[Revision] Chemistry Part-3: Hydrogen Economy, Hard Water types & treatment, Hydrogen Peroxide, Acid, Base, Salt[Mrunal]

Prologue

- Continuing on…This article contains revision note out of Chapter 6, 7, 8 and 9 of Chemistry Class11.
- As such nothing much from 6 to 8 because they deal with technical stuff in thermodynamics, redox equation etc.

Water: Importance in Biosphere

- Water plays a key role in the biosphere because compared to other liquids, water has a higher specific heat, thermal conductivity, surface tension, dipole moment and dielectric constant.
- Water moderates climate and body temperature because of its high heat of vaporisation and heat capacity are responsible.
- Water is an excellent solvent for transportation of ions and molecules for plant-animal metabolism.
- ice cube floats on water because Ice’s density is less than that of water..
- In winter season ice formed on the surface of a lake gives thermal insulation & helps aquatic life to survive.

Table 9.2 Estimated World Water Supply

Source	% of Total
Oceans	97.33
Saline lakes and inland seas	0.008
Polar ice and glaciers	2.04
Ground water	0.61
Lakes	0.009
Soil moisture	0.005
Atmospheric water vapour	0.001
Rivers	0.0001

POSSIBLE MCQ: ASCENDING DESCENDING ORDER OF WATER SOURCES)

Water: Chemical Properties

1. Water can dissolve many salts, particularly in large quantity, makes it hard and hazardous for industrial use.
2. The polar nature of water makes it: (a) a very good solvent for ionic and partially ionic compounds; (b) to act as an amphoteric (acid as well as base) substance; and (c) to form hydrates of different types.

- Amphoteric Nature: Water can act as an acid as well as a base.
- Extensive hydrogen bonding between water molecules= high freezing point, high boiling point. And Due to this hydrogen bonding with polar molecules, even covalent compounds like alcohol and carbohydrates dissolve in water.
- Rain water is almost pure (except some dissolved gases from the atmosphere)
- When rain water flows through earth surface, it dissolves many

salts and becomes hard.

- Soft water: it doesn’t have calcium and magnesium’s soluble salts. Soft water gives lather with soap easily.

Hard Water: Properties

- Hard water does not give lather with soap.
- Presence of calcium and magnesium salts in the form of hydrogencarbonate, chloride and sulphate in water makes water ‘hard’.
- Soap containing sodium stearate reacts with hard water to precipitate out Ca/Mg stearate.
- Hard water forms scum/precipitate with soap, so it is unsuitable for laundry.
- This salt deposit also decreases efficiency of boiler.

Hard water: Types & Treatment

- Hardness of water is of two types: (i) temporary hardness, and (ii) permanent hardness.

Temporary hardness	Permanent Hardness
Due to the presence of magnesium and calcium hydrogen- carbonates.	Due to presence of presence of soluble salts of magnesium and calcium in the form of chlorides and sulphates in water.

Removed by following methods: 1. Boiling: to convert soluble carbonates into insoluble carbonates, then they're filtered off. 2. Clark's method: lime added to water. It'll precipitate out calcium carbonate and magnesium hydroxid. Then it is filtered off.	Not possible to remove this hardness by boiling. But following methods will work 1. Treatment with washing soda (sodium carbonate): It'll form insoluble carbonates that can be filtered off. 2. Calgon's method: add Sodium hexameta- phosphate. 'calgon' is the commercial name of this chemical. 3. Ion-exchange method using zeolite/permutit (Hydrated sodium aluminium silicate) 4. Synthetic resin ion exchangers.

Hydrogen Peroxide (H2O2)

Isotop	proton	neutron	rarity
protium	1	0	99.985% hydrogen is like this
Deuterium (heavy hydrogen)	1	1	0.015%
Tritium (radioactive)	1	2	trace amount in earth

Hydrogen paroxide: chemical properties

1. Pollution control treatment of domestic and industrial effluents.
2. Properties: Colourless-pale blue liquid. Acts as an oxidising as well as reducing agent in both acidic and alkaline media.
3. H2O2 decomposes slowly on exposure to light hence stored in dark.
4. In metal surfaces or traces of alkali (present in glass containers), H2O2 reaction is catalysed. Therefore it is stored in wax-lined glass or plastic vessels in dark.
5. Urea can be added as a stabiliser.
6. H2O2 must be kept away from dust because dust can induce explosive

decomposition of the compound.

H_2O_2: Uses

1. Hair bleach, bleaching agent for textiles, paper pulp, leather, oils, fats, etc.
2. Mild disinfectant, antiseptic (perhydrol).
3. Sodium based detergents.
4. Synthesis of pharmaceuticals (cephalosporin, hydroquinone), tartaric acid and certain food products
5. Used in Environmental (Green) Chemistry- for pollution control treatment of domestic and industrial effluents, oxidation of cyanides, restoration of aerobic conditions to sewage wastes, etc.

Water gas / Syngas

- Water gas/syngas/synthesis gas is the mixture of CO and H_2.
- It is further used for the synthesis of hydrocarbons such as methanol.
- Syngas is produced from sewage, saw-dust, scrap wood, newspapers etc.
- Coal gasification is the process of producing 'syngas' from coal.

Dihydrogen Properties and uses

- Dihydrogen is a colourless, odourless, tasteless, combustible gas.
- Prepared by (1) water-gas shift reaction from petrochemicals (2) electrolysis of brine.
- Lighter than air and insoluble in water.
- Dihydrogen =>Synthesis of ammonia =>mfg. of nitric acid and nitrogenous fertilizers.
- hydrogenation of polyunsaturated vegetable oils like soyabean, cotton seeds etc=> Vanaspati Ghee.
- Manufacture of methanol and other bulk organic chemicals.
- Mfg. of metal hydrides, hydrogen chloride.
- To reduce heavy metal oxides to metal
- Atomic hydrogen and oxy-hydrogen torches used for cutting and

welding purposes. They can generate the temperature of 4000 K.

- Dihydrogen fuel cells = electrical energy and rocket fuel.

Hydrogen Economy: basis principle

- use di-hydrogen to store and transport energy.
- Energy is transmitted in the form of dihydrogen and not as electric power.
- 2005: India launched pilot project to use dihydrogen as fuel for running automobiles.
- Initially 5% dihydrogen has been mixed in CNG for use in four-wheeler vehicles. It'll be increased gradually.
- dihydrogen can release 3x times more energy than petrol
- It produces less pollutants than than petrol.
- Dihydrogen's pollutant is called "oxides of dinitrogen". We can minimize its emission by adding water in the cylinder.

Limitations of Dihydrogen fuel

- Its cylinder weight 30 times more than petrol tank.
- Liquification requires cooling to 20K. This Is very expensive.

