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CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	RATE EQUATIONS
PAPER TYPE:	QUESTION PAPER - 3
TOTAL QUESTIONS	10
TOTAL MARKS	38

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Rate Equations - 3

1. This question involves the use of kinetic data to deduce the order of a reaction and calculate a value for a rate constant.

The data in Table were obtained in a series of experiments on the rate of the reaction between compounds A and B at a constant temperature.

Experiment	Initial concentration of A / mol dm ⁻³	Initial concentration of B / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹
1	0.12	0.26	2.10×10^{-4}
2	0.36	0.26	1.89×10^{-3}
3	0.72	0.13	3.78×10^{-3}

Show how these data can be used to deduce the rate expression for the reaction between A and B.

(3)

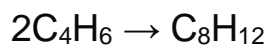
2. What is the rate determining step?

(2)

3. How could you find the rate expression using the initial rate method?

(4)

4. Butadiene dimerises according to the equation

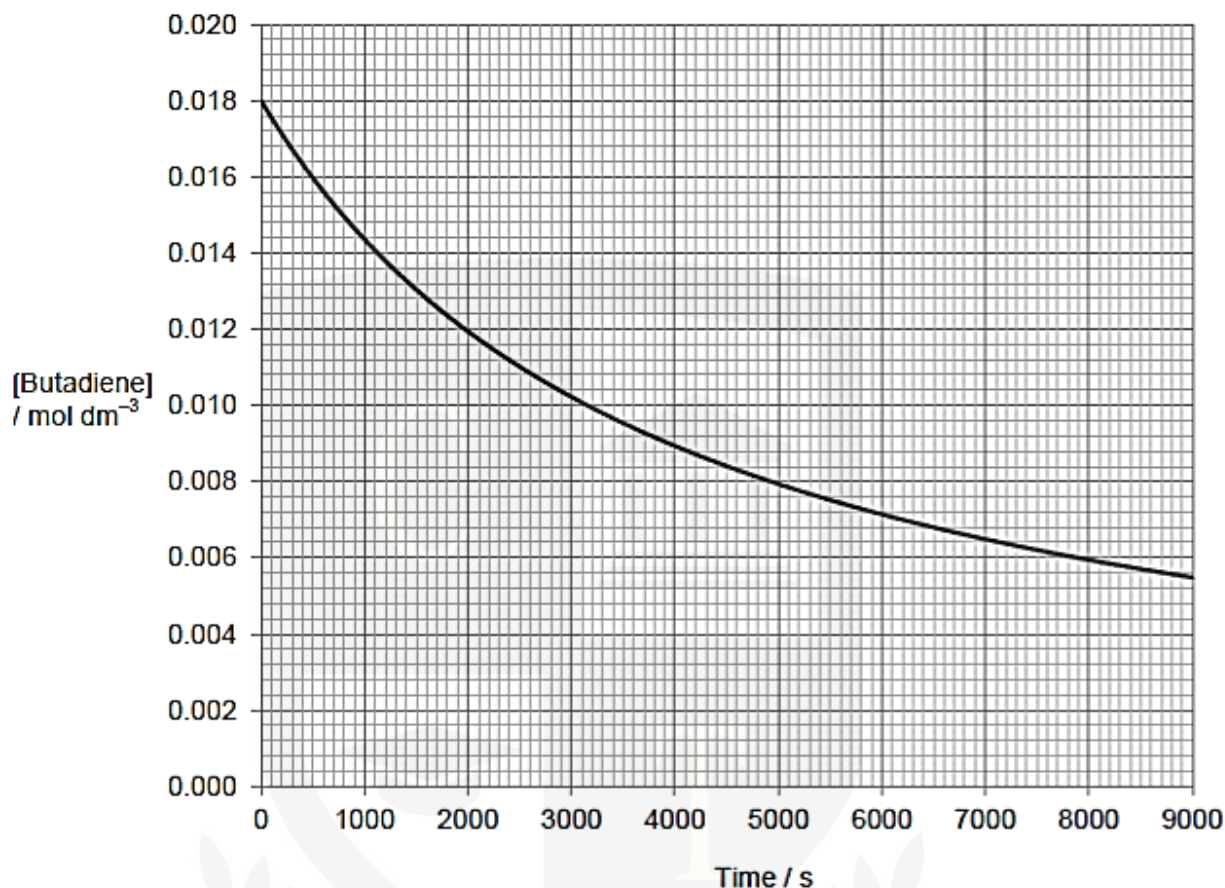


The kinetics of the dimerisation are studied and the graph of the concentration of a sample of butadiene is plotted against time.

The graph is shown below.

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- (a)** Draw a tangent to the curve when the concentration of butadiene is $0.0120 \text{ mol dm}^{-3}$.

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(1)

- (b)** The initial rate of reaction in this experiment has the value $4.57 \times 10^{-6} \text{ mol dm}^{-3} \text{ s}^{-1}$.

Use this value, together with a rate obtained from your tangent, to justify that the order of the reaction is 2 with respect to butadiene.

(5)

5. What is the Arrhenius equation? What does each term mean?

(3)

6. The data in the following table were obtained in two experiments about the rate of the reaction between substances B and C at a constant temperature.

