

Determining ΔH_c^\ominus

A student used a simple calorimeter to determine the enthalpy change of combustion of ethanal.

Given the following data, Mass of ethanal burnt = 1.65 g

Mass of water in the calorimeter = 250.0 g

Mass of calorimeter = 15.0 g

s.h.c. of calorimeter = $0.40 \text{ J g}^{-1} \text{ K}^{-1}$

s.h.c. of water = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

Initial temperature of water = $26.2 \text{ }^\circ\text{C}$

Final temperature of water = $69.0 \text{ }^\circ\text{C}$

Calculate the enthalpy change of combustion of ethanal if

a) The heat capacity of the calorimeter is negligible.

b) The heat capacity of the calorimeter is not negligible.

(RAM: H = 1.0, C = 12.0, O = 16.0;)

Suggested Answer

1. Equation: $\text{CH}_3\text{CHO}(\text{l}) + 2\frac{1}{2}\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
2. Mass of water = 250.0 g
3. $\Delta T = 69.0 - 26.2 = 42.8 \text{ }^\circ\text{C}$
4. Molar mass of ethanal = 44.0 g mol⁻¹
Number of mole of ethanal used = 1.65 / 44
= 0.0375
5. **Calculation (a): s.h.c. of calorimeter is negligible.**

$$\begin{aligned}\text{Energy absorbed by water} &= m c \Delta T \\ &= (250.0)(4.18)(42.8) \\ &= 44726 \text{ J} \\ &= 44.73 \text{ kJ}\end{aligned}$$

$$\begin{aligned}\text{Standard Enthalpy Change of Combustion, } \Delta H_c^\ominus & \\ &= - E / \text{mole of ethanal} \\ &= - 44.73 / 0.0375 \\ &= - 1193 \text{ kJ mol}^{-1}\end{aligned}$$

Calculation (b): s.h.c. of calorimeter is not negligible.

$$\begin{aligned}\text{Energy absorbed by water} &= m c \Delta T \\ &= (250.0)(4.18)(42.8) + (15.0)(0.40)(42.8) \\ &= 44983 \text{ J} \\ &= 44.98 \text{ kJ}\end{aligned}$$

$$\begin{aligned}\text{Standard Enthalpy Change of Combustion, } \Delta H_c^\ominus & \\ &= - E / \text{mole of ethanal} \\ &= - 44.89 / 0.0375 \\ &= - 1199.5 \text{ kJ mol}^{-1} \\ &= - 1200 \text{ kJ mol}^{-1}\end{aligned}$$