Acid, Base, Salts

Acid	Base
turn blue litmus paper into red	turn red litmus paper blue
Acid accepts electron pair	Donates pair of electrons
"acid" word derived from a latin word "acidus" meaning sour.	Bases are known to , taste bitter and feel soapy. Common example: washing soda.

• They liberate dihydrogen on reacting with metal • Arrhenius theory, acids are substances that dissociates in water to give hydrogen ions H + (aq) and bases are substances that produce hydroxyl ions OH – (aq)	

Table 7.5 The pH of Some Common Substances

Name of the Fluid	pH	Name of the Fluid	pH
Saturated solution of NaOH	~15	Black Coffee	5.0
0.1 M NaOH solution	13	Tomato juice	~4.2
Lime water	10.5	Soft drinks and vinegar	~3.0
Milk of magnesia	10	Lemon juice	~2.2
Egg white, sea water	7.8	Gastric juice	~1.2
Human blood	7.4	1M HCl solution	~0
Milk	6.8	Concentrated HCl	~–1.0
Human Saliva	6.4		

POSSIBLE MCQ: ASCENDING-DESCENDING ORDER

Hydrochloric acid	Gastric juice essential for digestions
Acetic acid	main constituent of vinegar.
Lemon juice	citric acid
Orange Juice	ascorbic acids
Tamarind paste	tartaric acid

Salts

- When acids and bases are mixed in the right proportion they react and give salts.
- Example: sodium chloride, barium sulphate, sodium nitrate.
- hydrochloric acid + sodium hydroxide.= Salt (Sodium chloride)

PH

- pH scale: Hydronium ion concentration in molarity – that is expressed on a logarithmic scale known as the pH scale.
- Buffer Solutions: These solutions resist change in pH in presence of acid or alkali.
- The pH of a solution is defined as the negative logarithm to base 10 of the activity
- PH Measurement has biological and cosmetic applications.
- Now-a-days pH paper is available with four strips on it. They can determine PH with an accuracy of ~0.5.
- pH meter is a device that measures the pH-dependent electrical potential of the test solution within 0.001 precision.
- pH meters of the size of a writing pen are now available in the market

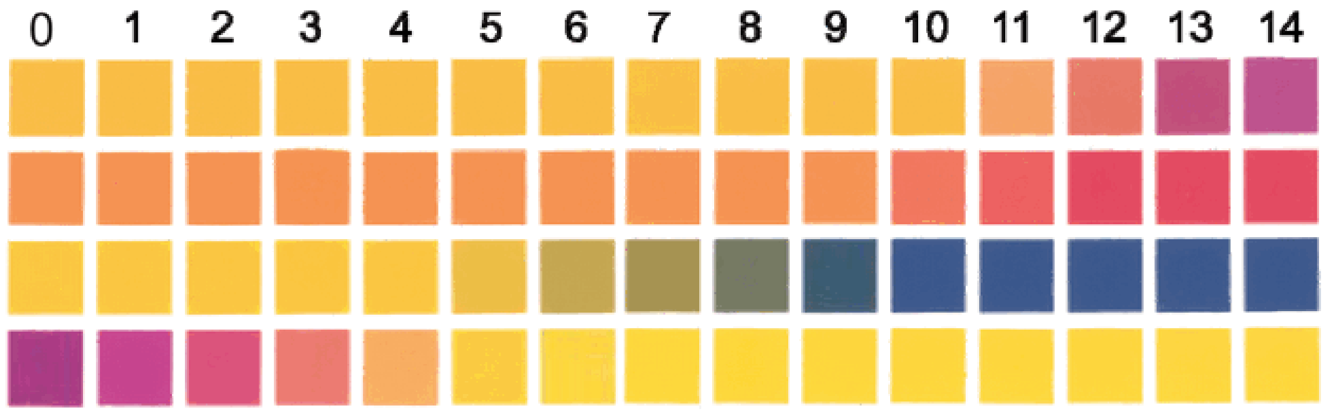
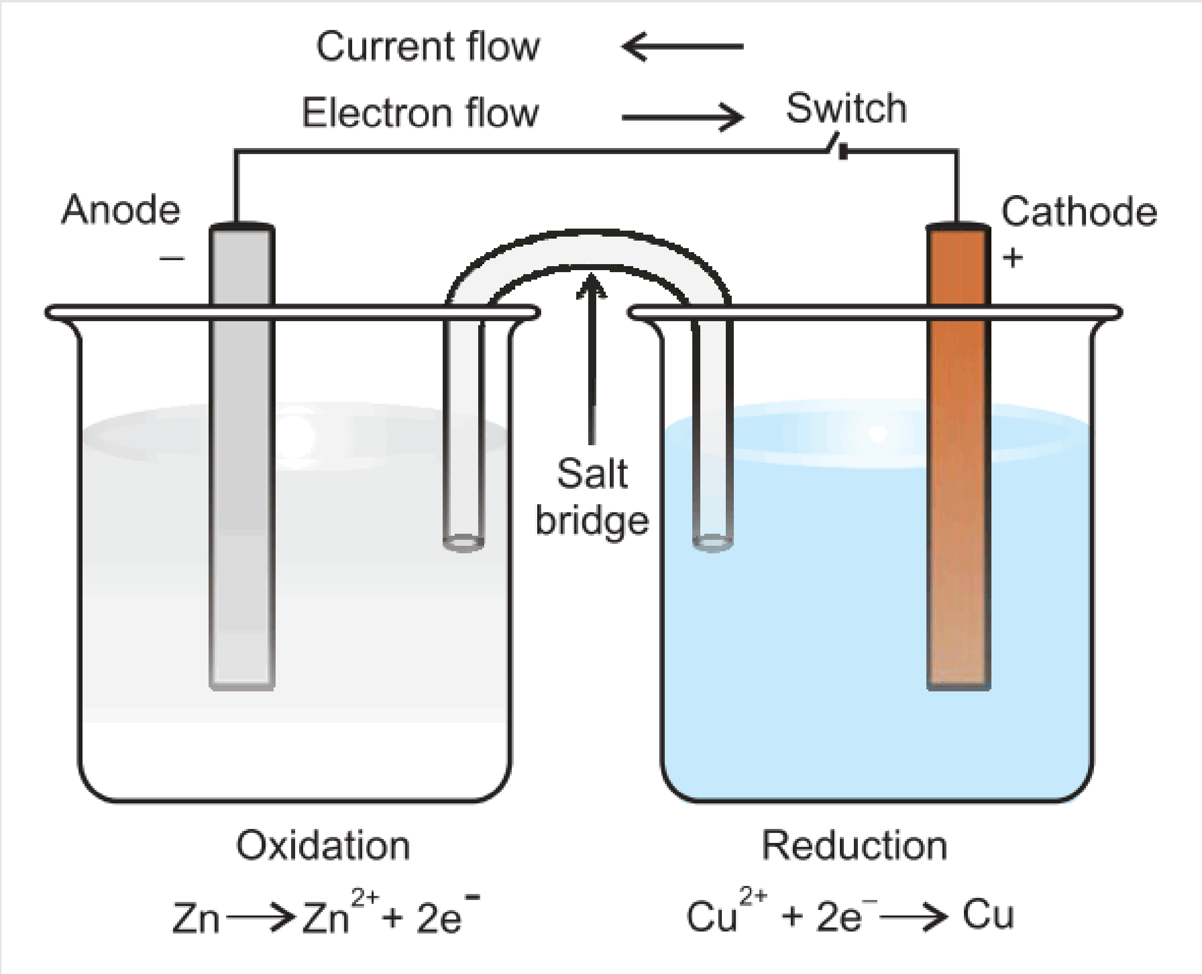


