Name:________________________________ Date:_____________________

Redox Unit Review

Instructions & Information 📝

📢 **Time Allowed:** 45 Minutes

Equipment Permitted: Scientific Calculator, Standard Reduction Potential Table (Data Booklet)

Instructions:

1. Answer ALL questions in the spaces provided.Show full working for calculation and balancing problems to receive full credit.Write your answers clearly.

Part A: Concepts & Definitions

Select the best answer for each of the following questions regarding fundamental redox concepts.

1. **In a redox reaction, the species that acts as the reducing agent:**	a) Gains electrons and is oxidized. b) Gains electrons and is reduced. c) Loses electrons and is oxidized. d) Loses electrons and is reduced.
2. **What is the oxidation number of Chromium in the dichromate ion ($Cr_2O_7^{2-}$)?**	a) +3 b) +6 c) +7 d) +12
3. **Which of the following conditions indicates a spontaneous redox reaction under standard conditions?**	a) E°cell is negative. b) E°cell is positive. c) E°cell is zero. d) Equilibrium constant (K) is less than 1.

4. **What is the primary function of a salt bridge in a galvanic cell?**	a) To transfer electrons from the anode to the cathode. b) To provide a pathway for ions to maintain electrical neutrality. c) To act as a catalyst for the redox reaction. d) To prevent the mixing of the two electrolyte solutions physically.

Part B: Oxidation Numbers & Balancing

Determine the oxidation number of the **bolded** element in the chemical species below.

Chemical Species	**Oxidation Number**
K**Mn**O_4	
H_2**C**$_2O_4$	
NH_4^+	
OF_2	

Balance the following redox equations using the half-reaction method. **Show your work**, including the oxidation and reduction half-reactions.

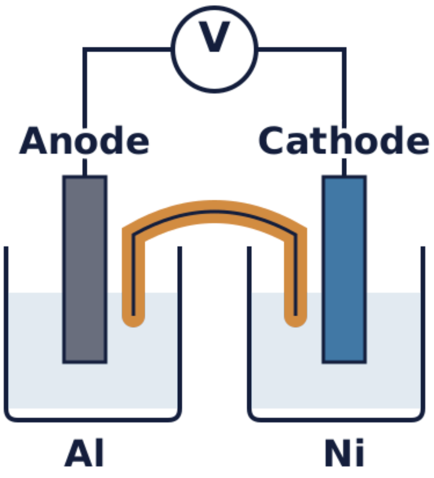
1. Balance in ACIDIC solution: $Zn(s) + NO_3^-(aq) \rightarrow Zn^{2+}(aq) + NH_4^+(aq)$

2. Balance in BASIC solution:
$MnO_4^-(aq) + SO_3^{2-}(aq) \rightarrow MnO_2(s) + SO_4^{2-}(aq)$

Part C: Electrochemical Cells 🔋

Use the standard reduction potentials provided below to analyze a galvanic cell constructed from an **Aluminum electrode in $Al(NO_3)_3$** and a **Nickel electrode in $Ni(NO_3)_2$**.

- $Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$ $E° = -1.66$ V$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$ $E° = -0.26$ V



Refer to the data above to answer the following.

1. Identify the Anode and Cathode:

Anode: ____________________

Cathode: ____________________

2. Calculate the standard cell potential (E°cell):

3. Write the standard cell notation (line notation) for this cell.

4. As the cell operates, describe the change in mass of the Nickel electrode and explain why this occurs at the molecular level.

Part D: Application & Analysis

Apply your knowledge of redox principles to answer the following questions regarding electrolytic cells and corrosion.

1. Compare Electrolysis of Molten vs. Aqueous NaCl:
When electrolyzing molten $NaCl(l)$, sodium metal is produced at the cathode. However, when electrolyzing aqueous $NaCl(aq)$ (brine), hydrogen gas is produced at the cathode instead. Explain why this difference occurs, using reduction potentials to support your answer.

2. Corrosion Prevention:

Underground iron pipes are often connected to a block of magnesium metal to prevent rusting. This is known as 'Cathodic Protection'.
A) Which metal acts as the sacrificial anode?
B) Explain how this arrangement protects the iron pipe.

Answer Key

Part A: Concepts & Definitions

Multiple Choice:
1. Loses electrons and is oxidized.
2. +6
3. E°cell is positive.
4. To provide a pathway for ions to maintain electrical neutrality.

Part B: Oxidation Numbers & Balancing

Mn: +7 | C: +3 | N: -3 | O: +2

Ox: $4(Zn \rightarrow Zn^{2+} + 2e^-)$
Red: $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$
Overall: $4Zn + NO_3^- + 10H^+ \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$

Red: $2(MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-)$
Ox: $3(SO_3^{2-} + 2OH^- \rightarrow SO_4^{2-} + H_2O + 2e^-)$
Overall: $2MnO_4^- + 3SO_3^{2-} + H_2O \rightarrow 2MnO_2 + 3SO_4^{2-} + 2OH^-$

Part C: Electrochemical Cells 🔋

Answer:
Anode: Aluminum (Al) | Cathode: Nickel (Ni)

Answer:
E°cell = E°cat - E°an = -0.26V - (-1.66V) = +1.40 V

$Al(s) \mid Al^{3+}(aq) \parallel Ni^{2+}(aq) \mid Ni(s)$

The mass of the Nickel electrode increases. Nickel ions (Ni^{2+}) from the solution gain electrons at the cathode surface and form solid Nickel (reduction), plating onto the electrode.

Part D: Application & Analysis

In aqueous solution, water is present and can be reduced. The reduction potential of water (-0.83V) is more positive (easier to reduce) than the reduction potential of Sodium ions (-2.71V). Therefore, water is preferentially reduced to form H_2 gas. In molten NaCl, no water is present, so Na^+ must be reduced.

A) Magnesium acts as the sacrificial anode.
B) Magnesium has a lower reduction potential (is more active/easily oxidized) than Iron. Therefore, the Magnesium will oxidize (corrode) preferentially, donating electrons to the Iron pipe. This keeps the Iron as the cathode, preventing it from losing electrons and oxidizing (rusting).