Dynamics (Newton Laws)

29 October 2020 08:43

Newton's 1st Law (law of Inertia)

If resultant force is **Zero** i.e
if forces are **balanced**
Rest → Rest.
constant velocity → constant velocity.
i.e **object maintains** its **"STATE"**

Newton's 2nd Law :-

Force is equal to "rate of change of momentum" (define force)

Momentum

- symbol p
- vector quantity (direction important
- defined as product of mass and velocity of an object
- formula $p = m \times v$ or $p = mv$
- units **kg·ms⁻¹** or
N·s $= (kgms^{-2})\cdot s = kgms^{-1}$

$F = \dfrac{\text{Change in momentum}}{\text{time}}$

$\boxed{F = \dfrac{\Delta p}{t}}$ → $\boxed{\Delta p = F \times t}$
Impulse

$F = \dfrac{p_f - p_i}{t}$

$F = \dfrac{mv - mu}{t}$

$F = m\left(\dfrac{v-u}{t}\right)$

since $\dfrac{v-u}{t} = a$

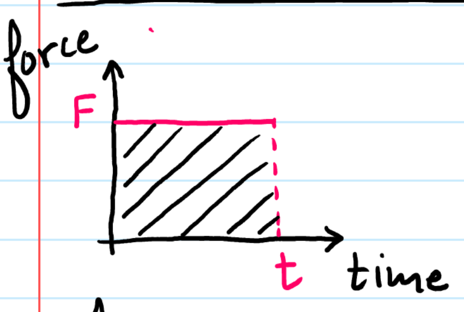
$\boxed{F = ma}$

define Impulse :-
product of force acting on an obj. and the time for which it acts

formula for Impulse

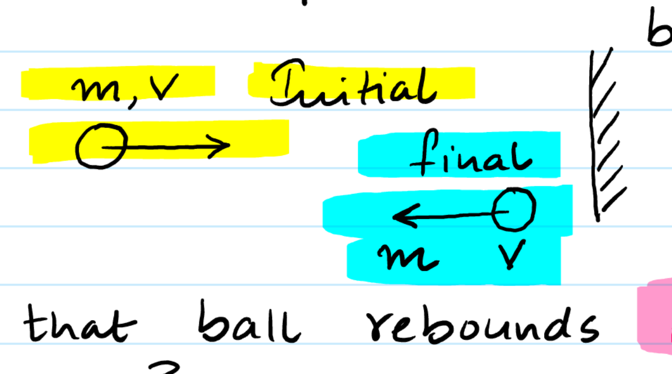
Impulse = $F \times t$
OR
Impulse = Δp
OR
Impulse = $p_f - p_i$.

units of Impulse
$F \times t$ = N·s
Δp = $kgms^{-1}$



Area under graph $F \times t$ = Impulse or Δp.

- How to calculate change in momentum Δp.



given that ball rebounds **elastically**
cal Δp ?

← +	+ →
$\Delta p = p_f - p_i$	$\Delta p = p_f - p_i$
$\Delta p = m\cdot v - m(-v)$	$\Delta p = m(-v) - m\cdot v$
$\Delta p = 2mv$	$\Delta p = -2mv$.
2mv to the left	-2mv to the right

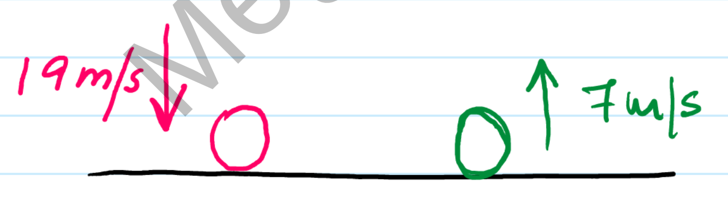
- Cal. Δp if the ball **did not rebound** at all.

← +	+ →
$\Delta p = p_f - p_i$	$\Delta p = p_f - p_i$
$\Delta p = 0 - m(-v)$	$\Delta p = 0 - mv$
$= mv$	$= -mv$

- Cal the **range of Δp** if ball rebounds **inelastically**. ?
answer should be in between the previous 2 answers i.e $mv < \Delta p < 2mv$

eg②

↓ $u = 4.3\ ms^{-1}$
$t = 1.51\ s$
to reach the ground



(i) Cal final velocity as it hits the ground +↓
$v = u + at$
$v = 4.3 + (9.81)(1.51)$
$v = 19\ m/s$

(ii) G. that it **rebounds** with speed of **7 m/s**. Cal. the Δp **during impact**. **$m = 50\,g$**.

+↑ $\Delta p = p_f - p_i$
$\Delta p = (0.05)(7) - (0.05)(-19)$ (19)

$\Delta p = 1.3\ Ns$ (one possible answer)
whereas the other alternate answer
+↓ $\Delta p = -1.3\ Ns$

(iii) time of impact is **12.5ms**. Cal. the **force** exerted on the ground during impact.

$F = \dfrac{\Delta p}{t}$

+↑ $F = \dfrac{1.3}{12.5 \times 10^{-3}} = 104\ N$ one possible answer.

otherwise
+↓ $F = -104\ N$ (second possible answer).

Q :- mass = m
momentum = p
Kinetic energy = K.E

Use formula for Kinetic Energy and momentum to prove that

$\boxed{K.E = \dfrac{p^2}{2m}}$

Ans :-