

Exercise walk-through

4.3

Chemical equilibria (Topic 13)

Pearson Edexcel · International A-Level · Chemistry

Find the temperature boundary

Your turn

$\Delta H = +36.0 \text{ kJ mol}^{-1}$; $\Delta S(\text{system}) = +120 \text{ J mol}^{-1} \text{ K}^{-1}$. Which condition gives positive total entropy?

- A. T below 300 K
- B. T above 300 K
- C. Every temperature
- D. No temperature

Buffer after neutralisation

Your turn

0.0100 mol HA receives 0.00400 mol OH^- . Which HA:A⁻ ratio enters the buffer expression?

- A. 10:4
- B. 6:4
- C. 4:6
- D. 10:6

Independent structural identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has two carbon-13 signals, gives iodoform and no Tollens' silver. Which structure fits?

- A. Propanal
- B. Propanone
- C. Propan-1-ol
- D. Ethanoic acid

Exercises 2.1·2.3

2.1 Write K_c for $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, and derive its units for concentrations in mol dm^{-3} . [3]

2.2 A gas mixture contains 2.0 mol X and 3.0 mol Y at total pressure 5.0 atm. Calculate each partial pressure. [2]

2.3 Write K_p for $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$. Explain the omitted terms. [2]

Exercises 2.1·2.3

2.1 Write K_c for $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, and derive its units for concentrations in mol dm^{-3} . [3]

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

2.2 A gas mixture contains 2.0 mol X and 3.0 mol Y at total pressure 5.0 atm. Calculate each partial pressure. [2]

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

2.3 Write K_p for $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$. Explain the omitted terms. [2]

2.3 $K_p = p(CO_2)$; pure solids do not enter the expression, while both solid phases remain present.

Exercises 3.1·3.3

3.1 For $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$, equilibrium amounts are 0.60 mol N_2O_4 and 0.40 mol NO_2 at 2.50 atm total pressure. Calculate K_p with units. [4]

3.2 For $\text{A} + \text{B} \rightleftharpoons \text{C}$, 0.40 mol each A and B initially in 1.50 dm³ produces 0.10 mol C.

3.3 An appropriately standardised dimensionless equilibrium constant is $K = 20.0$ at 298 K. Use $\Delta S(\text{total}) = R \ln K$ and $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ to calculate total entropy. The forward reaction is endothermic. Explain the predicted change in K when temperature rises, assuming ΔH and system entropy are approximately constant. [4]

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

3.2 For $\text{A} + \text{B} \rightleftharpoons \text{C}$, 0.40 mol each A and B initially in 1.50 dm³ produces 0.10 mol C.

3.2 Equilibrium A and B are 0.30 mol each. Concentrations are 0.200, 0.200 and 0.0667 mol dm⁻³; $K_c = 0.0667/0.200^2 = 1.67$ dm³ mol⁻¹. Unequal total powers mean volume factors do not cancel.

3.3 An appropriately standardised dimensionless equilibrium constant is $K = 20.0$ at 298 K. Use $\Delta S(\text{total}) = R \ln K$ and $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ to calculate total entropy. The forward reaction is endothermic. Explain the predicted change in K when temperature rises, assuming ΔH and system entropy are approximately constant. [4]

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 sur-