Join the course's Teams

Introduction into Biochemistry

Course information

- Recommended textbooks
  - Marks' Basic Medical Biochemistry: A Clinical Approach 5th Edition, by Michael Lieberman (Author), Alisa Peet MD (Author), 2018
  - Biochemistry 8th edition by Mary Campbell (Author) and Shawn Farrell (Author)

- Online:

  https://themedicalbiochemistrypage.org/

- Instructors
  - Prof. Mamoun Ahram
  - Dr. Diala Abu Hassan

Outline

- Introduction
- Acids and bases, pH, and buffers
- Macromolecules
  - Carbohydrates, lipids, and amino acids, peptides, and proteins
- Protein structure-function relationship
  - part I: fibrous proteins: collagen, elastin, and keratins
  - part II: globular proteins (plasma proteins, myoglobin, hemoglobin, and immunoglobulins)
  - part III: Regulation of hemoglobin
- Enzymes
  - structural features and classification, kinetics, mechanisms of regulation, cofactors
- Protein purification and analysis

Biochemistry & chemical composition of living organisms

Biochemistry = understanding life

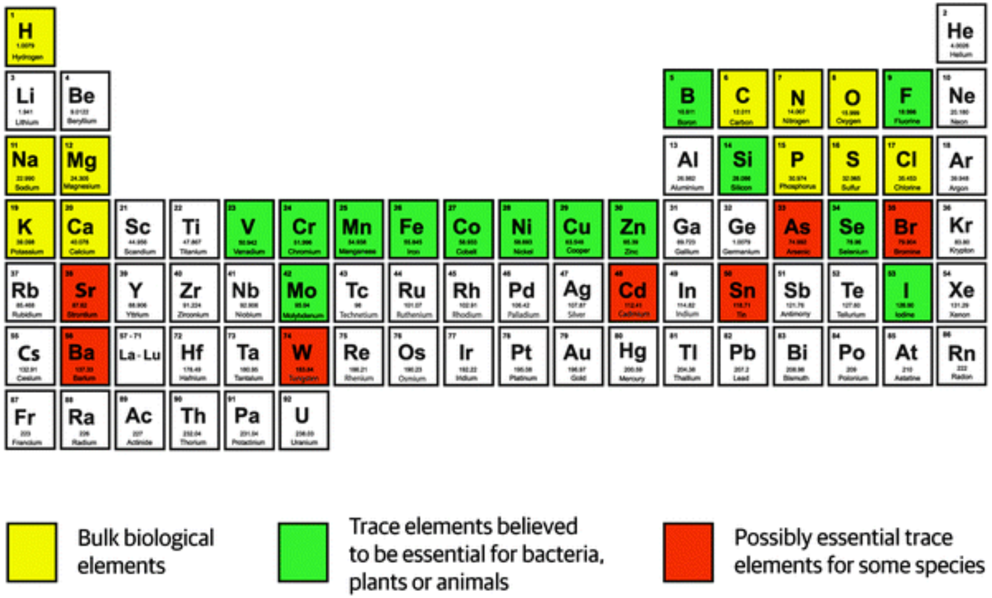
- Know the chemical structures of biological molecules
- Understand the biological function of these molecules
- Understand the interaction and organization of different molecules within individual cells and whole biological systems
- Understand bioenergetics (the study of energy flow in cells)

Biochemistry in medicine:

- ***explains all disciplines***
- ***diagnose and monitor diseases***
- ***design drugs (new antibiotics, chemotherapy agents)***
- ***understand the molecular bases of diseases***

Chemical elements in living creatures

- The human body is composed mainly of ~30 elements.
- Four primary elements: carbon, hydrogen, oxygen, and nitrogen (96.5% of an organism's weight)
- Then, calcium and phosphorus (that's 98.5%).
- Others exist in trace amounts but are essential, elements (mostly metals).



Just Know it you don't have to memorize it!

TABLE 2.1 Elements of the Human Body

Name	Symbol	Percentage of Body Weight
Major Elements (Total 98.5%)		
Oxygen	O	65.0
Carbon	C	18.0
Hydrogen	H	10.0
Nitrogen	N	3.0
Calcium	Ca	1.5
Phosphorus	P	1.0
Lesser Elements (Total 0.8%)		
Sulfur	S	0.25
Potassium	K	0.20
Sodium	Na	0.15
Chlorine	Cl	0.15
Magnesium	Mg	0.05
Iron	Fe	0.006

large

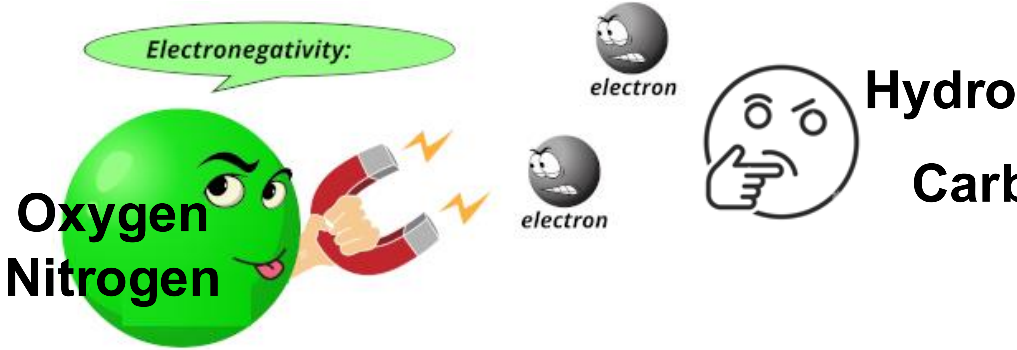
start to be less

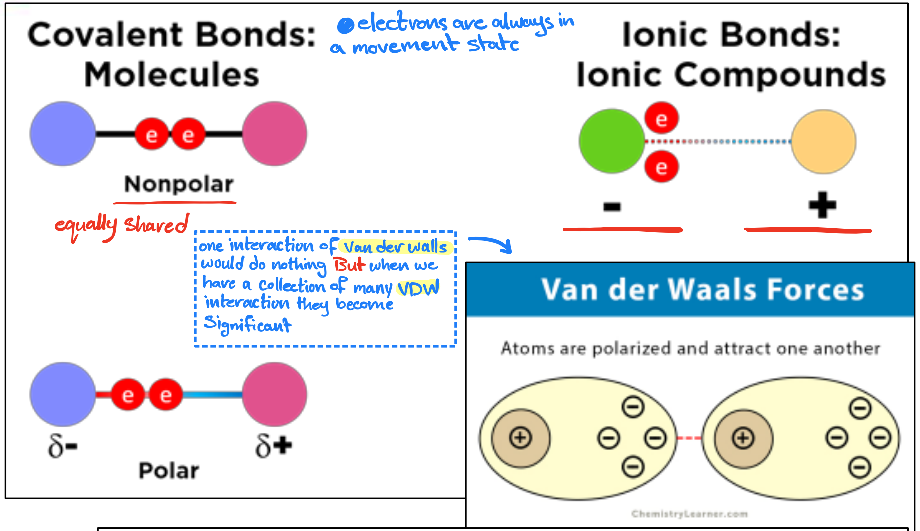
Trace Elements (Total 0.7%) *but essential*

