Reaction Types: Precipitation & Redox

Academic Boot Camp

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Reading

Silberberg: §4.1, 4.3, 4.5.

Overview

- _____
  - Formation of solid
- _____
  - Transfer of electrons
- Acid-Base
  - Arrhenius
  - Bronsted-Lowry
  - Lewis

Review: Solutions

- Solutions:
  - Solute: what dissolves in solvent
  - Solvent: what makes the solute dissolve

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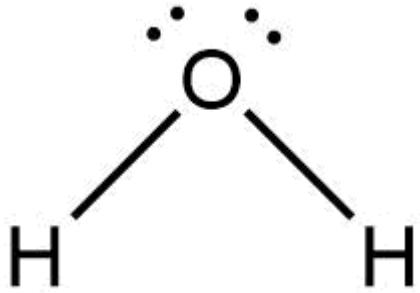
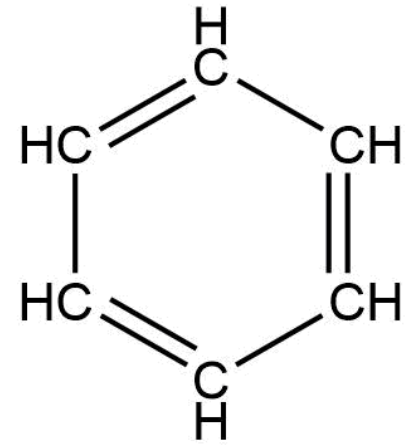
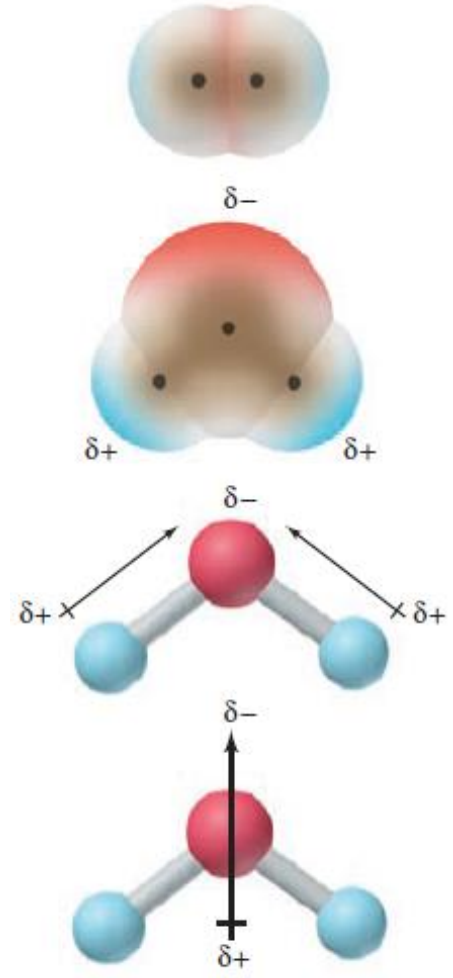
Precipitation Reactions: Solvent

- Substance in which chemicals dissolve
- Water => "aqueous" (aq)
  - Polar compound
- Benzene => "organic"
  - Or nonpolar compounds like it







