

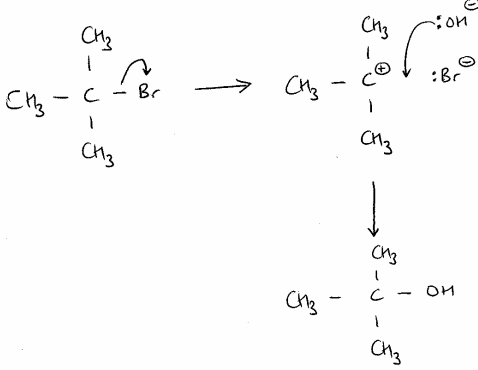
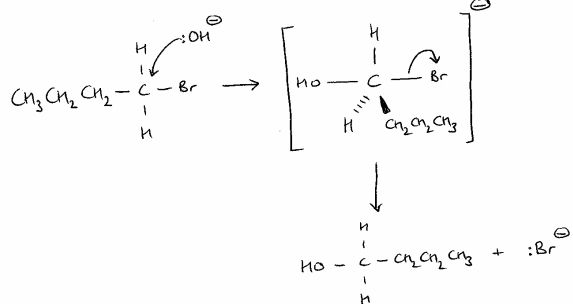
Question Number	Acceptable Answers	Reject	Mark
1 (a)(i)	5.7×10^{-5} / 5.71×10^{-5} / 5.714×10^{-5} / 0.000057 <i>IGNORE</i> SF except 1 (ie don't accept 6×10^{-5})		1

Question Number	Acceptable Answers	Reject	Mark
1 (a)(ii)	<p>C_4H_9Br: first order / 1 (1)</p> <p>(going from first to second experiment) rate doubles when concentration / number of moles doubles (and $[OH^-]$ constant) / rate and concentration increase in proportion (1) <i>ALLOW</i> 'time halves' instead of 'rate doubles'</p> <p>OH^-: zero order / 0 and (going from second to third expt) as increase in concentration does not affect rate (and $[C_4H_9Br]$ constant) (1)</p> <p><i>ALLOW</i> 'doubling in concentration of OH^- instead of 'increase in concentration'</p> <p><i>ALLOW</i> time increases by the same factor as increase in hydroxide concentration (5/3)</p> <p>May refer to experiment number rather than concentrations</p>		3

Question Number	Acceptable Answers	Reject	Mark
1 (a)(iii)	<p>Rate = $k[C_4H_9Br]$ OR Rate = $k[C_4H_9Br]^1[OH^-]^0$</p> <p><i>ALLOW</i> k in lower or upper case</p> <p>Rate equation must be consistent with orders in (a)(ii) If no order is given for hydroxide in (ii) mark cannot be given</p>		1

Question Number	Acceptable Answers	Reject	Mark
1 (a)(iv)	$k = \frac{2.9 \times 10^{-5}}{0.017}$ $= 1.7 \times 10^{-3} / 1.71 \times 10^{-3} / 1.706 \times 10^{-3} \text{ s}^{-1}$ <p><i>ALLOW</i> $k = 1.68 \times 10^{-3}$ (value obtained from experiment 2 or 3)</p> <p>value of k (1)</p> <p>units (1) stand alone mark</p> <p><i>ALLOW</i> TE from (a)(iii) <i>IGNORE</i> SF except 1</p> <p>Rate = $k[\text{C}_4\text{H}_9\text{Br}]^2$ gives $k = 0.10036 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$</p> <p>Rate = $k[\text{C}_4\text{H}_9\text{Br}][\text{OH}^-]$ gives $k = 1.42 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ <i>ALLOW</i> $k = 1.39 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ (value obtained from experiment 2 or 3)</p> <p>Rate = $k[\text{C}_4\text{H}_9\text{Br}][\text{OH}^-]^2$ gives $k = 1184.6 \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$</p> <p>Rate = $k[\text{C}_4\text{H}_9\text{Br}]^2[\text{OH}^-]$ gives $k = 83.62 \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$</p>		2

Question Number	Acceptable Answers	Reject	Mark
1(b)	<p>$[\text{OH}^-]$ is (in chemical equation but) not in rate equation / not in rate determining step (so is in a step other than rate determining step)</p> <p>OR</p> <p>Only $\text{C}_4\text{H}_9\text{Br}$ is in rate equation / rate determining step (so OH^- is in a step other than rate determining step)</p>		1

