Kinetics - Questions by Topic

Q1.

What can be deduced from the position of the activation energy on a Maxwell-Boltzmann distribution curve?
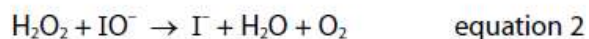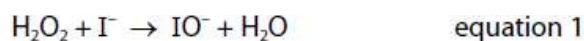
(1)

☐ **A** number of particles in the rate determining step

☐ **B** number of successful collisions per second

☐ **C** order of reaction

☐ **D** proportion of particles with sufficient energy to react

(Total for question = 1 mark)

Q2.

The mechanism for the rapid decomposition of hydrogen peroxide, H_2O_2, in the presence of iodide ions, is:

$$H_2O_2 + I^- \rightarrow IO^- + H_2O \qquad \text{equation 1}$$
$$H_2O_2 + IO^- \rightarrow I^- + H_2O + O_2 \qquad \text{equation 2}$$

(a) Write the overall equation for the reaction and hence state the role of the iodide ions.

(2)

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(b) In further experiments, a student calculated the rate constant for the decomposition of hydrogen peroxide at two different temperatures.

Temperature/°C	Rate constant (k) / $dm^3\,mol^{-1}\,s^{-1}$
22.0	4.90×10^{-4}
47.0	2.92×10^{-3}

The rate constant (k) is related to the temperature, T, (in Kelvin) by the following equation:

$$\ln k = -\frac{E_a}{R} \times \frac{1}{T} + \text{constant} \qquad R = 8.31\,\text{J}\,\text{K}^{-1}\,\text{mol}^{-1}$$

Use the data in the table to calculate the activation energy, E_a, for the reaction by a non-graphical method.
Give your answer in kJ mol^{-1} and to an appropriate number of significant figures.
Include a sign in your answer.

(4)

(c) If acid conditions are used, the decomposition of hydrogen peroxide proceeds by a different mechanism. The equation for this reaction is:

$$H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$$
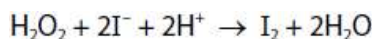
This reaction is first order with respect to both iodide ions and hydrogen peroxide.

The progress of this reaction is usually followed by adding a fixed quantity of sodium thiosulfate solution and a little starch solution to the reaction mixture, then timing the appearance of a blue-black colour. This is known as a clock reaction.

(i) Explain the formation of the blue-black colour and why its appearance is delayed.

(3)

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(ii) Although the oxidation of thiosulfate ions ($S_2O_3^{2-}$) by hydrogen peroxide is thermodynamically favourable, it does not take place in this clock reaction.
Suggest a reason for this.

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(Total for question = 10 marks)

Q3.

The halogenoalkane, 2-bromobutane, can be hydrolysed using aqueous sodium hydroxide.

Which technique can be used to follow the progress of this reaction?

(1)

☒ **A**   colorimetry

☒ **B**   measurement of gas volume change

☒ **C**   measurement of mass change

☒ **D**   titration of quenched samples

(Total for question = 1 mark)

Q4.

Iodine reacts with propanone under acid conditions. The reaction is first order with respect to propanone, first order with respect to hydrogen ions and zero order with respect to iodine.

What are the units of the rate constant?

(1)

☒ **A** $dm^3 \, mol^{-1} \, s^{-1}$

☒ **B** $mol \, dm^{-3} \, s^{-1}$

☒ **C** s^{-1}

☒ **D** $mol^{-2} \, dm^6 \, s^{-1}$

(Total for question = 1 mark)