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— **TUITION** —

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# CHEMISTRY

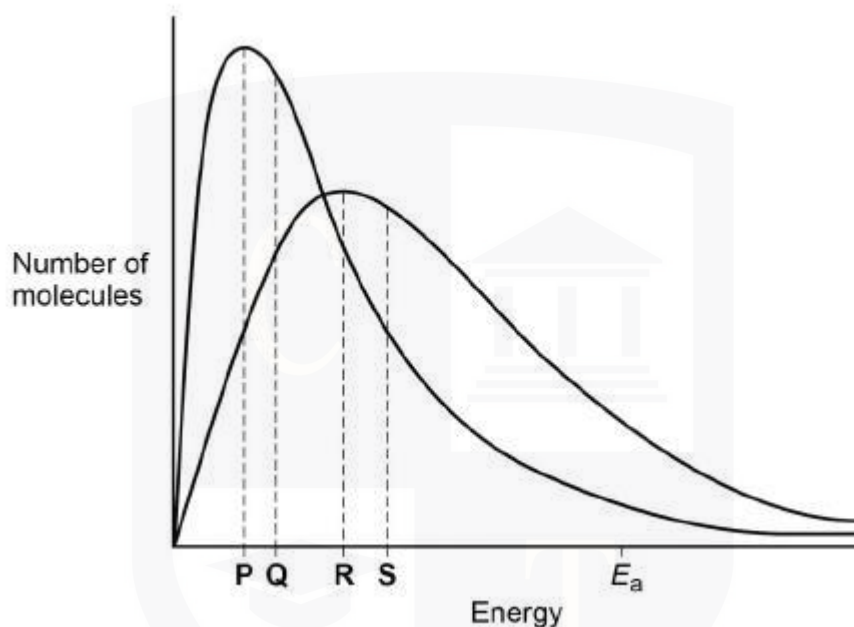
## Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	KINETICS
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	10
TOTAL MARKS	28

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## Kinetics - 1

1. The question below is about the Maxwell–Boltzmann distribution shown for a sample of a gas, X, at two different temperatures.



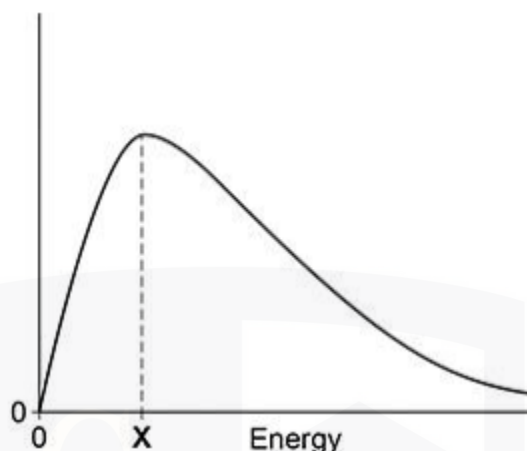
Which statement is correct for the higher temperature?

- A. The area under the curve to the left of  $E_a$  decreases.
- B. The total area under the curve increases.
- C. The activation energy decreases.
- D. More molecules have the mean energy.

**(Total 1 mark)**

2. The figure below shows the Maxwell–Boltzmann distribution of molecular energies in a sample of gas.

I am Sorry !!!!!



(a) Label the y-axis on the figure above.

(1)

(b) State why the curve starts at the origin.

(1)

(c) State what X indicates on the figure above.

(1)

3. A mixture of 2 dm<sup>3</sup> of hydrogen and 1 dm<sup>3</sup> of oxygen is at room temperature. Which statement is correct?

