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Teach Yourself DAT Organic Chemistry in 24 Hours

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DAT Organic Chemistry

Organic Compounds

Organic Chemistry DAT Series

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Russell Dahl, PhD
Kevin Stewart, PhD
Jennifer Green, PhD

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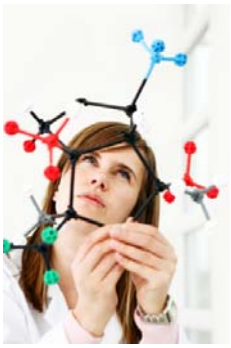
Learning Objectives

By completing this tutorial, you will learn about:



- The Chemistry of Carbon and the Language of Organic Chemistry.
- Functional Groups.
- Acids and Bases.
- Electrons and Mechanisms.
- Resonance and Delocalization.

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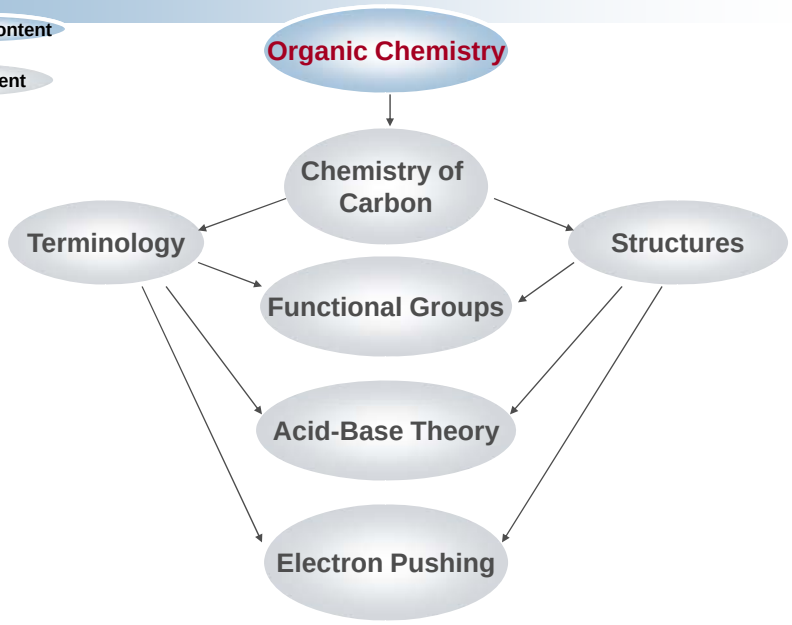
Concept Map – Organic Chemistry

Previous content

New content



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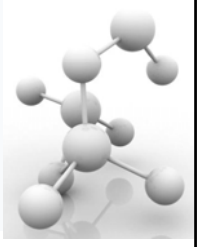
Organic Chemistry



1. The Chemistry of Carbon
2. Language of Organic Chemistry

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Chemistry of Carbon

The Importance of Organic Chemistry

- Carbon is the basis for all living things.
- Organic chemistry is the chemistry of carbon compounds.
- Organic compounds are used for food, medicine, fuel, plastics, and clothing.
- Organic chemists synthesize medicines, medical implants, plastics, paints, fibers, and many other items.
- The study of organic chemistry allows a student to understand these chemical processes with the goal of improving them and developing new products.

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Language of Organic Chemistry

Terminology

- Learn the proper vocabulary.
- Know the proper abbreviations.

Proper Structures

- Learn how to draw structures correctly.
- Know the number of bonds per atom (C has 4 bonds, N and P have 3 bonds, O and S have 2 bonds, and H, F, Cl, Br, and I have 1 bond).

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Organic Chemistry Summary

Carbon is the basis for all living things.

Organic chemistry is the chemistry of carbon compounds.

Organic compounds are used for food, medicine, fuel, plastics, and clothing.

Learn the proper vocabulary and abbreviations.

Learn how to draw structures correctly.