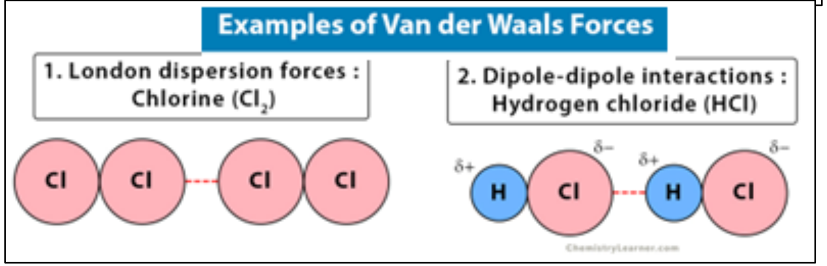
Name	Symbol	Name	Symbol
Chromium	Cr	Molybdenum	Mo
Cobalt	Co	Selenium	Se
Copper	Cu	Silicon	Si
Fluorine	F	Tin	Sn
Iodine	I	Vanadium	V
Manganese	Mn	Zinc	Zn

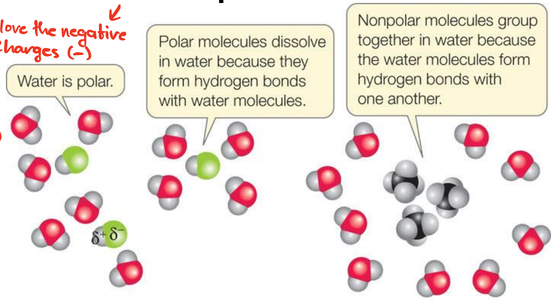
Important terms

- Electronegativity → Force to attract electron
- Covalent bonds تشاركية بالإلكترونات
  (stronger than non-covalent bond)
  - Polar vs. non-polar covalent bonds (non-polar → shared equally between 2 atoms! they are close equally; polar → not equally, here one is closer to the other!)
  - Single vs. multiple
- Non-covalent interactions → Very Important
  - Electrostatic interactions → Ion Bonds → Real charges interaction
  - Hydrogen bonds (donor and acceptor) → Partial & Partial atoms
    (there's need For H to be H-Bond Because H is the Donor)
  - Van der Waals interactions → electrons aren't distributed equally it happens at a certain moment also they're the weakest bond in non-covalent bonds
  - Hydrophobic interactions
  - Hydrophobic versus hydrophilic molecules (hydrophobic: it's when we have non-polar Covelant bond; hydrophilic: it's when we have polar Covalent bond)
- Nucleophile vs electrophile
  (nucleophile: love the positive charges (+) → it will become (-); electrophile: love the negative charges (-) → it will become (+))









(A) Hydrophilic (B) Hydrophobic

Important properties of bonds

- Bond strength (amount of energy that must be supplied to break a bond)
- Bond length: the distance between two nuclei (→ atoms)
- Bond orientation: bond angles determining the overall geometry of atoms

important

↳ here we are talking about the angle of the atom & its position in space

- The three-dimensional structures of molecules are specified by the bond (1) angles and bond lengths (2) for each covalent linkage.

three things

↳ & the strength of the bond

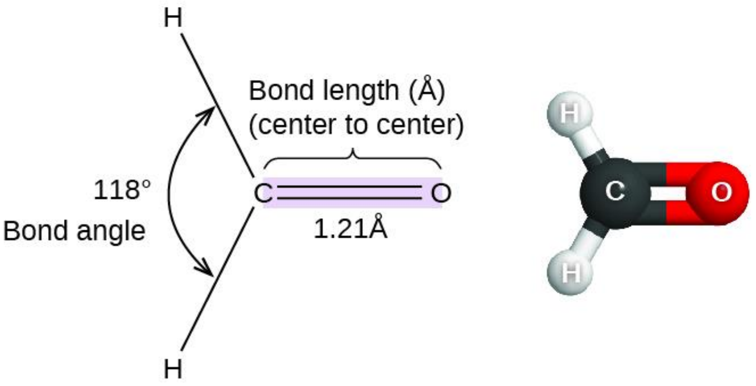
Bond strength ex:-

C–C it's strong bond

it required energy to break up

↳ Comes from the heat

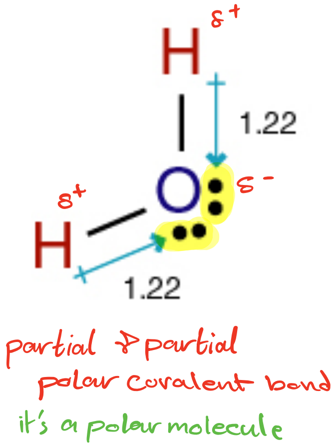
So! heat will break up bonds

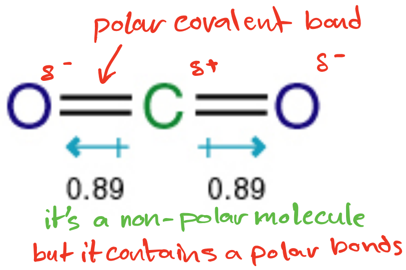


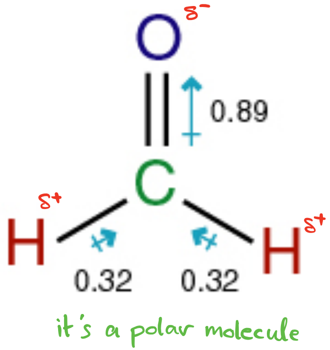
Polarity of covalent bonds

- Covalent bonds in which the electrons are shared unequally in this way are known as polar covalent bonds. The bonds are known as “dipoles”.
  - Oxygen and nitrogen atoms are electronegative
  - Oxygen and hydrogen
  - Nitrogen and hydrogen
  - Not carbon and hydrogen

Both water and CO_2 contain polar bonds, but only water is a polar molecule.

