**6.*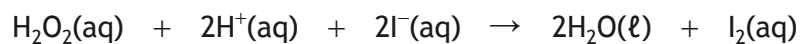* The reaction between iodide ions and hydrogen peroxide in the presence of thiosulfate ions, with starch as the indicator, can be used to determine the relationship between concentration and rate.
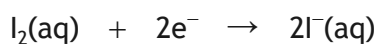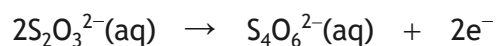
(a) Hydrogen peroxide, $H_2O_2(aq)$, reacts with iodide ions in acidic solution to form iodine.

$$H_2O_2(aq) \ + \ 2H^+(aq) \ + \ 2I^-(aq) \ \rightarrow \ 2H_2O(\ell) \ + \ I_2(aq)$$

Write the ion-electron equation for the reduction reaction taking place. **1**

(b) As iodine molecules are produced, they immediately react with thiosulfate ions, $S_2O_3^{2-}$, and are converted back to iodide ions.

$$2S_2O_3^{2-}(aq) \ \rightarrow \ S_4O_6^{2-}(aq) \ + \ 2e^-$$

$$I_2(aq) \ + \ 2e^- \ \rightarrow \ 2I^-(aq)$$

Combine the two ion-electron equations to give the overall redox equation. **1**

6. (continued)

(c) In the reaction, the mixture remains colourless until all the thiosulfate ions have been used up. This is shown by the sudden appearance of a blue/black colour.

A set of experiments were carried out to determine the relationship between concentration and rate. The concentration of iodide solution was varied by diluting the original concentration with water and keeping the total volume of solutions the same in each experiment. The time taken for the blue/black colour to appear was recorded.

The results of the experiments are shown.

	Experiment				
	1	**2**	**3**	**4**	**5**
Volume of iodide solution (cm^3)	25	20	15	10	5
Volume of water (cm^3)	0	5		15	20
Time to turn blue/black (s)	8	10	13	20	40
Rate of reaction (1/t) (s^{-1})	0.120	0.100	0.077	0.050	0.025

(i) Complete the table to show the volume of water needed for experiment 3.

1

(ii) A dry beaker must be used for each experiment.

Suggest a reason why the beaker should be dry.

1

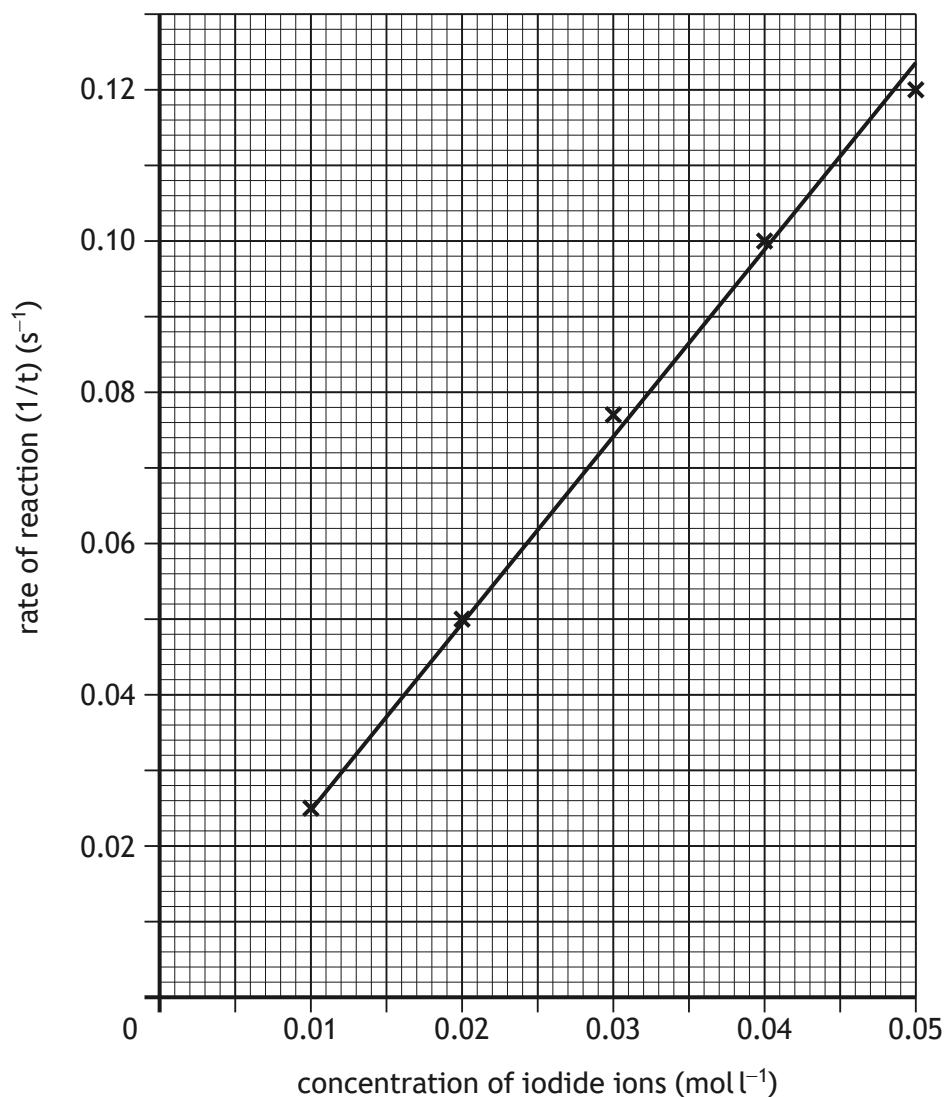**[Turn over**

6. (continued)

    (d) A graph of the rate of reaction against the concentration of iodide ions is shown for these results.

        (i) Use information from the graph to state what happens to the rate of reaction when the concentration of iodide ions is doubled.

1

        (ii) Use information from the graph to calculate the reaction time, in seconds, when the concentration of the iodide ions was 0.025 mol l^{-1}.

1

6. **(d)** **(continued)**

(iii) Explain **fully** why increasing the concentration causes an increase in reaction rate.

2

[Turn over