AQA

AS CHEMISTRY (7404/2)

Paper 2: Organic and Physical Chemistry

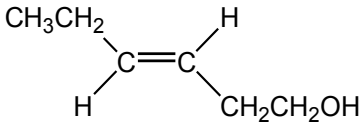
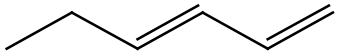
Mark scheme

Specimen paper

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.

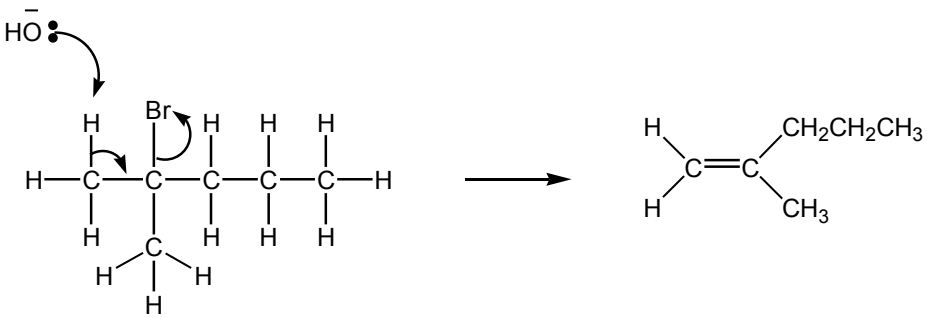
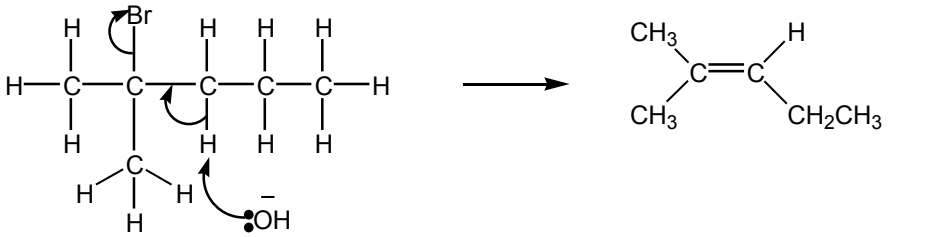
Further copies of this mark scheme are available from aqa.org.uk

Question	Marking guidance	Mark	AO	Comments
01.1		1	AO1a	
01.2		1	AO2c	

01.3				Extended response Maximum of 5 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.
	Stage 1: consider the groups joined to right hand carbon of the C=C bond			
	Consider the atomic number of the atoms attached	1	AO1a	M1 can be scored in stage 1 or stage 2
	C has a higher atomic number than H, so CH_2OH takes priority	1	AO2a	
	Stage 2: consider the groups joined to LH carbon of the C=C bond			
	Both groups contain C atoms, so consider atoms one bond further away	1	AO2a	
	C, (H and H) from ethyl group has higher atomic number than H, (H and H) from methyl group, so ethyl takes priority	1	AO2a	
	Stage 3: conclusion			
	The highest priority groups, ethyl and CH_2OH are on same side of the C=C bond so the isomer is Z	1	AO2a	Allow M5 for correct ECF conclusion using either or both wrong priorities deduced in stages 1 and 2
	The rest of the IUPAC name is 3-methylpent-2-en-1-ol	1	AO2a	

01.4	Moles of maleic acid = 10.0/116.0 = 8.62×10^{-2} AND mass of organic product expected = $(8.62 \times 10^{-2}) \times 98.0$ = 8.45 g Or moles of organic product formed = 6.53 / 98.0 = 6.66×10^{-2} % yield = 100 × 6.53/8.45 OR = 100 × $(6.66 \times 10^{-2}) / (8.62 \times 10^{-2})$ = 77.294 = 77.3% **AND** statement that the student was NOT correct	1 1	AO3 1a AO3 1a	