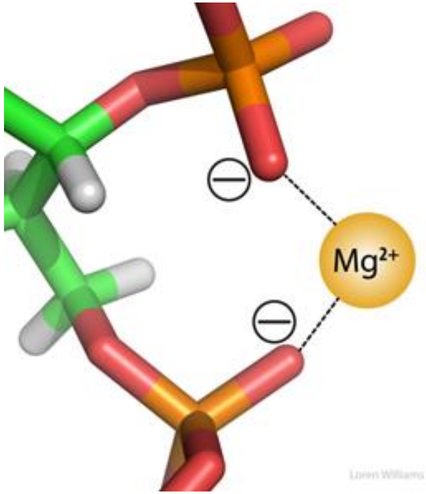






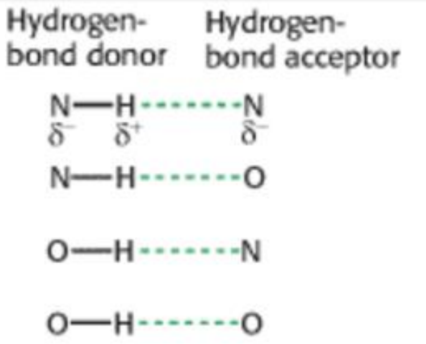
What are non-covalent interactions?

- They are reversible and relatively weak.



Electrostatic interactions (charge-charge interactions):

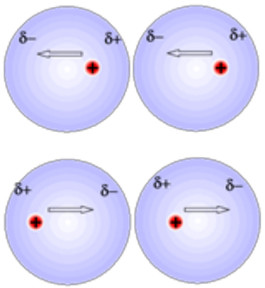
- **They are formed between two charged particles.**
- **These forces are quite strong in the absence of water .**



Hydrogen bonds (it's an interaction but they call it H-Bond)

A hydrogen atom is partly shared between two relatively electronegative atoms (a donor and an acceptor).

van der Waals interactions



Unequal distribution of electronic charge around an atom changes with time.

The strength of the attraction is affected by distance.

Hydrophobic interactions

→ it's important because it determine the structure of the molecule

→ it's also depends on a concept (عو عو ططبي)

↓ it can happen without the polar solvent

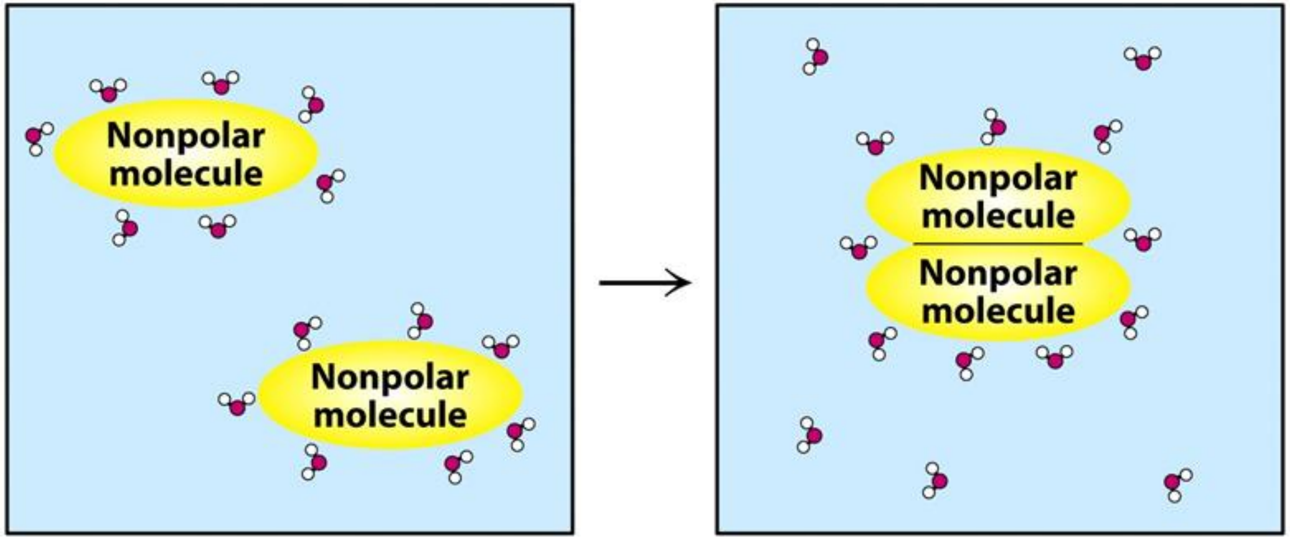
- Self-association of nonpolar compounds in an aqueous environment
- Minimize unfavorable interactions between nonpolar groups and water

interaction concept dosen't have sharing electrons weaker

it has charges only because of favorable interaction it's between molecule & molecule

Bond concept have sharing electrons & it can be equall & non-equall

it's a single molecule



Properties of noncovalent interactions

- Reversible → because at any point of time it can change it interaction
- Relatively weak
- Molecules interact and bind specifically.
- Noncovalent forces significantly contribute to the structure, stability, and functional competence of macromolecules in living cells.
- Can be either attractive or repulsive
- Involve interactions both within the biomolecule and between it and the water of the surrounding environment

