

Mahendra Singh

Expert in NEET UG

B.tech Gold Medalist, Awarded with Teaching Excellence by Unacademy. Produced AIR 49 in JEE Advanced, Got AIR 368 in GATE 2016 & AIR 192 in

23M Watch mins | **862K** Watch mins (last 30 days) | **66K** Followers | **4K** Dedications

hello physics

← Free live classes

HINDI PHYSICS

Kinematics One_D Practice Session

Starts on Apr 7, 2022 • 10:00 AM

In this session, Mahendra Singh will discuss Units and Measurements. It will be helpful for the aspirants preparing for NEET. This session will be conducted in Hindi and the notes will be provided in English.



Share | Reschedule

unacademy

India's Largest Learning Platform*

Unacademy Store

415-A, Gopalpura Bypass,
Ridhi Sidhi Circle, Jaipur

2-5 pm

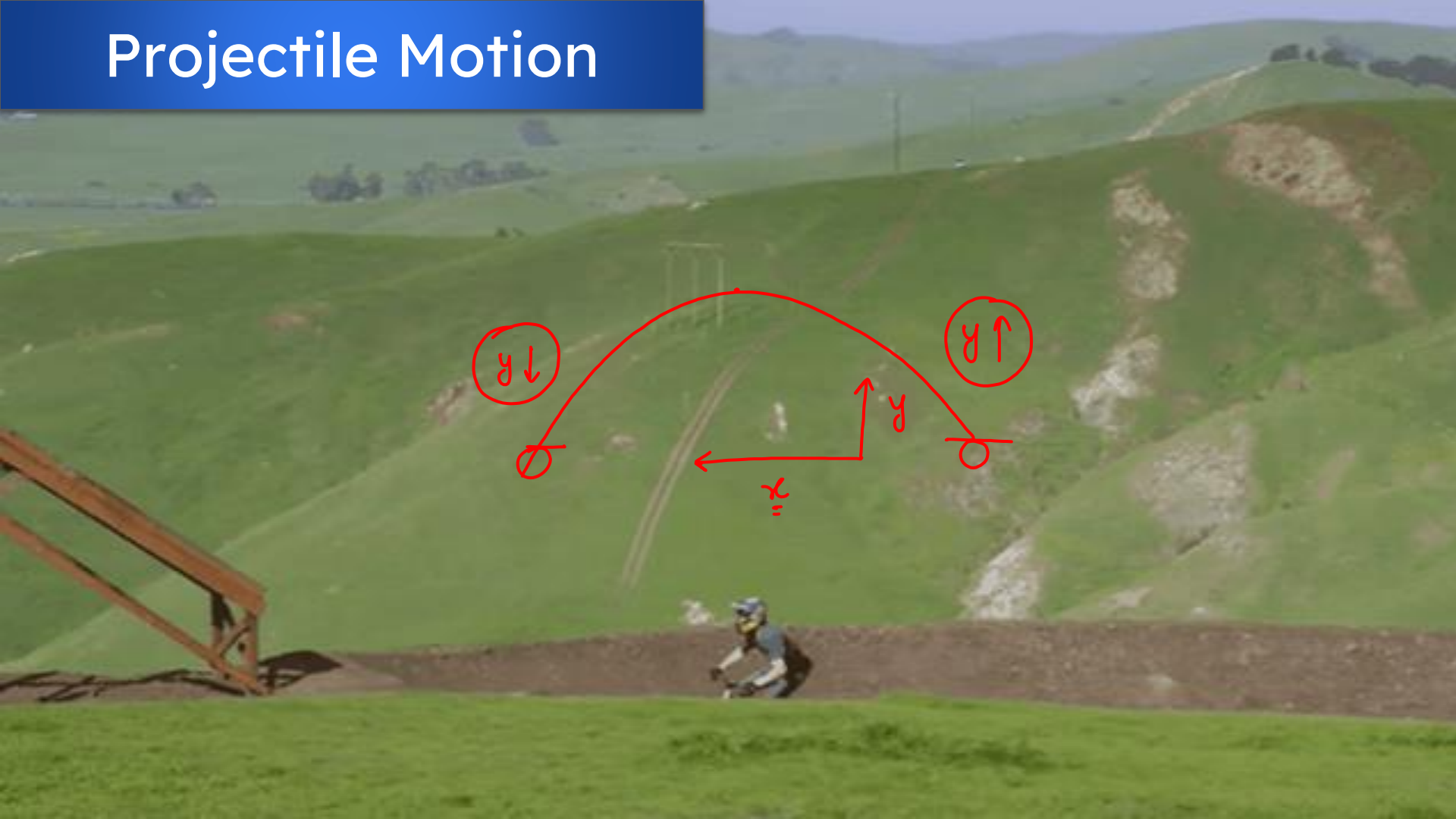
Registration is mandatory to **visit on April 9-10**

Register Now

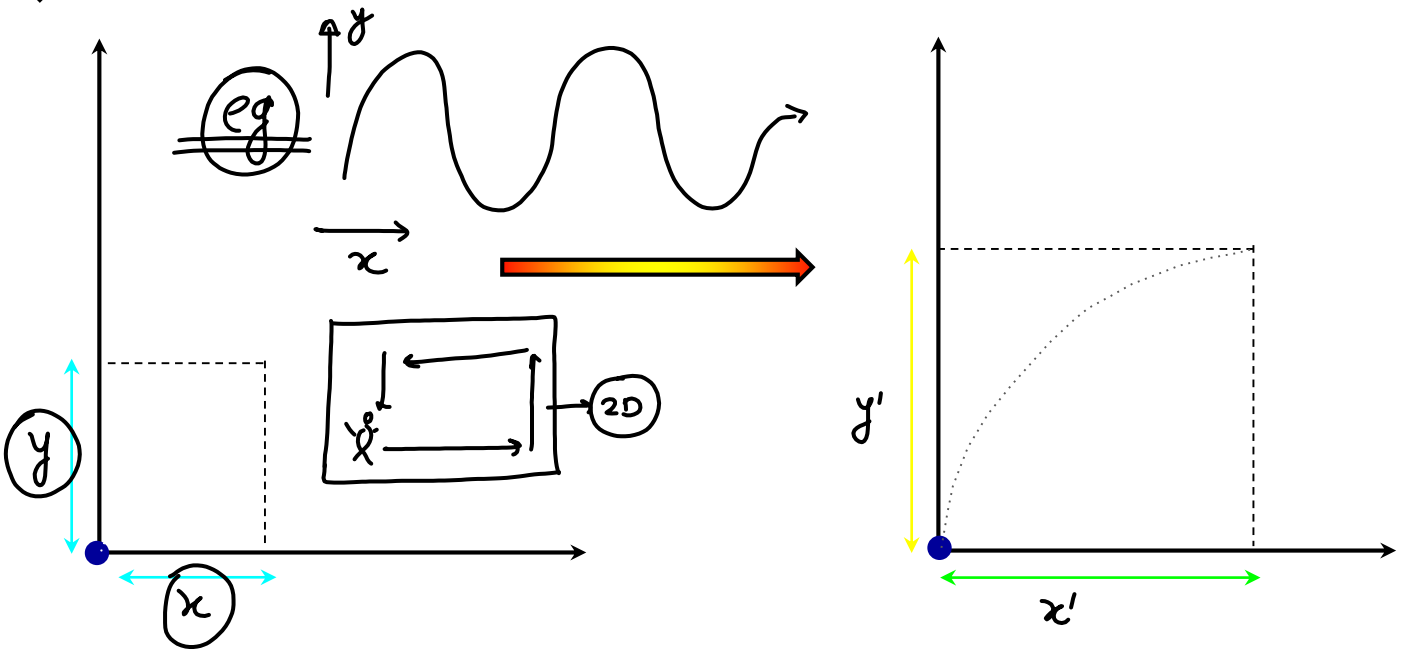


*Source: The Indian Edtech Story: Q1 2022 Round-Up by Markelytics.

Projectile Motion



Introduction to 2-D Motion



We will now discuss motion in which **2 Dimensions** are changing

Concept of 2-D Motion

Equations of motion can be written separately for each dimension

along x - axis

$$\begin{cases} v_x = u_x + a_x t \\ x = u_x t + \frac{1}{2} a_x t^2 \\ {v_x}^2 = {u_x}^2 + 2 a_x x \end{cases}$$

along y - axis

$$\begin{cases} v_y = u_y + a_y t \\ y = u_y t + \frac{1}{2} a_y t^2 \\ v_y^2 = u_y^2 + 2 a_y y \end{cases}$$

Example

MCQ type Question [+4 , -1]

Given That $\vec{a} = -2\hat{j}$ and $\vec{u} = 10\mathrm{i} + 10\hat{j}$

$\vec{v} = ?$ After 5 sec.

$\frac{d\vec{v}}{dt} \Leftarrow a_x = 0$ ✓, $a_y = 2\,m/s\downarrow$, $u_y = 10\hat{j}$

$\bar{V}_x$ = consl.

$\bar{V} = \bar{V}_x + \bar{V}_y$

$\bar{V} = 10\hat{i} + 0\hat{j}$

$V_y = u_y + a_y t$

$V_y = 10\hat{j} - 2\hat{j} \times 5$

$= 10\hat{j} - 10\hat{j}$

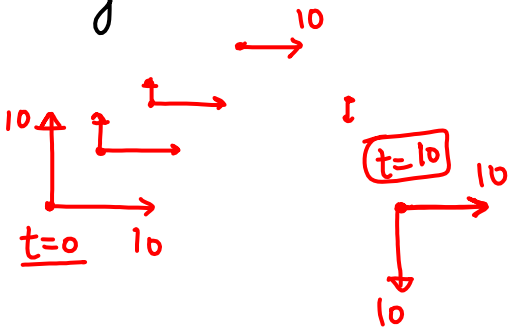
$\bar{V}_y = 0$

@ t = 7 sec

$\bar{V}_y = 10\hat{j} - 2(7)\hat{j} = -4\hat{j}$

at = 10 sec

$\bar{V}_y = 10\hat{j} - 2(10)\hat{j} = -10\hat{j}$



Conclusion

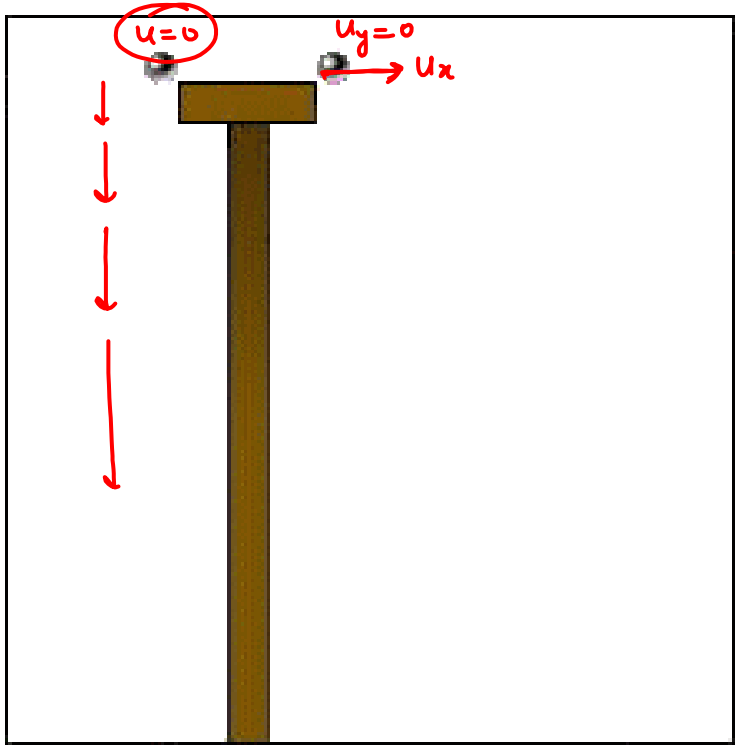
Horizontal and Vertical motion are independent of each other

$a_x = 0$

v_x = const

$a_y \neq 0$

$v_y \Rightarrow$ changing



Example

MCQ type Question [+4 , -1]

$\vec{v} = 5 - 4t$

The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and y are in meters and t in seconds. The acceleration of the particle at $t = 2s$ is

