Acids and Bases
3 – Acid Base Reactions

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Acids and Bases

Here again are the definitions for acids and bases

- **Arrhenius Acids and Bases** – acids give protons and bases give hydroxide.
- **Bronsted Lowry Acids and Bases** – acids give protons and bases accept protons.
- **Lewis Acids and Bases** – acids accept a pair of electrons and bases give a pair of electrons.

For acids and bases there is a pK_a scale to help determine if reactions will take place; there is no pK_a scale for Lewis acids and bases. Their effectiveness can be determined by how well they donate or accept electrons.

When and why does an acid base reaction occur? When correct starting materials are present. Acid base reactions occur when the products are weaker conjugate acids and bases.

Examples of Acid Base Reactions

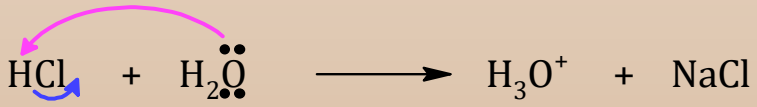
The reactions below are for common inorganic acids. These reactions are written to identify the acid and base and write the products formed. It is important to identify the acidic proton in the acid. Identify the high electron density in the base which will pick up the proton.

Below are the just the basic reactions. We will learn to write the mechanism of these reactions.

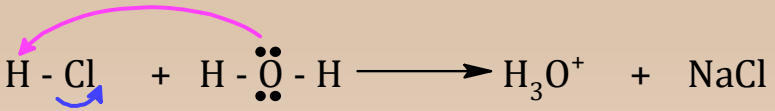
Mechanism of Acid Base Reactions

Here is the mechanism to show electron transfer, which is also showing the bond formation and bond breaking. All arrows are curved arrows. I have color coded them to help you understand the mechanism. The main arrow is the pink arrow (1st arrow) is from the base (high electron density) picking up a proton from the acid. A new bond is formed with this arrow. The blue arrow (2nd arrow) shows the electrons moving from the bond between the proton and another atom and shows bond breakage. (Sometimes we skip the blue arrow, although I would recommend that you draw it).

I am writing two reactions – 1st one not showing the bonds while the 2nd one showing all the covalent bonds in the reactants. You can do either way provided your arrows are going in the right direction and to the right atom.

