ToppersNotes

THE IIT-JEE SECRET
PHYSICS VOLUME-I

Sierra Innovations Pvt. Ltd.

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Kinematics

In Kinematics, we study the relation b/w parameters of motion not the cause of motion.

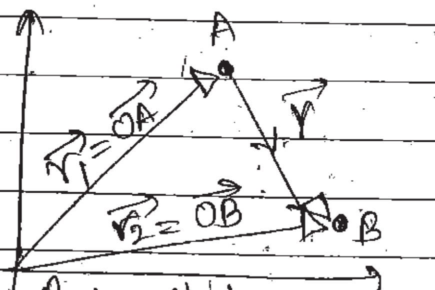
PARAMETERS

1- Position
2- Displacement
3- Distance
4- Average velocity
5- Inst. velocity
6- Avg. Speed
7- Inst. Speed
8- Acceleration

POSITION & DISPLACEMENT (vector)

→ Change in position vector is called displacement. It is directed along initial to final position.
→ Its magnitude is min. dist. b/w initial & final position
→ It is vector quantity.

~~किसी~~ Particle को exist करने के लिए Cartesian Plane जरूरी है। → Any particle requires cartesian plane for its existance



Change = Δ = final − initial

$$\boxed{\Delta\vec{r} = \vec{OB} - \vec{OA}}$$

$$\boxed{\vec{D} = \vec{AB}} \quad (\because \vec{AB} = \vec{OB} - \vec{OA})$$

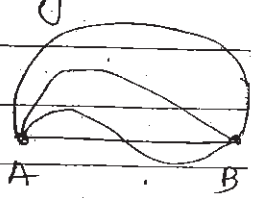
यह जरूरी नहीं होता है कि displacement वाली लाईन ही particle का path। → Its not necessary that displacement line is only the path followed by particle

DISTANCE (scalar)

→ Length of path travelled is known as distance.
→ Distance b/w two points A & B can have many values.
any value नहीं हो सकती है। Bcoz

$$\boxed{\text{Distance} \geq |\text{Displacement}|}$$

disp. से कम नहीं हो सकती है।
distance can't be less than displacement



Many paths Can be travelled

V_{avg} = average velocity
V_{avg} = average speed.

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AVERAGE & INST. VELOCITY (vector)

Average velocity is the ratio of total disp. and time taken.

$$\boxed{\vec{V}_{avg} = \frac{\vec{\Delta x}}{\Delta t} = \frac{\vec{D}}{t}}$$

Δ = Change
x = Position
Δx = disp.

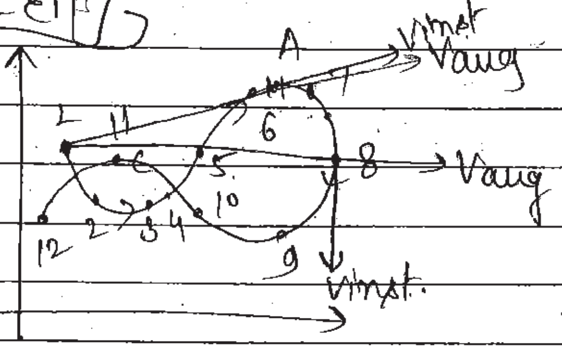
→ Velocity is not defined at a single pt. We need min. two pt. to define velocity.

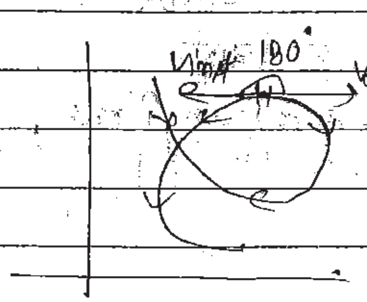
$$\boxed{V_{inst} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}}$$

distance & time interval are very small

→ ये जरूरी नहीं है कि Inst. & avg. velocity का magnitude हमेशा same हो।

Its not necessary that magnitude of ~~vagetra~~ instant and avg velocity always remain same





Vinst, and Vavg are same at pt. 'A' and Vinst and Vavg are mutually ⊥ at point '8'

But direction may be same.

→ Inst. velocity is rate of change of disp. vector w.r.t. time.

Direction of velocity will be diff. with
" " accel.

