BEGINNER'S BOX-1

1. t = 2 min 20 sec = 120 + 20 = 140 sec

after each complete rotation, displacement becomes zero.

Number of rotation = $\frac{140}{40} = 3 + \frac{1}{2}$

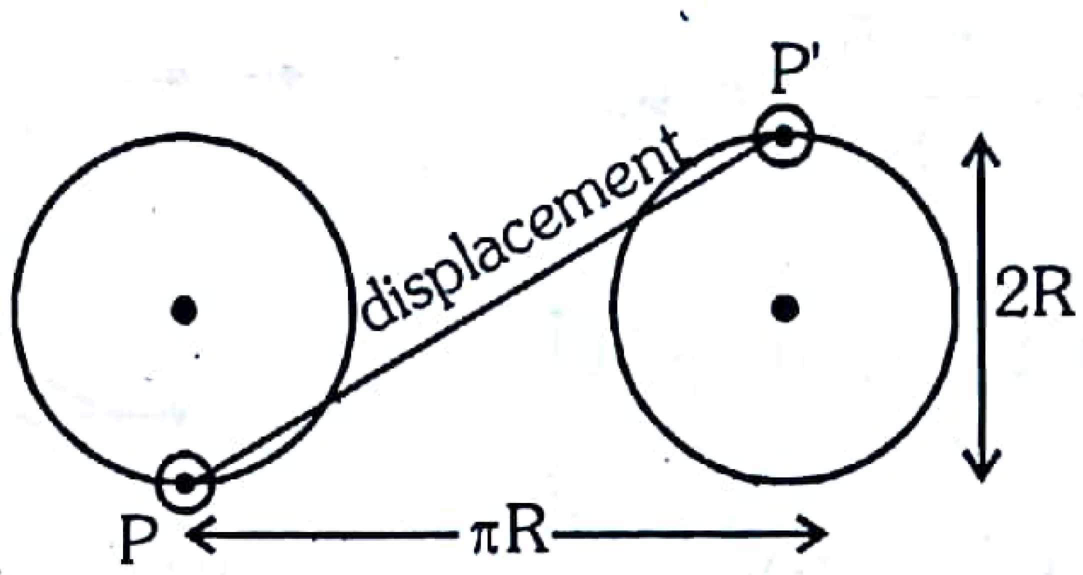
$\therefore$ displacement in $\frac{1}{2}$ rotation = 2r

(displacement for 3 rotation = 0)

Distance in 3 + $\frac{1}{2}$ rotation = $3 \times 2\pi r + \pi r = 7\pi r$

2. Since displacement is independent of path, the displacement is the shortest distance between initial position & final position. So the displacement for each girl will be 400 m. For girl 'B' the displacement will be equal to actual path length

3.



Displacement = $\sqrt{(\pi R)^2 + (2R)^2} = R\sqrt{\pi^2 + 4}$

4. Distance = 4 + 3 + 12 = 19 m

displacement = $\sqrt{4^2 + 3^2 + 12^2}$ = 13 m

5. Distance = path length = $\frac{1}{2}$ × circumference

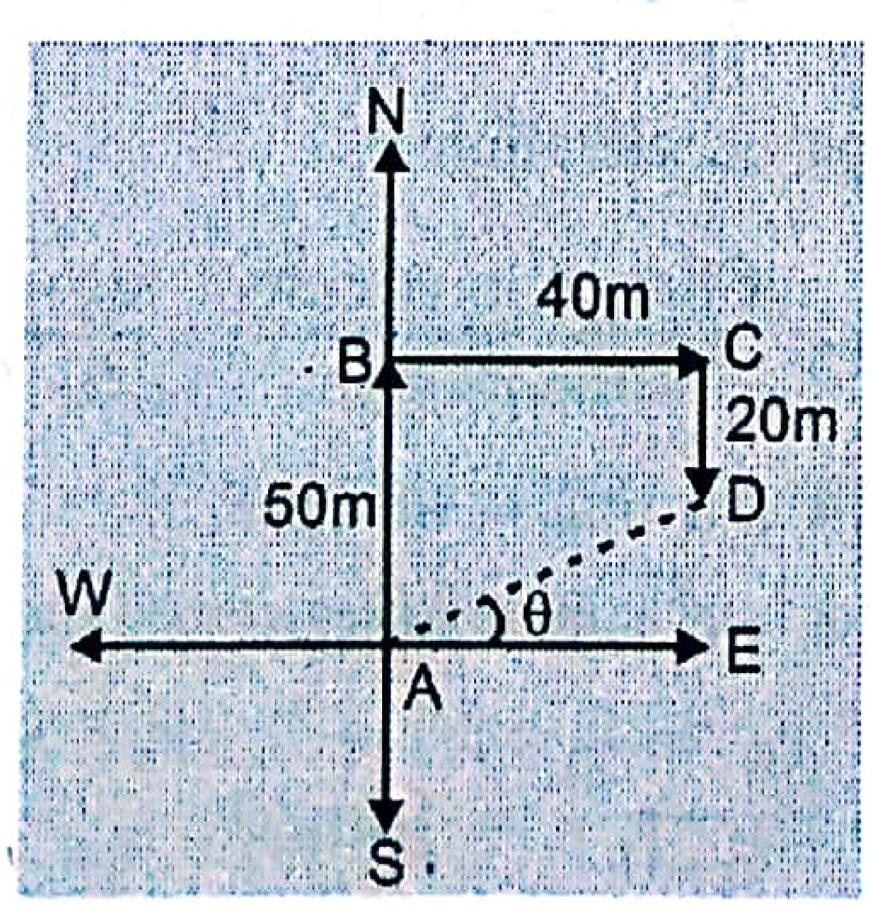
= $\frac{1}{2} \times 2\pi R = \pi R = (40\pi)$ m,

Displacement = $|\vec{d}|$ = 2r = 80m from A to B

6. (A) Total distance travelled = 50m + 40m + 20m = 110m

(B) Let east direction is $\hat{i}$ and north direction is $\hat{j}$ then

$\vec{AB} = 50\hat{j}, \vec{BC} = 40\hat{i}, \vec{CD} = -20\hat{j}$



According to law of polygon $\vec{AD} = \vec{AB} + \vec{BC} + \vec{CD}$

or $\vec{AD} = 50\hat{j} + 40\hat{i} - 20\hat{j} = 40\hat{i} + 30\hat{j}$

$|\vec{AD}| = \sqrt{40^2 + 30^2} = 50$m

Now, if angle of $\vec{AD}$ with east towards north is θ, then

$\tan\theta = \frac{30}{40} = \frac{3}{4}$, so $\theta = \tan^{-1}\left(\frac{3}{4}\right) = 37°$