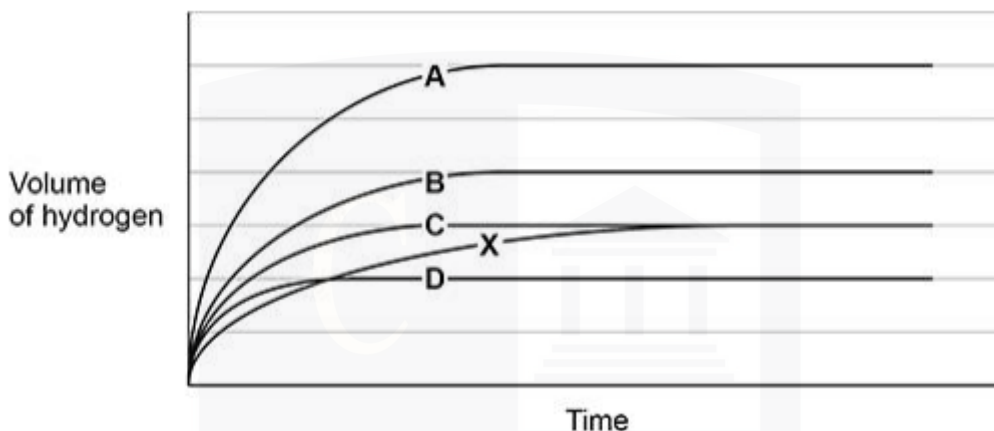
- A. There is no reaction to form water because the molecules do not collide with sufficient energy.
- B. There is no reaction to form water because the molecules do not collide with sufficient frequency.
- C. The mean velocity of the hydrogen molecules is less than that of the oxygen molecules.
- D. The partial pressure of each gas is the same.

(Total 1 mark)

4. An excess of magnesium reacts with hydrochloric acid to form hydrogen gas.

Line X on the graph shows how the volume of hydrogen produced changes with time as magnesium reacts with 30 cm<sup>3</sup> of 1.0 mol dm<sup>-3</sup> hydrochloric acid.

The reaction is repeated using 20 cm<sup>3</sup> of 2.0 mol dm<sup>-3</sup> hydrochloric acid, with all other conditions the same.



Which line shows how the volume of hydrogen produced changes with time?

- A.
- B.
- C.
- D.

**(Total 1 mark)**

5. A student investigates the effect of temperature on the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid.



The student mixes the solutions together in a flask and places the flask on a piece of paper marked with a cross.

The student records the time for the cross to disappear.

The cross disappears because the mixture becomes cloudy.

The table shows the student's results.

Temperature / °C	22	31	36	42	49	54
Time t for cross to disappear / s	87	48	36	26	44	12
1/t s <sup>-1</sup>	0.0115	0.0208	0.0278	0.0385	0.0227	

(a) The student uses a stopwatch to measure the time.

The stopwatch shows each time to the nearest 0.01 s

Suggest why the student records the times to the nearest second and not to the nearest 0.01 s

(1)

