INFUSION NOTES
WHEN ONLY THE BEST WILL DO

HPSC – HCS

(HARYANA PUBLIC SERVICE COMMISSION)

PRELIMS AND MAINS EXAM

लोक सेवा आयोग हरियाणा

Part – 6

General Science and Technology

PREFACE

Dear Aspirants, Presented Notes "**HPSC - CSE (PRE + MAINS)**" have been prepared by a team of teachers, colleagues and toppers who are expert in various subjects. These notes will help the Aspirants to the fullest extent possible in the examination of Haryana Civil Services conducted by the "**HARYANA PUBLIC SERVICE COMMISSION (HPSC).**"

Finally, despite careful efforts, there may be chances of some shortcomings and errors in the notes / So your suggestions are cordially invited in Infusion notes.

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Mob. : 9887809083

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General Science And Technology

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Chapter – I

Fundamental Elements of Science in Daily Life

❖ **Physical Science**

Physics is the branch of science that studies matter and energy and their interactions.

Measurement

- **Physical Quantities:** *The laws of physics expressed in terms of quantities are called physical quantities. Examples include length, force, speed, mass, density, etc. Physical quantities are classified into two types: scalar and vector.*
- **Scalar Quantities:** *Physical quantities that require only magnitude for their representation, without any direction, are called scalar quantities. Examples include Mass, Speed, Time, Distance, Energy, Charge, electric current, and potential.*
- **Vector Quantities:** *Physical quantities that require both magnitude and direction for their representation are called vector quantities. Examples include force, velocity, weight, acceleration, and displacement.*
- *The laws of physics are expressed through time, density, force, temperature, and other physical quantities.*

Units of Measurement

- *In physical science, three fundamental units are used for length, mass, and time. Other units are derived from these three fundamental units. Measurement units are classified into two types: fundamental units and derived units.*
- **Fundamental Units:** *Standards used to express a physical quantity that are independent of other standards are called fundamental units. For example, the units for length, time, and mass are meter, second, and kilogram, respectively.*
- **Derived Units:** *When a physical quantity is expressed in two or more fundamental units, it is called a derived unit. For example, the derived units for force, pressure, work, and potential are Newton, Pascal, Joule, and Volt, respectively.*

❖ **System of Units**

The following four systems are commonly used for measuring physical quantities:

i. **CGS System (Centimetre Gram Second System):** *In this system, the units for length, mass, and time are centimeter, gram, and second, respectively. Hence, it is called the Centimeter Gram Second or CGS system. It is also known as the French or metric system.*

ii. **FPS System (Foot Pound Second System):** *In this system, the units for length, mass, and time are foot, pound, and second, respectively. It is also referred to as the British system.*

iii. **MKS System (Metre Kilogram Second System):** *In this system, the units for length, mass, and time are meter, kilogram, and second, respectively.*

iv. **International System of Units (System International – S.I. Units):** *The SI system was adopted at the International Conference on Weights and Measures in 1960, officially named Le Systeme International d'Unites. This system is essentially a revised and extended form of the MKS system and is widely used today. It consists of seven fundamental units and two supplementary units.*

Seven Fundamental Units of SI :-

i. **Length:** *The fundamental unit of length is the meter (Meter). In SI, 1 meter is the distance traveled by light in a vacuum in 1/299792458 seconds.*

ii. **Mass:** *The fundamental unit of mass is the kilogram (Kilogram). The mass of a cylinder made of a platinum-iridium alloy, preserved at the International Bureau of Weights and Measures in Sèvres, France, is considered the standard kilogram. It is denoted as kg.*

iii. **Time:** *The fundamental unit of time is the second. One second is defined as the duration of 9192631770 periods of radiation corresponding to the transition between two energy levels of the ground state of cesium-133. Einstein used time as the fourth dimension in his famous Theory of Relativity.*

iv. **Electric Current:** *If two long, thin wires are placed parallel to each other in a vacuum at a distance of 1 meter and an electric current is passed through them such that a force of 2×10^{-72} Newton per meter length acts between the wires, that current is called 1 ampere, denoted as A.*

v. **Temperature:** *The fundamental unit of temperature is the Kelvin. One Kelvin is defined as 1/273.16 of* the thermodynamic temperature at the triple point of water, denoted as K.

vi. **Luminous Intensity:** The fundamental unit of luminous intensity is the candela. A light source emits a luminous intensity of 1 candela in a given direction if it emits monochromatic radiation of frequency 540×10^{12} hertz and a radiant intensity of 1/6831 watt per steradian in that direction. If it emits 1 joule of luminous energy per second within a solid angle, it is termed 1 watt per steradian.

vii. **Amount of Substance:** The fundamental unit of amount of substance is the mole. One mole is the amount of substance that contains 6.022×10^{23} elementary entities (atoms, molecules, etc.). This number is known as Avogadro's constant.

SI's Two Supplementary Units

i. Radian

The radian is the angle created at the center of a circle by an arc whose length is equal to the radius of that circle. This unit is used to measure plane angles.

ii. Steradian

The steradian is the solid angle subtended at the center of a sphere by an area on the surface of the sphere equal to the square of its radius. It is the unit used to measure solid angles.

Fundamental Units

(Physical Quantity)	(SI Unit)	(Symbol)
(Length)	(Metre)	M
(Mass)	(Kilogram)	Kg
(Time)	(Second)	S
(Electric Current)	(Ampere)	A
(Temperature)	(Kelvin)	K
(Luminous Intensity)	(Candela)	Cd
(Amount of Substance)	(Mole)	mol

Units for Measuring Very Long Distances

- **Astronomical Unit (A.U.)**

  This is a unit of distance. It is the average distance between the Sun and the Earth.

  1 A.U. = 1.495×10^{11} meters

- **Light Year**

  This is a unit of distance. A light year is the distance that light travels in a vacuum in one year, which is about **9.46×10^{15} meters**.

- **Parsec**

  This is the largest unit for measuring distance.

  1 Parsec = 3.08×10^{16} meters.

  Units of Length/Distance:

- **1 Kilometer (km)** = 1000 meters (m)
- **1 Mile** = 1.60934 kilometers (km)
- **1 Nautical Mile (NM)** = 1.852 kilometers (km)
- **1 Astronomical Unit (A.U.)** = 1.495×10^{11} meters (m)
- **1 Light Year (ly)** = 9.46×10^{15} meters (m) = 48,612 A.U.
- **1 Parsec** = 3.08×10^{16} meters (m) = 3.26 light years (ly)

Powers of Ten and Their Prefixes

Power of Ten	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	Mega	M
10^{3}	kilo	K
10^{2}	hecto	h
10^{1}	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	temto	f
10^{-18}	atto	a

Derived Quantities and Their Units

Quantity	Unit	Symbol
(Frequency)	(Hertz)	Hz
(Momentum)	(Kilogram meter/second)	kg m/s
(Impulse)	(Newton/second)	N/s
(Surface Tension)	(Newton/meter)	N/m

Quantity	Unit	Symbol
(Electric Charge)	(Coulomb)	C
(Voltage)	(Volt)	V
(Electrical Resistance)	(Ohm)	Ω
(Capacitance)	(Farad)	F
(Magnetic Flux)	(Weber)	Wb
(Luminous Flux)	(Lumen)	Lm
(Illuminance)	(Lux)	Lx
(Wavelength)	(Ångström)	[A]0
(Astronomical Distance)	(Light Year)	ly
(Work or Energy)	(Joule)	J
(Acceleration)	(Meter/second^2)	m/s^2
(Pressure)	(Pascal)	Pa
(Force)	(Newton)	N
(Power)	(Watt)	W
(Area)	(Square meter)	m^2
(Volume)	(Cubic meter)	m^3
(Speed)	(Meter/second)	m/s
(Angular Velocity)	(Radian/second)	Rad/s

Some Special Measuring Instruments

Measuring Instrument	Use
Barometer	To measure atmospheric pressure
Hydrometer	To measure the specific gravity of liquids
Anemometer	To measure wind speed
Air Meter	To measure wind speed
Hygrometer	To measure relative humidity
Manometer	To measure gas pressure
Galvanometer	To detect the presence of electric current
Audiometer	To measure sound intensity and frequency
Sonar	To find the distance of submerged objects in the sea
Altimeter	To measure altitude

Measuring Instrument	Use
Seismograph	To measure the intensity of earthquakes
Caratometer	To measure the purity of gold
Stethoscope	To listen to heart sounds
Fathometer	To measure the depth of the sea

Important Formulas for Physical Quantities

Physical Quantity	Formula
Density	Mass / Volume
Acceleration	Change in Velocity / Time
Momentum	Mass × Velocity
Pressure	Force / Area
Potential Energy	Mass × Gravitational Acceleration × Height
Power	Work / Time
Torque	Force × Perpendicular Distance
Impulse	Force × Time
Angle	Arc / Radius
Solar Constant	Energy / (Area × Time)

❖ Motion

Motion: When an object changes its position over time, it is said to be in motion.

- **Uniform Motion:** If an object covers equal distances in equal time intervals, it is referred to as uniform motion.
- **Non-uniform Motion:** If an object does not cover equal distances in equal time intervals, it is termed non-uniform motion.
- **Circular Motion:** When a particle moves along a circular path, it is called circular motion.

