Impulse.

(1) When a large force works on a body for very small time interval, it is called impulsive force.

An impulsive force does not remain constant, but changes first from zero to maximum and then from maximum to zero. In such case we measure the total effect of force.

(2) Impulse of a force is a measure of total effect of force.

(3) $\vec{I} = \int_{t_1}^{t_2} \vec{F}\, dt$.

(4) Impulse is a vector quantity and its direction is same as that of force.

(5) Dimension: [MLT^{-1}]

(6) Units: Newton-second or Kg-m-s^{-1} (S.I.) and Dyne-second or gm-cm-s^{-1} (C.G.S.)

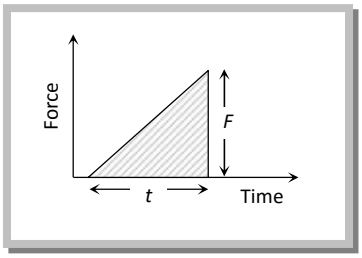
(7) Force-time graph: Impulse is equal to the area under F-t curve.

If we plot a graph between force and time, the area under the curve and time axis gives the value of impulse.

$I =$ Area between curve and time axis

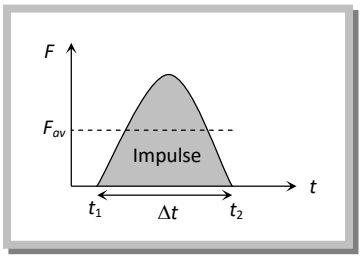
$= \frac{1}{2} \times$ Base $\times$ Height

$= \frac{1}{2} F\, t$



(8) If F_{av} is the average magnitude of the force then

$$I = \int_{t_1}^{t_2} F\, dt = F_{av} \int_{t_1}^{t_2} dt = F_{av} \Delta t$$



(9) From Newton's second law $\vec{F} = \frac{d\vec{p}}{dt}$

or $\int_{t_1}^{t_2} \vec{F}\, dt = \int_{p_1}^{p_2} d\vec{p} \Rightarrow \vec{I} = \vec{p}_2 - \vec{p}_1 = \overrightarrow{\Delta p}$

i.e. The impulse of a force is equal to the change in momentum.

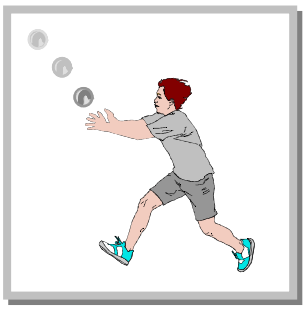
This statement is known as Impulse momentum theorem.

(10) Examples: Hitting, kicking, catching, jumping, diving, collision etc.

In all these cases an impulse acts. $I = \int F\, dt = F_{av} . \Delta t = \Delta p =$ constant

So if time of contact Δt is increased, average force is decreased (or diluted) and vice-versa.

(i) In hitting or kicking a ball we decrease the time of contact so that large force acts on the ball producing greater acceleration.



(ii) In catching a ball a player by drawing his hands backwards increases the time of contact and so, lesser force acts on his hands and his hands are saved from getting hurt.

(iii) In jumping on sand (or water) the time of contact is increased due to yielding of sand or water so force is decreased and we are not injured. However if we jump on cemented floor the motion stops in a very short interval of time resulting in a large force due to which we are seriously injured.

(iv) An athlete is advised to come to stop slowly after finishing a fast race. So that time of stop increases and hence force experienced by him decreases.

(v) China wares are wrapped in straw or paper before packing.