UNIT – I: BASIC MATHEMATICS FOR PHYSICS

1.1 Algebraic Identities

Algebraic identities are formulas that are always true and help simplify calculations.

(a) Identity: $(x + y)^2$

{"math_block_widget_always_prefetch_v2":{"content":"(x+y)^2 = x^2 + 2xy + y^2"}}

When we square a sum, we get:

- Square of first term
- Plus twice the product
- Plus square of second term

Example

$(2 + 3)^2 = 2^2 + 2(2)(3) + 3^2 = 4 + 12 + 9 = 25$

(b) Identity: $(x - y)^2$

{"math_block_widget_always_prefetch_v2":{"content":"(x-y)^2 = x^2 - 2xy + y^2"}}

Similar to above but middle term is negative.

Example

$(5 - 1)^2 = 25 - 10 + 1 = 16$

(c) Identity: $x^2 - y^2$

{"math_block_widget_always_prefetch_v2":{"content":"x^2 - y^2 = (x-y)(x+y)"}}

Difference of squares can be factorized.

Example

$49 - 25 = (7 - 5)(7 + 5) = 2 \times 12 = 24$

- Use in Physics
- Simplifies equations
- Used in derivations and problem solving

1.2 Binomial Theorem

The binomial theorem helps expand expressions like .

General Formula

$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \dots$

Explanation

It expands powers into a series using coefficients.

Example 1
$(1 + x)^2 = 1 + 2x + x^2$

Example 2
$(1 - x)^3 = 1 - 3x + 3x^2 - x^3$

- Use in Physics
- Approximation (small values)
- Used in waves, optics, and mechanics

1.3 Trigonometry

(a) Pythagoras Theorem
{"math_block_widget_always_prefetch_v2":{"content":"a^2 + b^2 = c^2"}}

In a right triangle:
$\text{Hypotenuse}^2 = \text{Base}^2 + \text{Perpendicular}^2$

Example
$a = 6, b = 8$

(b) Trigonometric Ratios

Example

If:
Perpendicular = 5
Base = 12
Hypotenuse = 13

$\sin \theta = \frac{5}{13}, \quad \cos \theta = \frac{12}{13}, \quad \tan \theta = \frac{5}{12}$

- Use in Physics
- Projectile motion
- Force resolution
- Wave motion

1.4 Differentiation and Integration

These are parts of calculus, very important in physics.

(a) Differentiation
It tells how a quantity changes with time or position.

Formula
$\frac{d}{dx}(x^n) = nx^{n-1}$

Example
$\frac{d}{dx}(x^3) = 3x^2$

Physical Meaning
Velocity = rate of change of position

Acceleration = rate of change of velocity

(b) Integration
It is the reverse of differentiation and gives total value.

Formula
$$\int x^n dx = \frac{x^{n+1}}{n+1} + C$$

Example
$$\int x^3 dx = \frac{x^4}{4} + C$$

- Physical Meaning
- Displacement from velocity
- Area under curve

1.5 Line Graph Representation
A graph shows relation between two variables.

Basic Concept
X-axis → independent variable (time)
Y-axis → dependent variable (distance, velocity)

Example Table

Time (s)	Distance (m)
1	3
2	6
3	9

👉 This forms a straight line → uniform motion

Slope of Line
{"math_block_widget_always_prefetch_v2":{"content":"m = \\frac{y_2 - y_1}{x_2 - x_1}"}}

Example
Points (2,6) and (4,12):
$$m = \frac{12 - 6}{4 - 2} = 3$$

Meaning of Slope in Physics
Distance-time graph → slope = velocity
Velocity-time graph → slope = acceleration

🌟 UNIT – II: UNITS AND MEASUREMENTS

2.1 Physical Quantities

A physical quantity is anything that can be measured and expressed with a number and unit.

(a) Fundamental Quantities

These are basic quantities that cannot be derived from others.