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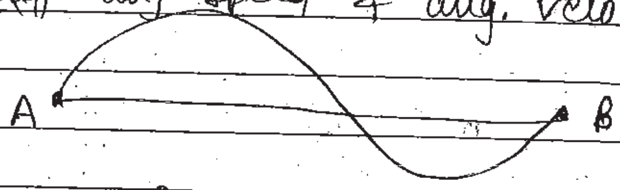
AVERAGE SPEED & INST. SPEED

Average speed is the ratio of total distance travelled & time taken.

$$\boxed{\underset{\text{(avg. speed)}}{V_{avg}} = \frac{\text{Dist}}{\text{Time}}}$$

Instantaneous speed is the magnitude of inst. velocity
But ऐसा avg. speed & avg. velocity के साथ नहीं होगा।



If the curve between A and B is divided by time, then we get avg speed, but if AB st. line is divided by time then we get avg. Velocity

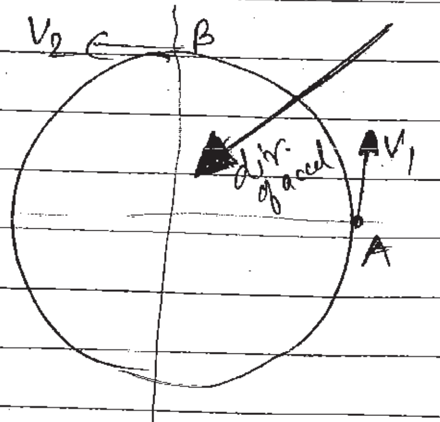
A & B के बीच के curve को time से divide करेंगे तो avg. speed मिलेगी but AB st. line को time से divide करने पर avg. velocity मिलेगा [bcoz for avg velocity we use disp/time and disp is st. line AB

$$\boxed{\left(\overset{\text{speed}}{V_{avg}}\right)_{min} = \left|\vec{v}_{avg\ (velo.)}\right|}$$

ACCELERATION

Rate of change of velocity vector w.r.t. time is known as acceleration. It is directed along the change in velocity, not in the direction of velocity.

$$\boxed{\vec{a} = \frac{d\vec{v}}{dt}}$$



$v = 4\,m/sec$

Time A to B = 2 sec

$V_1 = 4\hat{j}$ $\quad V_2 = -4\hat{i}$

$\vec{a} = \frac{\Delta\vec{V}}{\Delta t} = \frac{\vec{V_2} - \vec{V_1}}{2}$

$= \frac{-4\hat{i} - (4\hat{j})}{2} = -2\hat{i} - 2\hat{j}$

Now draw it to find dir. of accel.

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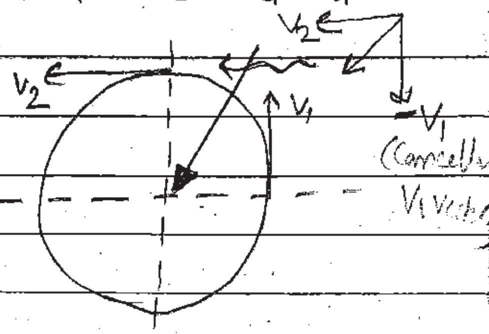
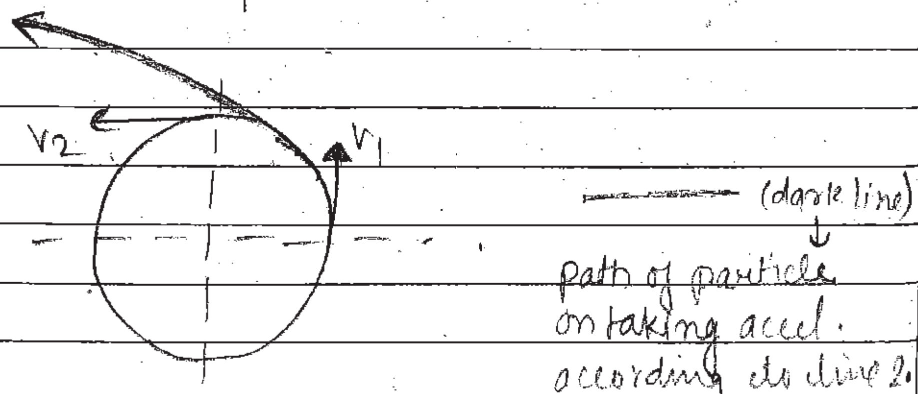
In previous question, the direction of acceleration is calculated by drawing the resultant vector of two vectors.



But

* यहाँ पर एक doubt आ सकता है कि हम accel. का position line 1 (red) की जगह line 2 (blue) क्यूँ नहीं लिया ?