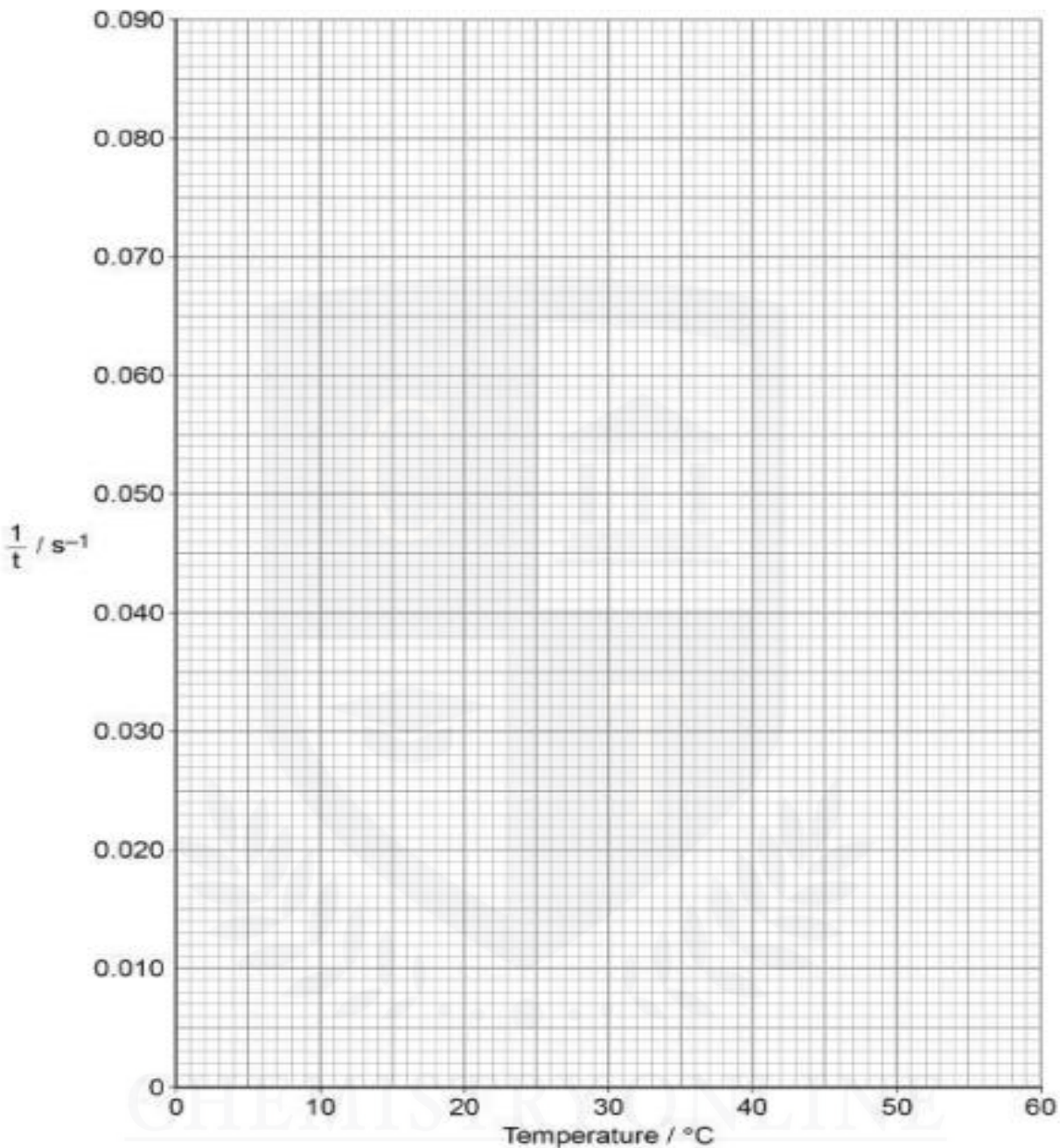
(b) The rate of reaction is proportional to 1/t  
Complete the table above.

(1)

(c) Plot the values of 1/t against temperature on the graph below.  
Draw a line of best fit.

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(2)

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(d) Use your line of best fit to estimate the time for the cross to disappear at 40 °C .

Show your working.

(1)

- (e) Suggest, by considering the products of this reaction, why small amounts of reactants are used in this experiment.

(1)

- (f) The student could do the experiment at lower temperatures using an ice bath.

Suggest why the student chose not to carry out experiments at temperatures in the range 1–10 °C

(1)

6. Which statement about the molecules in a sample of a gas is correct?

- A. At a given temperature they all move at the same speed.
- B. At a given temperature their average kinetic energy is constant.
- C. As temperature increases, there are more molecules with the most probable energy.
- D. As temperature decreases, there are fewer molecules with the mean energy.

(Total 1 mark)

7. Which statement is correct for the distribution curve of molecular energies in a gas?

- A. The curve is symmetrical about the maximum.
- B. There are always some molecules with zero energy.
- C. The position of the maximum of the curve is not dependent on the temperature.
- D. The mean energy of the molecules is greater than the most probable energy of the molecules.

(Total 1 mark)

8. Hydrogen peroxide solution decomposes slowly to form water and oxygen. The reaction is much faster in the presence of a manganese(IV) oxide catalyst.

