

# **Properties of Aqueous Solutions**

# Definitions

**A solution is a homogeneous mixture of two or more substances.**

**The substance present in smaller amount is called the **solute**.**

**The substance present in larger amount is called the **solvent**.**

**For now we will discuss only **aqueous solutions**.**

# Electrolytes vs Nonelectrolytes

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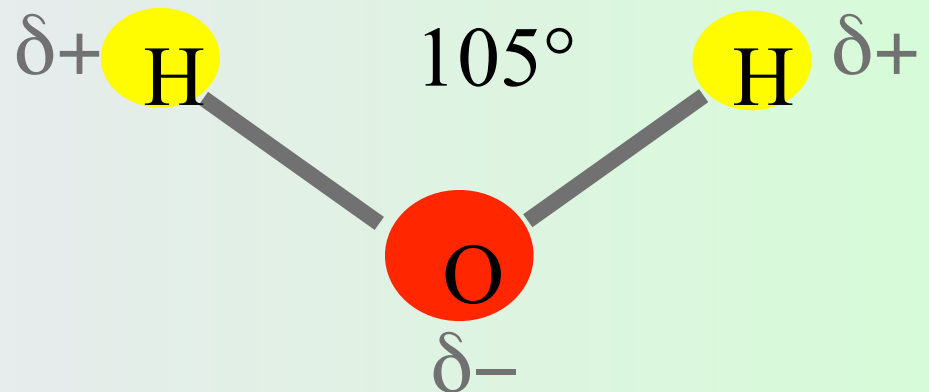
**An electrolyte is a substance that, when dissolved in water, gives a solution that can conduct electricity**

**A nonelectrolyte does not conduct electricity when dissolved in water.**

the most important property of water when dealing with aqueous solution is its **polarity**

Structure of water

O—H bonds are covalent but “polar”



# Dipole Moments

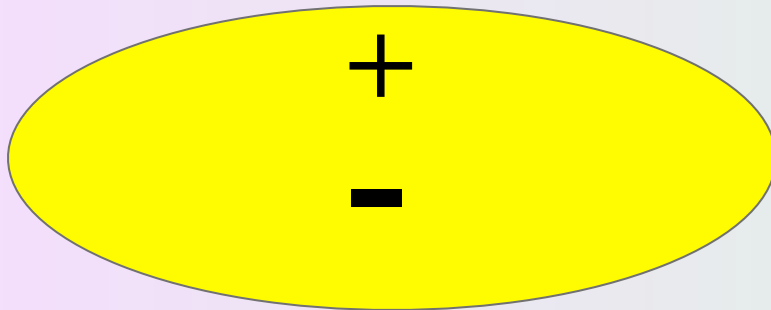
# Dipole Moment

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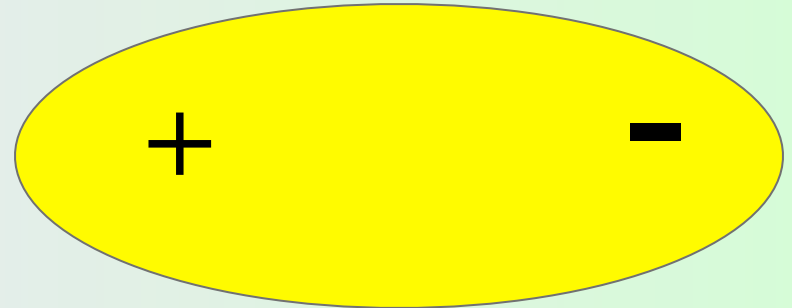
**a substance possesses a dipole moment if its centers of positive and negative charge do not coincide**