Fig.7.11 pH-*paper with four strips that may have different colours at the same* pH

Extensive vs. Intensive properties

extensive properties	intensive properties
Depends on quantity of the matter in system	Those properties which do not depend on the quantity or size of matter present
Examples: mass, volume, internal energy, enthalpy, heat capacity, etc.	Temperature, pressure, density



DANIELL CELL: ELECTRONS PRODUCED AT THE ANODE DUE TO OXIDATION OF ZN TRAVEL THROUGH THE EXTERNAL CIRCUIT TO THE CATHODE WHERE THESE REDUCE THE COPPER IONS.

Oxidation	Loss of electron(s) by any species. 20% of atmosphere is dioxygen, hence many elements combine with it and to form of their oxides.
Reduction	Gain of electron(s) by any species.
Oxidising agent	Acceptor of electron(s).
Reducing agent	Donor of electron(s).
Entropy	It is a measure of disorder or randomness. The greater the disorder in an isolated system, the higher is the entropy.

Heavy water	• Prepared by (1) water electrolysis (2) by-product in some fertilizer industries • Used as Moderator in nuclear reactors.
Svante Arrhenius (Sweden)	• Gave the Arrhenius acid theory. • He was the first to discuss the 'greenhouse effect' calling by that name. He received Nobel Prize in Chemistry in 1903 for his theory of electrolytic dissociation and its use in the development of chemistry
Faraday (London)	• worked on electricity and magnetism • Established modern field theory.

Possible MCQs

1. match the following: (1) methods to remove hardness of water vs. chemical principle (2) isotopes of hydrogen (3) chemical vs. its uses (4) food item vs. acid component
2. assertion reasoning related to (1) water's importance in biosphere (2) why water used in dihydrogen engine
3. which of the following statements are correct about (1) ice (2) hard water and its treatment methods (3) hydrogen
4. Arrange following xyz items in their ascending / descending order of PH.

[Revision] Chemistry Part-2: Metal, Non-Metal, Metalloid, Liquid, Surface tension,

Viscosity, Gas Laws, Periodic Table[Mrunal]

Prologue

- Continuing on…This article contains revision note out of Chapter 3, 4 and 5 of Chemistry Class11.
- Chapter 4 mostly ignored because it deals with Chemical Bonding And Molecular Structure, The valence bond (VB) approach, The VSEPR model, molecular orbital (MO) theory and other technical things.

Metal	Non-metal
1. Metals comprise more than 78% of all known elements 2. They appear on the left side of the Periodic Table	• located at the top right hand side of the Periodic Table. • the non- metallic character increases as one goes from left to right across the Periodic Table
usually solids at room temperature [mercury is an exception; gallium and caesium also have very low melting points (303K and 302K, respectively)].	Non-metals are usually solids or gases at room temperature with low melting and boiling points (boron and carbon are exceptions)
Have high melting and boiling points.	?
Good conductors of heat and electricity.	poor
malleable: can be flattened into thin sheets by hammering	Brittle
ductile: can be drawn into wires	nope

Semi-metals or Metalloids: silicon, germanium, arsenic, antimony and tellurium show properties that are characteristic of both metals and non- metals.

Liquids: Properties

1. Liquids have definite volume because molecules do not separate from each other.
2. Liquids can flow, they can be poured, because their Molecules can move past one another freely.
3. Liquids can assume the shape of the container in which these are stored.
4. Liquids may be considered as continuation of gas phase into a region of small volume and very strong molecular attractions.
5. Physical properties of liquid = (1) vapour pressure (2) surface tension (3) viscosity. These are due to strong intermolecular attractive forces.

Liquids: Vapour Pressure

- liquid evaporates and pressure exerted by vapour on the walls of the container (vapour pressure)
- The normal boiling point of water is 100 °C (373 K), its standard boiling point is 99.6 °C (372.6 K).
- Standard boiling point of the liquid is slightly lower than the normal boiling point because 1 bar pressure is slightly less than 1 atm pressure.
- Liquids at high altitudes boil at lower temperatures in comparison to that at sea level, because at high altitudes atmospheric pressure is low. (important for assertion-reasoning)
- In hills, water boils at low temperature therefore, Pressure cooker is used for cooking food.
- In hospitals surgical instruments are sterilized in autoclaves. Autoclaves increase the boiling point of water by increasing the pressure above the atmospheric pressure by using a weight covering the vent.
- Boiling does not occur when liquid is heated in a closed vessel.

Liquid: UPSC Surface Tension

Surface tension is responsible for following events (important for MCQ):

1. Small drops of mercury form spherical bead instead of spreading on the surface.
2. Particles of soil at the bottom of river remain separated but they stick together when taken out.
3. Liquid rise (or fall) in a thin capillary as soon as the capillary touches the surface of the liquid.
4. On flat surface, droplets are slightly flattened by the effect of gravity; but in the gravity free environments, the liquid drops will be perfectly spherical.

Principle: Liquids tend to minimize their surface area. Surface tension denoted by Gamma, its SI unit NM-1

Liquids: Viscosity & Laminar flow

- Viscosity is a measure of resistance to flow which arises due to the internal friction between layers of fluid
- SI unit of viscosity coefficient= 1 newton second per square metre = pascal second
- CGS unit of viscosity coefficient = Poise (named after great scientist Jean Louise Poiseuille).
- Greater the viscosity, the more slowly the liquid flows.
- Viscosity of liquids decreases as the temperature rises.
- Glass is an extremely viscous liquid- so viscous that many of its properties resemble solids.
- Windowpanes of old buildings- they become thicker at bottom than at top. This is because of liquid flow property of glass.
- Laminar flow is type of flow in which there is a regular gradation of velocity in passing from one layer to the next.

