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Ms Kropac's Quick and Easy Electrochemistry Review

Electrochemistry: the branch of chemistry studying redox reactions

Spectator ions: an ion present that does not take part in the reaction
- Think sports spectators, they watch the game without taking part
- The spectator ion will be the SAME on BOTH sides of the equation

REDOX (Oxidation and Reaction)

- REDOX reactions are made up of two half reactions
  - OXIDATION: The loss of electrons
    - A substance undergoing oxidation is said to be oxidized, undergoes oxidation
    -
  - REDUCTION: The gain of electrons
    - A substance undergoing reduction is said to be reduced.

LEO the lion says GER
Lose electrons = Oxidation
Gain electrons = reduction

Example of half reactions

- An example of an oxidation reaction
  - $Mg \longrightarrow Mg^{2+} + 2e^-$
- An example of a reduction reaction
  -
  - $Cu^{2+} + 2e^- \longrightarrow Cu$

Identify the oxidized and reduced reagents

1) Make sure the equation is balanced
2) Write ionic equation
3) Remove spectator ions
4) Identify which regent is gaining electrons and how many
5) Identify which regent is losing electrons and how many
6) Write a therefore statement. Therefore _____ is undergoing oxidation ad being oxidized. Therefore _____ is undergoing reduction and being reduced.

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Example:

- $Zn_{(s)} + Al(NO_3)_{3\ (aq)} \longrightarrow Zn(NO_3)_{2\ (aq)} + Al_{\ (s)}$

1) Make sure equations is balanced

- $3Zn_{(s)} + 2Al(NO_3)_{3\ (aq)} \longrightarrow 3\ Zn(NO_3)_{2\ (aq)} + 2Al_{\ (s)}$

2)Write ionic equation

- $3Zn_{(s)} + 2Al_{\ (aq)}^{\ 3+} + 6NO^{1-}{}_{(aq)} \longrightarrow 3\ Zn_{\ (aq)}^{\ 2+} + 6NO3^{1-}{}_{\ (aq)} + 2Al_{\ (s)}$

3)Remove spectator ions

- $3Zn_{(s)} + 2Al_{\ (aq)}^{\ 3+} \longrightarrow 3\ Zn_{\ (aq)}^{\ 2+} + 2Al_{\ (s)}$

4)Identify which regent is gaining electrons and how many

- $3Zn_{(s)} + \underline{2Al_{\ (aq)}^{\ 3+}} \longrightarrow 3\ Zn_{\ (aq)}^{\ 2+} + \underline{2Al_{\ (s)}}$

  Aluminum gains 6 electrons

5)Identify which regent is losing electrons and how many

- $\underline{3Zn_{(s)}} + 2Al_{\ (aq)}^{\ 3+} \longrightarrow \underline{3\ Zn_{\ (aq)}^{\ 2+}} + 2Al_{\ (s)}$

  Zinc loses 6 electrons

6)Write a therefore statement. Therefore _____ is undergoing oxidation ad being oxidized. Therefore _____ is undergoing reduction and being reduced.

- Therefore zinc is undergoing oxidation ad being oxidized. Therefore aluminum is undergoing reduction and being reduced.

Determining Oxidation State

- An oxidation state is a positive or negative number assigned to a given to an atom or element that represent the extent of it's oxidation.

To find oxidation state

1) Assign the oxidation state of the atom you are trying to find as N.
2) List all other charges of the other atoms off to the side.
3) Determine the overall charge of the compound
4) Multiple the number of each type of atoms by it's charge.
5) Use algebra to solve.

Example:

Determine the charge of the underlined atom $K_2\underline{C}O_3$

1) Assign the oxidation state of the atom you are trying to find as N.