Important Points

- An object moving in a straight line can have angular velocity under certain conditions. Both linear and angular motions can be uniform or non-uniform. If an object covers equal distances in equal time or moves through equal angles, it is termed uniform linear motion or uniform angular motion, respectively; otherwise, it is called non-uniform motion.

- ***Angular Velocity:*** *The angle through which a line connecting the center to a moving particle rotates in one second is called the angular velocity of that particle.*
  - *If this line rotates through an angle θ in t seconds, then:*

$$\omega = \frac{\theta}{t}$$

  - *Angular velocity is denoted by the Greek letter omega (ω).*

Motion under Gravity

A familiar example of uniform accelerated motion in a straight line is the vertical motion of an object near the surface of the Earth.

- *In the absence of air resistance, all objects fall to the Earth at the same rate, and the time taken to rise to a certain height is equal to the time taken to fall back to that height.*
- *If air resistance is negligible, the acceleration of a particle moving vertically is called gravitational acceleration, which is approximately constant near the Earth's surface. The value of gravitational acceleration near the Earth's surface is about 9.8 m/s^2.*

Projectile Motion

Definition: *When an object is thrown at an angle (between 0° and 90°) to the horizontal or vertical, its path follows a parabolic trajectory. This type of motion is known as projectile motion. Examples include the motion of cannonballs, rockets after fuel depletion, and bombs dropped from airplanes.*

Projectile Path:

An object thrown at an angle moves along a curved path known as the projectile path. This path is parabolic as long as the object's speed is not excessively high.

Conditions for a Parabolic Path:

For a projectile's path to be parabolic, the following conditions must be met:

1. *The magnitude and direction of the projectile's acceleration must remain constant, and the direction of acceleration must differ from the direction of the projectile's velocity.*
2. *The initial velocity of the projectile should not be too high.*
3. *The range and height of the projectile should not be excessively large.*

Flight Time of the Projectile:

The total time an object in projectile motion stays in the air is referred to as the flight time.

Height of the Projectile:

The maximum vertical distance covered by a projectile is called its height. When the angle (θ) is 90°, the height (H_{max}) achieved is maximum. For example, in high jump, when an athlete jumps vertically at an angle of 90°, they attain the highest height.

Range of the Projectile:

The horizontal distance covered by a projectile in motion is known as the range (R). To achieve maximum range, the projectile should be launched at an angle of 45°. In long jump, when an athlete jumps at a 45° angle, they cover the maximum horizontal distance (range).

Examples:

- *If one ball is dropped from a roof and another is thrown horizontally at the same time, both will hit the ground at the same time, but at different spots.*
- *If a hunter aims at a monkey sitting in a tree and shoots at the same time the monkey jumps down, the bullet will hit the monkey. However, if the monkey remains still, it won't get hit because the bullet falls due to gravity.*
- *If two cannonballs of 5 kg and 10 kg are fired with the same speed in the same direction, they will hit the ground simultaneously, as their flight time does not depend on their mass.*

Distance and Displacement

Distance:

Distance refers to the length of the path traveled by an object during a given time interval. It is always a positive or zero quantity and is a scalar quantity.

Displacement:

Displacement is the shortest distance between two points in a specific direction. Its SI unit is meters (m). Displacement can be positive, negative, or zero and is a vector quantity.

Speed and Velocity

Speed:

Speed is defined as the distance traveled by an

Centre of Gravity

*The **centre of gravity** of an object is the point where the entire weight of the object acts, regardless of its orientation. The weight acts downward through the centre of gravity. By applying an upward force equal to the object's weight at this point, the object can be balanced.*

Friction :-

***Friction** is a resistive force that acts in the opposite direction of an object's motion when it slides on a surface. There are three types of friction:*

1. ***Static Friction:***
   - *The force that prevents an object from moving when a force is applied. It acts between stationary surfaces.*
2. ***Rolling Friction:***
   - *The force that resists the motion of a rolling object on a surface. It occurs between the surfaces of the rolling object and the surface it rolls on.*
3. ***Kinetic (or Sliding) Friction:***
   - *The force that opposes the motion of two surfaces sliding past each other.*

Friction depends on the nature of the surfaces in contact and not on their surface area. Kinetic friction is usually less than static friction.

Examples of Frictional Force

1. ***Balance and Movement:** Frictional force allows humans to stand straight and walk.*
2. ***Slipping:** Without friction, we can slip on a banana peel or on a wet, slippery road.*
3. ***Vehicles:** If there is no friction on roads, the wheels will skid.*
4. ***Belt and Pulley:** If there is no friction between the belt and the pulley, the belt won't be able to turn the motor's wheel.*

➢ **Universal Gravitation**

***Universal Gravitation:** In the universe, every particle attracts every other particle due to its mass. The formula for the gravitational force (F) between two particles with masses m1 and m2 separated by a certain distance r, is given by:*

$$F = G\frac{m_1 \times m_2}{r^2}$$

where G is the universal gravitational constant, approximately 6.67×10^{-11} N m^2/kg^2. This is known as Newton's law of gravitation.

Kepler's Laws of Planetary Motion

***Kepler's Laws:** The celestial bodies that revolve around the Sun in their orbits are called planets. In our solar system, there are 8 planets.*

- *Each planet moves in an elliptical orbit around the Sun, with the Sun located at one of the foci of the ellipse.*
- *The area covered by each planet in its orbit remains constant over equal intervals of time, meaning that when a planet is closer to the Sun, it moves faster, and when it is farther away, it moves slower.*
- *The time taken by a planet to complete one full orbit around the Sun is called its orbital period (T). The square of the orbital period (T^2)is proportional to the cube of its average distance from the Sun (r^3), which can be expressed as: $T^2 \propto r^3$*
   - *This means that planets farther from the Sun take longer to complete their orbits. For example, Mercury, the closest planet to the Sun, takes 88 days to orbit, while Neptune, the farthest planet, takes 165 years.*

➢ **Gravitational Acceleration and Weight**

When the Earth exerts its gravitational force on an object, the object experiences acceleration, known as gravitational acceleration, represented by g. The value of g is approximately 9.8 meters per second squared (m/s^2) for any object freely falling on Earth, regardless of its mass.

1. ***Weight in Hydrogen:** An object's maximum weight is experienced in hydrogen gas.*
2. ***Change in Gravitational Acceleration:***
   - *If we ascend a mountain, g decreases.*
   - *On the Moon, g is one-sixth that of Earth, so an object weighs one-sixth of its Earth weight there.*
   - *If we go deep into a mine, g also decreases. At the center of the Earth, g becomes zero, leading to zero weight for the object.*

Variation in g

- *The value of g is maximum at the poles and minimum at the equator.*
- *If the Earth's rotational speed increases, g decreases; if it decreases, g increases.*
- *Moving above or below the Earth's surface reduces the value of g.*

- The cause of capillarity is the surface tension of the liquid.
- Plants absorb water from the soil through their roots, and this water travels through capillaries to different parts of the plant (stems, leaves, etc.).
- In lanterns, kerosene rises through the wick's capillaries, allowing it to burn continuously.

Viscosity

- Viscosity is the frictional force that opposes the relative motion between two layers of a fluid. It is a property that affects how fluids flow.
- An ideal fluid has zero viscosity.
- Viscosity is caused by cohesive forces between molecules. Gases have much lower viscosity than liquids.
- As temperature increases, the viscosity of liquids decreases, while the viscosity of gases increases.
- Viscosity is measured in units like Pascal-seconds or Poise.
- This property explains why a person can run faster in air than in water, and why a stirred liquid eventually comes to rest.
- Viscosity is measured using a viscometer.

Upthrust

- When an object is submerged in a liquid, an upward force acts on it, called the buoyant force or upthrust. Gases also exert buoyant forces like liquids do.
- If the buoyant force on an object is less than its weight, the object will sink; if it is more, the object will float.
- The value of the buoyant force can be determined using Archimedes' principle.

Archimedes' Principle

- When an object is partially or fully submerged in a liquid, it appears to lose weight equal to the weight of the liquid it displaces.
- There are three scenarios:
  - If the weight of the object is greater than the buoyant force, it will sink.
  - If the object's weight equals the buoyant force, it will float submerged.
  - If the weight is less than the buoyant force, it will float with part of it submerged.
- A piece of iron sinks in water but floats on mercury because its density is less than that of mercury but greater than that of water.
- Ships made of iron float because they are hollow, containing air, which decreases their overall density.

Law of Floatation

- When floating in a balanced state, an object displaces a weight of liquid equal to its own weight. This is the law of floatation.
- The weight of the liquid displaced equals the buoyant force. Thus, a denser liquid will cause less of the object to be submerged, while a less dense liquid will cause more of it to be submerged. This is why a ship rises slightly when it moves from a river to the sea, as seawater is denser than river water.

❖ Pressure

Pressure – The force applied perpendicular to a surface area is called pressure. Its unit is Newton per square meter (N/m^2). The smaller the area of an object, the more pressure it exerts on a surface. Examples from daily life include advice to a person stuck in mud to lie down or the pointed end of a nail.

The SI unit of pressure is Pascal (Pa). Pressure is a scalar quantity.

