Marks
5

- Consider the following reaction.

$$2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O(l)$$

A series of experiments gave the rate data shown in the table below.

Experiment number	initial $[ClO_2]$ (M)	initial $[OH^-]$ (M)	initial rate of decrease of $[ClO_2]$ ($M\ s^{-1}$)
1	0.0500	0.100	5.75×10^{-2}
2	0.100	0.100	2.30×10^{-1}
3	0.100	0.050	1.15×10^{-1}

Determine the rate expression for the above reaction.

Between experiments 1 and 2, $[OH^-]$ is kept constant. $[ClO_2]$ is doubled and this quadruples the rate: the reaction is second order with respect to $[ClO_2]$. Between experiments 2 and 3, $[ClO_2]$ is kept constant. $[OH^-]$ is halved and this halves the rate: the reaction is first order with respect to $[OH^-]$. Thus,

rate α $[ClO_2]^2[OH^-] = k[ClO_2]^2[OH^-]$

Rate = **$k[ClO_2]^2[OH^-]$**

What is the value of the rate constant? Include units in your answer.

Using experiment 1,

rate = $k[ClO_2]^2[OH^-]$

$(5.75 \times 10^{-2}\ M\ s^{-1}) = k \times (0.0500\ M)^2 \times (0.100\ M)$ so $k = 230\ M^2\ s^1$

$(M\ s^{-1}) = (\text{units of } k) \times (M)^2 \times (M)$ so the units of k are $M^{-2}\ s^{-1}$

k = **$230\ M^{-2}\ s^{-1}$**

What is the relationship between the rate of decrease of $[ClO_2]$ and the rate of increase of $[ClO_3^-]$?

From the chemical equation, two moles of ClO_2 are lost for every mole of ClO_3^- formed. Thus, the rate of decrease of $[ClO_2]$ is twice the rate of increase of $[ClO_3^-]$ (or the rate of increase of $[ClO_3^-]$ is half the rate of decrease of $[ClO_2]$).