

- Q. 03 **Boiling water :** Suppose 1.0 g of water is at atmospheric pressure ( $1.01 \times 10^5 \text{ Pa}$ ). Its volume is  $V_i = V_{\text{liquid}} = 1.0 \text{ cm}^3$  and its volume in vapor is  $V_f = 1671 \text{ cm}^3$ . Find the work done in the expansion and the heat added to the system. Ignore any mixing of the steam and the liquid. The latent heat of vaporization  $L_v = 2.26 \times 10^6 \text{ J/kg}$ .

**Solution** Because the expansion takes place at constant pressure,

$$\begin{aligned} W &= \int_{V_i}^{V_f} p_0 dV = p_0 \int_{V_i}^{V_f} dV \\ &= (1.01 \times 10^5) (1671 \times 10^{-6}) \\ &= 169 \text{ J} \end{aligned}$$

$$\begin{aligned} Q &= mL_v = (1.0 \times 10^{-3}) (2.26 \times 10^6) \\ &= 2260 \text{ J} \end{aligned}$$

Hence, from the first law, the change in internal energy is

$$\begin{aligned} \Delta U &= Q - W = 2260 - 169 \\ &= 2091 \text{ J} \end{aligned}$$