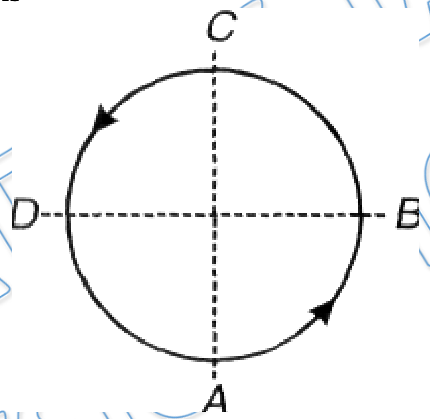
DPP - 7 (Kinematics)

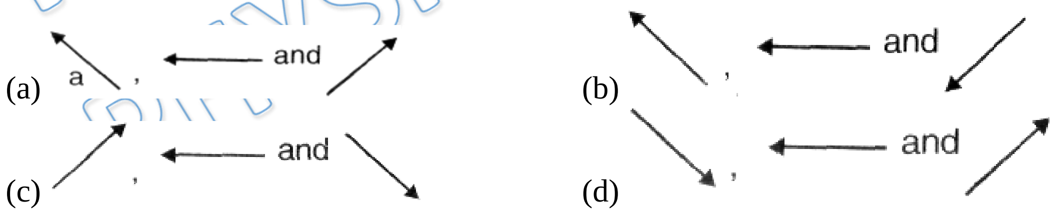
Video Solution on Website:- https://physicsaholics.com/home/courseDetails/52

Video Solution on YouTube:- https://youtu.be/U1KzcPu-QAg

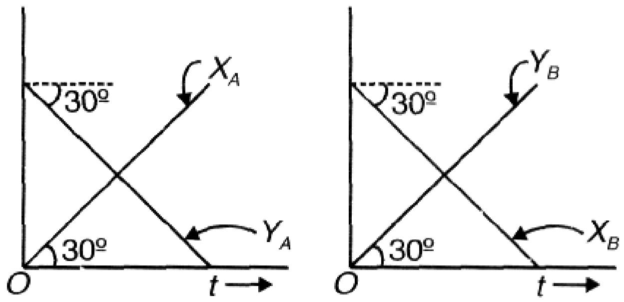
Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/74

Q 1. Four persons A, B, C and D are all moving on the same circular track with same constant speed in the anti-clockwise direction. At an instant they are located at the positions shown in figure, then the velocity of B, C and D as observed by A will have the respective directions





Q 2. Displacement versus time plot for two particles A and B is shown below. X_A, X_B and Y_A, Y_B refer to x and y coordinates of particles A and B. Velocity of particle A with respect to particle B is

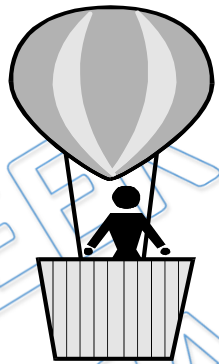


(a) $0\hat{\imath} + 0\hat{\jmath}$ (b) dependent of time t
(c) $\frac{2}{\sqrt{3}}\hat{\imath} - \frac{2}{\sqrt{3}}\hat{\jmath}$ (d) $-\frac{2}{\sqrt{3}}\hat{\imath} + \frac{2}{\sqrt{3}}\hat{\jmath}$

Q 3. Ball A is dropped from the top of a building. At the same instant ball B is thrown vertically upwards from the ground. When the balls collide, they are moving in opposite directions and the speed of A is twice the speed of B. At what fraction of the height of the building did the collision occurs?

(a) $\frac{1}{3}$ (b) $\frac{2}{3}$ (c) $\frac{1}{4}$ (d) $\frac{2}{5}$

Q 4. A man in a balloon, throws a stone downwards with a speed of 5 m/s with respect to balloon. The balloon is moving upwards with a constant acceleration of 5 m/s^2. Then velocity of the stone relative to the man after 2 second is (g = 10m/s^2):



(a) 10 m/s (b) 30 m/s
(c) 15 m/s (d) 35 m/s

Q 5. A train is standing on a platform, a man inside a compartment of a train drops a stone. At the same instant train starts to move with constant acceleration. The path of the particle as seen by the person who drops the stone is :

(a) parabola
(b) straight line for sometime & parabola for the remaining time
(c) straight line
(d) variable path that cannot be defined

Q 6. A coin is released inside a lift at a height of 2 m from the floor of the lift. The height of the lift is 10 m. The lift is moving with an acceleration of 9 m/s^2 downwards. The time after which the coin will strike with the lift is : (g = 10 m/s^2)

(a) 4 s (b) 2 s (c) $\frac{4}{\sqrt{21}}$s (d) $\frac{2}{\sqrt{11}}s$

Q 7. Two particles A and B start simultaneously from the same point and move in a horizontal plane. A has an initial velocity u_1 due east and acceleration a_1 due north. B has an initial velocity u_2 due north and acceleration a_2 due east

(a) Their path must intersect at same point
(b) They must collide at some point
(c) They will collide only if $a_1 u_1 = a_2 u_2$
(d) If $u_1 > u_2$ and $a_1 < a_2$ the particles will have the same speed at some point of time

Q 8. Two particles start moving from the same point along the same straight line. The first moves with constant velocity v and the second with constant acceleration a. During the time that elapses before the second catches the first, the greatest distance between the particles is

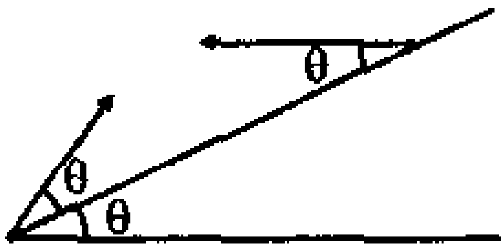
(a) $\frac{v^2}{a}$ (b) $\frac{v^2}{2a}$ (c) $\frac{2v^2}{a}$ (d) $\frac{v^2}{4a}$

Q 9. A person walks up a stationary escalator in time t_1. It he remains stationary on the escalator, then it can take him up in time t_2. How much time would it take him to walk up the moving escalator?

(a) $\frac{t_1 t_2}{t_1+t_2}$ (b) $\sqrt{t_1 t_2}$ (c) $\frac{t_1 t_2}{t_1+t_2}$ (d) $t_1 + t_2$

Q 10. Two stones are thrown up simultaneously from the edge of a cliff with initial speeds v and 2v. The relative position of the second stone with respect to first varies with time till both the stones strike the ground as :
(assume that the first stone comes to rest after striking the ground)
(a) linearly
(b) first linearly then parabolically
(c) parabolically
(d) first parabolically then linearly

Q 11. From an inclined plane two particles are projected with same speed at same angle θ, one up and other down the plane as shown in figure. Which of the following statement(s) is/are correct ?



(a) The particles will collide the plane with same speed
(b) The times of flight of each particle are same
(c) Both particles strike the plane perpendicularly
(d) The particles will collide in mid air if projected simultaneously and time of flight of each particle is greater than the time of collision

Q 12. A student is standing on a train travelling along a straight horizontal track at a speed of 10 m/s. The student throws a ball into the air along a path, that he sees to make an initial angle of 60° with the horizontal along the track. The professor standing on the ground observes the ball to rise vertically, the maximum height reached by the ball is H . Find H (in m)

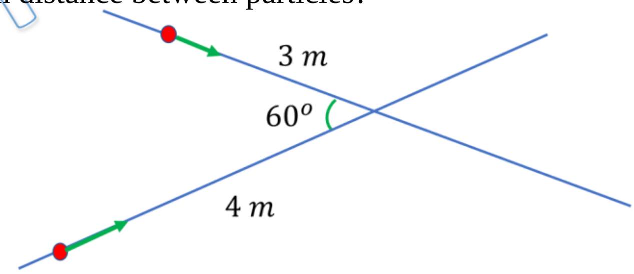
(a) 10 (b) 15 (c) 20 (d) none

Q 13. Two frames of reference P and Q are moving relative to each other at constant velocity. Let $\vec{v}_{OP}$ and $\vec{a}_{OP}$ represent the velocity and the acceleration respectively of a moving particle O as measured by an observer in frame P and $\vec{v}_{OQ}$ and $\vec{a}_{OQ}$ represent the velocity and the acceleration respectively of the moving particle O as measured by an observer in frame Q, then

(a) $\vec{v}_{OP} = \vec{v}_{OQ}$ (b) $\vec{v}_{OP} = \vec{v}_{OQ} + \vec{v}_{QP}$
(c) $\vec{a}_{OP} = \vec{a}_{OQ}$ (d) $\vec{a}_{OP} = \vec{a}_{OQ} + \vec{a}_{QP}$

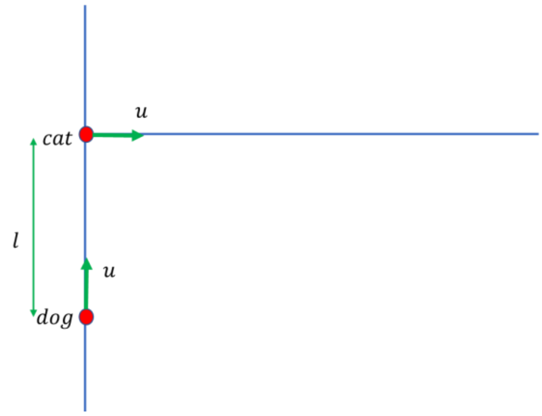
Q 14. A projectile is projected from a point O on ground. At same instant a bird starts moving uniformly with same initial velocity from same point. When projectile is at its maximum height, bird is distance h above projectile. Find height of bird when projectile falls on ground?
(a) h (b) 2h (c) 3h (d) 4h

Q 15. As shown in figure, particles moving with constant speed 10 m/s along the lines shown. Find minimum distance between particles?



