Acids and Bases
1- Introduction

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Acids and Bases: Definitions

Acids and bases are very common in organic chemistry and many reactions are classified as acid-base reactions. There are three definitions of acids and bases as given below in the table. Organic acids and bases can be classified by any one of these criteria.

Definition	Acid	Base
Arrhenius	proton (H^+) donor E.g.: HCl	hydroxide (OH^-) donor E.g. : NaOH
Brønsted–Lowry	proton (H^+) donor E.g.: HCl	proton (H^+) acceptor E.g.: NH_3
Lewis	electron pair acceptor E.g.: BF_3	electron pair donor E.g.: NH_3

One thing to remember is that acid in water is H_3O^+ not H^+.

Amphoteric substances behave like acids and bases.

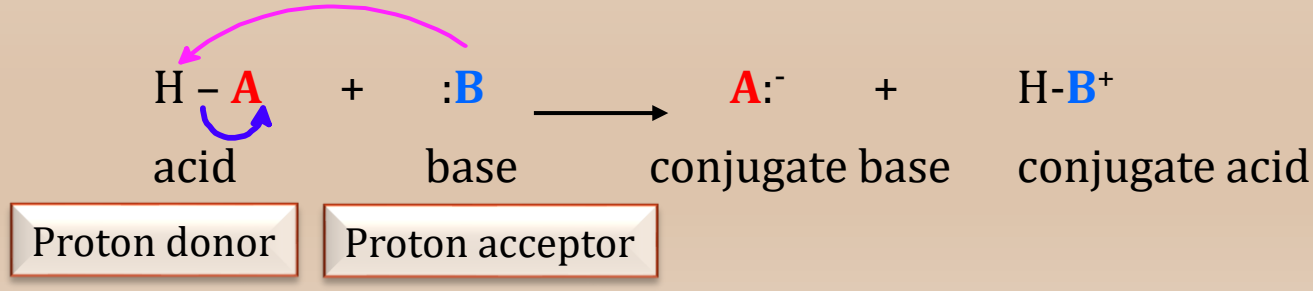
Acids and Bases

A Brønsted acid donates a hydrogen cation (H^+) while a Brønsted base accepts a H^+.

(*A "proton" is a synonym for H^+ - loss of an electron from H leaving the nucleus with only a proton*.)

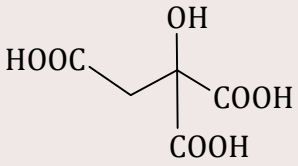
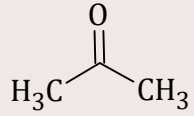
Acid base equations in organic chemistry are written by showing the transfer of a pair of electrons from electron rich to electron poor species in the reaction. This is also referred to as showing the mechanism of a reaction.

The pink curved arrow shows the base, electron rich, pick up (or attack) the proton of the acid, electron poor. This arrow also represents a new bond being formed. The blue arrow shows the breaking of a bond and transfer of the 2 electrons in the bond to **A**. A new bond is now formed between H and B.



Examples of Acids and Bases

There are inorganic (mineral) and organic acids and bases. Except for carbonic acid, all organic acids and bases will have carbons.

Bronstead Lowry Acids (HA)		Bronsted Lowry Bases (B:)	
Inorganic	**Organic**	**Inorganic**	**Organic**
HCl H_2SO_4 HNO_3 H_3PO_4 H_2CO_3 H_2O	CH_3CHOOH  Citric acid	H_2O NH_3 NaOH KOH	CH_3NH_2 $CH_3CH_2NH_2$ CH_3O-  Acetone
• The Bronsted Lowry acids will have a H^+ to donate. • Acids will be neutral or positively charged.		• The Bronsted Lowry bases will have a lone pair of electron or a pi bond. • Bases will be neutral or negatively charged.	

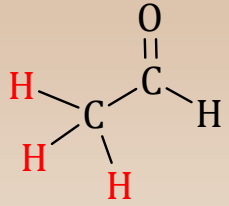
Identifying the Acidic Proton

The proton in inorganic acids is easy to identify since it is written first, e.g., HCl, HNO_3. However, in organic compounds, identifying the acidic proton can be challenging as the structures can be written in different ways.

The best way is to look for the polar bonds with the hydrogens in the compound. The more polar the bond, the easier it is for the proton to dissociate. For some compounds it will be easy to see, but for some you may have to draw the Lewis structure.