Gas: Properties

1. Gases are highly compressible

2. Gases exert pressure equally in all directions.
3. Gases have much lower density than the solids and liquids.
4. Gases can assume volume and shape of the container. Their volume and the shape of gases are not fixed.
5. Under suitable temperature and pressure conditions gases can be liquified
6. Gases mix evenly and completely in all proportions without any mechanical aid.
7. The noble gases exhibit very low chemical reactivity because all of their orbitals completely filled by electrons. Very difficult to add/remove electrons from it. (Example: helium, neon, argon, krypton, xenon, radon, and element 118)
8. 11 elements exist as gases.

Gas Laws

Robert Boyle,Anglo-Irish	• first reliable measurement on properties of gases (1662) • Boyle’s Law (Pressure – Volume Relationship) • at constant temperature, the pressure of a fixed amount (i.e., number of moles n) of gas varies inversely with its volume. • P1V1=P2V2= constant • Gases are highly compressible because when a given mass of a gas is compressed, the same number of molecules occupy a smaller space • This means that gases become denser at high pressure.

Charles' Law	• Temperature – Volume Relationship • At constant pressure, volume of a gas increases on increasing temperature and decreases on cooling. (V = k2T) • This new temperature scale is called the Kelvin temperature scale or Absolute temperature scale. • Kelvin scale of temperature is also called Thermodynamic scale of temperature and is used in all scientific works. • Each line of the volume vs temperature graph is called isobar. • The lowest imaginary temperature at which gases are supposed to occupy zero volume is called Absolute zero. • All gases obey Charles' law at very low pressures and high temperatures
Gay Lussac's Law	• Pressure- Temperature Relationship • Pressure in well inflated tyres of automobiles is almost constant, but on a hot summer day this increases considerably and tyre may burst if pressure is not adjusted properly. • During winters, on a cold morning one may find the pressure in the tyres of a vehicle decreased considerably. • At constant volume, pressure of a fixed amount of a gas varies directly with the temperature. Mathematically. P/T = constant. • This relationship can be derived from Boyle's law and Charles' Law. • Pressure vs temperature (Kelvin) graph Each line of this graph is called isochore.

Avogadro Law,Italy, 1811	Volume – Amount RelationshipEqual volumes of all gases under the same conditions of temperature and pressure contain equal number of molecules.As long as the temperature and pressure remain constant, the volume depends upon number of molecules of the gas V=k4n.
STP	• Standard temperature and pressure means 273.15 K (0°C) temperature and 1 bar (i.e., exactly 105 pascal) pressure. • These values approximate freezing temperature of water and atmospheric pressure at sea level.
Dalton Partial pressure, 1801	• Total pressure exerted by the mixture of non-reactive gases is equal to the sum of the partial pressures of individual gases • In a mixture of gases, the pressure exerted by the individual gas is called partial pressure. • pTotal = p1 +p2 +p3 +…..
gas liquification	• At 30.98 C carbon dioxide remains gas upto 73 atmospheric pressure. At 73 atmospheric pressure, liquid carbon dioxide appears. Therefore, 30.98 C is called critical temperature of carbon dioxide. Because this is the highest temperature at which liquid carbon dioxide is observed. • A gas below the critical temperature can be liquefied by applying pressure, and is called vapour of the substance.

Ideal Gas	**Real Gas**

Ideal gas follows Boyle’s law, Charles’ law and Avogadro law strictly-at all temperature and pressures.	They do not follow, Boyle’s law, Charles law and Avogadro law perfectly under all conditions.
Ideal gas equation: pV=nRT is applicable to them	N/A
Such a gas is hypothetical, it goes on assumption that intermolecular forces present in an ideal gas.	Their molecules interact with each other.
N/A	• Boyle temperature: At this temperature real gas obeys ideal gas law. • This Boyle point/temperature of a gas depends upon its nature.

Periodic Table

chemist	table name
Johann Dobereiner (German)	Triads
AEB De Chancourtois (French)	cylindrical table
Lothar Meyer (German)	His table closely resembles the Modern Periodic Table. But his work published after Mendeleev. Therefore, Mendeleev credited with Modern Periodic Table.

