

Chemistry
Higher level
Paper 2

Practice paper

Topic: Chemical Kinetics

Chemistry

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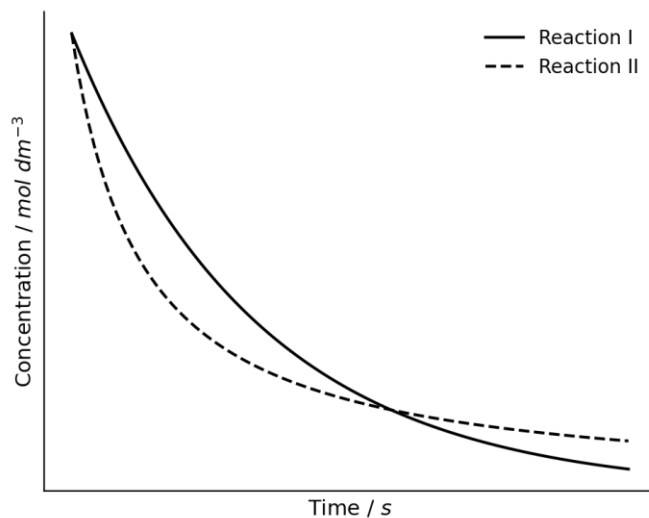
Specimen paper

2 hours 15 minutes

Instructions to candidates

- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is [65 marks].

1. The following concentration-time graphs show the decomposition of two different generic substances over time, labeled Reaction I and Reaction II.



(a) Sketch how you would determine the half-life of Reaction I from the graph. Based on the curvature, propose the order of Reaction I.

[2]

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(b) Reaction II has a changing half-life. State the order of Reaction II.

[1]

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2. The substitution reaction of 1-bromobutane with aqueous sodium hydroxide proceeds via an S_N2 mechanism.

(a) State the molecularity of this rate-determining step.

[1]

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(b) Formulate the rate expression for this specific reaction based on the S_N2 mechanism.

[1]

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(c) Predict the effect on the initial rate if the concentration of NaOH(aq) is tripled and the concentration of 1-bromobutane is halved simultaneously.

[2]

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3. The pre-exponential factor A in the Arrhenius equation represents the collision frequency factoring in geometric constraints.

(a) Explain why the value of A is typically an essentially constant numerical value independent of moderate temperature changes.

[2]

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4. A proposed overall equation is $2X + Y + Z \rightarrow \text{Products}$. A student establishes the rate expression is $\text{Rate} = k[X][Z]^2$ through a series of initial rate experiments.

(a) What is the order of reaction with respect to species Y ?

[1]

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(b) Determine the overall order of the reaction.

[1]

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5. Reaction A has an activation energy of 45 kJ mol^{-1} and Reaction B has an activation energy of 95 kJ mol^{-1} .

(a) Which reaction will show a larger proportional increase in its rate constant, k , for a 10 K temperature increase from 298 K to 308 K ? Justify your choice using the mathematical properties of the Arrhenius equation.

[3]

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6. A multi-step reaction mechanism possesses a highly unstable intermediate species.

(a) Describe how this intermediate connects with the concept of a transition state mathematically on a potential energy profile.

[2]

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7. A catalyst lowers the activation energy of a specific reaction from 80.0 kJ mol^{-1} to 50.0 kJ mol^{-1} at 298 K.

(a) Calculate the factor by which the rate constant k increases (assuming the pre-exponential factor A remains identical). Show your working.

[3]

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