Carbon

The road to diversity and stability

– (if there's Carbon there's life) –

↓

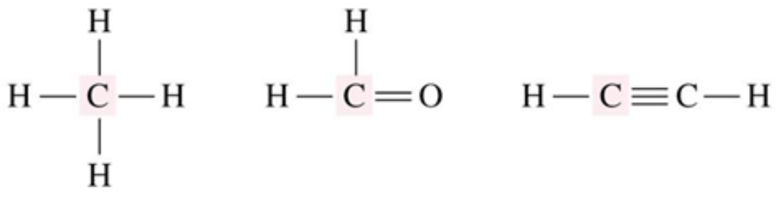
it makes diversity

& stably

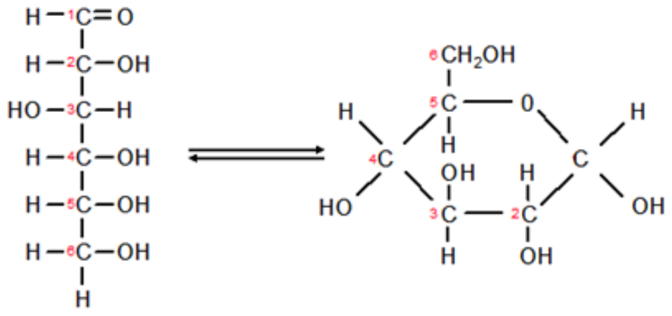
Properties of carbon (1)

life is all about diversity

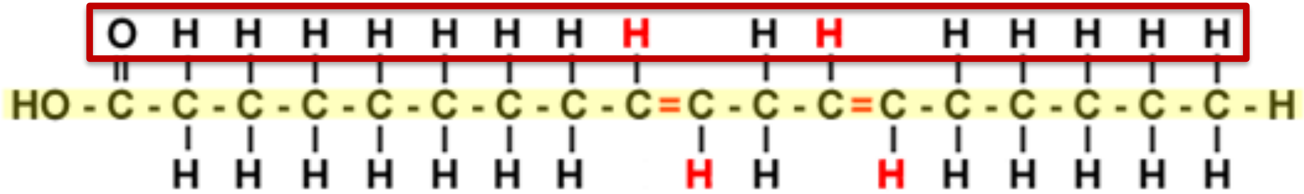
- It can form four bonds, which can be single, double, or triple bonds. (diversity)
- Each bond is very stable. lot of energy
  - strength of bonds: triple > double > Single)
- They link C atoms together in chains and rings. structures
  - These serve as a backbones. of the molecule



CH_4 (methane) CH_2O (formaldehyde) C_2H_2 (acetylene)



Glocouse



Properties of carbon (2)

- Carbon bonds have angles giving molecules three-dimensional structures.
- In a carbon backbone, some carbon atoms rotate around a single covalent bond producing molecules of different shapes.
- The electronegativity of carbon is between other atoms.
  - It can form polar and non-polar molecules.
- Pure carbon is not water soluble, but when carbon forms covalent bonds with other elements like O or N, the molecule that makes carbon compounds is soluble.

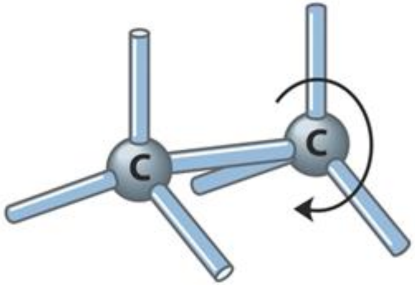
each bransh it structured by it own Surrounding enviorment

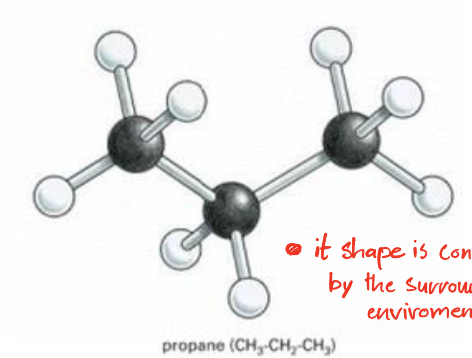
they can rotate & bind

it's intermediate → it makes non polar covalent bond with H; it makes polar covalent bond with O

hydrogen have weak E-vity compaired to Carbon

by forming certain bonds it can become soluble

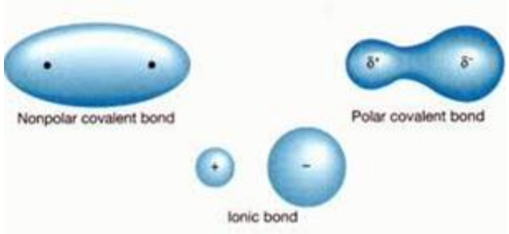


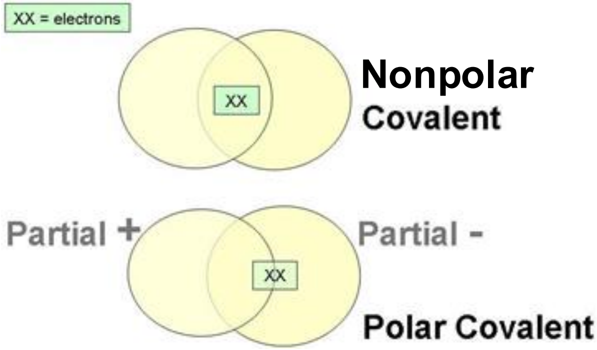


propane (CH_3-CH_2-CH_3)

it shape is controled by the surrounding enviroment

the reason is to make a favorable interaction between them





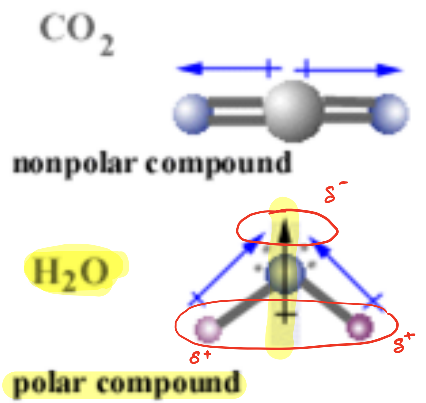
Water

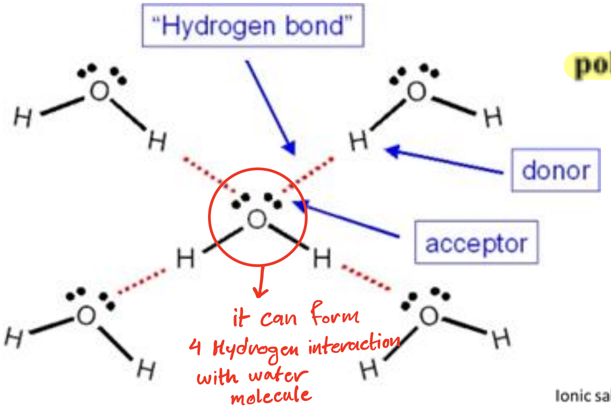
Properties of water (1)