Question Number	Acceptable Answers	Mark
1 (c)	<p>First mark Choice of bromoalkane must be consistent with rate equation in (a)(iii). If $[\text{OH}^-]$ is not in rate equation, secondary/tertiary bromoalkane. If $[\text{OH}^-]$ is in rate equation, primary/secondary bromoalkane. (1)</p> <p>Second and third marks Either SN1 or SN2 mechanism can score 2 marks regardless of choice of bromoalkane.</p>  <p>Lone pairs not required</p> <p>Curly arrow from C-Br bond to Br (making Br^-) (1)</p> <p>Curly arrow from anywhere on $\text{OH}^- / \text{HO}^-$ to C^+ in correct intermediate (making alcohol) (1)</p> <p>OR</p>  <p>Both curly arrows from OH^- and from C-Br bond to Br (may both be shown at start) (1)</p> <p>Transition state including minus charge (and product) (1)</p> <p>Do not penalise if C_2H_5 shown instead of C_3H_7. Bonds in transition state can be dotted. Do not penalise the missing H atoms in alkyl groups in mechanism.</p>	3

Question Number	Acceptable Answers	Reject	Mark
<p>1 (d) QWC</p>	<p>(Primary and tertiary) carbocation intermediates have different stabilities (1) as (inductive effects of) alkyl groups stabilise tertiary carbocation (1)</p> <p>OR</p> <p>Steric hindrance differs for attack on primary and tertiary carbon (in the molecule) / less space available for attack by OH⁻ on tertiary carbon / more space for attack by OH⁻ on primary carbon (1) as bulky / three alkyl groups obstruct attack (1)</p>	<p>“Tertiary bromoalkanes react by SN1” without further explanation</p> <p>carbocation intermediates have different reactivity</p> <p>steric hindrance in carbocation</p>	<p>2</p>

Question Number	Acceptable Answers	Reject	Mark
2(a)(i)	<ul style="list-style-type: none"> • In experiments 1 and 2, $[H^+]$ doubles (whilst keeping other concentrations constant) and the rate quadruples / rate increases x 4 (1) • Second order (with respect to H^+) (1) • In experiments 1 and 3, $[Br^-]$ doubles and $[BrO_3^-]$ triples (with $[H^+]$ constant) (1) • Rate increases by 3×2 / rate increases x 6 / rate increases to 5.04×10^{-5} (then to 1.01×10^{-4} stated or implied) (1) • First order with respect to Br^- (1) <p>OR</p> <ul style="list-style-type: none"> • In experiments 2 and 3, $[Br^-]$ doubles and $[BrO_3^-]$ triples and $[H^+]$ halves (1) • Rate increases by $3 \times 0.25 \times 2$ / rate increases x 1.5 (1) • First order with respect to Br^- (1) <p>Penalise OMISSION of Experiment Numbers once only</p> <p>Mark each point independently</p>		5

Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	<p>Rate = $k [BrO_3^-] [Br^-] [H^+]^2$</p> <p>Mark CQ on (a)(i) Allow "r" or "R" for "rate" in the rate equation. IGNORE If k appears to be in upper case.</p>		1

Question Number	Acceptable Answers	Reject	Mark
2(a)(iii)	<p>IGNORE sf except 1 sf THROUGHOUT</p> <p>FIRST, CHECK THE FINAL ANSWER IF answer $k = 1.49 \times 10^{-2} \text{ dm}^9 \text{ mol}^{-3} \text{ s}^{-1}$ award (3) marks</p> <p>$k = \frac{\text{rate}}{[\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]^2}$ $= \frac{1.68 \times 10^{-5}}{0.05 \times 0.25 \times (0.30)^2}$ (1) $= 0.014933333$ $= 0.0149$ (1) $\text{dm}^9 \text{ mol}^{-3} \text{ s}^{-1} / \text{mol}^{-3} \text{ dm}^9 \text{ s}^{-1}$ (1)</p> <p>IGNORE sf except 1 sf Mark CQ from (a)(ii) or, if no rate equation in (a)(ii), then any rate equation stated in (a)(iii)</p> <p>NOTE: IF the rate equation in (a)(ii) is given as Rate = $k [\text{BrO}_3^-] [\text{H}^+]^2$ CQ $k = 3.73 \times 10^{-3} \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$ scores (3)</p> <p>IF $[\text{H}^+]$ is not squared in the correct rate equation: $k = 4.48 \times 10^{-3} \text{ dm}^9 \text{ mol}^{-3} \text{ s}^{-1}$ OR $k = 4.48 \times 10^{-3} \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$ scores (2)</p> <p>ALLOW Correct answers derived from the data in the table for Experiment 2 or Experiment 3</p>		3

