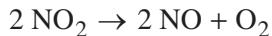
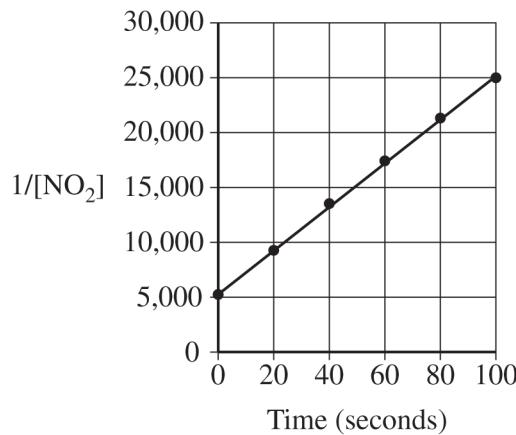
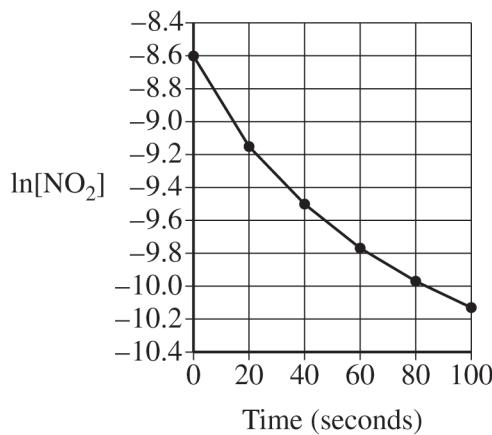


Begin your response to **QUESTION 6** on this page.

6. At elevated temperatures, NO_2 undergoes decomposition in the gas phase, forming NO and O_2 as represented by the following equation.



A scientist measures the change in $[\text{NO}_2]$ over the first 100. s of the reaction at 546°C. The scientist uses the data collected from the experiment to generate the following two graphs.



Based on these data, the scientist makes the claim that the rate law for the reaction is $\text{rate} = k[\text{NO}_2]^2$.

- (a) Explain how the graphs indicate that the reaction is second order with respect to NO_2 .

- (b) At a certain point in the reaction, the rate of disappearance of NO_2 is determined to be $6.52 \times 10^{-7} \text{ M/s}$.

Determine the rate of appearance, in M/s , of O_2 at this same point in the reaction.

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 6** on this page.

- (c) NO_2 is a molecule that contains an odd number of electrons and can be oxidized to form the NO_2^+ ion. In NO_2 , the unpaired electron is presumed to be localized on the nitrogen atom, as shown in the Lewis diagram in the box on the left.



- (i) In the box on the right, complete the Lewis diagram for NO_2^+ . Be sure to show all bonding and nonbonding electrons.
- (ii) A student makes the claim that the bond angles in NO_2 and NO_2^+ are different from each other. Do you agree or disagree with the student's claim? Justify your answer.

GO ON TO THE NEXT PAGE.

Question 6: Short Answer**4 points**

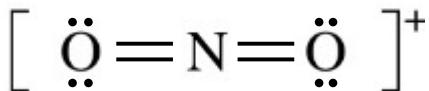
- (a)** For a correct explanation: 1 point

The plot of $\frac{1}{[\text{NO}_2]}$ versus time is the most linear, indicating that the reaction is second order with respect to NO_2 .

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

$$6.52 \times 10^{-7} \text{ M/s} \times \frac{1 \text{ mol O}_2}{2 \text{ mol NO}_2} = 3.26 \times 10^{-7} \text{ M/s}$$

- (c) (i)** For the correct Lewis diagram: 1 point



- (ii)** For the correct answer and a valid justification, consistent with part (c)(i): 1 point

Accept one of the following:

- Agree. The angle of NO_2^+ is different from the angle in NO_2 because there would no longer be a nonbonding electron on the central atom in NO_2 , and the O atoms would spread farther apart, forming a linear structure with a 180° bond angle.
- Agree. The hybridization of N in NO_2 is sp^2 , which would result in a bond angle of approximately 120° . The hybridization of N in NO_2^+ is sp , which would result in a bond angle of 180° .

Total for part (c) 2 points

Total for question 6 4 points