

Name of the Student: _____

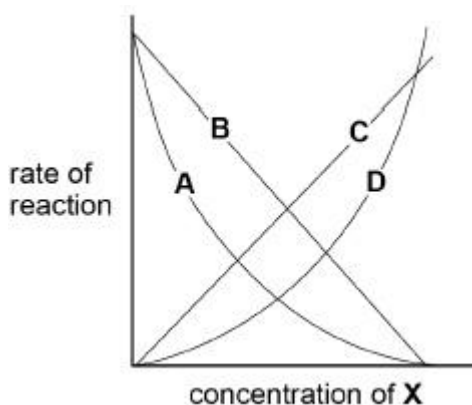
Max. Marks : 21 Marks

Time : 21 Minutes

Q1.

A series of experiments was carried out to find the order of reaction with respect to reactant **X**. In these experiments, only the concentration of **X** was changed.

Which graph would show that the reaction is second-order with respect to **X**?



A ☐

B ☐

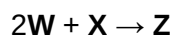
C ☐

D ☐

(Total 1 mark)

Q2.

Solutions of two compounds, **W** and **X**, react together in the presence of a soluble catalyst, **Y**, as shown in the equation



When the concentrations of **W**, **X** and **Y** are all doubled, the rate of reaction increases by a factor of four.

Which is a possible rate equation for this reaction?

A rate = $k [\mathbf{W}]^2 [\mathbf{X}]$ ☐

B rate = $k [\mathbf{W}]^2 [\mathbf{Y}]$ ☐

C rate = $k [\mathbf{X}] [\mathbf{Y}]$ ☐

D rate = $k [\mathbf{X}] [\mathbf{Z}]$ ☐

(Total 1 mark)

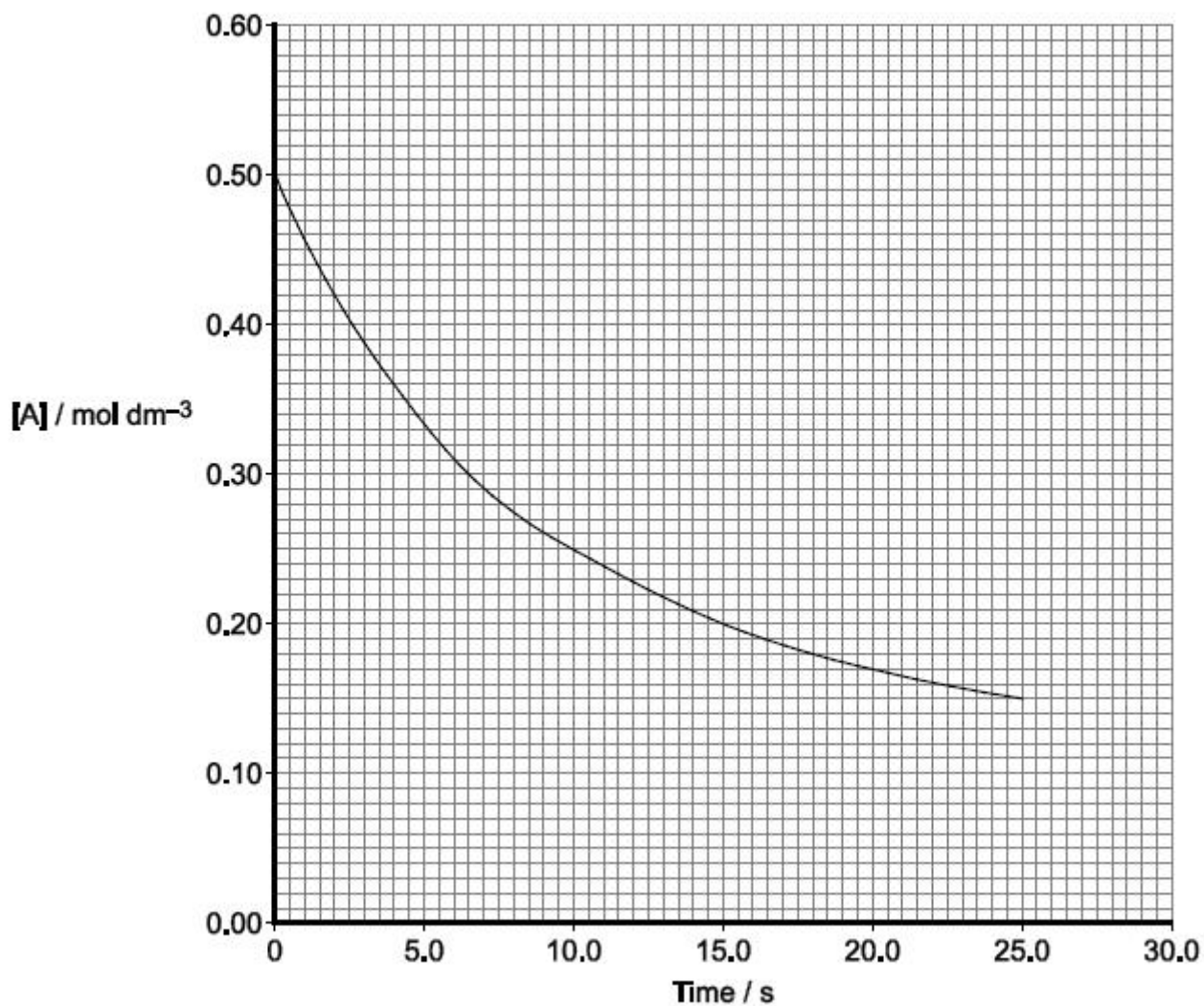
Q3.

