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CHEMISTRY WORKSHEET

EQUILIBRIUM CONSTANT

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Writing Kc expressions, ✓ Homogeneous equilibrium, ✓ Heterogeneous equilibrium, ✓ Calculating ✓ Kc from equilibrium concentrations, ✓ Calculating Kc from moles in a container, ✓ Reaction quotient (Q), ✓ Predicting equilibrium shifts, ✓ Manipulating Kc (reversing, scaling, adding equations), ✓ Kp and Kc conversions, ✓ ICE tables, ✓ Quadratic equilibrium problems, ✓ Percent dissociation problems

All problems are designed to reflect style and difficulty commonly seen on quizzes, tests, and final exams. Detailed solutions are included to help students understand the reasoning behind every step.

PART A - FUNDAMENTAL PROBLEMS
Problems 1-15. Simple calculations and basic applications

PART B - INTERMEDIATE PROBLEMS
Problems 16-30. Typical unit test questions involving multiple steps

PART C - ADVANCED PROBLEMS
Problems 31-40. More challenging calculations requiring deeper understanding

PART D - CHALLENGE PROBLEMS
Problems 41-50. Difficult exam-style questions combining multiple concepts

SUITABLE FOR:
quizzes, unit tests and final exam preparation

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Section 1. Essential Information

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Section 2. Practice Problems

Part A - Kc expressions and direct equilibrium calculations

Problem 8. At equilibrium, $[CO_2]$ = 0.240 M, $[H_2]$ = 0.240 M, [CO] = 0.0800 M, and $[H_2O]$ = 0.120 M. Calculate K_c

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$$

Part B - Manipulating K and using Q

Problem 16. For the equilibrium below, K_c = 0.212. Calculate K_c for the reverse reaction

$$N_2O_{4(g)} \rightleftharpoons 2\ NO_{2(g)}$$

Part C - ICE tables and equilibrium concentrations

Problem 32. Initially, $[PCl_5]$ = 0.500 M. At equilibrium, $[Cl_2]$ = 0.200 M. Calculate K_c

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

Part D - Challenge equilibrium constant problems

Problem 45. For the first equilibrium, $K_c = 3.20 \times 10^{-2}$.

Calculate K_c for the target reaction

$$2\ SO_{3(g)} \rightleftharpoons 2\ SO_{2(g)} + O_{2(g)}$$

$$\text{Target: } SO_{2(g)} + 1/2\ O_{2(g)} \rightleftharpoons SO_{3(g)}$$

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Section 3. Solutions

Problem 8 Solution

Given: $[CO_2]$ = 0.240 M, $[H_2]$ = 0.240 M, [CO] = 0.0800 M, and $[H_2O]$ = 0.120 M

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$$

Find: K_c

All coefficients are 1, so no concentration is raised to a power greater than 1

$K_c = ([CO_2][H_2]) / ([CO][H_2O])$

$K_c = (0.240)(0.240) / ((0.0800)(0.120)) = 0.0576 / 0.00960 = 6.00$

Final answer: $K_c = 6.00$. Reported to 3 significant figures

Problem 16 Solution

Given: $K_c = 0.212$ for the forward reaction

$$N_2O_{4(g)} \rightleftharpoons 2\ NO_{2(g)}$$

Find: K_c for the reverse reaction

Reversing a reaction takes the reciprocal of K_c

$K_c(\text{reverse}) = 1 / K_c(\text{forward})$

$K_c(\text{reverse}) = 1 / 0.212 = 4.72$

Final answer: $K_c(\text{reverse}) = 4.72$. Reported to 3 significant figures

Problem 32 Solution

Given: Initially $[PCl_5]$ = 0.500 M. At equilibrium, $[Cl_2]$ = 0.200 M

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

Find: K_c

Because PCl_3 and Cl_2 form in a 1:1 ratio, $[PCl_3]$ also equals 0.200 M

$K_c = [PCl_3][Cl_2] / [PCl_5]$

$[PCl_5]eq = 0.500 - 0.200 = 0.300$ M. $K_c = (0.200)(0.200) / 0.300 = 0.133$

Final answer: $K_c = 0.133$. Reported to 3 significant figures

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Problem 45 Solution

Given: $K_c = 3.20 \times 10^{-2}$ for the first reaction

$$2\ SO_{3(g)} \rightleftharpoons 2\ SO_{2(g)} + O_{2(g)}$$

Find: K_c for the target reaction

$$SO_{2(g)} + 1/2\ O_{2(g)} \rightleftharpoons SO_{3(g)}$$

The target is the reverse of the original reaction divided by 2, so take the reciprocal and then the square root

$K_c(\text{target}) = \sqrt{(1 / K_c(\text{original}))}$

$K_c(\text{target}) = \sqrt{(1 / (3.20 \times 10^{-2}))} = \sqrt{(31.25)} = 5.59$

Final answer: $K_c(\text{target}) = 5.59$. Reported to 3 significant figures

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Section 4. Answer Key

Problem	Answer
8	$K_c = 6.00$
16	$K_c(\text{reverse}) = 4.72$
32	$K_c = 0.133$
45	$K_c(\text{target}) = 5.59$

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