Mendeleev’s table: Characteristics

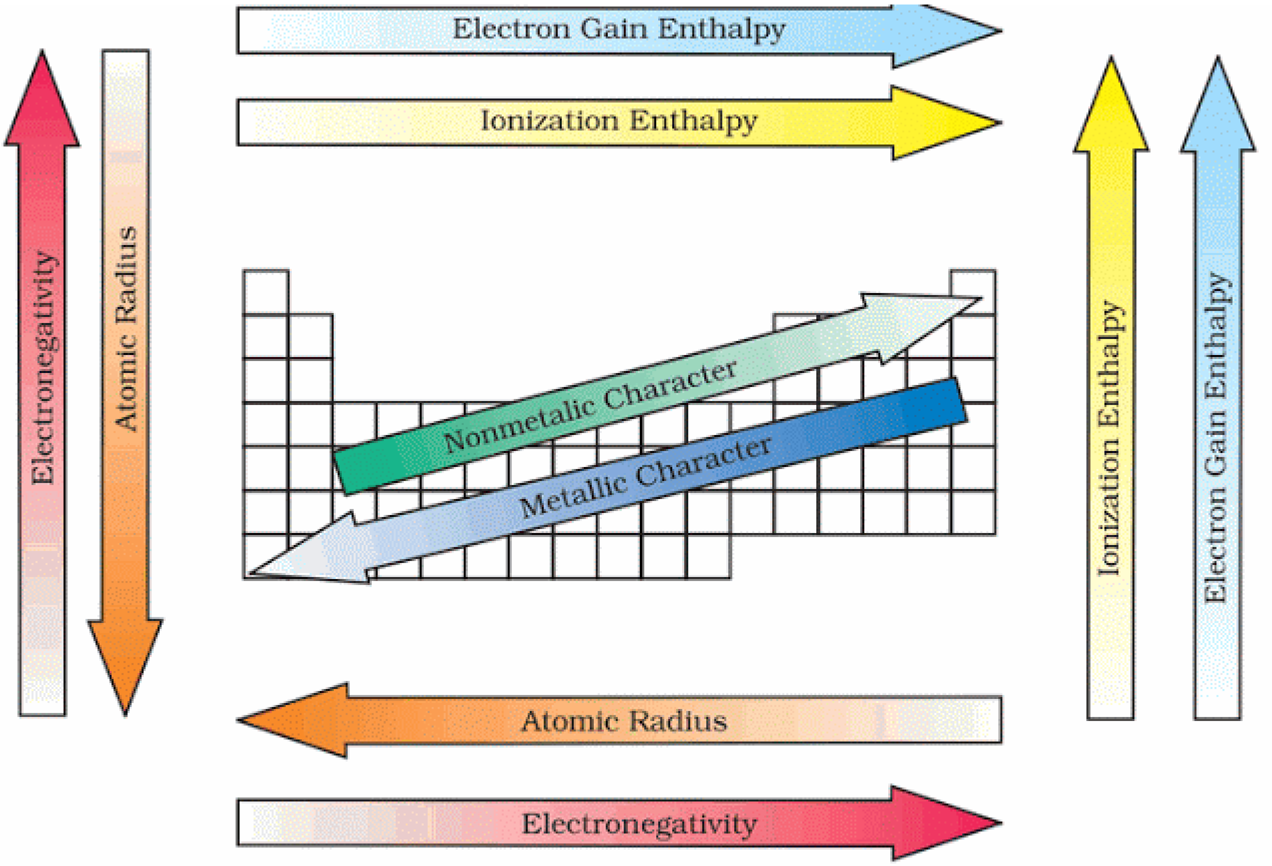


Fig. 3.7 *The periodic trends of elements in the periodic table*

- Russian Chemist Mandeleev (1834-1907) wrote famous textbook "Principles of Chemistry"
- Modern Periodic based on 3 principles: (1) physical and chemical properties of the elements are periodic functions of their atomic numbers. (2) aufbau (build up) principle (3) Electronic configuration of atoms provide a theoretical foundation for the periodic classification.
- He arranged elements in horizontal rows (periods- in increasing atomic weights.)
- And vertical columns (groups- they've same electron configuration in outer orbit).
- The elements with similar properties occupied the same vertical column or group.
- Left gaps for the elements that were not found in his time, predicted the elements that were yet to be found.
- Element with atomic number 101, as Mendelevium- is named in honor

of this scientist.

- If new element discovered, its permanent name and symbol are given by a vote of IUPAC representatives from each country.
- As per IUPAC note, latest element is 118 but its credit yet to be given.
- Chemical reactivity is highest at the two extremes of a period and is lowest in the centre.
- Highly reactive elements do not occur in nature in Free State; they usually occur in the combined form.
- Oxides of elements on left are basic
- Oxides of elements on the right are acidic
- Oxides of elements in the centre are amphoteric or neutral.

Block elements

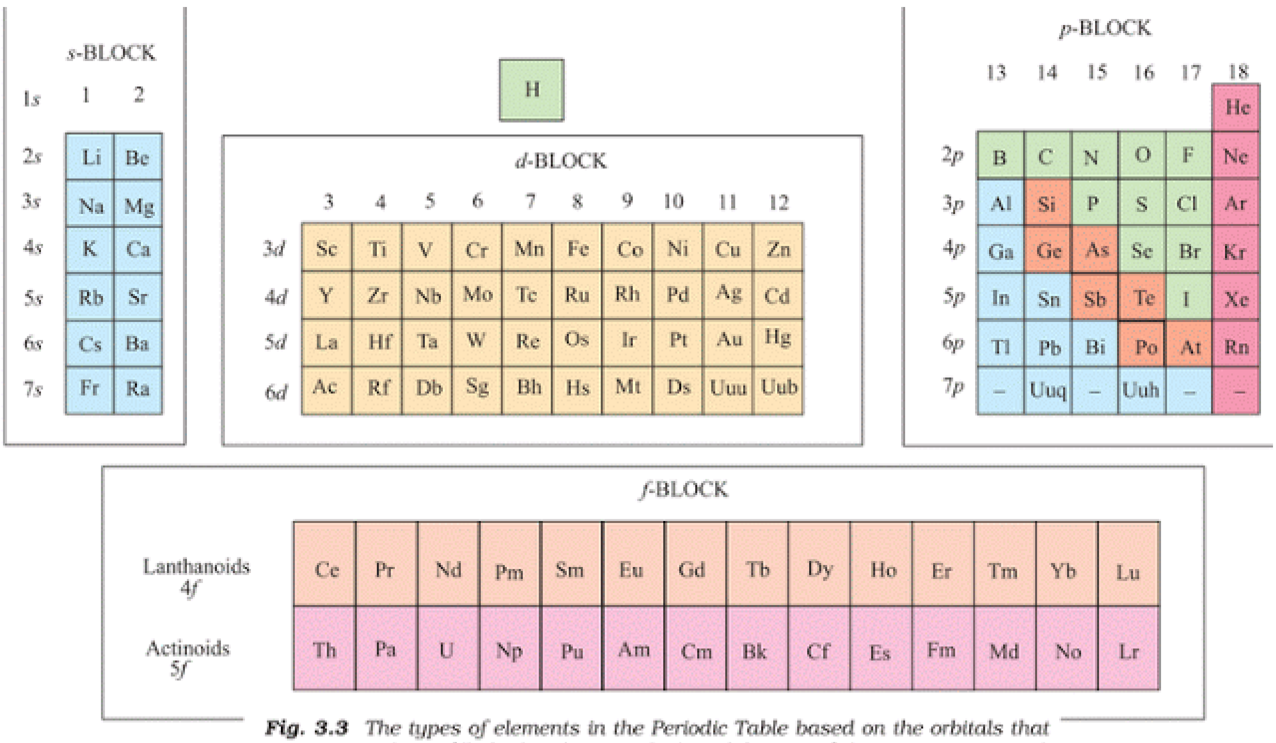


***Fig. 3.3** The types of elements in the Periodic Table based on the orbitals that are being filled. Also shown is the broad division of elements into METALS ( ), NON-METALS ( ) and METALLOIDS ( ).*

We can classify the elements into four blocks depending on the type of atomic orbitals that are being filled with electrons

s-block	Group 1 (alkali metals) and Group 2 (alkaline earth metals)

p-block	Representative Elements or Main Group Elements
d-block	• Transition Elements. • They mostly form coloured ions • they display paramagnetism (i.e. attracted by magnetic field) • They are used as catalysts
f-block	• Inner-Transition Elements • They are all metals. • located in bottom two rows of the table. • two rows of elements at the bottom of the Periodic Table, called the Lanthanoids and Actinoids, • Actinoid elements are radioactive. • Most actinoid elements found only in nanogram quantities during nuclear reactions and their chemistry is not fully studied. • The elements after uranium are called Transuranium Elements.

cation	anion
removal of an electron from an atom leads to cation	Gain of an electron leads to an anion.non-metals have strong tendency to gain electrons.
Smaller than parent atom, because less electrons.	Larger than parent atom.

