

Question: How much heat energy is required to
Convert 1kg of Ice at -5°C to water at 9°C ?

Answer: Mass (m) = 1kg = 1000g

process: 1kg of Ice at -5°C convert to water at 0°C

Stage-1: Ice at -5°C convert to Ice at 0°C
no phase change.
temperature difference $\Delta T = 5^{\circ}\text{C}$
Specific heat of Ice (S) = $0.5 \text{ cal/g}^{\circ}\text{C}$

$$\begin{aligned} \text{Heat required } (Q_1) &= m S \Delta T \\ &= 1000 \times 0.5 \times 5 \\ &= 2500 \text{ cal} \end{aligned}$$

Stage-2: Ice at 0°C convert to water at 0°C
no temperature difference.
phase change.

Latent heat of melting of Ice (L) = 80 cal/g

$$\begin{aligned} \text{Heat required } (Q_2) &= mL \\ &= 1000 \times 80 \\ &= 80000 \text{ cal} \end{aligned}$$

Stage-3: water at 0°C convert to water at 9°C

no phase change
temperature difference $\Delta T = 9^{\circ}\text{C}$
Specific heat of water (S) = $1 \text{ cal/g}^{\circ}\text{C}$

$$\begin{aligned} \text{Heat required } (Q_3) &= m S \Delta T \\ &= 1000 \times 1 \times 9 \\ &= 9000 \text{ cal} \end{aligned}$$

$$\begin{aligned} \therefore \text{Total Heat required } (Q) &= Q_1 + Q_2 + Q_3 \\ &= 2500 + 80000 + 9000 \\ &= 91500 \text{ cal} \end{aligned}$$

$$\begin{aligned} 1 \text{ cal} &= 4.2 \text{ Joule} \quad \text{So... } Q = 91500 \times 4.2 \\ &= 384300 \text{ J (approx..)} \end{aligned}$$