So direction of displacement is E 37° N

BEGINNER'S BOX-2

1. Air distance (shortest distance) = displacement = 260 km

Road distance = 320 km

(i) Average speed of bus = $\frac{\text{Total distance}}{\text{total time}}$

$= \frac{320}{8}$

= 40 km/h

(ii) Average velocity of bus

$= \frac{\text{Total displacement}}{\text{Time}} = \frac{260}{8}$

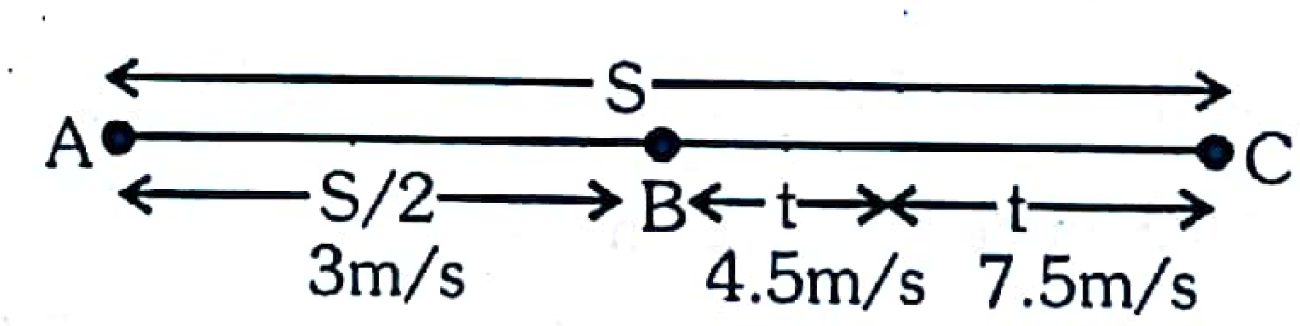
= 32.5 km/h

(iii) Average speed of plane = $\frac{260}{\frac{1}{4}}$ = 1040 km/h

(iv) Average velocity of aeroplane = $\frac{260}{1/4}$

=1040km/h

2.



Average speed from B to C

$(v_{Avg})_{B\to C} = \frac{4.5 \times t + 7.5 \times t}{2t}$

$(v_{Avg})_{B\to C} = 6$ m/s

Average speed from A to C

$(v_{Avg})_{A\to C} = \frac{\frac{S}{2} + \frac{S}{2}}{\frac{S}{2\times3} + \frac{S}{2\times6}}$

$(v_{Avg})_{A\to C} = 4$ m/s

3. **Between 6 : 00 to 6 : 30 a.m.**

In this time interval the tip of minute hand moves from (12 mark) to (6 mark).

$\therefore$ displacement

$= 2 \times$ (length of minute hand)

$= 2 \times 4.5$ cm $= 9$ cm

and time taken (t) $= 30$ min $= 30 \times 60 = 1800$s

$\therefore$ average velocity

$$= \frac{S}{t} = \frac{9}{1800} = 5 \times 10^{-3} \text{cm/s}$$

direction of average velocity is from 12 mark to 6 mark on the clock panel.

Between 6 : 00 a.m. to 6 : 30 p.m.

In this time interval also minute hand will move from (12 mark) to (6 mark).

$\therefore$ displacement

$= 2 \times$ (length of minute hand)

$= 2 \times 4.5$ cm $= 9$ cm

and time taken (t) $=$ 12 hrs and 30 minute

$= (12 \times 60 \times 60)$s $+ (30 \times 60)$s

$= 43200$ s $+ 1800$ s $= 45000$ s

$\therefore$ average velocity

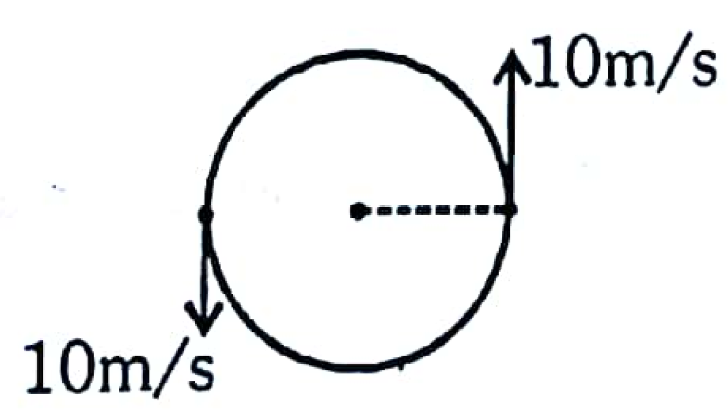
$$= \frac{s}{t} = \frac{9}{45000} = 2 \times 10^{-4} \text{cm/s}$$

direction of average velocity is from 12 mark to 6 mark on the clock panel.

4. Change in speed

$\Delta v = 10 - 10 = 0$

Change in velocity



$\Delta \vec{v} = \vec{v}_f - \vec{v}_i$

$= 10\hat{j} - (-10\hat{j}) = 20\hat{j}$

Magnitude $|\Delta \vec{v}| = 20$ m/s

5. (a) The distance travelled during time 0 to 5.0s is , $S = (2.5)(5.0)^2 = 62.5$ m

The average speed during this time is

$$v_{avg} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{62.5}{5} = 12.5 \text{ m/s}$$

(b) Given $S = (2.5)t^2$

$$\text{Instantaneous speed} = \frac{dS}{dt} = \frac{d}{dt}(2.5t^2) = (2.5)(2t) = 5t$$

$\therefore$ At $t = 5.0$ s the speed is

$[v]_{t=5S} = (5.0) \times (5.0) = 25$ m/s

6. Average velocity

$$= \frac{\text{Net displacement}}{\text{total time}} = \frac{AO + OB}{\text{time}}$$

$$= \frac{1+1}{1} = 2 \text{ m/s}$$

7. (a) Average speed $= \dfrac{\text{Total path length}}{\text{Total time}}$

$$= \frac{23}{28} = \frac{23}{(28/60)} = 49.3 \text{ kmh}^{-1}$$

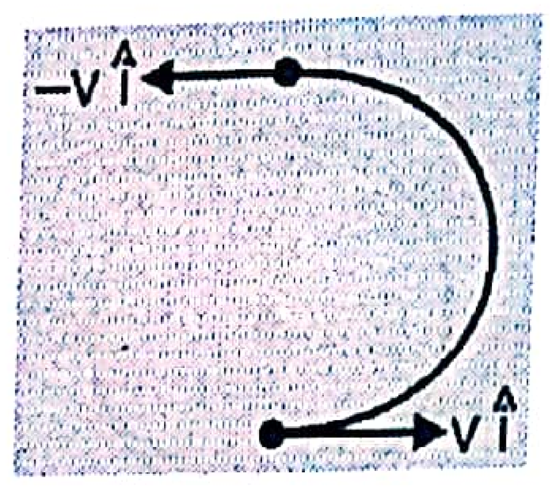
(b) Average velocity $= \dfrac{\text{Displacement}}{\text{Time}}$

$$= \frac{\text{Shortest distance}}{\text{Time}} = \frac{10}{28/60} = 21.4 \text{ km/h}$$

(c) Both are Not equal

BEGINNER'S BOX-3

1. $t = \dfrac{\pi R}{v} = \dfrac{\pi \times 5}{5} = \pi$ sec



$\Delta \vec{v} = (-5\hat{i}) - (5\hat{i}) = -10\hat{i}$

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{t} = \frac{-10\hat{i}}{\pi} \Rightarrow |\vec{a}_{avg}| = \frac{10}{\pi} \text{ m/s}^2$$

2. $x = 7t^2 - 2t + 5$

(i) $v = \dfrac{dx}{dt} = 14t - 2$

at $t = 5$, $v = 14 \times 5 - 2 = 68$ m/s

(ii) $a = \dfrac{dv}{dt} = 14$ m/s^2

(iii) Average velocity $= \dfrac{\text{displacement}}{\text{Time}} = \dfrac{x_5 - x_0}{5 - 0}$

$x_5 = 7(5)^2 - 2(5) + 5 = 170$ m

$x_0 = 7(0)^2 - 2(0) + 5 = 5$m

$v_{Avg} = \dfrac{170 - 5}{5} = 33$ m/s

(iv) Average acceleration

$$= \frac{\text{Change in velocity}}{\text{Time interval}} = \frac{v_5 - v_0}{5 - 0}$$

$v_5 = 14 \times 5 - 2 = 68$ m/s

$v_0 = 14 \times 0 - 2 = -2$m/s

$a_{Avg} = \dfrac{68 - (-2)}{5 - 0} = 14$m/s^2

BEGINNER'S BOX-4

1. Let $a = a_0$ & $u = 0$

So $S_1 = 0 + \frac{1}{2}a_0 (5)^2 = \frac{25}{2}a_0$

& $S_1 + S_2$ (distance covered in 15 sec.)