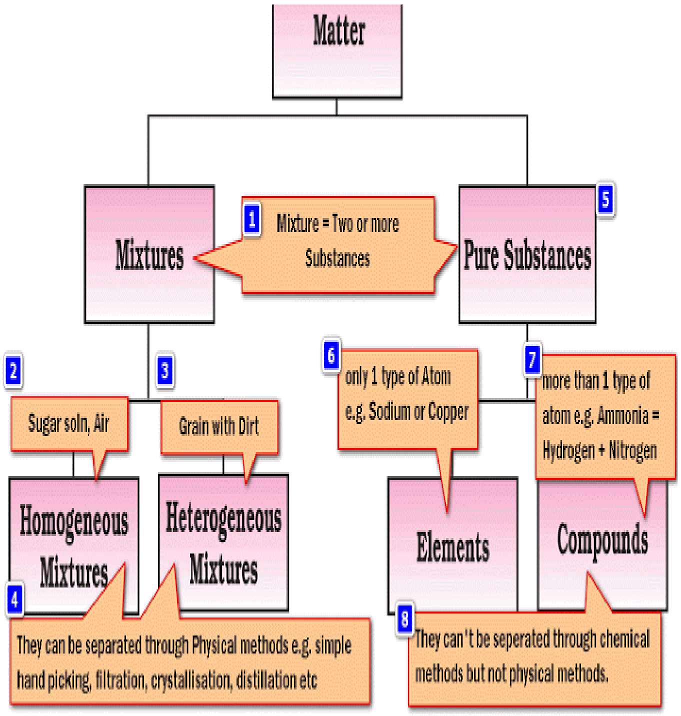
Possible MCQs

1. Which of the following metals exist as liquid?
2. Find correct statements about (1) metal (2) Non-metal (3) Metalloid (4) Gases (5) ideal gas (6) Modern Periodic table
3. Which of the following events are caused by surface tension?
4. Viscosity depends on which of the following factors?
5. Match the following: scientist vs. gas law, block-element vs characteristic

[Revision] Chemistry Part-1: Matter, Mass, Isotopes, Isobars,X-Ray, Alpha-Ray, Gamma-Ray, Cathode-Ray & More[Mrunal]

- This year's UPSC CAPF paper contained significant number of questions science, particularly higher level chemistry (Above class7-10 NCERTs)
- In recent years, UPSC has been shifting from Class 7 to 10 Science NCERTs towards 11-12 NCERTS) – This has been evident in all 3 exams conducted by UPSC viz. CAPF, CDS and CSE-prelims.
- Therefore, with help of Venkat sir, I'm preparing selected "revision notes" out of NCERT Science Books (11, 12). Most important: can't guarantee this project will be finished before prelim comes.
- First part of this article series deals with Class11 Chemistry NCERT Chapter 1 (Basic concepts of matter) and chapter 2 (Structure of Atom).

Matter classification



POSSIBLE MCQ: ASSERTION REASONING, “WHICH OF THE FOLLOWING 2-3 STATEMENTS ARE CORRECT?”

physical properties	chemical properties
• they’re measured or observed without changing the identity of material- e.g. colour, odour, melting point, boiling point, density	• we can observe them only after chemical change occurs. • e.g. acidity or basicity, combustibility

SI system of measurement

- Through Metre convention in Paris (1875), this International system of units was setup.
- accordingly, each country has an institute to maintain standards of measurement
- e.g. in India it is done by National physical laboratory @Delhi.

7 Basic units in SI measurement

Table 1.1 Base Physical Quantities and their Units

Base Physical Quantity	Symbol for Quantity	Name of SI Unit	Symbol for SI Unit
Length	l	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric current	I	ampere	A
Thermodynamic temperature	T	kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	I_v	candela	cd

POSSIBLE MCQ: MACTH THE FOLLOWING

Definition of SI units

Table 1.2 Definitions of SI Base Units

Unit of length	**metre**	The *metre* is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second.
Unit of mass	**kilogram**	The *kilogram* is the unit of mass; it is equal to the mass of the international prototype of the kilogram.
Unit of time	**second**	The *second* is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.
Unit of electric current	**ampere**	The *ampere* is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2 10^{-7} newton per metre of length.
Unit of thermodynamic temperature	**kelvin**	The *kelvin*, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
Unit of amount of substance	**mole**	1. The *mole* is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12; its symbol is "mol." 2. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.
Unit of luminous intensity	**candela**	The *candela* is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540 10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.

POSSIBLE MCQ: WHICH OF THE FOLLOWING STATEMENTS CORRECT ABOUT XYZ UNIT?

Mass	Weight
A substance's mass will remain same everywhere	Will change depending on gravity of the given place.
Measured using "Analytical balance"	measured using weighing scale

Why Pt-IR cylinder for weight standardization?

- The Mass standard is kilogram.
- Kilogram is defined as the mass of platinum-iridium (Pt-Ir)

cylinder that is stored in an airtight jar at International Bureau of Weights and Measures in Sevres, France.

- Pt-Ir was chosen for this standard because it is highly resistant to chemical attack and its mass will not change for an extremely long time.
- Assertion reasoning question possible from above factoids

Table 1.3 Prefixes used in the SI System

Multiple	Prefix	Symbol
10^{-24}	yocto	y
10^{-21}	zepto	z
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	µ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10	deca	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E
10^{21}	zeta	Z
10^{24}	yotta	Y

POSSIBLE MCQ: MATCH THE FOLLOWING PREFIX VS. MULTIPLE / CONVERT "X" INTO "Y"

°C (degree celsius)	• calibrated from 0° to 100° where these two temperatures are the freezing point and the boiling point of water respective • Negative values possible in celcius
°F (degree fahrenheit)	• fahrenheit scale is represented between 32° to 212°. • F = [9C/5]+32
K (kelvin)	• K=C+273.1 • Negative values not possible

Law of	Detail
1.Conservation of Mass	• matter can neither be created nor destroyed – Antoine Lavoisier (1789)
2.Definite Proportions	• a given compound always contains exactly the same proportion of elements – Joseph Proust • E.g. both naturally occurring and artificially synthesized Cupric carbonate will have same elements in same ratio.
3.Multiple Proportions	• if two elements can combine to form more than one compound, the masses of one element that combine with a fixed mass of the other element, are in the ratio of small whole numbers – Dalton • example 2 gm Hydrogen + 16 gm Oxygen = 18 gm water • but 2 gm Hydrogen + 32 gm Oxygen = 34 gm Hydrogen Peroxide.
4.Gaseous Volumes	• Gay Lussac (1808) • When gases combine or are produced in a chemical reaction they do so in a simple ratio by volume provided all gases are at same temperature and pressure. • If 100 ml hydrogen combine with 50 ml oxygen, we get 100 ml water vapour.
5.Avogadro Law	• equal volumes of gases at the same temperature and pressure should contain equal number of molecules • He differentiated atoms from molecules.

DALTON’S ATOMIC THEORY

1. Democritus, a Greek Philosopher (460 – 370 BC) said that matter is composed of small indivisible particles called ‘a-tomio’ (meaning –

indivisible). Indian philosophers also made similar statements. But they had no proofs.

