

Answer on Question #76843, Physics / Molecular Physics | Thermodynamics

A block of copper of mass 980g at a temperature of 120 degrees Celsius was placed in a beaker if water containing 250cm³ of water. If the water is at 12 degrees Celsius, explain what happens to the water with calculation for evidence.

Shc of water= 4200 J kg⁻¹ K⁻¹ Latent heat of fusion (Lf) = 2,340,000 J kg⁻¹ shc of copper = 450 J kg⁻¹ K⁻¹

Solution

Firstly let's consider an ideal situation when a block of copper is placed in a beaker and there is no exchange of matter and heat with surrounding. Then we will consider a real situation.

When a block of copper at temperature 120^oC is placed in a beaker with water at temperature 12^oC a process of heat exchange takes place until the temperature of heat equilibrium is reached.

A block of copper releases heat Q_{released} . Water absorbs heat Q_{absorbed} .

At the state of heat equilibrium $Q_{\text{released}} = Q_{\text{absorbed}}$.

$$Q_{\text{released}} = cm(T_2 - T_1)$$

Where c (Cu) = 450J/kg·K

$$m(\text{Cu}) = 0.980 \text{ kg}$$

$$T_1 = 120 + 273.15 = 393.15 \text{ K}$$

$$Q_{\text{released}} = 450 \cdot 0.980 (T_2 - 393.15)$$

$$Q_{\text{absorbed}} = cm (T_2 - T_1)$$

$$c(\text{H}_2\text{O}) = 4200 \text{ J/kg}\cdot\text{K}$$

$$m(\text{H}_2\text{O}) = V(\text{H}_2\text{O}) \cdot d(\text{H}_2\text{O}), d(\text{H}_2\text{O}) = 1\text{g/cm}^3;$$

$$m(\text{H}_2\text{O}) = 250 \cdot 1 = 250 \text{ (g)} = 0.250 \text{ kg}$$

$$T_1 = 12 + 273.15 = 285.15\text{K}$$

$$Q_1 = 4200 \cdot 0.250 (T_2 - 285.15)$$

$$Q_{\text{released}} = Q_{\text{absorbed}};$$

$$-450 \cdot 0.980 (T_2 - 393.15) = 4200 \cdot 0.250 (T_2 - 285.15)$$

$$T_2 = 317.09 \text{ K or } T_2 = 317.09 - 273.15 = 43.94 \text{ } ^\circ\text{C}.$$

In real situation the heat will also be absorbed by beaker. And there also will the heat exchange with surrounding.

Observation: the water will be heated to the temperature of 43.94°C , the block of copper will be cooled to the temperature of 43.94°C .

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