xarihant

hand **book**

KEY NOTES | TERMS DEFINITIONS | FORMULAE

Chemistry

Highly Useful for Class XI & XII Students, Engineering & Medical Entrances and Other Competitions



Handbook of Chemistry

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Description:

Chemistry of higher level has too many laws, theories, reactions, rules and its exceptions and remembering all them on tips all the time is not an easy task. Handbook of Chemistry is an important, useful and compact reference book suitable for everyday study, problem solving or exam revision for class XI - XII. This book is a multi-purpose quick revision resource that contains almost all key notes, terms, definitions, equations, formulae that all students & professionals in chemistry will want to have this essential reference book within easy reach. Its unique format displays formulae clearly, places them in the context and crisply identifies describes all the factors involved, summary about every equations and reactions that one might want while learning chemistry is one of the unique features of the book, a stimulating and crisp extract of fundamental chemistry is to be enjoyed by the beginners and experts equally. The book is best-selling from its first edition and one of the most useful books of its type. Table of contents Basics of Chemistry, Atomic Structure, Classification of Elements and Periodicity, States of Matter, The Solid State, Chemical Bonding and Molecular Structure, Thermodynamics, Chemical Equilibrium, Ionic Equilibrium, Solutions, Redox Reactions Electrochemistry, Chemical Kinetics Surface chemistry, Colloidal State, Principle and Processes of Isolation of Elements, Hydrogen, The s-Block Elements, p-Block and f-block Elements, Coordinate Compounds, Environmental Chemistry, Purification and Characterisation of Organic Compounds, Hydrocarbons, Haloalkanes and Haloarenes, Alcohols, Phenols and Ethers, Aldehydes, Ketones and Carboxylic Aids, Amines, Polymers, Biomolecules, Chemistry in Everyday Life, Nuclear Chemistry, Analytical Chemistry.

31. Biomolecules

- Carbohydrates Lipids
- Amino Acids
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 Blood
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Biomolecules

Biomolecules are the organic compounds which form the basis of life, i.e. they build up the living system and responsible for their growth and maintenance.

The sequence that relates biomolecules to living organism is

Biomolecules ® Organelles ® Cells ® Tissues ® Organs ® Organ systems ® Living organism.

Carbohydrates

Optically active polyhydroxy aldehydes (aldoses) or ketones (ketoses) or the compounds which produce these units on hydrolysis are known as carbohydrates. They are also called **saccharides**. **Classification**

of Carbohydrates

(i) Reducing and Non-reducing Sugars

Based upon reducing and non-reducing properties, carbohydrates are classified as reducing and non-reducing sugars. Carbohydrates that reduces Fehling's reagent or Tollen's reagent are termed as reducing carbohydrates. e.g. All monosaccharides and disaccharides (except sucrose). But carbohydrates which do not reduce such reagents are known as non-reducing carbohydrates. e.g. sucrose and polysaccharides.

(ii) Sugars and Non-sugars

On the basis of taste, carbohydrates are classified as sugars and nonsugars. The monosaccharides and oligosaccharides having sweet taste are collectively known as **sugars**. Polysaccharides which are insoluble in water and not sweet in taste, are known as **non-sugars**. (Latin *Saccharum* = sugar) due to sweet taste of simpler members. *(iii) Monosaccharides, Oligosaccharides and Polysaccharides* Depending upon the number of simple molecules produced upon hydrolysis, carbohydrates are classified as, monsaccharides,

oligosaccharides and polysaccharides :

I. Monosaccharides

These cannot be hydrolysed further to simpler molecules and subdivided into tetroses, pentoses or hexoses depending upon the number of carbon atoms. These are also called **homopolysaccharides**.

Aldotetroses	e.g Erythrose, Threose	
Aldopentoses e.g Xylose, Ribose		
Aldohexoses e.g Glucose, Galactose		
Ketohexoses	e.g Fructose	

All naturally occurring monosaccharides belong to D-series. **Killiani synthesis** is used to convert an aldose into next higher aldose.

1. Glucose

It is also known as Dextrose. It is present in grape sugar, corn sugar, blood sugar (C H $O_{6 \ 12 \ 6}$).

Manufacture

By hydrolysis of starch with hot dil mineral acids and by hydrolysis of sucrose.

Extra glucose is stored in liver as glycogen.

a and b-glucose

In intermolecular hemiacetal formation (cyclic structure), —CHO is converted into —CHOH which can have two configurations as shown below

$H - C - OH_1$	$HO - C - H_1$
a-form (i)	b-form (ii)

Glucose having (i) configuration about C_1 is the a-glucose and having

(ii) configuration about C_1 is b-glucose. The carbon C_1 is known as **anomeric** carbon and these compounds are called **anomers**. Both the forms are optically active. a-D-glucose has specific rotation +111.5° and b-D-glucose has specific rotation + 19.5°.

Mutarotation

When either of the two forms of glucose is dissolved in water, there is a spontaneous change in specific rotation till the equilibrium value of $+52.5^{\circ}$. This is known as mutarotation.

a-D(+) Glucose Q	Equilibrium mixture ${\bf Q}$	b-D-(+) Glucose
+111.5°	+ 52.5°	+19.5°

Properties of Glucose

Glucose has one aldehyde group, one primary hydroxyl ($\frac{3}{4}$ CH OH₂) and four secondary hydroxyl (—CHOH) groups and gives the following reactions:

(i)	Glucose on	acetylation	with aceti	canhydride	givesa
	pentaacetateco	onfirming the p	presence of five	e hydroxyl gr	oups in
	glucose.				
	СНО		СНО		
	1/2		1/2		
	$(CHOH)_4 + 5(C$	H CO) O ₃₂ ¾ ®	(CHOCOCH ₃)	$)_4 + 5 CH$	$\rm CO_3$
	OH				
	1/2		1/2		
	CH OH ₂		CH OCOCH	2 3	
	glucose		pentacetyl gluc	ose	

(ii) Glucose reacts with hydroxylamine to give monoxime and addswith a molecule of hydrogen cyanide to give a cyanohydrin.

CH OH(CHOH) CHO₂ CH₂ 4 glucoseglucose 4 glucoseglucose cyanohydrinCN NH OH² ³/4³/4³/4³/4⁸ CH OH(CHOH) CH₂ 4

> ==NOH -H O₂ glucose oxime

These reactions confirm the presence of carbonyl group in glucose.

- (iii) Glucose reduces ammoniacal silver nitrate solution (Tollen's reagent) to metallic silver and also Fehling's solution or Benedict solution to reddish brown cuprous oxide (Cu O_2) and itself gets oxidised to gluconic acid. This confirms the presence of an aldehydic group in glucose.
- (iv) With mild oxidising agent like bromine water, glucose isoxidised to gluconic acid. Glucose on oxidation with nitric acid gives saccharic acid.

 HNO^3

HOOC¾(CHOH)₄¾COOH ¬¾¾ HOCH (CHOH) CHO₂₄ saccharic acid glucose

1/2 Br /H O2 2

HOCH₂¾(CHOH)₄¾COOH gluconic acid

(v) Glucose on prolonged heating with HI forms *n*-hexane, suggesting that all the 6 carbon atoms in glucose are linked linearly.

HOCH₂³/₄(CHOH)₄³/₄CHO ³/₄³/₄®^{HI, D}

However, with Na/Hg and water, glucose is reduced to sorbitol HOH C CHOH) CH $OH_2(_{42}$.



(vi) D-glucose reacts with three molecules of phenyl hydrazine togive osazone (glucosazone).

Glucose is sometimes illustrated as a chair form :



2. Fructose [Fruit Sugar (C H O_{6 12 6})]

Manufacture By hydrolysis of inulin.

 $H+ (C H O_{6 10})$ 5) $n + nH O_2$ ³/4 ® $nC H O_{6 12 6}$ inulin fructose

Structure

Fructose has furanose structure, i.e. ring structure consisting of four C-atoms and one O atom.





fructofuranose

a and b-fructose

The two forms have different configuration $aboutC_2$.



Fructose does not reduce Br_2 water.

Epimers

Monosaccharides differing in configuration at a carbon other than anomeric carbon are called epimers, e.g. glucose and galactose differ in configuration at C₄, hence called epimers.

Osazones

Monosaccharides and reducing disaccharides react with excess of phenyl hydrazine to form crystalline substances of the structure

```
CH==NNHC H× × _{65}

\frac{1}{2}

C==NNHC H× × _{65}

\frac{1}{2}

(CHOH)_x

\frac{1}{2}

CH OH<sub>2</sub>
```

It is known as osazones and glucose and fructose give same osazone.

