

Solutions

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

2.1 $K_c = [NH_3]^2 / ([N_2][H_2]^3)$. Units $\text{dm}^6 \text{mol}^{-2}$.

2.2 $p_X = (2/5)5 = 2.0 \text{ atm}$; $p_Y = (3/5)5 = 3.0 \text{ atm}$.

2.3 $K_p = p(\text{CO}_2)$; pure solids do not enter the expression, while both solid phases remain present.

3.1 Total amount 1.00 mol; partial pressures 1.50 and 1.00 atm. $K_p = 1.00^2 / 1.50 = 0.667 \text{ atm}$.

3.2 Equilibrium A and B are 0.30 mol each. Concentrations are 0.200, 0.200 and $0.0667 \text{ mol dm}^{-3}$; $K_c = 0.0667 / 0.200^2 = 1.67 \text{ dm}^3 \text{mol}^{-1}$. Unequal total powers mean volume factors do not cancel.

3.3 $\Delta S_{\text{total}} = 8.31 \ln(20.0) = +24.9 \text{ J mol}^{-1} \text{K}^{-1}$. For positive ΔH , the negative surroundings term $-\Delta H/T$ becomes smaller in magnitude as T rises, so total entropy and $\ln K$ increase, hence K increases.