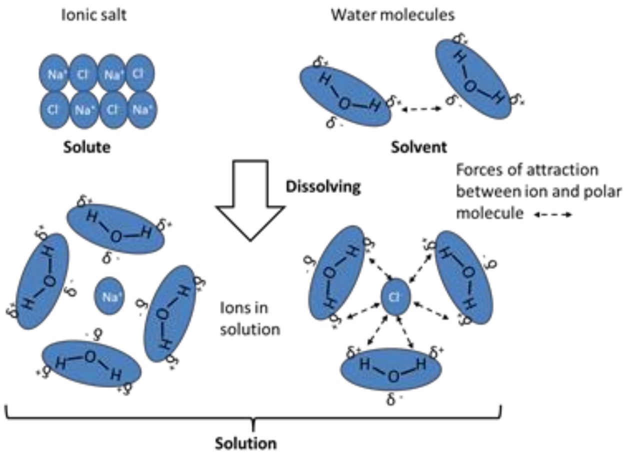
- Water is a polar molecule as a whole because of:
  - the different electronegativities between Hydrogen and oxygen
  - It is angular.
- Water is highly cohesive.
- Water molecules produce a network.
- Water is an excellent solvent because It is small, and it weakens electrostatic forces and hydrogen bonding between polar molecules.

→ because it has partial charges that's able to make interaction
→ it makes interaction with real charges

it means that the partial (-) or (+) charge can make an interaction with real charges



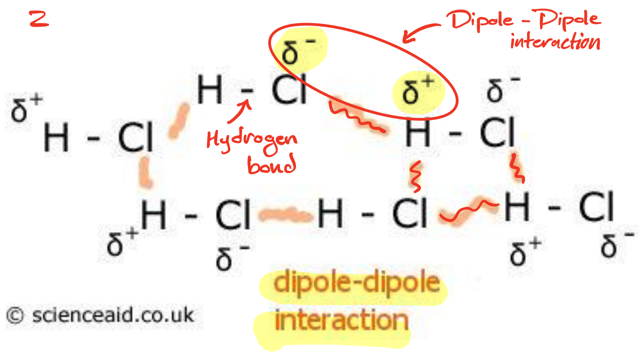


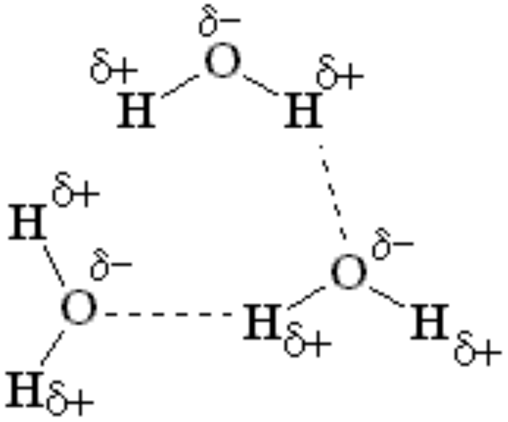


Note

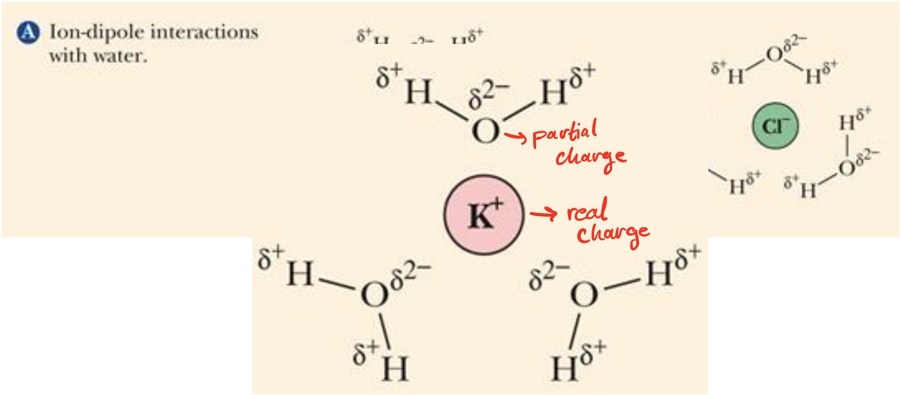
Dipole-dipole interaction

→ between 2 polar molecules





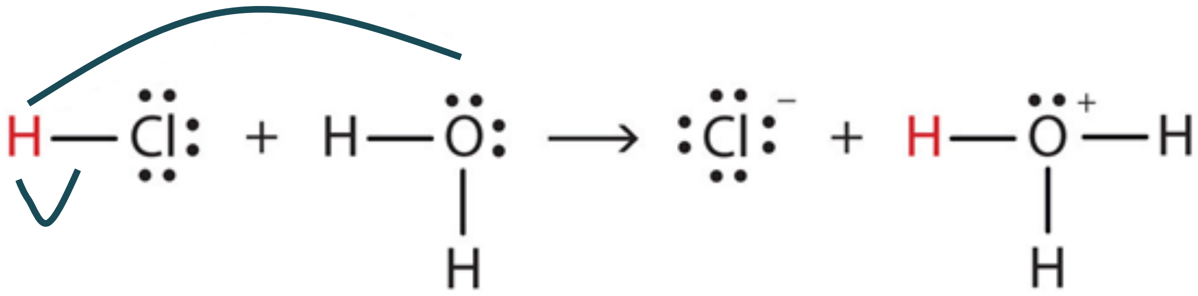
Dipole-charge interaction



Properties of water (3)

Water molecule is very reactive molecule & it's involved in a lot of reactions. Because O have the pair electrons that's ready to give it up.
Oxygen is ready to give up easily on Hydrogen

- It is reactive because it is a nucleophile.
  - A nucleophile is an electron-rich molecule that is attracted to positively-charged or electron-deficient species (electrophiles).