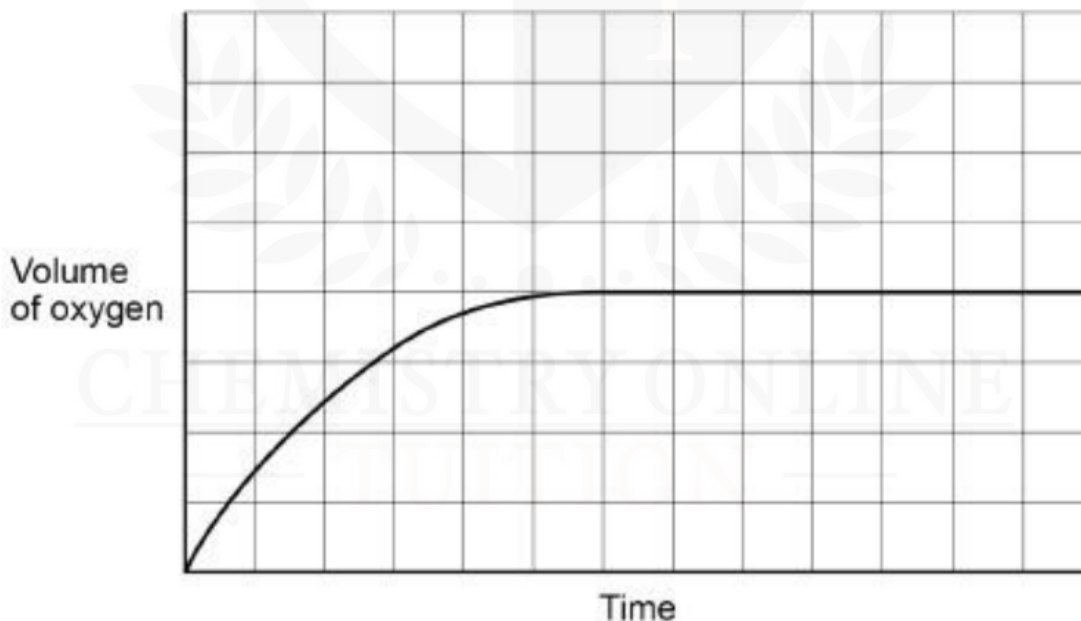


Three experiments, shown in the table, were carried out to investigate how the volume of oxygen produced varied over time under different conditions.

The same mass of catalyst was used in each experiment.

Experiment	Concentration of $\text{H}_2\text{O}_2(\text{aq}) / \text{mol dm}^{-3}$	Volume of $\text{H}_2\text{O}_2(\text{aq}) / \text{cm}^3$	Temperature / $^{\circ}\text{C}$	Catalyst
1	1.0	50	20	lumps
2	1.0	50	20	powder
3	0.5	50	20	lumps

The graph shows how the volume of oxygen collected varied with time in Experiment 1.



- (a) Explain, in general terms, how a catalyst increases the rate of a reaction.

(2)

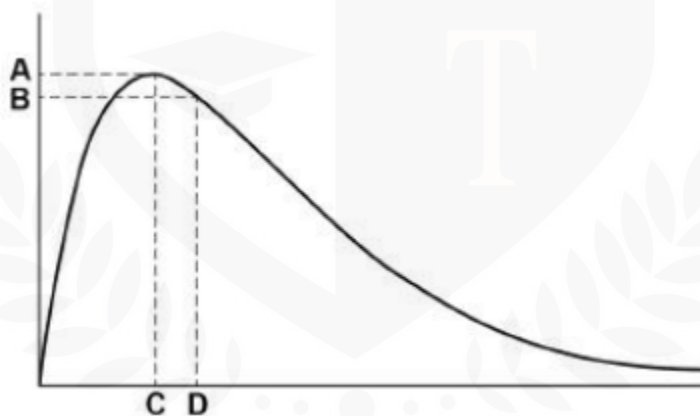


(b) Explain, in terms of collision theory, the effect of increasing the concentration of hydrogen peroxide on the rate of reaction.

(2)

9. The Maxwell–Boltzmann distribution of molecular energies in a sample of gas at a fixed temperature is shown.

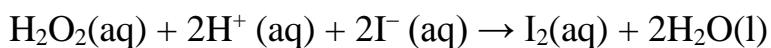
Which letter represents the mean energy of the molecules?



- A.
- B.
- C.
- D.