(a) 1 m (b) $\frac{\sqrt{3}}{2}$ m
(c) 2 m (d) $\sqrt{3}$ m

Q 16. Initial situation is shown in figure. Cat runts along x- axis with constant velocity u. Dog chases it with constant speed u and keeps its direction of motion always towards cat. Will the dog catch the cat? If not, then find distance between cat & dog after long time?



(a) l (b) $\frac{l\sqrt{3}}{2}$

(c) $\frac{l}{2}$ (d) $\sqrt{2}l$

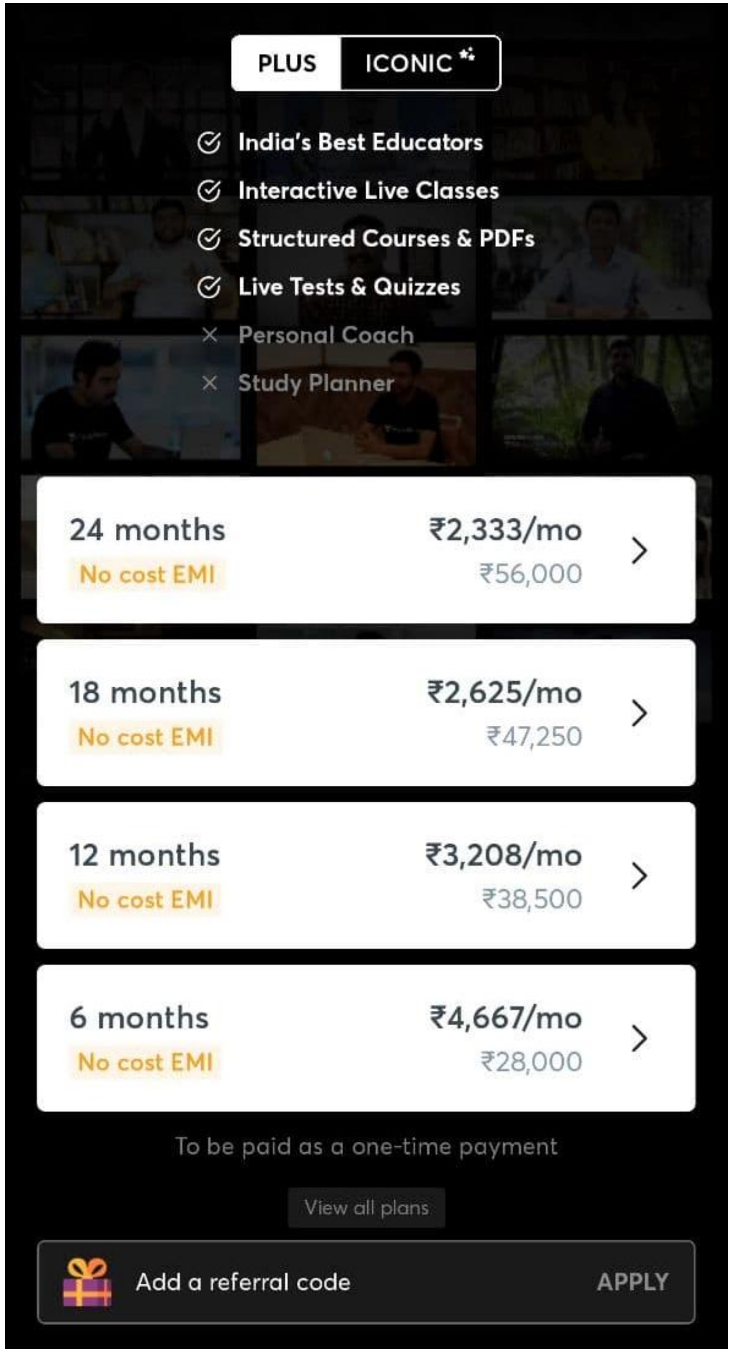
Q 17. A straight road connects two cities. In certain intervals of time two buses from each city move to the other with equal velocities. To a cyclist moving at 15 km/hr moving from one city to another a bus from behind overtakes in every 15 minutes and crosses from the other direction in every 9 minutes. Find the velocity of the buses and their time interval.

(a) 45 km/hr, 21 min. 25 sec (b) 60 km/hr, 11 min. 15 sec

(c) 15 km/hr, 45 min. 10 sec (d) 30 km/hr, 22 min. 30 sec

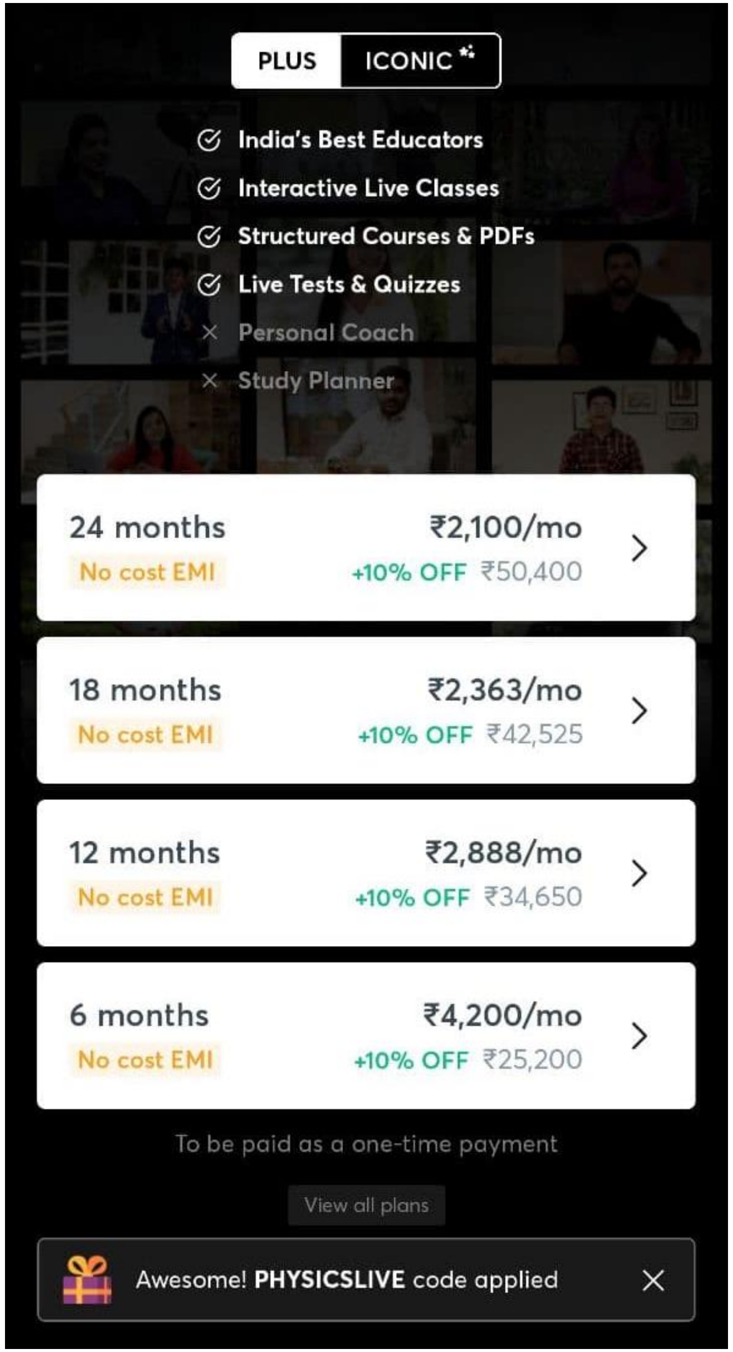
Answer Key

Q.1 b	Q.2 c	Q.3 b	Q.4 d	Q.5 c
Q.6 b	Q.7 a,c,d	Q.8 b	Q.9 c	Q.10 b
Q.11 b, d	Q.12 b	Q.13 b,c,d	Q.14 d	Q.15 b
Q.16 c	Q.17 b			



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.