The rate equation for the reaction between compounds **A** and **B** is

$$\text{rate} = k [\text{A}]^2[\text{B}]$$

The graph shows how, in an experiment, the concentration of **A** changes with time, t , in this reaction.

Figure 2



(a) Draw a tangent to the curve at $t = 0$

(1)

(b) Use this tangent to deduce the initial rate of the reaction.

Initial rate _____ $\text{mol dm}^{-3} \text{s}^{-1}$

(1)

- (c) The experiment was repeated at the same temperature and with the same initial concentration of **B** but with a different initial concentration of **A**.

The new initial rate was 1.7 times greater than in the original experiment.

Calculate the new initial concentration of **A**.

Initial concentration of A _____ mol dm⁻³
(2)
(Total 4 marks)

Q4.

A series of experiments is carried out with compounds **C** and **D**. Using the data obtained, the rate equation for the reaction between the two compounds is deduced to be

$$\text{rate} = k [\text{C}][\text{D}]$$

In one experiment at 25 °C, the initial rate of reaction is $3.1 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$ when the initial concentration of C is 0.48 mol dm^{-3} and the initial concentration of D is 0.23 mol dm^{-3}

- (a) Calculate a value for the rate constant at this temperature and give its units.

Rate constant _____ Units _____

(3)

- (b) An equation that relates the rate constant, k , to the activation energy, E_a , and the temperature, T , is

$$\ln k = \frac{-E_a}{RT} + \ln A$$

Use this equation and your answer from part (a) to calculate a value, in kJ mol^{-1} , for the activation energy of this reaction at 25 °C.

For this reaction $\ln A = 16.9$

The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

(If you were unable to complete part (a) you should use the value of 3.2×10^{-3} for the rate constant. This is not the correct value.)

Activation energy _____ kJ mol^{-1}

(4)

(Total 7 marks)

Q5.

The mechanisms of some reactions can be deduced from kinetic data.

The table shows the results of five experiments involving the reaction between benzaldehyde ($\text{C}_6\text{H}_5\text{CHO}$) and potassium hydroxide solution.

