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First Exam - Chapter Two

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معنا نرسم خطوط النجاح ...

Water: The Solvent for Chemical Reaction

Definitions:

- 1) **Polar bond:** a bond in which electrons are shared unequally between bonding atoms. So, electrons are shifted more towards one atom.
- 2) **Electronegativity:** The tendency of an atom to attract electrons to itself in a covalent bond. So, the bonding electrons are closer to the atom with higher electronegativity.

Note: each atom has its own electronegativity score, with flourine being the most electronegative element, carrying a value of 4.0.

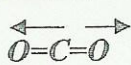
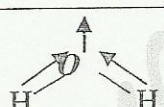
		H 2.1						
1A	2A		3A	4A	5A	6A	7A	
Li	Be		B	C	N	O	F	
1.0	1.5		2.0	2.5	3.0	3.5	4.0	

3) Non polar bond:

Is the bond in which the difference in electronegativity between atoms is very small or equal. An example of that is the C—H bond.

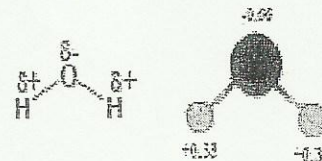
4) Dipole: is a bond with a -ve and +ve ends.

➤ Accordingly we have:

<u>Non polar molecule:</u> (May contain polar bonds but the overall geometry makes it non polar)	<u>Polar molecules:</u>
Ex: CO_2 	Ex: H_2O 
CO_2 contains <u>polar bonds</u> but in a <u>linear configuration</u> (all bonds are on the same straight line), so the attraction of electrons by the oxygen of one bond is cancelled by the attraction of the 2 nd one, because they are in opposite directions.	H_2O contains <u>polar bonds</u> but a <u>bent configuration</u> with the angle between the two bonds is 104.3°. So, the attraction of electrons by one bond is not cancelled by the other, and the electrons are deviated toward the oxygen atom.

➤ The Structure of water molecule:

- Two hydrogen atoms each carries a partial +ve charge (δ^+)
- One oxygen atom that carries a partial -ve charge (δ^-) and 2 pairs of unshared electrons.



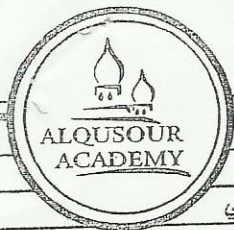
- Note they are partial not complete charges as in ionic compounds
- Water is hence a polar molecule due to the following:
 - It contains polar bonds with higher electronegativity of O atom which carries a partial -ve charge.
 - The configuration is bent and the polar bonds are not cancelled out.

➤ Solvent properties of water:

- Because water is polar molecule, it is considered a good solvent for:

1- Ionic compounds with full -ve and +ve charges (KCl, NaCl).

2- Polar compounds with partial charges (dipoles) such as: alcohols, amines and carboxylic acid.



- This solubility is due to the electrostatic attraction between unlike charges of the solvent and solute.

➤ Types of interactions found in solutions:

1. Ion-dipole interactions
2. Dipole-dipole interactions
3. Dipole-induced dipole interactions
4. Van Der Waals interactions

1- **ION-DIPOLE:** like between ionic compounds (NaCl, KCl) and water.

2- **DIPOLE-DIPOLE:** like between water molecules each other or with other polar compounds that contain one or more electronegative atoms. (E.g. Alcohol, amines, carboxylic acids).

- These types of interactions (1 & 2) hold the unlike charges in proximity to each other. Therefore, it lowers the energy of the system and makes it more stable and more likely to exist.

☺ Molecules that dissolve in water in this way are called **hydrophilic** (Water – loving).

3- **DIPOLE-INDUCED DIPOLE:**

- This kind of interactions is unique for non-polar molecules with water.

- In this type of interactions the permanent dipole (water) induces a temporary dipole in the non polar molecule by **distorting** the spatial arrangement of electrons in its bonds, so that temporary partial charges are formed and interact with the partial charges on water.

- BUT these interactions are not as strong as the previous ones, less likely to occur and less stable.