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Functional Groups

1. **Alkane, Alkene, Alkyne, Aromatic**
2. **Alkyl Halide, Alcohol, Ether, Thiol, Sulfide**
3. **Aldehyde, Ketone, Acid Halide**
4. **Carboxylic Acid, Ester, Anhydride**
5. **Amine, Amide, Nitrile**

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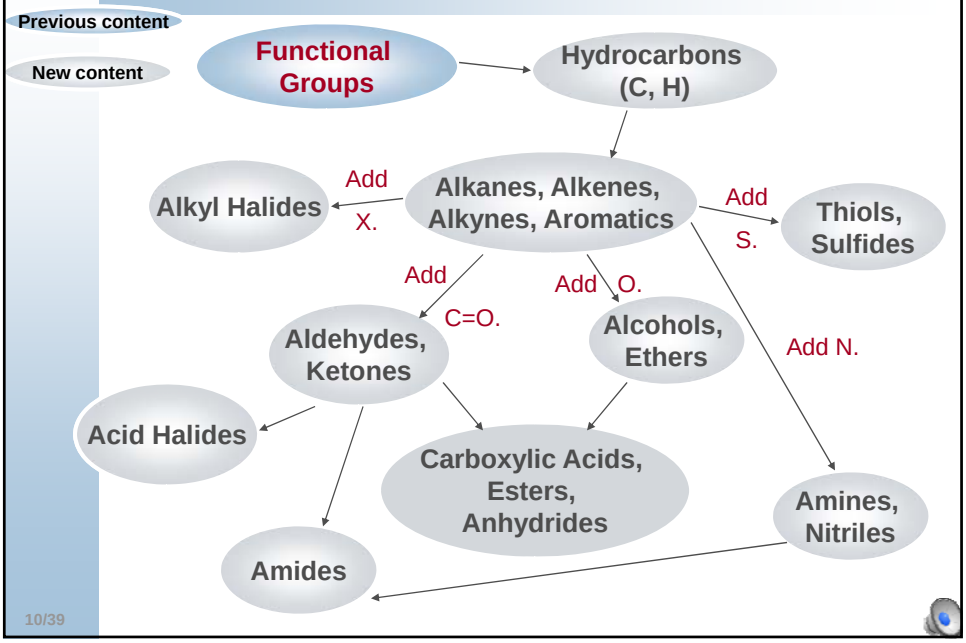
Concept Map – Functional Groups



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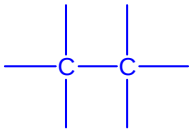
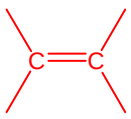
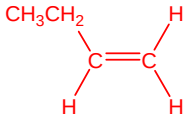
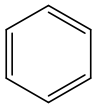
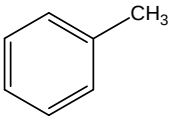
Functional Groups - 1

Hydrocarbons

Alkane  $CH_3CH_2CH_2CH_3$

Alkene  

Alkyne  

Aromatic  

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Functional Groups - 2

R = Alkyl group; X = F, Cl, Br, or I.

Alkyl Halide R—X $CH_3CH_2CH_2CH_2Br$

Alcohol R—OH $CH_3CH_2CH_2CH_2OH$

Ether R—O—R $CH_3CH_2OCH_2CH_3$

Thiol R—SH $CH_3CH_2CH_2CH_2SH$

Sulfide R—S—R $CH_3CH_2SCH_2CH_3$

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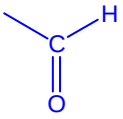
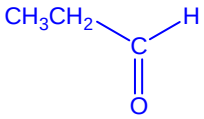
Functional Groups - 3

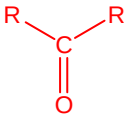
Compounds with C=O

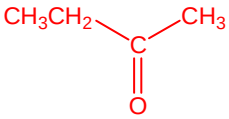
Aldehyde



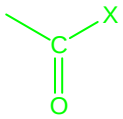


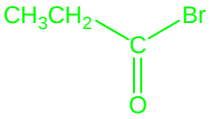
Ketone





Acid halide





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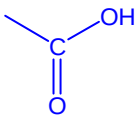
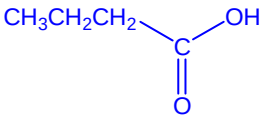
Functional Groups - 4

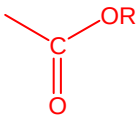
Compounds with O=C-O

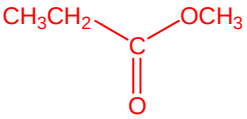
Carboxylic acid



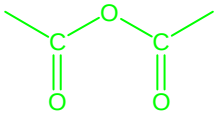


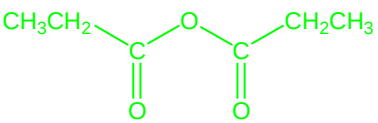
Ester





Anhydride





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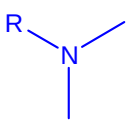
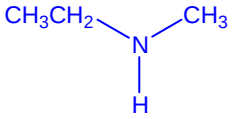
Functional Groups - 5