(a) $5\ m/s^2$ (b) $-4\ m/s^2$ ***[2017]***

(c) $-8\ m/s^2$ (d) 0

$a = \frac{d^2s}{dt^2}$

$a_x = -4$

$a_y = 0$

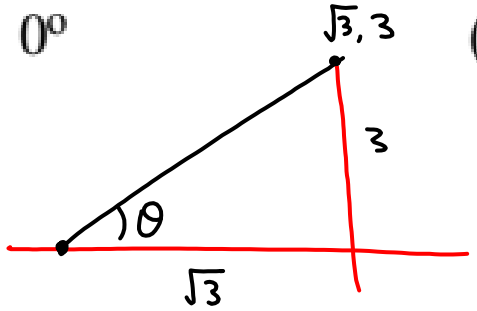
Example

MCQ type Question [+4 , -1]

A particle starting from the origin $(0, 0)$ moves in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x-axis an angle of *[2007]*

(a) 45^o (b) 60^o

(c) 0^o (d) 30^o

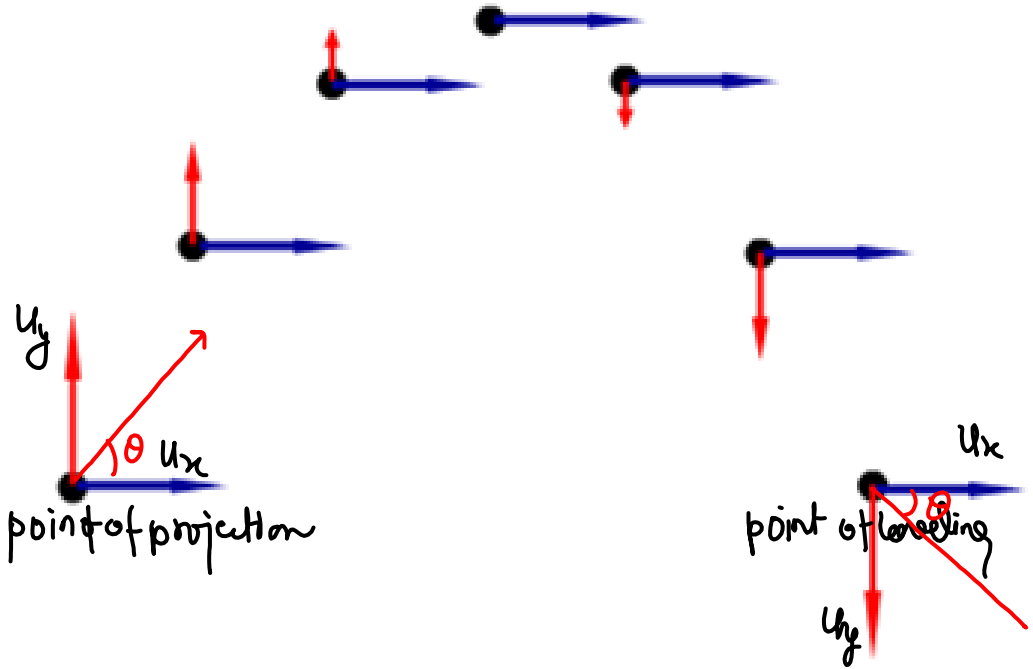


$\tan\theta = \frac{3}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \sqrt{3} = \tan 60^\circ$

$\theta = 60$

Projectile Motion

Horizontal component of velocity remains constant provided that air resistance is absence



Example

MCQ type Question [+4 , -1]

A ball is projected with velocity u at an angle α with horizontal plane. Its speed when it makes an angle β with the horizontal is -

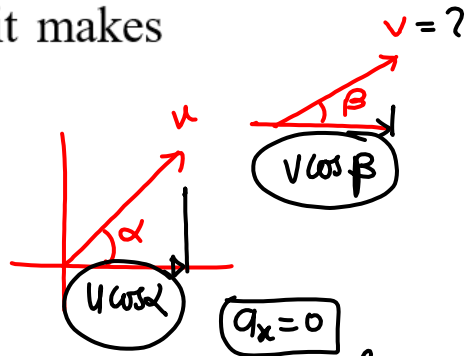
(A) u cos α

(B) $\frac{u}{\cos\beta}$

(C) u cos α cos β

(D) $\frac{u\cos\alpha}{\cos\beta}$

$u\cos\alpha = v\cos\beta$



$a_x = 0$

provided that

$a_x = 0$, air resist = 0

V_x = const.

Horizontal component of velocity remains constant provided that air resistance is absence



Example

MCQ type Question [+4 , -1]

$E = \frac{1}{2}mu^2$

A ball whose kinetic energy is E, is thrown at an angle of 45 with the horizontal, its kinetic energy at the highest point of its flight will be :–

$V_y = 0$, $u_x = u\cos\theta$

[AIPMT 1997, 2000]

@ Theory :-

$E' = \frac{1}{2}m(u\cos 45)^2$

$= \frac{1}{2}m\left(\frac{u}{\sqrt{2}}\right)^2$

$= \frac{1}{2}\left(\frac{1}{2}mu^2\right)$

(1) E

(2) $\frac{E}{\sqrt{2}}$

(3) $\frac{E}{2}$

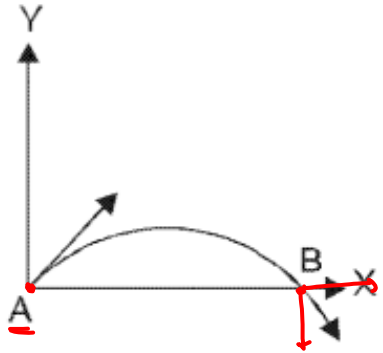
(4) zero

Example

MCQ type Question [+4 , -1]

The velocity of a projectile at the initial point A is $\left(2\hat{i}+3\hat{j}\right)$ m/s. It's velocity (in m/s) at point B is

[2013]



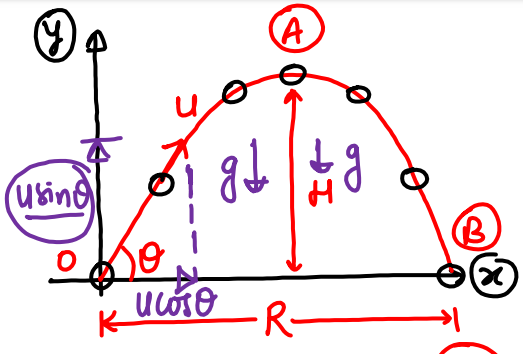
(a) $-2\hat{i}+3\hat{j}$

(b) $2\hat{i}-3\hat{j}$

(c) $2\hat{i}+3\hat{j}$

(d) $-2\hat{i}-3\hat{j}$

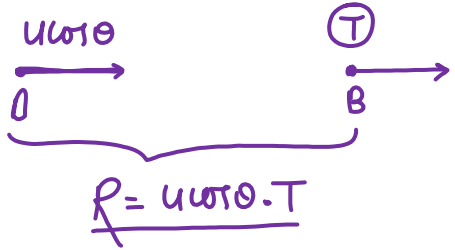
Projectile Motion



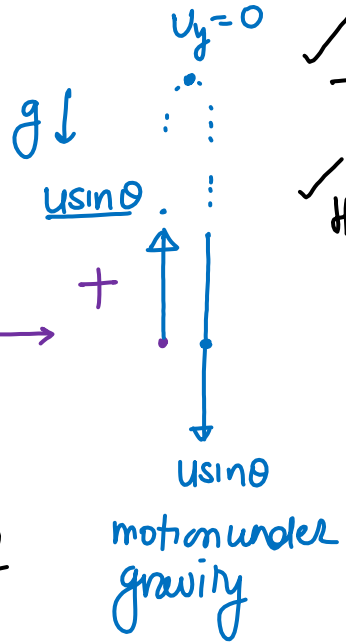
$t_{OB} = t_{OA} + t_{AB} = T$

$a_x = 0$, $v_x = \text{const}$

$\Rightarrow$



$R = u\cos\theta \cdot T$



$$T = \frac{2u_y}{g} = \frac{2u\sin\theta}{g}$$

$$H = \frac{u_y^2}{2g} = \frac{u^2\sin^2\theta}{2g}$$

$$R = u\cos\theta \times \frac{2u\sin\theta}{g}$$

$$\boxed{R = \frac{u^2}{g}\sin 2\theta = \frac{2u_x u_y}{g}}$$

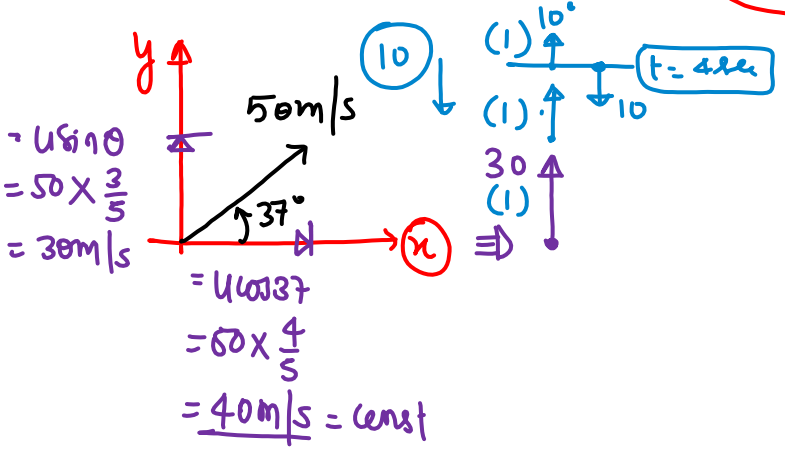
#

Example

MCQ type Question [+4 , -1]

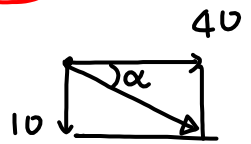
A body is thrown with a velocity of 50 m/s at an angle of 37^0 with the horizontal. Find :

Direction of velocity after 4 secs



$= u\sin\theta$
$= 50 \times \frac{3}{5}$
$= 30 m/s$

$= u\cos 37$
$= 50 \times \frac{4}{5}$
$= 40 m/s = const$



$\tan\alpha = \frac{10}{40}$

$\tan\alpha = \frac{1}{4}$

$\alpha = \tan^{-1}\left(\frac{1}{4}\right)$

$R = \frac{u^2 \sin 2\theta}{g} = \frac{2u_x u_y}{g}$

$R = \frac{u^2 \sin(2\times 37)}{g}$

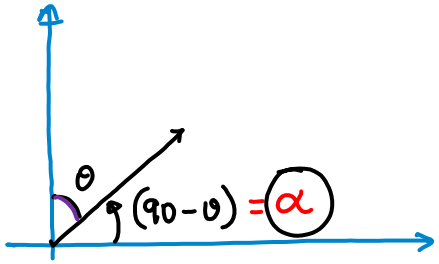
$= \frac{50^2}{10} * \sin(74)$

??

$R = \frac{2(40)(30)}{10}$

$= 240 m$

Projectile Motion



$\alpha + \theta = 90$
complementary angles.