$= \frac{1}{2}a_0 (15)^2 = \frac{225}{2}a_0$

So $S_2 = \frac{225}{2}a_0 - \frac{25}{2}a_0 = 100a_0$

$\Rightarrow \frac{S_1}{S_2} = \frac{\frac{25}{2}a_0}{100a_0} = \frac{1}{8} \Rightarrow S_1 = \frac{S_2}{8}$

2. $v^2 = u^2 + 2aL$

$\Rightarrow 2aL = v^2 - u^2$

also $v_m^2 = u^2 + 2a\frac{L}{2} = u^2 + \frac{1}{2}(v^2 - u^2)$

$= \frac{2u^2 + v^2 - u^2}{2} = \frac{u^2 + v^2}{2}$; $v_m = \sqrt{\frac{u^2+v^2}{2}}$

3. By using $v^2 = u^2 + 2as$

We have $\left(u - \frac{u}{n}\right)^2 = u^2 + 2(-a)s$

$\Rightarrow \left(\frac{2}{n} - \frac{1}{n^2}\right)u^2 = 2as$

Let no. of planks required be N

Then,

$0^2 = u^2 + 2(-a)Ns$

Therefore, $\left(\frac{2}{n} - \frac{1}{n^2}\right)u^2 = \frac{u^2}{N}$

$\Rightarrow N = \frac{n^2}{2n-1}$

4. initial velocity $u = 126 \times \frac{5}{18} = 35$ m/s,

$s = 200$ m

From equation of motion $v^2 = u^2 + 2as$

$\Rightarrow 0 = (35)^2 + 2\,a \times 200 \Rightarrow a = -3.06$ m/s^2

$\therefore$ retardation is 3.06 m/s^2

$v = u + at$; $0 = 35 - 3.06\,t$

$t = 11.4$ sec.

5. During the reaction time, the car will move with constant speed.

So, $S_1 = ut$

The distance covered by the car after brakes are applied $S_2 = \frac{o^2 - u^2}{-2a} = \frac{u^2}{2a}$

So Total distance travelled $= S_1 + S_2 = ut + \frac{u^2}{2a}$

6. $S_{n^{th}} = u + \frac{1}{2}a(2n-1)$

$1.2 = o + \frac{1}{2} \times a \times 11$;

$a = \frac{2.4}{11}$; $a = 0.218$ m/s^2

BEGINNER'S BOX-5

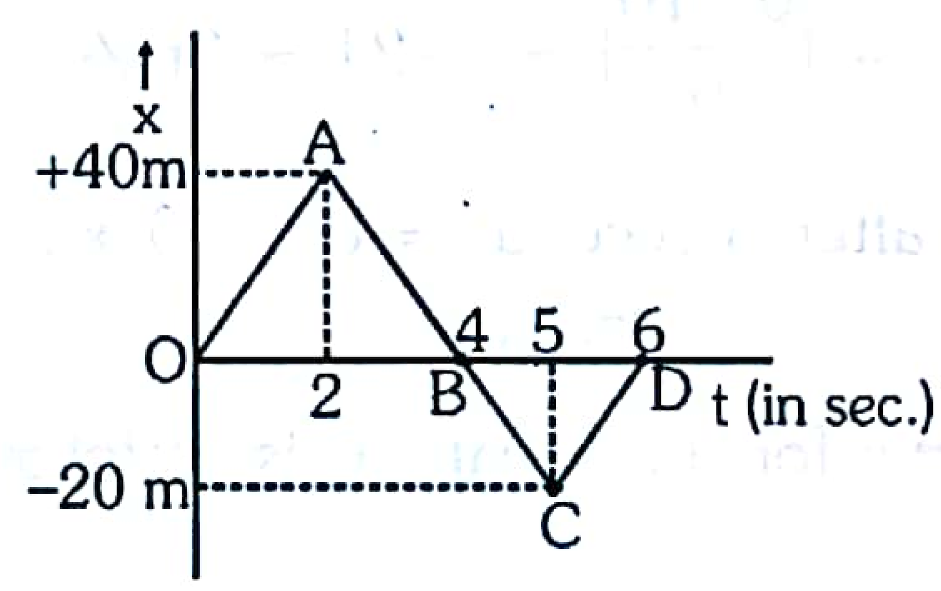
1. Velocity = Slope of s – t curve

So $\frac{v_A}{v_B} = \frac{\text{Slope of A}}{\text{Slope of B}} = \frac{\tan 30°}{\tan 60°} = \frac{1}{3}$

2. (i) Total distance travelled

$= x_{OA} + x_{AB} + x_{BC} + x_{CD}$

$= 40 + 40 + 20 + 20 = 120$ m



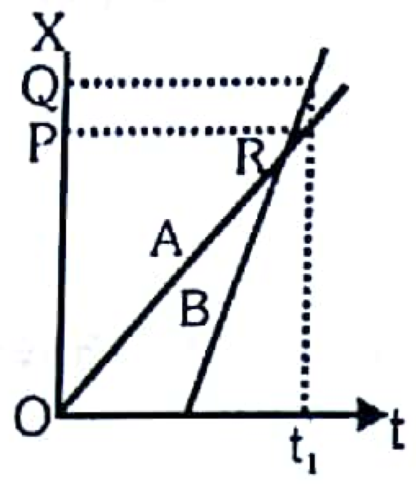
(ii) Displacement = final position – initial position

$= x_D - x_O = 0 - 0 = 0$

(iii) Average speed $= \frac{\text{Total distance}}{\text{Total time}} = \frac{120}{6} = 20$ m/s

(iv) Average velocity $= \frac{\text{displacement}}{\text{Time}} = \frac{0}{6} = 0$ m/s

3.



(a) A lives closer to the school than B (as P is close to O than Q)

(b) A starts earlier than B (A starts when time t = 0)

(c) B walks faster than A (slope of B is greater than slope of A)

(d) A and B reach home at the same time t_1 (as shown by dotted lines in the graph)

(e) B overtakes A on the road once (as graphs for A and B intersect only at one point R.)

