6

$$O_3(g) + NO(g) \rightarrow O_2(g) + NO_2(g)$$

6. Consider the reaction represented above.

(a) Referring to the data in the table below, calculate the standard enthalpy change, $\Delta H^\circ$, for the reaction at 25°C. Be sure to show your work.

| | $O_3(g)$ | $NO(g)$ | $NO_2(g)$ |
|---|---|---|---|
| Standard enthalpy of formation, $\Delta H_f^\circ$, at 25°C ($kJ\ mol^{-1}$) | 143 | 90. | 33 |

(b) Make a qualitative prediction about the magnitude of the standard entropy change, $\Delta S^\circ$, for the reaction a 25°C. Justify your answer.

(c) On the basis of your answers to parts (a) and (b), predict the sign of the standard free-energy change, $\Delta G^\circ$ for the reaction at 25°C. Explain your reasoning.

(d) Use the information in the table below to write the rate-law expression for the reaction, and explain how y obtained your answer.

| Experiment Number | Initial $[O_3]$ ($mol\ L^{-1}$) | Initial [NO] ($mol\ L^{-1}$) | Initial Rate of Formation of $NO_2$ ($mol\ L^{-1}\ s^{-1}$) |
|---|---|---|---|
| 1 | 0.0010 | 0.0010 | $x$ |
| 2 | 0.0010 | 0.0020 | $2x$ |
| 3 | 0.0020 | 0.0010 | $2x$ |
| 4 | 0.0020 | 0.0020 | $4x$ |

(e) The following three-step mechanism is proposed for the reaction. Identify the step that must be the slowes in order for this mechanism to be consistent with the rate-law expression derived in part (d). Explain.

Step I: $O_3 + NO \rightarrow O + NO_3$

Step II: $O + O_3 \rightarrow 2\,O_2$

Step III: $NO_3 + NO \rightarrow 2\,NO_2$

(a) $O_3 + NO_{(g)} \rightarrow O_{2(g)} + NO_{2(g)}$

$-143 \quad -90 \qquad\qquad 33$

$\Delta H^\circ = \Sigma \Delta H^\circ_{f\ prod} - \Sigma \Delta H^\circ_{f\ react}$

$= -33 - (-143 - 90)$

$= -200\ kJ$