θ measured from horizontal.

$$T = \frac{2u\sin\theta}{g}$$
$$H = \frac{u^2\sin^2\theta}{2g}$$
$$R = \frac{u^2\sin 2\theta}{g}$$

θ measured from vertical,

$\alpha = 90 - \theta$

$\sin(90-\theta) = \cos\theta$

$\cos(90-\theta) = \sin\theta$

$\sin(180-\theta) = \sin\theta$

$$T' = \frac{2u\sin\alpha}{g} = \frac{2u\cos\theta}{g}$$

$$H' = \frac{u^2\sin^2\alpha}{2g} = \frac{u^2\cos^2\theta}{2g}$$

$$R' = \frac{u^2}{g}\sin 2\alpha = \frac{u^2}{g}\sin(180-2\theta)$$
$$= \frac{u^2}{g}\sin 2\theta$$

$R' = R$

Example

MCQ type Question [+4 , -1]

A body is projected at an angle θ with horizontal. Another body is projected with the same velocity at an angle θ with the vertical. The ratio of the time of flights is-

(A) 1:1

(B) $\tan^2\theta$:1

(C) 1 : cot θ

(D) tan 2θ : 1

$$\frac{T}{T'} = \frac{\sin\theta}{\cos\theta} = \tan\theta = \frac{1}{\cot\theta}$$

Example

MCQ type Question [+4 , -1]

A body is projected at an angle θ with horizontal. Another body is projected with the same velocity at an angle θ with the vertical. The ratio of the maximum heights is

(A) 1:1

(B) $\tan^2\theta$:1

(C) 1 : cot θ

(D) tan 2θ : 1

$$\frac{H}{H'} = \frac{\sin^2\theta}{\cos^2\theta} = \frac{\tan^2\theta}{1}$$

$$\frac{H}{H'} = \left(\frac{T}{T'}\right)^2$$

Example

MCQ type Question [+4 , -1]

The number of bullets are fired in all possible directions with the same initial velocity u. The maximum area of ground covered by bullets is :-

[RPMT 2004]

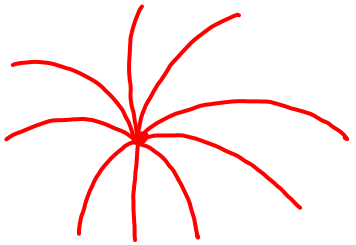
(1) $\pi\left(\frac{2u^2}{g}\right)^2$

(2) $3\pi\left(\frac{u}{g}\right)^2$

(3) $5\pi\left(\frac{u}{2g}\right)^2$

(4) $\pi\left(\frac{u^2}{g}\right)^2$

$A = \pi\left(\frac{u^2}{g}\right)^2$ =



$A = \pi r^2$

r = Range

$\downarrow$

max, R_{max}

$R = \frac{u^2}{g}\underbrace{\sin 2\theta}_{\hookrightarrow = 1 = \sin 90^\circ}$

$2\theta = 90$

$\theta = 45^\circ$ ✓

$R_{max} = \frac{u^2}{g}$

Example

MCQ type Question [+4 , -1]

Two projectiles are fired from the same point with the same speed at angles of projection 60° and 30° respectively. Which one of the following is true? 60+30 = 90 *[2000]*

(a) X Their maximum height will be same

(b) Their range will be same

(c) Their landing velocity will be same

(d) Their time of flight will be same

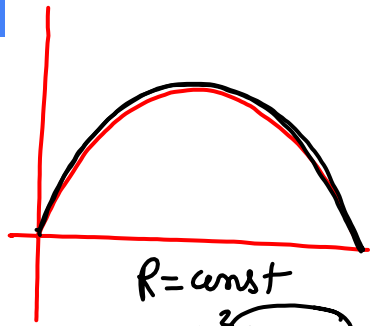
Example

MCQ type Question [+4 , -1]

A projectile is fired from the surface of the earth with a velocity of $5\ ms^{-1}$ and angle θ with the horizontal. Another projectile fired from another planet with a velocity of $3\ ms^{-1}$ at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) given $g = 9.8\ m/s^2$ ***[2014]***

(a) 3.5 (b) 5.9

(c) 16.3 (d) 110.8



$R = const$

$R = \frac{u^2 \sin 2\theta}{g}$

$\frac{u^2}{g} = const$

$\frac{5^2}{10} = \frac{3^2}{g'}$

$g' = \frac{9}{25} \times 5^2 = \frac{18}{5}$

Example

MCQ type Question [+4 , -1]

Two stones are projected with the same speed but making different angles with the horizontal. Their ranges are equal. If the angle of projection of one is $\left(\frac{\pi}{3}\right)$ and its maximum height is y_1 then the maximum height of the other will be :–

(1) $3y_1$

(2) $2y_1$

(3) $\frac{y_1}{2}$

(4) $\frac{y_1}{3}$

$\frac{H}{H'} = \tan^2\theta$

$\frac{y_1}{H'} = \left[\tan\left(\frac{\pi}{3}\right)\right]^2$

$\frac{y_1}{H'} = \left(\sqrt{3}\right)^2$

$H' = \frac{y_1}{3}$

Example

MCQ type Question [+4 , -1]

A projectile can have the same range R for two angles of projection. If t_1 and t_2 be the times of flight in the two cases :–

(1) $t_1 t_2 \propto R^2$

(2) $t_1 t_2 \propto R$

(3) $t_1 t_2 \propto \frac{1}{R}$

(4) $t_1 t_2 \propto \frac{1}{R^2}$

$t_1 = \frac{2u\sin\theta}{g}$

$t_2 = \frac{2u\cos\theta}{g}$.

$t_1 \times t_2 = \frac{2u(2u)}{g\,g}\sin\theta\cos\theta$

$= \left(\frac{2}{g}\right)\frac{u^2}{g}(\sin 2\theta)$

$t_1 t_2 = \frac{2}{g}R$

Example

MCQ type Question [+4 , -1]

Find the **time** after which the velocity will be perpendicular to initial velocity u = $40\sqrt{2}$ m/sec.

A. 4 Sec

B. 8 Sec

C. 6 Sec

D. None of the above

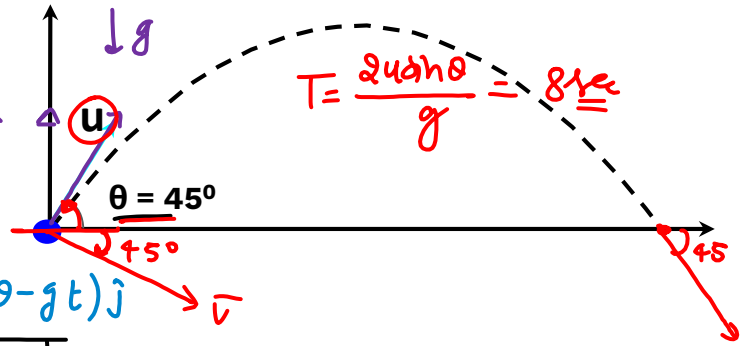
$\bar{v} = \bar{v}_x + \bar{v}_y$

$\bar{u} \perp \bar{v}$ $\quad \bar{u}\cdot\bar{v} = 0$

$\bar{u} = u\cos\theta\,\hat{i} + u\sin\theta\,\hat{j}$

$\bar{v}_y = (u\sin\theta - gt)\,\hat{j}$

$\bar{v} = u\cos\theta\,\hat{i} + (u\sin\theta - gt)\,\hat{j}$



$\bar{u}\cdot\bar{v} = 0$

$u^2\cos^2\theta + u\sin\theta(u\sin\theta - gt) = 0$

$u^2\cos^2\theta + u^2\sin^2\theta - u\sin\theta\, gt = 0$

$u^2(\sin^2\theta + \cos^2\theta) = u\sin\theta\, gt$

$t = \frac{u^2}{u\sin\theta\, g} = \frac{u}{g\sin\theta}$

$t = \frac{40\sqrt{2}}{40 \times \sin 45}$

$= 4(\sqrt{2})(\sqrt{2})$

$t = 8$ sec

Example

MCQ type Question [+4 , -1]

A body is thrown with a speed of 30 m/s at angle 30° with horizontal from a perfectly inelastic horizontal floor. The time after with it is moving perpendicular to it's initial direction of motion is -

(A) 6 sec

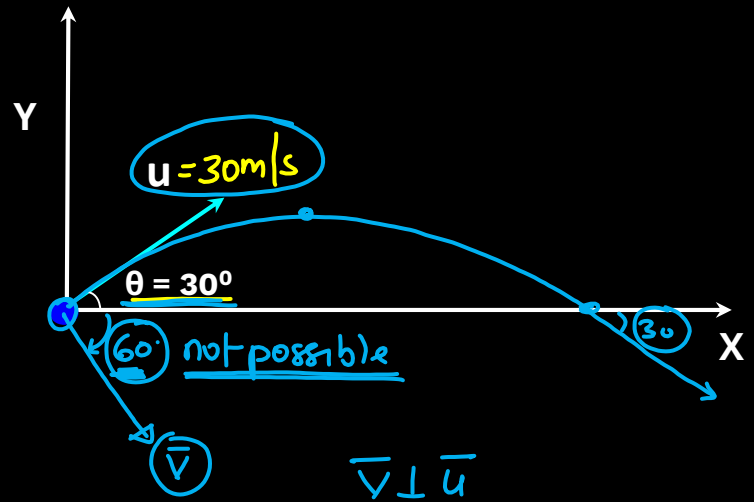
(B) 3 sec

(C) 1.5 sec

(D) Never

GET THE BEST, WITH THE BEST

Soltuon



$t = ?$

$\bar{u} \perp \bar{v}$

$\bar{u} \cdot \bar{v} = 0$

$t = \frac{u}{g\sin\theta} = \frac{30}{10 \sin 30}$

$= \frac{3}{\frac{1}{2}} = 6\,sec$

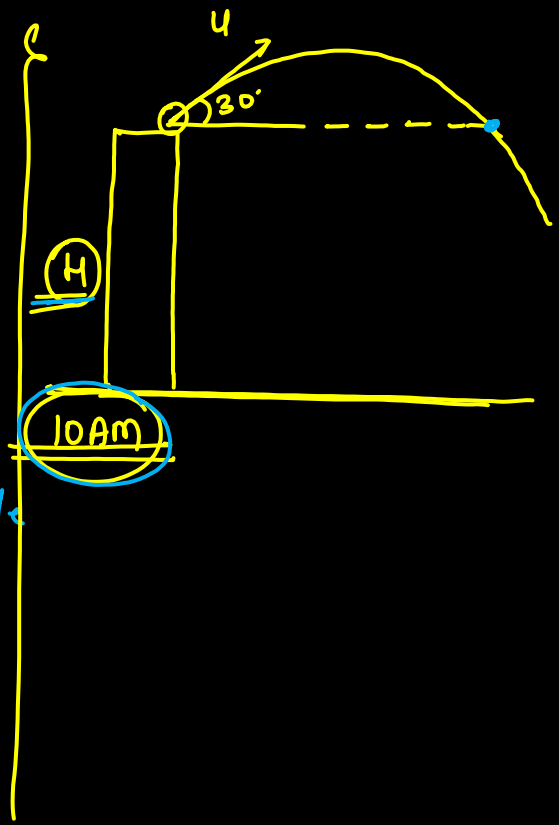
$\theta \geq 45°$

$\bar{v} \perp \bar{u}$

@ $\theta < 45°$ not possible

↓ angle of projectn

④ never ✓



R/H Relation

$$R = \frac{u^2}{g} 2\sin\theta\cos\theta \qquad H = \frac{u\sin\theta \; u\sin\theta}{2g}$$

$$R = \frac{u}{g}(u\sin\theta)\, 2\cos\theta \qquad \frac{u\sin\theta}{g} = \frac{2H}{u\sin\theta}$$

$$= u\, 2\cos\theta \times \frac{2H}{u\sin\theta}$$

$$\# \boxed{R = 4H\cot\theta}$$

Example

MCQ type Question [+4 , -1]

The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectiles is : ***[2012]***

(a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$ (b) $\theta = \tan^{-1}(4)$

(c) $\theta = \tan^{-1}(2)$ (d) $\theta = 45°$

$R = H$

$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$

$\cot\theta = \frac{1}{4} = \frac{1}{\tan\theta}$

$\tan\theta = 4$

Example

MCQ type Question [+4 , -1]

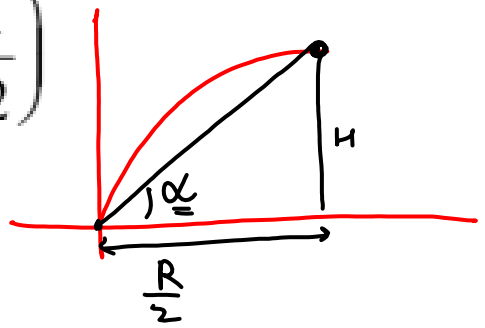
A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is *[2011M]*

(a) $60°$

(b) $\tan^{-1}\left(\frac{1}{2}\right)$

(c) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(d) $45°$



$\tan\alpha = \frac{H}{R/2} = \frac{2H}{R}$

$\tan\alpha = \frac{2H}{4H\cot\theta} = \frac{1}{2}$ (1)

Example

MCQ type Question [+4 , -1]

For a projectile thrown into space with a speed v, the horizontal range is $\frac{\sqrt{3}v^2}{2g}$. The vertical range is $\frac{v^2}{8g}$. The angle which the projectile makes with the horizontal initially is-

