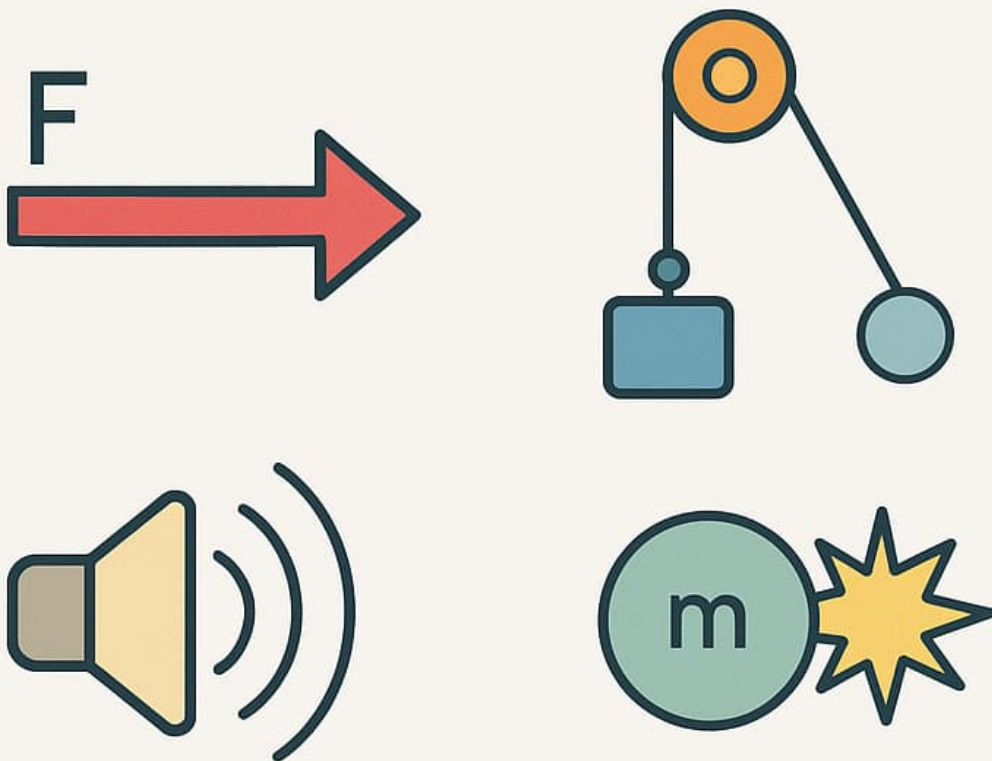


PHYSICS

CLASS 9 NOTES

Based on NCERT 2025-26

- Comprehensive notes
- Easy to understand language



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CONTENTS

Chapter 01
NCERT Chapter 07
Page No. 2-5

Motion

Chapter 02
NCERT Chapter 08
Page No. 6-9

Force And Laws Of Motion

Chapter 03
NCERT Chapter 09
Page No. 10-15

Gravitation

Chapter 04
NCERT Chapter 10
Page No. 16-19

Work And Energy

Chapter 05
NCERT Chapter 11
Page No. 20-24

Sound

Ch 07 – MOTION

- ⇒ **Motion:** A body is said to be in motion when it changes its position with respect to time.
- ⇒ **Rest:** A body is said to be in rest when it does not change its position with respect to time.
- ⇒ **Relative Nature of Motion:** The relative nature of motion means that motion is always observed with respect to a reference point. An object may appear to be in motion from one point of view but at rest from another.
- ⇒ **Reference Point:** A reference point is a fixed place or object used to determine the position or motion of another object. It acts as a starting point for measuring distances and directions.
- ⇒ **Types of Motion:**
- Translatory Motion – When an object moves in a straight or curved path.
 - Example: A car moving on a road.
 - Rotational Motion – When an object spins around a fixed axis.
 - Example: A spinning top or a rotating fan.
 - Oscillatory Motion – When an object moves back and forth around a fixed point.
 - Example: A pendulum swinging.
 - Periodic Motion – Motion that repeats itself at regular intervals.
 - Example: Motion of a clock's hands or planets around the sun.
 - Random Motion – Irregular or unpredictable movement.
 - Example: Movement of dust particles in air.
 - Linear Motion – Straight-line motion.
 - Example: Train moving on a straight track.
 - Circular Motion – Motion in a circular path.
 - Example: A satellite orbiting Earth.
- ⇒ **Physical Quantity:** A physical quantity is a property of an object that can be measured and expressed with a number and a unit. Example: Length, mass, time, temperature.
- Vector and scalar are two types of physical quantities:
- **Scalar Quantity:** A physical quantity that has only magnitude and no direction.
 - Examples: Mass, time, speed, temperature.
 - **Vector Quantity:** A physical quantity that has both magnitude and direction.
 - Examples: Displacement, velocity, force, acceleration.
- ⇒ **Distance:** Distance is the total length of the path traveled by an object. It is a scalar quantity and always positive.
Example: If you walk 3 km north and then 3 km south, your distance is 6 km.
- ⇒ **Displacement:** Displacement is the shortest straight-line distance from the initial position to the final position of an object. It is a vector quantity and can be positive, negative, or zero.
Example: If you walk 3 km north and then 3 km south, your displacement is 0 km because you end up where you started.
- ⇒ **Difference Between Distance and Displacement**

Distance	Displacement
The total path covered by an object.	The shortest straight-line path between two points.
Scalar quantity (only magnitude).	Vector quantity (magnitude and direction).