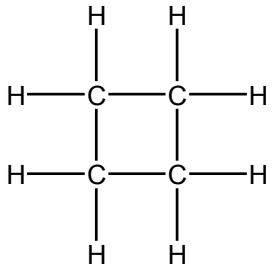
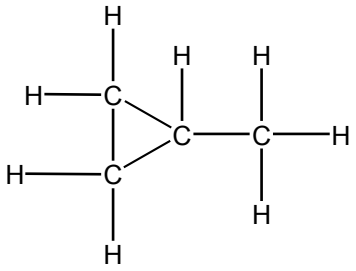
Question	Marking guidance	Mark	AO	Comments
02.1	$C_6H_{11}OH + 8\frac{1}{2}O_2 \longrightarrow 6CO_2 + 6H_2O$	1	AO2a	
02.2	Temperature rise = 20.1 q = 50.0 × 4.18 × 20.1 = 4201 (J) Mass of alcohol burned = 0.54 g and M_r alcohol = 100.0 ∴ mol of alcohol = n = 0.54/100 = 0.0054 Heat change per mole = q/1000n **OR** q/n = 778 kJ mol^{-1} **OR** 778 000 J mol^{-1} ΔH = –778 kJ mol^{-1} **OR** –778 000 J mol^{-1}	1 1 1 1	AO2h AO2h AO2h AO1a	M4 is for answer with negative sign for exothermic reaction Units are tied to the final answer and must match
02.3	Less negative than the reference Heat loss **OR** incomplete combustion **OR** evaporation of alcohol **OR** heat transferred to beaker not taken into account	1 1	AO3 1b AO3 1b	
02.4	Water has a known density (of 1.0 g cm^{-3}) Therefore, a volume of 50.0 cm^3 could be measured out	1 1	AO3 2a AO3 2a	

Question	Marking guidance	Mark	AO	Comments
03.1	(Compounds with the) same molecular formula but different structural / displayed / skeletal formula	1	AO1a	
03.2	(basic) elimination	1	AO1a	
	Mechanism points:			
	Correct arrow from lone pair on :OH^- to H on C adjacent to C–Br	1	AO2a	
	Correct arrow from C–H bond to C–C	1	AO2a	
	Correct arrow from C–Br bond to Br	1	AO2a	
	Structure of chosen product	1	AO2a	
				
	OR			
				

Question	Marking guidance	Mark	AO	Comments
04.1	Percentage of oxygen by mass = 100 – 40.9 – 4.5 = 54.6	1	AO1b	
	C H O			
	% 40.9 4.5 54.6			
	Divide by A_r 12 1 16			
	= 3.41 = 4.5 = 3.41	1	AO2b	
	Divide by smallest = 3.41/3.41 = 1 4.5/3.41 = 1.32 3.41/3.41 = 1			
	Nearest whole number ratio = 1 × 3 1.32 × 3 1 × 3			
	= 3 : 3.96 : 3			
	Nearest integer ratio = 3 : 4 : 3	1	AO2b	
	Empirical formula $C_3H_4O_3$			
	Empirical formula mass = 88 = molecular formula mass			
	Therefore, molecular formula is same as the empirical formula - $C_3H_4O_3$	1	AO2b	
04.2	$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$	1	AO1a	

04.3	Advantage – ethanol is produced at a faster rate Disadvantage – more energy is used / required in the reaction	1 1	AO2e AO2e	
04.4	Air gets in / oxidation occurs	1	AO1a	
04.5	Alcohol OH absorption in different place (3230–3550 cm^{-1}) from acid OH absorption (2500–3000 cm^{-1}) The C=O in acids has an absorption at 1680–1750 cm^{-1}	1 1	AO2e AO2e	

Question	Marking guidance	Mark	AO	Comments
05.1	UV light	1	AO1a	
	$CCl_4 \longrightarrow CCl_3\bullet + \bullet Cl$	1	AO2a	
05.2	$Cl\bullet + O_3 \longrightarrow ClO\bullet + O_2$	1	AO1a	
	$ClO\bullet + O_3 \longrightarrow Cl\bullet + 2O_2$	1	AO1a	
05.3	M_r of CF_3Cl = 104.5			
	Moles freon = $1.78 \times 10^{-4} \times 10^3 / 104.5 = 1.70 \times 10^{-3}$	1	AO1b	
	Number of molecules = $1.70 \times 10^{-3} \times 6.02 \times 10^{23} = 1.02 \times 10^{21}$	1	AO1b	
	Molecules in 500 cm^3 = $(1.02 \times 10^{21} \times 500 \times 10^{-6}) / 100$	1	AO1b	Allow answer in the range $5.10–5.13 \times 10^{15}$
	$= 5.10 \times 10^{15}$			Answer must be given to this precision