☺ So, non polar molecules are said to be not dissolved in water and are called **hydrophobic** (water-hating). An example of them is Hydrocarbons.

☺ Non polar compounds may be solid (which sequester and leave undissolved material in water) or liquid (forms a layer system when put in water such as oil).

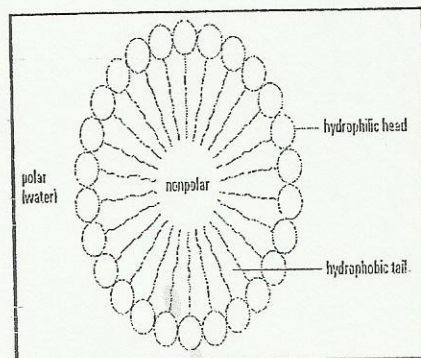
Table 2.2

Examples of Hydrophobic and Hydrophilic Substances

Hydrophilic	Hydrophobic
Polar covalent compounds [e.g., alcohols such as C_2H_5OH (ethanol) and ketones such as $(CH_3)_2C=O$ (acetone)]	Nonpolar covalent compounds [e.g., hydrocarbons such as C_6H_{14} (hexane)]
Sugars	Fatty acids, cholesterol
Ionic compounds (e.g., KCl)	
Amino acids, phosphate esters	

➤ Why do oil and water mixed together separate into layers?

The association of water with oil (hydrophobic molecules) is less thermodynamically stable and hence less favorable than the association of water molecules together, and thus oil arranges itself in water in the form of micelles.



➤ **Micelles:** structures formed in water by amphipathic molecules in which the polar head groups are in contact with the water and the nonpolar tails are away from the water (sequestering in the middle)

➤ **Amphipathic compounds:** These are compounds that contain both hydrophobic and hydrophilic portions; (e.g.: fatty acids and phospholipids that form cell membranes).

• The-2 portions are:

1. **Head;** *hydrophilic* carboxylic end. this part is very polar and can form carboxylate anion (COO^-) at neutral pH.
2. **Tail;** contains long chain of C—H bonds; it is non polar and do not dissolve in water (*hydrophobic*).

• That's why oil and water will separate when mixed.

4- VAN DER WAALS: interactions that occur between non polar compounds themselves.

➤ Here a temporary dipole forms by momentary clumping of bonding electrons at one end of the molecule. This temporary dipole can induce another dipole in an adjacent molecule in the same way that a permanent dipole does.

☺ These interactions are very weak and short lived.

Water can form all types of bonding with solutes except for van der waal type which is only found between nonplar molecules themselves. In addition to that water forms a unique type of bonding called the Hydrogen bond.

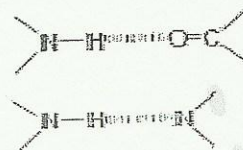
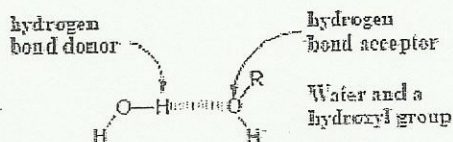
➤ HYDROGEN BONDS:

▪ It is a non covalent bond and a special type of dipole-dipole interaction.
How do such bonds form?

▪ In this kind of bonds, the partial +ve charge on H in the polar bonds like O—H , N—H , F—H , interacts with the unshared pairs of electrons on another electronegative atom (O, N, F).

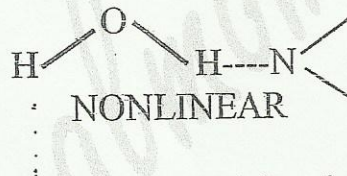
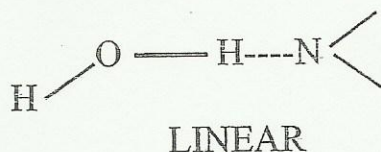
Components of the H-bond:

- 1) **H-Bond donor**: the electronegative atom which is covalently bonded to H.
- 2) **H-Bond acceptor**: the electronegative atom which gave the unshared pairs of electrons, and **NOT covalently bonded** to H.