Always positive.	Can be positive, negative, or zero.
Depends on the path taken.	Depends only on the initial and final positions.

⇒ **Uniform Motion:** An object is said to be in uniform motion if it covers equal distances in equal intervals of time. Example: A car moving at a constant speed.

⇒ **Non-uniform Motion:** An object is said to be in non-uniform motion if it covers unequal distances in equal intervals of time. Example: A car slowing down or speeding up in traffic.

⇒ **Speed:** The distance travelled by an object in unit time is called speed. It is a scalar quantity.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

SI Unit: meter per second (m/s) or (m s⁻¹)

Other Units: centimetre per second (cm s⁻¹) and kilometre per hour (km h⁻¹)

⇒ **Average Speed:** Average speed is the total distance travelled divided by the total time taken.

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

SI Unit: meter per second (m/s) or (m s⁻¹)

⇒ **Velocity:** Velocity is the speed of an object moving in a definite direction. Velocity is also defined as the rate of change of displacement. It is a vector quantity.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

SI Unit: meter per second (m/s) or (m s⁻¹)

The velocity of an object can be uniform or variable. It can be changed by changing the object's speed, direction of motion or both.

⇒ **Average velocity:** For non-uniform motion of object Average velocity is the total displacement divided by the total time taken.

$$\text{Average Velocity} = \frac{\text{Total Displacement}}{\text{Total Time}}$$

SI Unit: meter per second (m/s)

For uniform motion of object, average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time.

$$\text{Average Velocity} = \frac{\text{Initial Velocity} + \text{Final Velocity}}{2}$$

Mathematically, $v_{av} = \frac{u+v}{2}$

where v_{av} is the average velocity, u is the initial velocity and v is the final velocity of the object.

⇒ Speed and velocity have the same units, that is, m s⁻¹ or m/s.

Speed	Velocity
Speed is the distance travelled by an object per unit time.	Velocity is the displacement of an object per unit time.
It is a scalar quantity (has only magnitude).	It is a vector quantity (has both magnitude and direction).
Speed does not depend on direction.	Velocity depends on direction.
Speed is always positive.	Velocity can be positive, negative, or zero.

⇒ **Acceleration:** The rate of change of velocity is called acceleration. That is,

$$\text{Acceleration}(a) = \frac{\text{final velocity}(v) - \text{initial velocity}(u)}{\text{time taken}(t)}$$

$$a = \frac{v - u}{t}$$

This kind of motion is known as **accelerated motion**. The SI unit of acceleration is $m\ s^{-2}$.

- ⇒ **Uniform Acceleration:** An object has uniform acceleration if its velocity increases or decreases by equal amounts in equal intervals of time. Example: A freely falling object under gravity (ignoring air resistance) accelerates uniformly at $9.8\ m/s^2$.
- ⇒ **Non-Uniform Acceleration:** An object has non-uniform acceleration if its velocity changes by unequal amounts in equal intervals of time. Example: A car moving through traffic, speeding up and slowing down irregularly.

⇒ **Distance-Time Graphs:** The change in the position of an object with time can be represented on the distance-time graph. In this graph, time is taken along the x-axis and distance is taken along the y-axis.

Key Features:

- Straight Line (Sloped): Indicates uniform speed (steeper the line, higher the speed)
- Curved Line: Indicates non-uniform speed (acceleration or deceleration)
- Horizontal Line (Flat): Indicates the object is at rest (no change in distance over time)

⇒ **Velocity-Time Graphs:** The variation in velocity with time for an object

moving in a straight line can be represented by a velocity-time graph. In this graph, time is represented along the x-axis and the velocity is represented along the y-axis.

Key Features:

- Horizontal Line: The object is moving with uniform velocity. (zero acceleration)
- Curved Line: Indicates non-uniform acceleration
- Sloped Straight Line: Indicates uniform acceleration (Upward slope) or deceleration (Downward slope)

⇒ The area enclosed by velocity-time graph and the time axis is equal to the magnitude of the displacement.