4. (i) Total distance covered = Area under v – t curve

$$= \frac{1}{2}(2\times 2) + 2(4-2) + \frac{1}{2}(10+2)\times 1$$

$$\frac{1}{2}\times 5\times 10 = 37\text{m}$$

(ii) Average speed $= \frac{\text{Total distance}}{\text{Total time}} = \frac{37}{10} = 3.7$ m/s

(iii) Acceleration = Slope of v – t curve

So maximum acceleration will be in the part where the slope will be maximum i.e. BC

$$a_{max} = a_{BC} = \frac{10-2}{1} = 8\text{m/s}^2$$

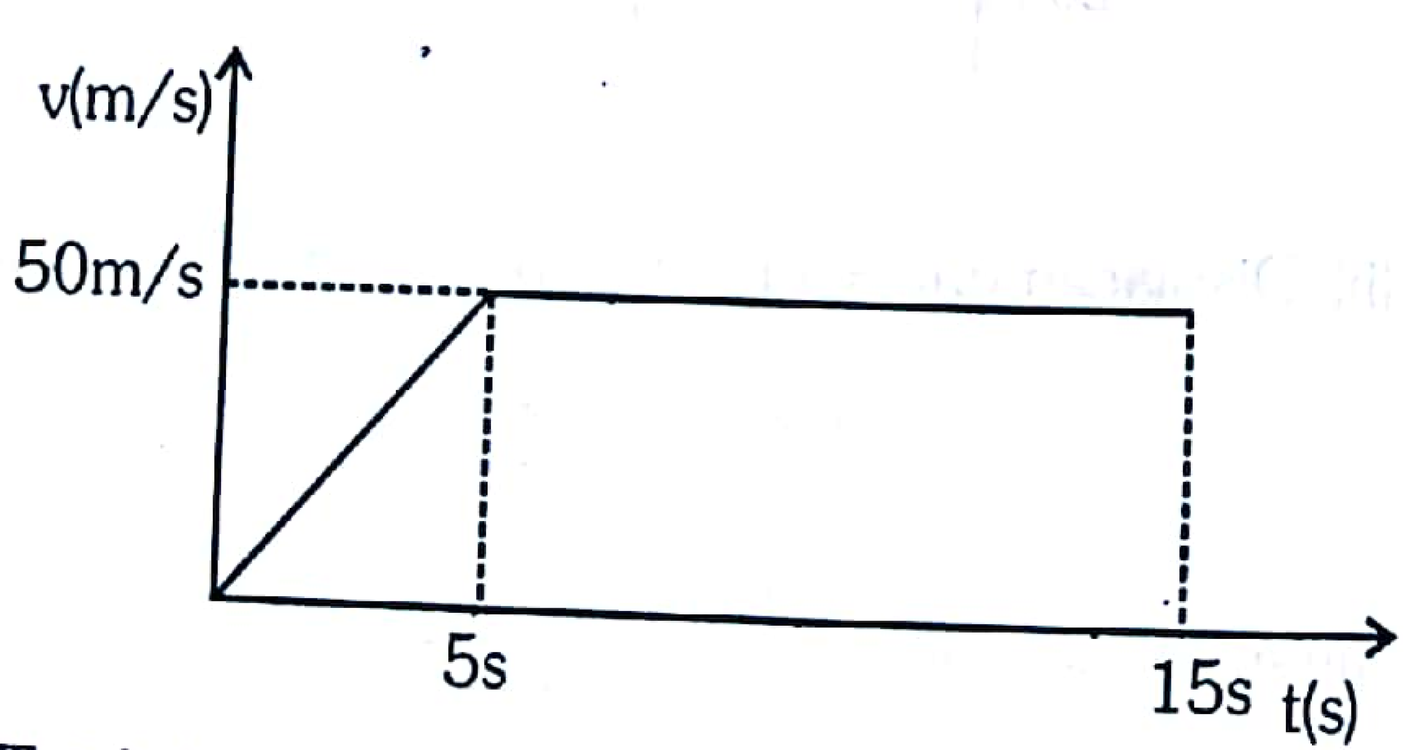
(iv) Retardation = Slope of CD (As it is negative)

$$= \left|\frac{0-10}{5}\right| = |-2| = 2\text{m/s}^2$$

5. Velocity after 5 seconds = 0 + 10 × 5

= 50m/s

v – t curve for the situations is as follows :



Total distance travelled = Area under v-t curve

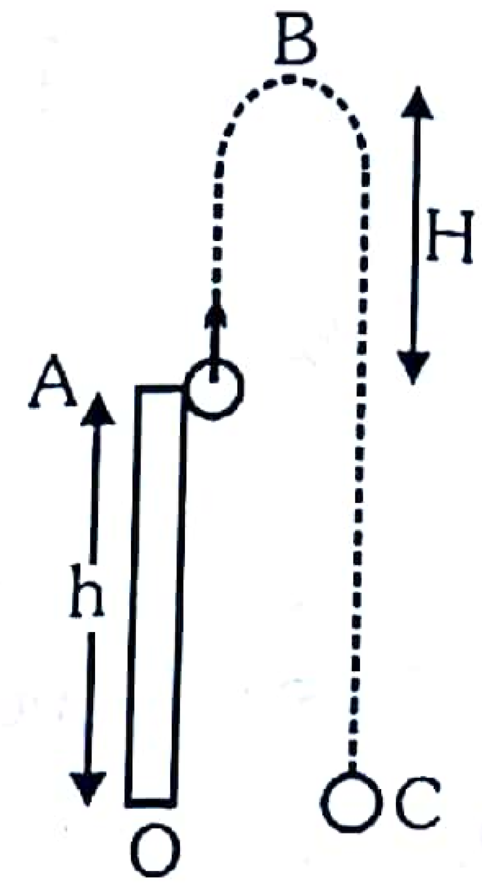
$$= \frac{1}{2}(50\times 5) + 50\times(15-5) = 625\text{m}$$

BEGINNER'S BOX-6

1. Time taken to reach the highest point $= \frac{u}{g}$

$$t = \frac{10}{10} = 1\text{s}$$

2. Time taken to reach B



$t_{AB} = \frac{u}{g} = \frac{10}{10} = 1$ sec.

t_{AC} = 5sec. (given

so t_{BC} = 5 – 1 = 4 sec.

$$S_{BC} = \frac{1}{2}gt^2 = \frac{1}{2}(10)(4)^2$$

= 80 m

$$S_{AB} = \frac{u^2}{2g} = \frac{(10)^2}{20} = 5\text{m}$$

(a) Height of tower h = 80 – 5 = 75 m

(b) $v_c = 0 + gt_{BC} = 40$ m/s

(c) Distance travelled = 5 + 80 = 85

(d) Average speed $= \frac{85}{5} = 17$ m/s

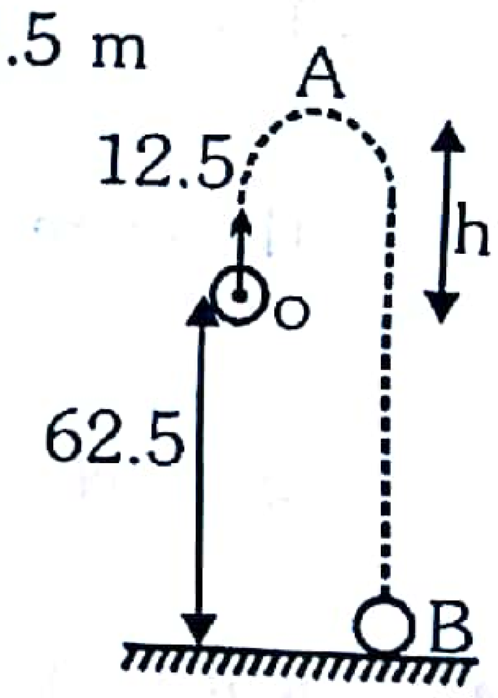
Average velocity $= -\frac{75}{5} = -15$ m/s

3. Velocity of balloon after 10 sec. = 0 + 1.25 × 10

= 12.5 m/s

distance travelled $= \frac{1}{2}at^2 = \frac{1}{2}(1.25)\times 10^2$

= 62.5 m



(i) $h = \frac{u^2}{2g}$

$$= \frac{(12.5)^2}{20} = 7.8125\text{ m}$$

height from ground = 62.5 + 7.8125 = 70.31 m

(ii) $t_{OA} = \frac{u}{g} = \frac{12.5}{10} = 1.25$ sec.

