

Topic: Motion in Nature, Force, Circular Motion, Centripetal and Centrifugal Forces

Subject: Physics

Class: SS1

Term: First Term

Duration: 2–3 Periods

Sub-themes: Mechanics, Motion, and Forces

1. MOTION IN NATURE

◆ Definition of Motion

Motion is the **change in position** of a body **with respect to time**.

◆ Types of Motion in Nature

1. **Linear Motion:** Motion along a straight path (e.g., a car on a straight road).
2. **Rotational Motion:** An object turns about an axis (e.g., a spinning top, Earth's rotation).
3. **Oscillatory (Vibratory) Motion:** Back-and-forth motion (e.g., pendulum, tuning fork).
4. **Random Motion:** Motion with no definite path (e.g., gas particles).
5. **Circular Motion:** Movement in a circular path (e.g., satellite orbiting Earth).

◆ Examples of Motion in Nature

- **Earth's Rotation and Revolution**
- **Orbit of the Moon around the Earth**
- **Tides due to gravitational motion**
- **Migration patterns of animals**
- **Water flow, wind movement, falling of fruits**

2. FORCE

◆ Definition of Force

Force is a **push or pull** that changes or tends to change the **state of rest or motion** of a body.

- **SI Unit:** Newton (N)
- **Symbol:** FFF

1 Newton is the force that gives a mass of 1 kg an acceleration of 1 m/s^2 :

$$F = ma$$

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◆ Types of Force

1. **Contact Forces:** Friction, tension, normal reaction.
2. **Non-Contact Forces:** Gravitational force, magnetic force, electrostatic force.
3. **Muscular Force:** Force from human or animal muscles.
4. **Frictional Force:** Opposes motion between two surfaces in contact.
5. **Elastic Force:** Restorative force from stretched/compressed materials (e.g., spring).

◆ Effects of Force

- Can move a stationary object.
- Can stop a moving object.
- Can change the speed or direction of motion.
- Can change the shape of an object.

3. CIRCULAR MOTION

◆ Definition

Circular motion is the motion of a body moving **along a circular path** with constant **speed** but changing **direction**.

- Even though speed is constant, **velocity changes** due to direction change.
- Since velocity changes, there is **acceleration** (called **centripetal acceleration**).

◆ Examples in Nature

- Earth's revolution around the Sun.
- A satellite orbiting Earth.
- A stone tied to a string and whirled.
- Water in a bucket spun in a vertical circle.

4. CENTRIPETAL FORCE

◆ Definition

Centripetal force is the **force directed towards the center** of a circular path that keeps an object moving in a circle.

- Without this force, the object would move in a straight line due to inertia.

◆ Formula

$$F_c = \frac{mv^2}{r}$$

Where:

- F_c = Centripetal force (N)
- m = mass (kg)
- v = velocity (m/s)
- r = radius of the circular path (m)

◆ Examples of Centripetal Force

- Tension in string (stone tied to string).
- Gravitational force (planet orbiting the sun).
- Friction (car turning on a road).
- Normal reaction (roller coaster loops).

5. CENTRIFUGAL FORCE

◆ Definition

Centrifugal force is the **apparent force** that acts **outward** on a body moving in a circular path, felt by the object in its rotating frame of reference.

It is a **reaction** to centripetal force, not a real force in Newtonian mechanics (fictitious force).

◆ Examples

- Clothes pressed against the wall of a spinning washing machine.
- Passengers being pushed outward when a car turns a sharp bend.
- Mud flying off a spinning tire.

◆ Differences between Centripetal and Centrifugal Force

Centripetal Force

Directed **towards** the center

Keeps object in **circular motion**

Real force

Example: tension in string

Centrifugal Force

Acts **away** from the center

Tends to make object **fly outward**

Apparent or **fictitious** force

Example: feeling thrown outward in a turning car