P-1

Tension = 10 N

$10\,N \longleftrightarrow 10\,N$

$\boxed{v = \frac{d}{t}} \rightarrow \boxed{d = vt}$

$10\,N \longleftrightarrow 15\,N$

$\longrightarrow 5\,N$

$\boxed{F = ma}$

$\Rightarrow a = \frac{F}{m} = \frac{5}{2} = 2.5\,m/s^2$

$\Rightarrow a = \frac{F}{m} = \frac{0}{100} = 0$

Momentum = Mass x velocity

$\boxed{P = mv}$ dimensional formula = $[MLT^{-1}]$

S.I. Unit of momentum = $kg\,ms^{-1}$ (kilogram meter per second).

It is a vector quantity.

Impulse = force x time

$= [MLT^{-2}] \times [T]$

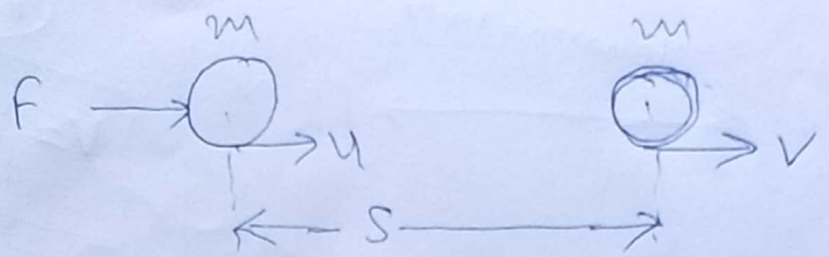
$= [MLT^{-1}]$

S.I. Unit is Ns (Newton second)

It is vector quantity

P-2

$$\boxed{a = \frac{v-u}{t}}$$



S = Displacement covered

t = time taken.

Initial momentum = mu

Final " " = mV

Change of momentum = $mV - mu$

Rate of change of momentum = $\frac{mV - mu}{t}$

According to Newton's 2nd Law of motion.

Rate of change of momentum $\propto$ Applied force

$$\Rightarrow \frac{mV - mu}{t} \propto F$$

$$\Rightarrow \frac{mV - mu}{t} = KF$$

$$\Rightarrow m\left(\frac{V-u}{t}\right) = KF$$

$$\Rightarrow ma = KF$$

$V = u + at$

$\Rightarrow at = V - u$

$\Rightarrow a = \left(\frac{V-u}{t}\right)$

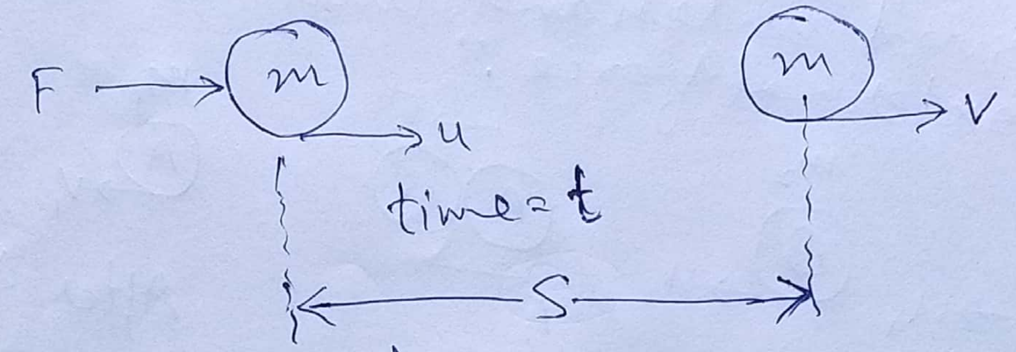
$N = kg\,m/s^2$

If $m = 1kg$, ~~a = 1~~ $F = 1N$ then $a = 1m/s^2$

So, $K = 1$

$$\Rightarrow \boxed{ma = F}$$

Proof of impulse equal to change of momentum



Initial velocity = u
Final velocity = v
Mass of the body = m
Initial momentum = mu
Final " = mv
Change of momentum = mv − mu
Rate of change of momentum = $\frac{mv - mu}{t}$
If Applied force = F
So, from Newton's 2nd Law of motion

Rate of change of momentum = Applied force

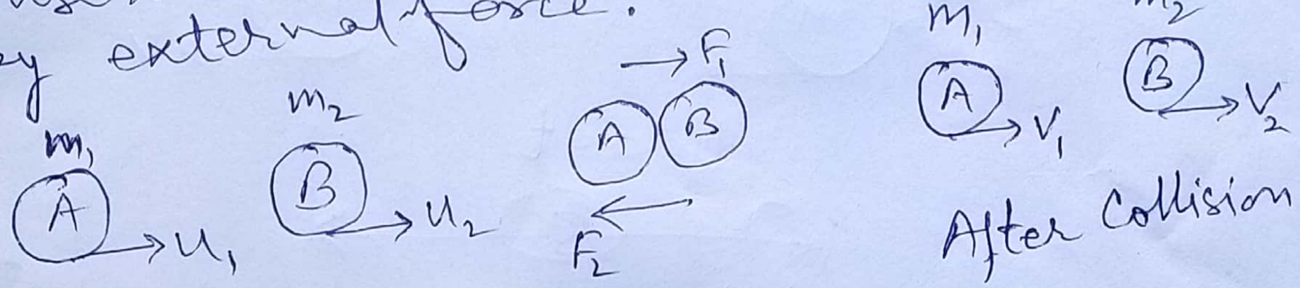
$$\Rightarrow \frac{mv - mu}{t} = F$$

$$\Rightarrow (mv - mu) = Ft$$

$\Rightarrow$ $\boxed{\text{Change of momentum} = \text{Impulse}}$

Conservation of linear momentum

"Linear momentum of a system remains conserved unless and until acted upon by external force."



$u_1 > u_2$

Before Collision   Collision   After Collision

Initial momentum of body A $= m_1 u_1$

" " " B $= m_2 u_2$

" Total momentum before collision $= m_1 u_1 + m_2 u_2$ —— (1)

Initial momentum of body A $= m_1 u_1$

Final " " $= m_1 v_1$

Change of momentum of body A $= m_1 v_1 - m_1 u_1$

Rate of change of momentum of body A $= \dfrac{m_1 v_1 - m_1 u_1}{t}$

Similarly for body B,

Rate of change of momentum of body B $= \dfrac{m_2 v_2 - m_2 u_2}{t}$

F_1 = Force acted by 1st body on 2nd

F_2 = " " " 2nd " " 1st.

From, Newton's 3rd law of motion

$$F_1 = -F_2$$

so, $$\left(\frac{m_1 v_1 - m_1 u_1}{t}\right) = -\left(\frac{m_2 v_2 - m_2 u_2}{t}\right)$$

$$m_1 v_1 - m_1 u_1 = -m_2 v_2 + m_2 u_2$$

$$\Rightarrow m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$$

$\Rightarrow$ Total momentum before collision = Total momentum after collision

This proves the law of conservation of linear momentum