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6A

6. Consider the reaction represented above.

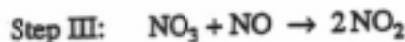
- (a) Referring to the data in the table below, calculate the standard enthalpy change,  $\Delta H^\circ$ , for the reaction at 25°C. Be sure to show your work.

	O <sub>3</sub> (g)	NO(g)	NO <sub>2</sub> (g)
Standard enthalpy of formation, $\Delta H_f^\circ$ , at 25°C (kJ mol <sup>-1</sup> )	143	90.	33

- (b) Make a qualitative prediction about the magnitude of the standard entropy change,  $\Delta S^\circ$ , for the reaction at 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 you obtained your answer.

Experiment Number	Initial [O <sub>3</sub> ] (mol L <sup>-1</sup> )	Initial [NO] (mol L <sup>-1</sup> )	Initial Rate of Formation of NO <sub>2</sub> (mol L <sup>-1</sup> s <sup>-1</sup> )
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 slowest in order for this mechanism to be consistent with the rate-law expression derived in part (d). Explain.



a)  $\Delta H_f^\circ = \Delta H_f \text{ products} - \Delta H_f \text{ reactants}$   
 $= (33 + 0) - (143 + 90) = \boxed{-200 \text{ kJ/mol}}$

b)  $\Delta S^\circ$  will be quite small for this reaction since all reactants/products are gases and the number of moles of reactants (2) and products (2) is

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