Ans:- अगर हम accel. की direction line 2 लेते तो velocity का कम्पोनेन्ट जो line 1 से produce हो रहा था तो वो v_1 के opposite direction में होने की वजह से उसे 0 (zero) कर रहा था जो कि acceleration के लिए जरूरी था। but अगर हम line 2 को accel. की direction लेते हैं तो v_1 zero नहीं होगा and v_2 भी नहीं जिसकी वजह से particle अपने पाथ से थोड़ा deviate हो जाएगा।



* A doubt can occur why we can't acceleration position on line 2 instead of line 1 ?

JEE

02.07.11

Eg

R

$\dfrac{d|\vec{v}|}{dt}$ (I) $\qquad \left|\dfrac{d\vec{v}}{dt}\right|$ (II)

Is any case there for wh

(A) $I = 0$, $II \neq 0$

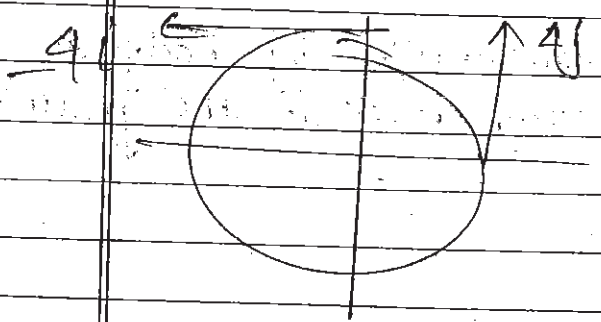
(B) $I \neq 0$, $II = 0$.

Sol $\dfrac{d|\vec{v}|}{dt}$ $\qquad |\vec{v_1}|, |\vec{v_2}|$

(So) A can exist but B can't

$$\frac{d|\vec{v}|}{dt} = \frac{|\vec{v_2}| - |\vec{v_1}|}{dt}.$$

for this def we take example.



$t = 2s$

(I) $|\vec{v_1}| = 4$

$|\vec{v_2}| = 4$.

$$\frac{|\vec{v_2}| - |\vec{v_1}|}{dt} = \frac{4-4}{2} = 0.$$

(II) $$|-4i - 4j| = \frac{|d\vec{v}|}{|dt|} = \frac{4\sqrt{2}}{2} = 2\sqrt{2}$$

Means if (I) $= 0$, (II) may not be zero.

If $II = 0$. $\quad |\vec{v_2} - \vec{v_1}| = 0$ bcoz $dt \neq 0$ (never)

$\vec{v_2} = \vec{v_1} \Rightarrow |\vec{v_2}| - |\vec{v_1}| = 0$

Means if $II = 0$ ...

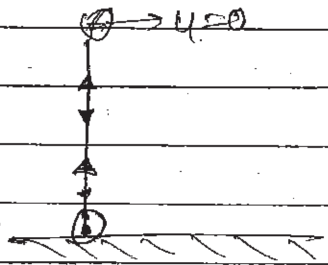
Distance travelled in nth second

$$\boxed{S_{nth} = u + \frac{g}{2}(2n-1)}$$

FREE - FALL :

Motion under gravity only is called free fall.

(1) Body ने ऊपर जाने के लिए $t = \frac{u}{g}$ time लिया है + वापस आने के लिए इसी same time लगेगी।



$$t = \frac{u}{g}_{(\text{जाने})} + \frac{u}{g}_{(\text{आने})}$$

$$\boxed{t = \frac{2u}{g}}$$

Time taken by body to reach back to the ground

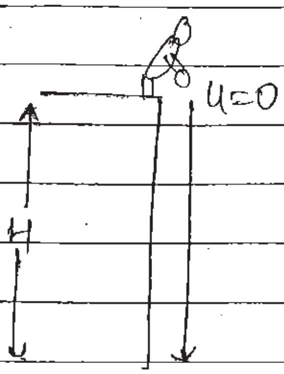
(2) Maximum height reached by ball when it is thrown with 'u' velocity

$$\boxed{h_{max} = \frac{u^2}{2g}}$$

(3)

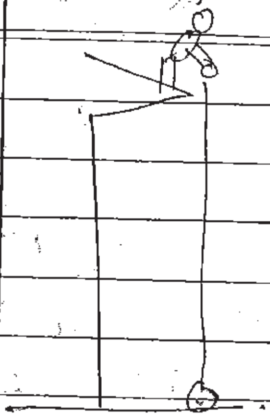
$$\boxed{t = \sqrt{\frac{2H}{g}}}$$

Time after ~~when the~~ which ball reach to the ground



Velocity & accel. opposite dir. में है speed slows
Velocity & accel same dir. → speed ↑