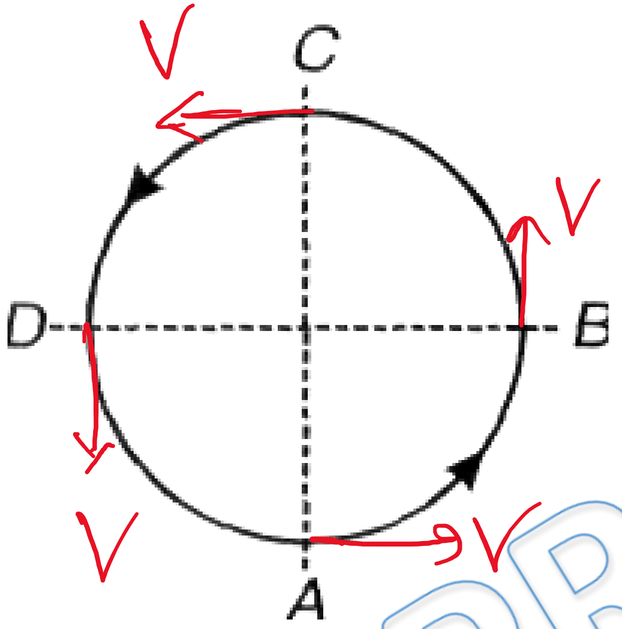


Written Solution

DPP-7 Relative motion in One-Dimension

By Physicsaholics Team

Solution: 1



$$\vec{V}_{C,A} = \vec{V}_C - \vec{V}_A = \vec{V}_C + (-\vec{V}_A)$$

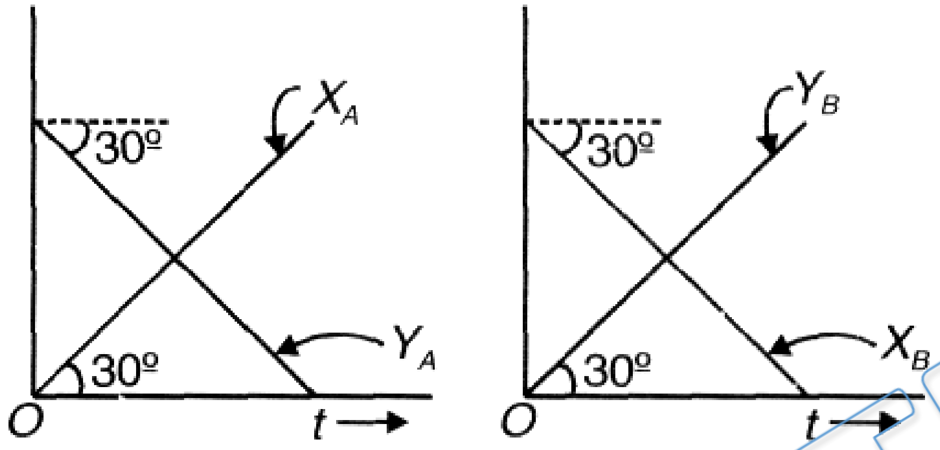
$$= \overleftarrow{V} + \overleftarrow{V} = 2V \leftarrow$$

$$\vec{V}_{B,A} = $$

$$\vec{V}_{D,A} = $$

ANS : b

Solution: 2



$$\vec{V}_{A,B} = \vec{V}_A - \vec{V}_B$$

$$= \frac{2}{\sqrt{3}}\hat{i} - \frac{2}{\sqrt{3}}\hat{j}$$

$$\vec{V}_A = x_A\hat{i} + y_A\hat{j}$$

$$= \tan 30\,\hat{i} + (-\tan 30)\hat{j}$$

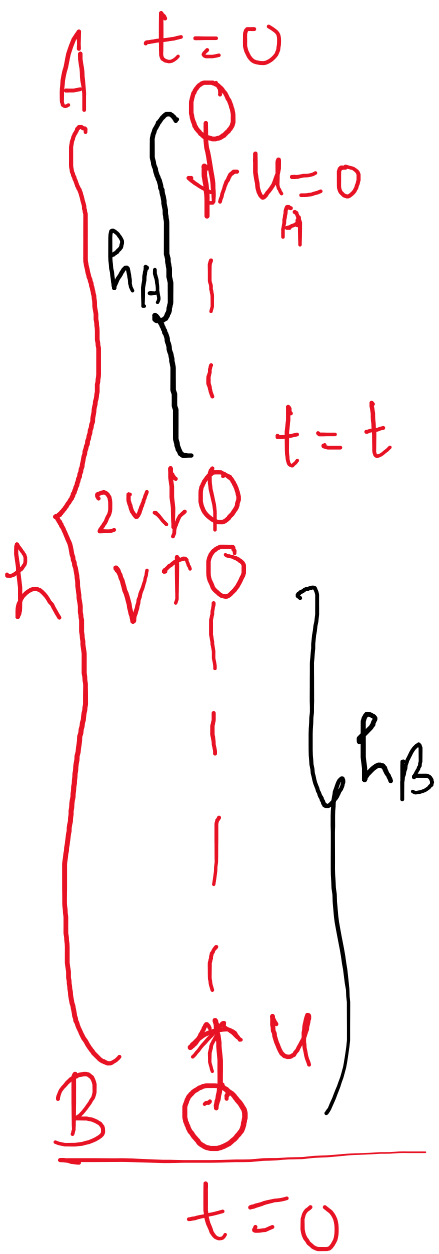
$$= \frac{1}{\sqrt{3}}\hat{i} - \frac{1}{\sqrt{3}}\hat{j}$$

$$\vec{V}_B = x_B\hat{i} + y_B\hat{j}$$

$$= -\tan 30\,\hat{i} + \tan 30\,\hat{j} = -\frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j}$$

ANS : c

Solution: 3



Since both have acceleration g↓, relative acceleration is zero ⇒ rel. velocity is constant.

