

How much heat is required to raise the temperature of 1 kg of ice at -30°C to steam that is 110°C ?

Solution

$$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$$

1. Find Q_1 – heat that is required to raise temperature of 1 kg of ice from -30°C to 0°C .

$$Q_1 = cm(T_2 - T_1), \text{ where } c \text{ (for ice)} = 2092 \text{ J/kg}\cdot^{\circ}\text{C}$$

$$Q_1 = 2092 \text{ J/kg}\cdot^{\circ}\text{C} \cdot 1 \text{ kg} \cdot (0 - (-30))^{\circ}\text{C} = 62760 \text{ J} = 62.8 \text{ kJ}$$

2. Find Q_2 -the heat of phase change (melting):

$$Q_2 = \lambda \cdot m, \text{ where } \lambda = 334.7 \text{ kJ/kg}$$

$$Q_2 = 334.7 \text{ kJ/kg} \cdot 1 \text{ kg} = 334.7 \text{ kJ}$$

3. Find Q_3 – heat that is required to raise temperature of water from 0°C to 100°C

$$Q_3 = cm(T_2 - T_1), \text{ where } c \text{ (for water)} = 4184 \text{ J/kg}\cdot^{\circ}\text{C}$$

$$Q_3 = 4184 \text{ J/kg}\cdot^{\circ}\text{C} \cdot 1 \text{ kg} \cdot (100 - 0)^{\circ}\text{C} = 418400 \text{ J} = 418.4 \text{ kJ}$$

4. Find Q_4 –the heat of phase change (boiling):

$$Q_4 = L \cdot m, \text{ where } L = 2.2310^6 \text{ J/kg},$$

$$Q_4 = 2.23 \cdot 10^6 \text{ J/kg} \cdot 1 \text{ kg} = 2.23 \cdot 10^6 \text{ J} = 2230 \text{ kJ}.$$

5. Find Q_5 – heat required to raise the temperature of steam from 100°C to 110°C .

$$Q_5 = cm(T_2 - T_1), \text{ where } c \text{ (for steam)} = 2008 \text{ J/kg}\cdot^{\circ}\text{C}$$

$$Q_5 = 2008 \text{ J/kg}\cdot^{\circ}\text{C} \cdot 1 \text{ kg} \cdot (110 - 100) = 20080 \text{ J} = 20.1 \text{ kJ}$$

6. Find Q

$$Q = 62.8 \text{ kJ} + 334.7 \text{ kJ} + 418.4 \text{ kJ} + 2230 \text{ kJ} + 20.1 \text{ kJ} = 3066 \text{ kJ}$$

Answer: 3066 J

Answer provided by AssignmentExpert.com