Marks 5

- 2-Bromo-2-methylpropane reacts with hydroxide ions to give 2-methyl-2-propanol.

$$(CH_3)_3CBr + OH^- \rightarrow (CH_3)_3COH$$

The following rate data were collected at 55 °C.

Experiment	$[(CH_3)_3CBr]_0$ (M)	$[OH^-]_0$ (M)	Initial rate ($d[(CH_3)_3COH]/dt$, M s^{-1})
1	0.050	0.10	5.0×10^{-4}
2	0.20	0.10	2.0×10^{-3}
3	0.20	0.30	2.0×10^{-3}

Determine the rate law for the reaction.

Between experiments (1) and (2), $[OH^-]_0$ is constant. $[(CH_3)_3CBr]_0$ is increased by a factor of 4 and this leads to the rate increasing by a factor of 4: rate α $[(CH_3)_3CBr]$.

Between experiments (2) and (3), $[(CH_3)_3CBr]_0$ is constant. $[OH^-]_0$ is increased by a factor of 3 and this leads to no change in the rate. The rate is independent of $[OH^-]_0$.

Overall, rate = $k[(CH_3)_3CBr]$.

Calculate the value of the rate constant at 55 °C.

From the rate law, k = rate / $[(CH_3)_3CBr]$.

For experiment 1, rate = 5×10^{-4} M s^{-1} and $[(CH_3)_3CBr]$ = 0.050 M and so

$k = (5 \times 10^{-4}$ M $s^{-1}) / (0.050$ M) = 1.0×10^{-2} s^{-1}

Answer: **$k = 1.0 \times 10^{-2}$ s^{-1}**

Suggest a possible mechanism for the reaction based on the form of the rate law. Explain your answer.

The rate is independent of $[OH^-]$ suggesting that it is involved in a step after the rate determining step.

The rate is directly proportional to $[(CH_3)_3CBr]$ suggesting that a rate determining step which is unimolecular in $(CH_3)_3CBr$.

A possible mechanism is:

(1) $(CH_3)_3Br \rightarrow (CH_3)_3^+ + Br^-$ slow
(2) $(CH_3)_3^+ + OH^- \rightarrow (CH_3)_3OH$ fast