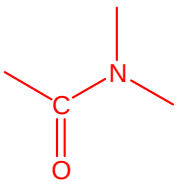
Compounds with N

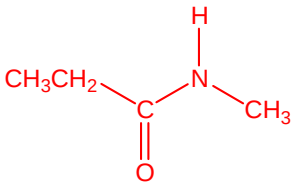
Amine



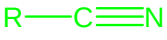


Amide





Nitrile



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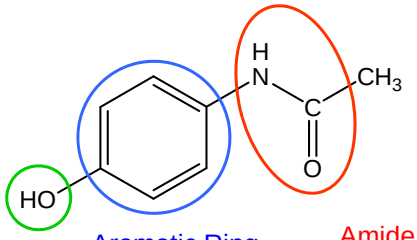
Functional Group Problem - 1

Circle the functional groups and name them.



Alcohol (contains OH)

Aromatic Ring (a ring, alternating single and double bonds)

Amide (N attached to C=O)

Acetaminophen (Active Ingredient in Tylenol™)

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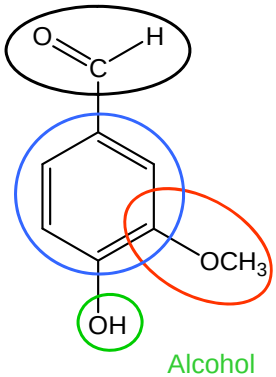
Functional Group Problem - 2

Circle the functional groups and name them.



Aldehyde
(contains H next to C=O)

Aromatic Ring
(a ring, alternating single and double bonds)

Ether
(ROR)

Alcohol
(ROH)

Vanillin

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Functional Groups Summary - 1

Definitions:

An alkane contains carbon-carbon single bonds.

An alkene contains a carbon-carbon double bond.

An alkyne contains a carbon-carbon triple bond.

An aromatic compound contains a ring with alternating double and single bonds.

R is an abbreviation for an alkyl group.

X is an abbreviation for the halogens: fluorine, chlorine, bromine, and iodine.

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Functional Groups Summary - 2

Definitions:

An **alkyl halide** (haloalkane, RX) contains an alkyl group (R) and a halogen (X).

An **alcohol** consists of a R and an OH (ROH).

An **ether** contains an O, with an R on both sides (ROR).

A **thiol** contains a S, with a R on one side and a H on the other side of the S (RSH).

A **sulfide** has a S with R groups on both sides (RSR).

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Functional Groups Summary - 3

Definitions:

An **aldehyde** contains a H attached to the C of a C=O [-(C=O)H]. H or R is on the other side.

A **ketone** contains two R groups attached to the C of the C=O [R(C=O)R].

An **acid halide** contains a X attached to the C of a C=O [R(C=O)X]. A H or R is attached on the other side.

A **carboxylic acid** contains a C=O with a H or R on one side and an OH attached to the C of the C=O [-(C=O)OH].

An **ester** has a H or R on one side and an OR attached to the C of the C=O [-(C=O)OR].

An **anhydride** contains two C=O groups separated by an O [-(C=O)O(C=O)-]. R or H is attached to the C of the C=O.

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Functional Groups Summary - 4

Definitions:

Amines contain a N bonded to three other R or H (NH_3, NRH_2, NR_2H, or NR_3).

Amides have a N attached to a C of the C=O [-(C=O)NH-, -(C=O)NR-]. The other positions are H or R.

A **nitrile** has an R attached to a C that is triple bonded to a N (RCN).

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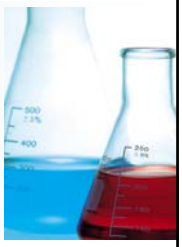
Acids and Bases



1. Arrenhius
2. Bronsted-Lowry
3. Lewis

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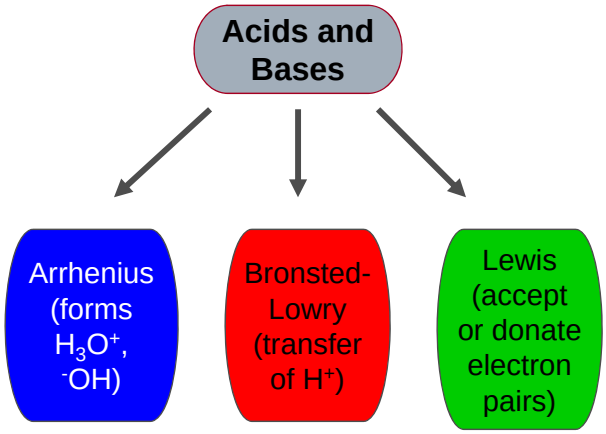
Acids and Bases



