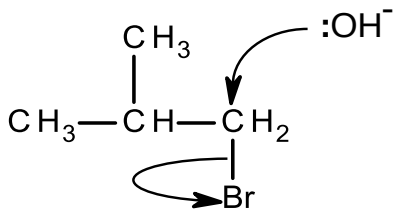
Question	Marking Guidance	Mark	Comments
02.2	**M1** dividing %s by relative atomic masses C = 83.7/12(.0), H = 16.3/1(.0) **M2** converting (C:H 6.975:16.3) to 3:7 **M3** empirical formula = C_3H_7 **M4** molecular formula = C_6H_{14}	1 1 1 1	**M1 & M2** are for working **M3** for C_3H_7 only, marked independently **M4** for C_6H_{14} only, marked independently (ignore additional correct structures) Formulae with no working cannot score **M1** or **M2** *Alternative method:* **M1** working that shows 83.7% of 86 is 72 **M2** idea of 72/12 gives 6 C atoms *Alternative method:* working that shows that C_6H_{14} (or C_3H_7) contains 83.7% C scores **M1** & **M2**

Ques	Marking Guidance		Mark	Comments
03	This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.		6	Indicative chemistry content **Stage 1 – deduces which compounds are saturated/unsaturated** 1a states that A & B are unsaturated / do contain C=C / alkenes (this can be obtained from the structures) 1b as they decolourise bromine water 1c states that C is saturated / does not contain C=C / is (cyclo)alkane (this can be obtained from the structures) 1d as it does not decolourise bromine water **Stage 2 – deduces the structures** 2a suggests suitable name/structure for **A** • pent-1-ene, • 2-methylbut-1-ene, • 3-methylbut-1-ene, • 2-methylbut-2-ene 2b **B** = pent-2-ene (name/structure) 2c suggests a suitable name/structure of **C** (cyclopentane, methylcyclobutane, any dimethylcyclopropane) **Stage 3 – can explain the stereoisomerism** 3a explains what stereoisomerism is in terms of molecules with the same structural formula but a different arrangement of atoms/bonds/groups in space 3b explains how it arises by discussing that C=C cannot rotate, 3c explains how it arises by discussing that each C in C=C has two different groups (ignore reference to M_r in this context) <u>or</u> by drawing the E and Z isomers of **B** Note • compounds may be identified by name or structure (but if both given and there is error in one, then award lower mark in whichever level the answer fits, i.e. it penalises the mark within a level, but not the overall level itself)
	Level 3 (5-6 marks)	All stages are covered, three correct structures are given and each stage is generally correct and virtually complete. Answer communicates reasoning coherently and shows a logical progression through the identification of structures including explaining about stereoisomerism.		
	Level 2 (3-4 marks)	Two stages are covered or parts of three stages (if two stages are covered, they must be complete for 4 marks)		
	Level 1 (1-2 marks)	One stage covered or parts of two stages (if one stage is covered, it must be complete for 2 marks)		
	Level 0 (0 marks)	No relevant correct chemistry to warrant a mark.		

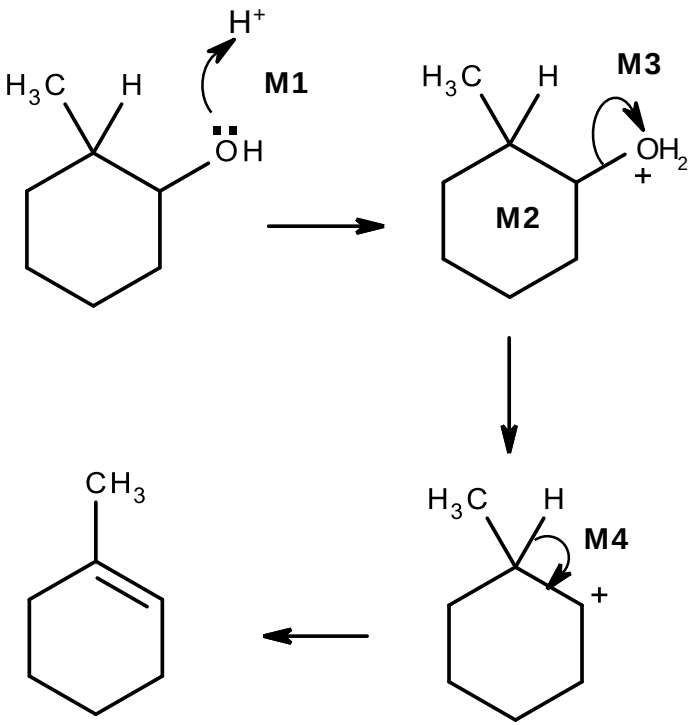
Question	Marking Guidance	Mark	Comments
04.1	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$	1	allow fractions / multiples allow any correct structural representation of molecules ignore state symbols
04.2	**M1** working that leads to n = 13 **M2** $C_{13}H_{28}$	1 1	e.g. –6650 = –(496**n** + 202) and/or 496**n** = 6650 – 202 and/or 496**n** = 6448 (**n** = 13) $C_{13}H_{28}$ scores **M1** and **M2** if some correct working shown $C_{13}H_{28}$ with no working scores **M2** only allow error carried forward for **M2** for a correct formula of an alkane from the value of **n** worked out for **M1** (but there must be some working shown leading to this incorrect value of **n**); for example, allow $C_{14}H_{30}$ if error in **M1** stemming from error in rearranging equation
04.3	Idea that • alkane is not gaseous or • equation relates to gaseous alkanes or • it takes energy to convert it into a gas or • that water/alkane/substances are gaseous in calculations using bond enthalpies	1	ignore references to heat loss, incomplete combustion, loss of evaporation, not being in standard conditions or that it is not standard state