2. Finally, a British Teacher John Dalton published book published ‘A New System of Chemical Philosophy’ (1808) with following points
3. Matter consists of indivisible atoms.
4. All the atoms of a given element have identical properties and identical mass.
5. Atoms of different elements differ in mass.
6. Compounds are formed when atoms of different elements combine in a fixed ratio.
7. Chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.

Good	Bad
his theory can explain following: • laws of chemical combination • law of conservation of mass • law of constant composition • law of multiple proportion	He couldn’t explain following • If glass or ebonite when rubbed with silk or fur, it’ll generate electricity. Why? • Same way result of many experiments, he couldn’t explain.

Table 2.1 Properties of Fundamental Particles

Name	Symbol	Absolute charge/C	Relative charge	Mass/kg	Mass/u	Approx. mass/u
Electron	e	-1.6022×10^{-19}	-1	9.10939×10^{-31}	0.00054	0
Proton	p	$+1.6022\times10^{-19}$	+1	1.67262×10^{-27}	1.00727	1
Neutron	n	0	0	1.67493×10^{-27}	1.00867	1

ASCENDING DESCENDING ORDER OF WEIGHT / CHARGE COULD BE ASKED IN MCQ

Discovery of	Was discovered by

1.Electron	A cathode ray discharge tube – cathode ray particles – observed though fluorescent or phosphorescent – negatively charged particles, called electrons
2.Proton	modified cathode ray tube – canal rays – positively charged particles
3.Neutron	Chadwick (1932). he bombarded alpha-particles on beryllium thin sheet.

Cathode Ray Tube & Television

- 1830: Michael Faraday showed that if electricity is passed through a solution of an electrolyte, matter will be liberated and deposited at the electrodes. (1830)
- 1850s: Faraday began to study electrical discharge in cathode ray tubes
- A cathode ray tube is a sealed glass tube containing two thin metal pieces (electrodes).
- Cathode rays start from cathode and move towards the anode.
- Cathode ray will travel in straight line IF there is no electrical or magnetic field,
- If there is electrical/magnetic field, cathode rays will behave like charged particles.
- Characteristics of cathode rays (electrons) do not depend upon (1) the material of electrodes (2) nature of the gas present in the cathode ray tube.
- Cathode rays themselves are not visible but their behaviour can be observed with the help of certain kind of materials (fluorescent or phosphorescent) which glow when hit by them.
- We can observe electrical discharge through the gases only at very low pressures and at very high voltages.
- Television picture tubes are cathode ray tubes
- Television pictures result due to fluorescence on the television screen coated with certain fluorescent or phosphorescent materials.

X-Ray & Roentgen

- Wilhalm Röentgen: strike electron to dense anode metal in Cathode ray tube => rays produced => these rays cause fluorescence in the fluorescent materials placed outside the cathode ray tubes. He called them X-Rays (1895)
- Henri Becqueral coined the term radioactivity. Marie Curie, Piere Curie, Rutherford and Fredrick Soddy worked further in this field.

Detail	penetrating power	characteristic
Alpha particles	1	• Alpha particles are Positive charged. • Alpha particle + 2 electron = helium • Rutherford bombarded very thin gold foil with alpha–particles but most of the a– particles passed through the gold foil undeflected. • Thus he provide Most of the space in the atom is empty. And volume occupied by the nucleus is negligibly small as compared to the total volume of the atom.
Beta Rays	100 x alpha	negatively charged particles similar to electrons
Gamma-Rays	1000 x alpha	• neutral in nature • don't have any particles.

Atomic Mass

- Greek word 'stoichiometry' =stoicheion (meaning element) + metron (meaning measure).
- Stoichiometry calculation of masses and volumes of reactants and

products of a chemical reaction.

- 19th Century scientists assigned mass of “1” to Hydrogen. (no units, only number). All the remaining elements were given mass number relative to Hydrogen.
- 1961: Carbon – 12 isotop is assigned a mass of exactly 12 atomic mass unit (amu) and masses of all other atoms are given relative to this standard.
- Thus, One atomic mass unit (AMU) = one- twelfth the mass of one carbon – 12 atom.
- Today, ‘amu’ has been replaced by ‘u’ which is known as unified mass.
- Today, we have sophisticated techniques e.g., mass spectrometry for determining the atomic masses fairly accurately.

Atomic number (Z)	**Mass Number (A)**
• total protons = Z • total electrons =Z	• Proton + neutron = nucleons. • total nucleons = A
• Z written in subscript below the element symbol, on left side.	• A written in superscript above element symbol, on left side.
• Isotopes= same “Z” but different “A”. means Isotopes have same number of protons but different number of neutrons.	Isobars= same “A” but different “Z”

Average Atomic Mass	• If an element has more than one isotope • Its Avg. atomic mass = weighted average of (atomic mass x its relative occurrence in percentages)

Formula Mass	e.g. formula mass of sodium chloride = atomic mass of sodium + atomic mass of chlorine

Isotop	proton	neutron	rarity
protium	1	0	99.985% hydrogen is like this
deuterium	1	1	0.015%
tritium	1	2	trace amount in earth

- Similarly Carbon has 3 isotopes, chlorine has 2 isotopes
- An Element’s chemical property depends on no. of electrons, and not much on neutrons. Therefore, Isotopes show same chemical behaviour. (can be asked for assertion-reasoning)

Mole and Avogadro

- One mole = Amount of a substance that contains as many particles as there are atoms in exactly 12 g (or 0.012 kg) of the Carbon 12 isotope.
- 1 mol is also known as ‘Avogadro’ constant, in honour of Amedeo Avogadro. It equals to 6.022×1023 atoms

Atomic Models

1.J.J.THOMSON,Britain	• also known as plum pudding, raisin pudding or watermelon model (1904) • he said atom possesses a spherical shape (radius approximately 10 –10 m) in which the positive charge is uniformly distributed. • The electrons are embedded into it in such a manner as to give the most stable electrostatic arrangement • He got Nobel Physics for discovering how gases conduct electricity. (1906)
2.RUTHERFORD’S NUCLEAR MODEL	• Atom resembles the solar system, nucleus is the Sun, and electrons are revolving planets. • Electrons and the nucleus are held together by electrostatic forces of attraction • he failed to explain stability of an atom. • it says nothing about the electronic structure of atoms i.e., how the electrons are distributed around the nucleus and what are the energies of these electrons.