- It is easier to burst a gas-filled balloon with a needle than with a fingernail because the needle's tip has a much smaller area than the fingernail.
- The internal pressure of a soap bubble is greater than the atmospheric pressure.

Atmospheric Pressure –

The air and gases around the Earth exert pressure on us, called atmospheric pressure. This pressure is 10^5 Newtons per square meter. We don't feel this pressure because the blood and other factors inside our bodies balance it out. As we go higher above the Earth's surface, the atmospheric pressure decreases. For example, in an airplane, a passenger's pen ink may start to flow, and people with high blood pressure are advised not to travel by air.

- The pressure at a point inside a liquid depends on the depth of the point from the free surface of the liquid, and the pressure is the same in all directions at any depth. As depth increases, pressure increases.

- At sea level, atmospheric pressure is 1.01325×10^5 Pa, which is expressed as 1 atm.
- Atmospheric pressure is measured using a barometer, which is a device made of a glass tube filled with mercury.
- Barometers are also used for weather forecasting.
- If the barometer reading drops suddenly, it indicates a possibility of a storm.
- If the reading drops slowly, it suggests the possibility of rain.
- If the reading slowly increases, it indicates clear weather.
- Increasing pressure raises the boiling point of water, which is why food cooks faster in a pressure cooker.

Pressure in Liquids –

The force applied on the walls or bottom of a container by the molecules of a liquid is called liquid pressure.

The pressure at a point inside the liquid is equal to the depth (h) of the point from the liquid's surface, multiplied by the density (ρ) of the liquid and the acceleration due to gravity (g): Pressure = $h \times \rho \times g$.

Law of Liquid Pressure –

- In a steady liquid, the pressure is the same at all points at the same horizontal level (same depth). This is why the water level is the same in containers of different shapes when connected by a horizontal pipe. This is called liquid static equilibrium.
- The pressure at any point in a steady liquid is the same in all directions.
- The pressure at a point in a liquid is proportional to the depth from the liquid's free surface.
- The pressure at a point depends on the density of the liquid. Higher density results in higher pressure.

Pascal's Law of Liquid Pressure –

- First Statement: If the effect of gravity is considered negligible, the pressure at each point inside a liquid in equilibrium is the same.
- Second Statement: When an external pressure is applied to a part of a confined liquid, it is transmitted equally and without loss in all directions.
- Pascal's law is the basis for the working of various devices like hydraulic brakes, hydraulic lifts, and hydraulic presses.

Effect of Pressure on Melting Point and Boiling Point:

Effect on Melting Point:

- When some substances expand on heating, their melting point increases when pressure increases. Examples: Wax, Ghee, etc.
- When some substances contract on heating, their melting point decreases when pressure increases. Example: Ice.

Effect on Boiling Point:

- The boiling point of all liquids increases when pressure increases.

Terminal Velocity

- When an object falls through a liquid, it experiences a drag force due to the liquid's viscosity. As the object's speed increases, so does the drag force until they balance out. At this point, the object falls at a constant speed known as terminal velocity. Raindrops and parachutists reach terminal velocity as they descend.

Critical Velocity

- If the flow speed of a liquid is below a certain threshold, it is laminar (smooth and predictable). The maximum speed for laminar flow is called critical velocity. If the flow speed exceeds this, turbulence occurs, creating eddies and chaotic flow.

Bernoulli's Theorem

When a fluid (liquid or gas) flows in a streamlined manner from one point to another, the total energy per unit volume at each point—comprising pressure energy, kinetic energy, and potential energy—remains constant.

- In regions where the fluid's velocity is low, the pressure is high, and where the velocity is high, the pressure is low.

Everyday Examples:

- **Swinging of a Cricket Ball:** When a ball is thrown with spin, it creates different air velocities on either side. The side with lower velocity has higher pressure, causing the ball to swing in the air.
- **Roofs Blowing Off During a Storm:** The rapid change in pressure can lift roofs.

Speed of Light

- The speed of light varies in different mediums.
- In a vacuum or air, the speed of light is highest at 3×10^8 m/s .
- The denser the medium, the slower the speed of light.
- The speed of light in a medium is given by the formula:

$$u = \frac{c}{\mu}$$

- Where c = 3×10^{8} m/s and μ is the refractive index of the medium.
- The speed of light was first calculated by Romer.
- It takes an average of 8 minutes and 16.6 seconds for sunlight to reach Earth.
- Light reflected from the Moon takes about 1.28 seconds to reach Earth.

Speed of Light in Different Mediums

Medium	Speed of Light (m/s)
Air	2.95×10^8
Water	2.25×10^8
Glass	2.00×10^8
Turpentine Oil	2.04×10^8
Vacuum	3.00×10^8

Solar Eclipse

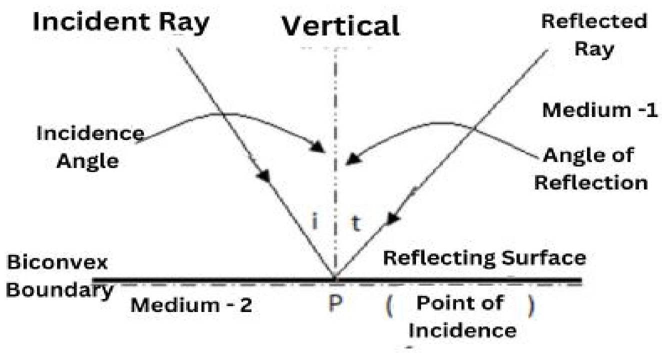
- A solar eclipse occurs when the Moon passes between the Earth and the Sun, blocking part of the Sun's light from reaching the Earth.
- This phenomenon happens on a new moon day.
- During a solar eclipse, only the solar corona is visible.

Lunar Eclipse

- A lunar eclipse occurs when the Earth passes between the Sun and the Moon, causing the Sun's light not to reach the Moon, making it invisible from Earth.
- This event happens on a full moon day.
- The orbital plane of the Earth makes an angle of 5 degrees with the orbital plane of the Moon, which is why lunar eclipses do not occur every month.

Reflection of Light

- Reflection is the phenomenon that occurs when a ray of light strikes a surface and returns to the same medium.



Reflection of Light

Terms Related to Reflection:

- **Reflective Surface:** A surface that completely reflects the incident light is called a reflective surface.
- **Incident Ray:** The ray of light that strikes the reflective surface is called the incident ray.
- **Reflected Ray:** The ray that bounces back into the same medium after striking the reflective surface is called the reflected ray.
- **Normal (N):** A perpendicular line drawn to the reflective surface at the point of incidence is called the normal.
- **Angle of Incidence (i):** The angle formed between the normal and the incident ray is called the angle of incidence.
- **Angle of Reflection (r):** The angle formed between the normal and the reflected ray is called the angle of reflection.
- **Angle of Deviation (Δ):** The angle formed between the original direction of the incident ray and the direction of the reflected ray is called the angle of deviation.

Laws of Reflection

1. **Angle of Incidence = Angle of Reflection:** $\angle I = \angle r$
2. **Incident Ray, Reflected Ray, and Normal:** All three are in the same plane.

Types of Reflection

Regular Reflection:

- When light falls on a surface, it reflects and travels in a specific direction. This event is called regular reflection.

❖ Heat

Definition of Heat: Heat is the energy that is transferred from one object to another due to a temperature difference. The amount of heat contained in an object depends on its mass.

If work W is converted to heat Q, then:

$$\frac{W}{Q} = J \quad \text{or} \quad W = JQ$$

Where J is a constant known as the mechanical equivalent of heat, with a value of 4.186 joules/calorie. This means that doing 4.186 joules of work will produce 1calorie of heat.

Units of Heat

- **S.I. Unit**: The S.I. unit of heat is the joule.
- **Calorie**: The amount of heat needed to raise the temperature of 1 gram of water by 1°C is called a calorie.
- **International Calorie**: The heat required to raise 111 gram of pure water from 14.5°C to 15.5°C is defined as 1 calorie.
- **British Thermal Unit (B.Th.U.)**: The amount of heat needed to raise the temperature of 1 pound of water by 1°F is called 1 B.Th.U.

Conversions

- 1 calorie = 4.186 joules
- 1 kilocalorie = 4186 joules
- 1 joule = 0.24 calories
- 1 erg = 10^{-7} joules
- 1 B.Th.U. = 252 calories
- 1 therm = 100,000 B.Th.U.

Temperature

Temperature is a physical quantity that determines the direction of thermal energy flow between two objects. It is the reason for energy transfer.

Measurement of Temperature

Thermometer: The device used to measure temperature is called a thermometer.

Temperature Scales

1. **Celsius Scale:** On the Celsius scale, the freezing point is set at 0°C and the boiling point at 100°C. The distance between the freezing point and the boiling point is divided into 100 equal parts. Each part is called 1°C (1 degree Celsius). This scale was invented by the Swedish scientist Celsius.
2. **Fahrenheit Scale:** On the Fahrenheit scale, the freezing point is set at 32°F and the boiling point at 212°F. The distance between the freezing point and the boiling point is divided into 180 equal parts. Each part is called 1°F (1 degree Fahrenheit). This scale was invented by the German scientist Fahrenheit.
3. **Réaumur Scale:** On the Réaumur scale, the freezing point is set at 0°R and the boiling point at 80°R. The distance between the freezing point and the boiling point is divided into 80 equal parts. Each part is called 1°R (1 degree Réaumur).
4. **Kelvin Scale:** On the Kelvin scale, the freezing point is set at 273K and the boiling point at 373K. The distance between the freezing point and the boiling point is divided into 100 equal parts. Each part is called 1K (1 Kelvin).