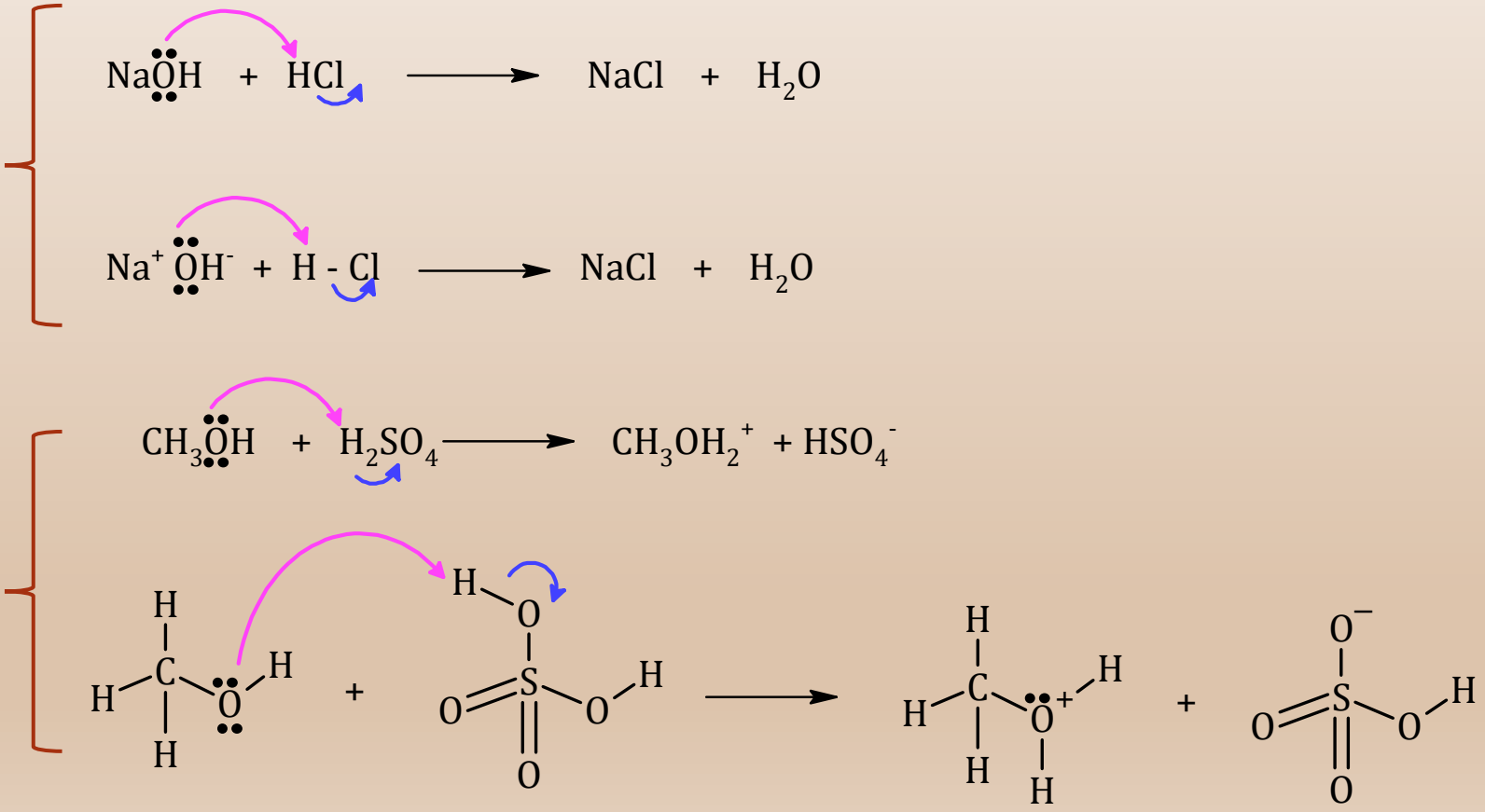


Acid Base



Mechanism of Acid Base Reactions – contd. 2

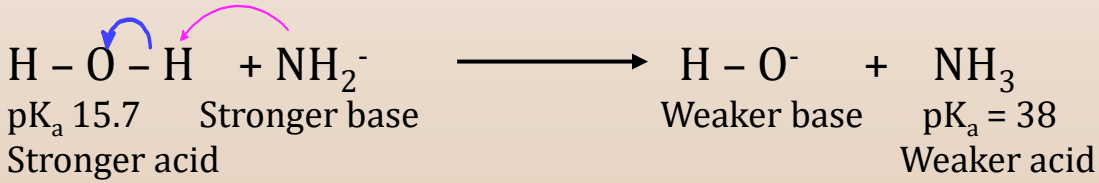
Here are the other two reactions with mechanisms: first written as condensed structures and 2nd with molecules showing the bonds.(*I have not drawn the lone pair of electrons on the acid as they are not participating in the reaction*).



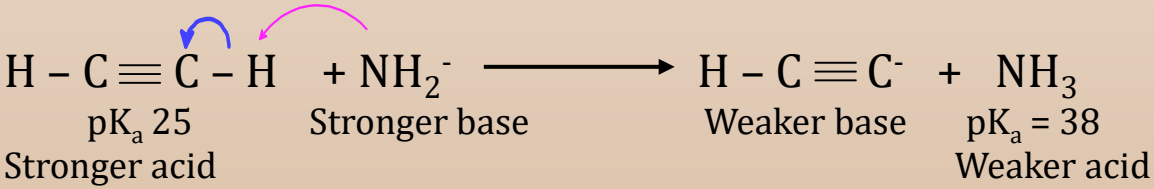
Why Acid-Base Reactions Occur

Acid base reactions occur only when the products forming are weaker acids and bases. Here I have added the pK_a to show that products are weaker acids and bases.

- Any base stronger than hydroxide will be converted to hydroxide in water.



