# 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 ofa 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 ofmotion 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

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# 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 = nn3

  The direction of momentum is same as that of the velocity

• Momentum is a vector quantity. Its SI unit is kg ms-I . Its dimensional formula is [ML?[l] ],

# Newton s Second Law of Motion

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According to Newton's second law of motion, the rate of [c]hange of momentum is directly proportional to the applied [fo]rce and takes place in the direction in which force acts.

F = k— = kmä , if m is a constant.

where F is the net external force on the body and ä its acceleration. In both SI and CGS systems constant of proportionality k = l .

- 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 ä = 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 ä 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.

  I N = I kg ms-2

  In CGS system the absolute unit of force is dyne.

  I dyne = I g cms $^{2}$
- Relationship between newton and dyne

  I N = $10^{5}$ dyne
- Gravitational unit : In SI system, the gravitational unit of force is kilogram weight (kg wt) or kilogram force (kg f).

  I kg wt or I kg f= 9.8 N.

  In CGS system, the gravitational unit of force is gram weight

  (g wt) or gram force (g f).

  I g wt or I g f = 980 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.