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CHEMISTRY WORKSHEET

REACTION QUOTIENT (Q)

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 Qc expressions, ✓ Writing Qp expressions, ✓ Excluding pure solids and pure liquids, ✓Calculating Q from concentrations, ✓ Calculating Q from partial pressures, ✓ Comparing Q with K, ✓ Predicting forward shifts, ✓ Predicting reverse shifts, ✓ Predicting no shift, ✓ Disturbances and volume changes, ✓ Reverse reactions, ✓ Scaled reactions, ✓ Combined reactions

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

This page includes only the formulas and habits needed to solve calorimetry problems efficiently.

Formula	Use
$q = m \times \Delta T$	Heat gained or lost by a substance
$\Delta T = T_f - T_i$	Temperature change with sign
$q_{cal} = C_{cal} \Delta T$	Heat absorbed by a calorimeter
$q_{system} = -q_{surroundings}$	Sign convention for coffee-cup and bomb calorimetry
$q_{hot} + q_{cold} = 0$	Heat exchange between substances
$\Delta H = q_{reaction}/n$	Molar enthalpy at constant pressure

Important definitions: coffee-cup calorimetry is usually constant pressure, so q_p can be used for ΔH. Bomb calorimetry is constant volume, so the result is commonly treated as ΔU for SCH4U-style calculations.

Fast method: identify what gains heat, identify what loses heat, convert volumes to masses when density is given, calculate ΔT carefully, include C_{cal} when provided, then apply the sign convention at the end.

Important notes: for dilute aqueous solutions, use density = 1.00 g/mL and $c = 4.184$ J/(g·°C) only when stated or clearly assumed. For reactions, the solution and calorimeter are surroundings, while the chemical reaction is the system.

Common mistakes: using only one solution volume after mixing, forgetting that $q_{reaction}$ has the opposite sign of $q_{solution}$, ignoring the limiting reagent, mixing J and kJ, and using the sample mass instead of moles when a molar answer is requested.

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Section 2 - Practice Problems

Part A - Fundamental Problems

Problem 8

For the reaction below, calculate Q_c when $[NO_2] = 0.120$ mol/L

and $[N_2O_4] = 0.0400$ mol/L

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

Part B - Intermediate Problems

Problem 16

For a reaction mixture, $Q_c = 10.0$ and $K_c = 50.0$. Predict whether the reaction shifts forward, shifts reverse, or is at equilibrium

Part C - Advanced Problems

Problem 32

For the reaction below, $Q_c = 0.125$. Determine Q_c for the reaction written with all coefficients divided by 2

$$N_{2(g)} + 3\ H_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$$

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Part D - Challenge Problems

Problem 45

A mixture for the reaction below is initially at equilibrium with $K_c = 1.00$ and all concentrations equal to 0.200 mol/L. Extra CO is injected so that [CO] becomes 0.500 mol/L before any shift occurs. Calculate Q_c and predict the direction of shift

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

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Section 3 - Solutions

Problem 8 Solution

$Q_c = [NO_2]^2 / [N_2O_4]$

$Q_c = (0.120)^2 / 0.0400 = 0.0144 / 0.0400 = 0.360$

Final answer: $Q_c = 0.360$

Problem 16 Solution

Compare Q_c with K_c. If $Q_c < K_c$, there is too little product compared with equilibrium

Final answer: $Q_c < K_c$, so the reaction shifts forward

Problem 32 Solution

Dividing all coefficients by 2 means the new quotient is the square root of the original quotient

$Q_{new} = (Q_{original})^{1/2}$

$Q_{new} = (0.125)^{1/2} = 0.354$

Final answer: $Q_{new} = 0.354$

Problem 45 Solution

After CO is injected, use the new [CO] immediately

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

$Q_c = (0.200)(0.200) / ((0.500)(0.200)) = 0.0400 / 0.100 = 0.400$

Comparison: 0.400 < 1.00, so the reaction shifts forward to use some added CO

Final answer: $Q_c = 0.400$, shift forward

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Section 4 - Answer Key

Problem	Answer	Problem	Answer
8	$Q_c = 0.360$	32	$Q_{new} = 0.354$
16	$Q_c < K_c$, so the reaction shifts forward	45	$Q_c = 0.400$, shift forward

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