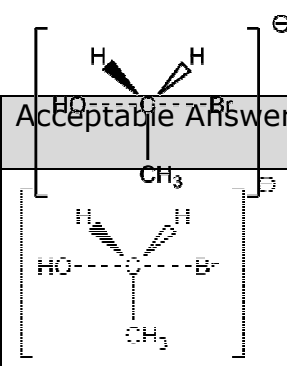
Question Number	Acceptable Answers	Reject	Mark
2(b)	<p>The number(s) (of particles) in the rate equation / rate-determining step do not match those in the equation for the reaction</p> <p>OR</p> <p>The chance of (simultaneous) collision of 12 particles is unlikely</p> <p>OR</p> <p>The chance of (simultaneous) collision of 4 particles is unlikely</p> <p>OR</p> <p>The chance of (simultaneous) collision of 3 reactants is unlikely</p> <p>ALLOW</p> <p>'molecules' / 'substances' for 'particles'</p> <p><u>NOTE</u></p> <p>ALLOW AS A CQ from (a)(ii) Br^- ions not in rate equation / Br^- ions not in rate-determining step / Zero order with respect to Br^- / (Only) two reactants in the rate-determining step / (only) two reactants in the rate-equation/ particles are in the equation (for the reaction) that are not in the rate equation</p>		1

Question Number	Acceptable Answers	Reject	Mark
2(c)	<p>REMEMBER TO SCROLL DOWN BELOW THE SPACE LEFT FOR A SKETCH-GRAPH TO SEE WHAT CANDIDATE HAS WRITTEN ON THE DOTTED LINES</p> <ul style="list-style-type: none"> • (Calculate) gradient (of tangent) (1) ALLOW 'slope' for 'gradient' • At $t = 0$ / at the start / at the beginning / when reaction is at its fastest / at the origin (1) <p>Each mark is stand-alone</p> <p>NOTE: Answer may be annotated on a suitable sketch-graph</p> <p>IGNORE any sketch-graph that shows an increase in concentration with time</p> <p>MAX (1) if sketch-graph shows a decrease in the concentration of a reactant / Br₂</p>	<p>Answers relating to half-life score (0) overall</p> <p>If sketch-graph or comments suggest that gradient is measured at other than $t = 0$ or at several values of t then max (1)</p>	2

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	$k = (1.54 \times 10^{-6}) \div (0.1 \times 0.15)$ (1) $(= 1.0267 \times 10^{-4})$ $= 1.03 \times 10^{-4}$ (1) must be to 3 SF $\text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$ (1) Unit mark is stand alone and units can be in any order Correct answer with units but no working (3) marks	1.02×10^{-4}	3

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	If correct unrounded answer to (a) (i) stored in calculator then $4.1067 \times 10^{-8} = 4.1 \times 10^{-8} (\text{mol dm}^{-3} \text{s}^{-1})$ OR If 1.0267×10^{-4} used then $4.1068 \times 10^{-8} = 4.1 \times 10^{-8} (\text{mol dm}^{-3} \text{s}^{-1})$ OR If 1.03×10^{-4} used then $4.12 \times 10^{-8} = 4.1 \times 10^{-8} (\text{mol dm}^{-3} \text{s}^{-1})$ IGNORE sf except 1sf IGNORE units even if incorrect TE from (a)(i)		1

Question Number	Acceptable Answers	Reject	Mark
3(b)(i)	$2^{(\text{nd})}/\text{second}/\text{two}/(1 + 1) = 2$ (order)		1

Question Number	Acceptable Answers	Reject	Mark
3(b)(ii)	 <p>Structure (1) ALLOW structure without wedged bonds Dotted bonds must be shown and OH and Br must be on opposite sides with a C-C or C-H bond between them</p> <p>Charge (1) Charge mark can be awarded for a near miss with a single error in the structure (e.g. one hydrogen atom missing)</p> <p>ALLOW -ve charge shown as δ- on both OH and Br Brackets not essential</p> <p>ALLOW -ve charge to be anywhere on the structure IGNORE δ+ on carbon atom</p>		2

