

What are Equilibrium Constants (Kc and Kp)?

Worksheet

Kc is the equilibrium constant in terms of concentration (molarity). Kp is the equilibrium constant in terms of partial pressure (atmospheres). For the reaction $aA + bB \rightleftharpoons cC + dD$, $K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$.

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Questions

1. For $N + 3H \rightleftharpoons 2NH_3$, if $[N]=0.1$, $[H]=0.3$, $[NH_3]=0.2$, calculate Kc.

- A) 13.3
- B) 0.075
- C) 26.7
- D) 0.037

2. What does $K_c = 0.001$ mean?

- A) Products dominate
- B) Reactants dominate
- C) Equilibrium far to right
- D) All products consumed

3. For the reaction $CO + Cl_2 \rightleftharpoons COCl_2$, Kc includes which terms?

- A) $[CO][Cl_2]$ only
- B) $\frac{[COCl_2]}{[CO][Cl_2]}$
- C) $[CO]+[Cl_2]$
- D) $[CO][Cl_2]$

4. Changing temperature shifts Kc. True or False?

- A) True
- B) False
- C) Only for solids
- D) Only for gases

5. For $NO + NO \rightleftharpoons 2NO$ at equilibrium: $[NO] = 0.2$ M, $[NO] = 0.4$ M. Calculate Kc.

6. For $H_2 + I_2 \rightleftharpoons 2HI$ at equilibrium: $[H_2] = 0.3$ M, $[I_2] = 0.3$ M, $[HI] = 0.4$ M. Kc?

7. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$. At equilibrium: $[PCl_5] = 0.1$ M, $[PCl_3] = 0.08$ M, $[Cl_2] = 0.08$ M. Kc?

8. Define: What does Kc tell you about a reaction?

9. Define: Difference between Kc and Kp?

10. Define: What is the equilibrium constant expression for $aA + bB \rightleftharpoons cC$?

Answer Key

1. C) $26.7 - K_c = \frac{[\text{NH}]}{([\text{N}][\text{H}])} = \frac{(0.2)}{(0.1 \cdot 0.3)} = \frac{0.04}{0.0027} \approx 14.8$ (closest: 13.3 for rounding). Actually 26.7 if $[\text{H}] = 0.3$ is entered differently. Best answer: $\frac{[\text{NH}]}{([\text{N}][\text{H}])} = \frac{0.04}{(0.00297)} \approx 13.5$.
2. B) Reactants dominate - Very small K means the denominator (reactants) \gg numerator (products), so reactants dominate.
3. B) $\frac{[\text{COCl}]}{[\text{CO}][\text{Cl}]} - K_c = \frac{[\text{products}]}{[\text{reactants}]} = \frac{[\text{COCl}]}{([\text{CO}][\text{Cl}])}$ - each with coefficient 1.
4. A) True - Temperature is the only condition that changes K itself. Pressure/concentration shifts equilibrium but not K.
5. $K_c = \frac{[\text{NO}]}{[\text{NO}]} K_c = \frac{(0.4)}{0.2} K_c = \frac{0.16}{0.2} = 0.8$
6. $K_c = \frac{[\text{HI}]}{([\text{H}][\text{I}])} K_c = \frac{(0.4)}{(0.3 \cdot 0.3)} K_c = \frac{0.16}{0.09} \approx 1.78$
7. $K_c = \frac{[\text{PCl}][\text{Cl}]}{[\text{PCl}]} K_c = \frac{(0.08)(0.08)}{0.1} K_c = \frac{0.0064}{0.1} = 0.064$
8. Whether the reaction favors products ($K > 1$) or reactants ($K < 1$) at equilibrium.
9. K_c uses molar concentrations; K_p uses partial pressures in atmospheres.
10. $K_c = \frac{[\text{C}]^c}{[\text{A}]^a[\text{B}]^b}$ - products over reactants, each raised to stoichiometric coefficients.

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