Examples

Quantity	Unit (SI)
Length	meter (m)
Mass	kilogram (kg)
Time	second (s)
Temperature	kelvin (K)
Electric current	ampere (A)

Example
Length of a rod = 2 m
Time taken = 5 s
These are fundamental because they are directly measured.

(b) Derived Quantities

These are formed using fundamental quantities.

Examples
Velocity = distance / time → m/s
Force = mass × acceleration → Newton
Energy = force × distance → Joule

Example

If:
Distance = 10 m
Time = 2 s
$\text{Velocity} = \frac{10}{2} = 5 \, m/s$

Systems of Units

(i) CGS System

Length → cm
Mass → g
Time → s

👉 Used in older physics studies.

(ii) MKS System

Length → m
Mass → kg
Time → s

(iii) SI System (Standard System)

Most widely used system in the world.

Examples

1. Force → Newton (N)
2. Energy → Joule (J)
3. Pressure → Pascal (Pa)

Example
Force = 10 kg × 2 m/s^2 = 20 N

2.2 Dimensions and Dimensional Analysis

(a) Dimensions

Dimensions show how a quantity depends on basic quantities.

Example
Velocity:
$\text{Velocity} = \frac{\text{distance}}{\text{time}}$
Dimension = $[L T^{-1}]$

(b) Dimensional Formula

It expresses a quantity in terms of fundamental quantities.

Example
Force:
F = ma

Dimension:
$[M L T^{-2}]$

(c) Principle of Homogeneity

In any correct equation: 👉 Dimensions on both sides must be equal.

Example
$s = ut + \frac{1}{2}at^2$

→ [L]
→ [L]

✔ Equation is correct

(d) Applications of Dimensional Analysis

1. Checking equations

Example:
$v = u + at$
Both sides → $[L T^{-1}]$ ✔

2. Conversion of Units

Example: Convert 1 m into cm
1 m = 100 cm

Practical Understanding
Dimensional analysis helps avoid mistakes in formulas.

2.3 Errors in Measurement

No measurement is perfectly accurate.

Types of Errors

(i) Instrumental Error
Due to faulty instruments.

👉 Example:
Broken scale gives wrong reading.

(ii) Systematic Error
Repeated error in same direction.

👉 Example:
Zero error in vernier caliper.

(iii) Random Error
Unpredictable errors.

👉 Example:
Human reading error.

Estimation of Errors

(a) Absolute Error
Difference between true value and measured value.

👉 Example: True value = 50 cm
Measured = 49 cm
Absolute error = 1 cm

(b) Relative Error
$\frac{\text{Absolute error}}{\text{True value}}$

(c) Percentage Error
$\text{Relative error} \times 100$

Example
$\frac{1}{50} \times 100 = 2\%$

Significant Figures
Digits that give meaningful precision.

Rules
Non-zero digits are significant
Leading zeros are not significant

Examples
3.45 → 3 significant figures
0.0045 → 2 significant figures

2.4 Measuring Instruments

(a) Vernier Calipers

Used to measure:

1. Diameter
2. Length
3. Depth

Example

Main scale = 2.5 cm
Vernier reading = 0.06 cm
Total = 2.56 cm

(b) Screw Gauge
Used to measure very small thickness.

Example
Diameter of wire = 0.32 mm

(c) Spherometer

Used to measure:

- Curvature of surfaces
- Thickness of glass

Example
Used in optical instruments.

2.5 Vector Analysis

(a) Scalar Quantities
Only magnitude, no direction.

👉 Examples:

- Mass
- Time
- Temperature

(b) Vector Quantities
Have both magnitude and direction.

👉 Examples:

- Velocity
- Force
- Displacement

(c) Resolution of Vectors
Breaking vector into components.