$\Rightarrow \quad u = 3v \quad \Rightarrow \quad v = u/3$

for A → $v^2 = u^2 + 2ax \Rightarrow \left(\frac{2u}{3}\right)^2 = 0 + 2g h_A$

$$h_A = \frac{2u^2}{9g}$$

for B → $v^2 = u^2 + 2ax \Rightarrow \frac{u^2}{9} = u^2 - 2g h_B$

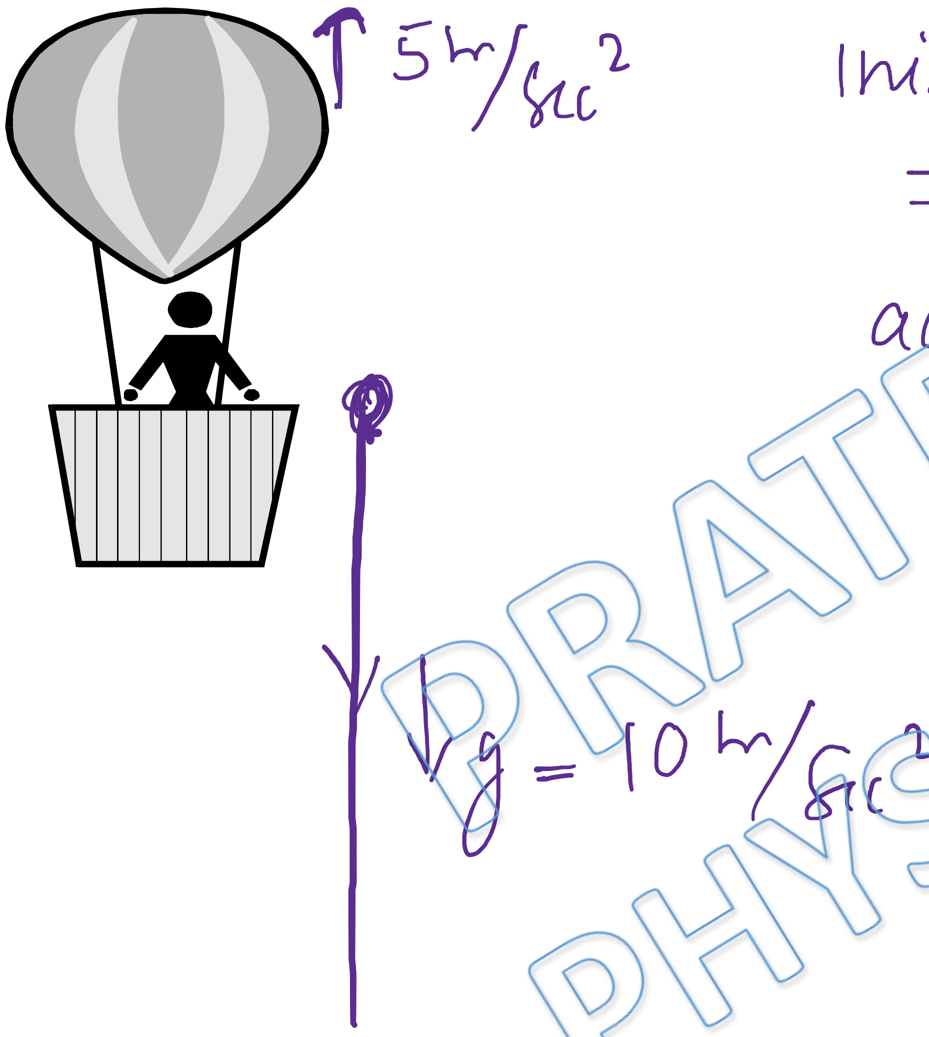
$$h_B = \frac{4u^2}{9g}$$

$\Rightarrow h = h_A + h_B = \frac{6u^2}{9g}$

$$\text{fraction} = \frac{h_B}{h} = \frac{4u^2/9g}{6u^2/9g} = 2/3$$

ANS : b

Solution: 4



Initial velocity of stone w.r.t. man $= 5\ m/sec \downarrow$

acceleration of stone w.r.t. man $= 15\ m/sec^2 \downarrow$

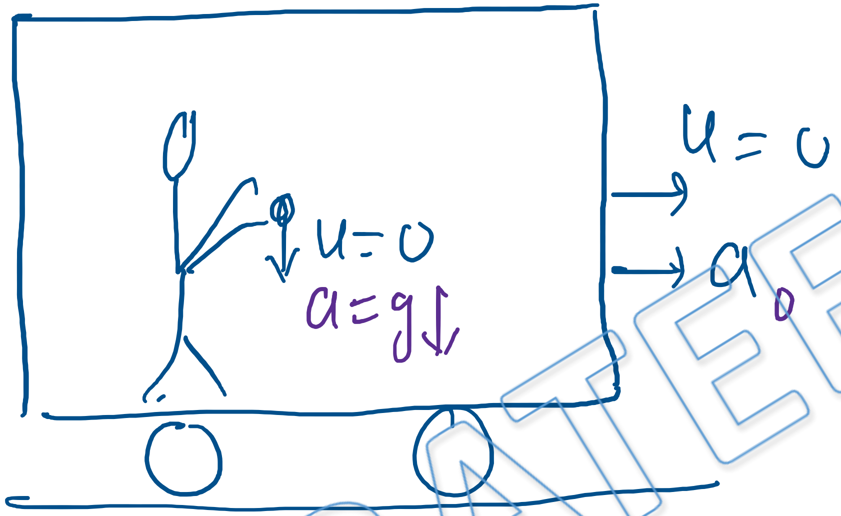
velocity of stone w.r.t. man $= u + at = 5 + 15 \times 2$

$= 35\ m/sec$

ANS : d

Solution: 5

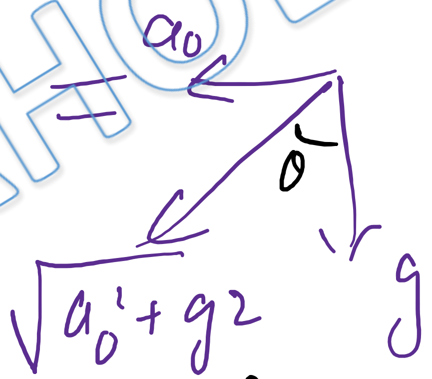
w.r.t. ground



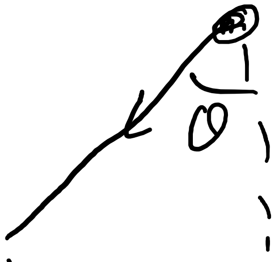
w.r.t. man

⇒ initial velocity of ball = 0

acceleration of ball



⇒ Path of ball

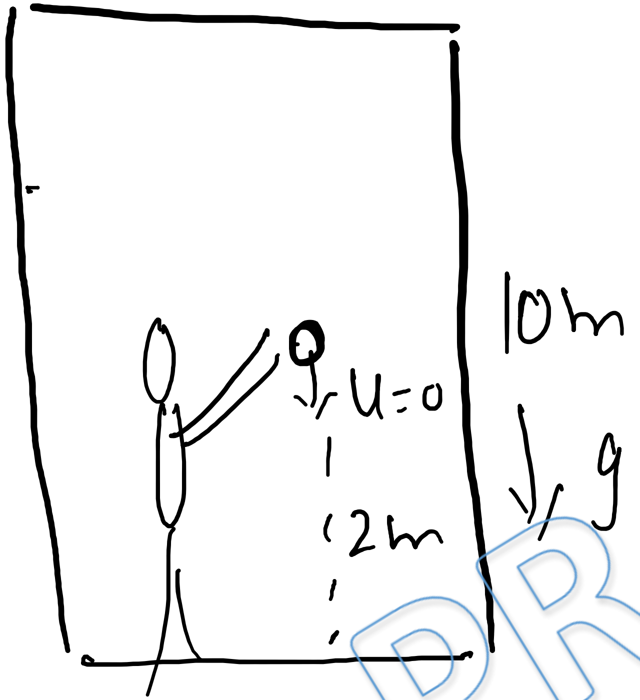


w.r.t. man, ball has zero initial velocity & constant acceleration ⇒ st. line path.

$\theta = \tan^{-1}\left(\frac{a_0}{g}\right)$

ANS : c

Solution: 6



Initial velocity of ball w.r.t. lift = 0

acceleration of ball w.r.t. lift $= \uparrow 9\,m/sec^2 \;\; \downarrow 10\,m/sec^2 = \downarrow 1\,m/sec^2$.

Displacement of ball w.r.t. lift $= 2m$.

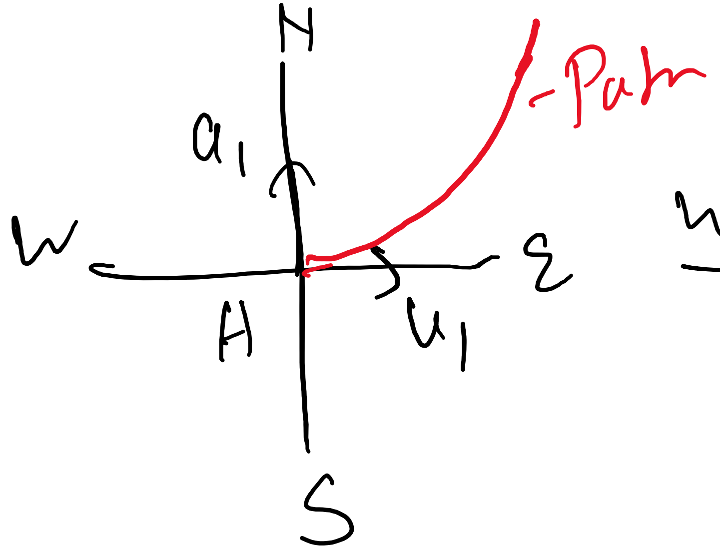
now →

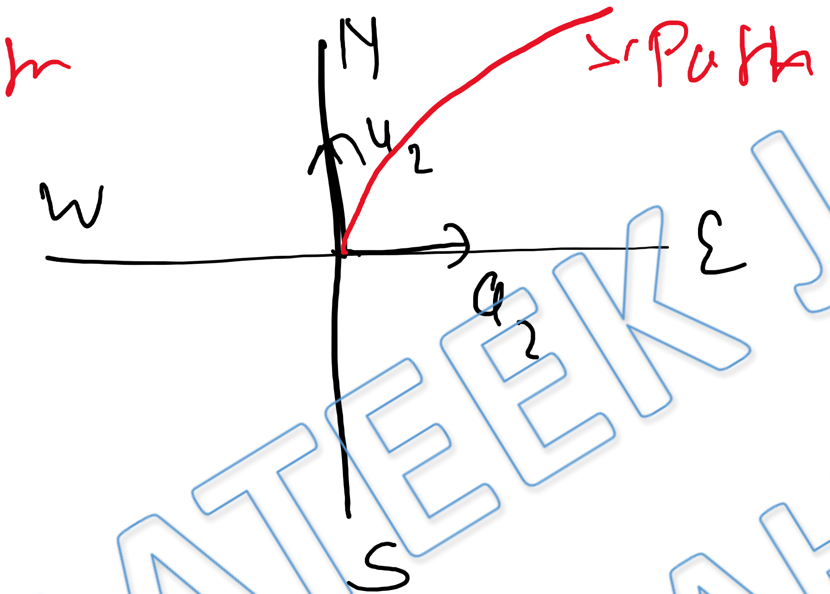
$$x = ut + \frac{1}{2}at^2 \Rightarrow 2 = \frac{1}{2} \times 1\, t^2$$

