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CHEMISTRY WORKSHEET

VOLTAIC (GALVANIC) CELLS

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓Anode and cathode identification ✓ Cell notation and overall cell reactions ✓ Standard reduction potentials and E°cell ✓ Electron flow and salt bridge ion movement ✓ ΔG°, K, and Nernst equation calculations ✓ Concentration cells and multi-step reasoning.

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

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Section 2 - Practice Problems

Part A - Fundamental Skills

Problem 8

In a Zn-Ag galvanic cell, state which direction anions and cations from the salt bridge move

Part B - Intermediate Applications

Problem 16

For a standard Al-Ni cell, write the balanced overall reaction and calculate $E°_{cell}$

Part C - Advanced Electrochemical Calculations

Problem 32

Determine whether the following reaction is spontaneous under standard conditions

$$Cu_{(s)} + Fe^{2+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Fe_{(s)}$$

Part D - Challenge and Mixed Practice

Problem 45

In acidic solution, $MnO_4^-{}_{(aq)}$ reacts with $Fe^{2+}_{(aq)}$. Write the balanced spontaneous redox reaction and calculate $E°_{cell}$

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Section 3 - Solutions

Problem 8 Solution

Given: In a Zn-Ag cell, zinc is oxidized and Ag^{+} is reduced.

Find: The direction in which salt-bridge anions and cations move.

At the zinc anode, neutral Zn atoms become Zn^{2+} ions, so positive charge accumulates in that half-cell. Salt-bridge anions migrate toward the anode to maintain electrical neutrality. At the silver cathode, Ag^{+} ions are removed from solution as silver metal forms. Salt-bridge cations move toward the cathode compartment to replace the positive charge being consumed.

Final answer: Anions move toward the Zn anode, and cations move toward the Ag cathode.

Problem 16 Solution

Given: $E°(Ni^{2+}/Ni) = -0.25$ V and $E°(Al^{3+}/Al) = -1.66$ V.

Find: The balanced overall reaction and $E°_{cell}$.

Nickel ions have the higher reduction potential and are reduced at the cathode. Aluminum metal is oxidized at the anode. Aluminum releases three electrons per atom, while each Ni^{2+} ion accepts two; the least common multiple is six electrons.

$2Al_{(s)} \rightarrow 2Al^{3+}_{(aq)} + 6e^{-}$

$3Ni^{2+}_{(aq)} + 6e^{-} \rightarrow 3Ni_{(s)}$

$2Al_{(s)} + 3Ni^{2+}_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3Ni_{(s)}$

$E°_{cell} = -0.25\text{ V} - (-1.66\text{ V}) = +1.41\text{ V}$

Final answer: $2Al_{(s)} + 3Ni^{2+}_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3Ni_{(s)}$; $E°_{cell} = +1.41$ V.

Problem 32 Solution

Given: $Cu_{(s)} + Fe^{2+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Fe_{(s)}$.

Find: Whether the reaction is spontaneous under standard conditions.

The reaction as written requires Fe^{2+} to be reduced and Cu metal to be oxidized. The iron reduction potential is lower than the copper reduction potential, so this direction is unfavourable.

$E°_{cell} = E°(Fe^{2+}/Fe) - E°(Cu^{2+}/Cu)$

$E°_{cell} = -0.44\text{ V} - (+0.34\text{ V})$

$E°_{cell} = -0.78\text{ V}$

A negative standard potential means that the reverse reaction, not the written reaction, is spontaneous.

Final answer: The reaction is not spontaneous as written; $E°_{cell} = -0.78$ V.

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Problem 45 Solution

Given: E°(MnO_4^-/Mn^{2+}) = +1.51 V and E°(Fe^{3+}/Fe^{2+}) = +0.77 V in acidic solution.

Find: The balanced spontaneous reaction and $E°_{cell}$.

Permanganate has the higher reduction potential and is reduced to Mn^{2+}. Fe^{2+} is oxidized to Fe^{3+}. The permanganate half-reaction consumes five electrons, so the iron oxidation half-reaction is multiplied by five.

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

$5Fe^{2+}{}_{(aq)} \rightarrow 5Fe^{3+}{}_{(aq)} + 5e^-$

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

$E°_{cell} = +1.51\ V - (+0.77\ V) = +0.74\ V$

Final answer: The balanced reaction is shown above; $E°_{cell}$ = +0.74 V.

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Section 4 - Answer Key

Problem	Answer
8	Anions → anode; cations → cathode
16	$2Al + 3Ni^{2+} \rightarrow 2Al^{3+} + 3Ni$; E° = +1.41 V
32	Not spontaneous; E° = -0.78 V
45	$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$; E° = +0.74 V

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