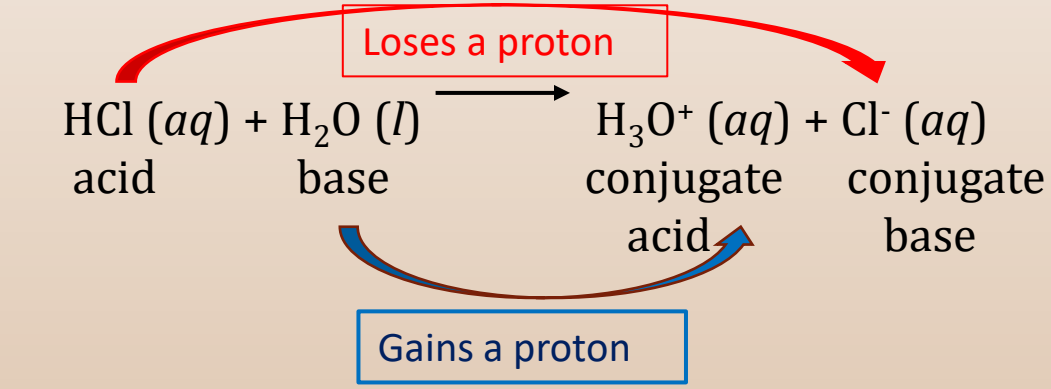
CH_3COOH	CH_3OH	CH_3CH_3	CH_3CHO
carboxylic acid	*alcohol*	*alkane*	*aldehyde*

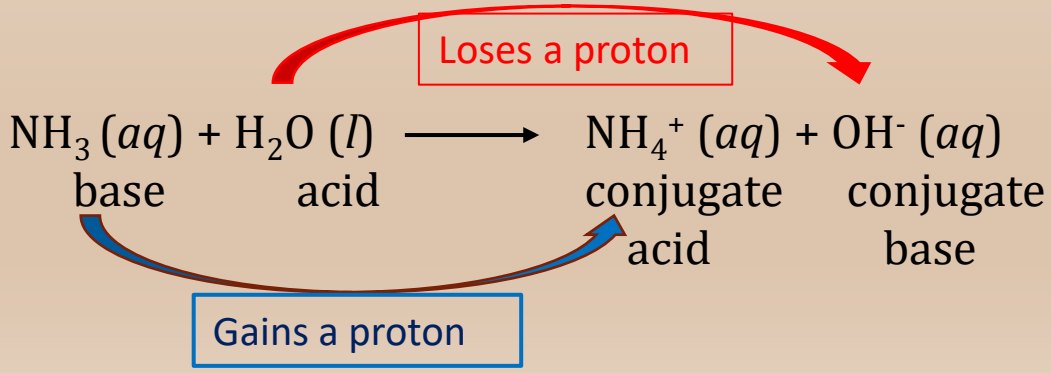
In the compounds above I have underlined the acidic proton. It might be easy to understand carboxylic acid and alcohol, since in both H is bonded to O which is electronegative hence a polar bond, but alkane? There is no polar bond between C-H. In alkanes the protons are not going to be acidic, but those are the only protons for us to select from. In case of aldehyde, it is better to draw the Lewis structure. The H of the aldehyde is part of the functional group hence unavailable for reaction, which leaves only the H on the CH_3 next to the C=O.



Conjugate Acid Base Pairs

- Conjugate base is formed from an acid after it donates a proton to a base.
  - A **strong acid** gives **a weak conjugate base** and vice versa.
- Conjugate acid is formed from a base when it accepts a proton from an acid.
  - A **strong base** gives a **weak conjugate acid** and vice versa.





Acid	Conjugate base
CH_3COOH	CH_3COO^-
H_2O	OH^-
NH_3	NH_2^-
H_2SO_4	HSO_4^-

Base	Conjugate acid
OH^-	H_2O
H_2O	H_3O^+
NH_3	NH_4^+
H_2NCONH_3	$H_2NCONH_4^+$

Solved Problem: Conjugate Acid/Base

Identify the conjugate acid or base in the following questions.

1. What is conjugate acid of NH_3?

2. What are the conjugate bases in the reaction below?

   $CO_3^{2-} + HSO_4^- \longrightarrow HCO_3^- + SO_4^{2-}$

3. For the reaction below which two substances which are both acids.

   $CH_3NH_3^+ + H_2O \longrightarrow CH_3NH_2 + H_3O^+$

4. A strong acid leads to what kind of base? .

ANSWER

1. NH_4^+
2. CO_3^{2-} and SO_4^{2-}
3. $CH_3NH_3^+$ and H_3O^+
4. weak conjugate base

Key Words/Concepts

- Know the definitions of acids and bases
- Identify acids and bases
- Write conjugate acid and bases