(A) 15° (B) 30° (C) 45° (D) 60°

$R = 4H\cot\theta$

$\frac{\sqrt{3}v^2}{2g} = 4\times\frac{v^2}{8g}\cot\theta$

$\cot\theta = \frac{1}{\tan\theta} = \sqrt{3}$

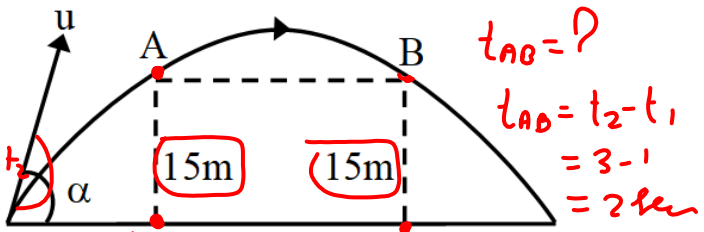
$\tan\theta = \frac{1}{\sqrt{3}}$

$\theta = 30$

Example

MCQ type Question [+4 , -1]

A golfer standing on level ground hits a ball with a velocity of u = 52 m/s at an angle α above the horizontal. If tanα = 5/12, then the time for which the ball is at least 15m above the ground (i.e. between A and B) will be (take g = 10 m/s^2) –

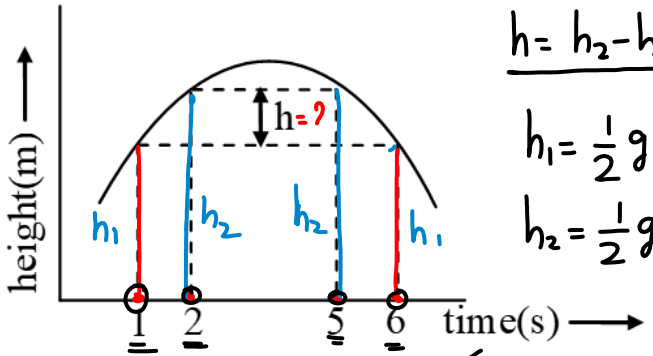


(A) 1 sec (B) 2 sec (C) 3 sec (D) 4 sec

Example

MCQ type Question [+4 , -1]

A ball is thrown upwards. Its height varies with time as shown in figure. If the acceleration due to gravity is 10 m/s^2, then the height h is-



$h = h_2 - h_1 = \frac{1}{2} g (10 - 6)$

$h_1 = \frac{1}{2} g (1 \times 6)$

$h_2 = \frac{1}{2} g (2 \times 5)$

(A) 10 m (B) 15 m (C) 20 m (D) 25 m

unacademy

7825860132

Crack NEET UG with Unacademy

101 days to go for the exam!

Never before pricing on the 3-month plus subscription

Old Price	Current Price
~~19,250~~	11,100

MSLIVE



Hurry! Offer Extended till today.

Enroll Now

Call for more details 8585858585

unacademy

Let's crack NEET UG with Unacademy

Introducing the 3-month Iconic Subscription

Hurry! Offer Extended till today.

₹ 22,000 Only!

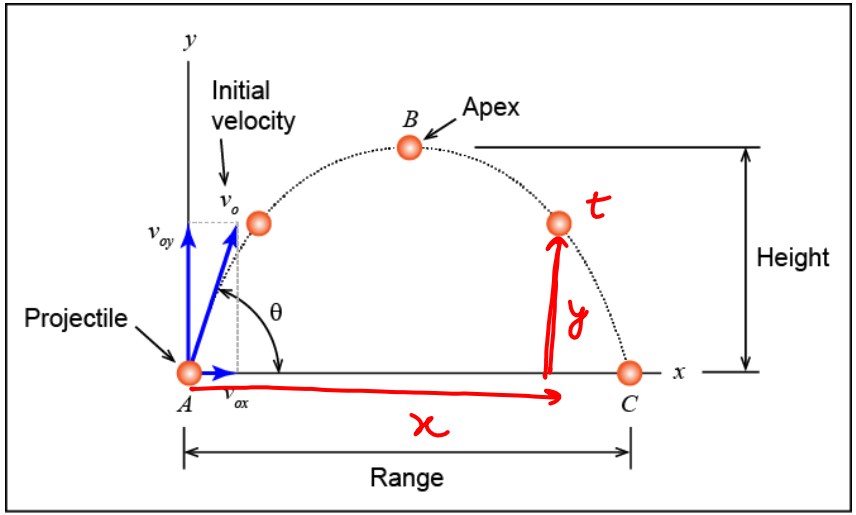
Enroll Now

Call for more details **8585858585**



Equation Of Trajectory

relatn b/w (x) and (y)



$$x = u\cos\theta \cdot t$$

$$t = \frac{x}{u\cos\theta}$$

$$y = u\sin\theta\, t - \frac{1}{2} g t^2$$

$$y = \cancel{u}\sin\theta \frac{x}{\cancel{u}\cos\theta} - \frac{1}{2} g \frac{x^2}{(u\cos\theta)^2}$$

$$y = x\tan\theta - \frac{gx^2}{2(u\cos\theta)^2}$$

(or)

$$y = x\tan\theta\left(1 - \frac{x}{R}\right)$$

Example

MCQ type Question [+4 , -1]

The equation of a projectile is $y = \sqrt{3}\,x - \frac{gx^2}{2}$

the angle of projection is :-

$y = x\tan\theta - \frac{gx^2}{2(u\cos\theta)^2}$

(1) 30 (2) 60

(3) 45 (4) none

$\tan\theta = \sqrt{3}$

Example

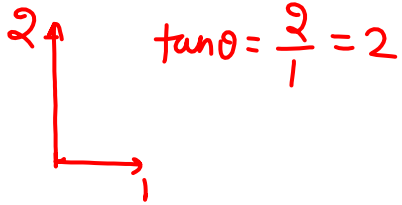
MCQ type Question [+4 , -1]

A projectile is given an initial velocity of $\hat{i} + 2\hat{j}$. The cartesian equations of its path is : ($g = 10\ m/s^2$)

A. $y = 2x - 5x^2$ **B.** $y = x - 5x^2$ **C.** $4y = 2x - 5x^2$ **D.** $y = 2x - 25x^2$

$u_x = 1$

$u_y = 2$



$\tan\theta = \frac{2}{1} = 2$

$y = x\tan\theta - \frac{gx^2}{2(u_x)^2}$

$y = 2x - 5x^2$

Horizontal Projectile motion

$$H = \frac{1}{2} g T^2$$

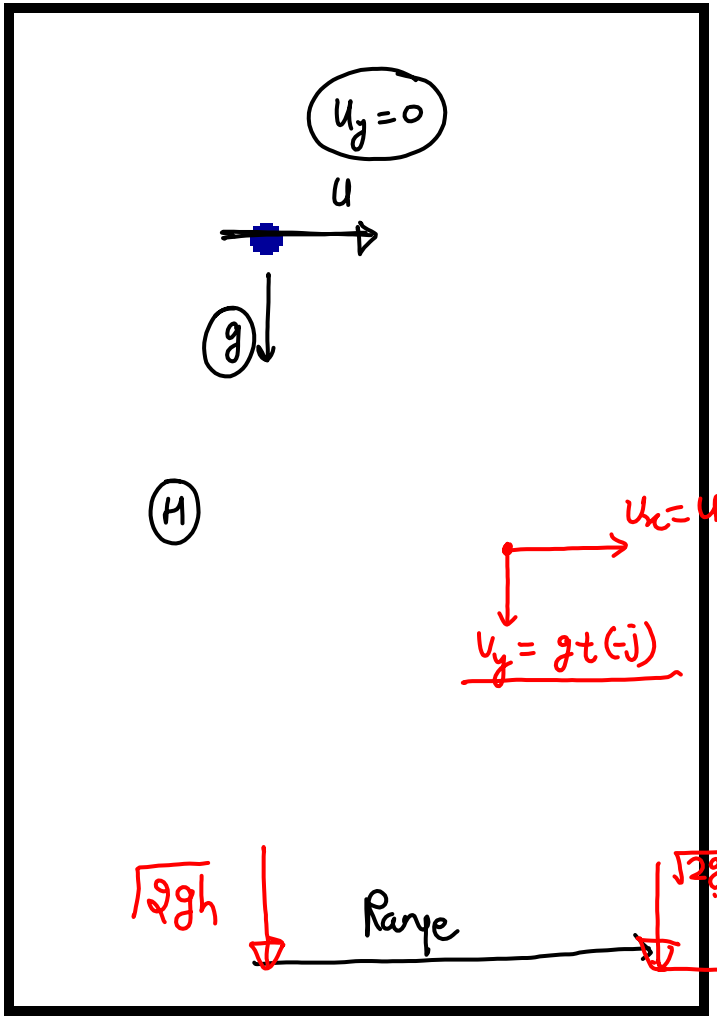
$$T = \sqrt{\frac{2H}{g}} \quad \#$$

$$\bar{v} = u\hat{i} + (-gt)\hat{j}$$

$$\text{Range} = u \cdot T = u\sqrt{\frac{2H}{g}}$$

$$|\bar{v}| = \sqrt{u^2 + 2gH}$$

at the ground



Example

MCQ type Question [+4 , -1]

A stone is thrown from a cliff of height h in a given direction then the speed with which it hits ground -

HW

(A) must depends on speed of projection

(B) must be larger than the speed of projection

(C) must be independent of angle of projection

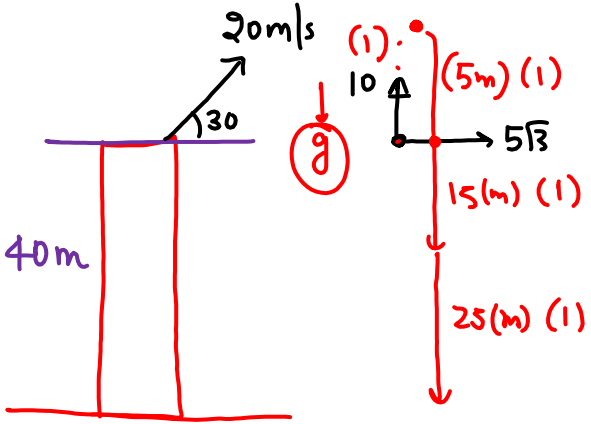
(D) All of above

Example

MCQ type Question [+4 , -1]

From the top of a tower of height 40m a ball is projected upward with a speed of 20m/sec at an elevation of 30^0. Then the ratio of the total time taken by the ball to hit the ground to time taken by ball to come at same level as top of tower.

A. 2 : 1 **B.** 3 : 1 **C.** 3 : 2 **D.** 4 : 1

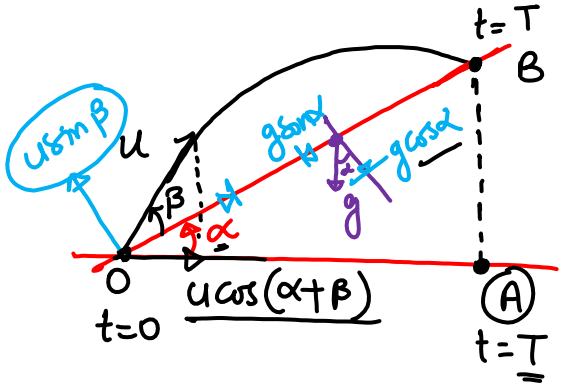


4 sec → ground

$$T = \frac{2u\sin\theta}{g} = \frac{2 \times 20 \times \frac{1}{2}}{10} = 2$$



Projectile on an Inclined Plane



Range (OB) = ?