- The 3 atoms that participate in the H-bond may have **LINEAR** or **NON LINEAR** arrangement.

- Which arrangement will give the strongest interaction?

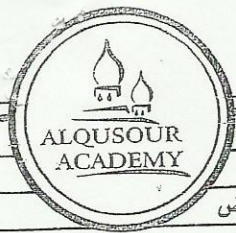


- The linear one gave the H the greatest +ve charge and thus the strongest possible interaction with the unshared pairs of electrons on the electronegative atom.

EXAMPLES of molecules that form H-bonds:

- H_2O : water constitute an optimum situation in terms of the number of H-bonds that each molecule can form. It has 2 H atoms and 2 pairs of electrons on the oxygen. Each water molecule is involved in 4 H-bonds with other water molecules; as a donor in two and as an acceptor in two.
- H-F : has only one H atom to enter into a hydrogen bond as a donor and 3 pairs of electrons that could bond to other hydrogen.
- NH_3 : Have 3 H atoms to donate to a hydrogen bond, but only one pair of electrons on the nitrogen.
- H-bonds are weaker than covalent bonds, so less energy is needed to break them; 20 kJ/mol is needed in comparison with 460 kJ/mol for covalent bonds.

	Type of Bond	Energy*	
		(kJ mol ⁻¹)	(kcal mol ⁻¹)
Covalent Bonds (Strong)	O—H	460	110
	H—H	416	100
	C—H	413	105
Noncovalent Bonds (Weaker)	Hydrogen bond	20	5
	Ion-dipole interaction	20	5
	Hydrophobic interaction	1-12	1-3
	Van der Waals interactions	1	1



➤ According to strength bonds can be arranged in the following order:

H-bond > ion-dipole > dipole-dipole > dipole induced dipole > Van der Waal

NOTE: The geometric arrangement of these H-bonds around the water molecule affects the properties of water as a solvent. The bond angle between the O—H bonds is 104.3° and the angle between the unshared pairs of electrons is the same.

➤ Also each water molecule can associate with 4 other molecules through 4 hydrogen bonds forming a tetrahedral structure.

☺ This arrangement of H-bond in water including the number, the strength and the geometry gives water the following characteristics:

- | | |
|-----------------------|-------------------------|
| 1- High melting point | 2- High boiling point |
| 3- Low density of ice | 4- Larger volume of ice |

EXPLANATION:

▪ In 1 & 2: the melting point and the boiling point of water are significantly higher than that for compounds with the same molecular weight as water like methane (CH_4) and ammonia (NH_3), why?

The forces of attraction between the molecules of these compounds are weaker than that between water molecules; this is because of the number and the strength of water H-bonds.

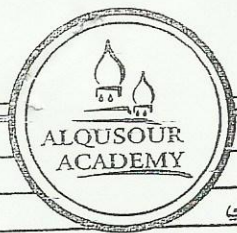
▪ In 3 & 4: H-bonds are found in both the liquid and ice forms of water.

▪ BUT in the liquid form only, these bonds are broken constantly and others are formed in a dynamic process that occurs in parts of seconds. So, liquid water is less extensively hydrogen-bonded than ice which has a fully hydrogen-bonded array in its crystals (lattice).

▪ Thus, there are no empty spaces between water molecules in the liquid form (*more packing*), while a lot of these spaces are seen in the ice crystals (*less packing*). That's why liquid water is denser and lesser in size than ice.

➤ H-BONDS AND WATER AS A SOLVENT:

H-bonds can also form between water and other polar molecules which can act as bond donor or acceptor, so non-specific dipole-dipole interactions are formed and these molecules are said to be dissolved in water. Examples of these molecules are Alcohols, amines, esters, carboxylic acids, aldehydes and ketones.