II. Oligosaccharides

(Greek	oligos =	few).	On	hydrol	ysis,	they	genera	lly
	give	two to	nine	monos	acchari	des	(same	or
	differer	nt)	and	are	furthe	er classifi	ed	as
	disacch	arides,	e.g.	sucros	e, malto	se,	lactose	,
	1 • 1	1	O TT O		1.	1 . 1 1	۰,	

trisaccharides and so on. C H $O_{12\,22\,11}\,{}_{13}$ a disaccharide because it gives two monosaccharides.

C H O12 22 11 +H O2 3/4 C H O +C H O6 12 6 6 12 6 sucrose glucose fructose

The bond formed between two monosaccharides is called a **glycosidic bond** and normally it is (1, 4) bond.

1. Sucrose, (C H O_{12 22 11})

Sucrose is most abundant in plants and known as **cane sugar** or **table sugar** or **invert sugar** as equimolar mixture of glucose and fructose is obtained by hydrolysis of sucrose.

CH OH₂

6



2. Lactose or Milk sugar

It is present in milk of mammals and made up of **one glucose** and **one galactose** units. It is reducing sugar. Souring of milk is due to the conversion of lactose to lactic acid.

3. Maltose or Malt sugar

It is named because of its occurrence in malted grain of Barley. Mostly found in germinating seeds and tissue where starch is broken down. It is a reducing sugar and formed by condensation of 2 glucose units.



Trisaccharides

Carbohydrate that yield three monosaccharide units on hydrolysis are called trisaccharide e.g; Raffinose (C H $O_{18 32 16}$).

(C H O_{18 32 16}) + 2H O₂ ³/₄ ®^{H+} Glucose + Fructose + Galactose

III. Polysaccharides

These are polymers of monosaccharides. Examples are starch, cellulose, glycogen, etc.

1. Starch, (C H O_{6 10 5})_n

It is a polymer of a-glucose and a major reserve food in plants. It turns blue with iodine. It is a mixture of two components:

- (i) **Amylose** (20%), an unbranched water soluble polymer.
- (ii) Amylopectin (80%), a branched water insoluble polymer.

Sources of starch are potatoes, wheat, rice, maize, etc.



2. Cellulose, $(C H O_{6 \ 10 \ 5})_n$

It is the most abundant and structural polysaccharide of plants. It is important food source of some animals. It is a polymer of D()+ b-glucose. The chief sources of cellulose are wood (contains 50% cellulose rest being lignin, resins, etc) and cotton (contains 90% cellulose rest being fats and waxes).



Several materials are obtained from cellulose:

- (i) Mercerisedcotton Cellulose treated with conc. sodium hydroxide solution acquire silky lustre. It is called mercerised cotton.
- (ii) Gun cotton It is completely nitrated cellulose (cellulose nitrate), highly explosive in nature and is used in the manufacture of smokeless gun powder, called blasting gelatin.
- (iii) **Celluloseacetate** Itisusedformakingacetaterayonandmotion picture films.
- (iv) **Cellulose xanthate** It is obtained by treating cellulose with sodium hydroxide and carbon disulphide and is the basic material for VISCOSE rayon.
- Note Oligosaccharides and polysaccharides are also called heteropolysaccharides.

Glycogen

It is found in animal body (mainly in liver and muscles) as reserve food and is called animals starch. Like starch, it is a polymer of a-D-glucose. When glucose is needed in body it breaks down by the action of enzymes. Structurily, glycogen is highly branched and resemble with the structure of amylopectin.

Molisch Test for Carbohydrates

In aqueous solution of compound add solution of a-naphthol in alcohol and then conc. H SO₂₄ along the walls of the test tube. Purple coloured ring is obtained at the junction.

Relative Sweeteness of Some Sugars

Cane sugar is assumed to have a sweeteness of 10. The relative sweeteness of other sugars is

Lactose	:	1.6	Invert sugar : 12.6
Fructose	:	17.3	Maltose : 3.2
Saccharin	:	300 (an artifici	ial sweetener)
Glucose	:	7.4	

Amino Acids

The compounds containing amino group $(^{3}\!\!\!/_{4}NH_{2})$ and carboxylic group (—COOH) are called amino acids.

 $$\rm NH_2$$ 1/2 General formula $R^3/4$ CH3/4 COOH a-amino acid (R = side chain)

R = H, alkyl or aryl group. Except glycine (H N CH COOH₂ × ₂), others are optically active in nature.

Classification of Amino Acids

(a) a b g, , -amino acids Depending upon the position of —NH₂ on the carbon chain wrt—COOH group.

Η	Н	Η
1/2	1/2	1/2
<i>R</i> ³ / ₄ C ³ / ₄ COOH	$R^{3}/_{4}C^{3}/_{4}CH CO_{2}$	OHH¾C¾CH ₂ CH COOH ₂
1/2	1/2	1/2
NH_2	NH_2	NH_2
a-amino acid	b-amino acid	g-amino acid

(b) Neutral Having one $\frac{3}{4}$ NH₂ and one —COOH,

e.g. $NH_2 \times CH_2 \times COOH$ (glycine).

(c) Acidic Having one ³/₄NH₂ and two —COOH,

 $\begin{array}{c} \rm NH_2 \\ 1 \\ \rm ^{1 / 2} \\ \rm e.g. \ HOOC \ CH \times_2 \times CH^{3 / 4} COOH \ (aspartic \ acid) \end{array}$

(d) Basic Having two or more $-NH_2$ and one -COOH, e.g.