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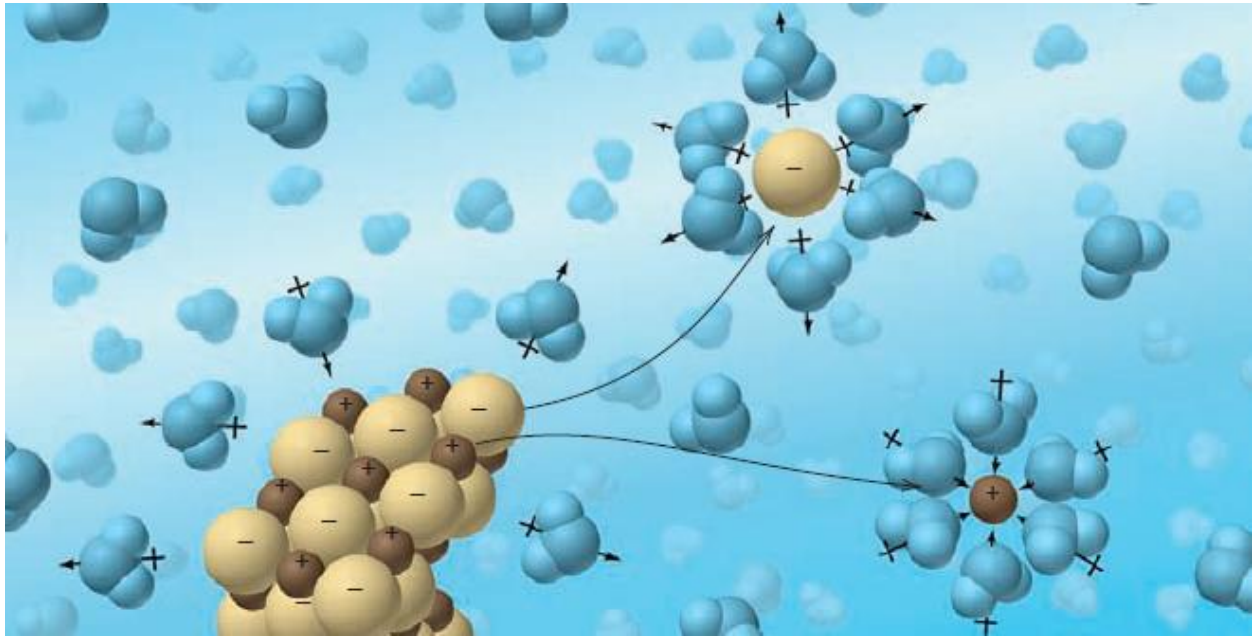
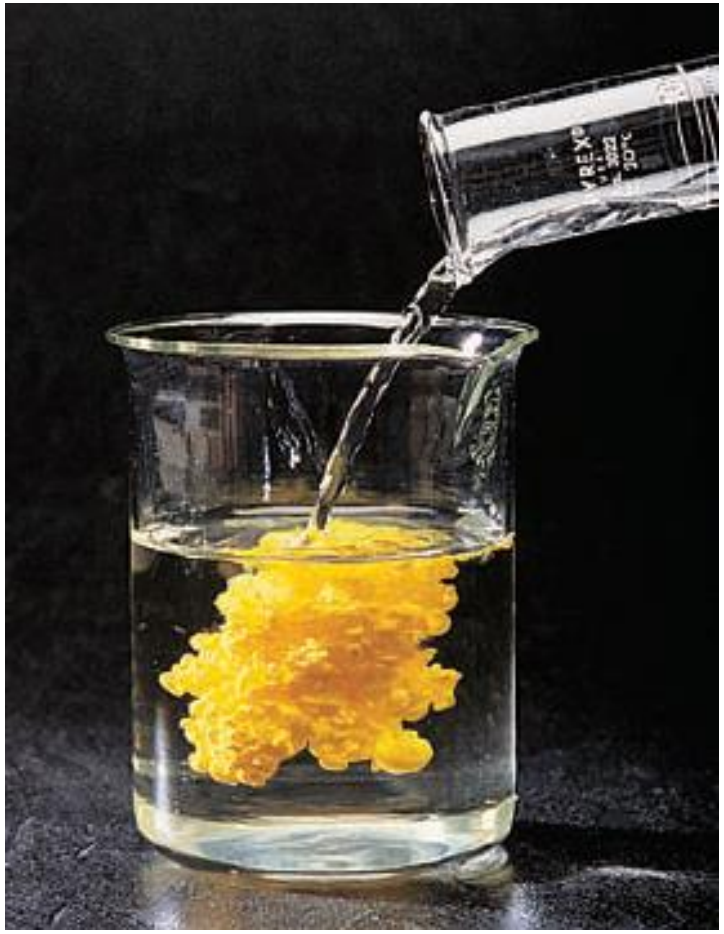
Precipitation Reactions: Solubility