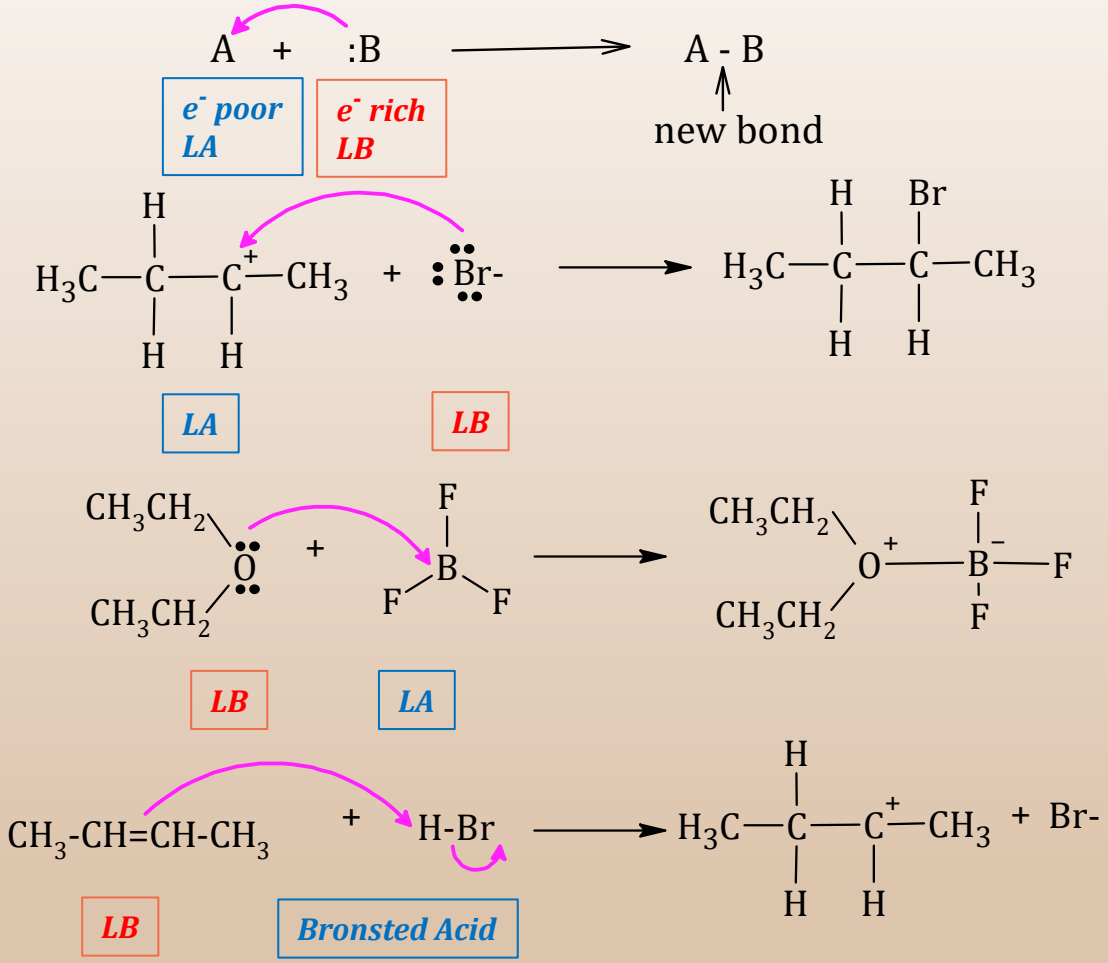
- Sodium amide can be used as a strong base in solvents such as liquid NH_3.



- Alkyl lithium reagents in hexane are very strong bases.

Examples of Lewis Acid Base Reactions

- For writing any acid base reactions look for electron poor (Lewis Acids) and electron rich (Lewis Base) sites.
- Electron poor sites are cations and/or incomplete valence shell.
- Electron rich sites are anions, lone pair of electrons, double and triple bonds.
- *NOTE: all the arrows indicate an electron pair is being transferred.*



Solved Problem: Predicting Acid-Base Problems

Predict the products, if any, for the following acid base reactions.

ANSWER

a) $CH_3COOH + KOH \longrightarrow$

$CH_3COO\mathbf{H} + K\mathbf{OH} \longrightarrow CH_3COO\text{-}K^+ + \mathbf{HOH}$

b) $CH_3CH_2CH{=}CH_2 + H_2O \longrightarrow$

$CH_3CH_2CH{=}CH_2 + H_2O$ *NO REACTION*

c) $CH \equiv CH + NaH \longrightarrow$

$CH \equiv C\mathbf{H} + Na\mathbf{H} \longrightarrow CH \equiv C^-Na^+ + \mathbf{HH}\ (H_2)$