Question	Marking guidance	Mark	AO	Comments
06.1	Alkenes  **OR** 	1 1	AO1a AO2a	 Correctly drawn molecule of cyclobutane or methyl cyclopropane, need not be displayed formula
06.2	C_6H_{14} (or correct alkane structure with 6 carbons)	1	AO2a	Allow hexane or any other correctly named alkane with 6 carbons
06.3	Poly(but-2-ene)	1	AO1a	
06.4	High pressure	1	AO1b	Allow pressure ≥ 1 MPa Mention of catalyst loses the mark

<table>
<tr>
<td>06.5</td>
<td colspan="2">This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.</td>
<td>6</td>
<td>1 AO1a
5 AO2a</td>
<td rowspan="4">Indicative chemistry content

Stage 1: consider effect of higher temperature on yield
(Or vice versa for lower temperature)
• Le Chatelier’s principle predicts that equilibrium shifts to oppose any increase in temperature
• Exothermic reaction, so equilibrium shifts in endothermic direction / to the left
• So a Higher T will reduce yield

Stage 2: consider effect of higher temperature on rate
(Or vice versa for lower temperature)
• At higher Temperature, more high energy molecules
• more collisions have E>Ea
• So rate of reaction increases/time to reach equilibrium decreases

Stage 3: conclusion
Industrial conditions chosen to achieve (cost-effective) balance of suitable yield at reasonable rate</td>
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<td>Level 3
5–6 marks</td>
<td>All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer communicates the whole process coherently and shows a logical progression from stage 1 and stage 2 (in either order) to stage 3.</td>
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<td>Level 2
3–4 marks</td>
<td>All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows progression. Some steps in each stage may be out of order and incomplete.</td>
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<tr>
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<td>Level 1
1–2 marks</td>
<td>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes isolated statements but these are not presented in a logical order or show confused reasoning.</td>
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<tr>
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<td>Level 0
0 marks</td>
<td>Insufficient correct chemistry to gain a mark.</td>
<td></td>
<td></td>
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Question	Marking guidance	Mark	AO	Comments
07.1	Measured volume would be greater	1	AO3 1b	
	Level in burette falls as tap is filled before any liquid is delivered	1	AO3 1b	
07.2	Drop sizes vary	1	AO3 1b	Allow percentage error for amount of oil will be large as the amount used is so small
07.3	Use a larger single volume of oil	1	AO3 2b	
	Dissolve this oil in the organic solvent	1	AO3 2b	
	Transfer to a conical flask and make up to 250 cm^3 with more solvent	1	AO3 2b	
	Titrate (25 cm^3) samples from the flask	1	AO3 2b	

07.4	Stage 1			Extended response calculation
	Mass of oil = $0.92 \times (5.0 \times 10^{-2} \times 5) = 0.23$ (g)	1	AO2h	To gain 4 or 5 marks, students must show a logical progression from stage 1 and stage 2 (in either order) to stage 3
	Mol of oil = $0.23 / 885 = 2.6 \times 10^{-4}$	1	AO2h	
	Stage 2			
	Mol bromine = $2.0 \times 10^{-2} \times 39.4 / 1000 = 7.9 \times 10^{-4}$	1	AO2h	
	Stage 3			
	Ratio oil : bromine			
	2.6×10^{-4} : 7.9×10^{-4}			
	Simplest ratio = $2.6 \times 10^{-4} / 2.6 \times 10^{-4} : 7.9 \times 10^{-4} / 2.6 \times 10^{-4}$			
	= 1 : 3	1	AO2h	
	Hence, 3 C=C bonds	1	AO3 1a	M5 cannot be awarded unless working for M4 is shown

Section B

In this section, each correct answer is awarded 1 mark.

Question	Key	AO
8	B	AO2b
9	C	AO1a
10	D	AO2d
11	C	AO2a
12	D	AO1b
13	B	AO1a
14	C	AO1b
15	A	AO1b
16	D	AO1a
17	D	AO1a
18	C	AO1a
19	C	AO1a
20	B	AO1a
21	A	AO3 2b
22	C	AO3 2b