Relationship between the four scales of temperature measurement:-

$$\frac{C-0}{5} = \frac{F-32}{9} = \frac{R-0}{4} = \frac{K-273}{5}$$

- Now we know that on Celsius scale 0°C = 32°F = 0°R = 273K and similarly 100°C = 212°F = 80°R = 373K
- At -40°C, the reading on both C and F scales will be same.
- Body temperature of a healthy human being is 36.9°C or approximately 37°C. Hence, on Kelvin scale, it is 37+273=310K. On Fahrenheit scale, this temperature will be equal to 98.6°F.

- Absolute Temperature- There is no maximum limit in physics, but there is a limit for the lowest temperature. The temperature of any object cannot be less than -273.15°C. This is called absolute zero temperature.

Thermodynamics

First Law of Thermodynamics: The first law primarily illustrates the conservation of energy. According to this law, the heat supplied to a system is used for two types of work:

1. To increase the internal energy of the system, resulting in a rise in temperature.
2. To perform external work.

Isothermal Process: When a change occurs in a system such that its temperature remains constant throughout the process, it is called an isothermal process.

Adiabatic Process: If a change occurs in a system where it neither gives heat to nor receives heat from the surroundings during the entire process, it is called an adiabatic process. An example of this is the sudden expansion of carbon dioxide, which turns into dry ice.

Second Law of Thermodynamics

The second law expresses the direction of heat flow. According to Kelvin, it is impossible for heat to be completely converted into work. Clausius states that "heat cannot flow from a colder object to a hotter one unless external energy is applied."

Heat Capacity

The heat capacity of a substance is the amount of heat it absorbs or releases to change its temperature. If a substance requires ΔT change in temperature for an amount of heat Δθ , then the heat capacity S is given by:

$$S = \frac{\Delta\theta}{\Delta T}$$

The S.I. unit of heat capacity is joules/kelvin.

Specific Heat Capacity

The specific heat capacity of a substance is the amount of heat required to raise the temperature of a unit mass of the substance by one degree. If 1 gram of a substance requires heat Q to raise its temperature by ΔT then its specific heat C is given by:

$$C = \frac{Q}{m\Delta T}$$

Heat Transmission

Heat transfer refers to the movement of heat from one object to another due to a temperature difference. There are three main methods of heat transfer:

1. **Conduction**: In conduction, heat transfers from one part of a substance to another without the movement of the substance itself. This occurs primarily in solids.
   - **Practical Applications**: Metals are good conductors of heat. Therefore, when substances are heated in metal containers, heat exchanges occur rapidly, which is why drinking hot tea from a metal cup can burn the lips, while it is easier to drink from a ceramic cup. In winter, metal chairs feel colder than wooden ones because metals conduct heat well. Woolen clothes keep us warm because the air trapped between the fibers acts as an insulator against cold. Concrete roofs heat up more in summer as concrete is a good conductor of heat.
2. **Convection**: In convection, heat transfer occurs through the movement of the substance itself. The movement creates convection currents.
   - **Gas and Liquid Transfer**: Heat transfer in gases and liquids occurs through convection. The atmosphere is heated by convection processes.

Convection-Related Examples

- **Water vs. Land Heating**: Water bodies heat up less compared to land because water has a higher specific heat capacity.
- **Inert Gases in Bulbs**: When bulbs are filled with inert gases (like argon), they become more efficient than in a vacuum. The heat generated by the filament spreads throughout the bulb via convection, preventing the temperature from reaching the melting point of the filament, which extends the bulb's lifespan.
- **Atmospheric Heating**: The Earth's atmosphere is warmed through convection processes.
- **Car Radiators**: Car radiators work on convection principles, where heat is transferred by water.

Radiation

In radiation, heat is transferred from a hot object to a cold object without any medium and without heating the medium, traveling in a straight line at the speed of light.

Examples of Radiation:

- **Solar Heat Transfer**: The Sun's heat reaches Earth through radiation, as it travels through the vacuum of space where no medium exists.
- **Thermos Design**: To make a thermos heat-resistant, its surface is made shiny to reflect all incident light, preventing absorption of external heat and loss of internal heat. The inner surface is often coated with a silver layer.
- **Light-Colored Fabrics**: Light-colored clothing is preferred in hot weather because lighter colors absorb less heat.

Thermal Expansion

Thermal expansion refers to the increase in dimensions of substances when they are heated.

Lead Storage Battery

- *In this battery, the anode is made of lead, while the cathode consists of a grid made of lead dioxide (PbO_2).*
- *A solution of 35% sulfuric acid (H_2SO_4) acts as the electrolyte.*
- *This battery is commonly used in vehicles and inverters. During charging, sulfuric acid is consumed.*

Nickel-Cadmium Battery

- *This battery has nickel hydroxide as the cathode and cadmium as the anode.*
- *Potassium hydroxide is used as the electrolyte.*
- *It is a rechargeable battery that does not contain a liquid or solution as the electrolyte.*
- *Common applications include use in shavers and flashlight batteries.*

❖ Acids, Bases, and Salts

Acids: *An acid is a compound that contains hydrogen ions, which are responsible for its acidic properties in solution (represented as H^+). According to the Brønsted-Lowry theory, an acid is a substance that can donate protons to other substances.*

Hydrogen ions are not found alone; they exist in combination with water molecules. Therefore, when dissolved in water, they form hydronium ions (H_3O^+).

The presence of hydrogen ions makes acids strong and good conductors of electricity.

Strong Acids: *Examples of strong acids include Hydrochloric acid, Sulfuric acid, and Nitric acid.*

Weak Acids: *Examples of weak acids are Acetic acid, Formic acid, and Carbonic acid.*

Acids usually taste sour and can be corrosive.

Indicators like turmeric, litmus, and hibiscus are some natural substances. Litmus is extracted from a plant lichen that belongs to the Thallophyta group. In distilled water, it appears purple. When placed in an acidic solution, it turns red, and in a basic solution, it turns blue.

Solutions that do not change the color of litmus to red or blue are called neutral solutions; these are neither acidic nor basic. Some indicators can also change their smell in acidic or basic environments.

Acid + Metal → Salt + Hydrogen gas

1. Arrhenius Theory of Acids and Bases:

Acids: Acids are substances that release Hydrogen ions (H^+) when dissolved in water. Strong acids are those that completely ionize in water and produce a large amount of hydrogen ions.
Examples *include HCl, H_2SO4, and HNO_3.*

Bases: *Bases are substances that release hydroxide ions (OH^-) in their aqueous solutions. Strong bases are those that completely ionize in water and produce a large amount of hydroxide ions.*
Examples *include NaoH and KoH.*

2. Brønsted-Lowry Theory of Acids and Bases:

Acids: According to this theory, acids are substances that tend to donate protons (H^+).

Bases: Bases are substances that tend to accept protons.

3. Lewis Theory of Acids and Bases:

Acids: Lewis acids are substances (molecules or ions) that tend to accept an electron pair. For example, molecules with an incomplete octet, like Boron Trifluoride (BF_3) and Aluminum Chloride ($AlCl_3$), behave as Lewis acids.

Bases: Lewis bases are substances that tend to donate an electron pair. For example, all anions, such as Cl-, OH-, and CN-, behave as Lewis bases, as do neutral elements with a lone electron.

Some Bases and Their Sources:

Calcium Hydroxide: Lime water

Ammonium Hydroxide: Window cleaner

Sodium Hydroxide / Potassium Hydroxide: Soap

Magnesium Hydroxide: Milk of magnesia

Chemical Properties of Acids and Bases:

1. Reaction of Acids and Bases with Metals:

Metals displace Hydrogen from acids, producing Hydrogen gas and forming a compound with the acid, which is called a salt.

Some metals (like copper, silver, and gold) do not react with dilute acids.

When metals react with bases, hydrogen gas is also produced, resulting in metal salts.

Example Reaction:

$2NaoH + Z_N \rightarrow Na_2Z_NO_2 + H_2$

2. Reaction of Metal Carbonates and Metal Hydrogen Carbonates with Acids:

All metal carbonates and metal hydrogen carbonates react with acids to form corresponding salts, Carbon Dioxide, and water.

When carbon dioxide gas is bubbled through lime water, a white precipitate of calcium carbonate is formed:

Limestone, chalk, and marble are different forms of calcium carbonate. If carbon dioxide is passed for a long time, calcium carbonate can dissolve in water, converting to calcium bicarbonate.

$Ca(OH)_2 + Co_2 - CaCo_3 + H_2o$

Reactions of Acids and Bases:

The reaction between acids and bases produces salt and water; this is also called neutralization reaction, which is an exothermic process.