- Substance in which chemicals dissolve
- Water => "aqueous" (aq)
  - Polar compound
- Polarity causes molecular orientation
- Ability to dissolve in water dependent on strength of ionic bond
  - Solubility



Precipitation Reactions

- "_____" compounds:
  - Dissolve in water
- "_____" compounds:
  - Do not dissolve in water
- Precipitation reactions:
  - Reactions between soluble compounds which form an insoluble product



$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$$

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Precipitation Reactions

Table 4.1 Solubility Rules for Ionic Compounds in Water

Soluble Ionic Compounds

1. All common compounds of Group 1A(1) ions (Li^+, Na^+, K^+, etc.) and ammonium ion (NH_4^+) are soluble.
2. All common nitrates (NO_3^-), acetates (CH_3COO^- or $C_2H_3O_2^-$), and most perchlorates (ClO_4^-) are soluble.
3. All common chlorides (Cl^-), bromides (Br^-), and iodides (I^-) are soluble, *except* those of Ag^+, Pb^{2+}, Cu^+, and Hg_2^{2+}. All common fluorides (F^-) are soluble, *except* those of Pb^{2+} and Group 2A(2).
4. All common sulfates (SO_4^{2-}) are soluble, *except* those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, and Pb^{2+}.

Insoluble Ionic Compounds

1. All common metal hydroxides are insoluble, *except* those of Group 1A(1) and the larger members of Group 2A(2) (beginning with Ca^{2+}).
2. All common carbonates (CO_3^{2-}) and phosphates (PO_4^{3-}) are insoluble, *except* those of Group 1A(1) and NH_4^+.
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Precipitation Reactions

- Given a reaction, consult solubility rules table
- If all compounds/ions involved are soluble, no precipitation occurs

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Precipitation Reactions: Example

- Given $Sr(NO_3)_{2(aq)} + 2KF_{(aq)} \rightarrow SrF_{2(s)} + 2KNO_{3(aq)}$

- Does precipitation occur?

Table 4.1 Solubility Rules for Ionic Compounds in Water

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(Net) Ionic Equations

- Total ionic equation: $Sr^{2+} + 2F^- + K^+ + 2NO_3^- \rightarrow SrF_2 + 2K^+ + 2NO_3^-$
- Net ionic equation: $Sr^{2+} + 2F^- \rightarrow SrF_2$

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Precipitation Reactions: Prediction

- Given $Sr(NO_3)_{2(aq)} + 2KF_{(aq)} \rightarrow ?$

- Does reaction occur? Does precipitation occur?

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Oxidation States

- Oxidation state (or oxidation number):
  - Number of electrons an atom would have (relative to ground state) if electrons were NOT shared in compound => *opposite of formal charge in this sense*

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- For ionic compound, O.N. is just charge on ion

- For covalent compound, O.N. is what charge on atom would be if it was ionic

Oxidation States

- Oxidation state (or oxidation number):
  - Number of electrons an atom would have (relative to ground state) if electrons were NOT shared in compound
- Rules in text: Table 4.3, p. 160
- Use context clues
  - _____
  - _____
- Use periodic table for prediction

Table 4.3 Rules for Assigning an Oxidation Number (O.N.)