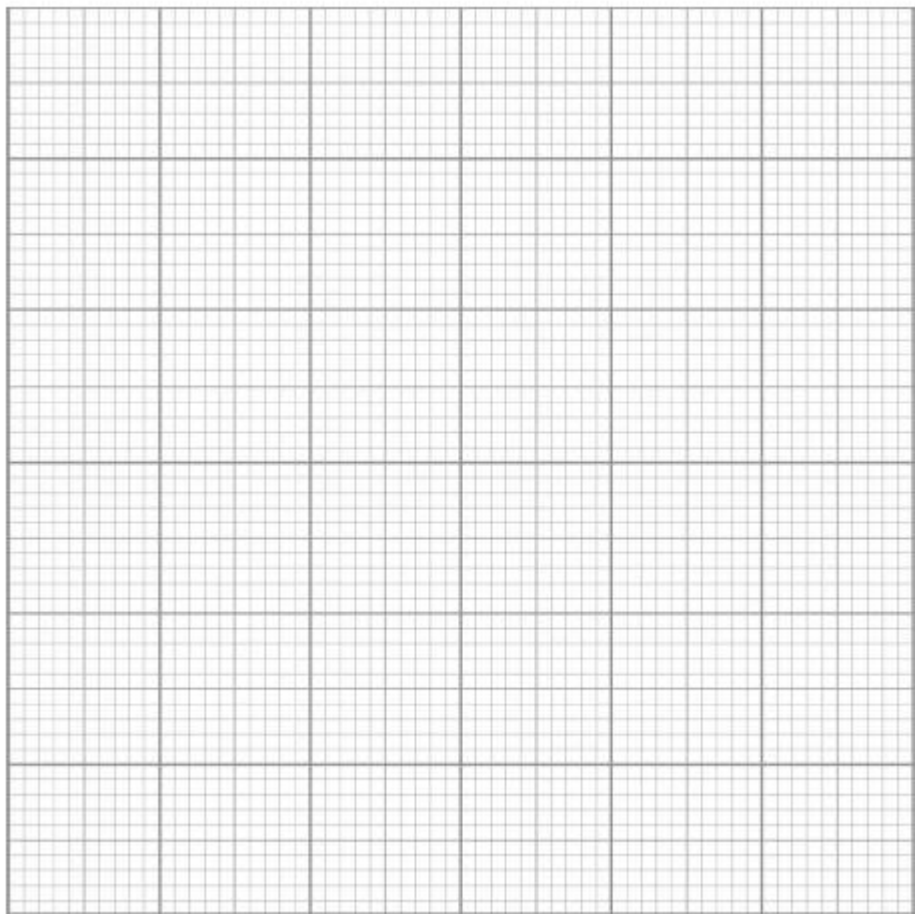
Experiment	Initial rate / $\text{mol dm}^{-3} \text{ s}^{-1}$	$[\text{C}_6\text{H}_5\text{CHO}]$ / mol dm^{-3}	$\text{C}_6\text{H}_5\text{CHO}]^2$	$[\text{KOH}]$ / mol dm^{-3}
1	0	0		0
2	2.90×10^{-6}	0.25		0.25
3	1.16×10^{-5}	0.50		0.25
4	2.61×10^{-5}	0.75		0.25
5	4.65×10^{-5}	1.00		0.25

(a) Calculate the value of $[\text{C}_6\text{H}_5\text{CHO}]^2$ for each experiment.

Write your answers in the table above.

Plot a graph of initial rate against $[\text{C}_6\text{H}_5\text{CHO}]^2$ on the grid below.

Label the axes with units.



(4)

(b) Deduce the order of the reaction with respect to $\text{C}_6\text{H}_5\text{CHO}$ from the graph.

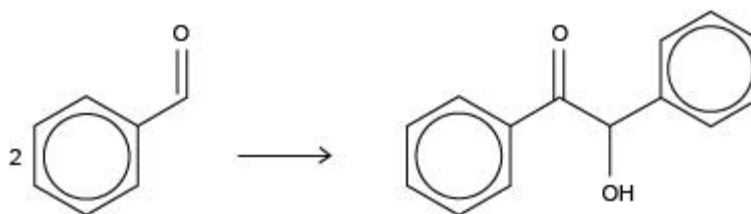
Explain your answer.

Order _____

Explanation _____

(2)

- (c) Benzaldehyde ($\text{C}_6\text{H}_5\text{CHO}$) undergoes a dimerisation reaction as shown:



The rate equation for the reaction is

$$\text{rate} = k [\text{C}_6\text{H}_5\text{CHO}] [\text{CN}^-]$$

Suggest the role of the cyanide ion in the reaction.

Explain your answer.

Role of CN^- _____

Explanation _____

(2)

(Total 8 marks)