➤ BIOLOGICAL IMPORTANCE OF H- BONDS:

These bonds play a key role in stabilizing the 3-D structure of several important biological molecules:

- 1- Interstrand H-bonds are found between the complement bases of DNA double helix.
- 2- It gives the 3D structure of t-RNA
- 3- In proteins, it gives the 3-D shape of α -helix and β -pleated sheets (Intra-strand and Inter-strand H-bonds).

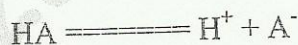
➤ ACIDS AND BASES:

Definitions:

Acid: any molecule that can act as proton (hydrogen ion) doner.

Base: any molecule that can act as proton acceptor.

- Acids are classified into:
 1. Strong acids with complete dissociation in water like HCL
 2. Weak acids with intermediate dissociation
 3. Very weak with almost no dissociation
- The **strength** of each acid can be measured numerically by calculating the **acid dissociation constant** (K_a value).
- K_a value express the amount of H^+ released when a given amount of acid is dissolved in water.
- RULE:** The larger the k_a value, the stronger the acid.
- To calculate the K_a we should know the acid dissociation equation:



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

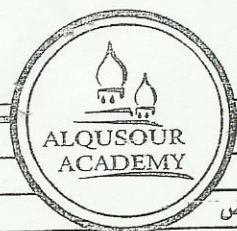
- A more correct way to write the equation is:
$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

Acid	base		conjugate	conjugate
			Acid	base

- In this equation water is the solvent and it acts as a base.

➤ What is pH?

- pH is a numerical measure of the acidity of the solution, and it range from 0 to 14.



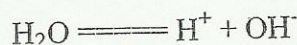
- pH is a number to express the hydrogen ion concentration in various solutions instead of using the exponential notation.
- pH can be calculated as follow:

$$\text{pH} = -\log [\text{H}^+]$$

- A one point difference in pH means a 10 fold difference in $[\text{H}^+]$ concentration.

☒ How to calculate the $[\text{H}^+]$ IN WATER?

Water in aqueous solutions self dissociate into:



- This dissociation is very small and the +ve and -ve ions interact with water molecules.

Quantitative estimation of the dissociation of water:

$$K_a = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$$

- The molar concentration of Pure water is large and constant and equals 55.5 [by dividing the number of grams of water in 1 L (1000g) by the MW of water (18g/mol)] $\rightarrow (1000/18 = 55.5\text{M})$

$$\text{So, } K_a * 55.5 = [\text{H}^+][\text{OH}^-] = K_w$$

- K_w is a new constant and is considered the ion product constant of water.
- Because water is considered a monoprotic acid (*it releases single proton/molecule*) then $[\text{OH}^-] = [\text{H}^+]$.
- In pure water at 25°C the $K_w = 10^{-14}$, so the concentration of $\text{H}^+ = 10^{-7}$. So,

$$\text{pH} = -\log 10^{-7} \rightarrow \text{pH} = 7$$

☺ So, pure water is considered a neutral solution

☺ Facts & Rules:

- Pure water $\rightarrow \text{pH} = 7$ Acids $\rightarrow \text{pH} < 7$ Bases $\rightarrow \text{pH} > 7$
- $\text{pK}_a = -\log K_a$.
- There is an inverse relation between pK_a and the strength of the acid.

- $K_w = [H^+] [OH^-] = 10^{-14}$
- $pH = -\log [H^+]$

Examples on the optimum pH for certain enzymes:

Pepsin functions properly at pH = 2
Lysozyme at pH = 5
Trypsin at pH = 6

EXAMPLE:

In pure water $[H^+] = 1 \times 10^{-7}$ and $pH = 7$, accordingly calculate the pH of the following solutions:

1- 1×10^{-3} M of HCL

This is a strong acid with full dissociation so the $[H^+] = [HCL] = 1 \times 10^{-3}$
 $pH = -\log 1 \times 10^{-3} = 3$

2- 1×10^{-4} M of NaOH

This is a strong base with full dissociation
 $[OH^-] = 1 \times 10^{-4}$
 $[H^+] = 1 \times 10^{-14} / 1 \times 10^{-4} = 1 \times 10^{-10}$
 $pH = 10$

☒ How can we calculate the pH for solutions containing weak acids?