- when we talk about enzymes
enzymes in general don't like water to be involved
- So they take the substrates away from the water in the active site because water can ruin the reaction
& after that the product will be released out from the active site
- Water is reactive and it can ruin the reaction

Properties of water (4)

- Water molecules are ionized to become a positively-charged hydronium ion (or proton), and a hydroxide ion:

$$H_2O + H_2O \rightleftharpoons H_3O^{\oplus} + OH^{\ominus}$$

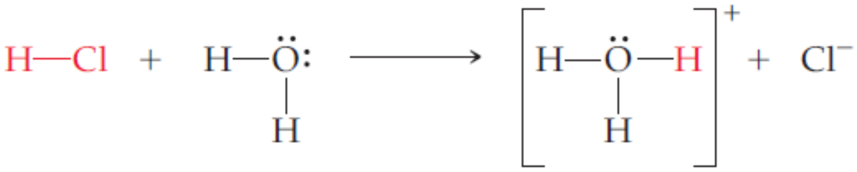
- it can dissociate to hydronuim ion "H_3O" which is like proton & hydroxide ion "OH^-"

Note: $H_3O^+ = H^+$

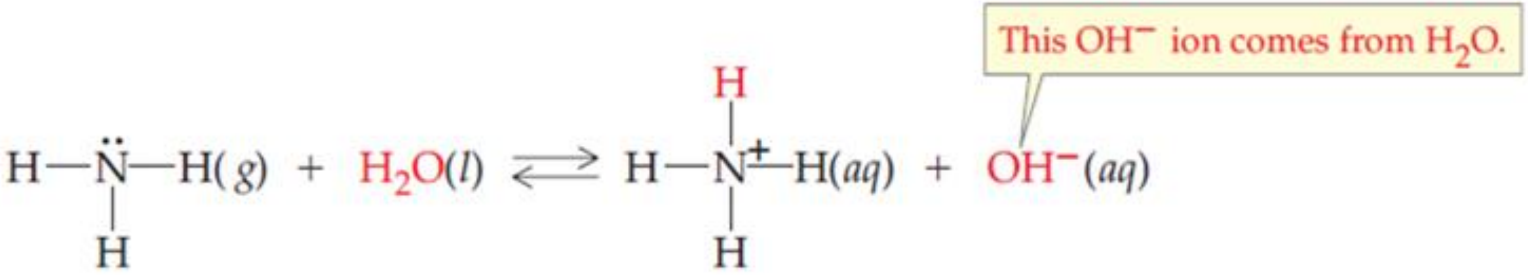
Same

Types of acids and bases

- Arrhenius acids and bases
- Acid: a substance that produces H+ when dissolved in water
    - H+ Reacts with water-producing hydronium ion (H_3O^+).



- Base: a substance that produces OH^- when dissolved in water.



Types of acids and bases

give H^+

- The Brønsted-Lowry acid: any substance (proton donor) able to give a hydrogen ion (H^+-a proton) to another molecule.
  - Monoprotic acid: HCl, HNO_3, CH_3COOH 1 mole → 1 mole
  - Diprotic acid: H_2SO_4 1 mole → 2 moles
  - Triprotic acid: H_3PO_3 1 mole → 3 moles

for H^+

- Brønsted-Lowry base: any substance that accepts a proton (H^+) from an acid.
  - $NaOH$, NH_3, KOH

Ammonia

Water = amphoteric → it means both

أمفوباتيك

- Substances that can act as an acid in one reaction and as a base in another are called **amphoteric substances.**
  - **Example: water**
- With ammonia (NH_3), water acts as an acid because it donates a proton (hydrogen ion) to ammonia.

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

- With hydrochloric acid, water acts as a base.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

- if water reacts with strong acid then water reacts as a base
- if water reacts with strong base then it reacts as an acid

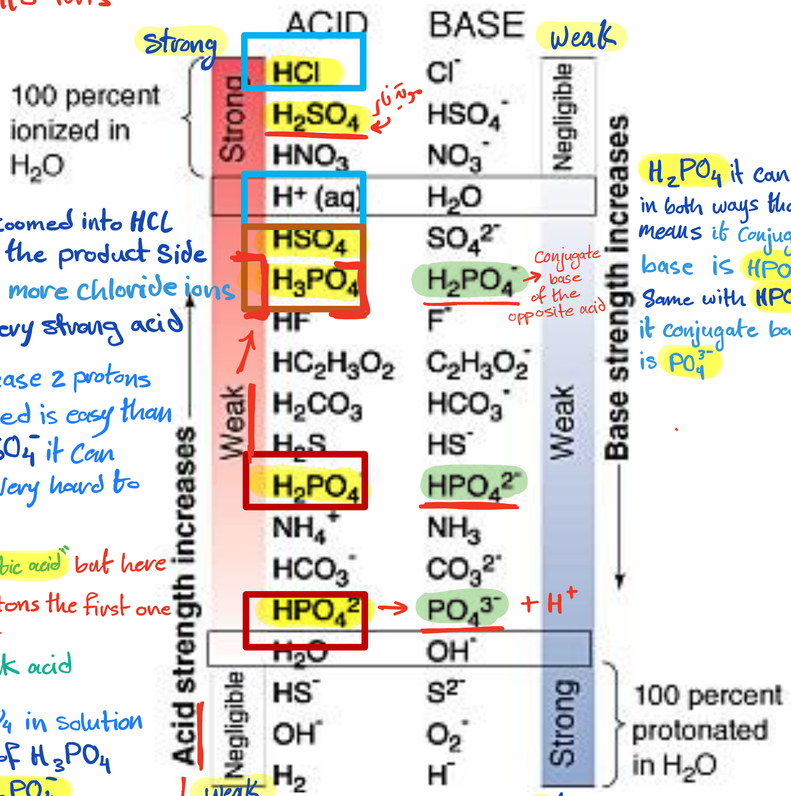
Ampho = 'both' or 'dual'

Join the course's Teams

Acid/base strength

the strength of acid depends on ability to dissociate into ions — more dissociated into products than reactance

- Acids differ in their ability to release protons. (ability → or strength)
  - Strong acids dissociate 100%.
- Bases differ in their ability to accept protons.
  - Strong bases have a strong affinity for protons.
- For multi-protic acids (H_2SO_4, H_3PO_4), each proton is donated at different strengths.



