Problem 67 (Cont.)

b) \[ \Delta H_f^\circ (\text{rxn}) = \Sigma \Delta H_f^\circ (\text{prod}) - \Sigma \Delta H_f^\circ (\text{react.}) \]

\[ = 2 \Delta H_f^\circ (\text{NH}_3) - [\Delta H_f^\circ (\text{N}_2) + 3 \Delta H_f^\circ (\text{H}_2)] \]

\[ = 2(-46.19 \text{ kJ/mol}) - [0 + 3(0)] \]

\[ = -92.38 \text{ kJ/mol} \]

Problem 68

a) \[ \text{H-H} + \overset{\text{H}}{\text{H}} = \overset{\text{C-C}}{\text{H}} \rightarrow \overset{\text{H}}{\text{H}} - \overset{\text{C}}{\text{C}} - \overset{\text{H}}{\text{H}} \]

\[ \Delta H_{\text{rxn}} = \Sigma (\text{bonds broken}) - \Sigma (\text{bonds formed}) \]

\[ = \text{H}(\text{H-H}) + 4 \text{H}(\text{C-H}) + \text{H}(\text{C}=\text{C}) - \left[ \text{H}(\text{C}-\text{C}) + 6 \text{H}(\text{C-H}) \right] \]

\[ = 436 \text{ kJ/mol} + 4(413 \text{ kJ/mol}) + 614 \text{ kJ/mol} - [548 \text{kJ/mol} + 6(413 \text{kJ/mol})] \]

\[ = -124 \text{ kJ/mol} \]

b) \[ \Delta H_f^\circ = \Sigma \Delta H_f^\circ (\text{prod}) - \Sigma \Delta H_f^\circ (\text{react.}) \]

\[ = -84.68 - [0 + 52.30] \]

\[ = -136.98 \text{ kJ/mol} \]

The two values are in reasonably good agreement. However, they don't agree exactly because bond enthalpies are averages over many different compounds. They cannot be used to calculate exact \( \Delta H_{\text{rxn}} \) values, but they can be used to obtain a reasonable estimate.

Problem 73

If the ions were just touching, the distance between nuclei would be

\[ d = \text{Radius (Na}^+\text{)} + \text{Radius (Cl}^-\text{)} = 0.97\AA + 1.81\AA = 2.78\AA \]

\[ d = 2.78 \times 10^{-10} \text{ m} \]