

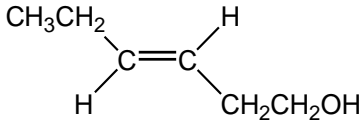

AS

Chemistry

Paper 2 (7404/2): Organic and Physical Chemistry
Mark scheme

7404
Specimen paper

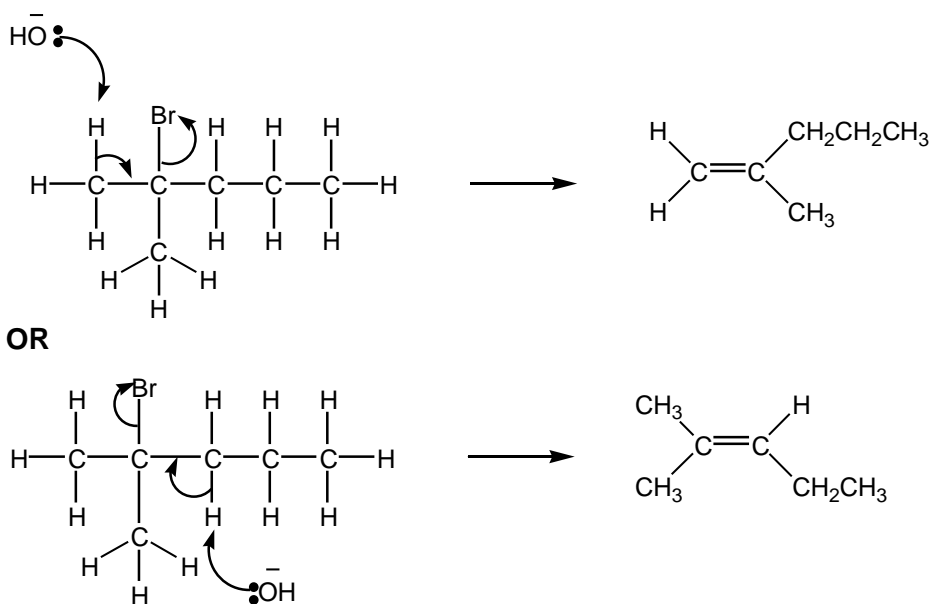
Version 0.5

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

01.3	<p>Stage 1: consider the groups joined to right hand carbon of the C=C bond</p> <p>Consider the atomic number of the atoms attached</p> <p>C has a higher atomic number than H, so CH₂OH takes priority</p> <p>Stage 2: consider the groups joined to LH carbon of the C=C bond</p> <p>Both groups contain C atoms, so consider atoms one bond further away</p> <p>C, (H and H) from ethyl group has higher atomic number than H, (H and H) from methyl group, so ethyl takes priority</p> <p>Stage 3: conclusion</p> <p>The highest priority groups, ethyl and CH₂OH are on same side of the C=C bond so the isomer is Z</p> <p>The rest of the IUPAC name is 3-methylpent-2-en-1-ol</p>			<p>Extended response</p> <p>Maximum of 5 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</p> <p>M1 can be scored in stage 1 or stage 2</p> <p>Allow M5 for correct ECF conclusion using either or both wrong priorities deduced in stages 1 and 2</p>
		1	AO1a	
		1	AO2a	
		1	AO2a	
		1	AO2a	
		1	AO2a	
		1	AO2a	

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

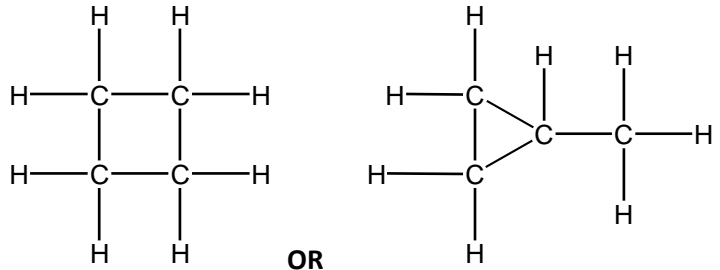
Question	Marking guidance	Mark	AO	Comments
02.1	$\text{C}_6\text{H}_{11}\text{OH} + 8\frac{1}{2}\text{O}_2 \longrightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$	1	AO2a	
02.2	Temperature rise = 20.1 $q = 50.0 \times 4.18 \times 20.1 = 4201 \text{ (J)}$ Mass of alcohol burned = 0.54 g and M_r alcohol = 100.0 \therefore mol of alcohol = $n = 0.54/100 = 0.0054$ Heat change per mole = $q/1000n$ OR q/n $= 778 \text{ kJ mol}^{-1}$ OR $778\,000 \text{ J mol}^{-1}$ $\Delta H = -778 \text{ kJ mol}^{-1}$ OR $-778\,000 \text{ J mol}^{-1}$	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	<p>(basic) elimination</p> <p>Mechanism points:</p> <p>Correct arrow from lone pair on :OH^- to H on C adjacent to C–Br</p> <p>Correct arrow from C–H bond to C–C</p> <p>Correct arrow from C–Br bond to Br</p> <p>Structure of chosen product</p> 	1	AO1a	
		1	AO2a	
		1	AO2a	
		1	AO2a	
		1	AO2a	

