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CHEMISTRY WORKSHEET

MIXED REDOX PRACTICE

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ oxidation numbers, ✓ redox half-reactions, ✓ balancing redox equations, ✓ galvanic cells, ✓standard and non-standard cell potentials, ✓ electrolysis, ✓ Faraday's law, ✓ custom redox tables.

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_{system} has the opposite sign of q_{surr}, 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. Balance the redox equation.

$Fe^{2+}_{(aq)} + Ce^{4+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Ce^{3+}_{(aq)}$

Part B - Intermediate Problems

Problem 16. Balance the redox equation in acidic solution.

$MnO_4^-{}_{(aq)} + Fe^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + Fe^{3+}_{(aq)}$

Part C - Advanced Problems

Problem 32. Balance the redox equation in acidic solution.

$BrO_3^-{}_{(aq)} + Br^-_{(aq)} \rightarrow Br_{2(l)}$

Part D - Challenge Problems

Problem 45. Concentrated aqueous NaCl is electrolyzed using inert electrodes. Write the main cathode reaction, anode reaction, and overall reaction.

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Section 3 - Solutions

Problem 8 Solution

Given: Fe^{2+} is oxidized to Fe^{3+}, and Ce^{4+} is reduced to Ce^{3+}.

Find: The balanced redox equation.

Each Fe^{2+} ion loses one electron.

$$Fe^{2+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + e^-$$

Each Ce^{4+} ion gains one electron.

$$Ce^{4+}_{(aq)} + e^- \rightarrow Ce^{3+}_{(aq)}$$

Because the electron coefficients are already equal, the half-reactions combine in a 1:1 ratio. The total charge is +6 on both sides.

Final answer: $Fe^{2+}_{(aq)} + Ce^{4+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Ce^{3+}_{(aq)}$.

Problem 16 Solution

Given: MnO_4^- is reduced to Mn^{2+}, and Fe^{2+} is oxidized to Fe^{3+} in acidic solution.

Find: The balanced redox equation.

Balance the permanganate reduction half-reaction by adding four H_2O molecules to balance oxygen and eight H^+ ions to balance hydrogen. Five electrons are then added to the reactant side to balance charge.

$$MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$$

Iron(II) loses one electron during oxidation.

$$Fe^{2+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + e^-$$

Multiply the iron half-reaction by five so that both half-reactions involve five electrons. Adding them cancels the electrons and gives an equation balanced for atoms and charge.

Final answer: $MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5Fe^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)} + 5Fe^{3+}_{(aq)}$.

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Problem 32 Solution

Given: BrO_3^- reacts with Br^- to form Br_2 in acidic solution.

Find: The balanced redox equation.

Bromate is reduced. Balance its three oxygen atoms with three H_2O molecules, its six hydrogen atoms with six H^+ ions, and the charge with six electrons.

$$BrO_3^-{}_{(aq)} + 6H^+{}_{(aq)} + 6e^- \rightarrow Br^-{}_{(aq)} + 3H_2O_{(l)}$$

Bromide is oxidized according to:

$$2Br^-{}_{(aq)} \rightarrow Br_{2(l)} + 2e^-$$

Multiply the oxidation half-reaction by three, then add. One Br^- ion appears on both sides and cancels, leaving five Br^- ions as reactants.

Final answer: $BrO_3^-{}_{(aq)} + 5Br^-{}_{(aq)} + 6H^+{}_{(aq)} \rightarrow 3Br_{2(l)} + 3H_2O_{(l)}$.

Problem 45 Solution

Given: Concentrated aqueous NaCl is electrolyzed using inert electrodes.

Find: The main cathode, anode, and overall reactions.

In aqueous solution, Na^+ is not reduced because water is reduced more readily. Water gains electrons at the cathode, producing hydrogen gas and hydroxide ions.

$$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-{}_{(aq)}$$

In concentrated brine, chloride ions are oxidized at the anode to chlorine gas.

$$2Cl^-{}_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$$

Adding the half-reactions cancels the two electrons. Sodium ions remain in solution and combine with the generated OH^- ions, producing NaOH in the solution.

Final answer: Cathode: $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-{}_{(aq)}$. Anode: $2Cl^-{}_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$. Overall: $2Cl^-{}_{(aq)} + 2H_2O_{(l)} \rightarrow H_{2(g)} + Cl_{2(g)} + 2OH^-{}_{(aq)}$.

Section 4 - Answer Key

Part A - Fundamental Problems

Problem	Final answer
8	$Fe^{2+}_{(aq)} + Ce^{4+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Ce^{3+}_{(aq)}$

Part B - Intermediate Problems

Problem	Final answer
16	$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

Part C - Advanced Problems

Problem	Final answer
32	$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$

Part D - Challenge Problems

Problem	Final answer
45	Cathode $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$; anode $2Cl^- \rightarrow Cl_2 + 2e^-$; overall $2Cl^- + 2H_2O \rightarrow H_2 + Cl_2 + 2OH^-$