

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

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

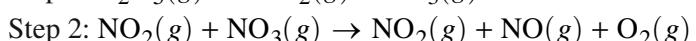
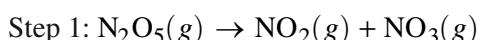


A sample of pure $\text{N}_2\text{O}_5(g)$ is placed in an evacuated container and allowed to decompose at a constant temperature of 300 K. The concentration of $\text{N}_2\text{O}_5(g)$ in the container is measured over a period of time, and the measurements are recorded in the following table.

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.

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.

Question 5: Short Answer**4 points**

- (a)** For the correct calculated value: 1 point

Accept one of the following:

- $k = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{1.67 \text{ hr}} = 0.415 \text{ hr}^{-1}$
- $k = \frac{\ln[A]_0 - \ln[A]_t}{t} = \frac{\ln(0.160) - \ln(0.0800)}{1.67 \text{ hr}} = 0.415 \text{ hr}^{-1}$
- $k = \frac{\ln[A]_0 - \ln[A]_t}{t} = \frac{\ln(0.160) - \ln(0.0400)}{3.33 \text{ hr}} = 0.416 \text{ hr}^{-1}$
- $k = \frac{\ln[A]_0 - \ln[A]_t}{t} = \frac{\ln(0.160) - \ln(0.0200)}{5.00 \text{ hr}} = 0.416 \text{ hr}^{-1}$

- For the correct units, consistent with the calculated value: 1 point

hr^{-1}

Total for part (a) 2 points

- (b)** For the correct answer and a valid justification: 1 point

Step 1 is the rate-determining step. The rate law of elementary step 1 is rate = $k[\text{N}_2\text{O}_5]$, which is consistent with the first order kinetics of the overall rate law.

- (c)** For the correct answer: 1 point

Remain the same. The rate constant, k, is independent of concentration and will remain the same at constant temperature.

Total for question 5 4 points