

INERTIA .

- It is an inherent property of all the bodies by virtue of which they cannot change their state of rest or uniform motion along a straight line on their own. Quantitatively, inertia of a body is measured by its mass. Thus heavier the body greater is its inertia.

Types of Inertia

Inertia of a body is of three types :

- Inertia of rest

- Inertia of motion

- Inertia of direction

- Inertia of rest : It is the inability of a body to change its state of rest by itself. e.g. a person standing in a stationary bus falls backward when the bus suddenly starts moving.
- Inertia of motion : It is the inability of a body to change its state of uniform motion by itself. e.g. a person getting down a moving bus or train falls forward.
- Inertia of direction : It is the inability of a body to change its direction of motion by itself. e.g. when a car suddenly takes a turn, the person sitting inside is thrown in the outward direction.

NEWTON S LAWS OF MOTION

Newton's First Law of Motion

- According to Newton's first law, every body continues to be in its state of rest or of uniform motion in a straight line, unless it is compelled by some external force to act otherwise.
- Newton's first law of motion can be expressed as : If the net external force on a body is zero, its acceleration is zero. Acceleration can be non zero only if there is a net external force on the body.
- Newton's first law is also known as law of inertia.
- Momentum : Momentum of a body (P) is defined as the product of its mass (m) and velocity (F) .
i.e. $p = mv$

The direction of momentum is same as that of the velocity

- Momentum is a vector quantity. Its SI unit is kg ms^{-1} . Its dimensional formula is $[ML^2T^{-1}]$,

Newton's Second Law of Motion

- According to Newton's second law of motion, the rate of change of momentum is directly proportional to the applied force and takes place in the direction in which force acts.

$$F = k \frac{dp}{dt} = km\ddot{a}, \text{ if } m \text{ is a constant.}$$

where F is the net external force on the body and \ddot{a} its acceleration. In both SI and CGS systems constant of proportionality $k = 1$.

- Newton's second law of motion gives us a measure for force.
- Newton's second law is consistent with the first law ($F = 0$ implies $\ddot{a} = 0$).

- Newton's second law of motion is applicable to a particle, and also to a body or a system of particles provided F is the total external force on the system and \ddot{a} is the acceleration of system as a whole.
- Units of force : The units of force are of two types o Absolute unit o Gravitational unit
- Absolute unit : In SI system the absolute unit of force is newton. It is denoted by symbol N.
 $1 \text{ N} = 1 \text{ kg ms}^{-2}$
In CGS system the absolute unit of force is dyne.
 $1 \text{ dyne} = 1 \text{ g cms}^{-2}$
- Relationship between newton and dyne
 $1 \text{ N} = 10^5 \text{ dyne}$
- Gravitational unit : In SI system, the gravitational unit of force is kilogram weight (kg wt) or kilogram force (kg f).
 $1 \text{ kg wt or } 1 \text{ kg f} = 9.8 \text{ N}$.
In CGS system, the gravitational unit of force is gram weight (g wt) or gram force (g f).
 $1 \text{ g wt or } 1 \text{ g f} = 980 \text{ dyne}$
- The gravitational unit of force is used to express the weight of a body. e.g. weight of a body of a mass 2 kg is 2 kg for 2 kg wt.
- Force is a vector quantity. Its dimensional formula is $[MLT^{-2}]$.
- The straight line along which a force is directed is called line of action of force.

Newton's Third Law of Motion

- According to Newton's third law of motion, to every action, there is an equal and opposite reaction.
- Newton's third law of motion can be stated as : Forces in nature always occur between pairs of bodies. Force on a body A by body B is equal and opposite to the force on the body B by body A.

e Action and reaction forces are simultaneous forces. There is no cause-effect relation between action and reaction. Any of the two mutual forces can be called action and the other . reaction. Action and reaction act on different bodies and so . they cannot be cancelled out.