Experiment	Initial concentration of B / mol dm ⁻³	Initial concentration of C / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹
1	4.2×10^{-2}	2.6×10^{-2}	8.4×10^{-5}
2	6.3×10^{-2}	7.8×10^{-2}	To be calculated

The rate equation for this reaction is known to be $\text{rate} = k[\text{B}]^2[\text{C}]$

(a) Use the data from Experiment 1 to calculate a value for the rate constant k at this temperature and deduce its units.

(3)

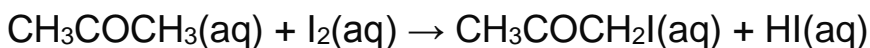
(b) Calculate a value for the initial rate in Experiment 2.

(1)

7. Write a generic rate expression and state what each term means.

(2)

8. This question is about rates of reaction. Iodine and propanone react together in an acid-catalysed reaction



A student completed a series of experiments to determine the order of reaction with respect to iodine.

Method

- Transfer 25 cm³ of 1.0 mol dm⁻³ propanone solution into a conical flask.
- Add 10 cm³ of 1.0 mol dm⁻³ HCl(aq)
- Add 25 cm³ of 5.0 × 10⁻³ mol dm⁻³ I₂ (aq) and start a timer.
- At intervals of 1 minute, remove a 1.0 cm³ sample of the mixture and add each sample to a separate beaker containing an excess of NaHCO₃(aq)
- Titrate the contents of each beaker with a standard solution of sodium thiosulfate and record the volume of sodium thiosulfate used.

(a) Suggest why the 1.0 cm³ portions of the reaction mixture are added to an excess of NaHCO₃ solution.

(2)

(b) Suggest why the order of this reaction with respect to propanone can be ignored in this experiment.

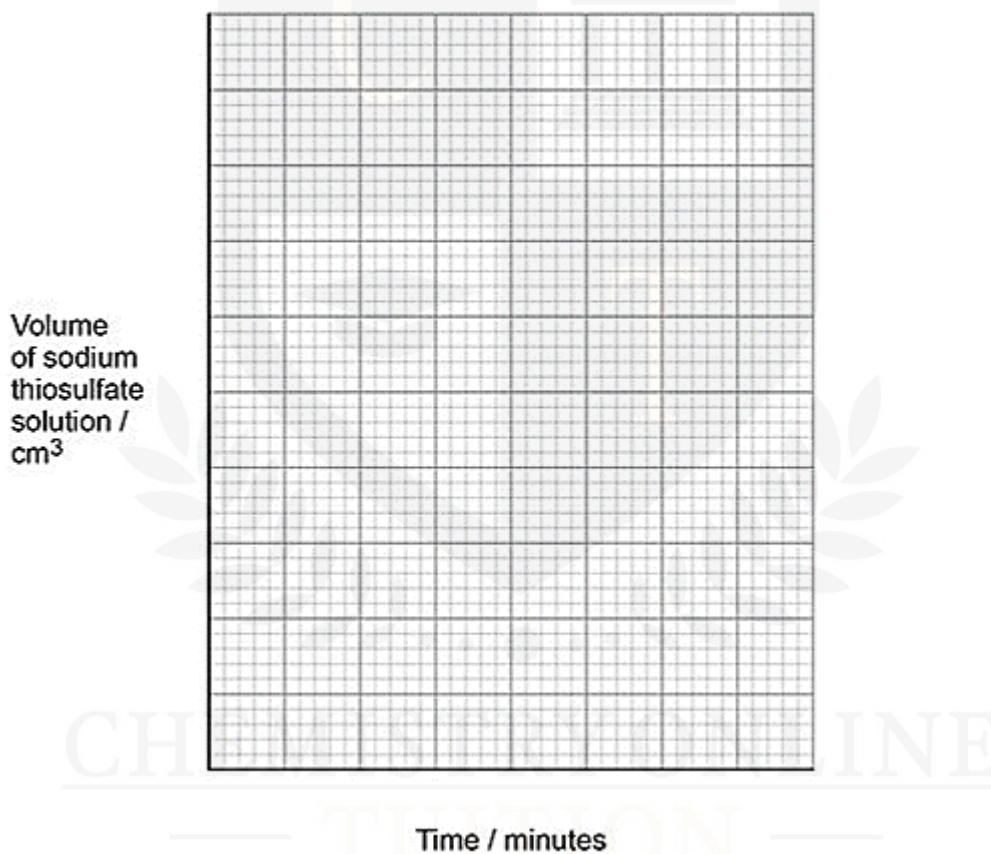
(2)

(c) The volume of sodium thiosulfate solution used in each titration is proportional to the concentration of iodine in each beaker.

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The table below shows the results of the experiment.

Time / minutes	Volume of sodium thiosulfate solution / cm ³
1	41
2	35
3	24
4	22
5	16
6	10



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(3)

(d) Explain how the graph shows that the reaction is zero-order with respect to iodine in the reaction between propanone and iodine.

(2)

9. Define the term order of a reaction with respect to a given product.

(2)

10. How does the rate determining step link to the species involved in the rate expression?

(3)

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