(Total 1 mark)

10. Iodide ions are oxidised to iodine by hydrogen peroxide in acidic conditions.



The rate equation for this reaction can be written as

$$\text{Rate} = k [\text{H}_2\text{O}_2]^a [\text{I}^-]^b [\text{H}^+]^c$$

In an experiment to determine the order with respect to  $\text{H}^+$  (aq), a reaction mixture is made containing  $\text{H}^+$  (aq) with a concentration of  $0.500 \text{ mol dm}^{-3}$

A large excess of both  $\text{H}_2\text{O}_2$  and  $\text{I}^-$  is used in this reaction mixture so that the rate equation can be simplified to  $\text{rate} = k_1[\text{H}^+]^c$

**(a)** Explain why the use of a large excess of  $\text{H}_2\text{O}_2$  and  $\text{I}^-$  means that the rate of reaction at a fixed temperature depends only on the concentration of  $\text{H}^+$ (aq).

**(2)**

**(b)** Samples of the reaction mixture are removed at timed intervals and titrated with alkali to determine the concentration of  $\text{H}^+$  (aq).

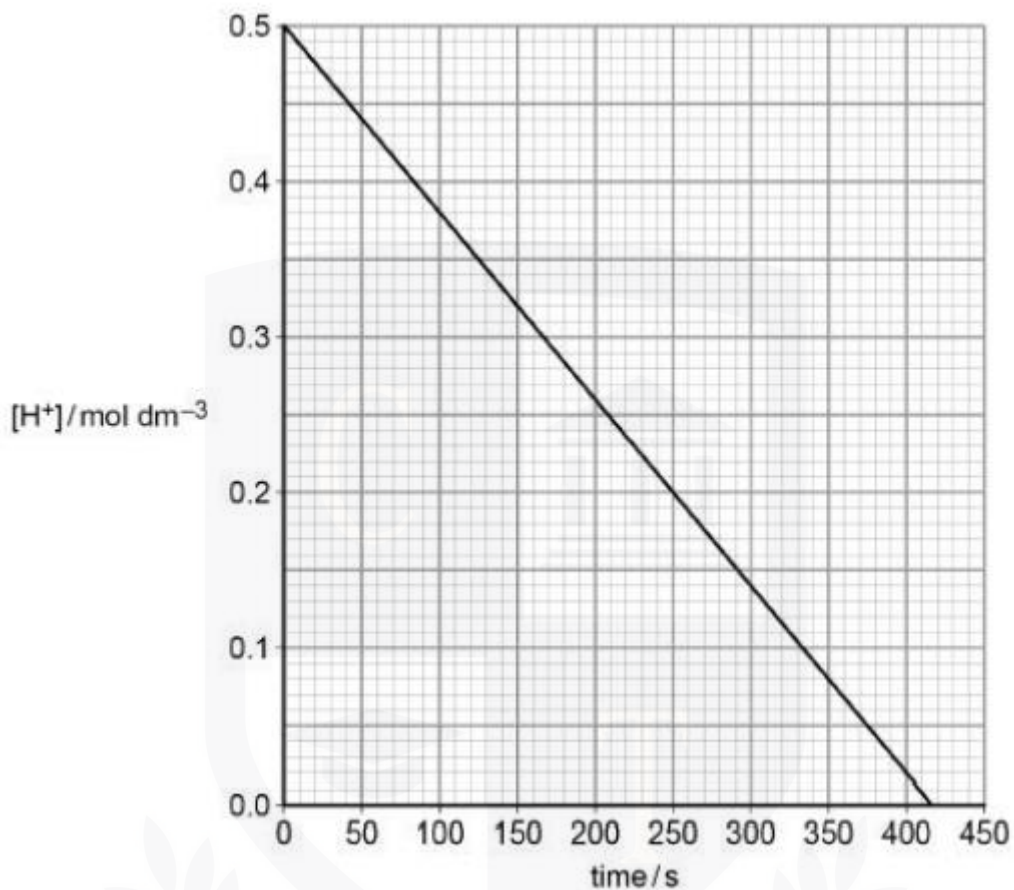
State and explain what must be done to each sample before it is titrated with alkali.