Example
Force = 10 N at angle θ
Horizontal =
Vertical =

(d) Addition of Vectors
Triangle Law
Vectors added head to tail.
Parallelogram Law

Resultant of two vectors:
$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

Example
$A = 6$, $B = 8$, $\theta = 90°$
$R = 10$

(e) Vector Multiplication

1. Dot Product (Scalar Product)
$A \cdot B = AB \cos \theta$

👉 Example: Work done = Force × displacement

2. Cross Product (Vector Product)
$A \times B = AB \sin \theta$

👉 Example: Torque = $r \times F$

UNIT – III: MECHANICS

3.1 FORCE AND NEWTON'S LAWS OF MOTION

Force

- Force is one of the most fundamental concepts in physics. In simple terms, force is defined as a push or pull acting on an object. However, in physics, force is much more than just pushing or pulling. It is the reason why objects change their state of motion.

- If an object is at rest and starts moving, or if it is moving and stops, or if its direction changes, all these changes occur because of force. Thus, force can:

1. Start motion
2. Stop motion
3. Change speed
4. Change direction
5. Change shape of an object

For example, when you push a stationary car, it starts moving. When you apply brakes on a bicycle, it stops. When a cricket bat hits a ball, the direction and speed of the ball change. All these are effects of force.

Mathematically, force is given by:
$F = ma$

This means force depends on the mass of the object and the acceleration produced in it.

Newton's First Law of Motion (Law of Inertia)

Newton's first law states that an object will remain at rest or continue to move with uniform velocity unless an external force acts on it.

This law introduces the concept of inertia, which is the natural tendency of an object to resist any change in its state of motion.

There are three types of inertia:

1. Inertia of rest – a body resists starting motion
2. Inertia of motion – a body resists stopping
3. Inertia of direction – a body resists change in direction

- For example, when a bus suddenly stops, passengers tend to fall forward. This happens because their body was in motion and wants to remain in motion (inertia of motion). Similarly, when a carpet is beaten, dust particles come out because they tend to remain at rest while the carpet moves.

- This law explains many real-life phenomena and shows that force is required to change motion, not to maintain motion.

Newton’s Second Law of Motion

Newton’s second law provides a quantitative definition of force. It states that the force acting on an object is equal to the rate of change of its momentum.

Momentum is defined as:

1. {"math_block_widget_always_prefetch_v2":{"content":"p = mv"}}
2. So, force can also be written as:
3. $F = \frac{dp}{dt}$

For constant mass, it becomes:
$F = ma$

This law tells us that:
A larger mass requires more force to accelerate
Greater acceleration requires more forc

For example, pushing a loaded truck requires much more force than pushing an empty cart. Similarly, when you hit a ball harder, it accelerates more because a greater force is applied.

This law is extremely important because it forms the basis of all mechanics calculations.

Newton’s Third Law of Motion

- Newton’s third law states that for every action, there is an equal and opposite reaction.
- This means that forces always occur in pairs. If object A exerts a force on object B, then object B also exerts an equal and opposite force on object A.

For example:

- When a gun fires a bullet forward, the gun moves backward (recoil).
- When a rocket launches, gases are pushed downward and the rocket moves upward.
- While walking, you push the ground backward, and the ground pushes you forward.
- This law explains how motion is possible in many systems, especially in rockets and vehicles.

Linear Motion

Linear motion refers to motion in a straight line. It is the simplest form of motion.

There are two types:

- Uniform motion – when velocity is constant
- Non-uniform motion – when velocity changes

The equations of motion are:
$v = u + at$
$v^2 = u^2 + 2as$

For example, if a car starts from rest and accelerates uniformly, its velocity increases linearly with time.

Momentum and Conservation of Momentum

Momentum is defined as the product of mass and velocity:

- $p = mv$
- It tells us how difficult it is to stop a moving object. A heavy and fast-moving object has large momentum.
- The law of conservation of momentum states that in the absence of external forces, total momentum remains constant.

For example, when a gun fires a bullet forward, the gun moves backward. This is because total momentum before and after firing remains the same.