I Δ OAB

$$\cos\alpha = \frac{OA}{OB}$$

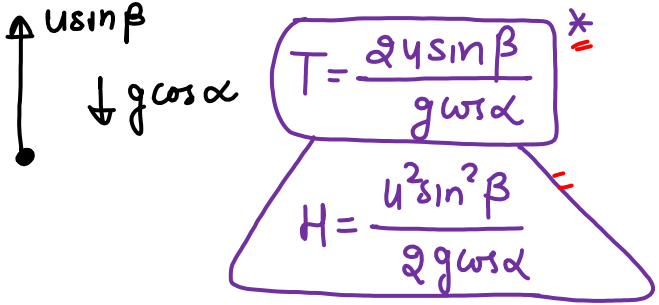
$$OB = \frac{OA}{\cos\alpha}$$

$$OB = \frac{u\cos(\alpha+\beta)\cdot T}{\cos\alpha}$$

$$OB = \frac{u\cos(\alpha+\beta)}{\cos\alpha} \cdot \frac{2u\sin\beta}{g\cos\alpha}$$

$$OB(R) = \frac{2u^2\cos(\alpha+\beta)}{g\cos^2\alpha}$$

$$R_{max} = \frac{u^2}{g(1+\sin\alpha)} \quad *$$

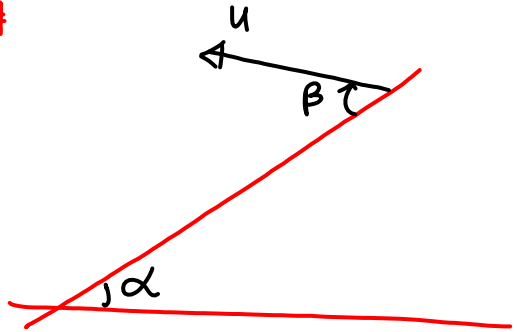


$$T = \frac{2u\sin\beta}{g\cos\alpha} \quad *$$

$$H = \frac{u^2\sin^2\beta}{2g\cos\alpha}$$

$$R = u\cos\beta\, t - \frac{1}{2}g\sin\alpha\, t^2$$

#



$$T = \frac{2u\sin\beta}{g\cos\alpha}$$

$$H = \frac{u^2\sin^2\beta}{2g\cos\alpha}$$

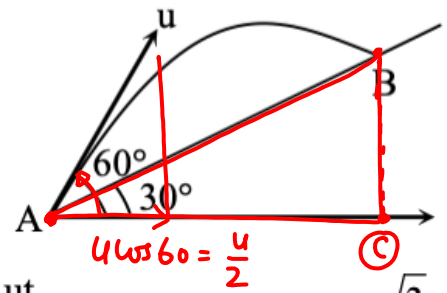
$$R = \frac{2u^2\cos(\alpha-\beta)}{g\cos^2\alpha}$$

$$R_{max} = \frac{u^2}{g(1-\sin\alpha)}$$

Example

MCQ type Question [+4 , -1]

Time taken by the projectile to reach A to B is t.
Then the distance AB is equal to –



$u\cos 60 = \frac{u}{2}$

(A) $\frac{ut}{\sqrt{3}}$

(B) $\frac{\sqrt{3}\,ut}{2}$

(C) $\sqrt{3}\,ut$

(D) 2 ut

$AC = u\cos 60 \; t = \frac{ut}{2}$

$\cos 30^\circ = \frac{AC}{AB}$

$AB = \frac{AC}{\frac{\sqrt{3}}{2}}$

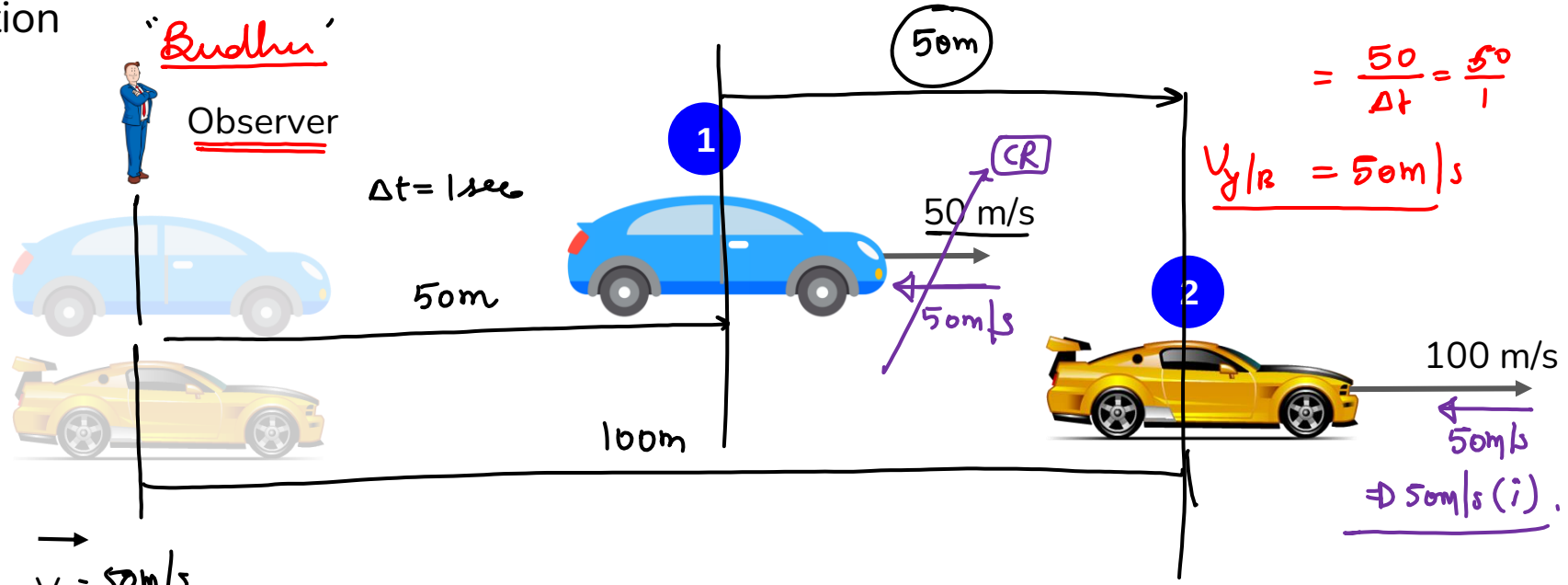
$= \frac{ut}{2} \times \frac{2}{\sqrt{3}}$

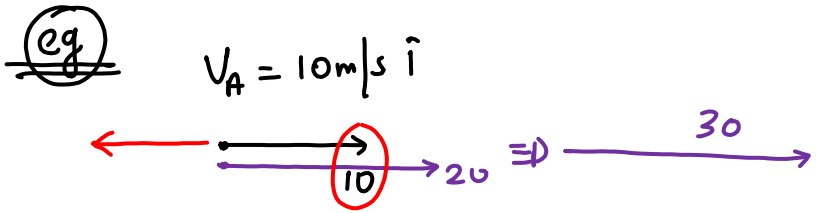
$= \frac{ut}{\sqrt{3}}$

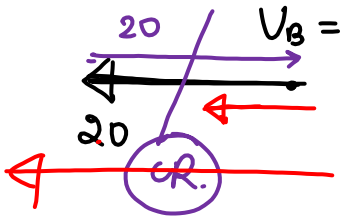
Relative Motion

Relative Motion

Observation of motion of a body w.r.t another moving body is known as Relative Motion

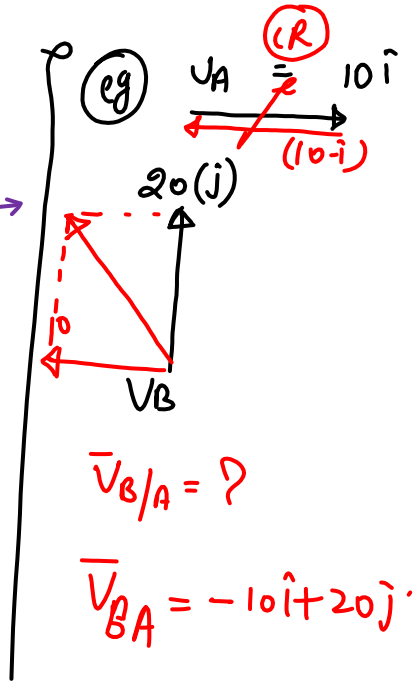






$\bar{V}_{A/B} = ? = 30 m/s\ \hat{i}$

$\bar{V}_{B/A} = ? = 30 m/s\ (-\hat{i})$



$\bar{V}_{B/A} = ?$

$\bar{V}_{BA} = -10\hat{i} + 20\hat{j}$

Example

MCQ type Question [+4 , -1]

A motorcycle is moving with a velocity 80 km/hr ahead of a car moving with a velocity of 65 km/hr in the same direction. What is the relative velocity of the motorcycle with respect to the car :-

[AFMC 2000]

(1) 15 km/hr

(2) 20 km/hr

(3) 25 km/hr

(4) 145 km/hr.

$= 80 - 65$

Example

MCQ type Question [+4 , -1]

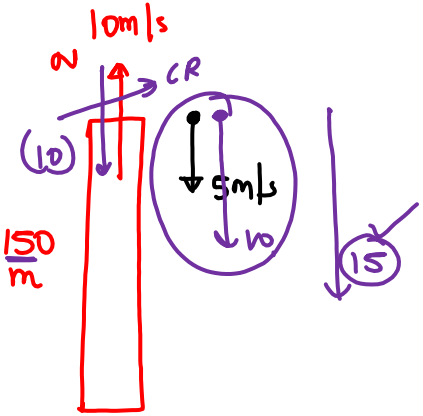
A train of 150m length is going towards north direction at a speed of 10 ms^{-1}. A parrot flies at a speed of 5ms^{-1} towards south direction parallel to the railway track. The time taken by the parrot to cross the train is equal to :–

(1) 12 s

(2) 8 s

(3) 15 s

(4) 10 s



If train is at rest

$\Rightarrow t = \frac{150}{5} = 30sec$

$t = \frac{150}{15} = 10sec$

Example

MCQ type Question [+4 , -1]

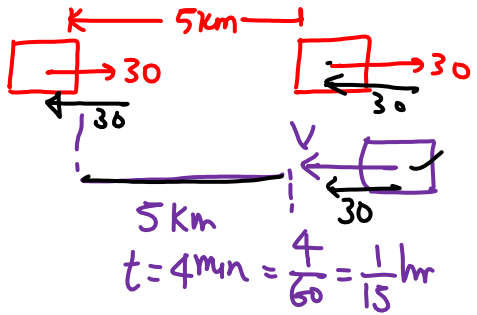
Two cars are moving in the same directions with the same speed of 30 km/hr. They are separated by 5 km. What is the speed of car moving in the opposite direction if it meets the two cars at an interval of 4 minute :-

(1) 45 km/hr.

(2) 60 km/hr

(3) 105 km/hr

(4) None



$V + 30 = \frac{5}{\frac{1}{15}}$

$V = 75 - 30$

Rain Men Problems

$\vec{V}_R = \vec{V}_x + \vec{V}_y$

$\vec{V}_m$

in most of the cases V_y (−).

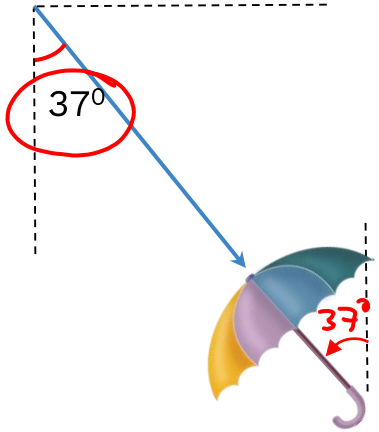
Example

MCQ type Question [+4 , -1]

Find angle with vertical which umbrella should be held if ,

$\vec{V}_r = 3\hat{i} - 4\hat{j}$

A. $\vec{V}_m = 0$



Example

MCQ type Question [+4 , -1]

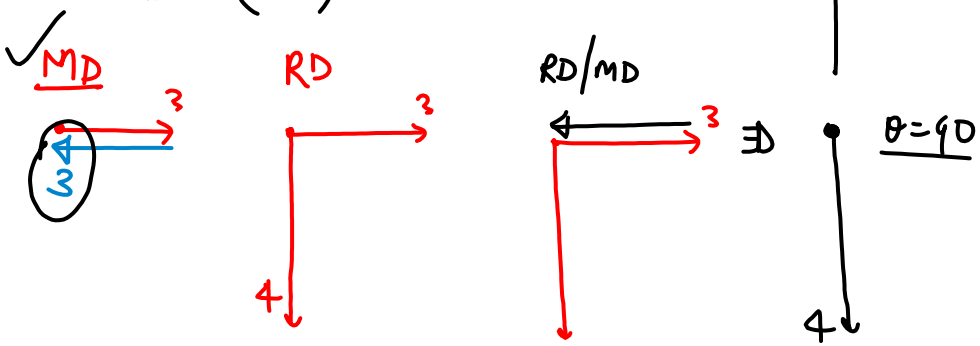
Find angle with vertical which umbrella should be held if ,

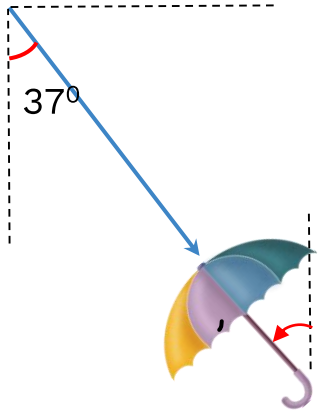
$\vec{V}_r = 3\hat{i} - 4\hat{j}$

$\vec{V}_{r/m}$

B.