Base + Acid → Salt + Water

Reactions of Acids with Metallic Oxides:

Metallic oxides react with acids to produce salt and water, similar to neutralization reactions. Thus, metallic oxides are considered basic in nature.

Metal Oxide + Acid → Salt + Water

Reactions of Bases with Non-Metallic Oxides:

Non-metallic oxides also react with bases in a manner similar to neutralization reactions, producing salt and water. Therefore, non-metallic oxides are acidic in nature.

Acids and Salts in Aqueous Solution:

Acids release hydrogen ions (H^+) only in the presence of water, which is necessary for their acidic properties. Without water, acids cannot release H^+ ions. Hydrogen ions cannot exist freely; they combine with water molecules.

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

Bases generate hydroxide ions (OH^-) in water.

$KOH + H_2O \rightarrow K^+ + OH^-$

Salts:

When an acid and a base react, they produce salt and water. This reaction is called a neutralization reaction.

Reaction Example: Acid + Base → Salt + Water

$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

(Sulfuric Acid + Calcium Hydroxide → Calcium Sulfate + Water)

Uses of Acids:

- The hydrochloric acid present in our stomach helps in digestion of food.
- Vitamin C or ascorbic acid provides essential nutrients for the body.
- Carbonic acid is used in making carbonated drinks and fertilizers.
- A preservative is a form of acetic acid called vinegar.
- At room temperature, high-quality sugarcane drink is made from sugarcane juice using alcohol fermentation and acetic acid bacteria during acetic fermentation.
- Vinegar is essentially a dilute solution of acetic (ethanoic) acid in water.
- Vinegar is used as a preservative both for home use and in the food industry.
- Vinegar does not contain benzoic acid.
- Acetic acid is produced by the oxidation of ethanol by acetic acid bacteria, and In most countries, commercial production involves double fermentation, where ethanol is produced by fermentation of sugar by yeast.
- Sulfuric acid is used in the production of fertilizers, paints, synthetic fibers, etc.
- Nitric acid is used to prepare aqua regia, which is used to purify precious metals like gold and silver.
- Boric acid is used for washing eyes.
- The alkalinity of an acid is defined as the number of hydrogen (H+) ions in an acid molecule that become ionized.
- For carboxylic acids containing acids, we do not count the number of hydrogen atoms, but rather the number of carboxyl groups (i.e., -COOH).

Acid Name	Chemical Formula	Basicity
Nitric Acid	HNO_3	1 Monobasic
Carbonic Acid	H_2CO_3	2 Dibasic
Sulfuric Acid	H_2SO_4	2 Dibasic
Phosphorous Acid	H_3PO_3	2 Dibasic
Phosphoric Acid	H_3PO_4	3 Tribasic

True Solution

True solutions consist of particles that are molecular in size, typically ranging from 10^{-7} to 10^{-8} cm. These particles can easily pass through filter paper, making true solutions the most stable and transparent. They cannot be seen with the naked eye or under a microscope.

Buffer Solution

A buffer solution is one that can absorb small amounts of acids or bases without significantly changing its acidity or alkalinity. For example, a mixture of sodium acetate and acetic acid forms an effective buffer when dissolved in water.

Tyndall Effect

The Tyndall effect occurs when a beam of light passes through a colloidal solution. When viewed with a microscope from the side, the colloidal particles appear to shine like pinheads against a dark background. This effect is caused by the scattering of light.

Brownian Motion

Brownian motion refers to the random movement of particles in a colloidal solution. These particles move around continuously and this motion does not depend on the nature of the colloidal particles. The smaller the particles, the less viscous the medium, and the higher the temperature, the faster the movement will be.

Vapor Pressure Properties of Solutions

Decrease in Vapor Pressure of Solutions: The vapor pressure of a solution is lower than that of the pure solvent. This decrease depends only on the concentration of solute particles, not their nature.

Elevation of Boiling Point: As the temperature of a liquid increases, its vapor pressure also increases. A liquid boils at the temperature when its vapor pressure equals the atmospheric pressure. For example, water boils at 100°C.

Effect of Non-volatile Solutes: The presence of a non-volatile solute lowers the vapor pressure of the solvent.

Depression of Freezing Point: Due to the decrease in vapor pressure, the freezing point of a solution is lower than that of the pure solvent. According to Raoult's law, when a non-volatile solid is added to a solvent, the vapor pressure of the solvent decreases, resulting in a lower freezing point.

Osmotic Pressure: Osmotic pressure is the pressure that prevents the flow of the solvent. It is a colligative property, meaning it depends on the number of particles (molecules or ions) in the solution, not their nature.

Carbon and Its Compounds

Carbon: Carbon is a non-metallic element found in group 14 and period 2 of the modern periodic table. Its atomic number is 6, and its electron configuration is $1s^2\ 2s^2\ 2p^2$. Carbon is the element with the most compounds, and all living structures are carbon-based. In the Earth's crust, carbon is present as minerals (such as carbonates and coal) in about 0.02%, and there is 0.03% carbon dioxide in the atmosphere. Additionally, it is found in all living organisms, plants, and rocks.

Allotropy

Allotropic substances have the same chemical properties but different physical properties. This phenomenon is known as allotropy. Carbon exists in two allotropes: crystalline and amorphous.

Allotropes of Carbon

- Crystalline Allotropes
  - Diamond, Graphite, Fullerenes
- Amorphous Allotropes:
  - Coke, Charcoal, Soot

Diamond: Diamond is the hardest known substance, which is why it is used for cutting rocks, sharpening tools, polishing objects, and drawing wires of metals like tungsten. Chemically, diamond is very inert and is an electrical insulator. Its special shine is due to its high refractive index, making it popular in jewelry. Diamond has a three-dimensional tetrahedral structure with sp^3 hybridization.

Common Substances and Their Chemical Names

Sr. No.	Commercial Name	Chemical Name and Formula
1	Ammonium Chloride	Ammonium Chloride (NH_4Cl)
2	Alum	Potassium Aluminum Sulfate [$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$]
3	Litharge	Lead Oxide (PbO)
4	Gypsum	Calcium Sulfate ($CaSO_4 \cdot 2H_2O$)
5	Blue Vitriol	Copper Sulfate ($CuSO_4$)
6	Bleaching Powder	Calcium Hypochlorite ($Ca(OCl)_2$)
7	Green Vitriol	Ferric Sulfate [$Fe_2(SO_4)_3$]
8	Dry Ice	Solid Carbon Dioxide (CO_2)
9	Caustic Potash	Potassium Hydroxide (KOH)
10	Chili Saltpeter	Sodium Nitrate ($NaNO_3$)
11	Borax	Borax ($Na_2B_4O_7 \cdot 10H_2O$)
12	Spirit	Methyl Alcohol (CH_3OH)
13	Alcohol	Ethyl Alcohol (C_2H_5OH)
14	Caustic Soda	Sodium Hydroxide (NaOH)
15	Baking Soda	Sodium Bicarbonate ($NaHCO_3$)
16	Red Lead	Lead Tetroxide (Pb_3O_4)
17	Washing Soda	Sodium Carbonate (Na_2CO_3)
18	Chalk	Calcium Carbonate ($CaCO_3$)
19	Hydrochloric Acid	Hydrogen Chloride (HCl)
20	Laughing Gas	Nitrous Oxide (N_2O)
21	Nitric Acid	Nitric Acid (HNO_3)

Glass ($Na_2O \cdot CaO \cdot 6SiO_2$):

- It is a supercooled liquid of silicates.
- The raw materials used for making glass are sodium carbonate, calcium carbonate, and sand.
- A well-prepared powdered mixture is known as a batch, which is mixed with cullet (broken glass pieces) and then melted in a tank furnace at 1673 K. After a few hours, molten glass is obtained.
- The molten glass is cooled slowly and uniformly. This slow and even cooling process is known as annealing.
- Different mixtures can produce glasses of various colors.

Substances Used	Color of Glass
Cuprous Oxide	Red
Cupric Oxide	Peacock Blue
Potassium Dichromate	Green or Greenish Yellow
Ferrous Oxide	Green
Ferric Oxide	Brown
Manganese Dioxide	Very dark, light pink
Cobalt Oxide	Blue
Gold Chloride	Ruby
Cadmium	Yellow
Carbon	Amber

