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CHEMISTRY WORKSHEET

LE CHÂTELIER PRINCIPLE

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Concentration stress shifts, ✓ Pressure and volume stress shifts, ✓ Temperature changes and Kc effects, ✓ Catalyst and inert gas effects, ✓ Qc vs Kc shift predictions, ✓ Common ion and solubility equilibrium shifts, ✓ Colour change equilibrium predictions, ✓ Weak acid and weak base equilibrium shifts, ✓ Industrial equilibrium conditions, ✓ Combined and competing equilibrium stresses.

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 $q_{reaction}$ has the opposite sign of q_{water}, 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 Problems

Problem 8

For the endothermic equilibrium below, predict the shift when temperature is decreased

$$CaCO_{3(s)} + \text{heat} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$

Part B - Intermediate Problems

Problem 16

For the equilibrium below, $K_c = 50$ at a certain temperature. Immediately after a disturbance, $Q_c = 20$. Predict the direction of shift

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

Part C - Advanced Problems

Problem 32

For the endothermic equilibrium below, the system is heated and then extra N_2O_4 is added. Predict the direction favoured by each change

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

Part D - Challenge Problems

Problem 45

For the equilibrium below, Cl_2 is added at constant temperature. Use Q_c reasoning to predict the shift and the effect on $[PCl_5]$

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

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Section 3 - Solutions

Problem 8 Solution

Given: Heat is a reactant, so the forward reaction is endothermic

Find: Effect of decreasing temperature

Method: Cooling removes heat. The system shifts in the direction that produces heat, which is the reverse direction

Final answer: The equilibrium shifts left, so less CO_2 forms

Problem 16 Solution

Given: $K_c = 50$ and $Q_c = 20$

Find: Direction of shift

Method: Compare Q_c with K_c. If $Q_c < K_c$, the system has too little product and shifts forward

Final answer: The equilibrium shifts right

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Problem 32 Solution

Given: Heat and N_2O_4 are both reactants

Find: Direction favoured by each change

Method: Adding heat favours the endothermic forward reaction. Adding N_2O_4 also makes the system consume reactant by shifting forward

Final answer: Both changes favour a shift to the right

Problem 45 Solution

Given: Cl_2 is a product and is added

Find: Shift and effect on $[PCl_5]$

Formula: $Q_c = [PCl_3][Cl_2]/[PCl_5]$

Method: Adding Cl_2 increases the numerator of Q_c, so Q_c becomes greater than K_c. The system shifts left to reduce Q_c

Final answer: The equilibrium shifts left, so $[PCl_5]$ increases

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Section 4 - Answer Key

Problem	Answer	Problem	Answer
8	Shifts left. Less CO_2 forms	32	Heating favours right. Adding N_2O_4 also favours right
16	Shifts right because $Q_c < K_c$	45	Q_c becomes greater than K_c. The system shifts left and $[PCl_5]$ increases