

Practice Question Set For A-Level
Subject : Chemistry
Paper-2 Topic: Rate Equations

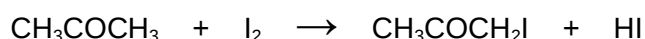
Name of the Student: _____

Max. Marks : 25 Marks

Time : 25 Minutes

Q1.

The reaction between propanone and iodine in the presence of hydrochloric acid was studied at a constant temperature.



The following rate equation was deduced.

$$\text{rate} = k [\text{CH}_3\text{COCH}_3][\text{H}^+]$$

- (a) Suggest why the order with respect to iodine is zero.

(1)

- (b) In an experiment the initial concentrations of propanone, iodine and hydrochloric acid were as shown in the table. The initial rate of reaction in this experiment was $8.64 \times 10^{-7} \text{ mol dm}^{-3} \text{ s}^{-1}$.

	Initial concentration / mol dm^{-3}
CH_3COCH_3	5.82×10^{-2}
I_2	1.78×10^{-3}
H^+	4.76×10^{-1}

Use the data in the table and the rate equation to calculate a value for the rate constant at this temperature.

Give units with your answer.

(2)

- (c) A series of experiments was carried out using concentrations of propanone approximately 100 times the concentrations of iodine and hydrochloric acid.

Suggest the rate equation under these conditions.
Explain your answer.

(2)

(Total 5 marks)

Q2.

Gases **A** and **B** react as shown in the following equation.



The initial rate of the reaction was measured in a series of experiments at a constant temperature. The following rate equation was determined.

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

An incomplete table of data for the reaction between **A** and **B** is shown in the table.

Experiment	Initial [A] / mol dm ⁻³	Initial [B] / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹
1	4.2×10^{-3}	2.8×10^{-3}	3.3×10^{-5}
2	7.9×10^{-3}	2.8×10^{-3}	
3		5.6×10^{-3}	1.8×10^{-4}

- (a) Use the data from Experiment **1** to calculate a value for the rate constant, k , at this temperature.
Deduce the units of k .

Calculation _____

Units _____

(3)

- (b) Use your value of k from (a) to complete the table for the reaction between **A** and **B**.
(If you have been unable to calculate an answer for (a), you may assume a value of 2.3. This is **not** the correct answer.)

(2)

- (c) The reaction is zero order with respect to **B**.

State the significance of this zero order for the mechanism of the reaction.

(1)

(Total 6 marks)

Q3.

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

- (a) The data in this table were obtained in a series of experiments on the rate of the reaction between compounds **E** and **F** at a constant temperature.

Experiment	Initial concentration of E / mol dm ⁻³	Initial concentration of F / mol dm ⁻³	Initial rate of reaction / mol dm ⁻³ s ⁻¹
1	0.15	0.24	0.42×10^{-3}
2	0.45	0.24	3.78×10^{-3}
3	0.90	0.12	7.56×10^{-3}

- (i) Deduce the order of reaction with respect to **E**.

(1)

- (ii) Deduce the order of reaction with respect to **F**.

(1)

- (b) The data in the following table were obtained in two experiments on the rate of the reaction between compounds **G** and **H** at a constant temperature.

Experiment	Initial concentration of G / mol dm ⁻³	Initial concentration of H / mol dm ⁻³	Initial rate of reaction / mol dm ⁻³ s ⁻¹
4	3.8×10^{-2}	2.6×10^{-2}	8.6×10^{-4}
5	6.3×10^{-2}	7.5×10^{-2}	To be calculated

The rate equation for this reaction is

$$rate = k[G]^2[H]$$

- (i) Use the data from Experiment **4** to calculate a value for the rate constant k at this temperature. Deduce the units of k .

Calculation _____

Units _____

(3)

- (ii) Calculate a value for the initial rate of reaction in Experiment **5**.

(1)
(Total 6 marks)

Q4.

- (a) 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

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

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

Calculation _____

Units _____

(3)

- (ii) Calculate a value for the initial rate in Experiment **2**.

(1)

- (b) The data in the following table were obtained in a series of experiments about the rate of the reaction between substances **D** and **E** at a constant temperature.

Experiment	Initial concentration of D / mol dm ⁻³	Initial concentration of E / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹
3	0.13	0.23	0.26×10^{-3}
4	0.39	0.23	2.34×10^{-3}
5	0.78	0.46	9.36×10^{-3}

- (i) Deduce the order of reaction with respect to **D**.

(1)

- (ii) Deduce the order of reaction with respect to **E**.

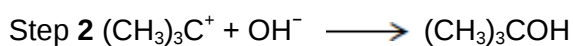
(1)

- (c) The compound $(\text{CH}_3)_3\text{CBr}$ reacts with aqueous sodium hydroxide as shown in the following equation.



This reaction was found to be first order with respect to $(\text{CH}_3)_3\text{CBr}$ but zero order with respect to hydroxide ions.

The following two-step process was suggested.



- (i) Deduce the rate-determining step in this two-step process.

(1)

- (ii) Outline a mechanism for this step using a curly arrow.

(1)

(Total 8 marks)