   $K_2 + N + O_3$

2) List all other charges of the other atoms off to the side.
$K_2 + N + O_3$ O=-2, K= +1
3) Determine the overall charge of the compound
$K_2 + N + O_3 = 0$
4) Multiple the number of each type of atoms by it's charge.
$2(+1) + N + 3(-2) = 0$
$2+ N - 6 = 0$
5) Use algebra to solve.
$N-4 = 0$
$N= +4$

Activity Series

The activity series is a series of metals in order from MOST reactive to LEAST reactive.

How to determine if there will be a reaction using the activity series.

In order for there to be a displacement reaction, a metal must be replaced by one that is HIGHER in the activity series.

Example:

In $Al_{(s)} + 3\ AgNO_{3(aq)}$, aluminum is found above silver in the activity series. Therefore the reaction will be $Al_{(s)} + 3\ AgNO_{3(aq)}$ ----> $Al(NO_3)_3 + 3\ Ag_{(s)}$

In $Ag_{(s)} + Zn(NO_3)_{2\ (aq)}$, zinc is above silver in the activity series, therefore no reaction will occur.

Galvanic Cells

A galvanic cell is a cell that derives electrical energy from a chemical reaction.

- It is made up of two distinct cells, and anode and a cathode.
- These cells are connected by a wire and a salt bridge
- The wire allows electrons to travel from one cell to another
- The salt bridge prevents charge build-up in the cells

A few key points to remember about galvanic cells

- The metal that is higher in the activity series is always found at the anode
- The anode is the site of oxidations
- Electrons travel from the anode to the cathode

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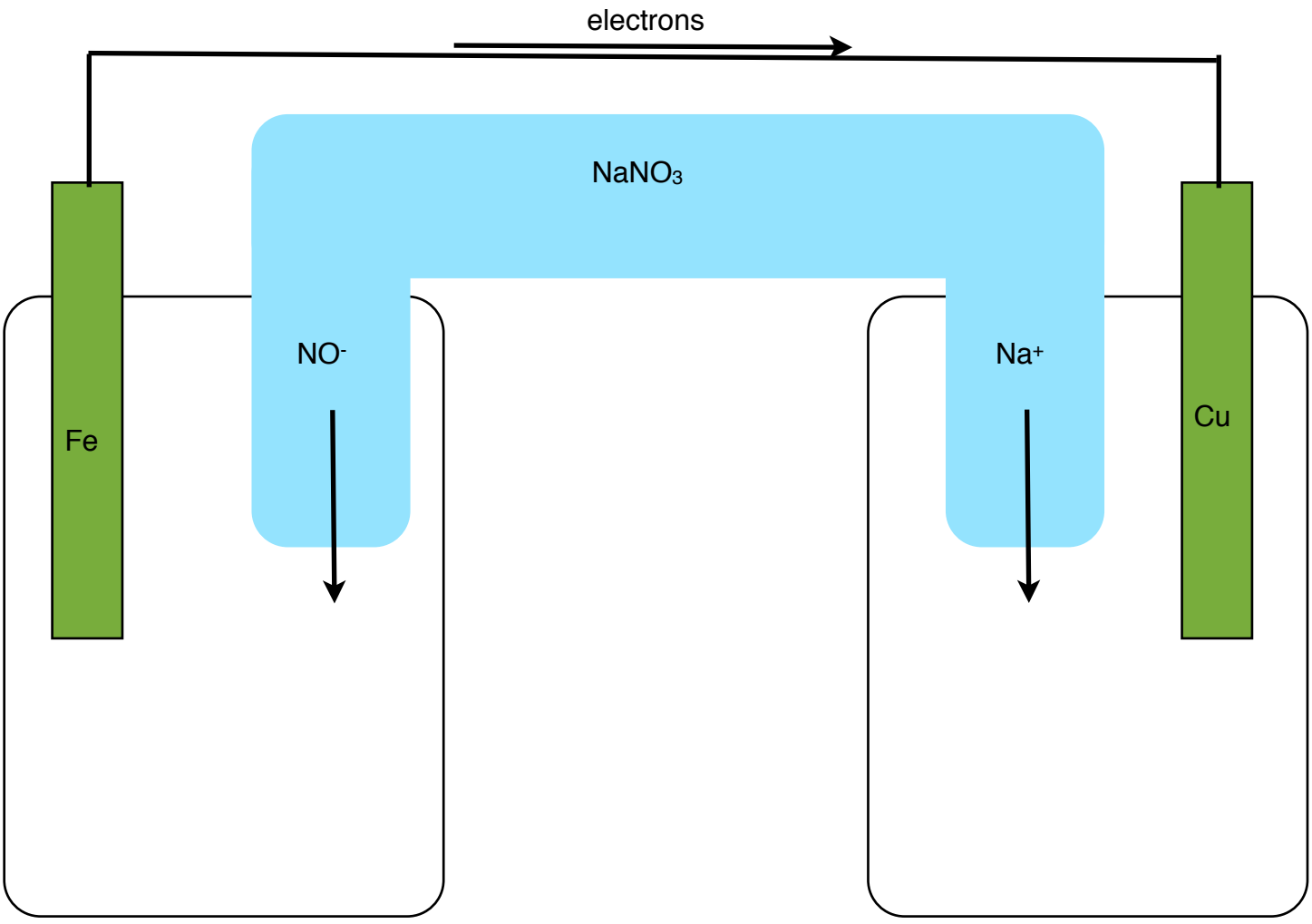
Example:

Show the following reaction on the galvanic cell diagram
$Fe_{(s)} + Cu(NO_3)_{2\,(aq)}$ -----> $Fe(NO_3)_{\,2\,(aq)} + Cu_{\,(s)}$

1) First determine which is metal will be placed at the anode (Fe)
2) Write the half reaction for the anode (oxidation) and the half reaction for the cathode (reduction)
   - A: $Fe_{(s)}$ ---> $Fe^{2+}(aq) + 2e^-$
   - C: $Cu^{2+}_{(aq)} + 2e^-$ ----> $Cu_{(s)}$
3) Show the flow of electrons.
   - From the anode to the cathode
4) Show which direction the ions in the salt bridge are flowing.
   - Positive ions flow to cathode, negative to anode.



Anode
- $Fe_{(s)}$ ---> $Fe^{2+}(aq) + 2e^-$

Cathode
- $Cu^{2+}_{(aq)} + 2e^-$ ----> $Cu_{(s)}$

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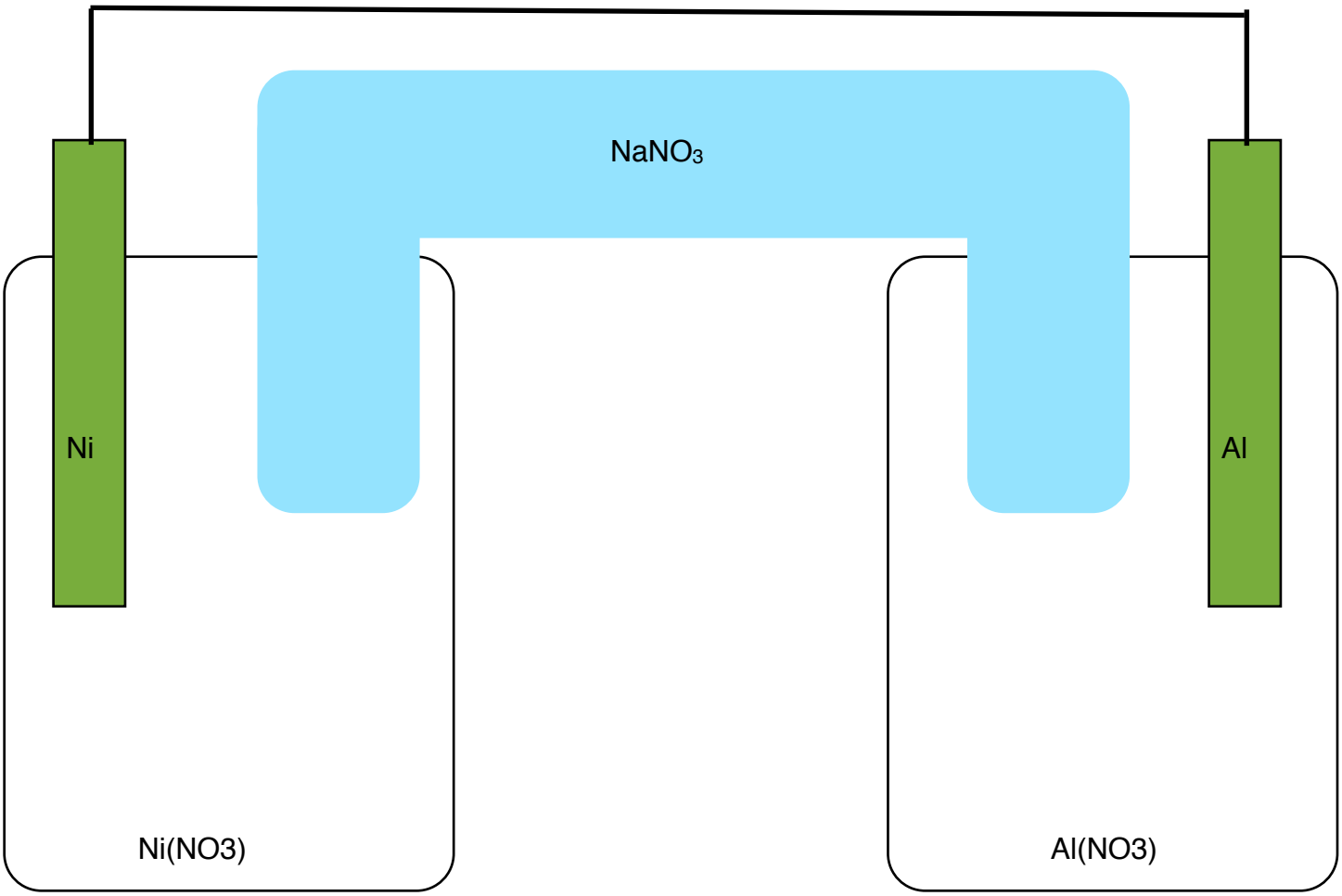

Example:
For the following digram, please:
a) Label the cathode and the anode of the cell
b) Write the chemical equation for the

Anode half reaction

Cathode half reaction

Overall cell reaction

c) Indicate the directions which electrons are flowing