$t_{AB} = \sqrt{\frac{2h_{AB}}{g}} = 3.75$ sec.

Total time = 5 sec.

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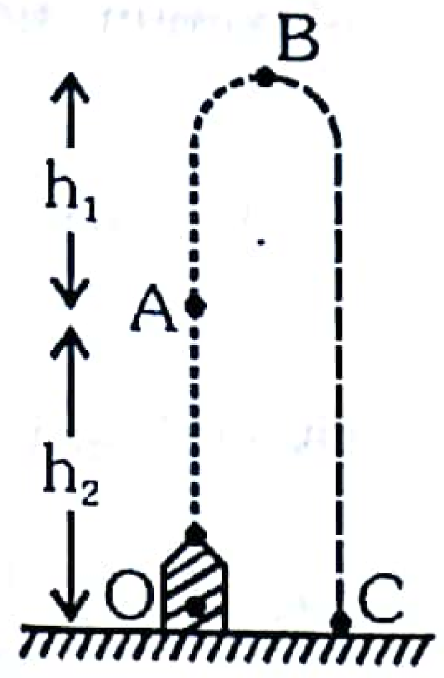
4. Point O → Point of projection

Point A → Point up to which fuel is consumed.

Point B → Highest point of path



$h_1 = 0 \times 60 + \frac{1}{2} \times 10 \times (60)^2$

$= 18$ km

$v_A = 0 + 10 \times 60 = 600$ m/s

$O = v_A^2 - 2gh_2 \Rightarrow h_2 = \frac{v_A^2}{2g} = \frac{(600)^2}{20} = 18$ km.

maximum height from ground = 18 + 18 = 36 km.

time taken from A to B :→ $O = 600 - gt \Rightarrow t = 60$ sec.

time taken in coming down to earth –

$36000 = \frac{1}{2}gt^2 \Rightarrow t = 60\sqrt{2}$ sec.

∴ Total time = $60 + 60 + 60\sqrt{2} = 60(2 + \sqrt{2})$ s.

$= (2 + \sqrt{2})$ min.

5. Let it takes n seconds to fall from tower then total distance $s = \frac{1}{2}g(n)^2$

distance travelled in n^{th} second

$= s_{n^{th}} = O + \frac{g}{2}(2n - 1) \Rightarrow s_{n^{th}} = \frac{9}{25}s$

$\Rightarrow \frac{g}{2}(2n - 1) = \frac{9}{25}\frac{g}{2}(n^2) \Rightarrow 9n^2 = 50n - 25$

$\Rightarrow n = \frac{50 + \sqrt{50^2 - 4 \times 9 \times (+25)}}{2 \times 9} = 5$ sec.

$H = \frac{1}{2}g(5)^2 = 125$ m

6. Let the particle covers its total journey in n seconds then

$\frac{1}{2}g(n)^2 - \frac{1}{2}g(n - 2)^2 = 40$

$\Rightarrow (4n - 4) = 8 \Rightarrow n = 3$

height of tower $= \frac{1}{2}g(3)^2 = 45$ m

7. (a) Acceleration is directed downwards

(b) At highest point v = 0, a = g (downwards)

(c) For upward motion (Reference point to be the highest point)

x → Positive

v → negative

a → positive

For downward motion

x → Positive

v → Positive

a → Positive

(d) $H = \frac{v^2}{2g} = 44.1$ m $\Rightarrow T = \frac{2v}{g} = 6$ sec.

8. Let time of fall be 'n'

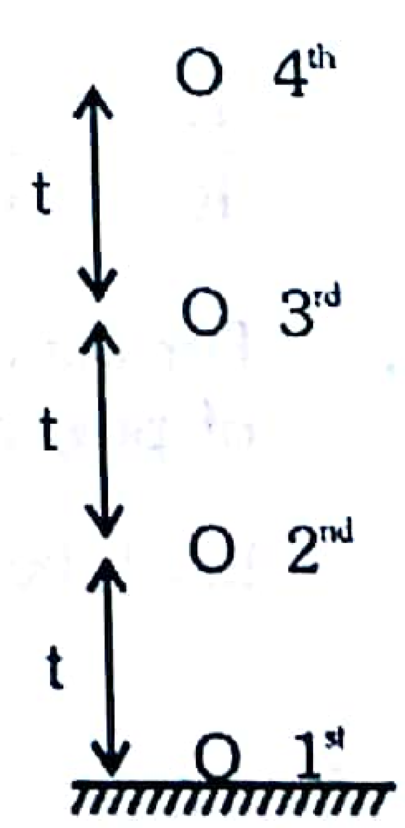
$\frac{1}{2}g(2n - 1) = \frac{1}{2}g(3)^2$

$\Rightarrow n = 5$ sec.

Height of tower $= \frac{1}{2}g(5)^2 = 125$ m.

9. $3t = \sqrt{\frac{2 \times 9}{10}}$ $\left[t = \sqrt{\frac{2H}{g}}\right]$

$t = \sqrt{\frac{1}{5}}$



Position of 2^{nd} drop

$\Rightarrow S_2 = \frac{1}{2} \times 10 \times \left(2\sqrt{\frac{1}{5}}\right)^2 = 4$ m

Position of 3^{rd} drop

$\Rightarrow S_3 = \frac{1}{2} \times 10\left(\sqrt{\frac{1}{5}}\right)^2 = 1$ m

BEGINNER'S BOX-7

1. (a) Time taken by the ball to reach the highest point

$$t = \frac{T}{2} = \frac{u\sin\theta}{g} = \frac{20}{10}\times\sin 30° = 2\times\frac{1}{2} = 1s$$

(b) The maximum height attained

$$= \frac{u^2\sin^2\theta}{2g} = \frac{(20)^2\times\sin^2 30°}{2\times 10} = 5m$$

(c) The horizontal range

$$= \frac{u^2\sin 2\theta}{g} = \frac{(20)^2\times\sin(2\times 30°)}{10} = 34.64m$$

(d) The time of flight

$$= \frac{2u\sin\theta}{g} = \frac{2\times 20\times\sin 30°}{10} = 2s$$

2. Let u be the velocity of projection of the ball. The ball will cover maximum horizontal distance when angle of projection with horizontal, $\theta = 45°$. Then

$$R_{max} = \frac{u^2}{g} = 100\ m$$

If ball is projected vertically upwards ($\theta = 90^0$ from ground) then H attains maximum value,

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

∴ the height to which cricketer can throw the ball is $= \frac{R_{max}}{2} = \frac{100}{2} = 50$ m.

3. $\frac{H_1}{H_2} = \frac{\sin^2\alpha}{\sin^2(90°-\alpha)} = \tan^2\alpha$

$\frac{R_1}{R_2} = \frac{\sin 2\alpha}{\sin 2(90°-\alpha)} = 1$

4. For the first ball, angle of projection = θ, velocity of projection, u = 40 m/s.

Let h be the maximum height attained by it.