Types of Glass and Their Uses

1. Soft Glass: Made from sodium or calcium silicates. Used for windows, mirrors, and regular glass items.

2. Hard Glass: Made from potassium and calcium silicates, this glass is more resistant to acids.

3. Flint Glass: A mix of sodium, potassium, and lead silicates. Used for making bulbs and optical instruments.

4. Pyrex Glass (Borosilicate Glass): Used for pharmaceutical containers, laboratory equipment, and kitchen items.

5. Quartz Glass (Silica Glass): Used for chemical equipment and optical devices.

6. Crown Glass: Used to make lenses for glasses.

7. Photochromatic Glass: Darkens when exposed to bright light, helpful for sun protection.

8. Safety Glass: Made of three layers bonded together, it doesn't shatter easily and is used in vehicle windshields.

9. Optical Glass: Used to make microscopes, telescopes, and eyeglass lenses.

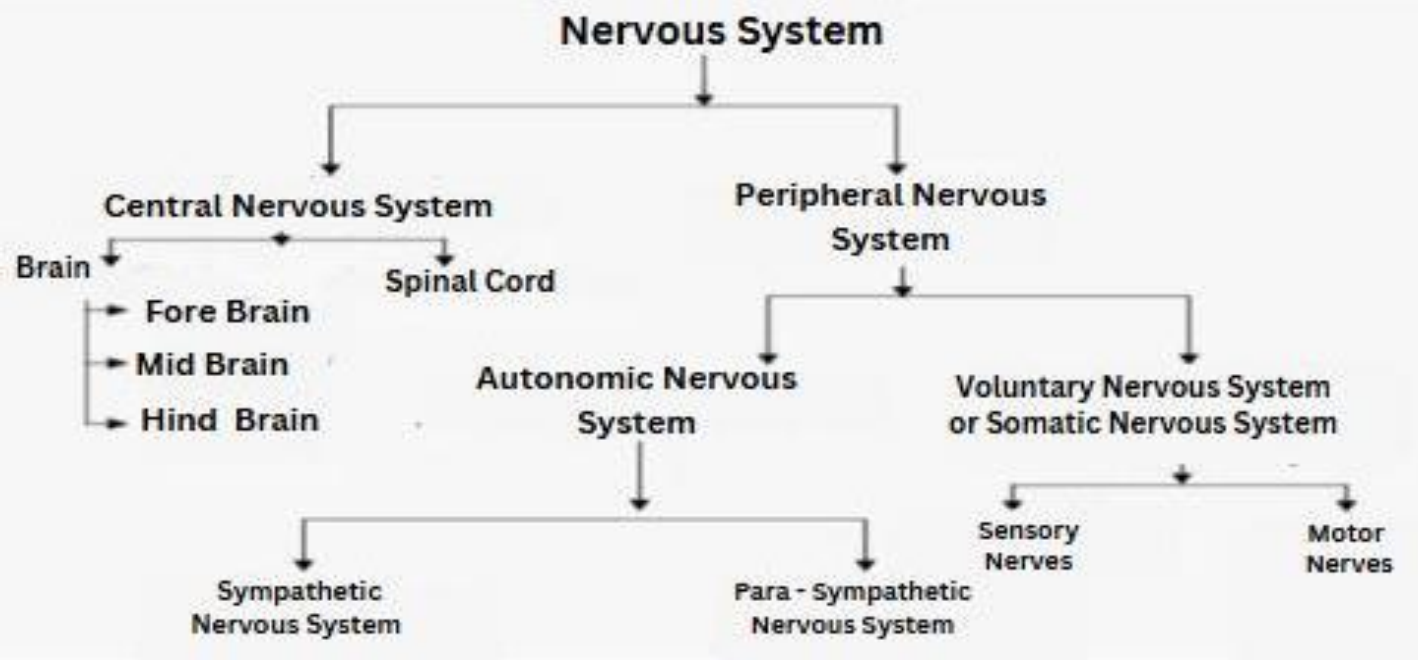
10. Glass Fiber: Used as insulation in ovens and refrigerators.

11. Optical Fiber: Used in telecommunications and surgeries; can transmit images around corners.

12. Lead Crystal Glass: Has a high refractive index, used for expensive glassware.

13. Glass Etching: Uses hydrofluoric acid (HF) to etch glass.

Parts of the nervous system



3. Chemical Control and Coordination

- The chemicals used for controlling and coordinating bodily functions are called hormones.
- Hormones are secreted by endocrine glands, forming the endocrine system.

Hormones:

- They are specific organic compounds.
- Hormones act as messengers.
- Compared to nervous control and coordination, hormonal control has a slower effect, but their impact lasts longer.
- Many bodily functions in humans are regulated by hormones.

Human Endocrine System

The endocrine glands found in the human body include:

1. **Pituitary Gland**
2. **Thyroid Gland**
3. **Parathyroid Gland**
4. **Adrenal Gland**
5. **Islets of Langerhans**
6. **Gonads**

1. Pituitary Gland:

- Located in a cavity of the sphenoid bone in the skull.
- Often referred to as the "master gland."
- It is divided into two main parts: anterior (front) lobe and posterior (back) lobe.
- **Functions:**
  - The anterior lobe secretes growth hormone, which regulates growth in muscles and bones.
    - Excess secretion of this hormone can lead to **gigantism**, where a person's height significantly exceeds the average, and bones become heavy and thick.
    - Insufficient secretion can cause **dwarfism**, halting normal growth.
  - Other hormones secreted by the anterior lobe regulate the production of sperm in males and eggs (ova) in females.
  - One hormone stimulates milk production in female breasts.
  - The posterior lobe releases hormones that help maintain the body's water balance.
  - It also secretes a hormone that aids in childbirth in females.

2. Thyroid Gland

- This gland is located in the trachea (windpipe).
- It secretes a hormone called **Thyroxine**.
- The synthesis of thyroxine requires iodine.
- A deficiency of iodine leads to decreased production of thyroxine by the thyroid gland. In an attempt to increase thyroxine production, the gland may enlarge, a condition known as **Goitre**.

3. Parathyroid Gland

- The hormone secreted by this gland regulates the levels of calcium in the blood.

4. Adrenal Gland

- Also known as the **suprarenal gland**.

- The adrenal gland has two parts:
  - **A) Cortex**
  - **B) Medulla**

A) Hormones Secreted by the Cortex and Their Functions:

1. **Glucocorticoids**:
   - Play a crucial role in metabolism of food.
   - Regulate the metabolism of carbohydrates, proteins, and fats.
   - Assist in controlling water balance in the body.
2. **Mineralocorticoids**:
   - Main function is to regulate the reabsorption of sodium by the kidneys and control the levels of other minerals in the body.
   - Help maintain water balance in the body.
3. **Sex Hormones**:
   - These hormones regulate the development of muscles and bones, the pattern of hair growth, and sexual behavior.

B) Hormones Secreted by the Medulla and Their Functions:

1. **Epinephrine**:
   - This hormone is released during high physical and mental stress, fear, anger, and excitement.
2. **Norepinephrine**:
   - It increases the excitability and contractility of heart muscles.

5. Islets of Langerhans:

- This gland secretes the hormone **Insulin**.
- Insulin regulates the amount of glucose in the blood.
- A deficiency in insulin secretion can lead to the disease known as **Diabetes**.

6. Gonads:

- The main function of gonads is to produce **Gametes** (reproductive cells).

1. **Ovaries**:
   - The ovaries secrete several hormones.
   - These hormones are responsible for the changes occurring in girls during puberty.
2. **Testes**:
   - The hormones secreted by the testes are called **Androgens**.
   - These hormones promote the development of male sexual characteristics and influence sexual behavior.

❖ Human Body Systems

- The human body consists of various groups of organs that are interconnected. Each organ serves a specific function, and together they form systems. This group of organs working together for a common function is called a system.
- The systems that regulate and execute the body's functions include the following:

Digestive System

Food

- All living beings require energy for physical growth, repairing damaged tissues, and carrying out essential biological processes, which they obtain from food.

Components of Food

The components of food include:

1. **Carbohydrates**:
   - Provide energy to the body.
2. **Proteins**:
   - Help in the growth and repair of cells.
3. **Fats**:
   - Provide energy to the body in solid form.
4. **Vitamins**:
   - Essential for body development and enhancing the immune system; they do not provide energy.
5. **Minerals**:
   - Elements like sodium (Na), potassium (K), phosphorus (P), iodine (I), and calcium (Ca) are necessary for various bodily functions.
6. **Water**:
   - Acts as a solvent and is a crucial part of human nutrition.

Digestion

We consume food in the form of complex substances like carbohydrates, fats, and proteins. Our body cannot absorb these complex forms directly, so digestion is necessary to break them down into smaller, absorbable parts. Thus, the process of gradually converting complex food substances into simpler forms is known as digestion.

1. In a way, digestion can be described as a **hydrolytic reaction**.
2. All the enzymes involved in digestion collectively are called **hydrolases**.

Components of the Human Digestive System

The organs involved in the digestive process are divided into two main parts:

- ***Alimentary Canal**: The pathway through which food travels.*
- ***Accessory Digestive Glands**: Glands that aid in digestion.*

Phases of Digestion

The process of digestion in the human body occurs in five stages.