d) State the direction in which the ions move:

Sodium ion , Na^+
Nitrate ions, NO_3^-

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Corrosion

Corrosion: The deterioration of a metal as a result of slow oxidation

Factors that affect the rate of corrosion
- Moisture, electrolytes, contact with a less reactive metal, mechanical stress

Ways to protect against corrosion
- Protective coatings, corrosion resistant metals, cathode protection

Extra Practice

Identify the oxidized and reduced agents

$Zn_{(s)} + CuSO_{4(aq)}$ ----> $ZnSO_{4\,(aq)} + Cu_{\,(s)}$
$Pb_{(s)} + Cu(NO_3)_{2(aq)}$ -------> $Cu_{(s)} + Pb(NO_{\,3})_{\,(aq)}$
$3CuCl_{2(aq)} + 2Al_{(s)}$ -------> $3Cu_{(s)} + 2AlCl_{3(aq)}$

Use the activity series to determine if a reaction will occur. If it does write the balanced chemical equation.

$Mg_{\,(s)\,+}\,FeCl_2$
$Ag_{\,(s)} + Cu(NO_3)_2$

Identify the oxidation states for the following

P_2O_5
$(PO_4)^{3-}$
$KMnO_4$

Draw a galvanic cell for:
$Zn(NO_3)$ & $Cu(NO_3)_2$
$Pb(NO_3)_2$ & $Ni(NO_3)_2$