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CHEMISTRY WORKSHEET

REDOX FUNDAMENTALS

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, ✓ reducing and oxidizing agents, ✓ balancing redox reactions, ✓ redox stoichiometry

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 $q_{surroundings}$, 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 - Oxidation Numbers and Redox Vocabulary

Problem 8

Determine the oxidation number of carbon in CO_2, CH_4, and HCO_3^-

Part B - Balancing Redox Equations

Problem 16

Balance the redox reaction in acidic solution

$$Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$$

Part C - Redox Stoichiometry and Titrations

Problem 32

A 50.00 mL iodide solution is titrated in acidic solution with 20.00 mL of 0.0150 mol/L $K_2Cr_2O_7$. Calculate $[I^-]$

$$Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$

Part D - Mixed Challenge Problems

Problem 45

A 5.00 mL H_2O_2 sample is diluted to 250.0 mL. A 25.00 mL aliquot of the diluted solution requires 18.60 mL of 0.0200 mol/L $KMnO_4$ in acidic solution. Calculate the original H_2O_2 concentration in percent mass per volume, g/100 mL

$$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$$

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Section 3 - Solutions

Problem 8 Solution

Given: CO_2 and CH_4 are neutral. HCO_3^- has charge -1. O is -2 and H is +1

Find: Oxidation number of carbon in each species

Set the sum of oxidation numbers equal to the total charge

Carbon spans a wide range of oxidation states. Oxygen pulls the assigned value upward in carbon dioxide and bicarbonate, while hydrogen causes carbon to take a negative value in methane.

CO_2: $x + 2(-2) = 0$. CH_4: $x + 4(+1) = 0$. HCO_3^-: $+1 + x + 3(-2) = -1$

CO_2: $x = +4$. CH_4: $x = -4$. HCO_3^-: $x = +4$

Final answer: C is +4 in CO_2, -4 in CH_4, and +4 in HCO_3^-

Not applicable because oxidation numbers are exact values

Problem 16 Solution

Given: The reaction occurs in acidic solution

Find: Balanced redox equation

Balance the Mn half-reaction with H_2O and H^+, then balance electrons with the Fe half-reaction

Permanganate reduction requires five electrons, whereas each iron(II) ion supplies only one. Multiplying the iron half-reaction by five gives equal electron totals before the half-reactions are added.

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$. $Fe^{2+} \rightarrow Fe^{3+} + e^-$

Multiply the iron half-reaction by 5 so that 5 electrons cancel

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

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

Not applicable because balancing coefficients are exact

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Problem 32 Solution

Given: $V(Cr_2O_7^{2-}) = 20.00\ mL = 0.02000\ L$, $C(Cr_2O_7^{2-}) = 0.0150\ mol/L$, $V(I^-) = 50.00\ mL = 0.05000\ L$

Find: $[I^-]$

Convert dichromate volume to moles, then apply the 1:6 dichromate-to-iodide ratio

The measured dichromate amount determines the iodide amount in the original sample. Because one mole of dichromate oxidizes six moles of iodide, the titrant moles must be multiplied by six before dividing by the sample volume.

$n = C \cdot V$. $n(I^-) = 6n(Cr_2O_7^{2-})$. $C = n/V$

$n(Cr_2O_7^{2-}) = (0.0150\ mol/L)(0.02000\ L) = 3.00 \times 10^{-4}\ mol$. $n(I^-) = 6(3.00 \times 10^{-4}) = 1.80 \times 10^{-3}\ mol$. $[I^-] = (1.80 \times 10^{-3}\ mol)/(0.05000\ L) = 0.0360\ mol/L$

Final answer: $[I^-] = 0.0360\ mol/L$

The concentration 0.0150 mol/L has 3 significant figures, so the answer is reported to 3 significant figures

Problem 45 Solution

Given: Original sample volume = 5.00 mL, diluted volume = 250.0 mL, aliquot = 25.00 mL, $V(KMnO_4) = 18.60\ mL = 0.01860\ L$, $C(KMnO_4) = 0.0200\ mol/L$, $M(H_2O_2) = 34.02\ g/mol$

Find: Original H_2O_2 concentration in g/100 mL

Find moles H_2O_2 in the aliquot, scale to the full diluted flask, convert to mass, then express per 100 mL of original sample

The titration analyzes one tenth of the diluted flask, so the hydrogen peroxide amount found in the aliquot must first be scaled to the full 250.0 mL solution. That total originated from the original 5.00 mL sample and is then expressed per 100 mL.

$n(MnO_4^-) = C \cdot V$. $n(H_2O_2) = (5/2)n(MnO_4^-)$. $m = n \cdot M$. g/100 mL = mass in 5.00 mL · (100 mL/5.00 mL)

$n(MnO_4^-) = (0.0200\ mol/L)(0.01860\ L) = 3.72 \times 10^{-4}\ mol$. $n(H_2O_2)$ in aliquot $= (5/2)(3.72 \times 10^{-4}) = 9.30 \times 10^{-4}\ mol$. The full 250.0 mL diluted solution is 10 times the aliquot, so total $n = 9.30 \times 10^{-3}\ mol$. mass $= (9.30 \times 10^{-3}\ mol)(34.02\ g/mol) = 0.316\ g$ in the original 5.00 mL sample. $g/100\ mL = 0.316\ g \times 20.0 = 6.32\ g/100\ mL$

Final answer: Original H_2O_2 concentration = 6.32% m/v

The titrant concentration and original volume have 3 significant figures, so the answer is reported to 3 significant figures

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Section 4 - Answer Key

Problem	Answer
8	C: +4, -4, +4
16	$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$
32	0.0360 mol/L
45	6.32% m/v

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