$\vec{V}_m = (3\hat{i})$





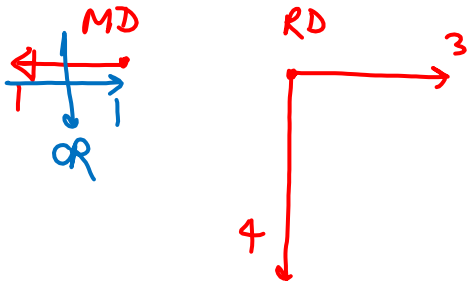
Example

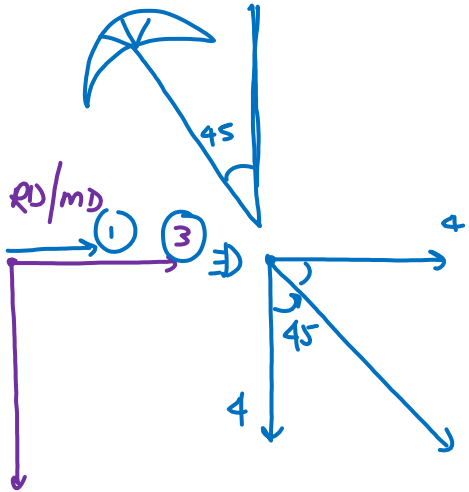
MCQ type Question [+4 , -1]

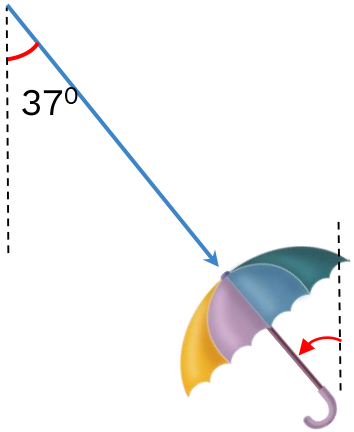
Find angle with vertical which umbrella should be held if ,

$\vec{V}_r = 3\hat{i} - 4\hat{j}$

C. $\vec{V}_m = -\hat{i}$







Example

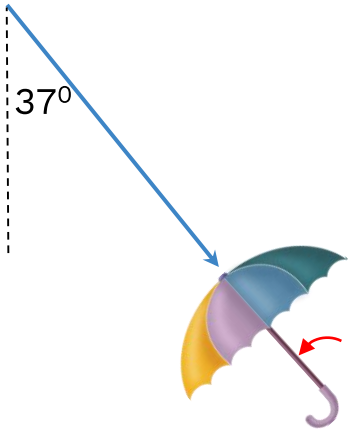
MCQ type Question [+4 , -1]

Find angle with vertical which umbrella should be held if ,

Hw

$\mathbf{V_r} = 3\hat{i} - 4\hat{j}$

D. $\vec{V}_m = 6\hat{i}$

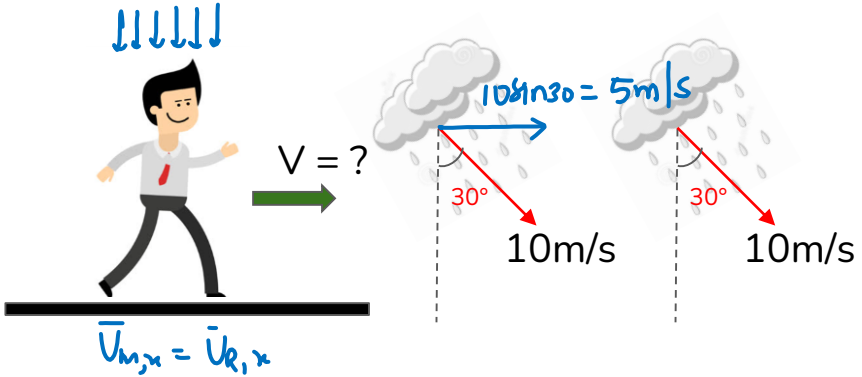


Example

MCQ type Question [+4 , -1]

Find velocity of men so that rain appears to fall vertically to man.

A. 5 m/s east
B. 5 m/s west
C. 10m/s east
D. None of those

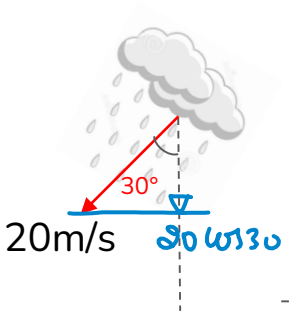


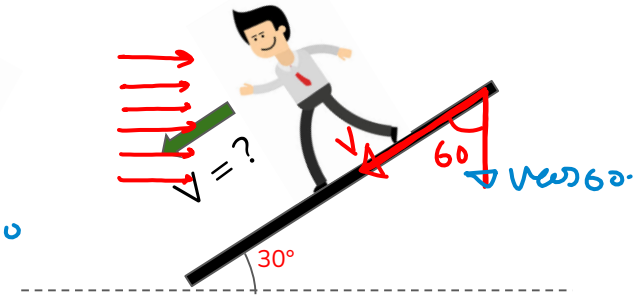
Example

MCQ type Question [+4 , -1]

Find the velocity of man so that rain appears to fall horizontally.

A. 20 √3 m/s
B. 10 √3 m/s
C. 20 / √3 m/s
D. 10 /√3 m/s





$V_{m,y} = V_{R,y}$

$V\cos 60 = 20\cos 30$

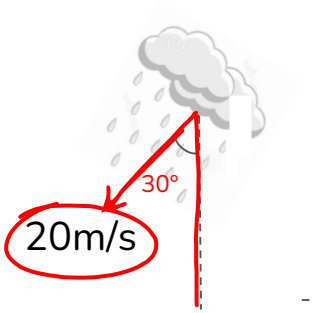
$\frac{V}{2} = \frac{20\sqrt{3}}{2}$

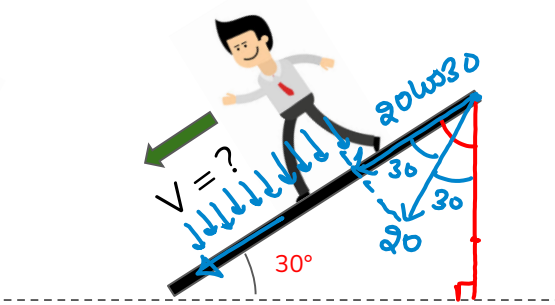
Example

MCQ type Question [+4 , -1]

Find the velocity of man so that rain appears to fall perpendicular to the incline.

A. 20 √3 m/s
B. 10 √3 m/s
C. 20 / √3 m/s
D. 10 /√3 m/s





$\overline{V}_{m,\text{incline}} = \overline{V}_{R,\text{incline}}$

$V = 20\cos 30$

$V = 10\sqrt{3}$ m/s

Example

MCQ type Question [+4 , -1]

HW

A man standing on a road has to hold his umbrella at 30 with the verticle to keep the rain away. He throws the umbrella and starts running at 10 km/hr then he finds that rain drops are hitting his head vertically, then speed of rain drops with respect to moving man :–

(1) 20 km/hr.

(2) $10\sqrt{3}$ km/hr.

(3) $\frac{10}{\sqrt{3}}$ km/hr.

(4) 10 km/hr.

Example

MCQ type Question [+4 , -1]

HW

A boy is running on the plane road with velocity (v) with a long hollow tube in his hand. The water is falling vertically downwards with velocity (u). At what angle to the vertical, he must incline the tube so that the water drops enters in it without touching its side :–

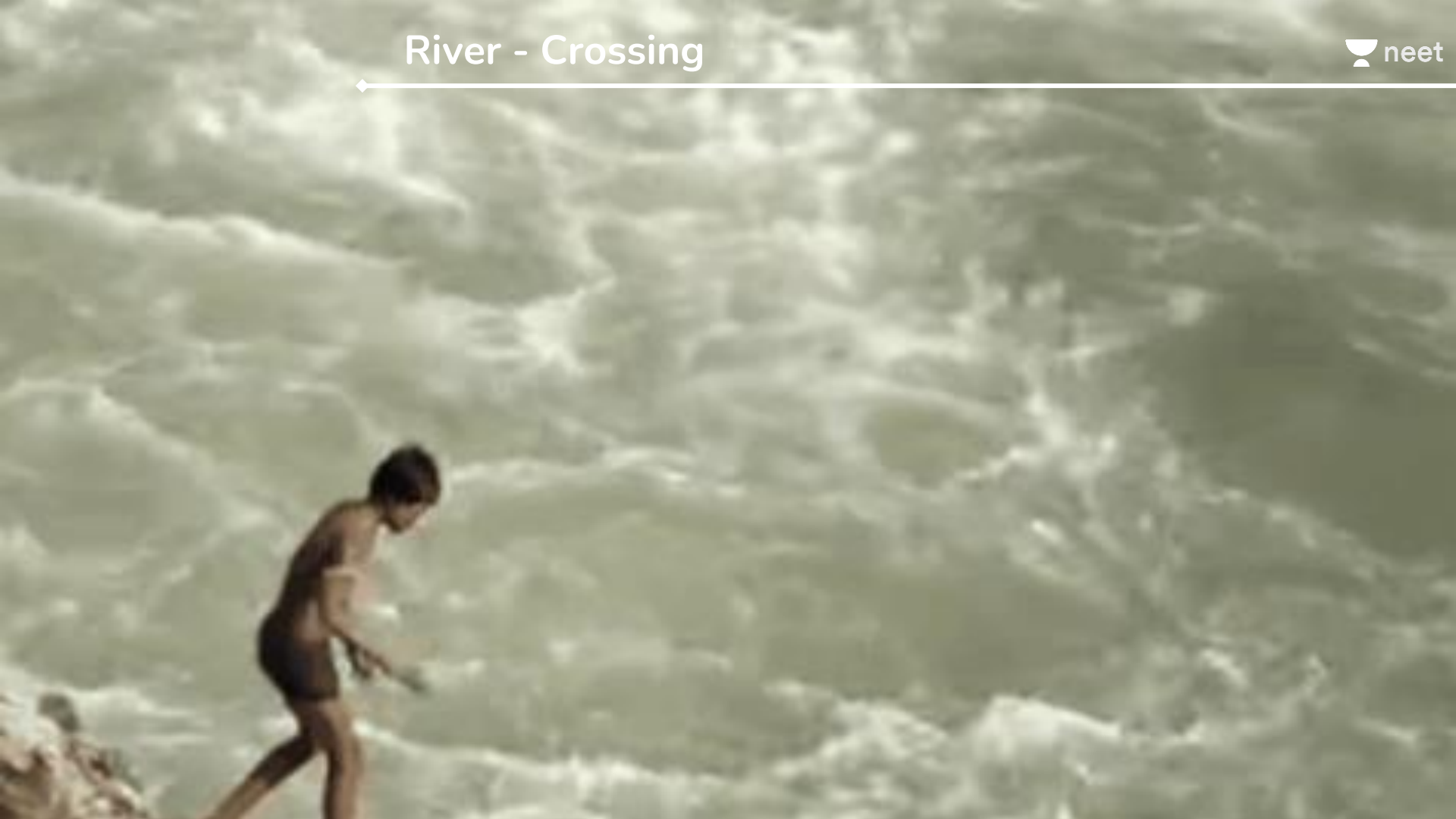
(1) $\tan^{-1}\left(\frac{v}{u}\right)$

(2) $\sin^{-1}\left(\frac{v}{u}\right)$

(3) $\tan^{-1}\left(\frac{u}{v}\right)$

(4) $\cos^{-1}\left(\frac{v}{u}\right)$

River - Crossing



$$\bar{V}_{S/W} = \bar{V}_{S/G} - \bar{V}_{W/G} \quad ; \quad \bar{V}_{S/G} = \bar{V}_{S/W} + \bar{V}_{W/G}$$

$$\bar{V}_{S/W} = V$$

$$\bar{V}_{W/G} = u = \bar{V}_R$$

Example

MCQ type Question [+4 , -1]

A boat is sailing at a velocity $(3\hat{i}+4\hat{j})$ with respect to ground and water in river is flowing with a velocity $(-3\hat{i}-4\hat{j})$. Relative velocity of the boat with respect to water is :-

(1) $8\hat{j}$

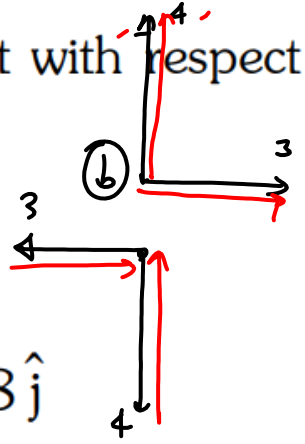
(2) $5\sqrt{2}$

(3) $6\hat{i}+8\hat{j}$

(4) $-6\hat{i}-8\hat{j}$

$\vec{V}_{b/g} = 3\hat{i}+4\hat{j}$

$\vec{V}_{w/g} = -3\hat{i}-4\hat{j}$



$\vec{V}_{b/w} = \vec{V}_{b/g} - \vec{V}_{w/g}$

$= 3\hat{i}+4\hat{j}-(-3\hat{i}-4\hat{j})$.

