Worksheet 9 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Stars and the Stefan-Boltzmann Law

1. \( q_{\text{out}} \) is the total energy radiated per unit surface area per unit time. It has units of J m\(^{-2}\) s\(^{-1}\).
   
   \( T \) is the absolute temperature. It has units of K.

2. \( q_{\text{out}} = 3.85 \times 10^{26} \text{ J s}^{-1} \).

3. \( q_{\text{in}} = 1.75 \times 10^{17} \text{ J s}^{-1} \).

4. 279 K.

5. If 28% is reflected back, then only 72% of \( q_{\text{in}} \) is absorbed: \( q_{\text{in}}' = 1.3 \times 10^{17} \text{ J m}^{-2} \text{ s}^{-1} \).

6. 260 K.

7. The polar ice caps are white and reflect sunlight. Melting of the polar ice caps would cause less of the sunlight to be reflected. This would cause a temperature increase which would, in turn, lead to more melting.

8. Molecules in the atmosphere absorb the radiation. This is known as the Greenhouse Effect.

Model 2: Enthalpy of Atomization (\( \Delta_{\text{atom}}H \)) and Enthalpy of Atom Combination (\( \Delta_{\text{ac}}H \))

1. \( \Delta_{\text{atom}}H = -\Delta_{\text{ac}}H \)

2. \( \Delta H = 0 \)

Model 3: Enthalpy of Reaction using \( \Delta_{\text{atom}}H \) and \( \Delta_{\text{ac}}H \)

1. It involves bond breaking only, which requires energy.

2. It involves bond making only, which releases energy.

3. \( \Delta H = (239 + 435) \text{ kJ mol}^{-1} + (2 \times -431) \text{ kJ mol}^{-1} = -188 \text{ kJ mol}^{-1} \)

4. \( \Delta_{\text{rxn}}H = \Delta_{\text{ac}}H \text{ (products)} - \Delta_{\text{ac}}H \text{ (reactants)} \)

5. \( \Delta_{\text{rxn}}H = \Delta_{\text{atom}}H \text{ (reactants)} - \Delta_{\text{atom}}H \text{ (products)} \)

6. \( \Delta_{\text{rxn}}H \) will be positive. If the bonds that need to be broken in the reactants are stronger than those formed in the products, the reaction is endothermic.
Model 3: Enthalpy of Reaction using $\Delta_f H$

1. $\Delta_f H^\circ (\text{O}_2(\text{g}))$ refers to the formation of O$_2$(g) from the element in its standard state (i.e. O$_2$(g)):

   \[ \text{O}_2(\text{g}) \rightarrow \text{O}_2(\text{g}) \]

   $\Delta_f H^\circ (\text{H}_2(\text{g}))$ refers to the formation of H$_2$(g) from the element in its standard state (i.e. H$_2$(g)):

   \[ \text{H}_2(\text{g}) \rightarrow \text{H}_2(\text{g}) \]

   Both processes involve no change and so $\Delta H^\circ = 0$.

2. $\Delta_{\text{rxn}} H^\circ = -882 \text{ kJ mol}^{-1}$

3. $\Delta_{\text{rxn}} H^\circ = ((-1096) - (-602 + -394)) \text{ kJ mol}^{-1} = -100 \text{ kJ mol}^{-1}$