Impulse

Impulse is defined as the product of force and time:

- Impulse = F \times t
- It represents the change in momentum.
- For example, when catching a ball, you move your hands backward. This increases the time of impact, reducing the force and preventing injury.

Parallelogram Law of Forces

When two forces act at a point, their resultant is given by the diagonal of a parallelogram.

R = \sqrt{A^2 + B^2 + 2AB\cos\theta}

For example, if two people pull an object at different angles, the object moves in a direction determined by the resultant force.

FRICTION

Friction is the force that opposes motion between two surfaces in contact. Although it resists motion, it is extremely useful in daily life.

Without friction:

- We cannot walk
- Vehicles cannot move
- Writing would be impossible

Types of friction:

1. Static friction (before motion starts)
2. Kinetic friction (during motion)
3. Rolling friction (least friction)
4. Friction depends on the nature of surfaces and the force pressing them together.

Lubricants such as oil and grease reduce friction by forming a thin layer between surfaces. They are widely used in machines to reduce wear, heat, and energy loss.

🔴 3.2 CIRCULAR AND ROTATIONAL MOTION

Circular motion occurs when an object moves along a circular path.
Angular displacement is the angle covered by the object. Angular velocity is the rate of change of this angle, and angular acceleration is the rate of change of angular velocity.

The relation between linear and angular velocity is:
$$v = r\omega$$

Centripetal force acts towards the center of the circle and keeps the object in circular motion:
$$F = \frac{mv^2}{r}$$

For example, when a car takes a turn, centripetal force keeps it on the curved path.
Centrifugal force is an apparent force that seems to push objects outward.

Applications include:
Banking of roads
Cyclists leaning while turning

◆ Rotational Motion

Rotational motion involves rotation about an axis.

Torque is the turning effect of force:

- $\tau = r \times F$
- Moment of inertia measures resistance to rotation. A heavier object or one with mass farther from the axis has greater inertia.
- Center of mass is the point where the entire mass can be considered concentrated.
- Applications include engines, turbines, and rotating wheels in vehicles.

🔴 3.3 WORK, POWER AND ENERGY

Work is done when a force moves an object:
$$W = Fd\cos\theta$$

Power is the rate of doing work:
$$P = \frac{W}{t}$$
Energy is the ability to do work.

Kinetic energy is energy of motion:
$$KE = \frac{1}{2}mv^2$$

Potential energy is energy due to position:
$$PE = mgh$$

For example, a moving car has kinetic energy, while water stored in a dam has potential energy.

3.4 WORK-ENERGY THEOREM AND CONSERVATION

The work-energy theorem states that work done on an object equals the change in its kinetic energy.

The law of conservation of energy states that energy cannot be created or destroyed, only transformed.

For example, in a falling object:

- At the top → potential energy
- During fall → both KE and PE
- At bottom → kinetic energy

Energy transformations occur everywhere:

- Electrical → light
- Chemical → mechanical
- Mechanical → heat

🌟 UNIT – IV: MATTER

🔴 *4.1 ELASTICITY*

🔹 What is Elasticity?
Elasticity is the property of a material by virtue of which it regains its original shape and size after the removal of an external force.
When a force is applied to a body, it deforms (changes shape). When the force is removed, if the body returns to its original shape, it is said to be elastic.

👉 Example:
A rubber band stretches when pulled and returns to its original shape when released.
A spring regains its shape after compression.

🔹 ***Stress***
Stress is defined as the force applied per unit area.

$$\text{Stress} = \frac{Force}{Area}$$

Types of Stress
1. Tensile stress → pulling force
2. Compressive stress → pushing force
3. Shear stress → force applied parallel to surface

👉 Example: Stretching a wire produces tensile stress.

🔹 ***Strain***
Strain is the deformation produced in a body divided by its original dimension.

$$\text{Strain} = \frac{\text{Change in dimension}}{\text{Original dimension}}$$

Strain has no unit.