Question	Marking guidance	Mark	AO	Comments												
04.1	<p>Percentage of oxygen by mass = $100 - 40.9 - 4.5 = 54.6$</p> <table style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <tr> <td style="width: 30%;"></td> <td style="width: 20%; text-align: center;">C</td> <td style="width: 20%; text-align: center;">H</td> <td style="width: 30%; text-align: center;">O</td> </tr> <tr> <td>%</td> <td style="text-align: center;">$\frac{40.9}{12}$</td> <td style="text-align: center;">$\frac{4.5}{1}$</td> <td style="text-align: center;">$\frac{54.6}{16}$</td> </tr> <tr> <td>Divide by A_r</td> <td style="text-align: center;">= 3.41</td> <td style="text-align: center;">= 4.5</td> <td style="text-align: center;">= 3.41</td> </tr> </table> <p>Divide by smallest = $\frac{3.41}{3.41} = 1$ $\frac{4.5}{3.41} = 1.32$ $\frac{3.41}{3.41} = 1$</p> <p>Nearest whole number ratio = 1×3 1.32×3 1×3 = 3 : 3.96 : 3</p> <p>Nearest integer ratio = 3 : 4 : 3</p> <p>Empirical formula $C_3H_4O_3$</p> <p>Empirical formula mass = 88 = molecular formula mass</p> <p>Therefore, molecular formula is same as the empirical formula - $C_3H_4O_3$</p>		C	H	O	%	$\frac{40.9}{12}$	$\frac{4.5}{1}$	$\frac{54.6}{16}$	Divide by A_r	= 3.41	= 4.5	= 3.41	1 1	AO1b AO2b AO2b	
	C	H	O													
%	$\frac{40.9}{12}$	$\frac{4.5}{1}$	$\frac{54.6}{16}$													
Divide by A_r	= 3.41	= 4.5	= 3.41													
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	1	AO2e	
	Disadvantage – more energy is used / required in the reaction	1	AO2e	
04.4	Air gets in / oxidation occurs	1	AO1a	
04.5	Alcohol OH absorption in different place ($3230\text{--}3550\text{ cm}^{-1}$) from acid OH absorption ($2500\text{--}3000\text{ cm}^{-1}$)	1	AO2e	
	The C=O in acids has an absorption at $1680\text{--}1750\text{ cm}^{-1}$	1	AO2e	

Question	Marking guidance	Mark	AO	Comments
05.1	UV light	1	AO1a	
	$\text{CCl}_4 \longrightarrow \text{CCl}_3\bullet + \bullet\text{Cl}$	1	AO2a	
05.2	$\text{Cl}\bullet + \text{O}_3 \longrightarrow \text{ClO}\bullet + \text{O}_2$	1	AO1a	
	$\text{ClO}\bullet + \text{O}_3 \longrightarrow \text{Cl}\bullet + 2\text{O}_2$	1	AO1a	
05.3	M_r of $\text{CF}_3\text{Cl} = 104.5$ Moles freon = $1.78 \times 10^{-4} \times 10^3 / 104.5 = 1.70 \times 10^{-3}$ Number of molecules = $1.70 \times 10^{-3} \times 6.02 \times 10^{23} = 1.02 \times 10^{21}$ Molecules in $500 \text{ cm}^3 = (1.02 \times 10^{21} \times 500 \times 10^{-6}) / 100$ $= 5.10 \times 10^{15}$	1 1 1	AO1b AO1b AO1b	Allow answer in the range $5.10\text{--}5.13 \times 10^{15}$ Answer must be given to this precision

Question	Marking guidance	Mark	AO	Comments
06.1	Alkenes 	1 1	AO1a AO2a	Correctly drawn molecule of cyclobutane or methyl cyclopropane, need not be displayed formula
06.2	C ₆ H 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

06.5	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	1 AO1a 5 AO2a	<p>Indicative chemistry content</p> <p>Stage 1: consider effect of higher temperature on yield (Or vice versa for lower temperature)</p> <ul style="list-style-type: none"> • 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 <p>Stage 2: consider effect of higher temperature on rate (Or vice versa for lower temperature)</p> <ul style="list-style-type: none"> • At higher Temperature, more high energy molecules • more collisions have $E > E_a$ • So rate of reaction increases/time to reach equilibrium decreases <p>Stage 3: conclusion</p> <p>Industrial conditions chosen to achieve (cost-effective) balance of suitable yield at reasonable rate</p>
	Level 3 5–6 marks	<p>All stages are covered and the explanation of each stage is generally correct and virtually complete.</p> <p>Answer communicates the whole process coherently and shows a logical progression from stage 1 and stage 2 (in either order) to stage 3.</p>			
	Level 2 3–4 marks	<p>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.</p> <p>Answer is mainly coherent and shows progression. Some steps in each stage may be out of order and incomplete.</p>			
	Level 1 1–2 marks	<p>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.</p> <p>Answer includes isolated statements but these are not presented in a logical order or show confused reasoning.</p>			
Level 0 0 marks	Insufficient correct chemistry to gain a mark.				

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	1	AO2h	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 = $0.23 / 885 = 2.6 \times 10^{-4}$						
	Stage 2				1	AO2h	
	Mol bromine = $2.0 \times 10^{-2} \times 39.4 / 1000 = 7.9 \times 10^{-4}$						
	Stage 3						
Ratio oil : bromine	1	AO2h					
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	AO3 1a	M5 cannot be awarded unless working for M4 is shown				
Hence, 3 C=C bonds							

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