

COMPONENT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark, apart from extended response questions where a level of response mark scheme is applied.

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Extended response question

A level of response mark scheme is applied. The complete response should be read in order to establish the most appropriate band. Award the higher mark if there is a good match with content and communication criteria. Award the lower mark if either content or communication barely meets the criteria.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

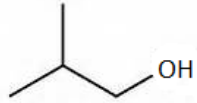
Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

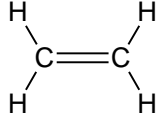
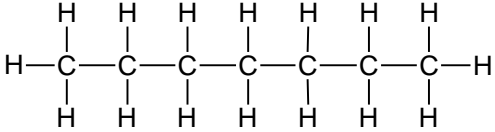
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

Section A

Question				Marking details	Marks available					
					A01	A02	A03	Total	Maths	Prac
1.	(a)			volume of gas produced over time		1		1		1
	(b)			break into smaller pieces / powder	1			1		1
2.				2,2-dimethylbutane		1		1		
3.						1		1		
4.				3 in top box 2 in bottom box – both needed		1		1		
5.				$\Delta H + (-137) = -85$ (1) no error carried forward (ecf) 52 (1) award (2) for correct answer only (cao)		2		2		
6.				infrared / IR spectroscopy	1			1		
7.				$\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$		1		1		
8.				condenser	1			1		1
				Section A total	3	7	0	10	0	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)	(i)		$50 \times 4.18 \times 9.6$ (1) $2006 / 2006.4$ (1)		2		2		2
		(ii)		$n(\text{CuSO}_4) = 0.02525$ and $n(\text{Mg}) = 0.0370$ (1) $\Delta H = \frac{2.006}{0.02525}$ (1) $= -79.4$ must be negative value (1) no ecf possible		1	1	3	1	3
		(iii)		reaction has a higher rate / is quicker / powder has greater surface area (1) heat given out more quickly allowing more accurate determination of maximum temperature (1)	1		1	2		2
		(iv)		heat is lost to the environment (1) place a lid on the polystyrene cup (1) or no cooling correction for highest temperature recorded (1) measure temperature at time intervals, plot graph and extrapolate (1)			2	2		2

Question				Marking details	Marks available						
					AO1	AO2	AO3	Total	Maths	Prac	
	(b)			bonds broken = $1648 + 612 + 2(\text{O—H})$ bonds formed = $2060 + 348 + 360 + (\text{O—H})$ (1) both required $-45 = [2260 + 2(\text{O—H})] - [2768 + (\text{O—H})]$ $(\text{O—H}) = 463$ (2) award (2) overall for -463 ecf possible		3		3	3		
				Question 9 total	1	7	4	12	5	9	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
10.	(a)		van der Waals forces must be overcome in order for boiling to occur (1) the greater the number of carbon atoms the more van der Waals forces (1)	2			2		
	(b)		correct combination for example  		2		2		
	(c)		technique e.g. IR spectroscopy; ¹ H NMR (1) relevant explanation e.g. propene has absorption due to C=C bond but this is not present in cyclopropane; propane has 3 peaks in its ¹ H NMR spectrum but cyclopropane has only 1 (1) accept answers based on other appropriate techniques	1			2		2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
10.	(d)	(i)	$ \begin{array}{cccc} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ & \text{H} & \text{H} & \text{OH} & \text{H} \end{array} $		1		1		
		(ii)	<p>oxygen 18.4% (1)</p> <p>$\frac{67.9}{12.0} : \frac{13.7}{1.01} : \frac{18.4}{16.0}$</p> <p>5.66 : 13.56 : 1.15 (1)</p> <p>$\frac{5.66}{1.15} : \frac{13.56}{1.15} : \frac{1.15}{1.15}$</p> <p>$\text{C}_5\text{H}_{12}\text{O}$ (1) ecf possible</p>					1	
			Question 10 total	3	7	0	10	2	5