$$\mu = e \times d$$

**Expressed in debye units**



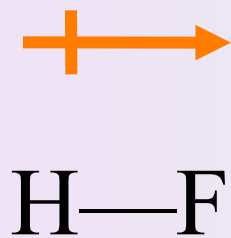
not polar



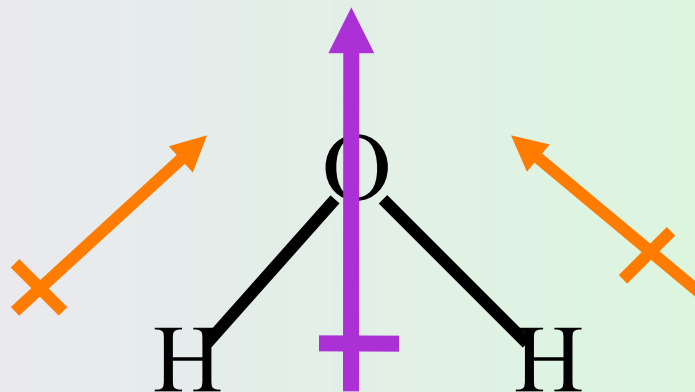
polar

# examples

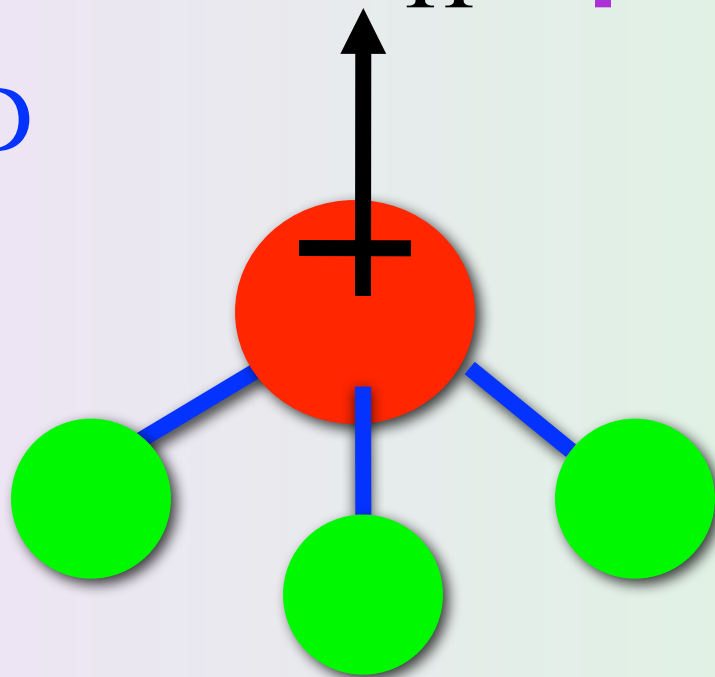
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$$\mu = 1.7 \text{ D}$$



$$\mu = 1.8 \text{ D}$$

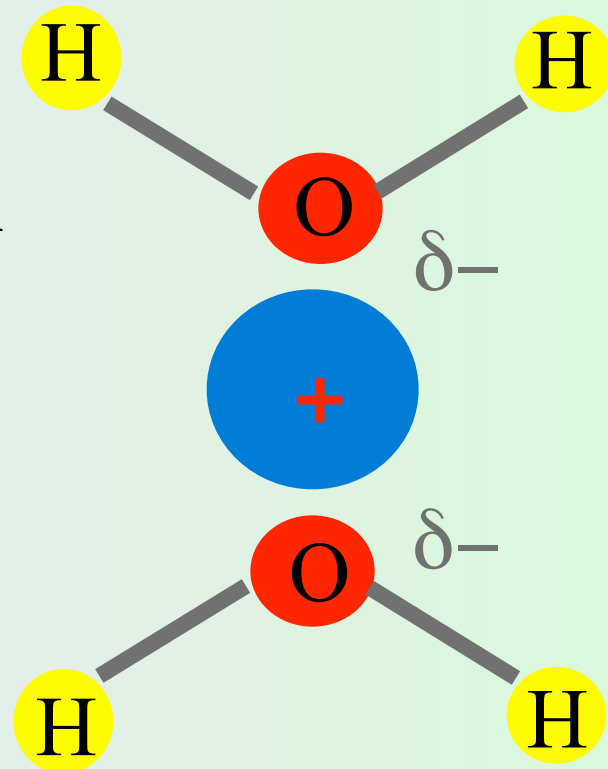


$$\mu = 1.5 \text{ D}$$

# Solvation

Clustering of molecules of solvent around solute:

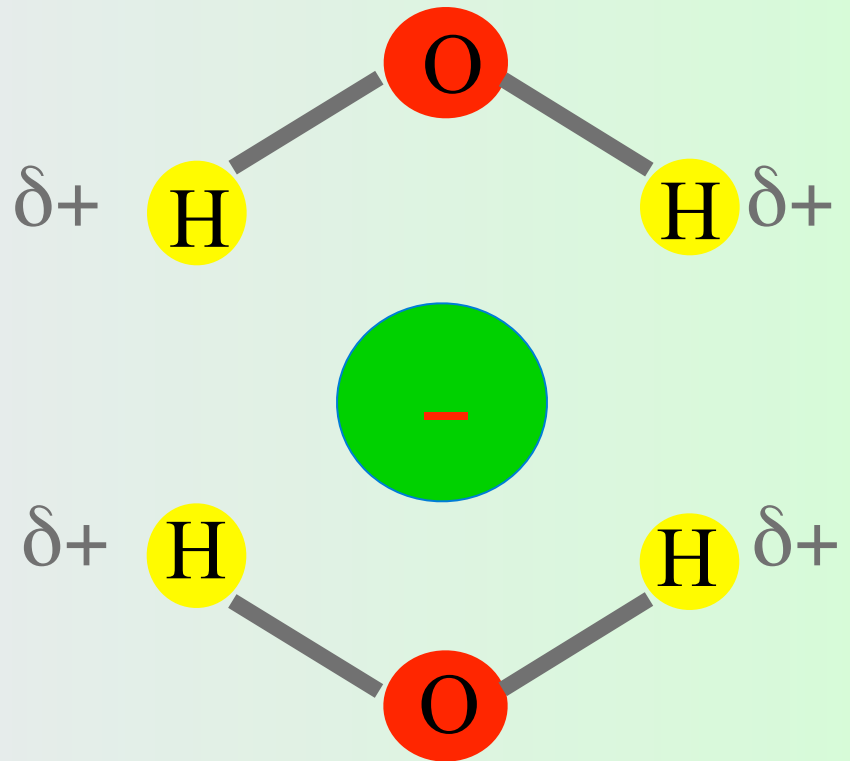
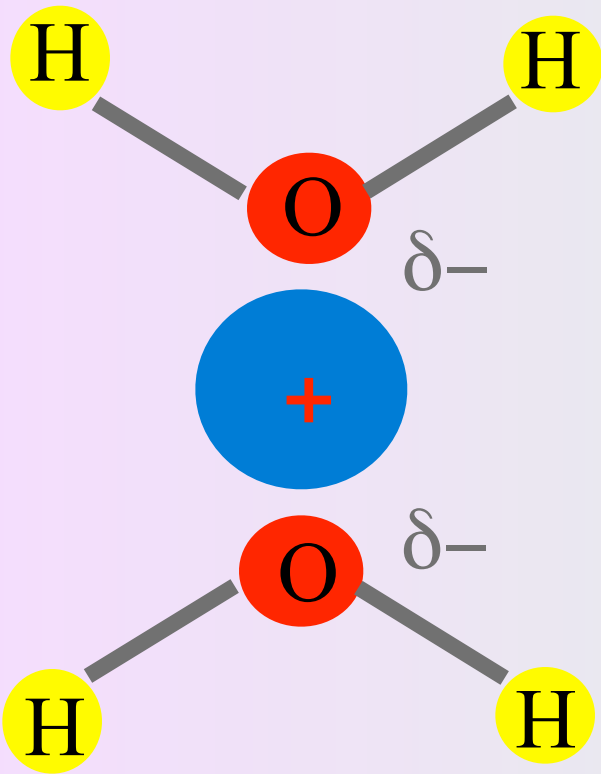
**hydration** is specific term for solvation when water is solvent





