Chemical Equilibrium, Q & K

INSTRUCTOR / SELF-STUDY ANSWER KEY

Answers and reasoning appear in red. Use these to discuss why incorrect choices are incorrect.

Part A — Concept checks

1. **At chemical equilibrium the forward and reverse rates are…**

   Answer: B. equal — Dynamic equilibrium has equal forward and reverse rates.

2. **If Q < K, the reaction has a net tendency to shift…**

   Answer: B. right — More products must form to reach K.

3. **For A ⇌ 2 B, the expression for Kc is…**

   Answer: C. $[B]^2/[A]$ — Stoichiometric coefficients become exponents.

4. **Which species is omitted from a Kc expression?**

   Answer: D. $CaCO_3(s)$ — The activity of a pure solid is constant.

5. **Does a catalyst change K at a fixed temperature?**

   Answer: C. no — A catalyst changes kinetics, not thermodynamic equilibrium K.

6. **If Q > K, the net reaction tends toward…**

   Answer: A. more reactants — Excess product relative to K drives the reverse reaction.

Part B — Application and explanation

7. For 2 $NO_2(g) \rightleftharpoons N_2O_4(g)$, $[N_2O_4] = 0.040$ M and $[NO_2] = 0.020$ M at equilibrium. Find Kc.

   Model solution: $K_c = [N_2O_4]/[NO_2]^2 = 0.040/(0.020)^2 = 100$ (using the introductory concentration convention). Final answer: $K_c = 1.0 \times 10^2$

8. Explain why this guideline matters, with an example of what could go wrong if you ignore it: A catalyst helps equilibrium be reached more quickly but does not change K or the final equilibrium composition at fixed temperature.

   Model explanation: A catalyst helps equilibrium be reached more quickly but does not change K or the final equilibrium composition at fixed temperature. Example/check: Forward and reverse reactions continue at equal rates at equilibrium; concentrations are constant, not necessarily equal.

REFERENCE RELATIONSHIP

for aA + bB ⇌ cC + dD, Kc = [C]^c[D]^d / ([A]^a[B]^b)