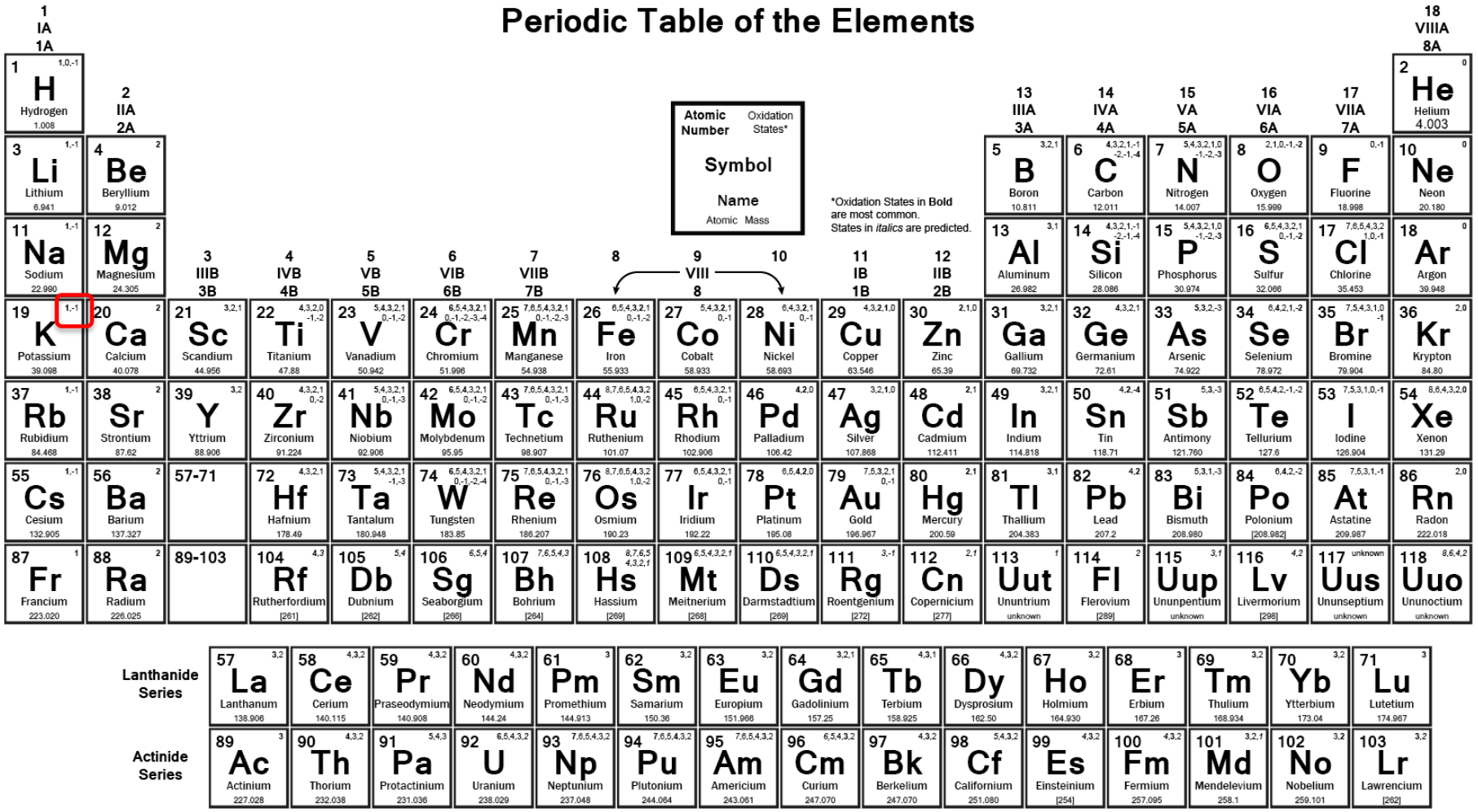
General Rules

1. For an atom in its elemental form (Na, O_2, Cl_2, etc.): O.N. = 0
2. For a monatomic ion: O.N. = ion charge
3. The sum of O.N. values for the atoms in a molecule or formula unit of a compound equals zero. The sum of O.N. values for the atoms in a polyatomic ion equals the ion's charge.