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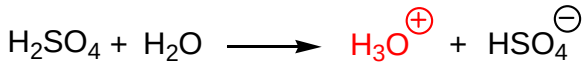
Arrhenius Acids and Bases

Arrhenius Acid

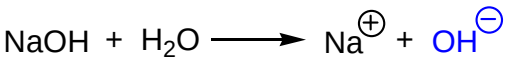
- Substance that dissociates to give H_3O^+ (hydronium ion).

Arrhenius Base

- Substance that dissociates to give ^-OH (hydroxide ion).



Arrhenius Acid



Arrhenius base

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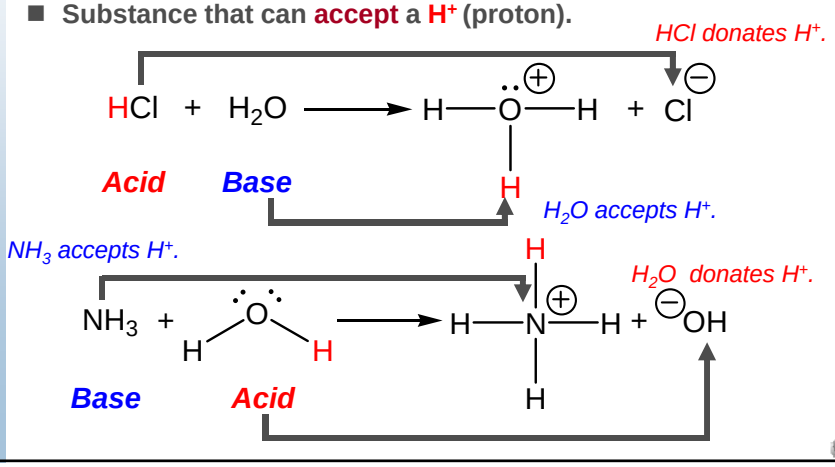
Bronsted-Lowry Acids and Bases

Bronsted-Lowry Acid

- Substance that can **donate** a **H^+** (proton).

Bronsted-Lowry Base

- Substance that can **accept** a **H^+** (proton).



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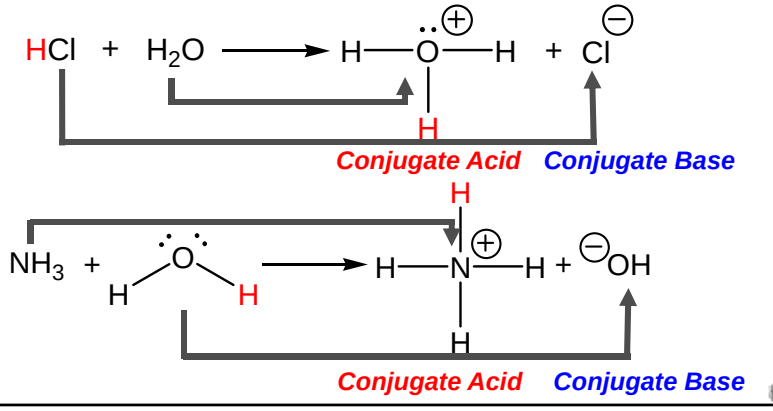
Bronsted-Lowry Conjugate Acids & Bases

Conjugate Acid

- The acid that results from the Bronsted-Lowry base gaining a H^+.

Conjugate Base

- The base that results from the Bronsted-Lowry acid losing a H^+.



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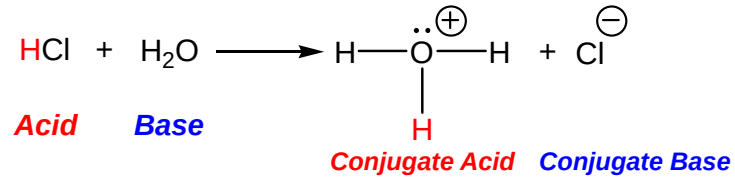
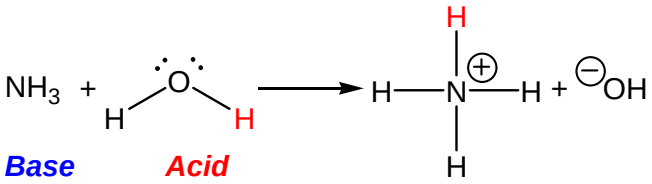
Amphoteric Compounds

Amphoteric Compound

- A compound that can act as an acid or a base.
- Water is reacting as an acid or base in the following examples.





