Answer on Question #80268, Physics / Other

Specific heat capacity of water = 4200 J/kg/K

Specific heat capacity of aluminium = 900 J/kg/°C

Specific heat capacity of ice = 2100 J/ kg/K

Latent heat of fusion of ice = 334 000 J/ kg

Latent heat of vaporization of water =2 250 000J/kg

We wish to determine the specific heat capacity of a new alloy of an unknown specific heat capacity.

1. A 0.15 kg sample of alloy is heated to 540°C. It is then quickly placed in 400 g of water at 10°C which is contained in a 200 g aluminium cup. The final temperature of the mixture is 30.5°C. Calculate the specific heat capacity of the alloy.

NB: Heat lost by alloy is gained by both the water and the cup containing the water.

Solution:

The sum of the internal energy changes of alloy sample (1), water (2) and aluminium cup(3) equals zero:

$$m_1 \cdot C_1 \cdot (T_{i1} - T_f) + m_2 \cdot C_2 \cdot (T_{i2} - T_f) + m_3 \cdot C_3 \cdot (T_{i3} - T_f) = 0$$

So,

$$C_1 = \frac{(m_2 \cdot C_2 + m_3 \cdot C_3) \cdot (T_f - T_{i2})}{m_1 \cdot (T_{i1} - T_f)} =$$

$$= \frac{(0.4 \cdot 4200 + 0.2 \cdot 900) \cdot (30.5 - 10)}{0.15 \cdot (540 - 30.5)} = 498.9 \frac{J}{kg\ K} \approx 500 \frac{J}{kg\ K}$$

Answer: $500 \frac{J}{kg\ K}$

2. Determine the rate at which heat is removed from 1.5 kg of water at 20°C to make ice at -12°C by a refrigerator if it is kept on for 2 hours.

Solution:

Total heat removed from water to make ice is

$$Q = Q_1 + Q_2 + Q_3 = C_{water} m_{water} (\Delta T_1) + L_{ice} m_{water} + C_{ice} m_{water} (\Delta T_2) =$$

$$= m_{water} (20 \cdot C_{water} + L_{ice} + 12 \cdot C_{ice}) =$$

$$= 1.5 \cdot (20 \cdot 4200 + 334000 + 12 \cdot 2100) = 664800\ J$$

The rate is

$$\dot{Q} = \frac{Q}{t} = \frac{664800\ J}{2\ hr \cdot 3600\ s} = 92.3\ J/s$$

Answer: $92.3\ J/s$