Exemplar exam question – Chapter 6

1 **a** Explain why the rate of reaction between calcium carbonate and hydrochloric acid is faster with 1.0 mol dm^{-3} hydrochloric acid than 0.1 mol dm^{-3} hydrochloric acid. [2]

Higher Level only

b The rate of the reaction between bromate(V) ions and bromide ions in the presence of acid can be followed colorimetrically. The equation for the reaction is:

$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

Use the experimental data below to deduce the order of reaction with respect to bromide ions and H^+ ions. [4]

Experiment	Concentration of BrO_3^- / mol dm^{-3}	Concentration of Br^- / mol dm^{-3}	Concentration of H^+ / mol dm^{-3}	Rate / mol dm^{-3} s^{-1}
1	1.00×10^{-2}	1.00×10^{-2}	1.00×10^{-2}	2.00×10^{-4}
2	1.00×10^{-2}	2.00×10^{-2}	1.00×10^{-2}	4.00×10^{-4}
3	1.00×10^{-2}	2.00×10^{-2}	3.00×10^{-2}	3.60×10^{-3}

Commentary

It is essential, when answering questions on rates, that the idea of time appears in the answer.

a Possible answer:

The concentration of 1.0 mol dm^{-3} hydrochloric acid is higher, therefore there are more particles in a certain area.

There will therefore be more collisions between calcium carbonate particles and hydrochloric acid particles.

In the first point, the word **volume** would be better than **area**.

There is no idea of time anywhere in this answer. The second point would be better worded as:

There will therefore be more **frequent** collisions (or there will be more collisions **in a certain time**) between calcium carbonate particles and hydrochloric acid particles.

b The word 'deduce' is important in this question and it will not be enough to just state the orders. You must give sufficient explanation too.

Model answer:

The order with respect to Br^- is 1. [1]

Using experiments 1 and 2, the concentrations of BrO_3^- and H^+ remain constant and when the concentration of Br^- is doubled the rate of reaction also doubles. [1]

The order with respect to H^+ is 2. [1]

Using experiments 2 and 3, the concentrations of BrO_3^- and Br^- remain constant and when the concentration of H^+ is trebled the rate of reaction increases by a factor of 9, i.e. 3^2. [1]