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Writing and Balancing Half Reactions

Identifying if a reaction is a redox reaction

Are electrons transferred? To answer this question you'll have to write down the chemical equation for the process and assign oxidation numbers to the atoms in all of the reactants and products. If the oxidation numbers for any of the atoms in the reactants are different from the oxidation number for the same atoms on the product side, electron transfer must have occurred, and you have a redox reaction. Based on the reading passage above, write how you can tell if a reaction is a redox reaction.

You know it's redox when...	You know it's NOT redox when...
-OX # change -a single replacement reaction occurs	-ox #s dont change - double replacement reactions,

Half Reaction

- Half reaction shows the exchange of electrons in a redox reaction
- One half reaction shows oxidation; the other shows reduction

Example of a Reduction Half Reaction

- $Fe^{3+} + 3e^- \rightarrow Fe^0$ (electrons gained - are a reactant)
- Electrons on the left side, gained in the reaction

Remember!
Lose Electrons Oxidation
Gain Electrons Reduction

Example of an Oxidation Half Reaction

- $Fe^0 \rightarrow Fe^{3+} + 3e^-$ (electrons lost - are a products)
- Electrons are the right hand side, loss of electrons in the reaction
- Always add electrons to the side the reaction that has the more positive charge

Complete the Incomplete Half-Reactions – rewrite the equation and place the correct number of electrons on the appropriate side

- $I_2 \rightarrow 2I^-$ $I_2^0 + 2e^- \rightarrow 2I^-$
- $Cr^{2+} \rightarrow Cr^{3+}$ $Cr^{+2} \rightarrow Cr^{+3} + e^-$
- $Sr \rightarrow Sr^{2+}$ $Sr^0 \rightarrow Sr^{2+} + 2e^-$

Following the law of conservation

- Half reactions follow:
  - Law of conservation of mass: same number of atoms on both sides of the reaction
  - Conservation of charge: net charge must be the same on both sides of the equation (# of electrons lost = # electrons gained)

Rules for setting up half reactions

- Assign oxidation numbers

$$\overset{0}{Mg} + \overset{+2\ -1}{ZnCl_2} \rightarrow \overset{+2\ -1}{MgCl_2} + \overset{0}{Zn}$$

Mg: 0 → +2
Zn +2 → 0
Cl: -1 → -1

- Identify oxidation and reduction
  - Mg is oxidized because electrons were lost and the oxidation number increased

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- Zn is reduced because electrons were gained and the oxidation number decreased

- Write the oxidation and reduction half reactions

$Mg^0 + ZnCl_2 \rightarrow MgCl_2 + Zn$

Mg: 0 → +2 (ox)
Zn: +2 → 0 (red)
Cl: -1 → -1

- Reduction Half Reaction: $Zn^{+2} + 2e^- \rightarrow Zn^0$
- Oxidation Half Reactions: $Mg^0 \rightarrow Mg^{+2} + 2e^-$

- Balance masses (change coefficients) and balance charge – multiply each half reaction to have the same number of electrons

$Mg + ZnCl_2 \rightarrow MgCl_2 + Zn$

- Reduction: $Zn^{+2} + 2e^- \rightarrow Zn^0$
- Oxidation: $Mg^0 \rightarrow Mg^{+2} + 2e^-$

} everything is already balanced.

Practice: For each reaction, write the oxidation and reduction half reactions. Then balance out the equations.

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$Li + Ca^{+2} \rightarrow Li^{+1} + Ca$ Li: 0 → +1, Ca: +2 → 0

Red: $Ca^{+2} + 2e^- \rightarrow Ca^0$

Ox: $Li^0 \rightarrow Li^{+1} + e^-$

Balance ox rxn $(Li^0 \rightarrow Li^{+1} + e^-)\,2$

$2Li^0 \rightarrow 2Li^{+1} + 2e^-$

combined: $2Li + Ca^{+2} \rightarrow 2Li^+ + Ca$

$Mn + Cu^{+2} \rightarrow Mn^{+4} + Cu$ Mn: 0 → +4, Cu: +2 → 0

Red: $Cu^{+2} + 2e^- \rightarrow Cu^0$

Ox: $Mn^0 \rightarrow Mn^{+4} + 4e^-$

Balance $(Cu^{2+} + 2e^- \rightarrow Cu^0)\,2$

$\hookrightarrow 2Cu^{2+} + 4e^- \rightarrow 2Cu^0$

Combined: $Mn^0 + 2Cu^{+2} \rightarrow Mn^{+4} + 2Cu$

$Ni + Fe^{+3} \rightarrow Ni^{+3} + Fe$ Ni: 0 → +3, Fe: +3 → 0

Red: $Fe^{+3} + 3e^- \rightarrow Fe^0$

Ox: $Ni^0 \rightarrow Ni^{3+} + 3e^-$

Balance?: - Not needed

Combined $Fe^{+3} + Ni^0 \rightarrow Ni^{+3} + Fe$

$Zn + Cr^{3+} \rightarrow Zn^{2+} + Cr$ Zn: 0 → +2, Cr: +3 → 0

Red: $Cr^{+3} + 3e^- \rightarrow Cr^0$

Ox: $Zn^0 \rightarrow Zn^{+2} + 2e^-$

Balance: $2(Cr^{+3} + 3e^- \rightarrow Cr^0) = 2Cr^{+3} + 6e^- \rightarrow 2Cr^0$

$3(Zn^0 \rightarrow Zn^{+2} + 2e^-) = 3Zn^0 \rightarrow 3Zn^{+2} + 6e^-$

Combine: $3Zn^0 + 2Cr^{+3} \rightarrow 3Zn^{+2} + 2Cr^0$