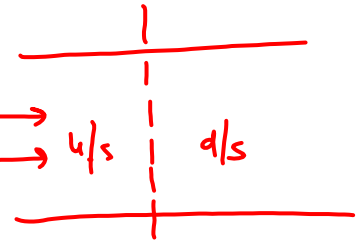
Example

MCQ type Question [+4 , -1]

A boat covers certain distance between two spots on a river taking 't_1' time, going down stream and 't_2' time going upstream, what time will be taken by the boat to cover the same distance in still water :-

(1) $\frac{t_1 + t_2}{2}$

(2) $\frac{t_1}{2} + \frac{3}{4} t_2$

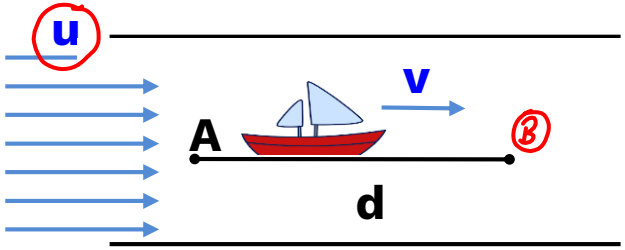


(3) $\frac{2t_1 t_2}{t_1 + t_2}$

(4) $\frac{t_1 + t_2}{2t_1 t_2}$

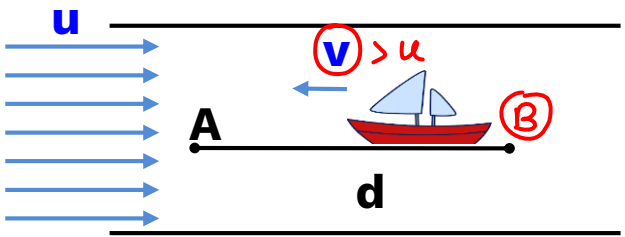


Solution



$$\frac{d}{u+v} = t_1$$

$$d = \boxed{(u+v)\,t_1 = (v-u)\,t_2}$$



$$\frac{d}{v-u} = t_2$$

$v > u$

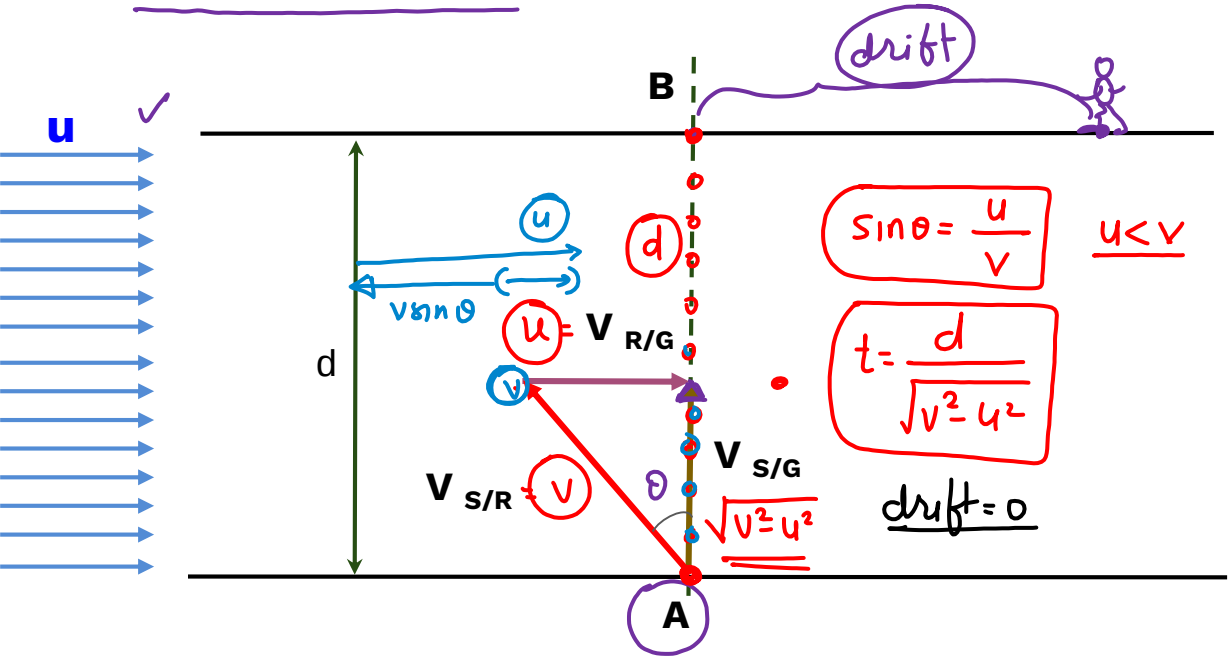
$v < u$

boat will never reach (A)

$u = 0$, still water

$$t_3 = \frac{d}{v} = \frac{2t_1t_2}{t_1+t_2}$$

Shortest distance (minimum Drift)



$\sin\theta = \frac{u}{v}$ $u<v$

$t = \frac{d}{\sqrt{v^2-u^2}}$

drift = 0

what if $u>v$

$\sin\theta \not> 1$

$\sin\theta = \frac{v}{u}$ $v<u$

$v_x = (u - v\sin\theta)$

$t = \frac{d}{v\cos\theta}$

$x = v_x t = (u - v\sin\theta)\frac{d}{v\cos\theta}$

Swimmer crosses river perpendicularly

Example

MCQ type Question [+4 , -1]

A man wishes to swim across a river 0.5 km. wide. If he can swim at the rate of 2 km/h. in still water and the river flows at the rate of 1 km/h. The angle (w.r.t. the flow of the river) along which he should swim so as to reach a point exactly opposite his starting point, should be :-

$d = \frac{1}{2}$ km

$v = 2$ km/hr

$u = 1$ km/hr

$u < v$

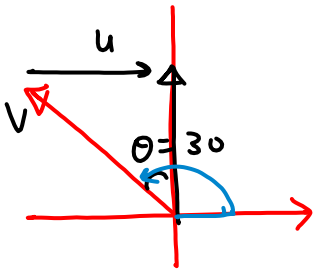
drift = 0

(1) 60

(2) 120

(3) 145

(4) 90



$\sin\theta = \frac{u}{v} = \frac{1}{2}$

$\alpha = 90 - \theta$

$= 90 - 30.$

Example

MCQ type Question [+4 , -1]

A boat man can row with a speed of 10 km./hr. = v in still water. The river flow steadily at 5 km/hr. = u and the width of the river is 2 km. (d) If the boat man cross the river with reference to minimum distance of approach then time elapsed in rowing the boat will be :-

$\frac{dw}{} = 0$, $t = \frac{d}{\sqrt{v^2-u^2}} = \frac{2}{\sqrt{10^2-5^2}} = \frac{2}{5\sqrt{3}}$

(1) $\frac{2\sqrt{3}}{5}$ hour

(2) $\frac{2}{5\sqrt{3}}$ hour

(3) $\frac{3\sqrt{2}}{5}$ hour

(4) $\frac{5\sqrt{2}}{3}$ hour

Example

MCQ type Question [+4 , -1]

A boat which has a speed of 5km per hour in still water crosses a river of width 1km along the shortest possible path in fifteen minutes. The velocity of the river water in km per hour is :-

$t = \frac{d}{\sqrt{v^2 - u^2}} = 15\text{min} = \frac{15}{60} = \frac{1}{4}$

[CET (PUNJAB) 1996, AIPMT 2000]

(1) 1

(2) 2

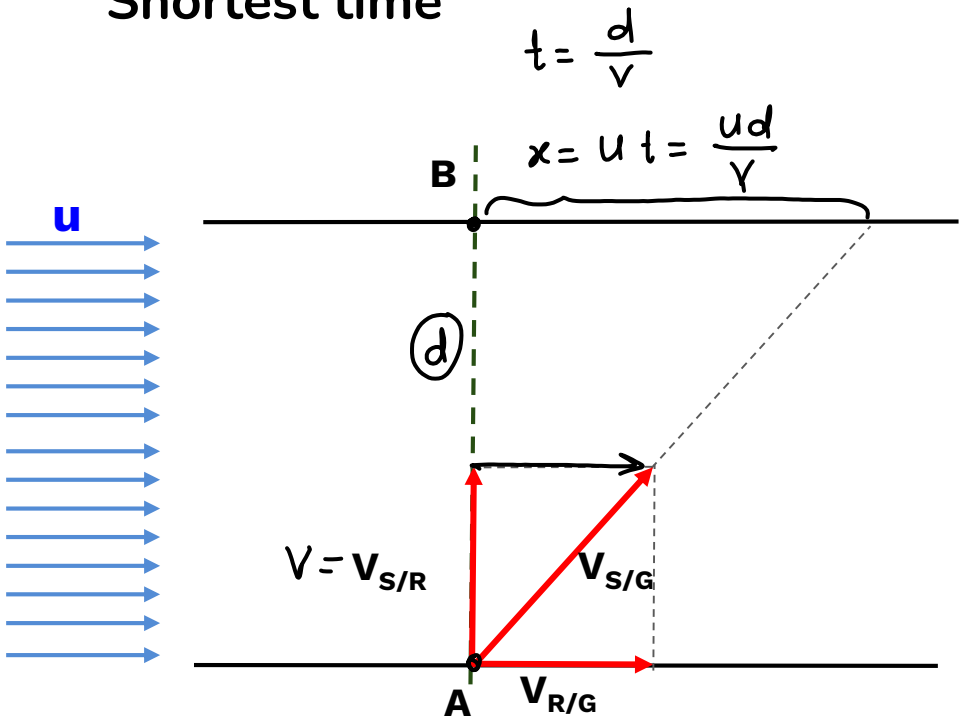
(3) 3

(4) $\sqrt{41}$

$\frac{1}{\sqrt{5^2 - u^2}} = \frac{1}{4}$

$4 = \sqrt{5^2 - u^2}$

Shortest time



Swimmer swims **perpendicular** to river flow.