As maximum height attained $= \frac{u^2\sin^2\theta}{2g}$

$$\therefore h = \frac{(40)^2\sin^2\theta}{2\times 10} \quad .....(1)$$

For second ball, Angle of projection = (90° – θ). velocity of projection, u = 40 m/s

Maximum height reached = (h + 50) m

$$\therefore h + 50 = \frac{u^2\sin^2(90°-\theta)}{2g} = \frac{(40)^2\cos^2\theta}{2\times 10} \quad .....(2)$$

By adding (1) and (2),

$$2h + 50 = \frac{(40)^2}{2\times 10}\times(\sin^2\theta + \cos^2\theta) = \frac{(40)^2}{2\times 10} = 80$$

⇒ 2h = 80 – 50 = 30 ⇒ h = 15 m

Height of the first ball, h = 15 m & Height of the second ball = h + 50 = 15 + 50 = 65 m

5. $R = \frac{u^2\sin(2\times 15°)}{g} = 1.5$ or $\frac{u^2}{g}\times\frac{1}{2} = 1.5$

or $\frac{u^2}{g} = 3$ km

Horizontal range for angle of projection 45° is

$$R' = \frac{u^2}{g}\times\sin(2\times 45°) = \frac{u^2}{g}\sin 90° = \frac{u^2}{g} = 3km$$

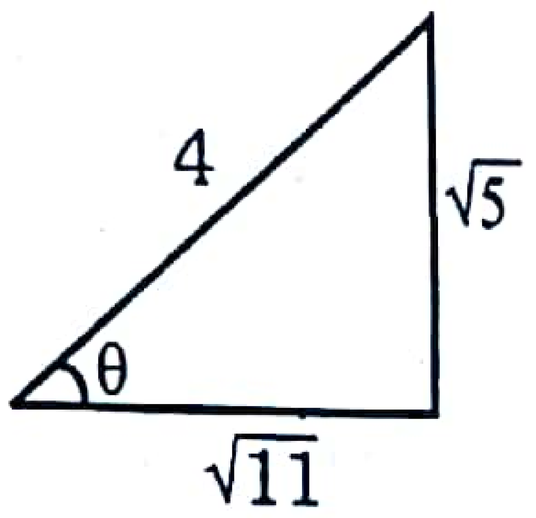
6. $H_m = \frac{u^2\sin^2\theta}{2g}$; $R = \frac{u^2}{g}\sin 2\theta = \frac{2u^2}{g}\sin\theta.\cos\theta$

$\frac{H_m}{R} = \frac{1}{4}\tan\theta \Rightarrow \theta = \tan^{-1}\left(\frac{4H_m}{R}\right)$

7. Since their time of flight is same so their vertical velocity will be same so will be the maximum heights

8. H ≤ 25 m

$\Rightarrow \frac{u^2}{2g}\sin^2\theta \le 25$ m



$\Rightarrow \sin^2\theta \le \frac{25}{80} = \frac{5}{16}$

$\Rightarrow \sin\theta \le \frac{\sqrt{5}}{4}$

For maximum range $\sin\theta = \sqrt{\frac{5}{4}}$

$\tan\theta = \sqrt{\frac{5}{11}} \Rightarrow R = \frac{4H}{\tan\theta} = \frac{4\times 25}{\sqrt{5/11}} = 148.32$ m

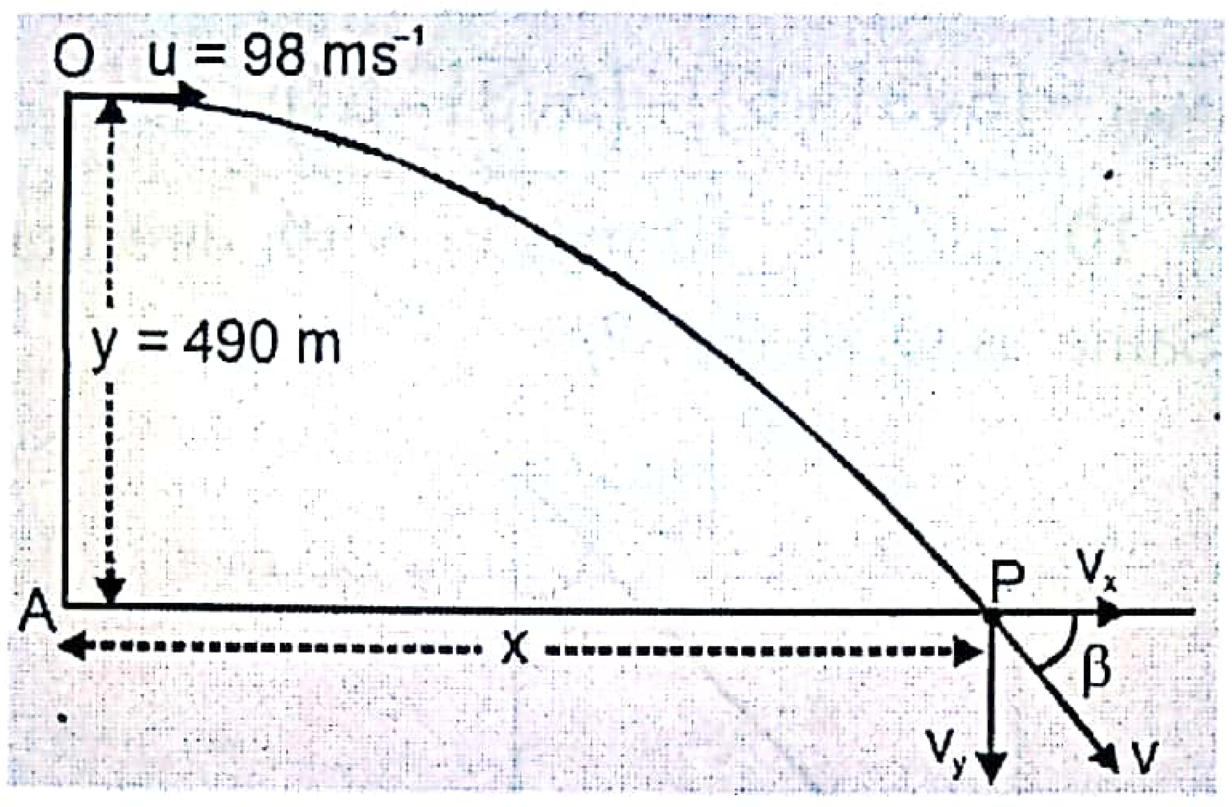
BEGINNER'S BOX-8

1. (i) The projectile is fired from the top O of a hill with velocity u = 98 m/s along the horizontal OX. It reaches the target P vertical distance

OA = y = 490 m

As $y = \frac{1}{2}gt^2$

$\therefore \quad 490 = \frac{1}{2} \times 9.8\, t^2$



or $\quad t = \sqrt{100} = 10\text{ s}.$

(ii) Distance of the target from the hill is

AP = x = horizontal velocity × time

= 98 × 10 = 980m.