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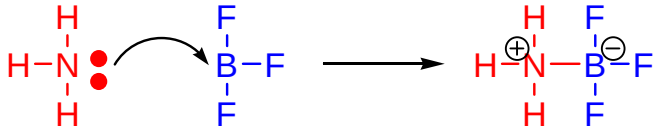
Lewis Acids and Bases

Lewis Acid

- Substance that can accept electron pairs to form new bonds.

Lewis Base

- Substance that can donate electron pairs to form new bonds.



Lewis Base Lewis Acid

NH_3 donates an electron pair to BF_3.

BF_3 accepts an electron pair from NH_3.

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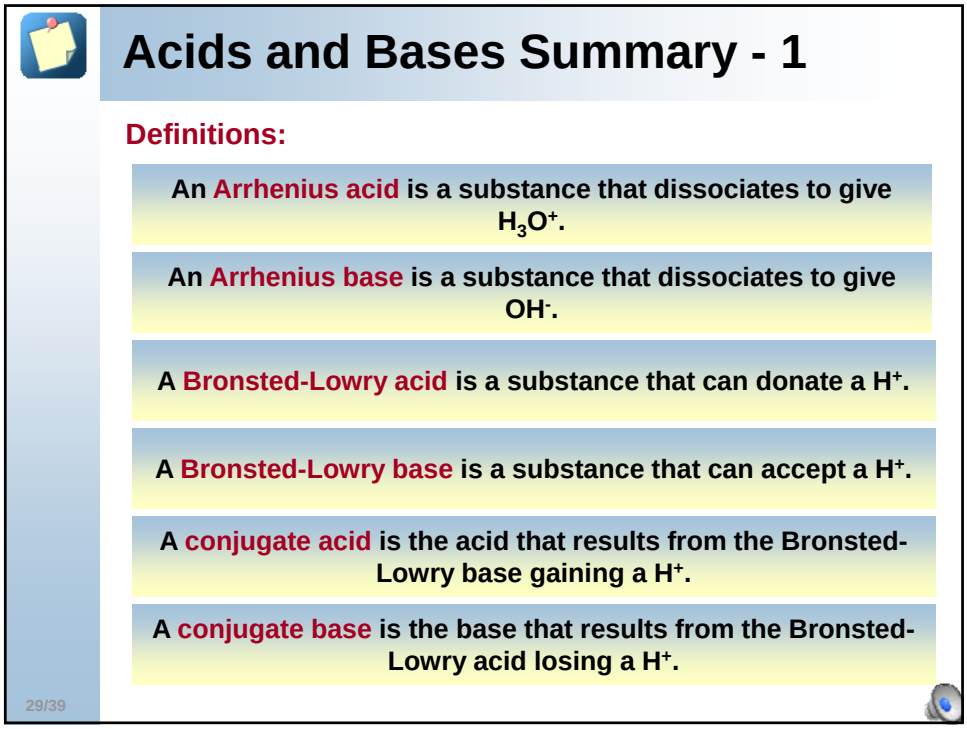