- By using the Handerson Hasselbalch equation:

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

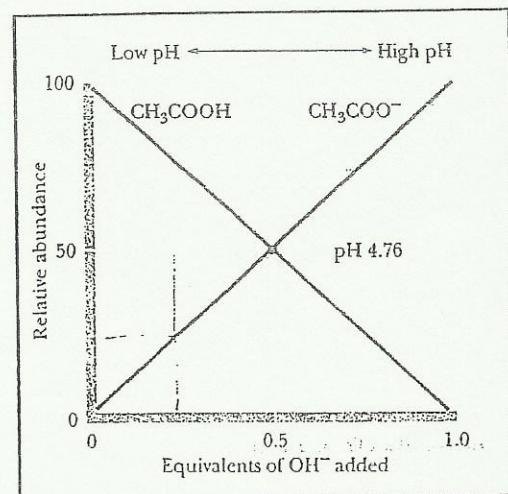
- According to this equation, there is a special situation in which $pH = pK_a$. This occurs *when the weak acid is 50% dissociated*, so the $[HA] = [A^-]$ and the *ratio between them is 1*, and as you know $\log 1 = \text{zero}$.

☒ Titration and titration curves:

- Titration is an experiment where a measured amount of base is added to a measured amount of acid and the pH is monitored during the reaction with a pH meter.

? What happens during the titration process?

- During the addition of the base, the concentration of the acid is decreasing (because it reacts with the added base) and the concentration of the conjugated base is increasing. The opposite is true when adding the strong acid.



- Notice that at each point in the reaction the sum of $[A^-] + [HA]$ adds up to 100%; as you can see in the figure to the right.
- In the figure, CH_3COOH is the acetic acid (HA), while CH_3COO^- is the acetate (A^-).
- Points to know in the titration curve:

1- Equivalence point:

It is the pH at which all the acid has been neutralized by the base; which means that all the acid is in the deprotonated form (A^-).

2- Inflection point:

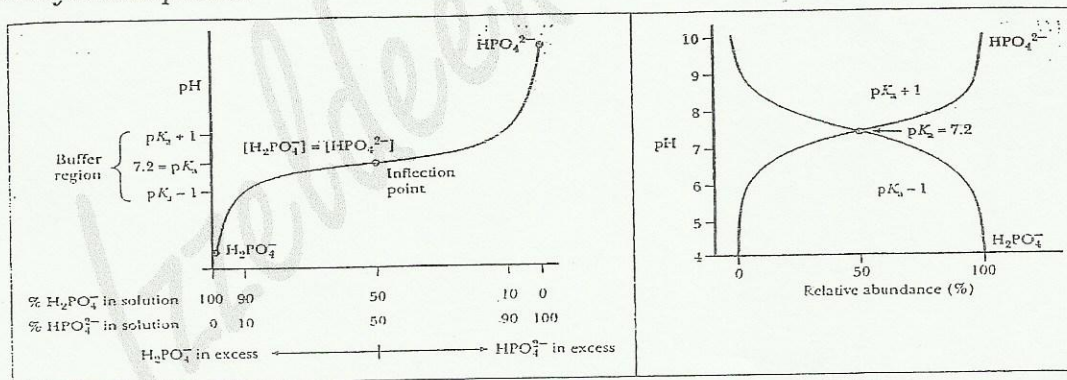
It is the pH at which equal amounts of the weak acid and its conjugated base is present, that is $[A^-] = [HA]$.

☺ At this point 50% of the weak acid is dissociated; So, when applying Henderson Hasselbach equation;

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

Then the $[A^-] / [HA]$ ratio equals 1----- at this point $pH = pK_a$

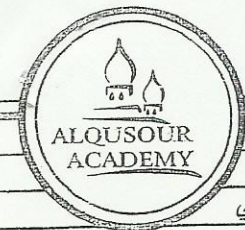
NOTE: For each weak acid the value of pK_a determines the pH at the equivalence and the inflection points.



