Northern Tutoring™

more worksheets with solutions

CHEMISTRY WORKSHEET

MIXED CHEMICAL EQUILIBRIUM PRACTICE

Course: SCH4U Grade 12 Chemistry

DOWNLOAD FULL WORKSHEET (PDF)

50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Equilibrium expressions, ✓ Quadratic ICE table solving, ✓ Shift equilibrium direction, ✓ Effect of concentrations, pressure, temperature, catalysts, solids, inert gases

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

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_{system} has the opposite sign of $q_{surroundings}$, ignoring the limiting reagent, mixing J and kJ, and using the sample mass instead of moles when a molar answer is requested.

Section 2. Practice Problems

Part A. Fundamental Skills

Problem 8

At equilibrium, $[H_2] = 0.015$ mol/L, $[I_2] = 0.022$ mol/L, and $[HI] = 0.180$ mol/L.

Calculate K_c

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

Part B. Intermediate Mixed Practice

Problem 16

For this system, $K_c = 0.200$. A mixture has $[N_2O_4] = 0.100$ mol/L

and $[NO_2] = 0.200$ mol/L. Calculate Q_c and predict the shift

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

Part C. Advanced ICE Table Calculations

Problem 32

Initially, $[COCl_2] = 0.250$ mol/L and no products are present.

If $K_c = 0.0100$, calculate the equilibrium concentrations

$$COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$$

Part D. Challenge and Le Châtelier Reasoning

Problem 45

The container volume is decreased at constant temperature.

Predict the direction of shift

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

DOWNLOAD FULL WORKSHEET (PDF)

Section 3. Solutions

Problem 8 Solution

$K_c = [HI]^2/([H_2][I_2])$

$K_c = (0.180)^2/((0.015)(0.022)) = 98.2$

Final answer: $K_c = 98.2$

Problem 16 Solution

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

$Q_c = (0.200)^2/0.100 = 0.400$

Since $Q_c > K_c$, the system has too much product and shifts left

Final answer: $Q_c = 0.400$, shift left

Problem 32 Solution

ICE setup: $[COCl_2] = 0.250 - x$, $[CO] = x$, $[Cl_2] = x$

$K_c = x^2/(0.250 - x) = 0.0100$

$x^2 + 0.0100x - 0.00250 = 0$, so $x = 0.0452$

Final answer: $[COCl_2] = 0.205$ mol/L, $[CO] = 0.0452$ mol/L, $[Cl_2] = 0.0452$ mol/L

DOWNLOAD FULL WORKSHEET (PDF)

Problem 45 Solution

Decreasing volume increases pressure, so the system shifts to the side with fewer gas moles

The left side has 1 mol gas and the right side has 2 mol gas

Final answer: The system shifts left

DOWNLOAD FULL WORKSHEET (PDF)

Section 4. Answer Key

Problem	Answer
8	$K_c = 98.2$
16	$Q_c = 0.400$, shift left
32	$[COCl_2] = 0.205$ M, $[CO] = 0.0452$ M, $[Cl_2] = 0.0452$ M
45	Shift left

DOWNLOAD FULL WORKSHEET (PDF)