3.NEILS BOHR, Denmark	• Orbit is a circulate path around nucleus. Electrons move only in Orbit. • He was the first to explain quantitatively the general features of hydrogen atom structure and its spectrum. Though the theory is not the modern quantum mechanics. • He could not explain how atoms form molecules by chemical bonds. Hence Max Plank, Schrödinger et al began towards Quantum theory. • James Maxwell: discussed electromagnetic radiation. • Post WW-1, Bohr worked for peaceful uses of atomic energy, got Nobel in 1922.
4.Wolfgang Pauli, Austria	• No two electrons in an atom can have the same set of four quantum numbers. • Only two electrons may exist in the same orbital and these electrons must have opposite spin.
5.Millikan	• Oil drop experiment to measure charge of electrons.

Quantum Mechanic Model

- Classical atomic models ignore dual behavior of particles.
- Just like radiation, particles also have dual properties i.e. Wave like properties and particle like properties (French physicist, de Broglie in 1924).
- This is known as “Quantum mechanics”- Erwin Schrödinger – Nobel winner Austrian physicist was the front runner of this theoretical science.

- We can’t find the exact position and exact momentum (or velocity) of an electron at the same time, because electron and other similar particles don’t have definite paths or trajectories of electrons and other similar particles- This is Heisenberg’s Uncertainty Principle.

- Heisenberg was a German who shared Nobel with Schrödinger in Physics. He researched atomic bomb for Germany during WW2
- Electrons wave-like properties are utilized in electron microscope, it can give a magnification of about 15 million times.

Photoelectric Effect: Einstein & Planck

German physicist Max Planck observed that:

- When Light strikes surface = electrons ejected without any time lag.
- How many electrons ejected? Ans. Proportional to light’s brightness.
- How much is the kinetic energy of these ejected electrons? Ans. NOT in proportion of light’s brightness.
- If red light shined on potassium for hours but no photoelectrons are ejected.
- But even if a very weak yellow light shines on the potassium metal, the photoelectric effect is observed.
- German born American physicist Albert Einstein was able to explain this Photoelectric effect using Planck’s quantum theory of electromagnetic radiation.
- Einstein said light shining = shooting photon particle beam =collision with electrons=electrons ejected.
- Brighter light = more protons = more electrons ejected.
- He Won Nobel Prize in Physics in 1921 for his explanation of the photoelectric effect.

Spectrum

- Speed of light depends upon the nature of the medium through which it passes.

▪ As a result, the beam of light is deviated or refracted from its original path as it passes from one medium to another.
▪ The light of red colour which has longest wavelength is deviated the least while the violet light, which has shortest wavelength is deviated the most.
▪ Examples of continuous spectrum: (1) White light spectrum (2) rainbow. Because they have all colors from violet to red.
▪ The study of emission or absorption spectra is referred to as spectroscopy

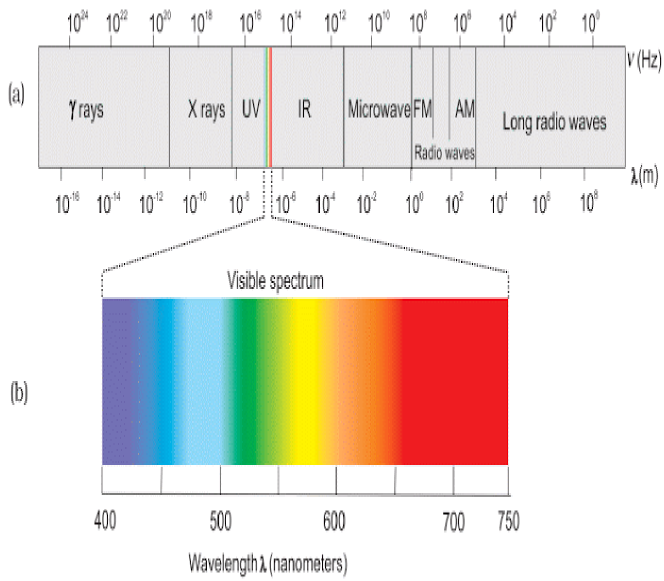


Fig. 2.7 *(a) The spectrum of electromagnetic radiation. (b) Visible spectrum. The visible region is only a small part of the entire spectrum.*

POSSIBLE MCQ: ASCENDING DESCENDING ORDER OF RAYS DEPENDING ON THIER FREQUENCIES / THEIR UTILITY

Electromagnetic spectrum

▪ Water wave and sound wave need medium. They can't move in vaccum
▪ Electromagnetic waves do not require medium and can move in vacuum.
▪ There are many types of electromagnetic radiation depending on their wavelength (or frequency).
▪ Collectively, they're called electromagnetic spectrum

Wavelength	• Distance between two successive crests (or troughts) • SI unit is units of length is meter (m). • Wave number = Wavelengths per unit length. Unit is 1/m.
Frequency	• frequency is the number of waves that pass a given point in one second • SI unit is Hz, named after Heinrich Hertz

Black Bodies

Wave nature of Electromagnetic radiation can explain following:

Diffraction	it is the bending of wave around an obstacle
Interference	it is the combination of two waves of the same or different frequencies to give a wave

- But above things can’t explain a black body radiation. Later Max Planck explained it in following manner:
- When solids are heated they emit radiation over a wide range of wavelengths.
- Heating Iron rod = dull red (low frequency) => more heating => bright red color (higher frequency)=>more heating=> white=>Blue…frequency keeps on increasing, wavelength keeps on decreasing.
- Black body is the ideal body that emits and absorbs all frequencies.
- The radiation emitted by such a body is called black body radiation.
- Black Body’s radiation depends only on its temperature….At a given temperature, intensity of radiation emitted increases with decrease of wavelength, reaches a maximum value at a given wavelength and then starts decreasing with further decrease of wavelength

(something like a bell curve).

- Planck suggested that atoms and molecules could emit (or absorb) energy only in discrete quantities and not in a continuous manner. This smallest energy quantity is “quantum”.

Mug up following drugs because given in class11 Chemistry NCERT

Cisplatin, Taxol	Cancer
AZT: Azidothymidine	AIDS

Mock Questions

Following type of MCQs can be framed:

1. Whatever “cause-consequence” or “x because of y” type of information is given in this note, it can be utilized for assertion reasoning questions e.g. (1) why Pt-IR used in weight std. (2) how cathode-ray works in TV
2. Match the following (1) scientist vs. principle. (2) basic physical quantity vs name of the SI unit (3) range of electromagnetic spectrum vs. utility of those rays (4) alpha, beta, gamma and x-rays vs their properties (similar qs. asked in CAPF) (5) isotopes of hydrogen vs. no. of neutrons present in them
3. You can be given a term, and asked to identify the “factor responsible or variable attached.” example (1) Black body radiation depends on which of the following factors? (2) Cathode ray’s travel path depends on which of the following factors?
4. 2 or 3 statements about Biography-contribution of Einstein- then you’re asked to identify the right or the wrong ones.
5. Which of the following statements are correct about (1) Atomic mass / number (2) isotope vs. isobar (3) mass vs. weight and so on.

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