

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 Positive: a gas is produced from solids, increasing dispersal/accessible arrangements.

2.2 $\Delta S = 2(150) - 200 = +100 \text{ J mol}^{-1} \text{ K}^{-1}$.

2.3 $\Delta S_{\text{surroundings}} = -18000/300 = -60.0 \text{ J mol}^{-1} \text{ K}^{-1}$. Total = $90.0 - 60.0 = +30.0 \text{ J mol}^{-1} \text{ K}^{-1}$.

3.1 At the boundary $0 = 120 - 36000/T$, so $T = 300 \text{ K}$. Above 300 K total entropy is positive. ΔH and system ΔS are treated as temperature-independent over the range.

3.2 The positive surroundings term $-\Delta H/T$ decreases as T rises, so it may cease to outweigh negative system entropy. Rate depends on activation energy/pathway rather than total entropy alone.

3.3 (a) Zero at 0 K for a perfect crystal; entropy increases on warming within a phase; it increases on melting and again on boiling as particles/energy have more accessible arrangements. (b) Released ions disperse through the solvent, but hydration can order surrounding water, so the net system change need not be positive. (c) Dispersal through the larger volume permits more molecular arrangements; the spontaneous direction increases total entropy of the gas and surroundings, without requiring molecules to disappear.