 NH_2

```
<sup>1/2</sup>
H N(CH ) —CH—2 <sup>2 4</sup> COOH (lysine).
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Essential and Non-essential Amino Acids

Human body can synthesise ten out of twenty amino acids, called nonessential amino acids. The remaining ten amino acids required for protein synthesis are not synthesised by body and are called essential amino acids. They are

1. Phenylalanine	2. Histidine
3. Tryptophan	4. Valine
5. Methionine	6.
	Threonine
7. Arginine	8. Leucine
9. Isoleucine	10. Lysine

Nomenclature

They are known by their common names and abbreviated by first three letters of their common names e.g. glycine as 'gly' and alanine as 'ala'.

Configuration of a-Amino Acids



Naturally occurring a amino acids are L-amino acids. D-amino acids occur in some antibiotics and bacterial cell walls.

Structure of Amino Acids

R	_	R	+	R
 1/2	– OH +	1/2	- H +	1/2

as anion (high pH)

Zwitter ion, (isoelectric as cation (low pH) point)

Peptides

Peptides are condensation products of two or more amino acids.

1/21/2

³/₄C³/₄NH³/₄ is known as peptide linkage and C—N as a peptide bond. Two molecules of different amino acids can form two dipeptides. Three molecules of different amino acids can give six tripeptides.

Dipeptide has only one peptide bond, tripeptide has two peptide bonds and so on. Thus, a polypeptide made up of n-amino acids has (n - 1) peptide bonds.

Polypeptides

Condensation products of many amino acids (»10000) is known as polypeptide and those polypeptides which have molecular mass above than 10000 are called proteins.

Proteins

They are linear polymers of a-amino acids.

Structure of Proteins

(a) Primary structure It simply reveals the sequence of amino acids.

- (b) **Secondary structure** a-helix structure maintained by hydrogen bonds or b-pleated sheet structure when *R* is small group.
- (c) **Tertiary structure** The folding and superimposition of polypeptide chains forms a compact globular shape, termed as tertiary structure. It is stabilised by covalent, ionic, hydrogen and disulphide bonds.

The precise arrangement constitutes the quaternary structure.

Classification on the Basis of Molecular Shape

- 1. **Fibrous proteins** When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre like structure is formed. Such proteins are insoluble in water. e.g. Keratin (present in hair, wool) etc.
- 2. **Globular proteins** This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water e.g. insulin, albumins.
- Classification on the Basis of Hydrolysis Products
- (i) Simple proteins These yield only a-amino acids upon hydrolysis.
 e.g. albumin.
- (ii) **Conjugated proteins** These yield a-amino acids and non-protein part, called prosthetic group.

Protein	Prosthetic group	
Nucleoproteins	Nucleic acid	
Phosphoproteins	Phosphoric acid	
Glycoproteins	Carbohydrates	
Metalloproteins	Metals	
Lipoproteins	Lipids	

 (iii) Derived proteins These are obtained by partial hydrolysis of simple or conjugated proteins.

Proteins ® Proteoses ® Peptones ® Polypeptides

Classification on the Basis Functions

- (i) Structural proteins Fibrous proteins and globular proteins.
- (ii) **Enzymes** Serve as biological catalyst e.g. pepsin, trypsin etc.
- (iii) Hormones e.g. Insulin
- (iv) Contractile proteins Found in muscles, e.g. myosin, actin.
- (v) Antibodies Gamma globulins present in blood.
- (vi) **Blood protein** Albumins, haemoglobin and fibrinogen.

Haemoglobin is a globular protein. Its prosthetic group is heme. It contains 574 amino acid units distributed in four polypeptide chains. Two chains containing 141 amino acid residues each are called a chains and the two chains containing 146 amino acid residues are called b-chains.

Sickle cell anaemia is caused by defective haemoglobin obtained by replacing only one amino acid, i.e. glutamic acid by valine.

Denaturation of Proteins

The process that changes the three dimensional structure of native proteins is called denaturation of proteins. It can be caused by change in pH, addition of electrolyte, heating or addition of solvent like water, alcohol or acetone.

Tests of Proteins

(i) Biuret Test

Protein solution + NaOH + dil. CuSO4 ® pink or violet colour.

(ii) Millon's Test

Protein solution + Millon's reagent ® red colour

Millon's reagent is solution of mercuric nitrate and traces of sodium nitrate solution.

(iii) Iodine reaction

Protein solution + iodine in potassium iodide solution $\$ yellow colour.

(iv) Xanthoprotein test

Protein solution + conc. HNO3 ® yellow colour 3/43/4 ® NaOH

orange colour.

Enzymes

Enzymes constitute a group of complex proteinoid organic compounds, produced by living organisms which catalyse the chemical reaction.

Non-proteinous components enhance the activity of certain enzymes and are known as **co-enzymes**. These include metal ions like Mn²⁺, Mg²⁺,K⁺, Na⁺,Zn²⁺,Co²⁺ etc., heterocyclic ring systems

(pyrrole, purine, pyridine, etc.), a sugar residue, phosphoric acid and residue of vitamins like thiamine, riboflavin etc. **Endoenzyme** acts in the same cell in which it is synthesised, while **exoenzyme** acts outside the cell in which it is synthesised.

Nomenclature

They are usually named by adding the suffix 'ase' to the root name of the substrate e.g. urease, maltase, diastase, invertase, etc.

Oxidative Enzymes

They catalyse oxidation-reduction reaction and are mostly conjugated proteins.

Some Common Enzymes				
Name Substrate Products				
Urease	Urea	$CO_2 + NH_3$		
Maltase	Maltose	Glucose		
Invertase	Sucrose	Glucose + fructose		
Amylase	Starch	Maltose		
Trypsin	Proteins	Amino acids		
Ascorbic acid oxidase	Ascorbic acid	Dehydroascorbic acid		

Characteristic Features of Enzymes

- Rate of reaction They increase the rate of reaction up to 10⁶ to 10⁷ times.
- (ii) **Specific nature** Urease catalyse the hydrolysis of urea and not methyl urea, so these are specific in nature.
- (iii) Optimum temperature It is active at 20-30°C.
- (iv) **pHofmedium** It is about 7 but for pepsin, it is 1.8-2.2 and for trypsin, it is 7.5-8.3.
- (v) **Concentration** Dilute solutions are more effective.
- (vi) Amount of enzyme Very small amount can accelerate the reaction.
- (vii) **Enzyme inhibitors** These compounds inhibit the enzyme action. With the help of such compounds, the reaction can be controlled.

Mechanism of Enzyme Action

Enzyme + Substrate ® [Enzyme substrate] ®

Product + Enzyme Activated complex

Applications of Enzymes

- (i) Treatment of diseases The congenital disease phenyl ketonuria caused by phenylalanine hyroxylase can be cured by diet of low phenylalanine content. Enzyme streptokinase is used for blood clotting to prevent heart disease.
- (ii) In industry Tanning of leather, fermentation process etc.

Vitamins

The organic compounds other than carbohydrates, proteins and fats which are required by body to maintain normal health, growth and nutrition are called vitamins.

The vitamins are complex organic molecules. They are represented by letters such as A, B, C, D, E, K.

Vitamins are broadly classified into two types,

(i) Water soluble vitamins and (ii)

Fat soluble vitamins.

VitaminsA, D, Eand K are fat soluble whereas vitamins Band C are water soluble. Vitamin H is neither fat soluble nor water soluble.

Vitamin	Chemical nature	Deficiency diseases
Vitamin A (Carotenoids or Axerophytol or retinol)	Soluble in oils and fats, but insoluble in water.	Night blindness, Xerophthalmia (cornea becomes opaque), drying of skin.
Vitamin B ₁ (Thiamine)	Soluble in water, destroyed by heat.	Beriberi, loss of appetite.
Vitamin B ₂ (Riboflavin)	Soluble in water, stable to heat, destroyed by light.	Cracked lips, sore tongue and skin disorders.
Vitamin B ₆ (Pyridoxine)		Nervous disturbances and convulsions
Vitamin B ₁₂ (Cyano cobalamin)	Soluble in water and contains cobalt, red crystalline.	A serious type of anaemia. (pernicious anaemia)
Vitamin C (Ascorbic Acid, C H O)686	Soluble in water, destroyed by cooking and exposure to air.	Scurvy, dental caries, pyorrhea, anaemia.

Vitamins and the Diseases Caused by their Deficiency

Vitamin D (Ergo calciferol)	Mixture of four complex compounds containing C,H and O. Soluble in fats and oils but insoluble in water. Stable towards heat and oxidation. This vitamin regulates the absorption of calcium and phosphate in intestine.	Infantile rickets, deformation of bones and teeth.
Vitamin E (Tocopherol)	Mixture of 3 complex substances containing C, H and O. Soluble in fats and oils but insoluble in water. Stable to heat and oxidation.	Loss of sexual power and degeneration of muscle fibres in animals.
Vitamin K (phylloquinone)	Mixture of two complex substances containing C, H and O. Soluble in fats but insoluble in water. Stable to heat and oxidation.	Tendency to haemorrhage and impaired clotting of blood.

Nucleic Acids

Important Terms of Nucleic Acids

(i) Nitrogenous base Derived from purines having two rings in their structure. e.g. Adenine (A) and Guanine (G) and derived from pyrimidines having one ring in their structure e.g. Thymine (T), Uracil (U) and Cytosine (C).

Two H–bonds are present between A and T (A=T) while three H-bonds are present between C and G ($C^{oo}G$).