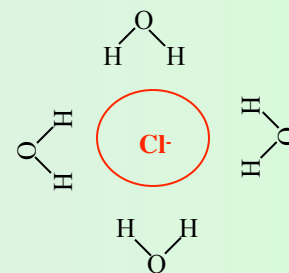
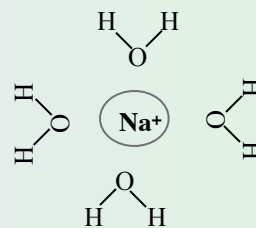
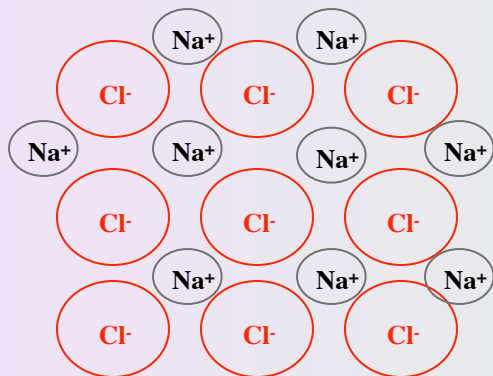
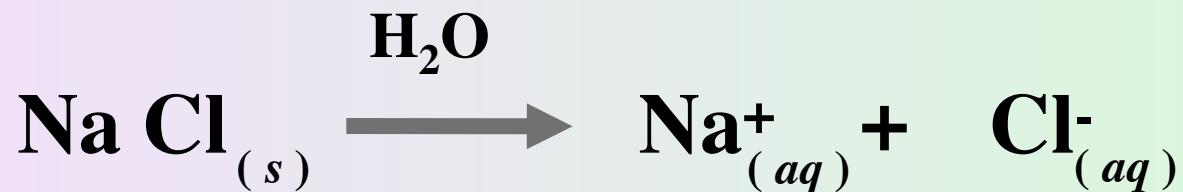
# Water can solvate both cations and anions

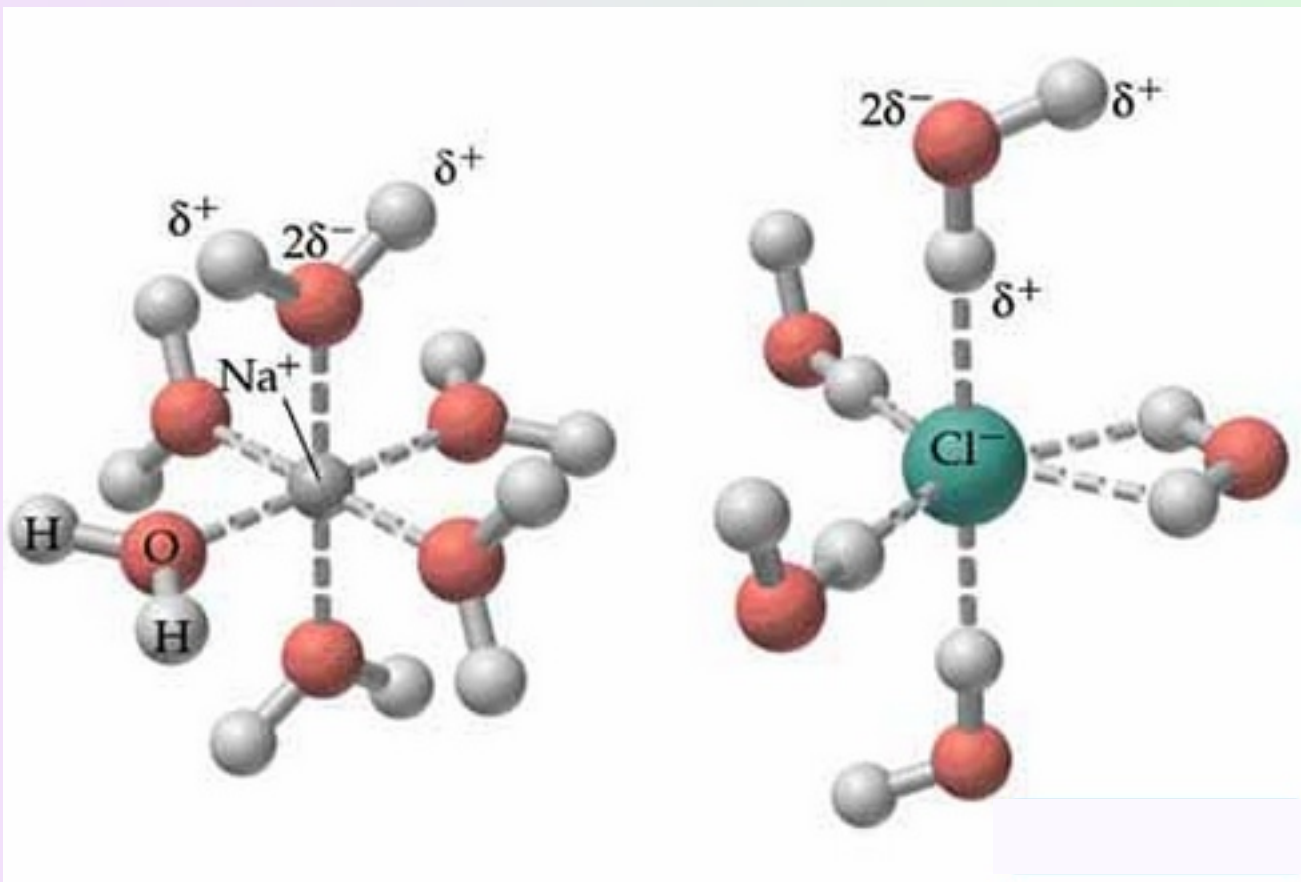
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# Dissociation