🔹 ***Hooke's Law***
Hooke's law states that within the elastic limit, stress is directly proportional to strain.

$$\text{Stress} \propto \text{Strain}$$

🔍 Explanation
This means if we increase force, deformation increases proportionally, but only up to a certain limit (elastic limit).

🔹 Modulus of Elasticity
It is the ratio of stress to strain.

$$\text{Modulus} = \frac{\text{Stress}}{\text{Strain}}$$

Types
1. Young's Modulus → length change
2. Bulk Modulus → volume change
3. Shear Modulus → shape change

🔹 ***Stress-Strain Diagram***
This graph shows how material behaves under force.

Important Points
Elastic limit → body returns to original shape
Plastic region → permanent deformation
Breaking point → material breaks

🔹 ***Engineering Applications***
Construction of bridges
Design of buildings
Springs and shock absorbers
Steel cables in cranes

👉 Engineers must choose materials with proper elasticity to avoid failure.

🟡 ***4.2 PRESSURE***

🔹 Definition of Pressure
Pressure is defined as force acting per unit area.
$P = \frac{F}{A}$

🔹 Units of Pressure
SI unit → Pascal (Pa)
1 Pa = 1 N/m^2

🔹 Atmospheric Pressure
The pressure exerted by air on the surface of the Earth.

👉 Value:
$1.013 \times 10^5 \, Pa$

🔹 Fortin's Barometer
It is an instrument used to measure atmospheric pressure.

👉 Working:
Based on mercury column height
Higher mercury → higher pressure

🔹 Gauge Pressure and Absolute Pressure
Gauge pressure → pressure above atmospheric
Absolute pressure → total pressure
$\text{Absolute pressure} = \text{Atmospheric pressure} + \text{Gauge pressure}$

🔹 ***Pascal's Law (Concept)***
It states that pressure applied to a fluid is transmitted equally in all directions.

👉 Example:
Hydraulic lift
Hydraulic brakes

🔹 ***Bernoulli's Theorem (Concept)***
It states that as velocity of fluid increases, pressure decreases.

👉 Examples:
Airplane wings (lift force)
Spray bottles
Fast-moving air reduces pressure

🔹 Compressibility of Fluids
It refers to the ability of a fluid to change its volume under pressure.

Gases → highly compressible
Liquids → slightly compressible

🔹 Engineering Applications
Hydraulic machines
Compressors
Pumps
Aircraft design

🔴 ***4.3 SURFACE TENSION***

🔹 Concept of Surface Tension
Surface tension is the property of a liquid due to which its surface behaves like a stretched elastic membrane.

🔍 Explanation
Molecules inside liquid are equally attracted in all directions, but molecules at the surface experience inward force, making the surface tight.

🔹 Units
SI unit → N/m

🔹 Examples
Water droplets are spherical
Needle floats on water
Insects walk on water

🔹 Applications
Detergents reduce surface tension (cleaning)
Capillary action (plants absorb water)
Ink flow in pens

🔹 Effect of Temperature

Increasing temperature → decreases surface tension

🔹 Effect of Impurities
Soap → decreases surface tension
Salt → increases surface tension

🔴 ***4.4 VISCOSITY***

🔹 What is Viscosity?

Viscosity is the property of a fluid that resists the flow of layers.

👉 It is internal friction of fluid.

🔍 Examples
Honey flows slowly → high viscosity
Water flows easily → low viscosity

🔹 Coefficient of Viscosity
It measures how much a fluid resists flow.

🔹 Stoke's Law
F = 6\pi \eta r v

🔍 Explanation

It gives viscous force acting on a spherical body moving in fluid.

🔹 Terminal Velocity

When gravitational force = viscous force, object falls with constant velocity.