Example

MCQ type Question [+4 , -1]

A river is flowing from east to west at a speed of 5m/min. A man on south bank of river, capable of swimming 10 m/min in still water, wants to swim across the river in shortest time; he should swim :–

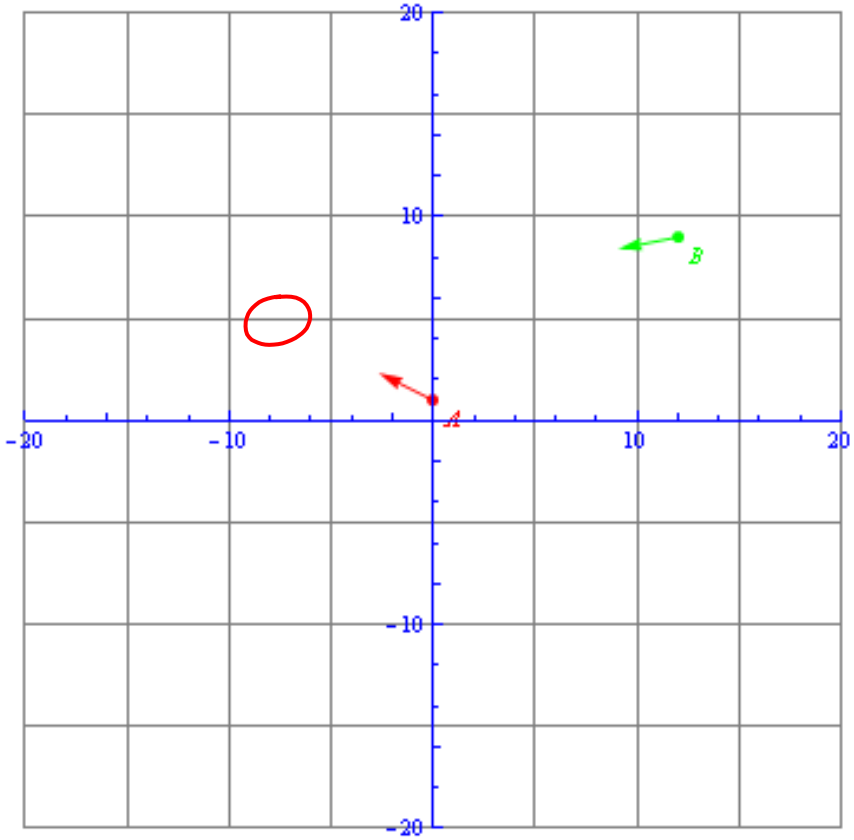
(1) due north

(2) due north-east

(3) due north-east with double the speed of river

(4) none of the above

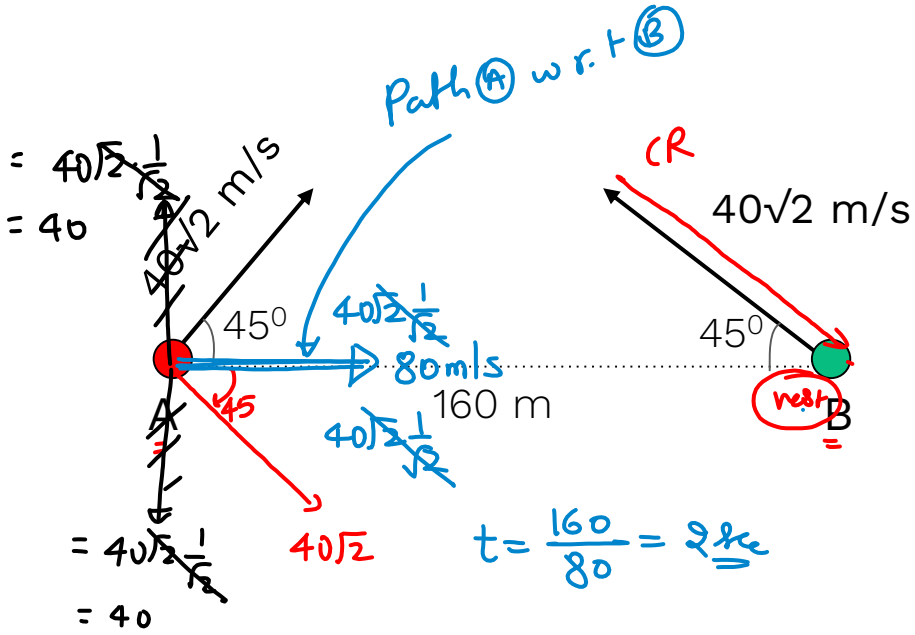
Collision of moving particle



Example

Find the time of collision

$$V_{A/B} = \frac{x_{B/A}}{\Delta t}$$

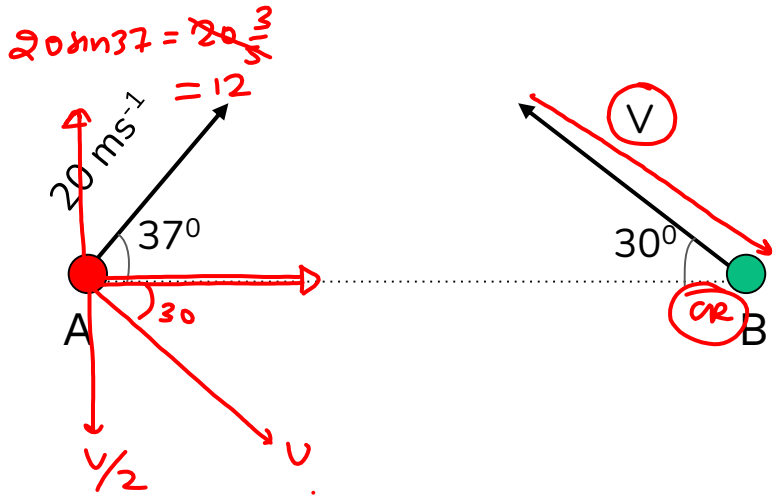


Example

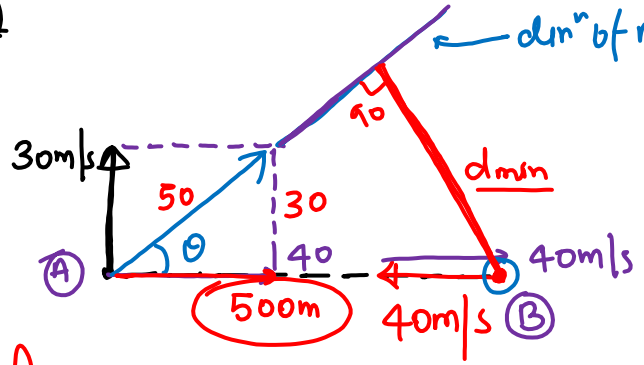
Find ‘V’ so that two particles collide.

$12 = \frac{V}{2}$

$V = 24\ m/s$



eg



i) whether they collide or not ?

⇓

No

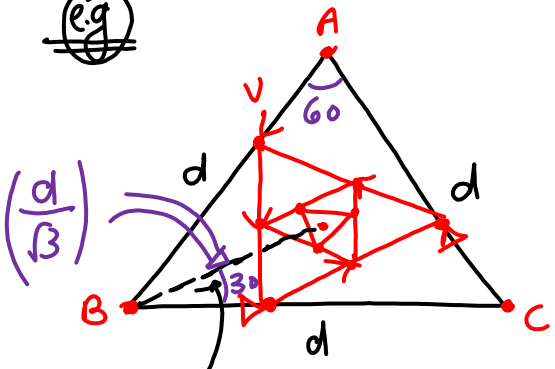
$d_{min} = ?$

$\sin\theta = \frac{d_{min}}{500}$

$d_{min} = 500 \sin\theta = \overset{100}{\cancel{500}} \times \frac{3\cancel{0}}{\cancel{50}}$

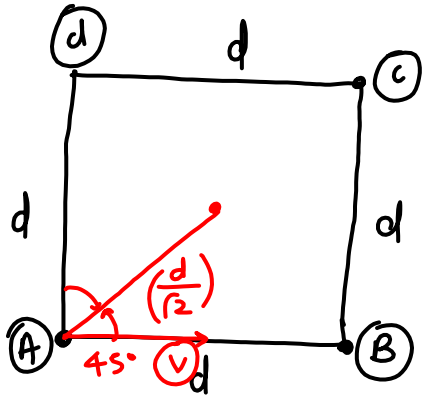
$d_{min} = 300\,m$

e.g



dist travelled by particle to collide with other

$$t = \frac{d}{\sqrt{3}\, V\cos 30^\circ} = \frac{d}{\frac{\sqrt{3}\sqrt{3}V}{2}} = \frac{2d}{3V}$$



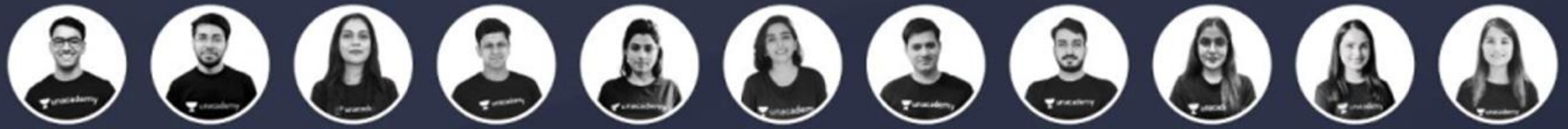
time of collision ?

$$t = \frac{d/\sqrt{2}}{V\cos 45} = \frac{d}{\sqrt{2}V\frac{1}{\sqrt{2}}} = \frac{d}{V}$$

unacademy

All Star Batch for NEET 2022

Starts on April 4, 2022



Mahendra Singh | Vishal Vivek | Garima Goel | Gaurav Gupta | Ritu Rattewal | Rakshita Singh | Anurag Tiwari | Sunil Yadav | Komal Yadav | Gargi Singh | Seep Pahuja

Enroll Now

Call for more details **8585858585**

unacademy

Crack NEET UG with Unacademy

101 days to go for the exam!

Never before pricing on the 3-month plus subscription

Old Price	Current Price
~~19,250~~	11,100

MSLIVE



Hurry! Offer Extended till today.

Enroll Now

Call for more details 8585858585

unacademy

Let's crack NEET UG with Unacademy

Introducing the 3-month Iconic Subscription

Hurry! Offer Extended till today.

₹ 22,000 Only!

Enroll Now

Call for more details **8585858585**



unacademy

Envision Batch for Target 2023

Starts on April 6, 2022


Anoop Vashishtha


Komal Yadav


Mahendra Singh

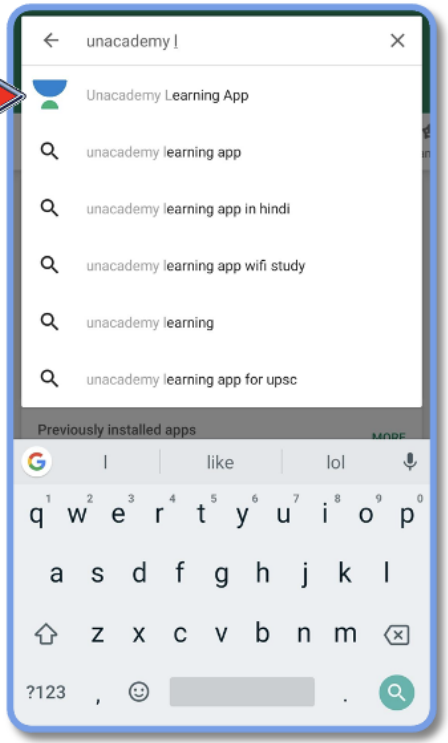

Seep Pahuja


Akansha Karnwal

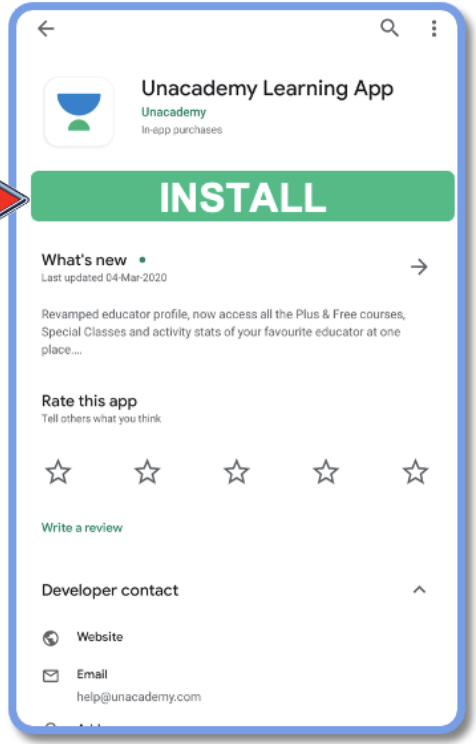
Enroll Now

Call for more details **8585858585**

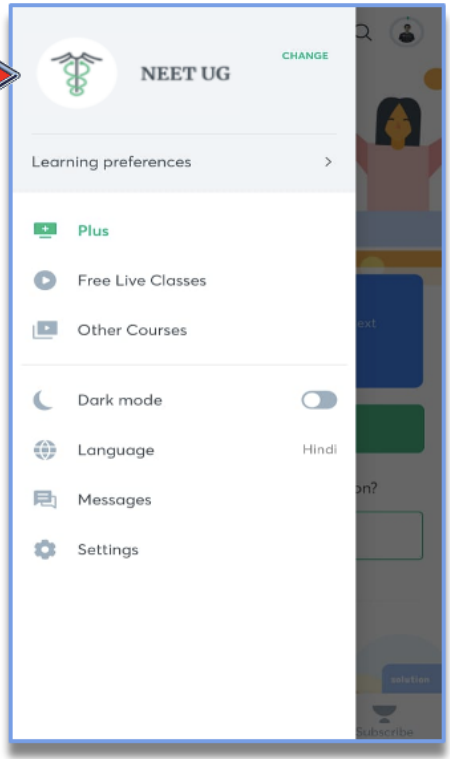
Step 1



Step 2



Step 3



THANK YOU

#NEETLiveDaily

Give a Boost to Your Preparation With

MSLIVE