⇒ **Equations of Motion:** The equations of motion are a set of three mathematical formulas that describe the relationship between velocity, acceleration, time, and displacement of an object moving with uniform acceleration.

$$v = u + at \quad \text{velocity-time relation}$$

$$s = ut + \frac{1}{2}at^2 \quad \text{position-time relation}$$

$$2as = v^2 - u^2 \quad \text{position-velocity relation}$$

where u is the initial velocity of the object which moves with uniform acceleration a for time t , v is the final velocity, and s is the distance travelled by the object in time t .

⇒ **Uniform Circular Motion:** Uniform Circular Motion is the motion of an object moving in a circular path at a constant speed.

The circumference of a circle of radius r is given by $2\pi r$. If the athlete takes t seconds to go once around the circular path of radius r , the speed v is given by

$$v = \frac{2\pi r}{t}$$

Although the object's speed remains constant, its velocity is continuously changing because the direction of motion is constantly changing as the object moves around the circle. This results in an acceleration, called **centripetal acceleration**, which always points towards the center of the circular path.

Examples of Uniform Circular Motion:

- A car turning around a circular track at constant speed
- A satellite orbiting the Earth
- A stone tied to a string and swung in a circle
- Earth's revolution around the Sun
- A ceiling fan rotating at a constant speed

Ch 08 – FORCE AND LAWS OF MOTION

⇒ Force:

- Definition: A force is a push, pull, or hit that causes a change in an object's motion.
- Nature of Force: Cannot be seen or touched directly but is understood through its effects on objects.
- Forces are needed to start, stop, or alter the motion of an object.

⇒ Effects of Force:

- Change the magnitude of velocity (speed up or slow down an object).
- Change the direction of motion.
- Change the shape or size of an object.

Balanced and Unbalanced Forces

⇒ **Balanced Forces:** Two or more forces acting on an object that are equal in magnitude and opposite in direction, resulting in no change in the object's state of motion (no movement or constant velocity).

⇒ **Unbalanced Forces:** Forces that are not equal and opposite, causing a change in the object's motion (acceleration or change in direction).

⇒ **Friction:** A force that opposes motion, acting between two surfaces in contact.

⇒ Key Concepts:

- When equal forces pull a block from opposite sides, the forces are balanced, and the block remains at rest.
- When forces of different magnitudes act on an object from opposite sides, the greater force dominates, resulting in unbalanced forces that move the object in the direction of the stronger force.
- Friction acts against the applied force and can prevent motion if it balances the applied force.
- An object starts moving only when the applied force exceeds friction, creating an unbalanced force.
- In everyday examples like riding a bicycle, friction slows the motion when no force is applied.

⇒ Motion under forces:

- When forces are balanced, an object moves with uniform velocity (constant speed and direction).
- When an unbalanced force acts, the object accelerates (changes speed or direction).
- If the unbalanced force stops, the object continues moving at the velocity it had when the force was removed.

First Law of Motion

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

- "An object remains at rest or in uniform motion in a straight line unless acted upon by an external unbalanced force."
- This means objects resist any change in their motion due to a property called inertia.

⇒ **Inertia:**

The inherent property of objects to resist changes in their state of rest or uniform motion.

⇒ **Concepts from Practical Examples:**

- When a force rapidly removes support from underneath stacked objects (like coins), the objects above tend to remain at rest and fall vertically due to inertia.
- When a card beneath a stationary coin is quickly pulled away, the coin stays momentarily at rest and drops straight down because of inertia resisting sudden motion.
- When a container filled with water is rapidly rotated, the water tends to spill because inertia resists the sudden change in motion, causing the liquid to move differently from the container.

⇒ **Everyday Examples Explaining Inertia:**

- Passengers in a moving vehicle lurch forward when brakes are applied suddenly, as their bodies resist the change in motion.
- When a vehicle starts suddenly, passengers may fall backward because their bodies tend to remain at rest.
- Sharp turns cause passengers to slip sideways due to their bodies resisting the change in direction.

Inertia and Mass

⇒ **Inertia:** The natural tendency of an object to resist any change in its state of rest or uniform motion.

⇒ **Mass:** Mass is the quantitative measure of an object's inertia.

⇒ **Key Concepts:**

- All objects exhibit inertia, meaning they resist changes to their motion.
- Different objects have different amounts of inertia.
- Heavier or more massive objects have greater inertia and are harder to start or stop moving.
- For example, it is easier to push an empty box than a full box because the full box has more mass and hence more inertia.
- Similarly, a train has more inertia than a small cart, so the same force causes a much smaller change in the train's motion.
- Mass directly measures how much inertia an object has.

Newton's Second Law of Motion

⇒ Newton's Second Law of Motion states:

- *"The rate of change of momentum of an object is directly proportional to the applied unbalanced force and takes place in the direction of that force."*

Mathematically:

$$F = ma$$

Where:

F = force (in newtons, N)

m = mass (in kg)

a = acceleration (in m/s^2)