- ***Gland**: An organ that secretes a substance is referred to as a "gland."*
- ***Enzyme**: These act as biological catalysts, increasing the rate of chemical reactions. They are called enzymes.*

Alemetry canal:-

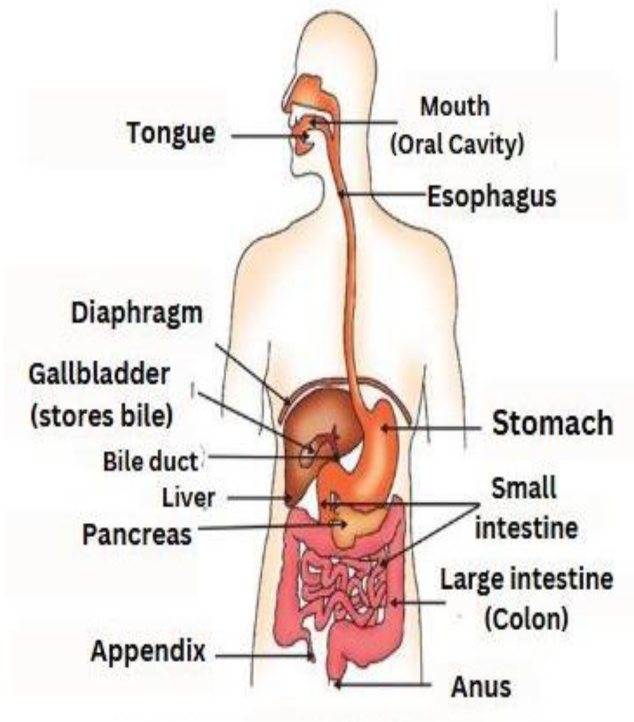


Diagram - Human Digestive System

Digestive Tract

The digestive tract extends from the mouth to the bladder, measuring approximately 30-35 feet in length. It is divided into four parts:

1. ***Buccopharyngeal Cavity***
2. ***Oesophagus***
3. ***Stomach***
4. ***Intestine***

Buccopharyngeal Cavity

- *This is the first part of the alimentary canal.*
- *It contains the teeth and tongue.*
- *The tongue has taste buds for flavor perception.*

Buccal Cavity

- *Digestion begins in the buccal cavity.*
- *Here, about 30% of starch is digested into maltose by enzymes.*
- *Nutrient absorption does not occur here; it takes place in the intestines.*

Pharynx

- *No digestion or absorption occurs in the pharynx.*
- *It serves as a passageway for food and aids in swallowing.*

Oesophagus

- *Saliva-mixed food passes from the buccal cavity to the oesophagus.*
- *It is a narrow tube approximately 25 cm long that connects to the stomach.*
- *The oesophagus provides a pathway for food to reach the stomach, facilitated by peristaltic movements.*
- *There is no digestion occurring in the oesophagus.*

Stomach

- *The stomach is the widest part of the alimentary canal.*
- *It is located on the left side of the abdominal cavity.*
- *The inner walls of the stomach have numerous gastric glands that secrete gastric juice.*
- *Food stays in the stomach for about 3-4 hours.*
- *Three types of enzymes are secreted in the stomach:*

1. ***Pepsin**: Breaks down proteins into peptides.*
2. ***Renin**: Converts milk protein (casein) into Para casein.*
3. ***Lipase**: Digests fats.*

Various Types of Juices and Their Importance

1. Gastric Juice

- ***pH Level**: 0.9-3 (acidic)*
- ***HCl Secretion**:*
  - *Functions as an antibacterial agent.*
  - *Prevents food from spoiling.*
  - *Creates an acidic environment for digestion.*
  - *Breaks down tough food into simpler forms.*
- ***Gastric Ulcer**:*
  - *Usually occurs in the last part of the stomach.*
  - *Caused by the bacteria "Helicobacter pylori."*

2. Intestine

- *The intestine is the longest part of the alimentary canal, measuring about 22 feet.*

Respiration

- Generally, the process of taking in O_2 and expelling CO_2 is called respiration.
- Respiration is a crucial process that produces energy. In this process, food (glucose) is oxidized in the presence of O_2, releasing energy. $C_6H_{12}O_6$ is referred to as cell fuel.
- The respiration process occurs similarly in both animals and plants.

Atmospheric Composition

- The air taken in from the environment contains approximately **21% O_2** and **0.03% CO_2**.
- The exhaled breath through the nose contains about **16% O_2** and **3.6% CO_2**.
- The respiration rate is about **12-15 breaths per minute** in adults and approximately **44 breaths per minute** in infants.

The Entire Process of Respiration

The entire process of respiration can be divided into the following parts:

1. **External Respiration**
2. **Gas Transport**
3. **Internal Respiration**

1. External Respiration

- The intake of O_2 into the body and the expulsion of CO_2 from the body is known as external respiration. This process is accomplished by the lungs, hence it is also referred to as **Pulmonary respiration**.
- This involves the mixing of O_2 with blood and the removal of CO_2 from the blood.
- It is also called **Gaseous exchange**.

Comparison of Aerobic Respiration and Anaerobic Respiration

S.No.	Aerobic Respiration	Anaerobic Respiration
1	Requires oxygen gas.	Does not require oxygen gas.
2	Complete breakdown of glucose molecules occurs.	Complete breakdown of glucose molecules does not occur.
3	Produces a high amount of energy (686 kilocalories) from one molecule of glucose.	Produces only 56 kilocalories of energy from one molecule of glucose.
4	Large amounts of carbon dioxide are produced.	Smaller amounts of carbon dioxide are produced.
5	Ends with carbon dioxide and water.	Ends with the formation of ethanol (ethyl alcohol).
6	Equation: $C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + 686$ kcal	Equation: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + 56$ kcal
7	Occurs in the mitochondria as part of the Krebs cycle.	Occurs in the cytoplasm of the cell.

Note on Gas Exchange and Respiration

1. **Oxygen in the Lungs:**
   - Oxygen (O_2) reaches the lungs and combines with hemoglobin (Hb) in the blood to form oxyhemoglobin (OxyHb). This compound gives blood its red color. O_2 reaches the cells in the form of OxyHb.
2. **Gas Transport:**
   - The transport of O_2 obtained from the respiratory organs to various cells and bringing back CO_2 to the respiratory organs is known as gas transport. This process occurs with the help of the circulatory system.
3. **Internal Respiration:**
   - The exchange of gases between blood and tissue fluid inside the body is called internal respiration. It occurs within cells, hence it is also known as cellular respiration. In this process, OxyHb breaks down into Hb and O_2 due to reduced pressure of O_2, allowing about 25% of O_2 to reach the tissues.
   - Equation: $[HBO_2 \rightarrow HB + O_2]$

Note:

- The average amount of hemoglobin (Hb) in a normal person is 15 gm per 100 ml of blood.
- Internal respiration occurs in two types:
  - **Aerobic Respiration**
  - **Anaerobic Respiration**

Chapter - 5
Computers, Information, and Communication Technology

Development of Computers
Computer Generations

The development of computers has been marked by different generations, each aiming to create computers that are cheaper, smaller, faster, and more reliable. Here's a brief overview of the various generations of computers:

Generations of Computers and Their Features

First Generation:

1. Used vacuum tubes in electronic circuits.
2. Used magnetic drums for primary internal storage.
3. Limited main storage capacity.
4. Slow input-output processes.
5. Low-level programming languages like machine language and assembly language.
6. Problems with heat control.
7. Used mainly for payroll processing and record keeping.
8. Examples: IBM 650, UNIVAC.

Second Generation:

1. Introduced transistors.
2. Increased main storage capacity.
3. Faster input-output processes.
4. Used high-level languages (COBOL, FORTRAN).
5. Smaller size and less heat generation.
6. Faster and more reliable.
7. Commonly used for billing, payroll processing, and inventory file updates.
8. Examples: IBM 1401, Honeywell 200, CDC 1604.

Third Generation:

1. Used integrated circuits.
2. Used magnetic core and solid-state storage (SSI and MSI).
3. More flexible input-output processes.
4. Faster, smaller, and reliable.
5. Widespread use of high-level languages.
6. Supported remote processing, time-sharing systems, and multiprogramming.
7. Software available to control input-output.
8. Used in airline reservation systems, credit card billing, and market forecasting.
9. Examples: IBM System/360, NCR 395, Burroughs B6500.

Fourth Generation:

1. Used VLSI (Very Large Scale Integration) and ULSI (Ultra Large Scale Integration).
2. High-capacity and fast storage.
3. Compatibility between different hardware manufacturers, so consumers aren't locked into one vendor.
4. Increased use of mini computers.
5. Introduction of microprocessors and mini computers.
6. Used for electronic fund transfers, business production, and personal use.
7. Examples: IBM PC-XT, Apple I.

Fifth Generation:

1. Used optical disks for storage.
2. Development of the internet, email, and the World Wide Web (WWW).
3. Very small, fast, and easy-to-use plug-and-play devices.
4. Used for internet and multimedia applications.
5. Examples: IBM notebooks, Pentium PCs, supercomputers, etc.

Secondary Memory Devices, Their Storage Medium, and Storage Capacity

Device	Storage Medium	Capacity
Floppy Disk (5.25 inch)	Magnetic	1.2 MB
Floppy Disk (3.5 inch)	Magnetic	80 KB to 1.44 MB
Floppy Disk (8 inch)	Magnetic	20 MB to 80 GB
CD-ROM	Optical	640 MB to 680 MB
DVD-ROM	Optical	4.7 GB to 17 GB
Pen Drive	Solid State	1 GB to 256 GB
Magnetic Tape	Magnetic	60 MB to 8 MB

Special Purpose and General Purpose Computers

1. **Special Purpose Computers:** These computers are designed to solve specific problems. They are very effective for particular tasks. Examples include automatic traffic control systems and automatic aircraft landing systems.
2. **General Purpose Computers:** These computers are not made for a specific task. They can handle

Artificial DNA

Artificial DNA was first synthesized in January 2000 at the University of Texas and is known as Synthetic Organism-1. It is a long chain of DNA created by humans, containing thousands of base pairs. Synthetic Organism-1 is a microorganism, but its functions remain unknown.