Ⓐ The titration curve of $H_2PO_4^-$, showing the buffer region for the $H_2PO_4^-/HPO_4^{2-}$ pair.

Ⓑ Relative abundance of $H_2PO_4^-$ and HPO_4^{2-} .

- From the curve, notice that pH changes around the inflection point is very minimal and is called the plateau region, and this area represents the area of the buffering capacity of the weak acid.
- Also notice in the curve of relative abundance above, that when the pH of the solution is less than pK_a then most of the acid is in the protonated form.
- BUT when the pH is larger than the pK_a , then most of the acid will be in the deprotonated form (conjugated base).



☒ In general we have 3 groups of acids in terms of their dissociation:

1. Monoprotic acids

One H^+ is released from one molecule of the acid, they have one pKa.

2. Diprotic acids

Two H^+ is released from one molecule of the acid, they have two pKa values.

3. Polyprotic acids

More than 2 pKa values and more than two H^+ is released examples are Citric acid and phosphoric acid.

Note: Amino Acids and Peptides are considered di- and polyprotic acids.

Example on titration:

Calculate the amount of acetic acid and acetate ion when 1 mole of acetic acid is titrated with 0.3 mole of NaOH and then calculate the pH of the solution?

FIRST, the reaction between acetic acid and NaOH is a 1:1 reaction. That is one mole of the acid reacts with one mole of the base.

SO, the added 0.3 mole of NaOH will react with 0.3 mole of acetic acid and consequently 0.7 moles of the acetic acid remains in the solution and 0.3 mole of acetate ion is formed.

Using the equation:

$$\begin{aligned} \text{pH} &= \text{pKa} + \log \frac{[A^-]}{[HA]} \\ &= 4.76 + \log 0.3/0.7 \\ &= 4.39 \end{aligned}$$

Calculate the pH for the same solution when 0.5 mole of NaOH is added?

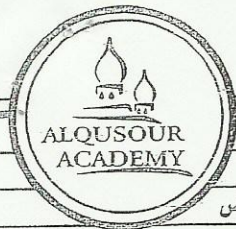
0.5 Mole of NaOH will react with 0.5 mole of acid so 0.5 mole of acid remain and 0.5 mole of acetate form.

So, the $[A^-] = [HA] = 0.5$

▪ At this point the $\text{pH} = \text{pKa} = 4.76$ (the inflection point).

☒ Buffers and their importance:

▪ Buffer is a solution of a weak acid and its conjugate base which RESISTS pH changes when small to moderate amount of strong acid or base is added.



- For example we can't consider pure water as a Buffer because drastic changes in pH will take place when HCL or NaOH is added to. To convince you, look at this example:

EXAMPLE:

Calculate the pH of the solution of 99 ml of pure water when:

- 1) 1ml of 0.1 M HCL is added?
- 2) 1ml of 0.1 M NaOH is added?

Note: the total volume will be $99+1=100\text{ml}$

1) $[\text{HCL}] = 0.1/100 = 0.001 = 1 \times 10^{-3}$
SO $[\text{H}^+] = 1 \times 10^{-3}$
pH = 3

2) $[\text{NaOH}] = 0.001$
So, $[\text{OH}^-] = 1 \times 10^{-3}$
 $[\text{H}^+] = 10^{-14} / 10^{-3} = 10^{-11}$
pH = 11

So as you notice drastic changes took place from the original pH value of pure water which was 7 upon adding v.small amounts of both acid or base

- Always remember to use the following equations for 1. Water 2. Strong acids and bases:

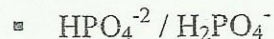
$$K_w = 10^{-14} = [\text{H}^+][\text{OH}^-] \quad \text{pH} = -\log [\text{H}^+]$$

- BUT for weak acids use the *Henderson Hasselbalch equation*:
 $\text{pH} = \text{pKa} + \log [\text{A}^-]/[\text{HA}]$

How can the buffer solutions maintain the pH?