Rules for Specific Atoms or Periodic Table Groups

1.	For Group 1A(1):	O.N. = +1 in all compounds
2.	For Group 2A(2):	O.N. = +2 in all compounds
3.	For hydrogen:	O.N. = +1 in combination with nonmetals
		O.N. = −1 in combination with metals and boron
4.	For fluorine:	O.N. = −1 in all compounds
5.	For oxygen:	O.N. = −1 in peroxides
		O.N. = −2 in all other compounds (except with F)
6.	For Group 7A(17):	O.N. = −1 in combination with metals, nonmetals (except O), and other halogens lower in the group

Oxidation States



Oxidation States

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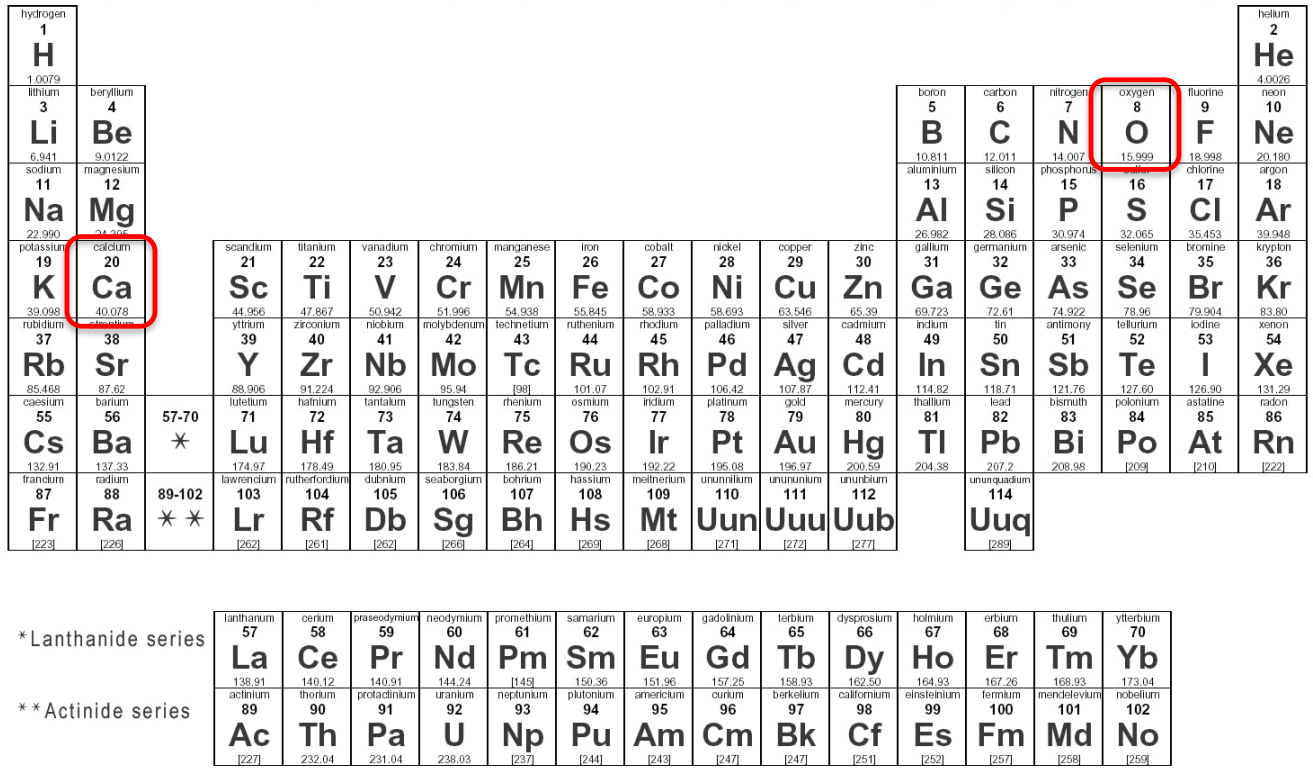
- Example: CaO