Strong / Weak (acid column); Weak / Strong (base column)

- if we zoomed into HCL it's mainly in the product side more protons → more chloride ions than HCL so it's very strong acid
- $H_2SO_4^-$ can release 2 protons first proton released is easy than second one So! HSO_4^- it can release proton but it's very hard to release it
- Same goes with H_3PO_4 "Triprotic acid" but here it release 3 protons the first one is the easiest but it still a weak acid
- H_2PO_4 it can act in both ways that means it conjugate base is HPO_4^{2-} same with HPO_4^{2-} it conjugate base is PO_4^{3-}
- conjugate base of the opposite acid
- HPO_4^{2-} → PO_4^{3-} + H^+
- if we zoomed in H_3PO_4 in solution mainly in the form of H_3PO_4 & littel of it $H^+ + H_2PO_4^-$
- $H_2PO_4^-$ it releasing of proton is not easy (it mainly exist in this form) HPO_4^{2-} same but weak but also it can exist in PO_4^{3-}
- the more it release proton the more of an acid it's strong acid = proton releasing is easy

Rule

- The stronger the acid, the weaker the conjugate base.

  the product we have

- Strong vs. weak acids
  - Strong acids and bases are one-way reactions

$$HCl \rightarrow H^+ + Cl^-$$

the ability to associate to proton is weak
it likes to be in form of chloride ion

$$NaOH \rightarrow Na^+ + OH^-$$

  - Weak acids and bases do not ionize completely

$$HC_2H_3O_2 \leftrightarrow H^+ + C_2H_3O_2^-$$

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

Equilibrium constant and Acid dissociation constant

- Acid/base solutions are at constant equilibrium.
- We can write equilibrium constant (K_{eq}) for such reactions

HA <--> H^++A^- → conjugate base

Acid

proton product amount of molarity of conjugate base

$$K_a = \frac{[H_3O^+] \cdot [A^-]}{[HA]}$$

reactant concentration of acid

Note: $H_3O^+ = H^+$

- The value of the K_a indicates the direction of the reaction.
  - When K_a is greater than 1 the product side is favored.
  - When K_a is less than 1 the reactants are favored.

Ka > 1 the products higher than the reactanc → Strong acid (it's mainly in the dissociated form)

Ka < 1 the reactanc higher than the products → Weak acid (it's mainly likes to be in the associated form "HA form")

What is pKa?

$$pK_a = -\log K_a$$

- Comparing Formic acid & Acetic acid: which one of them is stronger as an acid?
  - Formic acid → Stronger because we have more protons. It dissociate to proton & Conjugate base. unlike Acetic acid

TABLE 2.4 Dissociation constants and pK_a values of weak acids in aqueous solutions at 25°C

Acid	K_a(M)	pK_a
HCOOH (Formic acid)	1.77×10^{-4}	3.8
CH_3COOH (Acetic acid)	1.76×10^{-5}	4.8
$CH_3CHOHCOOH$ (Lactic acid)	1.37×10^{-4}	3.9
H_3PO_4 (Phosphoric acid)	7.52×10^{-3}	2.2
$H_2PO_4^{\ominus}$ (Dihydrogen phosphate ion)	6.23×10^{-8}	7.2
$HPO_4^{2\ominus}$ (Monohydrogen phosphate ion)	2.20×10^{-13}	12.7
H_2CO_3 (Carbonic acid)	4.30×10^{-7}	6.4
$HCO_3^{\ominus}$ (Bicarbonate ion)	5.61×10^{-11}	10.2
$NH_4^{\oplus}$ (Ammonium ion)	5.62×10^{-10}	9.2
$CH_3NH_3^{\oplus}$ (Methylammonium ion)	2.70×10^{-11}	10.7

- HCOOH (Formic acid) → we have more Formic acid than product "weak acid" ($K_a < 1$)
- CH_3COOH (Acetic acid) → " " "weak acid" ($K_a < 1$)
- Formic acid stronger than Acetic acid; stronger than Lactic acid
- H_3PO_4 stronger than $H_2PO_4^-$; $H_2PO_4^-$ stronger than HPO_4^{2-}

- HCL doesn't dissociate 100% we still have small amount of HCL really small
- it's in the product form than reactant

Strong Acids — the lower the pKa, the stronger the acid

TABLE | 9.4 K_A AND pK_A VALUES FOR SELECTED ACIDS

Name	Formula	K_a	pK_a
Hydrochloric acid	HCl	1.0×10^{7}	−7.00
Phosphoric acid	H_3PO_4	7.5×10^{-3}	2.12
Hydrofluoric acid	HF	6.6×10^{-4}	3.18
Lactic acid	$CH_3CH(OH)CO_2H$	1.4×10^{-4}	3.85
Acetic acid	CH_3CO_2H	1.8×10^{-5}	4.74
Carbonic acid	H_2CO_3	4.4×10^{-7}	6.36
Dihydrogenphosphate ion	$H_2PO_4^-$	6.2×10^{-8}	7.21
Ammonium ion	NH_4^+	5.6×10^{-10}	9.25
Hydrocyanic acid	HCN	4.9×10^{-10}	9.31

- which one is stronger H_3PO_4 or $H_2PO_4^-$?
  - H_3PO_4 → stronger.
  - Because the ability of $H_2PO_4^-$ to release a proton is harder than H_3PO_4
- Scientist used the (log) to make numbers easier to read & understand instaid of using K_a → $pK_a = -\log(K_a)$
- the lower the pKa the stronger the acid
- it's hard for a negativly charged molecule to release a proton

Molarity of solutions

- Solutions can be expressed in terms of its concentration or molarity.
- Moles of a solution are the amount in grams in relation to its molecular weight (MW or a.m.u.).

$$\text{moles} = \text{grams} / \text{MW}$$

- A molar solution is where the number of grams equal to its molecular weight (moles) in 1 liter of solution.

$$\text{M} = \text{moles} / \text{volume (L)}$$

- Since (mol = grams / MW), you can calculate the grams of a chemical you need to dissolve in a known volume (L) of water to obtain a certain concentration (M) using the following formula:

$$\text{grams} = \text{M} \times \text{volume (L)} \times \text{MW}$$

- Acids and bases can also be expressed in terms of their normality (N) or equivalence (Eq).

Exercise

molarity

molecular wighte

M x V(L) x MW

- How many grams do you need to make 5M NaCl solution in 100 ml (MW 58.4)?

100 ml ÷ 1000 = 0.1 L

v.I

- grams = 58.4 x 5 M x 0.1 liter = 29.29 g

5 x 0.1 x 58.4 ≃ 29.3

29.29

it's better to talk about acids, bases, and ions as

Because we remove anything that relate to molarity, number of charges, number of volumes we remove the factors

Equivalents

→ much easeir

- When it comes to acids, bases and ions, it is useful to think of them as equivalents.
- An equivalent is the amount of moles of hydrogen ions that an acid can donate .
  - or a base can accept.
- A 1 g-Eq of any ion is defined as the molar mass of the ion divided by the ionic charge.