**(2)**

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(c) Graph of the results is shown in Figure 1.



Explain how the graph shows that the order with respect to  $\text{H}^+$  (aq) is zero.

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(2)

(d) A second reaction mixture is made at the same temperature.

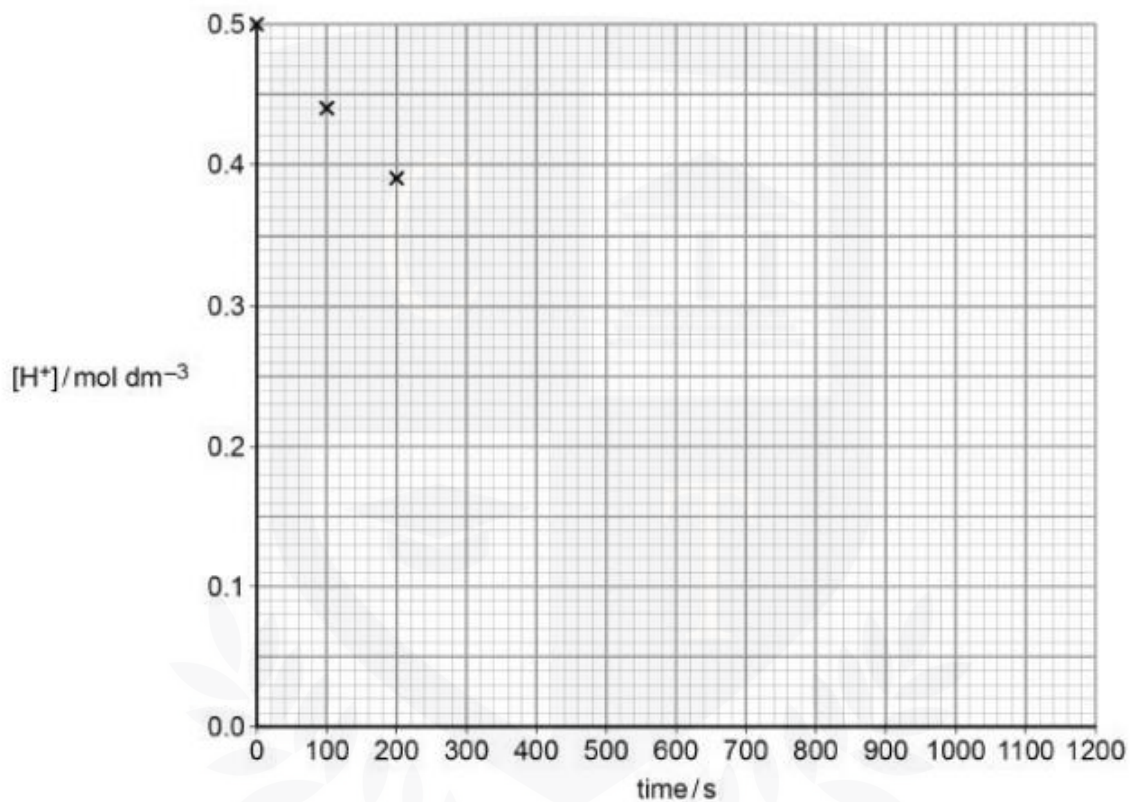
The initial concentrations of  $\text{H}^+$  (aq) and  $\text{I}^-$  (aq) in this mixture are both  $0.500 \text{ mol dm}^{-3}$ . There is a large excess of  $\text{H}_2\text{O}_2$ .

In this reaction mixture, the rate depends only on the concentration of  $\text{I}^-$  (aq). The results are shown in the table.

Time / s	0	100	200	400	600	800	1000	1200
[H <sup>+</sup> ] / mol dm <sup>-3</sup>	0.50	0.44	0.39	0.31	0.24	0.19	0.15	0.12

Plot these results on the grid in Figure .

The first three points have been plotted.



(1)

(e) Draw a line of best fit on the grid in Figure.

(1)

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- Founder & CEO of Chemistry Online Tuition Ltd.
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