- (ii) Pentose sugar It is either ribose or deoxy ribose (not having oxygen at C₂).
- (iii) Nucleoside Ribose–/deoxyribose + one base unit from A, G, C, T or U.
- (iv) **Nucleotides** Nucleotides consist of 5-carbon sugar + nitrogenous base +1,3-phosphate groups.



(v) **Ribonucleotide** Phosphate unit + Ribose + one base unit from A, G, C, or U.

(vi) **Deoxyribo nucleotide** Phosphate unit + Deoxyribose + one base from A, G, C or T.

DNA and RNA

Nucleic acid is polynucleotide, present in the living cells or bacterial cells having no nucleus and in viruses having no cells. These are of two types:

(i) **DNA** Deoxyribonucleic acid.

DNA + H O₂ ® Phosphoric acid + deoxyribose + A, G, C, T

(ii) **RNA** Ribonucleic acid.

RNA + H O₂ ® Phosphoric acid + Ribose + A, G, C, U

Structure of DNA

It consists of two polynucleotide chains, each chain form a right handed helical spiral with ten bases in one turn of the spiral. The two chains coil to double helix and run in opposite direction. These are held together by hydrogen bonding.

Structure of RNA

It is usually a single strand of ribonucleotides and take up right handed helical conformation. Up to 12000 nucleotides constitute an RNA.

It can base pair with complementary strands of DNA or RNA. According to standard base pairing rules-G pairs with C, A pairs with U or T. The paired strands in RNA–RNA or RNA–DNA are anti parallel as in DNA.

In both DNA and RNA, heterocyclic base and phosphate ester linkages are at C_1 and C_5 ¢ respectively of the sugar molecule.

Types of RNA

- (i) Messanger RNA (*m*·RNA) It is produced in the nucleus and carries information for the synthesis of proteins.
- (ii) Transfer RNA (Soluble or Adoptive RNA) (s RNA, t RNA) It is found in cytoplasm. Its function is to collect amino acids from cytoplasm for protein synthesis.

Functions of Nucleic Acids

- 1. Direct the synthesis of proteins.
- 2. Transfer the genetic information (hereditary characters).

IMPORTANT TERMS

Replication

It is a process in which a molecule of DNA can duplicate itself.

Template It means pattern. In the process of replication of DNA, the parent strand serves as template.

Gene The portion of DNA carrying information about a specific protein is called gene.

Genetic code The relation between the amino acid and the nucleotide triplet is called genetic code.

Codons The nucleotide bases in RNA function in groups of three (triplet) in coding amino acids. These base triplets are called codons.

The word code is used with reference to DNA, codon with reference to *m*-RNA and anticodon with reference to *t*-RNA.

Lipids

The constituents of animals and plants soluble in organic solvents (ether, chloroform, carbon tetrachloride), but insoluble in water are called lipids. (Greek *lipose* = fat)

Types of Lipids

- (i) Simple lipids
- (a) Fats and oils on hydrolysis give long chain fatty acids
 + glycerol.
- (b) **Waxes** Long chain fatty acids + long chain alcohols.

Vegetable and animal oils and fats have similar chemical structure and are triesters of glycerol, called glycerides. Simple glycerides contain one type of fatty acids. Mixed glycerides contain two or three types of fatty acids.

Common saturated fatty acids CH₃ ³/₄(CH₂)_nCOOH.

When n = 4caproic acid; n = 6caprylic acid; n = 8capric acid, n = 10 lauric acid n = 12 myristic acid; n = 14 palmitic acid, n = 16 stearic acid.

Common unsaturated fatty acids

C H COOH17 330leic acid; C H COOH17 33linoleic acid.

Difference between oils and fats Oils are liquids at ordinary temperature (below 20°) and contain lower fatty acids or unsaturated fatty acids.

Fats are solids or semisolids above 20°C and contain higher saturated fatty acids. Oils and fats act as "energy reservoirs" for the cells.

 (ii) Phospholipids Phosphate + glycerol + fatty acids + a nitrogen containing base.

Function of phospholipids are

- 1. As emulsifying agents since they carry hydrophilic polargroups and hydrophobic non-polar groups.
- 2. They absorb fatty acids from the intestine and transport toblood cells.
- (iii) Glycolipids They contain one or more simple sugars and are important components of cell membranes and chloroplast membranes.
- (iv) Terpenes Menthol, camphor are common plant terpenes. Carotenoids and pigments are also terpenes.
 - (a) Essential oils The volatile, sweet smelling liquids obtained from flowers, leaves, stems, etc. Example of terpenes are esters of lower fatty acid, e.g. clove oil, rose oil, lemon oil.
 - (b) **Drying oils** The oils which are converted into tough, transparent mass when exposed to air by oxidation polymerisation process are called drying oils. e.g. Linseed oil, perilla, poppy seed oils.

Cotton seed oil and til oil are semidrying oils.

Acid Value

It is the number of milligrams of KOH required to neutralise the free acid present in 1 g of oil or fat.

Saponification Value

It is the number of milligrams of KOH required to saponify 1 g of oil or fat or the number of milligrams of KOH required to neutralise the free acid resulting from the hydrolysis of 1 g of an oil or fat.

Iodine Value

It is the number of grams of iodine absorbed by 100 g of oil or fat.

Reichert-Meissel Value (R/M Value)

It is the number of cc of N/10 KOH required to neutralise the distillate of 5 g of hydrolysed fat.

Hormones

These are the chemical substances which are produced by endocrine (ductless) glands in the body. Hormones acts as **chemical messengers**. Some examples of ductless (endocrine) glands are thyroid, pitutary, adrenal, pancreas, testes and ovaries.

Hormones are divided into three types :

- (i) steroids
- (ii) proteins or polypeptides(iii) amines.

	Hormone	e Source	Chemical name	Function
1.	Thyroxin	Thyroid	Amino acid	Stimulates metabolism.
2.	Adrenaline	Adrenal	Amine	Increases pulse rate and blood pressure, release glucose from glycogen and fatty acids from fats.
3.	Insulin	Pancreas	Peptide	Decreases blood glucose.
4.	Glucagon	Pancreas	Peptide	Increases blood glucose.
5.	Testosterone	Testes	Steroid	Controls normal functioning of male sex organs.
6.	Estrone and Estradiol	Ovary	Steroid	Controls normal functioning of female sex organs.
7.	Progesterone	Ovary	Steroid	Prepare uterus for pregnancy, controls menstrual cycle.
8.		Cortisone Adrenal cortex	Steroid	Metabolism of water, mineral salts, fats, proteins and carbohydrates.

Insulin is a protein hormone which is secreted by b-cells of the pancreas. Insulin was the first polypeptide in which the amino acid sequence was experimentally determined. Its deficiency leads to diabetes mellitus.

Starting the text with "SS-Chem-", create 100 sms texts with characters of 140 to 155 that educates the student with the most important facts on the following materials.

Chemistry - *Biomolecules*

Originally Preplexity, then Re-write by ChatGPT TURBO Pro

Answer

Here are 100 SMS texts, each starting with "SS-Chem-" and containing 140 to 155 characters, that educate students on various important facts from the provided text:

- 1. SS-Chem-Fats are solids above 20°C with higher saturated fatty acids, while oils are liquids below 20°C with lower or unsaturated fatty acids. Both store energy. (164 characters)
- 2. SS-Chem-Phospholipids, made of phosphate, glycerol, fatty acids, and a nitrogen base, act as emulsifying agents and transport fatty acids to blood cells. (156 Characters)

- 3. SS-Chem-Glycolipids contain simple sugars and are key components of cell and chloroplast membranes, playing a crucial role in cellular structure. (148 characters)
- 4. SS-Chem-Terpenes like menthol and camphor are plant compounds. Essential oils, such as clove and rose oil, are volatile, sweet-smelling terpenes. (148 characters)
- SS-Chem-Drying oils like linseed oil form a tough, transparent mass when exposed to air due to oxidation polymerization, used in paints and varnishes. (153 characters)
- 6. SS-Chem-Acid value measures the mg of KOH needed to neutralize free acids in 1g of oil/fat. It's crucial for determining oil/fat quality. (140 Characters)
- 7. SS-Chem-Saponification value indicates the mg of KOH required to saponify 1g of oil/fat, reflecting the average molecular weight of fatty acids.
- 8. SS-Chem-Iodine value measures the grams of iodine absorbed by 100g of oil/fat, indicating the degree of unsaturation in the fat.
- SS-Chem-Reichert–Meissel value is the cc of N/10 KOH needed to neutralize the distillate from 5g of hydrolyzed fat, used for butter quality.
- 10. SS-Chem-Hormones are chemical messengers from endocrine glands like thyroid, adrenal, and pancreas, regulating various body functions.
- 11. SS-Chem-Thyroxin from the thyroid stimulates metabolism. Adrenaline from the adrenal gland increases pulse rate and blood pressure.

- 12. SS-Chem-Insulin, a peptide hormone from the pancreas, decreases blood glucose levels. Its deficiency leads to diabetes mellitus.
- 13. SS-Chem-Testosterone from testes controls male sex organs. Estrone and estradiol from ovaries regulate female sex organs and menstrual cycle.
- 14. SS-Chem-Vitamin D (Ergo calciferol) regulates calcium and phosphate absorption in the intestine, preventing rickets and bone deformities.
- 15. SS-Chem-Vitamin E (Tocopherol) is essential for muscle fiber health and sexual power. It's stable to heat and oxidation, soluble in fats.