- Ca:
  - Valence electrons: 2

- O:
  - Valence electrons: 6



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Oxidation States

- Oxidation state (or oxidation number):
  - Number of electrons an atom would have (relative to ground state) if electrons were NOT shared in compound
- Example: CaO
  - Assuming electrons are not shared:
    - $EN_{Ca} < EN_{O}$
- Ca:
  - Valence electrons: 2
- Ca:
  - Valence electrons: 0
  - Ca oxidation state: +2
- O:
  - Valence electrons: 6
- O:
  - Valence electrons: 8
  - O oxidation state: -2

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Precipitation Reactions: Prediction

- Given $Sr(NO_3)_2 + 2KF \rightarrow SrF_2 + 2KNO_3$
- Does reaction occur? Does precipitation occur?
- List of ions:
  - Sr^{+2}, NO_3^{-1}, K^{+1}, F^{-1}
- _____

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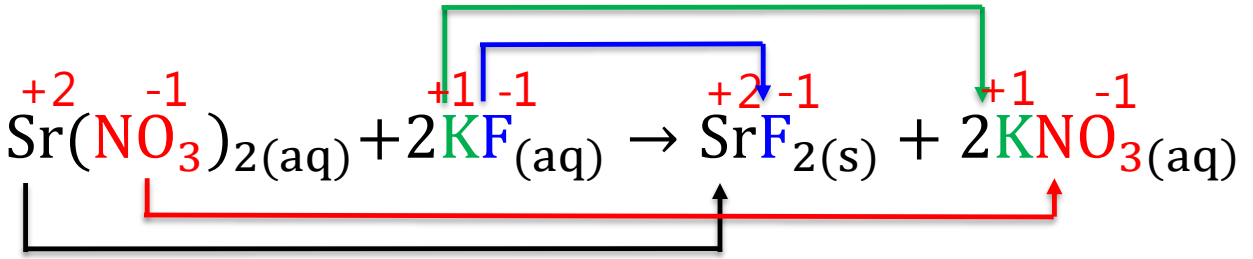
Redox Reactions

$$Sr^{2+} + 2F^- + K^+ + 2NO_3^- \rightarrow SrF_2 + 2K^+ + 2NO_3^-$$

- A reaction caused by the transfer of electrons to and from atoms
- Oxidation state of at least 1 atom changes

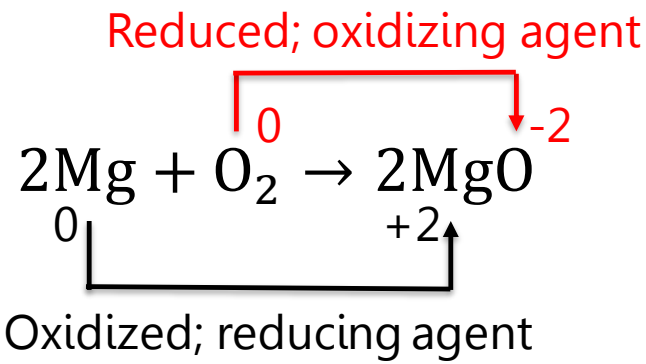
Redox Reactions



- A reaction caused by the transfer of electrons to and from atoms
- Oxidation state of at least 1 atom changes
- Above is NOT a redox reaction… no oxidation states change

Redox Reactions

- "Redox" is short for "Reduction-Oxidation" reactions
- _____: gaining electrons
  - "Reducing agent" reduces another atom. The agent itself is oxidized
- _____: losing electrons
  - "Oxidizing agent" oxidizes another atom. The agent itself is reduced
- Example:



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Reaction Examples

1. $$2Al_{(s)} + 3H_2SO_{4(aq)} \rightarrow Al_2(SO_4)_{3(aq)} + 3H_{2(g)}$$

2. $$Ba(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaNO_{3(aq)}$$

3. $$\frac{1}{2}O_{2(g)} + 2e^- \rightarrow O_{(g)}$$

4. $$PbO_{(s)} + CO_{(g)} \rightarrow Pb_{(s)} + CO_{2(g)}$$

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Questions?

- Next time:
  - Reaction types:
    - Review
    - Acid-base
- Homework #3:
  - *Due Wednesday, July 27*