💡 Example

Raindrops fall with constant speed

Small particles settle slowly in liquid

🔹 Effect of Temperature
Liquids → viscosity decreases with temperature
Gases → viscosity increases with temperature

🔹 ***Applications of Viscosity***

1. Lubrication in machines
2. Blood flow in human body
3. Oil selection in engines
4. Paint and ink flow

🌟 UNIT – V: HEAT AND TEMPERATURE

🔴 *5.1 Difference Between Heat and Temperature*

🔹 Heat
Heat is a form of energy that flows from a hotter body to a colder body due to temperature difference.

👉 It is not stored, it is always in transfer.

🔍 Concept
Heat depends on mass and temperature
Measured in Joule (J) or calorie
👉 Example: If you touch a hot cup of tea, heat flows from the tea to your hand.

🔹 Temperature (Detailed Explanation)
Temperature is a measure of the degree of hotness or coldness of a body.
👉 It tells how hot or cold an object is, but not how much heat it contains.

🔍 Concept
Independent of mass
Measured in Kelvin (K), Celsius (°C), Fahrenheit (°F)

👉 Example: A small cup of boiling water and a large bucket of warm water may have different heat content but same temperature.

🔹 Key Differences

Heat	Temperature
Form of energy	Measure of hotness
Depends on mass	Independent of mass
Unit: Joule	Unit: °C, K

🔹 Measurement of Temperature

Temperature is measured using a thermometer based on physical properties like:
Expansion of liquids
Change in resistance
Thermoelectric effect

🔹 Temperature Scales

1. Celsius Scale
Freezing point = 0°C
Boiling point = 100°C

2. Fahrenheit Scale
Freezing = 32°F
Boiling = 212°F

3. Kelvin Scale (SI Unit)
Absolute zero = 0 K

🔹 Relation Between Scales
$$\frac{C}{100} = \frac{F-32}{180} = \frac{K-273}{100}$$

💡 Example
Convert 25°C to Kelvin:
K = 25 + 273 = 298K

🔴 *5.2 EXPANSION OF MATTER*

When temperature increases, substances expand.

🔹 Expansion of Solids

(a) Linear Expansion
$$\Delta L = \alpha L \Delta T$$
👉 α = coefficient of linear expansion

💡 Example
Railway tracks have gaps to allow expansion.

🔹 Surface Expansion
$$\Delta A = \beta A \Delta T$$

🔹 Cubical Expansion
$$\Delta V = \gamma V \Delta T$$

🔹 Relation Between Coefficients
$$\beta = 2\alpha, \quad \gamma = 3\alpha$$

🔹 Expansion of Liquids
Liquids expand more than solids.
👉 Example: Water expands when heated.

🔹 Expansion of Gases
Gases expand the most.
👉 Example: Air in balloon expands on heating.

🔴 *5.3 MODES OF HEAT TRANSFER*

🔹 (a) Conduction

Heat transfer through direct contact without movement of particles.
👉 Example: Metal rod heated at one end becomes hot at other end.

🔹 (b) Convection
Heat transfer by movement of fluid.
👉 Example: Boiling water forms convection currents.

🔹 (c) Radiation
Heat transfer without medium.
👉 Example: Heat from Sun reaches Earth.

🔹 ***Coefficient of Thermal Conductivity***

It measures how well a material conducts heat.
👉 Metals → high conductivity
👉 Wood → low conductivity

🔹 Engineering Applications
Conduction → cooking utensils
Convection → air conditioning
Radiation → solar heaters

🌟 UNIT – VI: WAVES AND OSCILLATIONS

🔴 ***6.1 SIMPLE HARMONIC MOTION (S.H.M.)***

🔹 **Definition of S.H.M.**

Simple Harmonic Motion (SHM) is a special type of oscillatory motion in which a particle moves to and fro about a mean (equilibrium) position such that the restoring force is directly proportional to the displacement and always acts towards the mean position.
In simpler terms, whenever a body is displaced from its central position, a force tries to bring it back, and this results in repeated motion.

Mathematical Condition of SHM

$F \propto -x$

The negative sign indicates that the force is always opposite to displacement.

