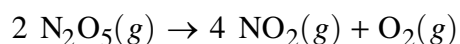


The following equation represents the decomposition of N_2O_5 , for which the rate law is $\text{rate} = k[\text{N}_2\text{O}_5]$.

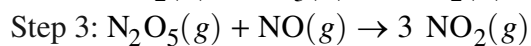
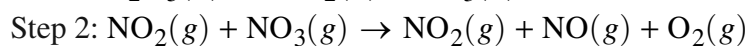
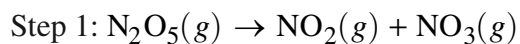


A sample of pure $\text{N}_2\text{O}_5(g)$ is placed in an evacuated container and allowed to decompose at a constant temperature of 300 K. The concentration of $\text{N}_2\text{O}_5(g)$ in the container is measured over a period of time, and the measurements are recorded in the following table.

Time (hr)	$[\text{N}_2\text{O}_5](M)$
0	0.160
1.67	0.0800
3.33	0.0400
5.00	0.0200

(a) Determine the value of the rate constant, k , for the reaction. Include units in your answer.

(b) The following mechanism is proposed for the decomposition of $\text{N}_2\text{O}_5(g)$.



Identify which step of the proposed mechanism (1, 2, or 3) is the rate-determining step. Justify your answer in terms of the rate law given.

GO ON TO THE NEXT PAGE.

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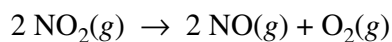
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Continue your response to **QUESTION 5** on this page.

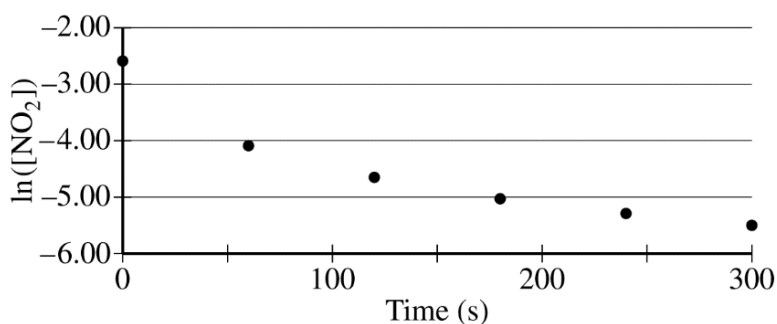
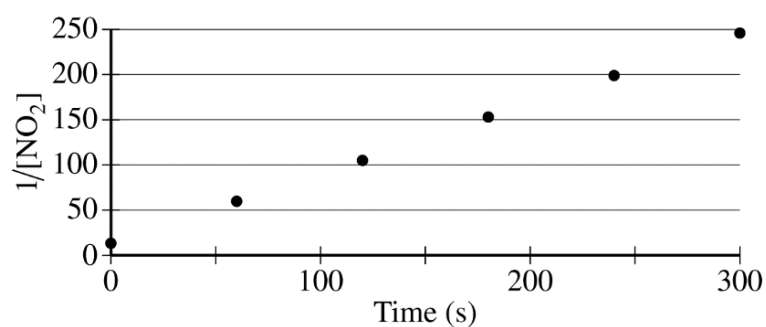
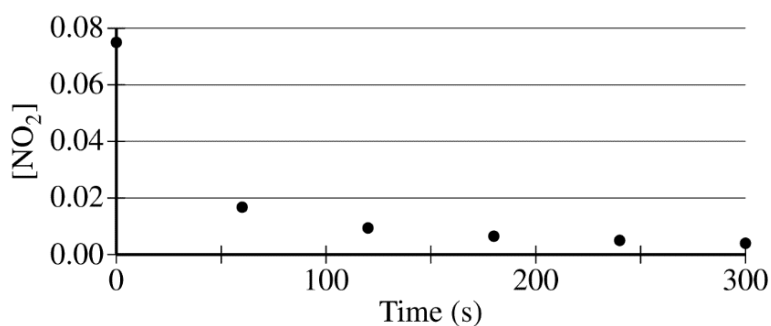
- (c) If this experiment was repeated at the same temperature but with twice the initial concentration of N_2O_5 , would the value of k increase, decrease, or remain the same? Explain your reasoning.

GO ON TO THE NEXT PAGE.

6. Nitrogen dioxide, $\text{NO}_2(g)$, is produced as a by-product of the combustion of fossil fuels in internal combustion engines. At elevated temperatures $\text{NO}_2(g)$ decomposes according to the equation below.



The concentration of a sample of $\text{NO}_2(g)$ is monitored as it decomposes and is recorded on the graph directly below. The two graphs that follow it are derived from the original data.

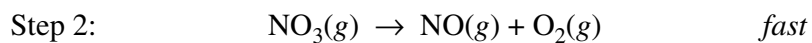
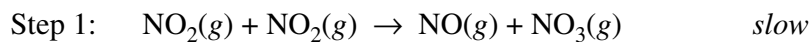


- (a) Explain how the graphs indicate that the reaction is second order.
- (b) Write the rate law for the decomposition of $\text{NO}_2(g)$.

(c) Consider two possible mechanisms for the decomposition reaction.

- (i) Is the rate law described by mechanism I shown below consistent with the rate law you wrote in part (b) ? Justify your answer.

Mechanism I



- (ii) Is the rate law described by mechanism II shown below consistent with the rate law you wrote in part (b) ? Justify your answer.

Mechanism II