- When a strong acid is added (H^+) it reacts with the conjugate base. So, all the added H^+ will be consumed and won't change the pH.
- AND VICE VERSA, when a strong base is added (OH^-) it react with the weak acid so it is consumed and the pH doesn't change that much.
- RECALL THAT The buffering capacity of the system is located around the inflection point where little changes occur in pH at the time when pH is equal or around the pKa of the weak acid; **Buffering capacity** area is located between the values pKa +1 and pKa -1 and include the point at which the ratio of $[\text{A}^-]/[\text{HA}] = 1$

Example on buffers:



The pK_a for this acid is 7.2 and accordingly it acts as a buffer when the pH is equal or around 7.2.

If this pH is increased by one (it became 8.2) then the ratio of $[\text{HPO}_4^{2-}] / [\text{H}_2\text{PO}_4^-]$ is increased by 10.

If it increases by 2, the ratio increase by 100 Etc.

If the pH equals	The ratio of base form/acid form equals
$pK_a - 3$	1 / 1000
$pK_a - 2$	1 / 100
$pK_a - 1$	1 / 10
pK_a	1 / 1
$pK_a + 1$	10 / 1
$pK_a + 2$	100 / 1
$pK_a + 3$	1000 / 1

Important:

- The condition that a buffer contains appreciable amount of both a weak acid and its conjugate base applies both to the ratio of the two forms and to the absolute amount of each present in a given solution.
- So, if a buffer solution contained a suitable ratio of acid to base, but very low concentration of both, it would take very little added base to use up all of the acid form, and vice versa. So, buffers are divided into buffers with:
 - 1) Low buffer capacity:
Contains low concentration of the acid and base forms.
 - 2) High buffer capacity
Contains high concentration of both.

Example showing how buffer solutions resist changes in pH when a strong acid or base is added:

A 99 ml buffer solution contains 0.063 M of HPO_4^{2-} and 0.1 M of H_2PO_4^- . Calculate the pH of the solution when 1 ml of 0.1 M of HCL is added: ($pK_a = 7.2$).

The new volume is $99 + 1 = 100\text{ml}$

FIRST, we calculate the new HCl concentration
 $[\text{HCL}] = 0.1/100 = 0.001 \text{ M} = 1 \times 10^{-3} \text{ M}$

	[HPO ₄ ⁻²]	[H ⁺]	[H ₂ PO ₄]
Before HCl	0.063	1 x 10 ⁻⁷	0.1
With HCl, no reaction	0.063	1 x 10 ⁻³	0.1
After reaction	0.062	???	0.101

$$\begin{aligned} \text{pH} &= \text{pKa} + \log \frac{[\text{HPO}_4^{-2}]}{[\text{H}_2\text{PO}_4]} \\ &= 7.2 + \log 0.062/0.101 \\ &= 6.99 \end{aligned}$$

As you notice this is a very minimal change in pH from 7.2 to 6.99.

☒ Biological importance of the buffers:

The main buffer systems in our bodies:

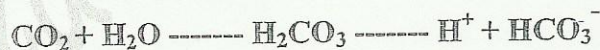
1. Phosphate H₂PO₄⁻/ HPO₄⁻², present inside cells
2. Carbonic acid H₂CO₃/HCO₃⁻, the main buffer system in the BLOOD.

The pKa of H₂CO₃ is 6.37

The pH of the blood is 7.4

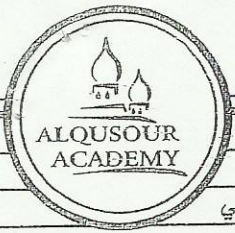
☺ Explanation:

When CO₂ is produced it will dissolve in water containing fluids (blood mainly) and carbonic acid (H₂CO₃) will be produced, which in turn dissociates to produce bicarbonate ion (HCO₃⁻).



And because the pH of the blood is slightly higher than the pKa, then most of the CO₂ is present in the form of bicarbonate (the deprotonated form).

- ☺ Buffering systems in our bodies are important to maintain pH in a constant range so that our enzymes and proteins will function optimally.