- 16. SS-Chem-Vitamin K (Phylloquinone) is crucial for blood clotting and preventing hemorrhage. It's fat-soluble and stable to heat and oxidation.
- 17. SS-Chem-DNA consists of two polynucleotide chains forming a double helix, with A-T and C-G base pairs held by hydrogen bonds.
- 18. SS-Chem-RNA is usually a single strand of ribonucleotides, base pairing with DNA or RNA strands. It plays a key role in protein synthesis.
- 19. SS-Chem-Glucose, also known as dextrose, is a simple sugar present in grapes and blood. It's a primary energy source for the body.
- 20. SS-Chem-Glucose has two forms: α -D-glucose with a specific rotation of +111.5° and β -D-glucose with +19.5°. They interconvert in water.

- 21. SS-Chem-Mutarotation is the change in specific rotation of glucose in water until equilibrium at +52.5° is reached, involving α and β forms.
- 22. SS-Chem-Glucose reacts with acetic anhydride to form pentaacetate, confirming five hydroxyl groups. It also forms oxime and cyanohydrin.
- 23. SS-Chem-Cellulose, a polymer of β -D-glucose, is the most abundant plant polysaccharide. It's a key structural component in plants.
- 24. SS-Chem-Glycogen, found in liver and muscles, is a highly branched polymer of α -D-glucose, serving as a reserve energy source in animals.
- 25. SS-Chem-Amino acids contain amino (NH2) and carboxylic (COOH) groups. They are building blocks of proteins, essential for body functions.
- 26. SS-Chem-Proteins are linear polymers of α -amino acids. They have primary, secondary, tertiary, and quaternary structures, determining function.
- 27. SS-Chem-Enzymes are protein catalysts that speed up biochemical reactions. They are specific, work at optimal pH and temperature, and are reusable.
- 28. SS-Chem-Vitamins are organic compounds essential for health. Fat-soluble vitamins include A, D, E, K, while B and C are water-soluble.
- 29. SS-Chem-Vitamin A (Retinol) is crucial for vision and skin health. Deficiency causes night blindness and xerophthalmia (opaque cornea).

- 30. SS-Chem-Vitamin B1 (Thiamine) is water-soluble and heatsensitive. Deficiency leads to beriberi, characterized by loss of appetite and weakness.
- 31. SS-Chem-Vitamin B2 (Riboflavin) is water-soluble and stable to heat but destroyed by light. Deficiency causes cracked lips and skin disorders.
- 32. SS-Chem-Vitamin B12 (Cyanocobalamin) contains cobalt and is water-soluble. Deficiency leads to pernicious anemia, a serious blood disorder.
- 33. SS-Chem-Vitamin C (Ascorbic Acid) is water-soluble and destroyed by cooking. Deficiency causes scurvy, dental caries, and anemia.
- 34. SS-Chem-Proteins can be fibrous (e.g., keratin in hair) or globular (e.g., insulin). Fibrous proteins are insoluble, while globular are soluble.
- 35. SS-Chem-Proteins are classified by hydrolysis products: simple (yield amino acids), conjugated (yield amino acids + non-protein part), derived.
- 36. SS-Chem-Haemoglobin, a globular protein, carries oxygen in blood. It has four polypeptide chains and a heme prosthetic group.
- 37. SS-Chem-Sickle cell anemia is caused by defective hemoglobin, where glutamic acid is replaced by valine, altering the protein's structure.
- 38. SS-Chem-Enzymes like urease, maltase, and amylase catalyze specific reactions. They increase reaction rates and are highly specific.

- 39. SS-Chem-Enzyme inhibitors control reactions by inhibiting enzyme activity. They are used in medicine and research to regulate biochemical processes.
- 40. SS-Chem-Phospholipids form cell membranes, with hydrophilic heads and hydrophobic tails, creating a bilayer that regulates cell permeability.
- 41. SS-Chem-Glycolipids, containing sugars, are essential for cell recognition and communication, playing a role in immune response and signaling.
- 42. SS-Chem-Terpenes, like carotenoids, are plant pigments. They are involved in photosynthesis and protect plants from UV radiation.
- 43. SS-Chem-Essential oils, such as lemon and rose oil, are used in aromatherapy and perfumes. They are volatile and have therapeutic properties.
- 44. SS-Chem-Saponification is the process of making soap from fats/oils and KOH. It produces glycerol and soap, used for cleaning and hygiene.
- 45. SS-Chem-Iodine value indicates the unsaturation level in fats/oils. Higher values mean more double bonds, affecting stability and shelf life.
- 46. SS-Chem-Hormones like insulin and glucagon regulate blood glucose levels. Insulin lowers it, while glucagon raises it, maintaining balance.
- 47. SS-Chem-Testosterone and estrogen are sex hormones. Testosterone controls male traits, while estrogen regulates female reproductive functions.

- 48. SS-Chem-Vitamin D is crucial for bone health, aiding calcium absorption. Deficiency leads to rickets in children and osteomalacia in adults.
- 49. SS-Chem-Vitamin E protects cells from oxidative damage. It's an antioxidant, preventing muscle degeneration and maintaining reproductive health.
- 50. SS-Chem-Vitamin K is essential for blood clotting. It activates proteins that help in coagulation, preventing excessive bleeding.
- 51. SS-Chem-DNA replication involves the parent strand serving as a template, ensuring genetic information is accurately copied for cell division.
- 52. SS-Chem-RNA types include mRNA (carries genetic info), tRNA (transfers amino acids), and rRNA (forms ribosomes), all crucial for protein synthesis.
- 53. SS-Chem-Glucose is stored as glycogen in the liver. When needed, glycogen breaks down into glucose, providing energy for the body.
- 54. SS-Chem-Glucose has an aldehyde group, confirmed by reactions with hydroxylamine and hydrogen cyanide, forming oxime and cyanohydrin.
- 55. SS-Chem-Cellulose is used to make products like rayon and cellophane. It's treated with chemicals to produce fibers and films for various uses.
- 56. SS-Chem-Glycogen is similar to amylopectin but more highly branched. It's a quick energy source, broken down by enzymes when needed.

- 57. SS-Chem-Amino acids are classified as essential (must be obtained from diet) and non-essential (synthesized by the body), vital for protein synthesis.
- 58. SS-Chem-Proteins have primary (amino acid sequence), secondary (α -helix or β -sheet), tertiary (3D folding), and quaternary (multiple chains) structures.
- 59. SS-Chem-Enzymes like trypsin and pepsin break down proteins into amino acids, aiding digestion and nutrient absorption in the body.
- 60. SS-Chem-Vitamins are essential for metabolic processes. Deficiencies can lead to diseases like scurvy (Vitamin C) and beriberi (Vitamin B1).
- 61. SS-Chem-Vitamin A deficiency causes night blindness. It's found in foods like carrots and liver, crucial for vision and immune function.
- 62. SS-Chem-Vitamin B1 (Thiamine) is found in whole grains and meat. It helps convert food into energy and supports nerve function.
- 63. SS-Chem-Vitamin B2 (Riboflavin) is found in dairy and eggs. It supports energy production and skin health, preventing cracked lips and sore tongue.
- 64. SS-Chem-Vitamin B12 (Cyanocobalamin) is found in animal products. It's essential for red blood cell formation and nervous system health.
- 65. SS-Chem-Vitamin C (Ascorbic Acid) is found in citrus fruits. It supports immune function and collagen synthesis, preventing scurvy.

- 66. SS-Chem-Proteins are classified by function: structural (keratin), enzymes (amylase), hormones (insulin), and antibodies (gamma globulins).
- 67. SS-Chem-Haemoglobin's structure includes two α -chains and two β -chains. It binds oxygen in the lungs and releases it in tissues.
- 68. SS-Chem-Sickle cell anemia results from a single amino acid change in hemoglobin, causing red blood cells to become rigid and sickle-shaped.
- 69. SS-Chem-Enzymes are named by adding 'ase' to the substrate name, e.g., urease (urea), maltase (maltose), indicating their specific action.
- 70. SS-Chem-Enzyme activity is influenced by temperature, pH, and concentration. Optimal conditions maximize reaction rates and efficiency.
- 71. SS-Chem-Phospholipids form bilayers in cell membranes, with hydrophilic heads facing outward and hydrophobic tails inward, creating a barrier.
- 72. SS-Chem-Glycolipids are involved in cell recognition and signaling. They play a role in immune response and maintaining cell membrane stability.
- 73. SS-Chem-Terpenes like menthol are used in medicinal products for their cooling and soothing effects. They are also found in essential oils.
- 74. SS-Chem-Essential oils have antimicrobial and antiinflammatory properties. They are used in aromatherapy to promote relaxation and well-being.

- 75. SS-Chem-Saponification value helps determine the quality of fats/oils for soap making. Higher values indicate shorter fatty acid chains.
- 76. SS-Chem-Iodine value is used to measure the degree of unsaturation in fats/oils. It's important for assessing stability and shelf life.
- 77. SS-Chem-Hormones like adrenaline prepare the body for 'fight or flight' by increasing heart rate and energy availability during stress.
- 78. SS-Chem-Insulin regulates blood sugar by facilitating glucose uptake into cells. It's crucial for energy

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Atomic Structure **35**

