

# Acids and Bases

## Overview of Acids and Bases

### Acid-base Acids and Bases

Acids: Donates its proton in these process (H<sup>+</sup>)  
 Base: Donates its lone pair to form a bond



Remember: It only is acids, if only H<sup>+</sup> is a free

What does organic molecules and inorganic substance?

### Organic Acids and Bases

Acids are proton donors, (the molecule is trying to lose H<sup>+</sup> to become a base)  
 Bases are proton acceptors, (the molecule is trying to gain H<sup>+</sup> to become an acid)



### General Acids and Bases of Acid-Base reactions

1) Look for the atom that has lone pairs (usually oxygen of the base) and attach to some protons (hydrogen) of the acid.  
 2) Break the bond of the hydrogen and move the electrons to the other atom.

Remember: **acid always don't accept of electrons**

### Acid-Base and General Definitions: are from Proton Properties

What if there is no proton involved?

### Organic Acids and Bases

Acids work as proton donors  
 Bases work as proton acceptors



So in the 2 case bases, acids and bases are described in terms of electron

1) One of the best base theories is based on lone pairs

As a general practice, consider acids as 1 and bases as 2

## Acid Strength

### What does it mean "strong acid"?

Generally speaking, the more the acid dissociates into a proton, the stronger it is



The dissociation of the acid is a reversible reaction that is described by equilibrium constant



## Acid Strength and pKa

The Ka value of acid dissociation (Ka) and acid bases (Kb) are shown below



The smaller is a stronger acid because in this equation

To simplify the equation, **logKa is used instead of the pKa of the given acid**

$$\text{pKa} = -\log K_a$$

$$\text{pKa}_1 + \log K_{a2} = \text{pH} \quad \text{pKa}_2 + \log K_{a3} = \text{pH}$$

So, **the stronger the acid, the lower the pKa value** (It's the opposite for Kb)

Below are pKa values of some common functional groups



### What makes the Acid Strong?

The strength of the acid is defined by the stability of the conjugate base (the base after the acid dissociates)

**The stronger the acid, the more stable its conjugate base**



Stable if more lone pairs and electronegative atoms provide their charge and

There are 3 factors that is considered when assessing the stability of the conjugate base:

- 1) The first and the best factor is the **charge** to which the hydrogen is connected. Usually to oxygen (Alcohols/ethers) and fluorine (halogenoacids).
- 2) When the same atom, oxygen (and other things such as electronegativity) is the best



Stronger is more electronegative, that is why fluorine is more acidic

1) When comparing elements in different rows, the more electronegative

Larger atoms have higher polarizability and results for negative charge better in the charge is spread over



There are more acidic when charge oxygen is more electronegative than sulfur

The sulfur atom is larger and distributes the negative charge better



### 1) The best factor for determining the acidity is called **inductive**

Inductive or inductive effect is the transmission of charge through atoms

Electronegative atoms pull the negative charge and help to stabilize the conjugate base



The more electronegative, the more electron withdrawing, the stronger the acid



The closer the electronegative atom to the hydrogen, the stronger the acid

### Remember: Acids

### 2) The best factor is the **resonance** of the atom connected to the hydrogen

The explains the great difference of pKa values of alcohols, aldehydes, and ketones



3) which is more electronegative than O, or the atom it's connected, the stronger the acid

Therefore, for **acids**, **aldehydes** > **ketones** > **alcohols**

The primary acids: **Alcohols**, **Aldehydes**, **Ketones**, defined the decreasing the acidity of a compound's structure as **alcohols**

### Remember: the stability for conjugate base



## The Position of Equilibrium for an Acid-Base Reaction

is the following reaction, remember, possible?



Acid-base reactions are reversible, so another way of asking the question is:

is the equilibrium of the reaction shifted to the right (products) or to the left (reactants)?

To answer this question, you need to remember that the equilibrium of acids and bases reactions is shifted towards the weaker acid and base

So, you need to compare the pKa of the acid with acid and to compare with acid with acid

The equilibrium will be shifted to the higher pKa (weaker acid) side



is the acid the pKa of the conjugate acid is clearly higher than acid pKa, or the equilibrium is shifted to the right. Therefore, the right pointing arrow is always longer

## Choosing a Base to Deprotonate a Given Compound

Suppose you need to deprotonate the following compound:  $\text{CH}_3\text{COCH}_2\text{CH}_3$

(Deprotonate means remove the most acidic proton)

First, find its pKa value:  $\text{CH}_3\text{COCH}_2\text{CH}_3 \rightarrow \text{pKa} = 20$

What are the chemical equations of the conjugate reacting with a conjugate base (B<sup>-</sup>)



The pKa of the conjugate acid must be higher than 20, so water will not be a good

Find a conjugate base with pKa value with pKa > 20. Acetate will work since pKa = 4.75



## Choosing an Acid to Protonate a Given Compound

Suppose you need to protonate a given compound:  $\text{CH}_3\text{COCH}_2\text{CH}_3$  (which is a very reactive base and needs to be quenched before being shipped)

To do this, write the chemical equation of what's acid is with pKa



The pKa of the acid conjugate acid of what's acid is 15.7. Therefore, the pKa of acid must be lower than 15.7, stronger acid means, weaker acid bases

Acetic acid will work in a given case (acid) for protonating the what's because its pKa is 4.75 and is a clear stronger of an acid than water



## Remember: Hammett's Equation

The equation shows whether the compound with a given pKa is or is not acidic or basic (deprotonated) there is an equation relation depending on the pKa of the electron

$$\text{pKa} = \text{pKa}^0 + \rho \log \frac{K}{K^0}$$

But please not to forget of the Hammett Hammett's equation



Remember: **EWG** (electron withdrawing group) **EDG** (electron donating group)



The pKa of organic compounds with  $\rho = -1$ . Therefore, it is usually to be acidic than base because its conjugate pKa < 15, which is the environment of the acid pKa 15. So, they will be in an acidic form. There

# Chemistry Study Guide Acids And Base

**Annelies Wilder-Smith**



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