

### Impulse:

Large force acts on a body for short period of time is called impulse.

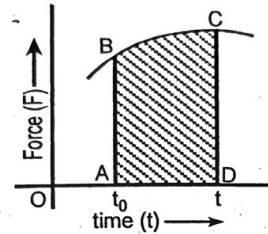
Impulse of a force is defined as the product of the average force and the time for which the force acts.

i.e.  $Impulse (I) = Average\ force (F_{av}) \times time(t)$

$$I = F_{av} \times t$$

Impulse is given by area enclosed by time-force graph:

i.e.  $Impulse = Area\ of\ ABCD$



- Example of Impulse are kicking a ball, collision of two bodies.
- Impulse gives the measurement of net effect of force.
- Impulse is mathematically equal to the change in momentum.
- Impulse is a vector quantity.
- Its SI unit is *Newton second (Ns)*.
- Its dimensional formula is  $[M^1L^1T^{-1}]$

$$\Rightarrow F = ma = m \frac{(v - u)}{t}$$

$$\Rightarrow F \times t = mv - mu$$

$\therefore Impulse = Change\ in\ Momentum$

Note:  $Force (F) = \frac{Impulse(I)}{time(t)} = \frac{Change\ in\ momentum}{time}$

$$Force (F) \propto \frac{1}{time}$$

To change the momentum of a body, if we increase the time of action, less force is required. Hence, as a result it is likely to be less hurt.

### Applications of Impulse:

- While catching a ball, a cricket player lowers his hand to increase the time of impact. As  $F \propto \frac{1}{dt}$ , greater the time of impact ( $dt$ ), smaller is the force and vice-versa. However, the change in momentum or impulse is same in both cases.
- A person falling on a cemented floor from a certain height gets more injury than when he is falling on sand because on the cemented floor the time of impact will be less and greater force acts on him.
- China wares, glass wares etc. are wrapped in a paper or straw before packing to increase the time of jerks during transportation. This decreases the possibility of action of greater force and subsequent damage to them.

**Newton's Laws of Motion: (The force used in Newton's laws of motion is the external force)**

### Newton's First Law of motion [Law of Inertia]

Statement: "Everybody continues in its state of rest or uniform motion in a straight line unless it is acted on by an external resultant force to change that state"

- The first law gives the definition of force. Force is an external agency that changes or tends to change the state of rest or the state of the motion of the body.
- The first law gives the qualitative definition of force. (Significance of first law)
- The first law is also called the law of Inertia.
- According to this law, every object has a tendency to preserve its state of rest or uniform motion unless acted by an unbalanced external force. This tendency of the body is called inertia. Thus, the First law of motion is sometimes called as law of inertia.
- Inertia is an inherent characteristic of a material due to which it is unable to change its state.