Benefits of Artificial DNA

- **Targeted Therapeutics:** This technology can be used to create designer bugs that effectively target specific tissues, such as cancerous tumors, helping to destroy them.
- **Vitamin Production:** It can potentially influence the human gut to produce beneficial substances like vitamin C.

Dangers of Artificial DNA

The greatest threat posed by artificial DNA is the possibility of creating a microbial master race that could endanger humans and animals, as well as impact the environment. In the current stage of research and development, the dangerous consequences of mutations resulting from artificial DNA are unpredictable.

Biometric Technology

Biometric technology is an automated process for identifying or verifying a person based on their physical and behavioral characteristics. This includes analyzing facial features, retina patterns, fingerprints, palm lines, iris patterns, voice characteristics, and handwriting.

To ensure people's identity and prevent unauthorized access, the Bhabha Atomic Research Centre (BARC) has developed a biometric-based system that uses the hand as a biological identifier. This system operates primarily on a one-to-one matching method, where the sample taken from the individual's hand is compared with a pre-recorded sample.

❖ Human Genome Project

The Human Genome Project (HGP) is one of the world's largest and most ambitious biological research projects. It began in 1990, involving scientists from 18 countries, including India. The primary objective of the project was to determine the accurate chemical sequence of DNA found in each cell of the human body. In June 2000, the scientists involved in the project successfully deciphered the human genome, revealing that it is composed of approximately 3.1 billion base pairs. The human body contains more than 50,000 genes, collectively referred to as the genome. Human chromosomes are made up of tightly coiled DNA, and there are a total of 23 pairs of chromosomes in the human body. The project aimed to decode these chromosomal structures. Even slight errors in genetic instructions can lead to various diseases.

Benefits of the Human Genome Project

1. **Disease Treatment:** The project will enable the development of drugs for diseases such as cancer, AIDS, diabetes, heart disease, and Alzheimer's.
2. **Gene Therapy:** By identifying deficiencies or defects in genes, corrective measures can be taken through gene therapy or gene treatments.
3. **Personalized Medicine:** It has the potential to reveal genetic differences among individuals, allowing for tailored treatments and medications, and the identification of hereditary diseases along with specific treatment methods.
4. **Understanding Evolution:** Insights from genomics will help in understanding human evolution and our relationships with other organisms.
5. **Identification of War Victims:** The genome can aid in identifying war victims, especially when remains are unrecognizable.
6. **Determining Parentage:** It will assist in determining the biological parents of a child.
7. **Forensic Applications:** Biological evidence such as hair and skin can be used to identify actual perpetrators of crimes.
8. **Organ Transplantation:** The human genome can facilitate matching donors and recipients in organ transplant programs.

India's First DNA Bank

India's first DNA bank has been established in Kolkata. This project involved an in-depth study of a large number of homogeneous population groups, resulting in the creation of a genomic DNA bank for future forensic and clinical studies. The samples are labeled with unique numbers that include a population code, individual code, and storage location code for each sample.

Dear Aspirants, here are the our results in differents exams (Proof Video Link)

RAS PRE. 2021 - https://shorturl.at/qBJ18 (74 प्रश्न , 150 में से)

RAS Pre 2023 - https://shorturl.at/tGHRT (96 प्रश्न , 150 में से)

UP Police Constable 2024 - http://surl.li/rbfyn (98 प्रश्न , 150 में से)

Rajasthan CET Gradu. Level - https://youtu.be/gPqDNlc6UR0

Rajasthan CET 12th Level - https://youtu.be/oCa-CoTFu4A

RPSC EO / RO - https://youtu.be/b9PKjl4nSxE

VDO PRE. - https://www.youtube.com/watch?v=gXdAk8S6WI8&t=202s

Patwari - https://www.youtube.com/watch?v=X6mKGdtXyu4&t=2s

PTI 3rd grade - https://www.youtube.com/watch?v=iA_MemKKgEk&t=5s

SSC GD – 2021 - https://youtu.be/2gzzfJyt6vI

EXAM (परीक्षा)	DATE	हमारे नोट्स में से आये हुए प्रश्नों की संख्या
MPPSC Prelims 2023	17 दिसम्बर	63 प्रश्न (100 में से)
RAS PRE. 2021	27 अक्तूबर	74 प्रश्न आये
RAS Mains 2021	October 2021	52% प्रश्न आये

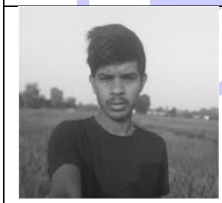
whatsapp -https://wa.link/dx3m7n 1 web.- https://shorturl.at/XiCHA

RAS Pre. 2023	01 अक्टूबर 2023	96 प्रश्न (150 मेंसे)
SSC GD 2021	16 नवम्बर	68 (100 में से)
SSC GD 2021	08 दिसम्बर	67 (100 में से)
RPSC EO/RO	14 मई (1st Shift)	95 (120 में से)
राजस्थान S.I. 2021	14 सितम्बर	119 (200 में से)
राजस्थान S.I. 2021	15 सितम्बर	126 (200 में से)
RAJASTHAN PATWARI 2021	23 अक्तूबर (1st शिफ्ट)	79 (150 में से)
RAJASTHAN PATWARI 2021	23 अक्तूबर (2nd शिफ्ट)	103 (150 में से)
RAJASTHAN PATWARI 2021	24 अक्तूबर (2nd शिफ्ट)	91 (150 में से)
RAJASTHAN VDO 2021	27 दिसंबर (1st शिफ्ट)	59 (100 में से)
RAJASTHAN VDO 2021	27 दिसंबर (2nd शिफ्ट)	61 (100 में से)
RAJASTHAN VDO 2021	28 दिसंबर (2nd शिफ्ट)	57 (100 में से)
U.P. SI 2021	14 नवम्बर 2021 1st शिफ्ट	91 (160 में से)
U.P. SI 2021	21नवम्बर2021 (1st शिफ्ट)	89 (160 में से)
Raj. CET Graduation level	07 January 2023 (1st शिफ्ट)	96 (150 में से)
Raj. CET 12th level	04 February 2023 (1st शिफ्ट)	98 (150 में से)
UP Police Constable	17 February 2024 (1st शिफ्ट)	98 (150 में से)

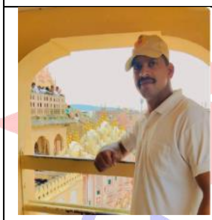
& Many More Exams like UPSC, SSC, Bank Etc.

Our Selected Students

Approx. 137+ students selected in different exams. Some of them are given below -

Photo	Name	Exam	Roll no.	City
	**Mohan Sharma S/O Kallu Ram**	Railway Group - d	114195120370022	PratapNagar Jaipur
	**Mahaveer singh**	Reet Level- 1	1233893	Sardarpura Jodhpur
	**Sonu Kumar Prajapati S/O Hammer shing prajapati**	SSC CHSL tier-1	2006018079	Teh.-Biramganj, Dis.-Raisen, MP
N.A	**Mahender Singh**	EO RO (81 Marks)	N.A.	teh nohar , dist Hanumangarh
	**Lal singh**	EO RO (88 Marks)	13373780	Hanumangarh
N.A	**Mangilal Siyag**	SSC MTS	N.A.	ramsar, bikaner

	**MONU S/O KAMTA PRASAD**	SSC MTS	3009078841	kaushambi (UP)
	**Mukesh ji**	RAS Pre	1562775	newai tonk
	**Govind Singh S/O Sajjan Singh**	RAS	1698443	UDAIPUR
	**Govinda Jangir**	RAS	1231450	Hanumangarh
N.A	**Rohit sharma s/o shree Radhe Shyam sharma**	RAS	N.A.	Churu
	**DEEPAK SINGH**	RAS	N.A.	Sirsi Road , Panchyawala
N.A	**LUCKY SALIWAL s/o GOPALLAL SALIWAL**	RAS	N.A.	AKLERA , JHALAWAR
N.A	**Ramchandra Pediwal**	RAS	N.A.	diegana , Nagaur

	**Monika jangir**	RAS	N.A.	jhunjhunu
	**Mahaveer**	RAS	1616428	village-gudaram singh, teshil-sojat
N.A	**OM PARKSH**	RAS	N.A.	Teshil-mundwa Dis- Nagaur
N.A	**Sikha Yadav**	High court LDC	N.A.	Dis- Bundi
	**Bhanu Pratap Patel s/o bansi lal patel**	Rac batalian	729141135	Dis.-Bhilwara
N.A	**mukesh kumar bairwa s/o ram avtar**	3rd grade reet level 1	1266657	JHUNJHUNU
N.A	**Rinku**	EO/RO (105 Marks)	N.A.	District: Baran
N.A.	**Rupnarayan Gurjar**	EO/RO (103 Marks)	N.A.	sojat road pali
	**Govind**	SSB	4612039613	jhalawad

	**Jagdish Jogi**	EO/RO (84 Marks)	N.A.	tehsil bhinmal, jhalore.
	**Vidhya dadhich**	RAS Pre.	1158256	kota
	**Sanjay**	Haryana PCS	96379 	Jind (Haryana)

And many others......

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