$$t = 2\,Sec$$

ANS : b

Solution: 7

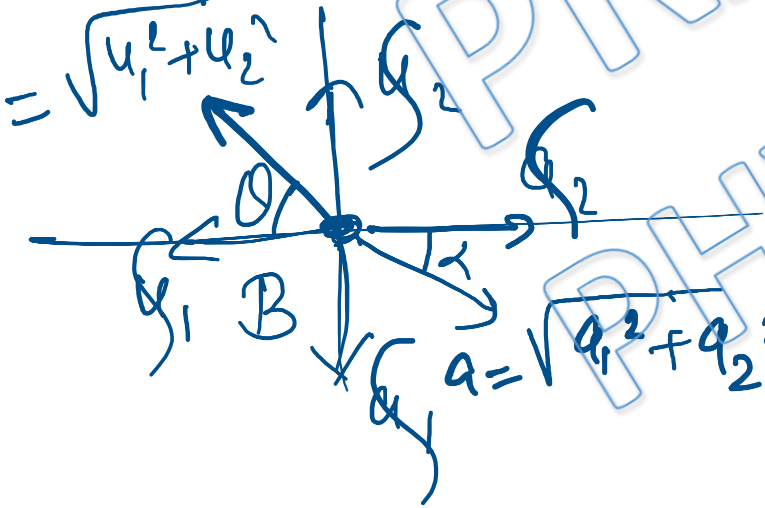




⇒ It is clear that Paths are intersecting

w.r.t. A

$u = \sqrt{u_1^2 + u_2^2}$



$a = \sqrt{a_1^2 + a_2^2}$

If $\vec{u}$ & $\vec{a}$ are just opposite,

⇒ B will appear to move on st. line & return back to hit A after sometime

for this $\theta = \alpha \Rightarrow \tan\theta = \tan\alpha$

$\Rightarrow \frac{u_2}{u_1} = \frac{a_1}{a_2} \Rightarrow u_1 a_1 = u_2 a_2$

If $u_1 a_1 \neq u_2 a_2 \Rightarrow$ They will not Collide

velocity of A at t = t $\Rightarrow \vec{V_A} = u_1 \hat{i} + a_1 t \hat{j}$

" " B " " $\Rightarrow \vec{V_B} = u_2 \hat{j} + a_1 t \hat{i}$

for $V_A = V_B$

$\Rightarrow u_1^2 + a_1^2 t^2 = u_2^2 + a_2^2 t^2$

$u_1^2 - u_2^2 = t^2 (a_2^2 - a_1^2)$

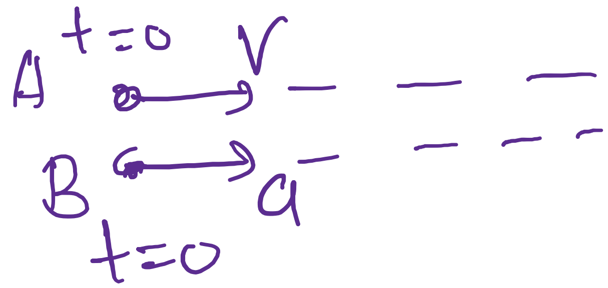
$t^2 = \frac{u_1^2 - u_2^2}{a_2^2 - a_1^2}$

we will get +ve value of t^2 if $u_1 > u_2$ & $a_2 < a_1$

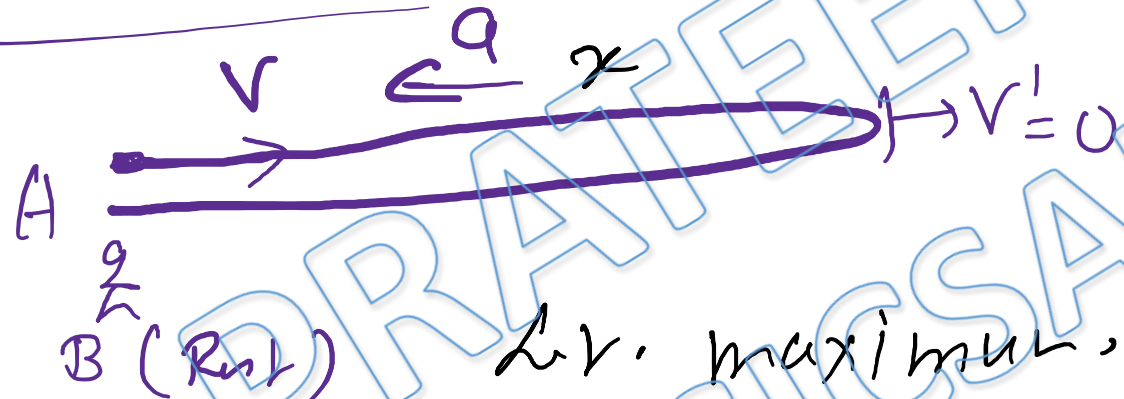
$\Rightarrow$ they will have same speed after some time if $u_1 > u_2$ & $a_2 < a_1$

ANS : a,c,d

Solution: 8



w.r.t. B



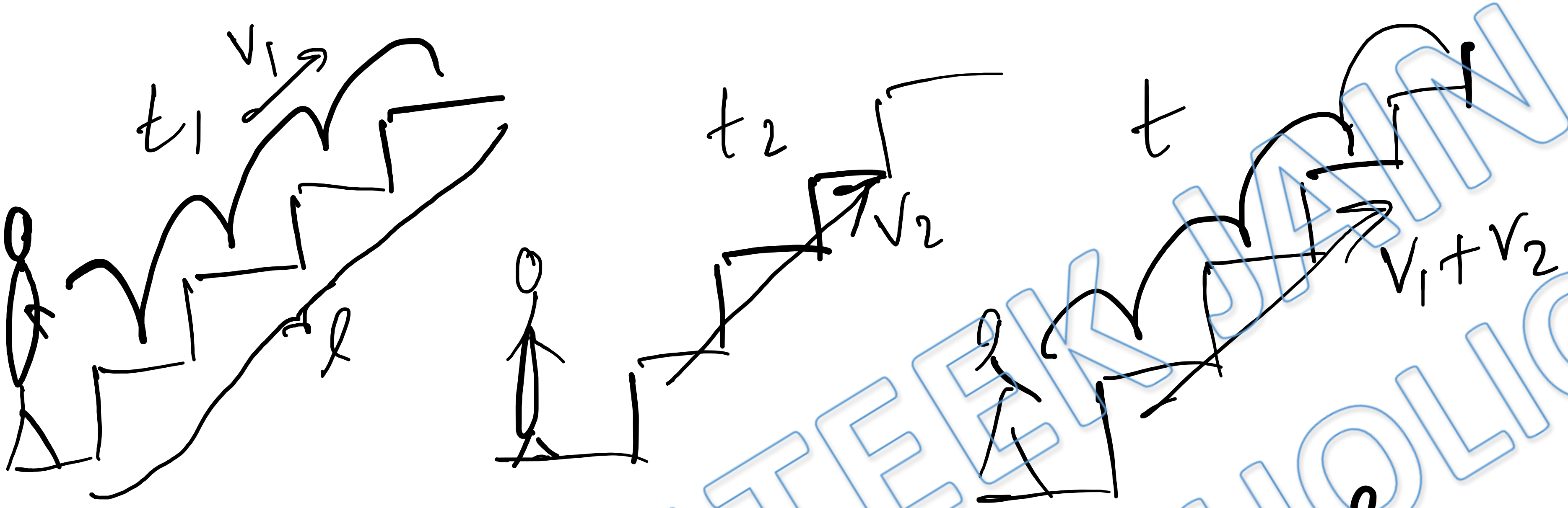
Let maximum distance b/w A & B is x.

$$V'^2 = V^2 - 2ax = 0$$

$$\Rightarrow x = \frac{V^2}{2a}$$

ANS : b

Solution: 9

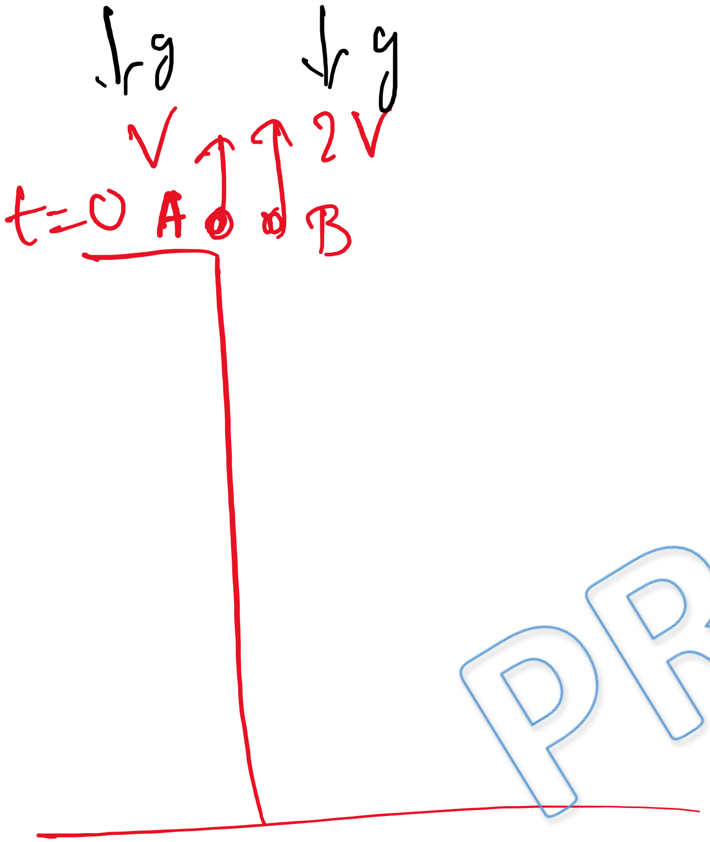


$$v_1 = \frac{\ell}{t_1} \qquad v_2 = \frac{\ell}{t_2} \qquad t = \frac{\ell}{v_1+v_2} = \frac{1}{\frac{v_1}{\ell}+\frac{v_2}{\ell}}$$

$$t = \frac{1}{\frac{1}{t_1}+\frac{1}{t_2}} = \frac{t_1 t_2}{t_1+t_2}$$

ANS : c

Solution: 10



Velocity of B w.r.t. A $= V \uparrow$

acceleration " " $= 0$

$\Rightarrow$ x-t graph is st. line.