The breaking up of a compound into cations and anions





# Electrolytes vs Nonelectrolytes

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**Nonelectrolyte**

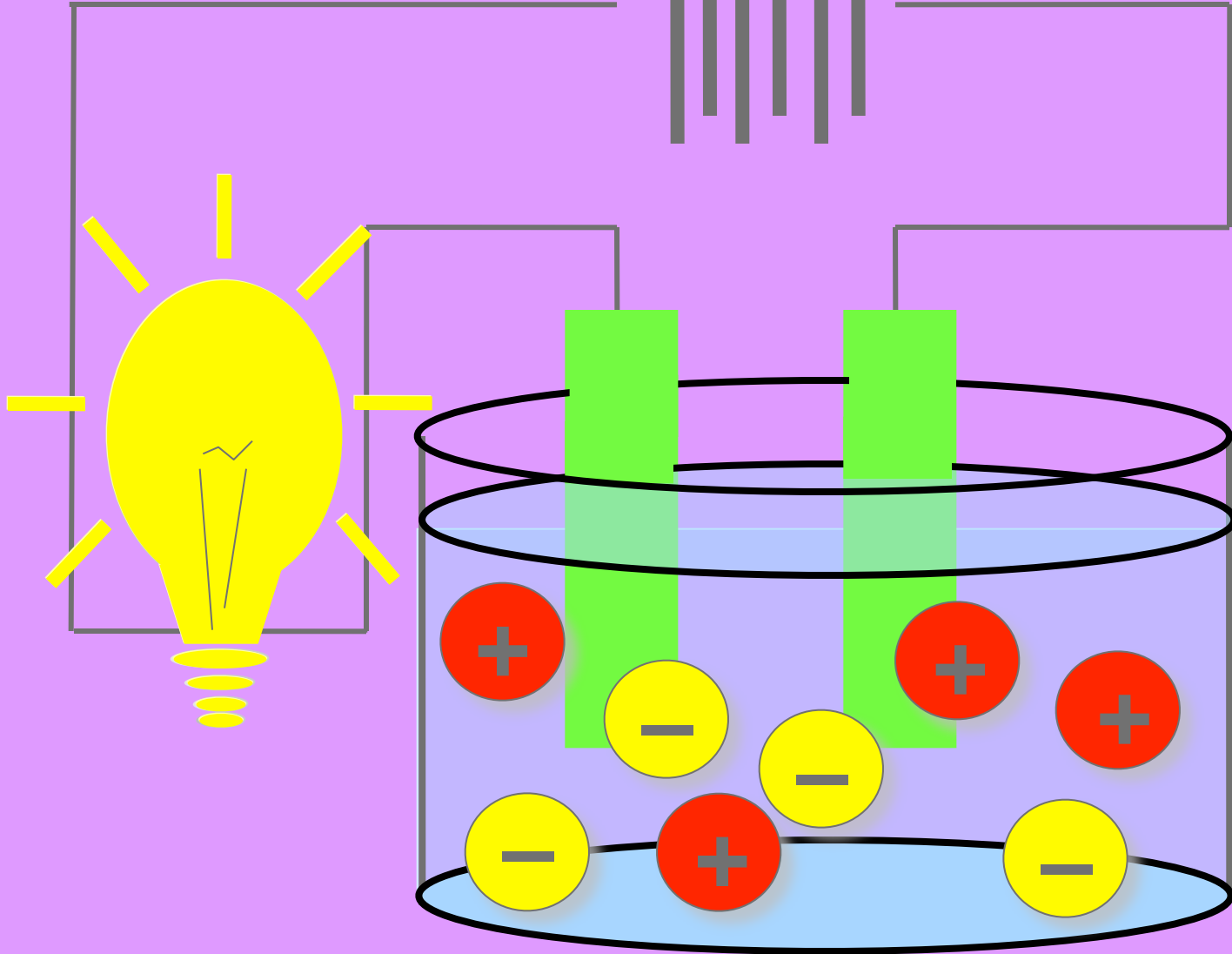
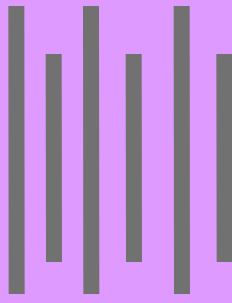
**not ionized in water**