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11.	(a)			the instruments were less accurate during the earlier period (1) there were fewer records / measurements made / temperatures are estimates during the earlier period (1)			2	2		
	(b)			any two for (1) each up to max 2 <ul style="list-style-type: none"> • more fossil fuels burned (1) • more industry / transportation (1) • deforestation (1) 	2			2		
	(c)			$n = \frac{pV}{RT} = \frac{101000 \times 24}{8.31 \times 298}$ (1) $n = 979$ (1) molar mass is 48 which is the molar mass of O ₃ (1)	1		1			3
				Question 11 total	3	0	4	7	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12.	(a)			CH ₄ + Cl• → CH ₃ • + HCl (1) CH ₃ • + Cl ₂ → CH ₃ Cl + Cl• (1)	2			2		
	(b)			two CH ₃ • radicals combine (in a termination reaction)	1			1		
	(c)	(i)		CH ₃ Cl + OH ⁻ → CH ₃ OH + Cl ⁻		1		1		
		(ii)		nucleophilic substitution	1			1		
		(iii)		methanol has hydrogen bonding between molecules (1) chloromethane has van der Waals forces / dipole-dipole forces between molecules (1) hydrogen bonding is stronger than van der Waals / dipole-dipole forces (1)	1	2		3		
				Question 12 total	5	3	0	8	0	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
13.	(a)	(i)	labelled axes with units (1) points correctly plotted – within half a small square (1) appropriate straight line drawn (1)	1 1	1		3	1 1	3
		(ii)	1.1×10^{-4} (1) accept range $\pm 0.1 \times 10^{-4}$ $\text{mol dm}^{-3} \text{s}^{-1}$ (1)		2		2	2	2
		(iii)	colorimetry method (1) calibrate colorimeter with iodine solution of known concentration (1) measure light passing through to determine concentration at intervals (1)	1	1	1	3		3
		(iv)	concentration of hydrogen peroxide is directly proportional to the rate/doubling the concentration of hydrogen peroxide doubles the rate (1) concentration of iodide ions is directly proportional to the rate/doubling the concentration of iodide ions doubles the rate (1)			2	2	1	2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
13.	(b)		<p>Boltzmann distribution curve two curves with appropriate shape, clearly labelled to show different temperatures and increased number of particles having energy greater than E_a at higher temperature (2) [award (1) for one curve with appropriate shape and E_a indicated if all above criteria not met]</p> <p>at higher temperature, more particles have energy greater than E_a (1) therefore greater proportion of collisions will result in reaction (1)</p>	4			4		
			Question 13 total	7	4	3	14	5	10

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
14.	(a)		hydrolysis / nucleophilic substitution reaction occurs / $C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ (1) white precipitate of silver chloride is formed (1) cream precipitate of silver bromide is formed (1) $Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3(aq) + X^-(aq) \rightarrow AgX(s) + NO_3^-(aq)$ (1)	1	2		4		2
	(b)	(i)	dichlorodifluoromethane / difluorodichloromethane		1		1		
		(ii)	compounds containing bromine most destructive to ozone / compounds containing fluorine least destructive to ozone (1) increasing the number of chlorine/bromine atoms increases destructive effect (1)			2	2		
			Question 14 total	1	4	2	7	0	2

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
15.	(a)	<p>Indicative content</p> <p> $\text{CH}_3\text{CH}=\text{CH}_2 \longrightarrow \text{CH}_3\overset{+}{\text{C}}\text{H}-\text{CH}_2 \longrightarrow \text{CH}_3\underset{\text{Br}}{\text{C}}\text{H}-\underset{\text{H}}{\text{C}}\text{H}_2$ </p> <ul style="list-style-type: none"> dipole shown on H—Br molecule both curly arrows shown in first stage charges and curly arrow in second stage two different carbocations can form leading to two different products – 2-bromopropane and 1-bromopropane secondary carbocation is more stable than primary carbocation more 2-bromopropane formed (than 1-bromopropane) <p>5-6 marks: All dipoles, curly arrows and charges shown; comparison of relative stabilities of carbocations; both products named; correct main product</p> <p><i>The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.</i></p> <p>3-4 marks: Dipoles, some curly arrows and charges shown correctly; one carbocation represented and one correctly identified product; recognition that two products are formed.</p> <p><i>The candidate constructs a coherent account including most of the key elements of the indicative content and little irrelevant material. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.</i></p>	6			6		

			<p>1-2 marks: Correct dipole shown on HBr; reference to carbocation; one carbocation or product represented.</p> <p><i>The candidate attempts to link at least two relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. There is some evidence of appropriate use of scientific conventions and vocabulary.</i></p> <p>0 marks: <i>The candidate does not make any attempt or give an answer worthy of credit.</i></p>						
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Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Prac	
15.	(b)	(i)	any three for (1) each up to max 3 infrared absorption at 1750 corresponds to C=O (1) infrared absorption at 3200 corresponds to O-H (1) molecular ion peak at 60 gives relative molecular mass of 60 (1) fragments at 15 and 45 correspond to CH ₃ and COOH respectively (1) fourth mark reserved for product ethanoic acid / CH ₃ COOH (1)		1	1				
		(ii)	peaks at approximately 2 and 11 (1) height ratio of 3:1 for peak at 2 to peak at 11 (1)		1	1	2		2	
			Question 15 total	6	3	3	12	0	5	

COMPONENT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS**SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES**

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	3	7	0	10	0	3
9.	1	7	4	12	5	9
10.	3	7	0	10	2	5
11.	3	0	4	7	3	0
12.	5	3	0	8	0	0
13.	7	4	3	14	5	10
14.	1	4	2	7	0	2
15.	6	3	3	12	0	5
Totals	29	35	16	80	15	34