(iii) The horizontal components of velocity v of the projectile at point P is $v_x = u = 98$ m/s

and vertical component

$v_y = u_y + gt = 0 + 9.8 \times 10 = 98$ m/s

$\therefore v = \sqrt{v_x^2 + v_y^2} = \sqrt{98^2 + 98^2}$

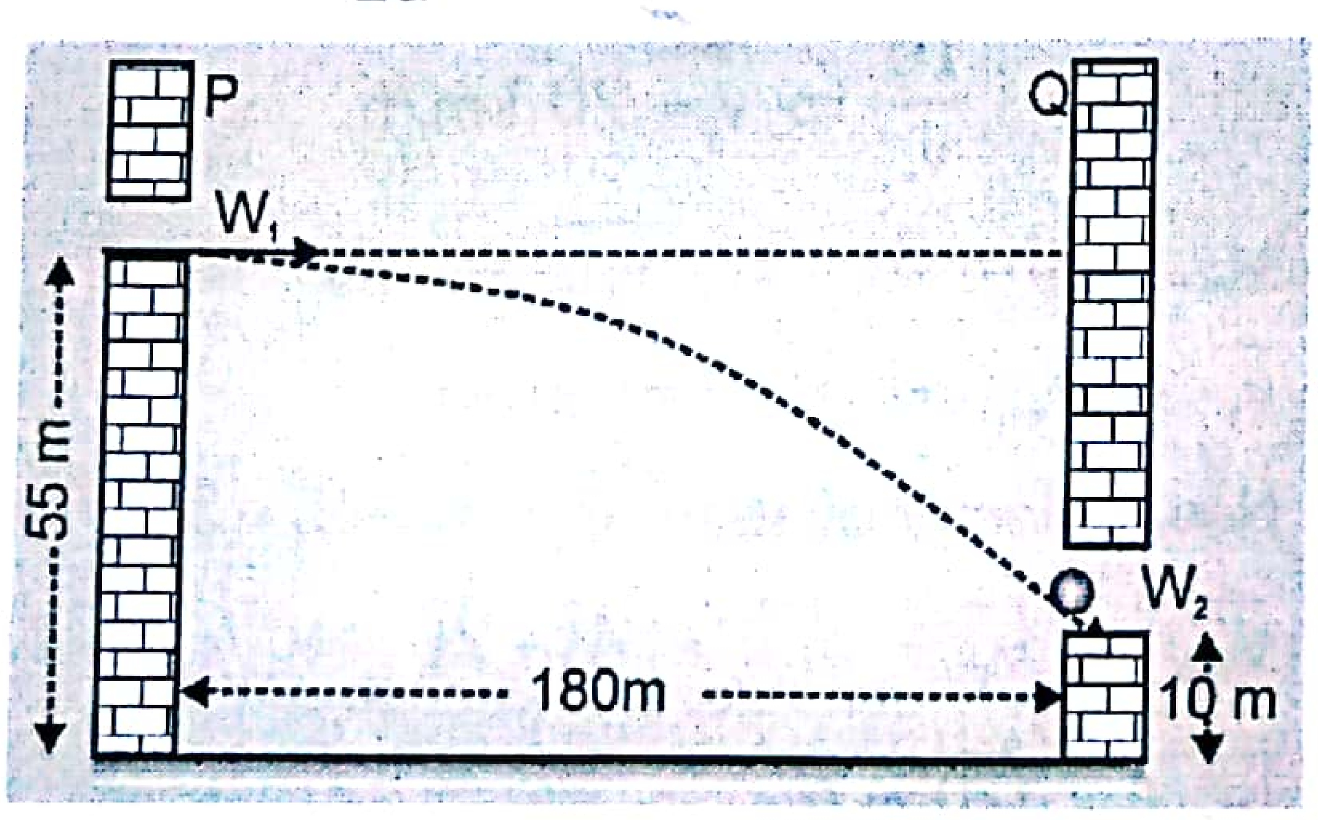
$= 98\sqrt{2} = 138.59$ m/s.

Now if the resultant velocity v makes angle β with the horizontal, then

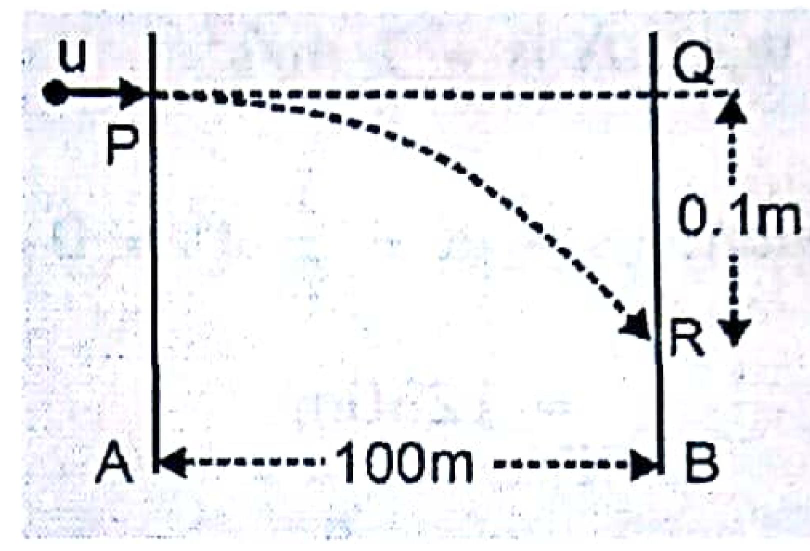
$\tan\beta = \frac{v_y}{v_x} = \frac{98}{98} = 1 \quad$ or $\quad \beta = 45°$

2. eq^n of trajectory $y = \frac{gx^2}{2u^2}$

$45 = \frac{10 \times (180)^2}{2u^2} \Rightarrow u = 60$ m/s



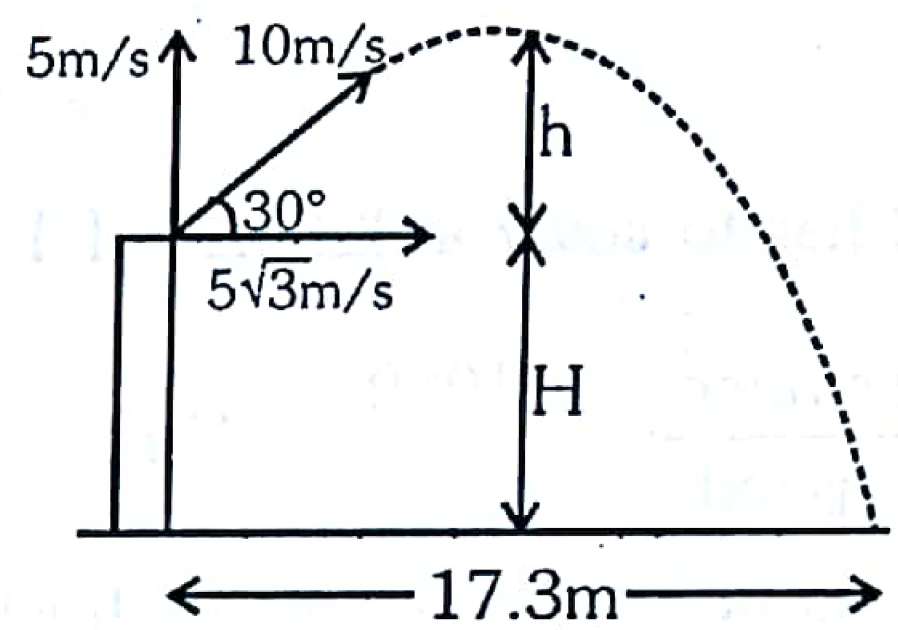
3. Assume that the bullet hits the screen A with velocity u and pierces the screen B after time t.



eq^n of trajectory $y = \frac{gx^2}{2u^2}$

$(10 \times 10^{-2})^2 = \frac{10 \times (100)^2}{2u^2} \Rightarrow u = 70$ m/s

4. Total flight time



$R = u_x T$

$T = \frac{R}{u_x}$

$T = \frac{17.3}{5(1.73)} = 2\text{sec.}$

Time to reach maximum height $= \frac{5}{g} = 0.5$ sec.