🔹 Expression for Displacement

$x = A \sin(\omega t)$

Explanation
→ displacement
→ amplitude (maximum displacement)
→ angular frequency
→ time
This equation shows that displacement varies sinusoidally with time.

💡 Example
A simple pendulum moving back and forth shows SHM for small angles.

🔹 Velocity in SHM

$v = \omega A \cos(\omega t)$

🔍 Understanding
Velocity is maximum at mean position
Velocity becomes zero at extreme positions

💡 Example
At the center of swing, pendulum moves fastest.

🔹 Acceleration in SHM

$a = -\omega^2 x$

🔍 Explanation
Acceleration is always directed towards mean position
Maximum at extreme positions

Zero at mean position

💡 Example
When pendulum is at extreme point, acceleration is maximum.

🔹 Time Period of SHM
$T = \frac{2\pi}{\omega}$

🔍 Meaning
Time taken to complete one full oscillation.

🔹 Frequency
$f = \frac{1}{T}$

🔍 Meaning
Number of oscillations per second.

🔹 Energy in SHM

Total energy remains constant and is sum of:
Kinetic Energy
Potential Energy

At mean position → KE maximum, PE minimum
At extreme position → PE maximum, KE zero

💡 Example
In a spring system, energy continuously converts between KE and PE.

🔹 Time Period of Simple Pendulum
$T = 2\pi \sqrt{\frac{l}{g}}$

🔍 Explanation
Depends on length of pendulum
Independent of mass

💡 Example
Longer pendulum takes more time to oscillate.

🔹 SHM Waves
In SHM, motion can be represented as waves where displacement varies sinusoidally.

🔴 ***6.2 WAVES AND SOUND***

🔹 Transverse Waves
In transverse waves, particles vibrate perpendicular to direction of wave propagation.

💡 Examples

Waves on string
Light waves

🔍 Explanation
These waves have crests and troughs.

🔹 Longitudinal Waves
In longitudinal waves, particles vibrate parallel to direction of motion.

💡 Examples
Sound waves
Compression and rarefaction

🔹 Sound Waves
Sound waves are longitudinal waves produced by vibrating objects.

🔍 Properties of Sound

(a) Frequency
Number of vibrations per second.

👉 Unit: Hertz (Hz)
👉 High frequency → high pitch sound

(b) Wavelength
Distance between two consecutive compressions.

(c) Amplitude
Maximum displacement of particles.
👉 Determines loudness of sound

(d) Speed of Sound
v = f\lambda

💡 Examples
Speed of sound in air ≈ 343 m/s
Sound travels faster in solids than gases

🔴 ***6.3 ACOUSTICS OF BUILDINGS***

🔹 Reverberation
Reverberation is the persistence of sound in a hall even after the source stops.

🔍 Explanation
Sound reflects multiple times from walls, causing prolongation.

🔹 Reverberation Time
Time taken for sound intensity to reduce to one-millionth.

💡 Example
Large empty hall has long reverberation time.

🔹 Echo
Echo is repetition of sound due to reflection.

💡 Example
Shouting near mountains produces echo.

🔹 Coefficient of Absorption
It measures how much sound is absorbed by material.

🔹 Control of Reverberation
Methods:
Use curtains
Use carpets
Acoustic panels

🔹 Applications
Auditoriums
Classrooms
Cinema halls

6.4 ULTRASONIC WAVES

🔹 Definition
Ultrasonic waves are sound waves with frequency greater than 20,000 Hz.

🔹 Properties
Cannot be heard by humans
Travel in straight line
Highly energetic

🔹 Engineering Applications

Detect cracks in metals
SONAR (depth measurement)
Cleaning delicate parts

🔹 ***Medical Applications***

Ultrasound imaging
Detect internal body problems
Breaking kidney stones

💡 Example
Doctors use ultrasound to see baby inside womb.