

Question #68473, Engineering / Mechanical Engineering

determine the amount of heat energy needed to change 250g of ice at -10c into superheated stream at 130c given that the latent heat of fusion of ice is 335kj/kg the specific heat capacity of ice is 2.14kj/kg the specific heat capacity of water is 4.2kj/kg the specific heat capacity of stream is 2.01kj/kgk the latent heat of vaporization of water is 2.26mj/kg

Solution

Stage 1: heating the ice.

$$Q_1 = Cm\Delta T = 2.14 \times 10^3 \times 0.25 \times 10 = 5350 \text{ J}$$

Stage 2: melting ice.

$$Q_2 = H_{melt}m = 335 \times 10^3 \times 0.25 = 83750 \text{ J}$$

Stage 3: heating the water.

$$Q_3 = Cm\Delta T = 4.2 \times 10^3 \times 0.25 \times 100 = 105000 \text{ J}$$

Stage 4: evaporation.

$$Q_4 = H_{vapor}m = 2.26 \times 10^6 \times 0.25 = 565000 \text{ J}$$

Stage 5: heating the vapor.

$$Q_5 = Cm\Delta T = 2.01 \times 10^3 \times 0.25 \times 30 = 15075 \text{ J}$$

Total heat required:

$$Q = \sum Q_i = 5350 + 83750 + 105000 + 565000 + 15075 = 774175 \text{ J} = 774.2 \text{ kJ}$$

Answer: 774.5 kJ