Questions:

- 1) The Van Der Waal interactions are:
 - a. Strong and permanent
 - b. Strong and temporary
 - c. Weak and permanent
 - d. Weak and temporary
 - e. None of all

- 2) All are hydrophilic compounds Except:
 - a. Alcohol-
 - b. Ammonia
 - c. Lipids
 - d. Carboxylic acid
 - e. Acetone-

- 3) Which of the following atoms will be the electronegative pole if covalently bonded with nitrogen atom?
 - a. Phosphorous
 - b. Sulfur
 - c. Oxygen
 - d. Nitrogen
 - e. Hydrogen

- 4) The inflection point is characterized by:
 - a. $\text{PH} = \text{pKa}$
 - b. $[\text{A}^-] = [\text{HA}]$
 - c. High buffering capacity
 - d. All of the above

- 5) When $\text{pH} = \text{pKa} + 1$, the (dissociation) / (undissociation) ratio will be:
 - a. 100/1
 - b. 1000/1
 - c. 10/1
 - d. 1/1
 - e. None of the above

- 6) If the pKa of acetic acid is 5 and the ratio of $\text{CH}_3\text{COO}^- / \text{CH}_3\text{COOH}$ is 100, the pH will be:
 - a. 3
 - b. 4
 - c. 5
 - d. 6
 - e. 7

7) 99% dissociation of amino acid occur when:

- $pK_a < pH$ with one unit
- $pK_a < pH$ with two unit
- $pH < pK_a$ with one unit
- $pH < pK_a$ with two unit

8) Which substance would be a suitable buffer at pH 7.4?

- One with a pK_a of 3.8
- One with a pK_a of 4.8
- One with a pK_a of 6.3
- One with a pK_a of 7.7

9) The pK_a values given below represent different weak electrolytes, which one has the strongest tendency to give up its protons?

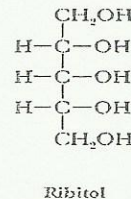
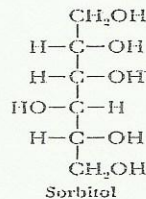
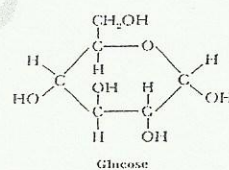
- 2.6
- 9.4
- 3.7
- 1.8
- 7.4

10) The protonated form of an acid in a titration curve predominates when:

- $pH < pK_a$
- $pH > pK_a$
- $pH = pK_a$
- at the equivalence point
- at the inflection point

11) How many water molecules could hydrogen bond directly to molecules of:

- Glucose
- Sorbitol
- Ribitol



12) Identify the conjugate acid and bases in the following pairs of substances:

- $(CH_3)_3NH^+ / (CH_3)_3N$
- $^+H_3N-CH_2COOH / ^+H_3N-CH_2COO^-$
- $^+H_3N-CH_2COO^- / H_2N-CH_2COO^-$
- $^-OOC-CH_2-COOH / ^-OOC-CH_2-COO^-$
- $^-OOC-CH_2-COOH / HOOC-CH_2-COOH$

Solutions

Question no.	Answers
1	D. Weak and temporary
2	C. Lipids
3	C. Oxygen
4	D. All of the above
5	C. 10/1
6	E. 7
7	B. $pK_a < pH$ with two unit.
8	D. One with a pK_a of 7.7
9	D. 1.8
10	A. $pH < pK_a$

Answer for question # 11: Glucose → 17 water molecule
Sorbitol → 18 water molecule
Ribitol → 15 water molecule

Answer for question # 12:

- 1) Conjugate acid / conjugate base
- 2) Conjugate acid / conjugate base
- 3) Conjugate acid / conjugate base
- 4) Conjugate acid / conjugate base
- 5) Conjugate base / conjugate acid

تواصل معنا

نحن يمكننا معرفة التلاخيص المطروحة لحظة إصدارها
و معرفة كل جديد لدينا من دورات من خلال



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