1) A 2.0 kg piece of ice at 0 °C melts in a tub and the resulting water comes to room temperature at 20 °C. How much heat did the ice absorb from its surroundings?

2) A tray containing 0.250 kg of water at 20 °C is put into a refrigerator. How much hear must the refrigerator remove from the water to turn it into ice at 0 °C?

3) If 1 kg of water at 20 °C is mixed with 2 kg of water at 50 °C, what will be the final temperature of the mixture?

Solution: 1) If we need to know, how much heat only the ice absorbed, then it is equal to the heat absorbed by melting of this ice: $Q = m \cdot \Delta H_f$, where Q is the amount of absorbed heat, J; m is the mass of melted ice, kg; ΔH_f is the latent heat of fusion of ice, $333 \cdot 10^3$ J/kg.

Then, $Q = 2 \cdot 333 \cdot 10^3 = 666 \cdot 10^3$ J $= 666$ kJ.

2) The total amount of removed heat is equal to the sum of heat released during the cooling of water and the heat of crystallization: $Q = Q_1 + Q_2 = c \cdot m \cdot (T_{0w} - T_w) + m \cdot \Delta H_f$, where c is the specific heat capacity of water (4180 $J \cdot kg^{-1} \cdot K^{-1}$); m is the mass of water, kg; T_{0w}, T_w are the initial and final temperatures of water, °C, respectively.

Then, $Q = 4180 \cdot 0.25 \cdot (20 - 0) + 0.25 \cdot 333 \cdot 10^3 = 104{,}150$ J $= 104.15$ kJ.

3) The hot water will lose heat, which will be absorbed by cold water, temperature of the hot water will decrease, while the temperature of cold water will increase, and their final temperature will be equal.

According to the law of conservation of energy, amount of heat lost by the hot water is equal to the amount of heat, absorbed by the cold water. Then, $Q_{hot} = Q_{cold}$; $c \cdot m_{hot} \cdot (T_{0h} - T_h) = c \cdot m_{cold} \cdot (T_c - T_{0c})$; $T_c = T_h = T$. From this equation, $T = \frac{m_{hot} \cdot T_{0h} + m_{cold} \cdot T_{0c}}{m_{hot} + m_{cold}}$, where m_{hot}, m_{cold}, T_{0h}, T_{0c} are the masses and initial temperatures of hot and cold water, respectively.

Then, $T = \frac{2 \cdot 50 + 1 \cdot 20}{2 + 1} = 40$ °C.

Answer: 1) 666 kJ; 2) 104.15 kJ; 3) 40 °C.