

Answer on Question #72857, Chemistry / General Chemistry

How much heat is required in kJ to convert 30.7 g of water at 97.5°C to steam at 105.5°C? The boiling point of water is 100.0°C, C_m for liquid water = 75.4 J/(mol•°C), $\Delta H_{\text{vap}} = 40.67$ kJ/mol, and C_m for steam = 33.6 J/(mol•°C).

Solution

$Q_{\text{total}} = Q_{\text{liq}} + Q_{\text{vap}} + Q_{\text{st}}$, where Q_{liq} – energy required to heat water from 97.5°C to 100°C ($\Delta T_1 = 2.5^\circ\text{C}$);

Q_{vap} -- energy required to evaporate water;

Q_{st} -- energy required to heat steam from 100°C to 105.5°C ($\Delta T_2 = 5.5^\circ\text{C}$).

$$Q_{\text{total}} = C_{m_{\text{liq}}}v\Delta T_1 + \Delta H_{\text{vap}}v + C_{m_{\text{st}}}v\Delta T_2$$

$$v_{\text{water}} = \frac{30.7}{18} = 1.71 \text{ (mol)}$$

$$Q_{\text{total}} = 0.0754 \times 1.71 \times 2.5 + 40.67 \times 1.71 + 0.0336 \times 1.71 \times 5.5 = \mathbf{70.18 \text{ kJ}}$$

Answer

70.18 kJ of heat are required to convert 30.7 g of water at 97.5°C to steam at 105.5°C.