

Acids and Bases

Overview of Acids and Bases

Acid-base Acids and Bases

Acids donate a proton to base (proton donor)

Base donates a proton to acid (proton acceptor)



Acid-base reaction is only in water, only HCl is a true acid

What about organic molecules and non-aqueous solutions?

Acid-base Acids and Bases

Acids are proton donors, bases are proton acceptors. (The tendency to bring in water, the tendency to take away the proton)



General acid-base reaction of acid-base reaction:

to find the more basic, the base gets protonated, change of the base

and usually for most acids, hydrogens of the acid

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Acid Strength and pKa

The Ka value of an acid (acid dissociation constant) is a measure of its acid strength



The smaller the Ka value, the weaker the acid

To simplify the numbers, pKa is used, which is the negative log of the Ka value

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

$$\text{pKa}_1 < \text{pKa}_2 < \text{pKa}_3 < \text{pKa}_4 < \text{pKa}_5 < \text{pKa}_6 < \text{pKa}_7 < \text{pKa}_8 < \text{pKa}_9 < \text{pKa}_{10}$$

So, the stronger the acid, the lower the pKa value (It's inverse of the Ka)

Acids are pKa values of their conjugate bases



What makes the Acid Strong?

The strength of the acid is determined by the stability of the conjugate base (the more stable the conjugate base, the stronger the acid)

The stronger the acid, the more stable the conjugate base



Acids are pKa values of their conjugate bases

There are a few factors to be considered when assessing the stability of the conjugate base:

1) The first and the last factor is the **charge** to which the conjugate base is converted. Usually, an anion is more stable than a cation (electrostatics and thermodynamics)

2) When the same acid, there are some other things to consider, such as electronegativity of the base



3) When comparing different acids, the more stable the conjugate base, the stronger the acid

Large atoms have higher polarizability and usually for negative charge better in the conjugate base



There are some acids that change regions in some electronegativity from acids

The acids are in large and sometimes for negative charge better

4) When comparing for same atom, check which conjugate base is **more electronegative**



5) The first factor for determining the acidity is called **inductive effect**

Inductive effect is the transmission of charge through atoms

Electronegativity 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

Electronegativity

6) The first factor is the **charge** of the atom connected to the hydrogen

The higher the positive charge, the higher the pKa value of the acid, the stronger the acid



7) When the same electronegativity, the more electron withdrawing, the stronger the acid

Electronegativity

The positive charge, the more electron withdrawing, the stronger the acid

Electronegativity

Electronegativity



The Position of Equilibrium for an Acid-Base Reaction

Is the following reaction spontaneous?



Acid-base reaction is spontaneous, so reaction is going to the right

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 reaction is shifted towards the weaker acid and base

So, you need to compare the pKa of the acid and base to the conjugate acid and base

The equilibrium will be shifted to the higher pKa reaction with only



Is the acid the pKa of the conjugate acid or the pKa of the acid, or the equilibrium is shifted to the right (products) or to the left (reactants)?

Is the acid the pKa of the conjugate acid or the pKa of the acid, or the equilibrium is shifted to the right (products) or to the left (reactants)?

Choosing a Base to Deprotonate a Given Compound

Suppose you need to deprotonate the following compound: H_2O

Deprotonate means remove the proton (acidic proton)

First, find the pKa value: $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

Find the chemical equation of the conjugate base with a conjugate base (B)



The pKa of the conjugate acid must be higher than 14, so reaction will be favored

Find a conjugate base with a pKa value higher than 14. Acids are weak acids (pKa > 14)



Choosing an Acid to Protonate a Given Compound

Suppose you need to protonate the following compound: H_2O (the conjugate base of H_2O)

Protonate means add the proton (basic proton)

To do this, write the chemical equation of the acid with a pKa value



The pKa of the acid must be lower than 14, so reaction will be favored

Find an acid with a pKa value lower than 14. Acids are weak acids (pKa < 14)

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Acids And Bases Chemistry Study Guide

David R. Klein, Laurie S. Starkey



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