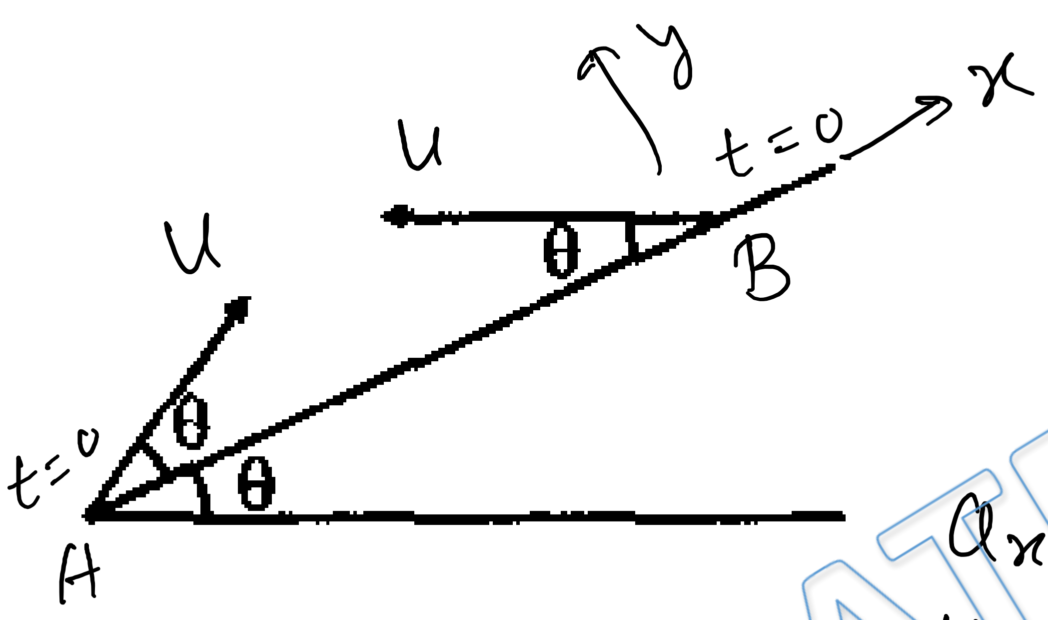
when A falls on ground & B is still in air

acceleration of B w.r.t. A $= g \downarrow$

$\Rightarrow$ x-t graph is Parabola.

ANS : b

Solution: 11



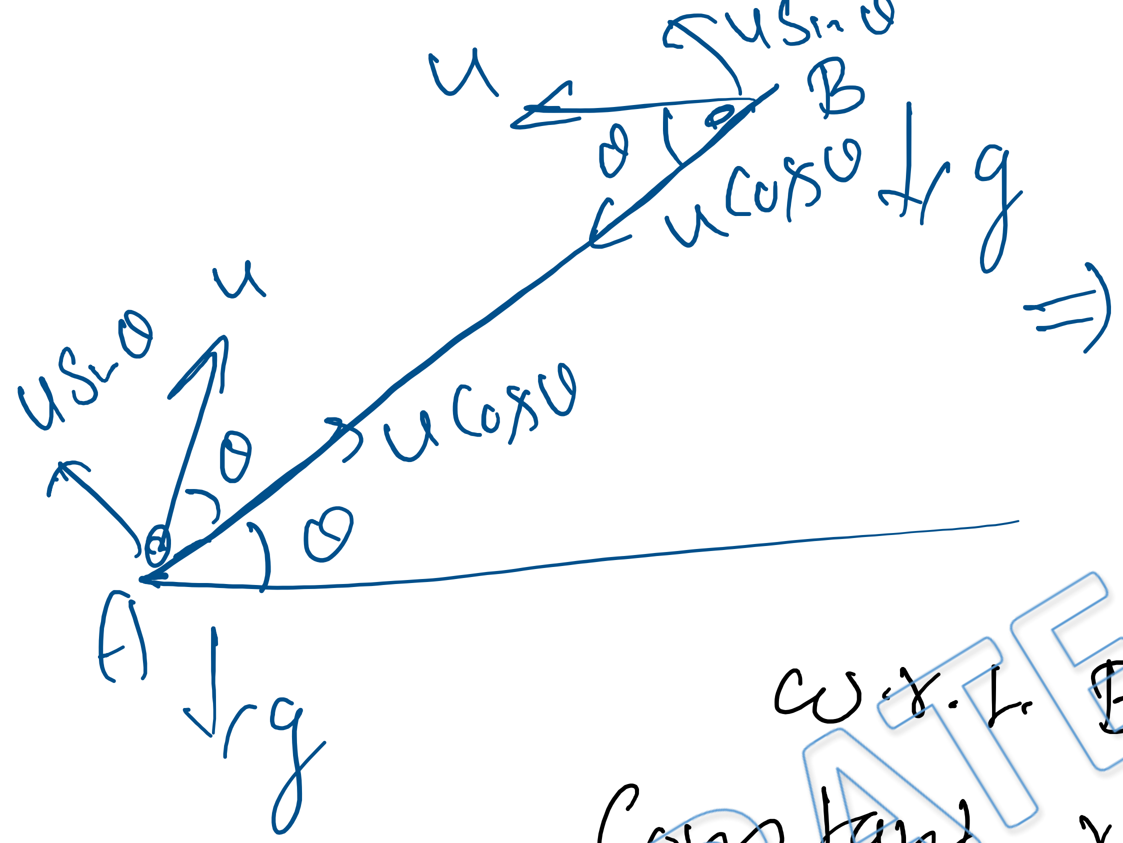
Their motions along y axis have same velocity & same acceleration $\Rightarrow$ same final V_y & T

but along x axis (A) has u_x & a_x in opposite direction & B has u_x & a_x in same direction

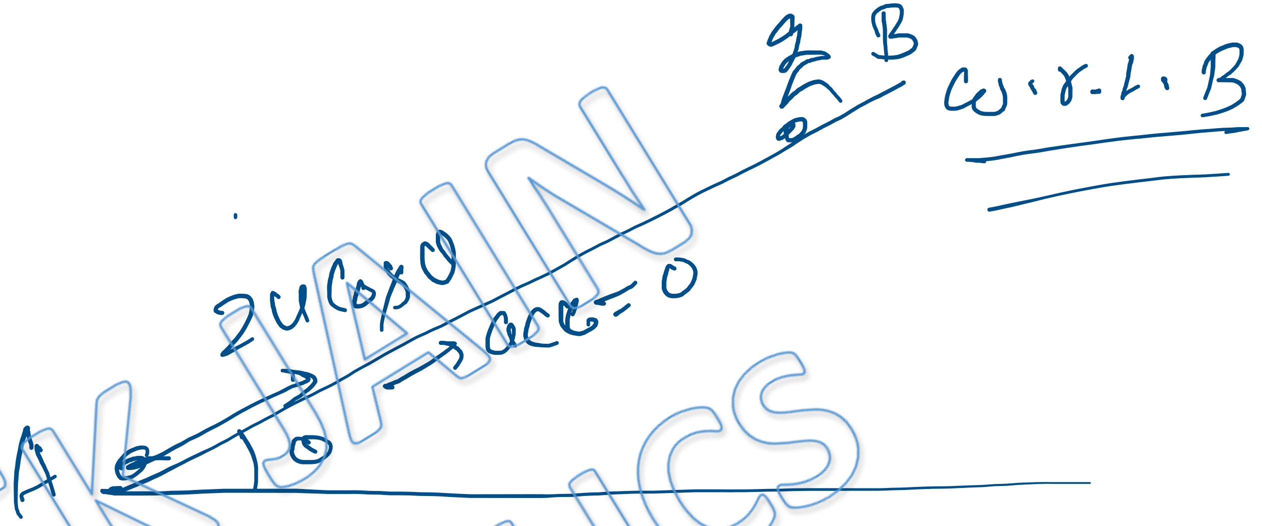
$\Rightarrow$ different final V_x

$\Rightarrow$ different final speed

(A) is wrong. (B) is Correct.