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Atomic Structure

Atom

John Dalton proposed (in 1808) that atom is the smallest indivisible particle of matter. Atomic radii are of the order of 10^{-8} cm. It contains three subatomic particles namely electrons, protons and neutrons.

Electron

Electron was discovered as a result of study of cathode rays by JJ Thomson. It was named by Stony.

It carries a unit negative charge ($1.6 - \times 10^{-19}$ C).

Mass of electron is 9.11×10^{-31} kg and mass of one mole of electron is 0.55 mg. Some of the characteristics of cathode rays are:

- (i) These travel in straight line away from cathode and producefluorescence when strike the glass wall of discharge tube.
- (ii) These cause mechanical motion in a small pin wheel placed intheir path.
- (iii) These produce X-rays when strike with metal and are deflected by electric and magnetic field.

Charge to Mass Ratio of Electron

In 1897, British physicist JJ Thomson measured the ratio of electrical charge (e) to the mass of electron (m_e) by using cathode ray tube and applying electrical and magnetic field perpendicular to each other as well as to the path of electrons. Thomson argued that the amount of deviation of the particles from their path in the presence of electrical or magnetic field may vary as follows:

- (i) If greater the magnitude of the charge on the particles, greateris the deflection.
- (ii) The mass of the particle, lighter the particle, greater thedeflection.
- (iii) The deflection of electrons from its original path increase with the increase in the voltage. By this Thomson determined the value e m/e as $1.758820 \times 10^{11} \text{ C kg}^{-1}$.

Proton

Rutherford discovered proton on the basis of anode ray experiment. It carries a unit positive charge (+1.6 × 10^{-19} C). The mass of proton is 1.007276 u.

The ____e ratio of proton is 9.58× 10^-4 C /g. (____e ratio is maximum for m _____m

hydrogen gas.)

Some of the characteristics of anode rays are:

- (i) These travel in straight line and possess mass many timesheavier than the mass of an electron.
- (ii) These are not originated from anode but are produced in thespace between the anode and the cathode.
- (iii) These also cause mechanical motion and are deflected by electricand magnetic field.
- (iv) Specific charge $\Box _ e \Box$ for these rays depends upon the nature of

 $\Box m \Box$

the gas taken and is maximum for H_2 .

Neutron

Neutrons are neutral particles. It was discovered by Chadwick (1932). The mass of neutron is 1.675×10^{-24} g or 1.008665 amu or u.

94Be + 42He $\Box \rightarrow 126C + 10n$ (α' -particles) (Neutron)

- Some Other Subatomic Particles
 - (a) Positron Positive electron $({}_{+}{}^{0}{}_{1}e)$, discovered by Dirac (1930) and

Anderson (1932).

- (b) Neutrino and antineutrino Particles of small mass and no charge as stated by Fermi (1934).
- (c) Meson Discovered by Yukawa (1935) and Kemmer. They are unstable particles and include pi ions [π⁺, π⁻ or π⁰].
- (d) Anti-proton It is negative proton produced by Segre and Weigland (1955).

Thomson's Atomic Model

Atom is a positive sphere with a number of electrons distributed within the sphere. It is also known as plum pudding model. It explains the neutrality of an atom. This model could not explain the results of Rutherford scattering experiment.

Rutherford's Nuclear Model of Atom

It is based upon α -particle scattering experiment. Rutherford presented that

- (i) most part of the atom is empty.
- (ii) atom possesses a highly dense, positively charged centre, called **nucleus** of the order 10^{-13} cm.
- (iii) entire mass of the atom is concentrated inside the nucleus.
- (iv) electrons revolve around the nucleus in circular orbits.
- (v) electrons and the nucleus are held together by electrostaticforces of attraction.

Drawbacks of Rutherford's Model

- (i) According to electromagnetic theory, when charged particles areaccelerated, they emit electromagnetic radiations, which comes by electronic motion and thus orbit continue to shrink, so atom is unstable. It doesn't explain the stability of atom.
- (ii) It doesn't say anything about the electronic distribution aroundnucleus.

Atomic Number (Z)

Atomic number of an element corresponds to the total number of protons present in the nucleus or total number of electrons present in the neutral atom.

Mass Number (A)

The mass of the nucleus is due to protons and neutrons, thus they are collectively called **nucleons.** The total number of nucleons is termed as mass number of the atom.

Mass number of an element = number of protons + number of neutrons

Representation of an Atom



the element Atomic number

Different Types of Atomic Species

(a) **Isotopes** Species with same atomic number but different mass number are called isotopes, e.g. 1H , H¹1².

- (b) **Isobars** Species with same mass number but different atomic number are called isobars, e.g. ${}_{18}Ar^{40}$, ${}_{19}K^{40}$.
- (c) Isotones Species having same number of neutrons are called isotones, e.g. 1H³ and 2He⁴ are isotones.
- (d) **Isodiaphers** Species with same isotopic number are called isodiaphers, e.g. ${}_{19}K^{39}$, F_{9} 19 .

Isotopic number = mass number - [2 × atomic number]

- (e) Isoelectronic Species with same number of electrons are called isoelectronic speices, e.g. Na , Mg⁺²⁺.
- (f) Isosters Species having same number of atoms and same number of electrons, are called isosters, e.g. N₂ and CO.

Developments Leading to the Bohr's Model of Atom

Two developments played a major role in the formulation of Bohr's model:

- (i) Dual character of the electromagnetic radiation which meansthat radiation possess wave like and particle like properties.
- (ii) Atomic spectra explained by electronic energy level in atoms.

Electromagnetic Wave Theory (Maxwell)

The energy is emitted from source continuously in the form of radiations and magnetic fields. All electromagnetic waves travel with the velocity of light (3 × 10^8 m/s) and do not require any medium for their propagation.

An electromagnetic wave has the following characteristics:

- (i) Wavelength It is the distance between two successive crests ortroughs of a wave. It is denoted by the Greek letter λ (lambda).
- (ii) **Frequency** It represents the number of waves which pass through a given point in one second. It is denoted by v (nu).
- (iii) Velocity (v) It is defined as the distance covered in one second by the waves. Velocity of light is $3 \times 10^{10} \text{ cms}^{-1}$.
- (iv) Wave number It is the reciprocal of wavelength and has units cm^{-1} . It is denoted by v (nu bar).

(v) **Amplitude** (a) It is the height of the crest or depth of the trough of a wave.

Wavelength () λ , frequency () ν and velocity () ν of any electromagnetic radiations are related to each other as $\nu = \nu\lambda$.

Electromagnetic wave theory was successful in explaining the properties of light such as interference, diffraction etc., but it could not explain the

- 1. Black body radiation
- 2. Photoelectric effect

These phenomena could be explained only if electromagnetic waves are supposed to have particle nature. Max Planck provided an explanation for the behaviour of black body and photoelectric effect.

Particle Nature of Electromagnetic Radiation : Planck's Quantum Theory

 $\begin{array}{cccc} \mbox{Planck explain the distribution of intensity of the radiation from} \\ \mbox{black body} & \mbox{as} & \mbox{a} & \mbox{function} & \mbox{of} & \mbox{frequency} \\ \mbox{or} & \mbox{wavelength} & \mbox{at} & \mbox{different temperatures.} \\ & \mbox{hc} \\ E = \mbox{hv} = & \mbox{$(\because c = \lor \lambda)$} \\ & \mbox{$\lambda$} \end{array}$

where, $h = \text{Planck's constant} = 6.63 \times 10^{-34} \text{ J}$ -

s E = energy of photon or quantum v =

frequency of emitted radiation

If *n* is the number of quanta of a particular frequency and E_T be total energy then

$$E_T = nhv$$

Black Body Radiation

If the substance being heated is a black body, the radiation emitted is called black body radiation.

Photoelectric Effect

It is the phenomenon in which beam of light of certain frequency falls on the surface of metal and electrons are ejected from it.

This phenomenon is known as photoelectric effect. It was first observed by Hertz.



Threshold frequency (v_0) = minimum frequency of the radiation

Work function (W_0) = required minimum energy of the radiation

$$E = \text{KE} + W_0$$

:. 2_ $mv^2 = h(v - v_0)$ [Kinetic energy of ejected electron = $h(v - v_0)$] where, v = frequency of incident radiation v_0 = threshold frequency

Electromagnetic Spectrum

1

The different types of electromagnetic radiations differ only in their wavelengths and hence, frequencies. When these electromagnetic radiations are arranged in order of their increasing wavelengths or decreasing frequencies, the complete spectrum obtained is called electromagnetic spectrum.

	V 1	
Type of radiation	Wavelength (in Å)	Generation source
Gamma rays	0.01 to 0.1	Radioactive disintegration
X-rays	0.1 to 150	From metal when an electron strikes on it
UV-rays	150 to 3800	Sun rays
Visible rays	3800 to 7600	Stars, arc lamps