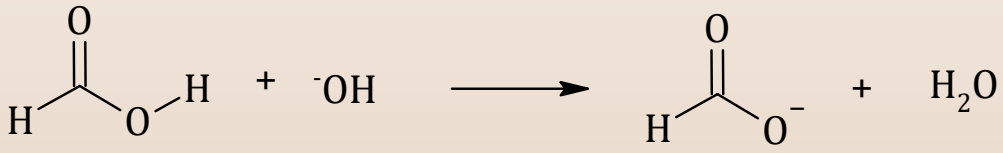
d) $CH_3CH_2OH + CH_3O^- \longrightarrow$

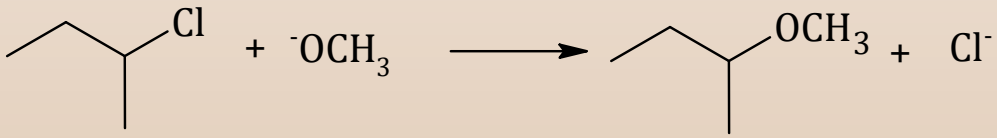
$CH_3CH_2O\mathbf{H} + CH_3\mathbf{O}^- \longrightarrow CH_3CH_2O^- + CH_3\mathbf{OH}$

Solved Problem: Writing Arrows in Acid-Base Equations

Complete the following acid base equations with arrows for the first two and arrows and products for the next two.

Start by looking for the acidic proton (acid) and electrons (base). For Lewis acid look for electron deficiency.

a) 

b) 

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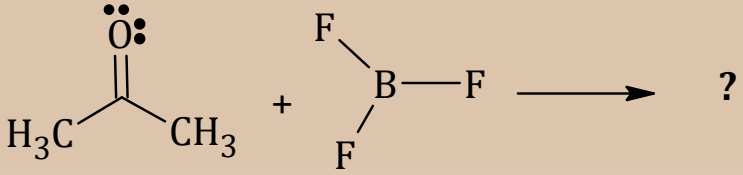
d) 

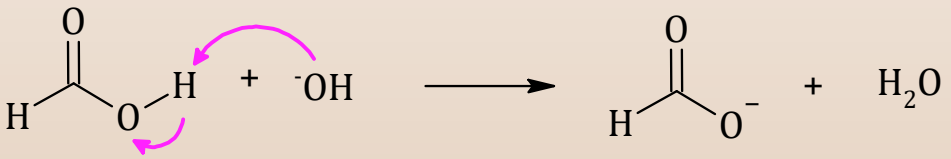
Answers: Writing Acid-Base Equations

Complete the following acid base equations with arrows for the first two and arrows and products for the next two.

ANSWER

Start with looking for the acidic proton (acid) and electrons (base). For Lewis acid look for electron deficiency.

a)



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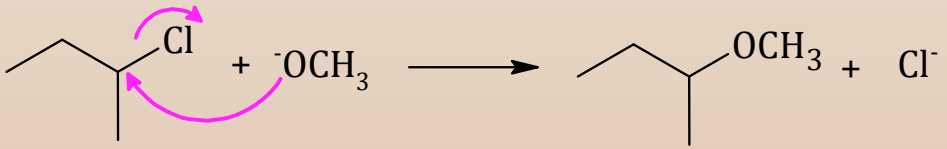

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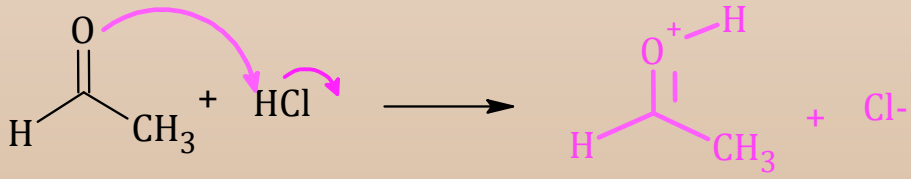

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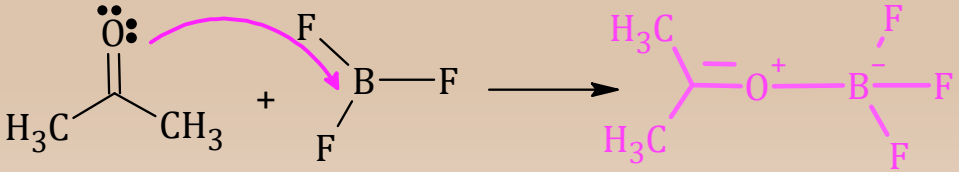

Key Words/Concepts

- Be able to draw arrows in acid base reactions
- Be able to predict products.
- Be able to predict if a reaction will take place or not.