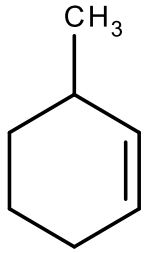
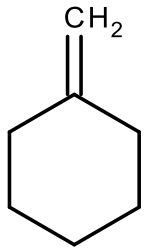
Question	Marking Guidance	Mark	Comments
04.4	**M1** plotting the <u>four</u> values correctly (allow one error where point is ±1 square out) **M2** smooth best fit <u>curve</u> **M3** value from their best fit line for 3 C atoms (allow ± 1 square)	1 1 1	If plotted points for wrong number of C atoms for two or more compounds, cannot score **M1** or **M2**, but could score **M3** if read value off for 3C atoms **M2** best fit curve for their <u>four</u> points for the correct number of C atoms **M3** need – sign (but ignore units); cannot score **M**3 unless there is a line on the graph
04.5	**M1** mass of isooctane = 692 (g) **M2** 3.31×10^4 or 33100 (kJ) (**<u>3sf only</u>**)	1 1	correct answer scores **M1** and **M2** **M2** correct value to incorrect number of sig figs is 1 mark; ignore sign ; no error carried forward for **M2**

Question	Marking Guidance	Mark	Comments
05.1	**M1** Amount NaOH = 0.02530 x 0.500 = 0.01265 mol **M2** Amount acid = 0.006325 mol (i.e. **M1**÷2) **M3** M_r = 90(.0) **M4** mass acid = 569 (mg) (allow 567 to 576) (i.e. **M2** x **M3** in mg)	1 1 1 1	567-590 = 4 marks 0.567-0.590 = 3 marks Allow ECF at each stage **M3** can be scored from use of value of 90(.0) within working **M4** should be to at least 2sf. Any individual marks for **M1/2/3** should be to at least 2sf (or 90 for **M3**) 1134-1180 = 3 marks (due to not dividing moles of NaOH by 2) 1.134-1.180 = 2 marks (due to not dividing moles of NaOH by 2 and not converting to mg)
05.2	Idea that it ensures all ethanedioic acid / acid / sodium hydroxide / alkali / reactants are in the mixture / solution / reaction or the idea that some of the ethanedioic acid / acid / sodium hydroxide / alkali / reactants would be on the sides of the flask	1	the idea that it is the transfer of all the acid/alkali alone is not enough
05.3	Titres that are within 0.1 cm^3 of each other	1	Units are needed Allow 0.05–0.15 cm^3 Do not allow idea of identical results Allow answers that refer to titres that are within the uncertainty of the burette/apparatus of each other

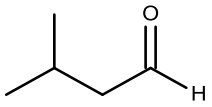
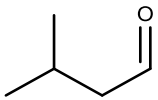
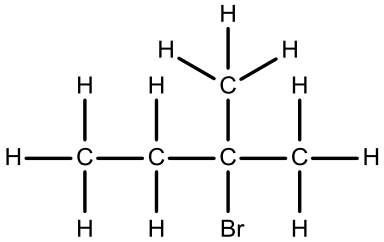
Question	Marking Guidance	Mark	Comments
06.1	**M1** nucleophilic substitution  **M2** curly arrow from lone pair on O of OH^- to C of C-Br **M3** curly arrow from C-Br bond to the Br	1 1 1	Penalise **M3** for formal charge on C and/or Br of C-Br or incorrect partial charges on C-Br Max 1 out of 2 for **M2** & **M3** for incorrect reactant or product (ignore poorly drawn bond from C to OH group in product if shown) For SN2 penalise **M2** for any additional arrow(s) on NaOH penalise **M3** for any additional arrow(s) to/from the Br to/from anything else If SN1 mechanism given (loss of Br first followed by attack by OH^-) then: **M2** curly arrow from C-Br bond to the Br **M3** curly arrow from lone pair on O of OH^- to positive C atom of correct carbocation penalise **M2** for any additional arrow(s) to/from the Br to/from anything else penalise **M3** for any additional arrow(s) on NaOH If curly arrows represent an attempt at an elimination mechanism, cannot score **M2** or **M3**