**Weak electrolyte**

**incompletely ionized in water**

**Strong electrolyte**

**completely ionized in water**



# Solubility

**The amount of solute that can be dissolved in a given amount of a saturated solution at a fixed temperature is the **solubility** of the solute in the solvent.**

# Solubility

**Some compounds are very soluble : NaCl, KCl, NH<sub>4</sub>Cl**

**Some are slightly soluble : AgCl**

*slightly soluble and insoluble can be used interchangeably*

# Strong electrolytes

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Soluble Ionic compounds

Strong acids

Strong bases



# Arrhenius definitions of acids and bases

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An **acid** dissolves in water to yield protons



A **base** dissolves in water to yield hydroxide ions



# Examples of Strong acids

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**Hydrochloric acid: HCl(aq)**



**Nitric acid: HNO<sub>3</sub>(aq)**



**Sulfuric acid: H<sub>2</sub>SO<sub>4</sub>(aq)**



# Examples of Strong bases

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**Sodium hydroxide:**

**NaOH(aq) is equivalent to  $\text{Na}^+ + \text{HO}^-(\text{aq})$**

**Likewise: KOH, Ba(OH)<sub>2</sub>, etc.**

# Weak electrolytes

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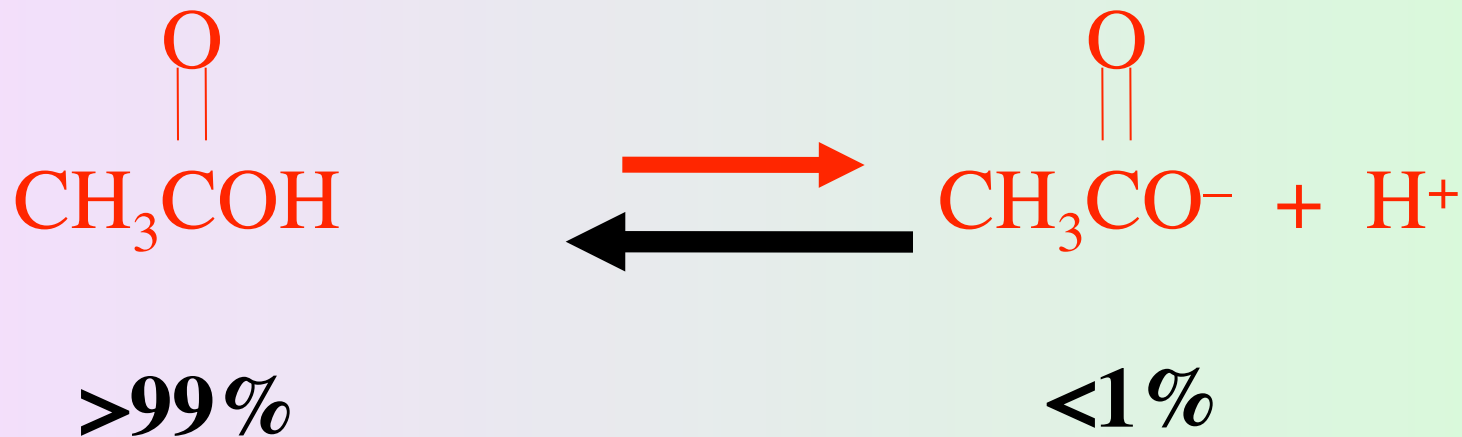
Weak acids

Weak bases

# A Weak Acid

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**Acetic acid:**



**Reversible reaction**

the reaction can occur in both directions

# A Weak Base

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**Ammonia:**



**>99%**

**<1%**