⇒

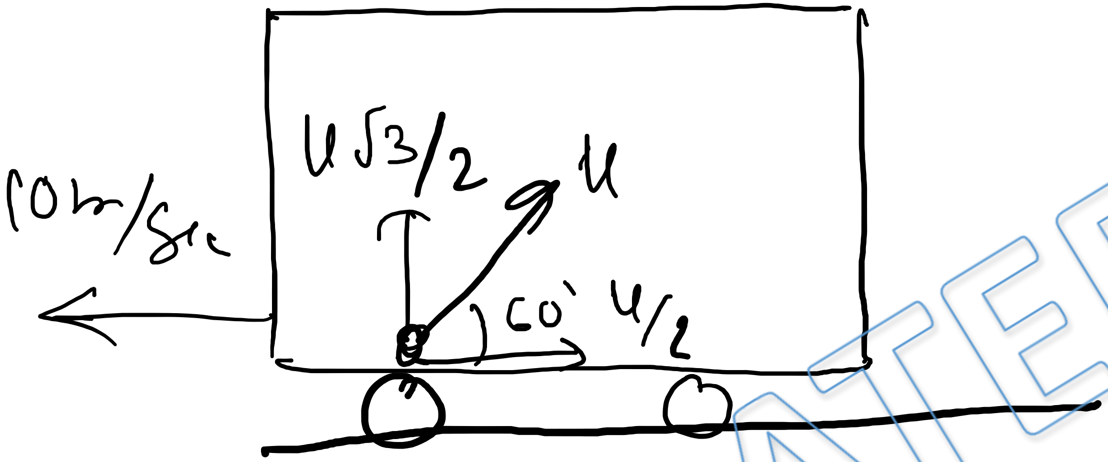


w.r.t. B, A is moving with constant velocity towards him.

⇒ They will collide if time of flight > time of collision.

ANS : b,d

Solution: 12



Velocity of ball w.r.t. student = $\uparrow \frac{u\sqrt{3}}{2}$, $\rightarrow \frac{u}{2}$

Velocity of train = $\leftarrow$ 10m/sec

Velocity of ball w.r.t. ground $= \vec{V}_{b,T} + \vec{V}_{T,g}$

$= \leftarrow 10$, $\uparrow \frac{u\sqrt{3}}{2}$, $\rightarrow \frac{u}{2}$

Since this velocity is in vertically upward direction $\frac{u}{2} = 10$

$\Rightarrow u = 20$ m/sec

$$H = \frac{u_y^2}{2g} = \frac{3}{4}\frac{u^2}{2g} = \frac{3 \times 400}{4 \times 2 \times 10}$$

$= 15$ m

ANS : b

Solution: 13

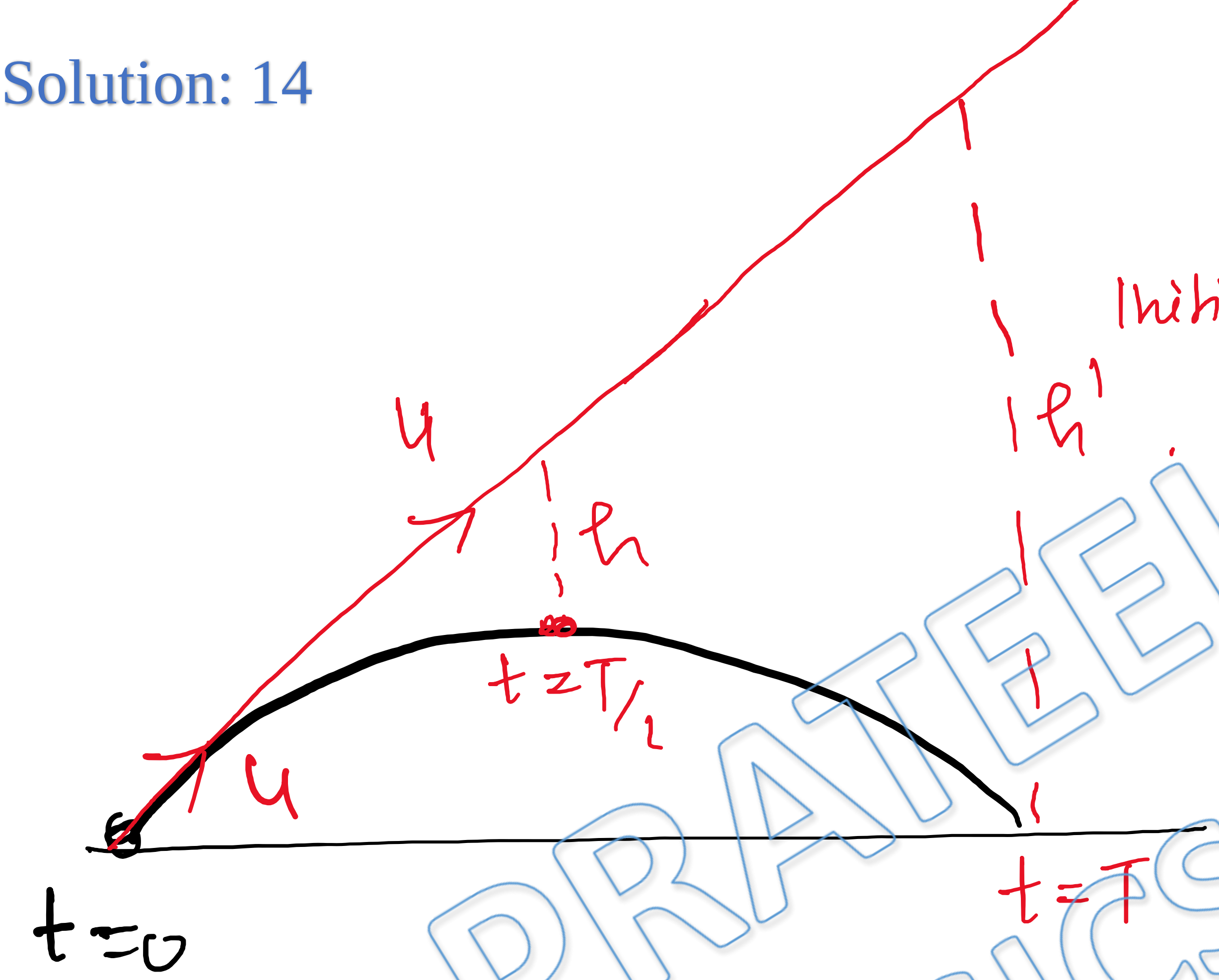
$\vec{V}_{P,Q} = \text{Constant} \Rightarrow \vec{a}_{P,Q} = 0\ ,\ \vec{a}_{Q,P} = 0$

$\vec{V}_{O,P} = \vec{V}_{O,Q} + \vec{V}_{Q,P} \rightarrow$ Standard formula.

Standard formula. $\leftarrow \vec{a}_{OP} = \vec{a}_{OQ} + \vec{a}_{Q,P} \Rightarrow \vec{a}_{OP} = \vec{a}_{OQ}$

