Dynamics (Newton Laws)
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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 $kg \cdot ms^{-1}$ or
  N·s $= (kgms^{-2}) \cdot s = kgms^{-1}$

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

$$\boxed{F = \frac{\Delta p}{t}} \longrightarrow \boxed{\Delta p = F \times t}$$
Impulse

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

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

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

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

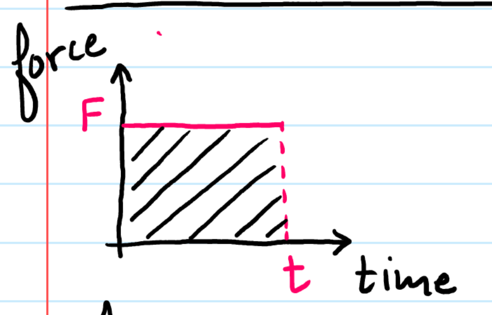
$$\boxed{F = ma}$$

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

formula for Impulse

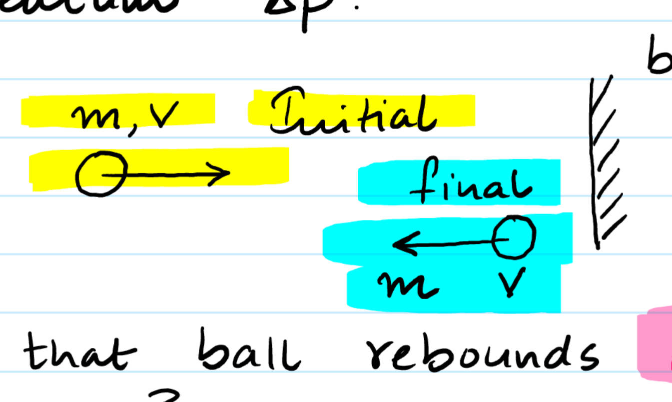
Impulse = $F \times t$
OR
Impulse = Δp
OR
Impulse = $p_f - p_i$.

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 **12.5 ms**. Cal. the **force** exerted on the ground during impact.

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

+↑ $F = \frac{1.3}{12.5 \times 10^{-3}} = 104\ N$ 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

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

Ans :-