Answer on Question #80209, Physics / Molecular Physics | Thermodynamics

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.
A 0.15 kg sample of alloy is heated to 540°C. It is then quickly placed in 400 g of water at l0°C which is contained in a 200 g aluminium cup. The final temperature of the mixture is 305°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 lost heat is equal to the gained heat.

$Q_{lost} = Q_{gained}$

The sample f alloy is the one that loses heat:

$Q_{lost} = c_{al}m\Delta T = c_{al}m(T_2 - T_1)$, where T_1 – the final temperature, T_2 – the initial temperature of the sample

Water and aluminium cup gain the heat, what is more water evaporates.

$Q_{gained} = c_{Al}m(T_1-T_3) + c_w m_w(100-T_3) + \lambda_w m_w$, where T_3 – the initial temperature of water and the cup, λ_w – latent heat of vaporization of water.

$c_{al}m(T_2 - T_1) = c_{Al}m(T_1-T_3) + c_w m_w(100-T_3) + \lambda_w m_w$

$$c(\text{alloy}) = \frac{C_{Al}m(T_1-T_3)+C_w m_w(100-T_3)+ \lambda_w m_w}{m(T_2-T_1)}$$

$$c(\text{alloy}) = \frac{900\times0.2\times(305-10)+4200\times0.4\times(100-10)+2250000\times0.4}{0.15\times(540-305)} = \mathbf{31328\ J/kg/K}$$

Answer

The specific heat capacity of the alloy is **31328 J/kg/K**

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