Answer on Question 58479, Physics, Mechanics, Relativity

Question:

Determine the quantity of heat required to convert $1\ kg$ of ice at $-20℃$ to water at $100℃$? Specific heat capacities of water and ice are $4186\ J/kg \cdot K$ and $2302\ J/kg \cdot K$ respectively. The latent heat of fusion of ice is $L_f = 3.33 \cdot 10^5\ J/kg$.

Solution:

Let's calculate the amount of heat required to convert a $1\ kg$ of ice at $-20℃$ to a water at $100℃$:

$$Q = Q_1 + Q_2 + Q_3,$$

where Q_1 is the amount of heat required to raise the temperature of ice from $-20℃$ to $0℃$, Q_2 is the latent heat required to change the state from ice at $0℃$ to water at $0℃$ and Q_3 is the amount of heat required to raise the temperature of water from $0℃$ to $100℃$.

$$Q_1 = m_{ice} c_{ice} \Delta t = 1\ kg \cdot 2302\ \frac{J}{kg℃} \cdot \big(0℃ - (-20℃)\big) = 46040\ J,$$

$$Q_2 = m_{ice} L_f = 1\ kg \cdot 3.33 \cdot 10^5\ \frac{J}{kg} = 333000\ J,$$

$$Q_3 = m_{water} c_{water} \Delta t = 1\ kg \cdot 4186\ \frac{J}{kg℃} \cdot (100℃ - 0℃) = 418600\ J,$$

$$Q = Q_1 + Q_2 + Q_3 = 46040\ J + 333000\ J + 418600\ J = 797640\ J.$$

Answer:

$Q = 797640\ J.$