ANS : b,c,d

Solution: 14



Initial velocity of bird w.r.t. projectile = 0

acceleration of bird w.r.t. projectile = g ↑

$$\Rightarrow h = \frac{1}{2} g \left(\frac{T}{2}\right)^2$$

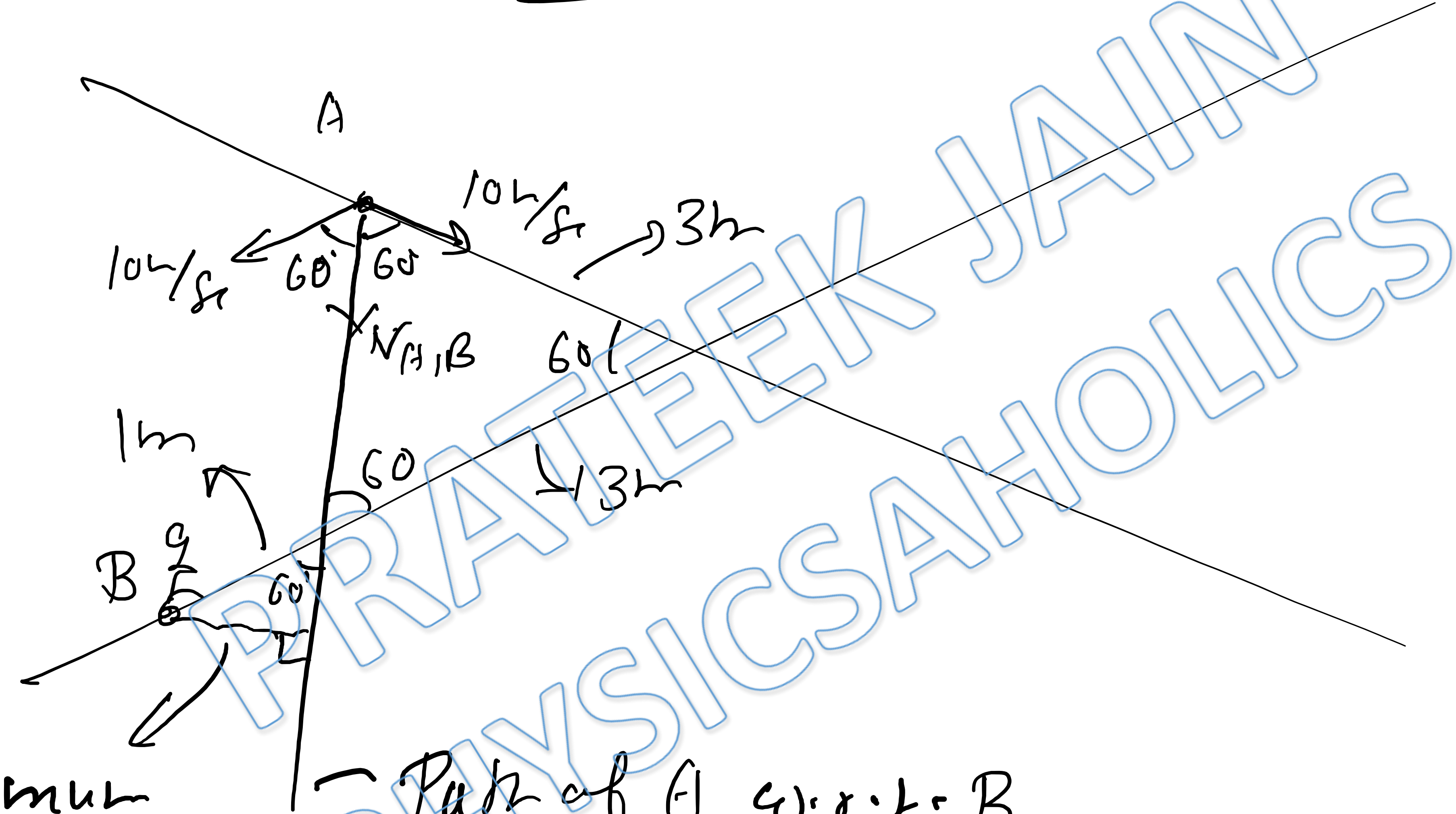
$$h' = \frac{1}{2} g T^2$$

$$\Rightarrow h' = 4h$$

ANS : d

Solution: 15

w.r.t. B



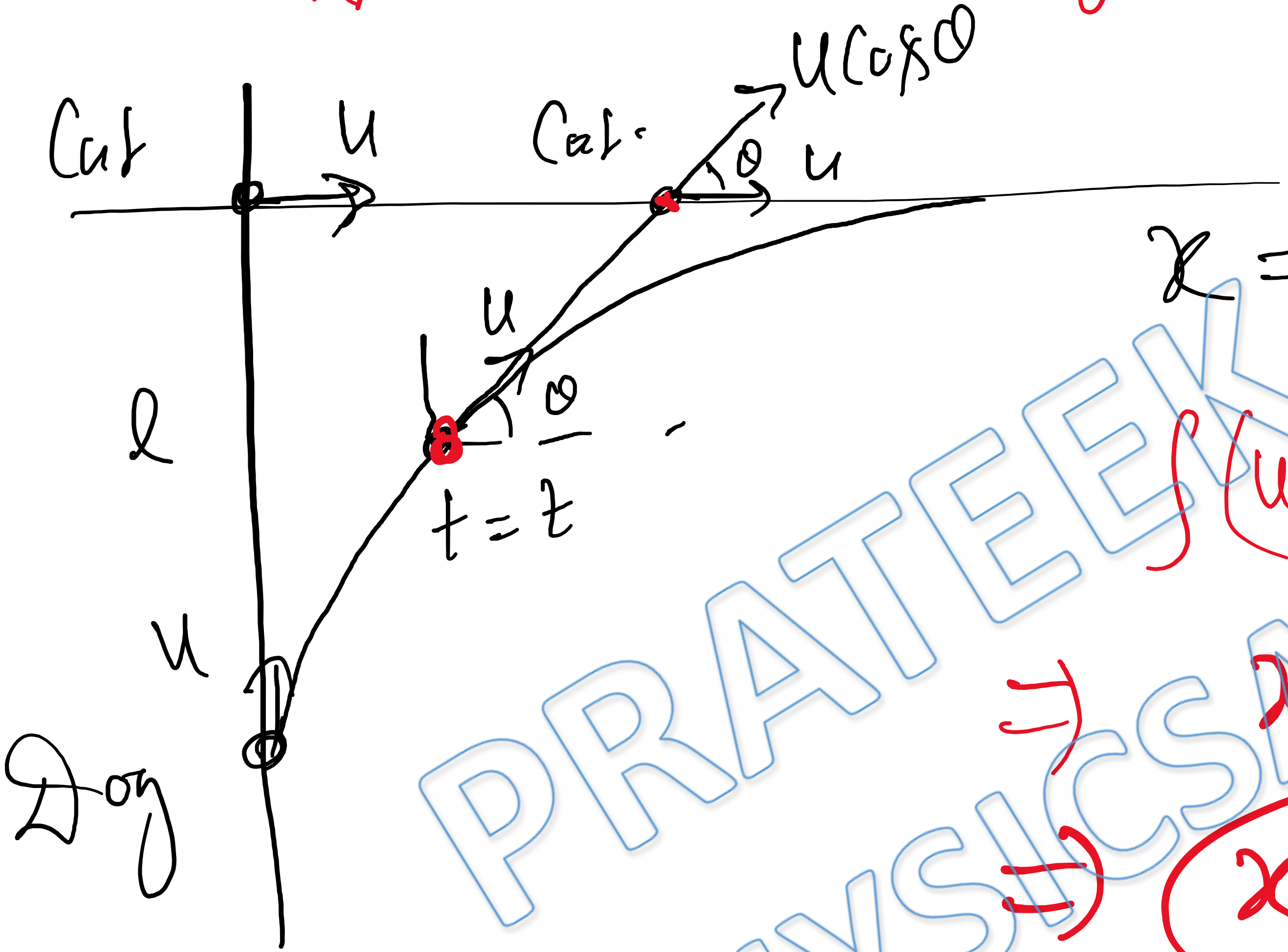
minimum — Path of A w.r.t. B

Distance = $1 \sin 60° = \sqrt{3}/2$ m.

ANS : b

Solution: 16

Let x is distance b/w dog & cat at $t \to \infty$



$$\int u\sin\theta \, dt = l$$

$$x = \int u\,dt - \int u\cos\theta \, dt$$

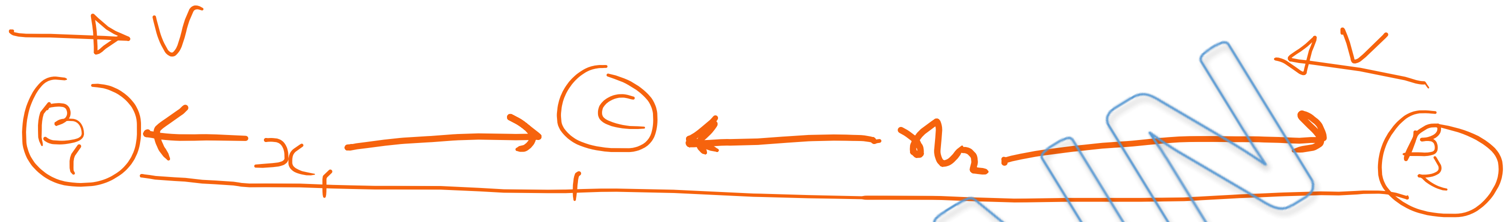
$$\int (u - u\cos\theta)\, dt = l - x$$

$$\Rightarrow x = l - x \Rightarrow 2x = l$$

$$\Rightarrow x = l/2$$

ANS : c

Solution: 17



$V_C = 15\ \text{km/hr}$

$x_1 = (V-15)\times\frac{15}{60}$ —(i)

$x_2 = (V+15)\times\frac{9}{60}$ —(ii)

$(V-15)\times\frac{15}{60} = VT$ —(i)

$(V+15)\,\frac{9}{60} = VT$ —(ii)

$(V-15)\times\frac{1}{4} = (V+15)\times\frac{3}{20}$

$\Rightarrow 5V - 75 = 3V + 45$

$\Rightarrow 2V = 120$

$\boxed{V = 60\ \text{km/hr}}$

$\Rightarrow (v+15) \times \frac{9}{60} = vT$

$\Rightarrow$ put $v = 60$

$\Rightarrow \cancel{75}^{5} \times \frac{9}{\cancel{60}_{4}} = \cancel{60}^{12}\, T$

$\Rightarrow T = \frac{9}{48}$ hr

$= \frac{9}{\cancel{48}_{4}} \times \cancel{60}^{5} = \frac{45}{4}$ min.

$= 11$ min 15 sec

ANS : b

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/52

Video Solution on YouTube:- https://youtu.be/U1KzcPu-QAg

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/74

Chalo Niklo