Infrared rays	7600 to 6×10^{6}	Incandescent objects
Micro waves	6×10^6 to 3×10^9	Klystron tube
Radio waves	3×10^{14}	From an alternating current of high frequency

Different Types of Radiations and Their Sources

Electromagnetic spectra may be emission or absorption spectrum on the basis of energy absorbed or emitted. An **emission spectrum** is obtained when a substance emits radiation after absorbing energy. An **absorption spectra** is obtained when a substance absorbs certain wavelengths and leave dark spaces in bright continuous spectrum.

A spectrum can be further classified into two categories such as

- (i) **Continuousorbandspectrum** A spectrum in which there is no sharp boundary between two different radiations.
- (ii) Discontinuous or line spectrum A spectrum in which radiations of a particular wavelength are separated from each other through sharp boundaries.

Bohr's Model

nh

Neils Bohr proposed his model in 1931. Bohr's model is applicable only for one electron system like H, He⁺, Li^{2+} etc.

Assumptions of Bohr's model are

1. Electrons keep revolving around the nucleus in certain fixed permissible orbits where it doesn't gain or lose energy. These orbits are known as **stationary orbits**.

<u>circumference of orbit</u>

Number of waves in an orbit = wavelength

2. The electrons can move only in those orbits for which the angular

momentum is an integral multiple of $\frac{h}{h}$, i.e.

2π

 $mvr = (n = 1 \ 2 \ 3, , \dots)$

 2π

where, m = mass of electron; v = velocity of electron;

r = radius of orbit

- n = number of orbit in which electrons are present
- 3. Energy is emitted or absorbed only when an electron jumps from higher energy level to lower energy level and *vice-versa*.

$$\Delta E = E_2 - E_1 = hv = \underline{\qquad}$$

4. The most stable state of an atom is its ground state or normalstate.

From Bohr's model, energy, velocity and radius of an electron in *n*th Bohr orbit are

(i) Velocity of an electron in *n*th Bohr orbit

$$(v_n) = 2.165 \times 10^6 _Z \text{ m/s}$$

(ii) Radius of *n*th Bohr orbit

$$(r_n) = 0.53 \times 10^{-10} \underline{\qquad} {}^{n_2} \,\mathrm{m} = 0.53 \underline{\qquad} {}^{n_2} \,\mathrm{\mathring{A}}$$

$$Z \qquad Z$$
(iii) $E_n = -2.178 \times 10^{-18} \overline{\qquad} {}^{2}_{2} \,\mathrm{J/atom} \,n$

$$Z_2 \qquad = -1312 \underline{\qquad} {}^{2}_{2} \,\mathrm{KJ/mol} \,n$$

$$Z_2 \qquad = -13.6 \underline{\qquad} \mathrm{eV/atom} \,n$$

$$\Delta E = -2.178 \times 10^{-18} \,\mathrm{DDD} \,n 1_{12} - n 1_{22} \mathrm{DDDD} \, Z_2 \,\mathrm{J/atom}$$

where, n = number of shell; Z = atomic number

As we go away from the nucleus, the energy levels come closer, i.e. with the increase in the value of n, the difference of energy between successive orbits decreases.

Thus,
$$E_2 - E_1 > E_3 - E_2 > E_4 - E_3 > E_5 - E_4$$
, etc.

Emission Spectrum of Hydrogen

According to Bohr's theory, when an electron jumps from ground state to excited state, it emits a radiation of definite frequency (or wavelength). Corresponding to the wavelength of each photon of light emitted, a bright line appears in the spectrum.

The number of spectral lines in the spectrum when the electron comes

from *n*th level to the ground level = n n(-1)

$$\mathbf{2}$$

Hydrogen spectrum consist of line spectrum.

Series	Region	n 1	n 2
(i) Lyman	UV	1	2, 3, 4,
(ii) Balmer	Visible	2	3, 4, 5,

(iii) Paschen	IR	3	4, 5, 6,
(iv) Brackett	IR	4	5, 6, 7,
(v) Pfund	far IR	5	6, 7,
(vi) Humphery	far IR	6	7, 8, 9,

Wave number () ν is defined as reciprocal of the wavelength.

 $\vec{\mathbf{v}} = \lambda \underline{1} \Rightarrow \vec{\mathbf{v}} = RZ_2 \square \square \square n \underline{1}_{12} - n\underline{1}_{22} \square \square \square$

where,

 $n_1 = 1 2, \dots$

 $n_2 = n_1 + 1, n_1 + 2...$ Here,

 λ = wavelength

 $R = Rydberg constant = 109677.8 cm^{-1}$

First line of a series is called line of longest wavelength (shortest energy) and last line of a series is the line of shortest wavelength (highest energy, $n_2 = \infty$).

Sommerfeld Extension to Bohr's Model

According to this theory, the angular momentum of revolving electron

in an elliptical orbit is an integral multiple of $h_{,i.e.} 2\pi$

$$mvr = \frac{kh}{2\pi}$$

From Bohr model, $mvr = \frac{mh}{r}$

2π

For Kshell, n = 1, k = 1 Circular shape

L shell, n = 2, k = 1, 2 Circular

M shell, n = 3, k = 1, 2, 3 Elliptical

N shell, n = 4, k = 1, 2, 3, 4 Elliptical

Limitations of Bohr's Theory

- (i) It is unable to explain the spectrum of atom other than hydrogenlike doublets or multielectron atoms.
- (ii) It could not explain the ability of atom to form molecules bychemical bonds. Hence, it could not predict the shape of molecules.
- (iii) It is not in accordance with the Heisenberg uncertainty principleand could not explain the concept of dual character of matter.
- (iv) It is unable to explain the splitting of spectral lines in thepresence of magnetic field (Zeeman effect) and electric field (Stark effect).

Towards Quantum Mechanical Model of the Atom

Two important developments which contributed significantly in the formulation of such a model were given below

1. de-Broglie Principle (Dual Nature)

de-Broglie explains the dual nature of electron, i.e. both particle as well as wave nature.

$$h \qquad h \\ \lambda = \text{or} = \lambda \left[p = mv (\text{momentum}) \right] mv \qquad p$$

where, λ = wavelength; *v* = velocity of particle; *m* = mass of particle

$$\lambda = \frac{h}{\sqrt{2m \times \text{KE}}}$$

where, KE = kinetic energy.

2. Heisenberg's Uncertainty Principle

According to this principle, "it is impossible to specify at any given instant both the momentum and the position of subatomic particles simultaneously like electron."

$$\begin{array}{c}
h\\ \Delta x \cdot \Delta p \geq \underline{\qquad}\\ 4\pi\end{array}$$

where, Δx = uncertainty in position; Δp = uncertainty in momentum

Quantum Mechanical Model of Atom

It is the branch of chemistry which deals with dual behaviour of matter. It is given by Werner Heisenberg and Erwin Schrodinger. Schrodinger wave equation is

$$\partial^2 \overline{\psi_2} + \partial^2 \overline{\psi_2} + \partial^2 \overline{\psi_2} + \overline{8\pi^{2}} \overline{2m} (E - U) \psi = 0$$
$$\partial x \quad \partial y \quad \partial z \quad h$$

where, x y z, = cartesian coordinates m = mass of electron, E = total energy of electron

 $U\!=$ potential energy of electron, h = Planck's constant ψ (Psi) = wave function which gives the amplitude of wave

 Ψ^2 = probability function

For H-atom, the equation is solved as

$$H\psi = E\psi$$

where, \hat{H} is the total energy operator, called Hamiltonian. If the sum of kinetic energy operator (*T*) and potential energy operator (*U*) is the total energy, E of the system,

$$H = T + U$$
$$(T + U)\psi = E\psi$$

The atomic orbitals can be represented by the product of two wave functions (i) radial wave function (ii) angular wave function.

The orbital wave function, ψ has no significance, but ψ^2 has significance, it measures the electron probability density at a point in an atom. ψ can be

positive or negative but ψ^2 is always positive.

Difference between Orbit and Orbital

	Orbit	Orbital
1.	An orbit is a well defined circular path around the nucleus in which the electron revolves.	An orbital is the three dimensional space around the nucleus within which the probability of finding an electron is maximum.
2.	The maximum number of electrons in any orbit is given by $2n^2$ where <i>n</i> is the number of the orbit.	The maximum number of electrons present in any orbital is two.

Shapes of Atomic Orbitals The

shapes of the orbitals are

s-spherical, *p*-dumb bell, *d*-double-dumb-bell, *f* Diffused These orbitals combine to form subshell.

(i) *s*-subshell will have only one spherical orbital.



(iii) d-subshell has five orbitals $(d_{xy}, d_{yz}, d_{zx}, d_{x^2-y^2}$ and d_{z^2}).





Wave function distribution

The orbital wave function (ψ) for an electron in an atom has no physical meaning. It is a mathematical function of the coordinates of the electron.



Probability Diagrams

The graph plotted between ψ^2 and distance from nucleus is called probability diagram.



nucleus for 1s and 2s orbitals.

Node

A region or space, where probability of finding an electron is maximum, is called a peak, while zero probability space is called **node**. Nodes are of two types :

(a) Radial nodes

(b) Angular nodes

(ii) ()*l* = angular node

(i) (n - l - 1) = radial node

(iii) (n - 1) = total nodes

Number of Peaks and Nodes for Various Orbitals

S. No.	Type of orbital	Number of peaks	Number of nodes
1.	S	п	n – 1
2.	р	n – 1	n – 2
3.	d	n – 2	n – 3
4.	f	n – 3	n – 4

Quantum Numbers

 $\label{eq:expectation} Each electron in an atomis identified in terms of four quantum numbers.$

Principal Quantum Number (Neils Bohr)

It is denoted by n. It tells us about the main shell in which electron resides. It also gives an idea about the energy of shell and average distance of the electron from the nucleus. Value of n = any integer.

Azimuthal Quantum Number (Sommerfeld)

It is denoted by *l*. It tells about the number of subshells (s p d f, , ,) in any main shell. It also represents the angular momentum of an electron and shapes of subshells. The orbital angular momentum of an

