"*Not enough speed*"

Y13 UNIT 4 TEST 1

4.1 KINETICS

BAHATI NJEMA!

Answer all questions
Total 50 marks

Name:……..

Mark for Section A……./37

Mark for section B…… /13

Total: …….. /50

Grade……..

SECTION A

1. (a) A chemical reaction is first order with respect to compound **X** and second order with respect to compound **Y**.

(i) Write the rate equation for this reaction.

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(ii) What is the overall order of this reaction?

.....

(iii) By what factor will the rate increase if the concentrations of **X** and **Y** are **both** doubled?

.....

(4)

(b) The table below shows the initial concentrations of two compounds, **A** and **B**. And also the initial rate of the reaction that takes place between them at constant temperature.

Experiment	[A]/mol dm^{-3}	[B]/mol dm^{-3}	Initial rate/mol dm^{-3} s^{-1}
1	0.2	0.2	3.5×10^{-4}
2	0.4	0.4	1.4×10^{-3}
3	0.8	0.4	5.6×10^{-3}

(i) Determine the overall order of the reaction between **A** and **B**. Explain how you reached your conclusion.

Overall order of reaction .....

Explanation .....

.....

(ii) Determine the order of reaction with respect to compound **B**. Explain how you reached your conclusion.

Order with respect to **B** .....

Explanation .....

.....

(iii) Write the rate equation for the overall reaction.

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(iv) Calculate the value of the rate constant, stating its units.

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(7)
(Total 11 marks)

2. The hydrolysis of methyl propanoate was studied in acidic conditions at 25°C and the rate equation was found to be

$$\text{rate} = k[CH_3CH_2COOCH_3][H^+]$$

(a) Use the data below to calculate the value of the rate constant, *k*, at this temperature. Deduce its units.

Initial rate of reaction / mol dm^{-3} s^{-1}	Initial concentration of methyl propanoate / mol dm^{-3}	Initial concentration of hydrochloric acid / mol dm^{-3}
1.15×10^{-4}	0.150	0.555

Rate constant .....

.....

.....

Units .....

.....

(3)

(b) The reaction in part (a) was repeated at the same temperature, but water was added so that the volume of the reaction mixture was doubled. Calculate the initial rate of reaction under these conditions.

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.....

(1)
(Total 4 marks)

3. (a) The following table shows the results of three experiments carried out at the same temperature to investigate the rate of the reaction between compounds **P** and **Q**.

	Experiment 1	Experiment 2	Experiment 3
Initial concentration of **P**/mol dm^{-3}	0.50	0.25	0.25
Initial concentration of **Q**/mol dm^{-3}	0.36	0.36	0.72
Initial rate/mol $dm^{-3}s^{-1}$	7.6×10^{-3}	1.9×10^{-3}	3.8×10^{-3}

Use the data in the table to deduce the order with respect to **P** and the order with respect to **Q**.

*Order with respect to **P*** .....

*Order with respect to **Q*** .....

(2)

(b) In a reaction between **R** and **S**, the order of reaction with respect to **R** is one, the order of reaction with respect to **S** is two and the rate constant at temperature T_1 has a value of 4.2×10^{-4} mol^{-2} dm^6 s^{-1}.

(i) Write a rate equation for the reaction. Calculate a value for the initial rate of reaction when the initial concentration of **R** is 0.16 mol dm^{-3} and that of **S** is 0.84 mol dm^{-3}.

Rate equation .....

Calculation .....

.....

(ii) In a second experiment performed at a different temperature, T_2, the initial rate of reaction is 8.1×10^{-5} mol $dm^{-3}s^{-1}$ when the initial concentration of **R** is 0.76 mol dm^{-3} and that of **S** is 0.98 mol dm^{-3}. Calculate the value of the rate constant at temperature T_2.

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(iii) Deduce which of T_1 and T_2 is the higher temperature.

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(6)
(Total 8 marks)

4. (a) The initial rate of the reaction between compounds **A** and **B** was measured in a series of experiments at a fixed temperature. The following rate equation was deduced.

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

(i) Complete the table of data below for the reaction between **A** and **B**.

Expt	Initial [**A**] /mol dm^{-3}	Initial [**B**] /mol dm^{-3}	Initial rate /mol dm^{-3} s^{-1}
1	4.80×10^{-2}	6.60×10^{-2}	10.4×10^{-3}
2	4.80×10^{-2}	3.30×10^{-2}	
3		13.2×10^{-2}	5.20×10^{-3}
4	1.60×10^{-2}		10.4×10^{-3}

(ii) Using the data for experiment 1, calculate a value for the rate constant, *k*, and state its units.

Calculation ……..…….…….

.....…….

Units …….

(6)

(b) State how the value of the rate constant, *k*, would change, if at all, if the concentration of **A** were increased in a series of experiments.

.....…….

(1)

(Total 7 marks)

5. Iodine and propanone react in acid solution according to the equation

$$I_2 + CH_3COCH_3 \rightarrow CH_3COCH_2I + HI$$

The rate equation for the reaction is found to be

$$\text{rate} = k\,[CH_3COCH_3][H^+]$$

(a) Deduce the order of reaction with respect to iodine and the overall order of reaction.

Order with respect to iodine .....

Overall order .....

(2)

(b) At the start of the experiment, the rate of reaction was found to be 2.00×10^{-5} mol dm^{-3} s^{-1} when the concentrations of the reactants were as shown below.

Reactant	Concentration / mol dm^{-3}
CH_3COCH_3	1.50
I_2	2.00×10^{-2}
H^+	3.00×10^{-2}

Use these data to calculate a value for the rate constant and deduce its units.

Rate constant .....

.....

.....

Units .....

(3)

(c) How can you tell that H^+ acts as a catalyst in this reaction?

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(2)
(Total 7 marks)

SECTION B

6. The reaction between hydrogen and iodine can be represented by the following equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +52 \text{ kJ mol}^{-1}$$

Kinetic data are available for both forward and reverse reactions. A series of experiments to investigate the kinetics of the forward reaction was carried out at a constant temperature. The results are shown in **Figure 1**.

Experiment	**Initial concentration of H_2 / mol dm^{-3}**	**Initial concentration of I_2 / mol dm^{-3}**	**Initial rate / mol dm^{-3} s^{-1}**
1	2.0×10^{-3}	3.0×10^{-3}	1.2×10^{-6}
2	6.0×10^{-3}	3.0×10^{-3}	3.6×10^{-6}
3	6.0×10^{-3}	6.0×10^{-3}	7.2×10^{-6}

Figure 1

(a) Explain the meaning of each of the following terms:

(i) rate of reaction;

(1)

(ii) rate constant;

(1)

(iii) overall order of reaction.

(2)

(b) (i) Use the results in **Figure 1** to work out the order of the forward reaction with respect to both hydrogen and iodine, explaining your reasoning.

(4)

(ii) Write the rate equation for the reaction between hydrogen and iodine.

(1)

(iii) Calculate the value of the rate constant for the forward reaction and give its units.

(3)

(c) The experiment was repeated with the following initial concentrations for reactants:

$[H_2] = 4.0 \times 10^{-3}$ mol dm^{-3} $\qquad$ $[I_2] = 5.0 \times 10^{-3}$ mol dm^{-3}

Calculate the initial rate of the reaction.

(1)

(Total 13 marks)