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	3.00×10^{-3} (1) IGNORE sf for 1/T	-5.60	2
	-5.58 (1) IGNORE sf except 1sf		

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	<p>Appropriate scale (1) Plotted points must cover at least half of the graph paper on each axis.</p> <p>Points plotted correctly and straight line drawn (1) through all points</p> <p>Gradient = -10230 ± 500 (1)</p> <p>Example $E_a = 10230 \times 8.31$ (1) allow TE from incorrect gradient</p> <p>$E_a = (+) 85.0 \text{ kJ}(\text{mol}^{-1}) / (+) 85\,000 \text{ J}(\text{mol}^{-1})$ (1) 3 sf</p> <p>E_a range from 80.9 to 89.2 kJ mol⁻¹</p> <p>ALLOW TE from incorrect gradient</p> <p>IGNORE SF except 1</p>	 K ⁻¹	5

Question Number	Acceptable Answers	Reject	Mark
4 (a)(i)	<p>These are stand alone marks</p> <p>First mark:</p> <p>(ensures that) $[H^+]$ and [propanone] (virtually) constant OR so that the $[H^+]$ and [propanone] do not affect the rate (1)</p> <p>Second mark:</p> <p>the $[I_2]$ / iodine concentration changes OR so that the overall order (of reaction) is not determined OR otherwise a curve (graph) is obtained (1)</p> <p>NOTE:-</p> <p>“only the $[I_2]$ changes scores (2) OR “only the I_2 concentration changes” scores (2) BUT “only the iodine changes” scores (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
4 (a)(ii)	<p>First mark:</p> <p>double the concentration of propanone OR change/increase/decrease the concentration of propanone (1)</p> <p>Second mark (mark consequentially):</p> <p>slope/gradient of line doubles ALLOW "rate doubles" OR slope or gradient changes/increases/decreases by same factor ALLOW "rate changes/increases/decreases by same factor" (1)</p> <p>NOTE: may suggest a different procedure:-</p> <p>First mark:</p> <p>monitor/measure [propanone] over time (1)</p> <p>Second mark (mark consequentially):</p> <p>plot [propanone] v. time graph and state that $t_{1/2}$ constant (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
4 (a)(iii)	<p>I₂ not involved in rate-determining step/ I₂ not involved in slow(est) step / H⁺ and propanone involved in rate-determining step/ H⁺ and propanone involved in slow(est)step (1)</p> <p>so there must be another step where I₂ is involved/ so there must be a fast step where I₂ is involved (1)</p> <p>BUT:-</p> <p>I₂ not involved until after the rate-determining step/ I₂ not involved until after the slow(est) step (2)</p> <p>ALLOW</p> <p>H⁺ involved in rate-determining step (1)</p> <p>and is regenerated as it is a catalyst (in another step) (1)</p>	I ₂ involved before rate-determining/slowest step (0)	2

Question Number	Acceptable Answers	Reject	Mark
4 (b)(i)	$\text{HCO}_3^- + \text{H}^+ \rightarrow \text{H}_2\text{O} + \text{CO}_2$ OR $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{H}_2\text{CO}_3$ OR $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightarrow 2\text{H}_2\text{O} + \text{CO}_2$ OR $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightarrow \text{H}_2\text{CO}_3 + \text{H}_2\text{O}$ ALLOW: $\text{NaHCO}_3 + \text{H}^+ \rightarrow \text{Na}^+ + \text{H}_2\text{O} + \text{CO}_2$ OR $\text{Na}^+ + \text{HCO}_3^- + \text{H}^+ \rightarrow \text{Na}^+ + \text{H}_2\text{O} + \text{CO}_2$ IGNORE any correct or any incorrect state symbols	$\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$ OR any equations with HA	1

Question Number	Acceptable Answers	Reject	Mark
4 (b)(ii)	$\text{CH}_3\text{COCH}_3 + 3\text{I}_2 + 4\text{NaOH}$ $\rightarrow \text{CHI}_3 + \text{CH}_3\text{COONa} + 3\text{NaI} + 3\text{H}_2\text{O}$ IGNORE any correct or any incorrect state symbols CHI₃ on RHS of equation (1) remaining species correct (1) balanced equation (1) NOTE: balancing mark is CQ on all species correct Accept correct ionic equation (i.e. Na ⁺ omitted) NOTE: If CH ₃ I, can only access second mark above		3