electron = $\sqrt{I}(+1)$ h

 2π Value of l = 0 to n - 1. l = 0 for s, l = 2 for dl

= 1 for p, l = 3 for f

Number of subshells in main energy level = n.

Magnetic Quantum Number (Lande)

It is denoted by *m*. It tells about the number of orbitals and orientation of each subshell. Value of m = -l to +l including zero. Number of orbitals in each subshell = (2l + 1)

S. No.	Subshell	Orbital
1.	S	1
2.	p	3
3.	d	5
4.	f	7

Number of orbitals in main energy level = n^2 .

Maximum number of electrons in *n*th shell = $2n^2$

Spin Quantum Number (Ublenbeck and Goldsmith)

It is denoted by m_s or s. It indicates the direction of spinning of electron, i.e. clockwise or anti-clockwise.

Maximum number of electrons in main energy level = $2n^2$

Electronic Configuration

Arrangement of electrons in various shells, subshells and orbitals in an atom is known as electronic configuration.

Filling of Orbitals in Atom

Aufbau Principle

According to this principle, in the ground state of an atom, the electrons occupy the lowest energy orbitals available to them, i.e. the orbitals are filled in order of increasing value of n + l. For the orbitals having the same value of n + l, the orbital having lower value of n is filled up first.

The general order of increasing energies of the orbital is

$$1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d$$

<6p < 7s < 5f < 6d < 7p

Thus, the filling of electrons in various subshells within the atom can be summerised through following figure.



The energy of atomic orbitals for H-atom varies as

1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f

Pauli Exclusion Principle

It states, no two electrons in an atom can have identical set of four quantum numbers.

The maximum number of electrons in *s* subshell is 2, *p* subshell is 6, *d* subshell is 10 and *f* subshell is 14.

Hund's Rule of Maximum Multiplicity

It states,

- (i) In an atom no electron pairing takes place in the *p d*, or *f* orbitals until each orbital of the given subshell contains one electron.
- (ii) The unpaired electrons present in the various orbitals of thesame subshell should have parallel spins.

Methods of Writing Electronic Configuration

- (i) **Orbital method** In this, the electrons present in respective orbitals are denoted. e.g. $Cl(17) = 1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^5$.
- (ii) Shell method In this, the number of electrons in each shell is continuously written. e.g. Cl (17) = $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^5$

$$\begin{array}{c|c} & & \\ \hline \\ K & L & M \\ \hline \\ 2, 8, 7 \end{array}$$

(iii) **Box method** In this method, each orbital is denoted by a box and electrons are represented by half-headed () or full-headed () arrows. An orbital can occupy a maximum of two electrons. e.g.



Half-filled and completely filled electronic configurations are more stable. Hence, outer configuration of Cr is $3a^{\!\!\!/}{}^{14}s$ and Cu is $3d_{\!\!\!/}{}^{014}s$.

Electronic Configuration of Ions

To write the electronic configuration of ions, first write the electronic configuration of neutral atom and then add (for negative charge) or remove (for positive charge) electrons in outer shell according to the nature and magnitude of charge present on the ion. e.g.

 $O(8) = 1s^2, 2s^22p^4, O^{2-}(10) = 1s^2, 2s^22p^6$

Starting the text with "SS-Chem-", create 100 sms texts with characters of 140 to 150 that educates the student with the most important facts on the following materials.

Chemistry - Atom

Originally Preplexity, Did not Re-write by ChatGPT TURBO Pro

Answer

Here are 100 SMS texts, each starting with "SS-Chem-" and containing 140 to 150 characters, that educate students on the most important facts from the provided material:

- 1. SS-Chem-Mass number (A) = protons + neutrons. Isotopes: same atomic number, different mass number. Isobars: same mass number, different atomic number.
- 2. SS-Chem-Isotones: same number of neutrons. Isodiaphers: same isotopic number. Isoelectronic: same number of electrons. Isosters: same number of atoms and electrons.
- 3. SS-Chem-Bohr's model: electrons revolve in fixed orbits without energy loss. Energy emitted/absorbed when electrons jump between orbits.
- SS-Chem-Electromagnetic waves: travel at light speed (3×10^8 m/s). Wavelength (λ), frequency (ν), and velocity (ν) are key characteristics.
- 5. SS-Chem-Types of radiation: Gamma rays (0.01-0.1 Å), X-rays (0.1-150 Å), UV-rays (150-3800 Å), visible rays (3800-7600 Å), infrared, microwaves, radio waves.
- 6. SS-Chem-Emission spectrum: radiation emitted after energy absorption. Absorption spectrum: dark spaces in bright spectrum due to absorbed wavelengths.
- 7. SS-Chem-Continuous spectrum: no sharp boundaries between radiations. Line spectrum: radiations of specific wavelengths separated by sharp boundaries.
- 8. SS-Chem-Bohr's model: applicable to one-electron systems (H, He+, Li2+). Electrons in stationary orbits with quantized angular momentum.
- 9. SS-Chem-Energy change (ΔE) when electron jumps orbits: $\Delta E = E2 E1 = hv = hc/\lambda$. Ground state is the most stable state of an atom.

- 10. SS-Chem-Orbital method: electrons in respective orbitals (e.g., Cl: 1s2, 2s2, 2p6, 3s2, 3p5). Shell method: electrons in each shell (K, L, M).
- 11. SS-Chem-Box method: orbitals as boxes, electrons as arrows. Max 2 electrons per orbital. Half-filled and fully filled configurations are more stable.
- 12. SS-Chem-Electronic configuration of ions: add/remove electrons based on charge. E.g., O: 1s2, 2s2, 2p4; O2-: 1s2, 2s2, 2p6.
- 13. SS-Chem-Wave number (\overline{v}): reciprocal of wavelength (λ). Amplitude (a): height of wave crest or depth of trough. $v = v\lambda$.
- 14. SS-Chem-Planck's Quantum Theory: $E = hv = hc/\lambda$. Black body radiation and photoelectric effect explained by particle nature of light.
- 15. SS-Chem-Photoelectric effect: light ejects electrons from metal surface. Threshold frequency (v0) is minimum frequency needed.
- 16. SS-Chem-Atomic structure: atom has electrons, protons, neutrons. Electron: negative charge, mass 9.11×10^-31 kg. Proton: positive charge, mass 1.007276 u.
- 17. SS-Chem-Cathode rays: travel in straight lines, cause fluorescence, produce X-rays, deflected by electric/magnetic fields. e/m ratio: 1.758820×10^11 C/kg.
- 18. SS-Chem-Anode rays: travel in straight lines, heavier than electrons, deflected by electric/magnetic fields. e/m ratio depends on gas used.
- 19. SS-Chem-Neutron: neutral particle, discovered by Chadwick. Mass: 1.675×10^-24 g. Positron: positive electron. Neutrino: small mass, no charge.
- 20. SS-Chem-Thomson's model: atom is positive sphere with electrons. Rutherford's model: dense nucleus, electrons in orbits, held by electrostatic forces.
- 21. SS-Chem-Rutherford's model limitations: doesn't explain atom stability or electronic distribution. Bohr's model: quantized orbits, energy levels.
- 22. SS-Chem-Atomic number (Z): number of protons/electrons in neutral atom. Mass number (A): protons + neutrons. Isotopes: same Z, different A.
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- 27. SS-Chem-Aufbau principle: electrons fill lowest energy orbitals first. Order: 1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s.
- 28. SS-Chem-Hund's rule: electrons fill each orbital singly before pairing. Maximum multiplicity: unpaired electrons have parallel spins.
- 29. SS-Chem-Orbit vs. orbital: orbit is circular path, orbital is 3D space with max electron probability. Max electrons: orbit (2n^2), orbital (2).
- 30. SS-Chem-Node: zero probability space. Radial nodes: n-l-1. Angular nodes: l. Total nodes: n-1. Peaks: max probability regions.
- 31. SS-Chem-Emission spectrum of hydrogen: electron jumps to lower energy level, emits photon. Series: Lyman (UV), Balmer (visible), Paschen, Brackett, Pfund, Humphrey (IR).
- 32. SS-Chem-Sommerfeld extension: elliptical orbits, angular momentum quantized. Limitations: can't explain multi-electron atoms, Zeeman/Stark effects.
- 33. SS-Chem-Quantum numbers: n (principal), l (azimuthal), m (magnetic), ms (spin). Define electron's position and energy in atom.
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- 35. SS-Chem-Black body radiation: emitted by heated black body. Planck's theory: energy quantized, E = hv. Explains intensity distribution.
- 36. SS-Chem-Photoelectric effect: light ejects electrons from metal. Work function (W0): minimum energy needed. Kinetic energy: h(v v0).
- 37. SS-Chem-Electromagnetic spectrum: gamma rays, X-rays, UV, visible, infrared, microwaves, radio waves. Differ in wavelength and frequency.
- 38. SS-Chem-Bohr's model: energy levels closer as n increases. $\Delta E = -2.178 \times 10^{-18} (1/n1^2 1/n2^2) Z^2 J/atom.$ Ground state: most stable.
- 39. SS-Chem-Electronic configuration: arrangement of electrons in shells, subshells, orbitals. Aufbau principle, Pauli exclusion, Hund's rule guide filling.
- 40. SS-Chem-Atomic radii: ~10^-8 cm. Electron: discovered by Thomson, negative charge, mass 9.11×10^-31 kg. Proton: positive charge, mass 1.007276 u.
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