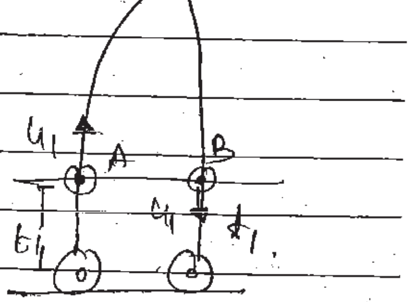
(4)



$$\boxed{V = \sqrt{2gH}}$$

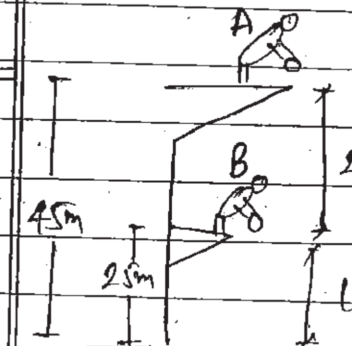
Velocity of ball when it reaches to ground.

**
(5) अगर velocity u से कोई बॉल फेंकी गई and उसके
** जाने और आने वाले दोनों path से अगर हमने एक line draw की see fig. then velocity at the pt. at which this line is cutting the path will same & time interval will also same.



velocity at pts. A & B will be same.

Ex.
R



Man A is ready to throw the ball and when this ball is reached to the man 'B' He will also throw his ball. Ball of man A will reach the ground first. Then find the time duration Δt after which the ball of man B will reach to ground.

$t = \sqrt{\frac{2H}{g}} \Rightarrow t = \sqrt{\frac{2 \times 25}{g}}$

$= \sqrt{5}$ sec

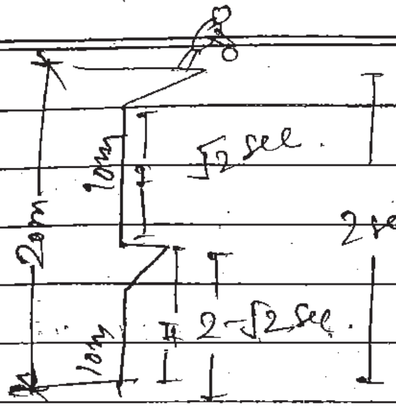
⇓

$t = \sqrt{\frac{2 \times 45}{10}}$

$= 3$ sec. $\quad \Delta t = (\sqrt{5} - 1)$ sec. Ans

$= 2$ sec $+ 1$ sec Ball will reach to the man B ~~aft~~ 2 seconds and then B will also throw his ball.

R. Ex.

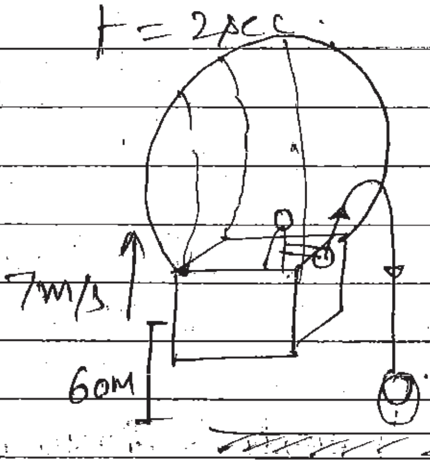


find ratio of time spent in I^{st} & II^{nd} Half $\frac{t_I}{t_{II}}$

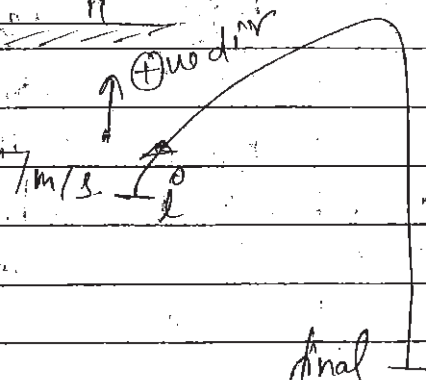
$$t = \sqrt{\frac{2\times 20}{10}} \qquad t = \sqrt{\frac{2\times 10}{10}}$$

$$t = 2\,sec \qquad \frac{t_I}{t_{II}} = \frac{\sqrt{2}}{2-\sqrt{2}}$$

R. Ex.



Situation is given in fig. find the time after which ball will reach to the ground.



direction of disp. is from i to f so take -ve sign.

$$S = ut + \frac{1}{2}at^2$$

$$-60 = 7t + \frac{1}{2}(-10)t^2$$

$$-60 = 7t - 5t^2$$

$$5t^2 - 7t - 60 = 0$$

$$\boxed{t = 4.3\,sec}$$

OR