

Equilibrium constants and shifts

AP Chemistry · Lab answers

The four values of K agree within a few per cent, which shows that K depends on temperature, not on starting concentrations. The qualitative tests are all explained by comparing Q with K or by the sign of ΔH . Keep two significant figures because the colorimeter readings have two.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 7

Question 1 K expression

$K_c = [\text{FeSCN}^{2+}]/([\text{Fe}^{3+}][\text{SCN}^-])$; units M^{-1} (L/mol).

Question 2 Tube 1

Change: $\text{Fe}^{3+} -x$, $\text{SCN}^- -x$, $\text{FeSCN}^{2+} +x$. $x = 1.8 \times 10^{-4} \text{ M}$, so $[\text{Fe}^{3+}] = [\text{SCN}^-] = 8.2 \times 10^{-4} \text{ M}$. $K_c = 1.8 \times 10^{-4}/(8.2 \times 10^{-4})^2 = \mathbf{2.7 \times 10^2 \text{ M}^{-1}}$.

Question 3 Other tubes

Tube 2: $[\text{Fe}^{3+}] = 1.69 \times 10^{-3}$, $[\text{SCN}^-] = 6.9 \times 10^{-4}$; $K = \mathbf{2.7 \times 10^2}$ (266). Tube 3: 2.59×10^{-3} and 5.9×10^{-4} ; $\mathbf{2.7 \times 10^2}$ (268). Tube 4: 3.52×10^{-3} and 5.2×10^{-4} ; $\mathbf{2.6 \times 10^2}$ (262).

Question 4 Is K constant?

Mean = $(268 + 266 + 268 + 262)/4 = \mathbf{266 \text{ M}^{-1}}$. The range is 262–268, within 1.2 % of the mean. **K is constant** although $[\text{Fe}^{3+}]_0$ changed fourfold.

Question 5 Explaining the disturbances

Adding Fe^{3+} raises the denominator of Q , so $Q < K$ and the forward reaction runs: **deeper red**. NaOH removes Fe^{3+} as $\text{Fe}(\text{OH})_3$, so Q rises above K and the reverse reaction runs: **paler**.

Question 6 Temperature

Warming makes the solution paler, so the reverse reaction is favoured and K decreases. The reverse is endothermic, so the forward reaction is **exothermic ($\Delta H < 0$)**.

Question 7 Dilution

Both concentrations halve, so $Q = (\frac{1}{2}[\text{FeSCN}^{2+}])/(\frac{1}{2}[\text{Fe}^{3+}] \times \frac{1}{2}[\text{SCN}^-]) = 2K > K$. The system shifts **to the left** (towards more particles), and the colour is paler than half the original.