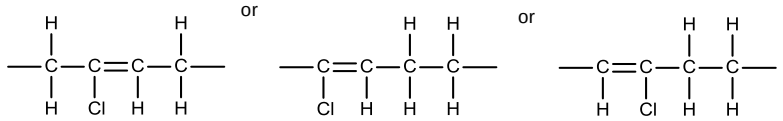
Question	Marking Guidance	Mark	Comments
06.2	**M1** Amount 1-bromo-2-methylpropane (= (2 x 1.26) / 136.9 = 2.52/136.9) = 0.0184 mol **M2** mass of 2-methylpropan-1-ol expected (= 0.0184 x 74.0) = 1.36 g **M3** % yield = 100 x (0.895/1.36) = 65.7% (65-67%)	1 1 1	Correct answer scores 3 marks; answer to at least 2sf and any individual marks for M1/2 should be at least 2sf; answers that are a factor of 10^x out score 2; Allow ECF through the question Alternative method: **M2** amount of 2-methylpropan-1-ol produced = 0.895/74.0 = 0.0121 mol **M3** % yield = 100 x (0.0121/0.0184) = 65.7% (65-67%) Allow 2 marks for 82.7-83% (comes from starting with 2 g not 2.52 g), with answers that are a factor of 10^x out from this scoring 1
06.3	**M1** methylpropene **M2** elimination	1 1	**M1** Do not allow any names with numbers for the position of the double bond. Allow 2-methylpropene but no other answer Ignore any drawn mechanism **M2** allow base (or basic) elimination but no other answer

Question	Marking Guidance	Mark	Comments
07.1			Ignore other species that are drawn, but penalise any curly arrows to/from other species for **M1**/**3**/**4** as relevant (but allow attack by an anion of phosphoric acid on the H that is lost in **M4** in addition to the arrow specified) for **M2**, the O of the $^{+}OH_2$ group must be bonded to the ring
	M1 curly arrow from lone pair on O to H^+	1	
	M2 correct structure of intermediate with + on O	1	
	M3 curly arrow from C-O bond to O	1	
	M4 curly arrow from correct C-H bond towards correct C-C <u>bond</u>	1	

Question	Marking Guidance	Mark	Comments
07.2		1	Any correct structural representation
07.3	**M1** more stable (carbocation formed) **M2** changes from secondary to tertiary (carbocation)	1 1	For **M1** penalise more stable product For **M2** allow explanation via inductive effect with more alkyl / C groups attached or inductive effect from methyl group as alternatives Allow 2^o or 2^y for secondary and 3^o or 3^y for tertiary
07.4		1	Any correct structural representation

Question	Marking Guidance	Mark	Comments
07.5	**M1** cyclohexene : van der Waals' forces (between molecules) **M2** cyclohexanol : hydrogen bonds (between molecules) **M3** phosphoric acid: hydrogen bonds (between molecules) **M4** idea that cyclohexene has weakest forces **M5** separated by (simple / fractional) distillation **M6** cyclohexene has lowest boiling point / boils off first	1 1 1 1 1 1	Extended response Maximum of 5 marks for answers which do not refer to the van der Waals forces or hydrogen bonds being between molecules in some way **M1** penalise reference to presence of other intermolecular forces **M1** allow vdW forces (on this occasion) **M1/2/3** penalise reference to breaking covalent bonds **M2** & **M3** ignore reference to van der Waals and/or (permanent) dipole-dipole forces **M2** allow use of term H bonds (on this occasion) **M4** allow converse argument **M4** & **M6** – allow correct comparison of cyclohexene forces and boiling point to one of the other two compounds if only one of cyclohexanol or phosphoric acid discussed

Question	Marking Guidance	Mark	Comments
08.1	 or 	1	Must be a skeletal structure
08.2		1	Must be a displayed structure
08.3	Any correct structural representation of alkene with 4 C atoms, either: but-1-ene or but-2-ene or methylpropene	1	allow butadiene

Question	Marking Guidance	Mark	Comments
09.1	**M1** it / PVC is bigger/longer molecule / has more electrons / has bigger surface area / greater M_r **M2** it / PVC has stronger (van der Waals' / dipole-dipole) forces <u>between molecules</u> / <u>intermolecular</u> forces	1 1	**M1** and **M2** independent of each other CE = 0 if reference to hydrogen bonds or breaking of covalent bonds when substances are melted Comparison must be implied in **M1** or **M2** to score 2 marks If there is no comparison at all, then 1 mark could score either for explaining that PVC has strong <u>intermolecular</u> forces due to being a big/long molecule / having many electrons / large surface area / large M_r, or, for explaining that chloroethene has weak <u>intermolecular</u> forces due to being a small/short molecule / having few electrons / low surface area / low M_r,
09.2	38	1	ignore additional words
09.3	Need both ideas that • it is present AND • because PVC needs to be flexible / bendy	1	penalise incorrect properties
09.4	Displayed structure required 	1	ignore any bracket or n

Question	Marking Guidance
10	B
11	C
12	A
13	A
14	C
15	D
16	D
17	B
18	B
19	A

20	C
21	D
22	B
23	A
24	C