1 mole HCL = ½ equivalent of H_2SO_4

Examples

- For acids:
- 1 mole HCl = 1 mole $[H^+]$ (proton) = 1 equivalent → it's the refeliction of how many protons: charges it can carries / can be preduced / can accept / hydroxil ion it can preduce
- 1 mole H_2SO_4 = 2 moles $[H^+]$ = 2 equivalents
  - 1 eq of H_2SO_4 = ½ mol (because 1 mole gives two moles of H^+ ions)

1 mole → 2 eq unlike 1/2 mole → 1 eq

- For ions:
- One equivalent of Na^+ = 23.1 g
- One equivalent of Cl^- = 35.5 g
- One equivalent of Mg^{2+} = (24.3)/2 = 12.15 g

Remember: One equivalent of any acid neutralizes one equivalent of any base.

- one equivalent of a certain ion = MW / charge

when I want to equalize acids and bases I have to take in consideration equivalents "not molarity or volume"
Because one equivalent of (A) should be equal of one equivalent of (B) regardless the charges

Molarity and equivalents

Equivalents = n x M x volume (L)

molarity → M; of the acid or the base → volume (L)

n → number of: charges; hydroxyl ions can be released; proton can accept; Proton can release

One equivalent of any acid neutralizes one equivalent of base.

Based on the equation above, since *x* eq of an acid is neutralized by the same *x* eq of a base, then (n x M x vol) of an acid is neutralized by (n x M x vol) of a base.

Problem 1

10.92 Titration of a 12.0 mL solution of HCl requires 22.4 mL of 0.12 M NaOH. What is the molarity of the HCl solution?

- Note that each one produces 1 mole of the ions (H^+ or OH^-), so 1M of HCl is equal to 1M of NaOH.

Eq of base = Eq of acid

n x M1 x Vol1 = n x M2 x Vol2

1 x M1 x 12= 1 x 0.12 x 22.4

M1 = (0.12 x 22.4) / 12

M1 = 0.224 M

Problem 2

10.93 What volume of 0.085 M HNO_3 is required to titrate 15.0 mL of 0.12 M $Ba(OH)_2$ solution?

- Note that 1 mole of HNO_3 produces 1 mole of H^+, but 1 mole of $Ba(OH)_2$ produces 2 moles of OH^-. In other words, the n is different.
- Also, remember that **Equivalents = n x M x volume (L), where n is the number of charges or the number of H + (or OH-) the acid or base can produce or accept.**
- Titration means that we an acid to a base slowly. At one point during titration, the acid and the base neutralize or cancel each other. In other words, "to titrate" means "to neutralize". At the point of neutralization, the concentration of H+ is equal to the concentration of OH-. The best way to calculate how much acid is needed to neutralize a base (or the opposite) is to calculate the equivalents.

$Eq = n \times M \times V(L)$

$HNO_3 = 1 \times 0.085 \times V(L)$?

$Ba(OH)_2 = 2 \times 0.12 \times 15 ml$

Eq of acid = Eq of base

N x M1 x Vol1 = n x M2 x Vol2

1 x 0.085 x Vol = 2 x 0.12 x 15

Vol = (2 x 0.12 x 15) / 1 x 0.085

Vol = 42.35 mL

$V(L) = \frac{2 \times 0.12 \times 0.015}{0.085}$

42.35 mL = 0.04235 L

Ionization of water

① ②

- Water dissociates into hydronium (H_3O^+) and hydroxyl (OH^-) ions.
- For simplicity, we refer to the hydronium ion as a hydrogen ion (H^+) and write the reaction equilibrium as:

change the Volume

((it exist in an equilibrium form))

thoes Should increase

$$H_2O \rightleftharpoons H^+ + OH^-$$

pure

if we increased it

وعلى قولة الدكتور :- " وإلي جاي "

everytime H_2O dissociate the products make joint forces to form H_2O at a certian equilibrium

wate must reach equilibrium

Equilibrium constant

- The equilibrium constant Keq of the dissociation of water is: (pure)

pure water exist in equilibrium So! there's equilibruim constant
like any acid
- water preduce proton → acid
- water preduce hydroxyl ion → base

the equilibruim Constant for water :- 1.8×10^{-16} M

$$K_{eq} = \frac{[H^{\oplus}][OH^{\ominus}]}{H_2O}$$

pure water → K_{eq} ; this's constant → K_{eq}

→ thoes product form a joint & make water ↳ that was dissociated

H_2O ← this's constant

- The equilibrium constant for water ionization under standard conditions is 1.8×10^{-16} M.

if I have 1 mole of H_2O then I have 1.8×10^{-16} of $[H^{\oplus}][OH^{\ominus}]$
which is realy little much much much less than H_2O
& that's why water mainly exist in H_2O form not as it ions

- which means if I have 1 mole of H_2O I should have 1 of $[H^{\oplus}][OH^{\ominus}]$ to give us 1.8×10^{-16} M
- Again if I have pure water I have concentration like you put pure water in water what's it molarity? it's Constant

- if we multipled H_2O & Keq we will have a constant
  - this also will lead that the molarity / moles will be constant
- the concentration of water isn't effected by anything "when it's a water – water reaction" Because the concentration will be the same and if you add water or remove water only the volum will change but not the concentration

Kw

- Since there are 55.6 moles of water in 1 liter, the product of the hydrogen and hydroxide ion concentrations results in a value of 1×10^{-14} for:

water concentration → $$K_{eq}(55.5\ M) = [H^{\oplus}][OH^{\ominus}]$$

- This constant, Kw, is called the ion product for water

$$K_w = [H^{\oplus}][OH^{\ominus}] = 1.0 \times 10^{-14}\ M^2$$

- Kw :- equilibrium constant / ionic product of water
  which is :- $[H^{\oplus}] \cdot [OH^{\ominus}] = 1.0 \times 10^{-14} M^2$

$[H^+]$ and $[OH^-]$

- the concentration of OH^- is relative to H^+ "the same"
- both of them 1.0×10^{-7} which:- $1.0\times10^{-7} \times 1.0\times10^{-7} = 1.0\times10^{-14}$
- water is neutral — Same amount of protons + hydroxyl ions

- For pure water, there are equal concentrations of $[H^+]$ and $[OH^-]$, each with a value of 1×10^{-7} M.
- Since Kw is a fixed value, the concentrations of $[H^+]$ and $[OH^-]$ are inversely changing.
- If the concentration of H^+ is high, then the concentration of OH^- must be low, and vice versa. For example, if $[H^+] = 10^{-2}$ M, then $[OH^-] = 10^{-12}$ M

- if I have a solution & the concentration of H^+ high the solution will be acidic
- if I have a solution & the concentration of OH^- high the solution will be basic / alkaline