Answer on question #61569, Physics / Molecular Physics | Thermodynamics

Statement of a problem

How many grams of ice must we add in 500g of water which has temperature 30 °C so when the ice melts completely, the final temperature of water would be 5 °C?

$t_1 = 30\ °C$ – initial temperature of the water;

$m_w = 0.5\ kg$– mass of the water;

$t_2 = 5\ °C$– final temperature of water;

$t_{ice} = 0\ °C$– temperature of the ice;

$\lambda = 3.5 \times 10^5\ J/kg$ – specific heat of fusion of ice

$C = 4.2 \times 10^3 J/kg$ – specific heat capacity of water

Find: $m_{ice} - ?$ – mass of the ice

Thermal balance equation

$Q_f + Q_1 = Q_2,$

Where $Q_f = \lambda m_{ice}$ – heat of fusion,

$Q_1 = Cm_{ice}(t_2 - t_{ice})$ – heat expended on heating the melt water

$Q_2 = Cm_w(t_1 - t_2)$ – heat from hot water

$\lambda m_{ice} + Cm_{ice}(t_2 - t_{ice}) = Cm_w(t_1 - t_2)$

$m_{ice}\big(\lambda + \mathrm{C}(t_2 - t_{ice})\big) = Cm_w(t_1 - t_2)$

$$m_{ice} = \frac{Cm_w(t_1 - t_2)}{\lambda + \mathrm{C}(t_2 - t_{ice})}$$

Calculation:

$$m_{ice} = \frac{4.2 \times 10^3 \times 0.5 \times (30 - 5)}{3.3 \times 10^4 + 4.2 \times 10^3 \times (5 - 0)} = \frac{2.1 \times 25 \times 10^3}{3.3 \times 10^4 + 2.1 \times 10^4} = \frac{5.25}{35.1} \approx 0.1496\ (kg)$$

$m_{ice} \approx 0.1496\ kg = 149.6\ g$

Answer: $m_{ice} \approx 0.1496\ kg = 149.6\ g$