Answer on Question #43752 - Chemistry - Inorganic Chemistry

Question:

How much energy (in kilojoules) is needed to heat 4.05g of ice from -11.5∘C to 28.5∘C? The heat of fusion of water is 6.01kJ/mol, and the molar heat capacity is 36.6 J/(K·mol) for ice and 75.3 J/(K·mol) for liquid water.

Solution:

Total energy needed is the sum of three items:

$$Q_\Sigma = Q_1 + Q_2 + Q_3$$

where Q_1 – the energy needed to heat the ice from the initial temperature (T_1 = -11.5∘C) to the ice melting temperature (T_2 = 0.0∘C); Q_2 – the energy needed to melt the given amount of the ice; Q_3 – the energy needed to heat the water from the melting temperature to the final temperature (T_3 = 28.5∘C).

Number of moles of ice/water:

$$n = \frac{m}{M_{H_2O}} = \frac{4.05\ g}{18.02\,\frac{g}{mol}} = 0.225\ mol$$

The energy needed to heat the ice:

$$Q_1 = n \cdot C_{ice} \cdot (T_2 - T_1) = 0.225\ mol \cdot 36.6\frac{J}{mol \cdot K} \cdot \big(0.0 - (-11.5)\big)K = 94.7\ J$$

The energy needed to melt the ice:

$$Q_2 = n \cdot r = 0.225\ mol \cdot 6.01\frac{kJ}{mol} = 1.352\ kJ$$

The energy needed to heat the water:

$$Q_3 = n \cdot C_{water} \cdot (T_3 - T_2) = 0.225\ mol \cdot 75.3\frac{J}{mol \cdot K} \cdot (28.5 - 0.0)K = 482.9\ J$$

The total energy:

$$Q_\Sigma = Q_1 + Q_2 + Q_3 = 94.7\ J + 1{,}352\ J + 482.9\ J = 1{,}929.6\ J = 1.930\ kJ$$

Answer: 1.930 kJ