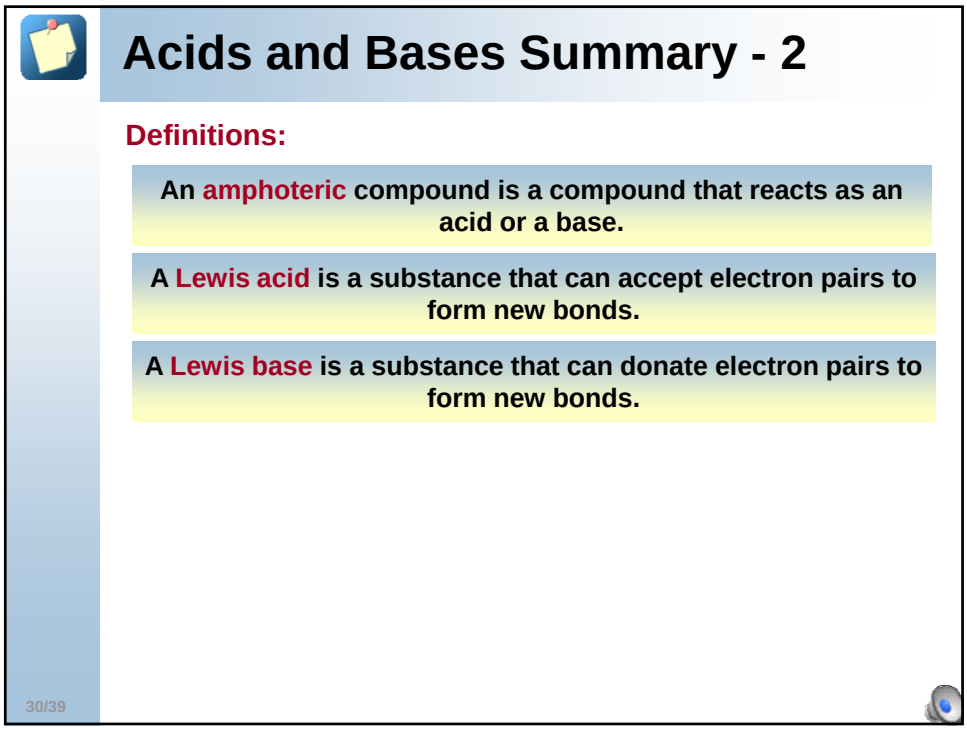

Electron Pushing

1. Electrons and Mechanisms
2. Resonance and Delocalization

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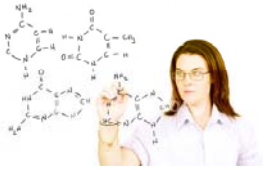
Electrons and Mechanisms - 1

Basic Rules for Drawing Mechanisms



- Identify the **most electronegative** atom and the **least electronegative** atom in a bond.
- Locate the **electrons** on the **more electronegative** atom.
- A **mechanism** is a **step-by-step explanation** of what happens in a chemical reaction.
- The **flow of electrons** in a mechanism is **from** the **most electronegative** atom **to** the **least electronegative** atom.

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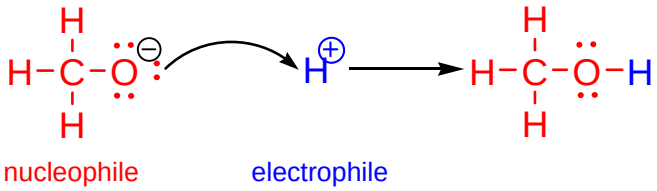
Electrons and Mechanisms - 2

Basic Rules for Drawing Mechanisms

- The **nucleophile** donates the electrons in a mechanism.
- The **electrophile** accepts the electrons in a mechanism.



nucleophile electrophile

- The **O** is the most electronegative.
- The **H^+** is the least electronegative.
- **CH_3O^-** is the **nucleophile**.
- **H^+** is the **electrophile**.

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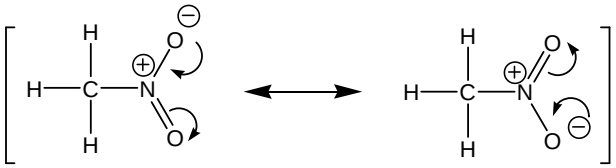
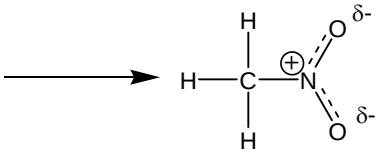
Resonance and Delocalization

Important Definitions from Resonance Theory:

- **Resonance structures** are two or more equivalent structures for the same molecule, the only difference is the location of the electrons.
- **Delocalization** of electrons occurs when electrons are distributed among more than two atoms in a molecule.



resonance structures



resonance hybrid

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Electron Pushing Summary - 1

Definitions:

Locate the **electrons** on the more electronegative atoms.

Identify the most **electronegative** atom and the least electronegative atom in a bond.

A **mechanism** is a step-by-step explanation of what happens in a chemical reaction.

The flow of electrons in a mechanism is from the most electronegative atom to the least electronegative atom.

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Electron Pushing Summary - 2

Definitions:

The **nucleophile** donates the electrons in a mechanism.

The **electrophile** accepts the electrons in a mechanism.

Resonance structures are equivalent structures for the same molecule, the only difference is the electrons.

Delocalization of electrons occurs when electrons are distributed among more than two atoms in a molecule.

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