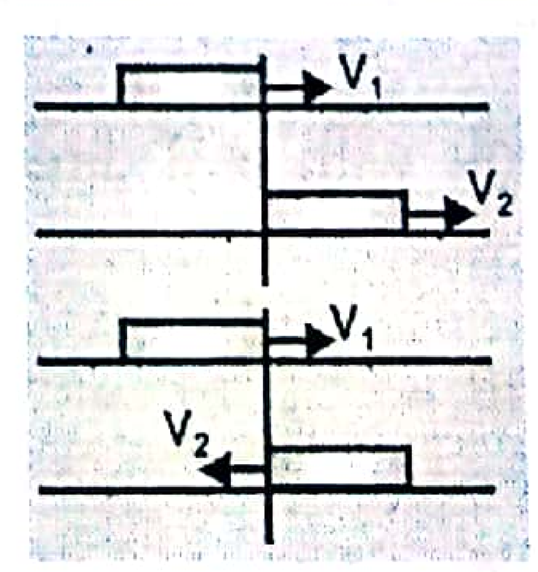
$h = \frac{1}{2}g(0.5)^2 = 1.25$ m

$H + h = \frac{1}{2}g(1.5)^2 = 11.25$ m

So $\quad H = 10$ m

BEGINNER'S BOX-9

1. $v_1 - v_2 = \frac{100}{40} = 2.5$



$v_1 + v_2 = \frac{100}{20} = 5$

Adding, $2v_1 = 7.5$

$\Rightarrow v_1 = 3.75$ m/s and $\quad v_2 = 1.25$ m/s

2. Let s = distance between the trains initially

Velocity of train B w.r.t. A is zero, acceleration of train B w.r.t. A is = 1 m/s^2

than distance $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times (50)^2$

$= 1250m$

3. Speed of car A $= 36 \times \frac{5}{18} = 10m/s$, speed of car B and car C $= 54 \times \frac{5}{18} = 15m/s$

Relative speed of B w.r.t. A $v_{BA} = 15 - 10$

$= 5$ m/s

Relative speed of C w.r.t. A $v_{CA} = 15 + 10$

$= 25$ m/s

Car C has to cover a distance of 1 km in time

$t = \frac{\text{distance}}{\text{speed}} = \frac{1000}{25} = 40s$

To avoid accident, the car B should cover the distance of 1 km in a time less than 40s. So, minimum acceleration of B

s = 1000 m, t = 40 s, u = 5 m/s

than $s = ut + \frac{1}{2}at^2 \Rightarrow 1000 = 5 \times 40 + \frac{1}{2}a(40)^2$

$\Rightarrow 800 = 800a \Rightarrow a = 1$ m/s

4. $T = \frac{2u}{g} = \frac{2 \times 49}{9.8} = 10$ s

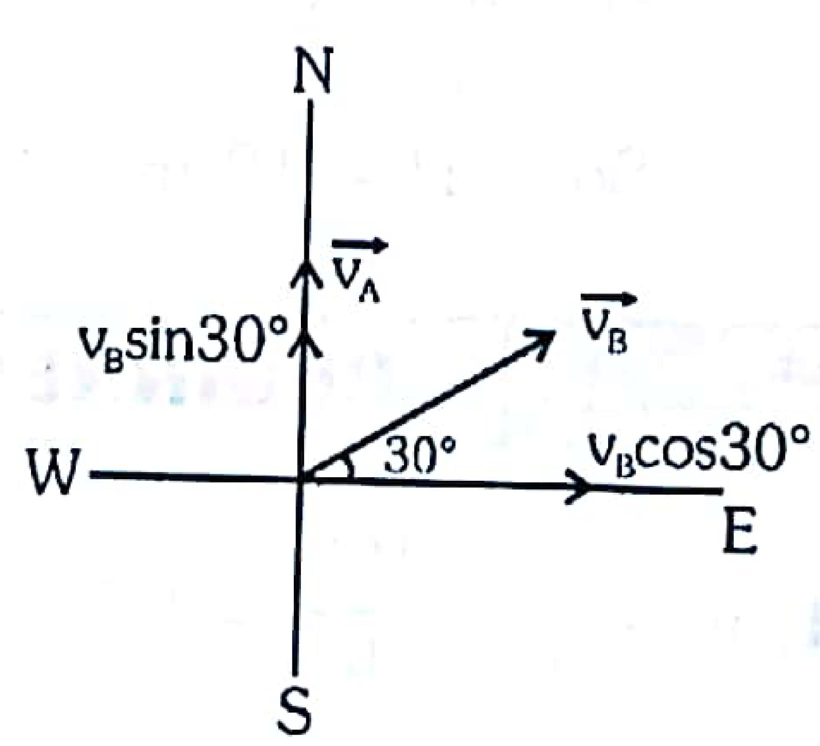
since the lift is not accelerating, time of flight will remain same.

BEGINNER'S BOX-10

1. $\overrightarrow{v_A} = 10\hat{j}$

$\overrightarrow{v_B} = 5\sqrt{3}\hat{i} + 5\hat{j}$

$\overrightarrow{v_{BA}} = \overrightarrow{v_B} - \overrightarrow{v_A} = 5\sqrt{3}\hat{i} - \hat{j}$

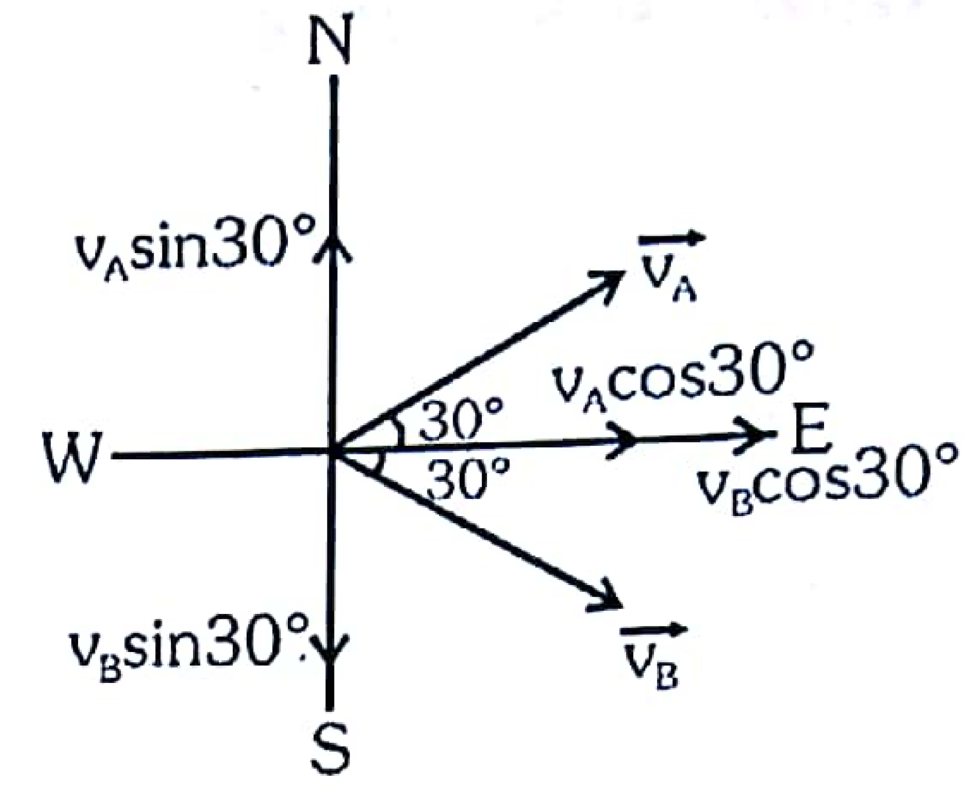


angle with east direction

$\tan\theta = -\frac{5}{5\sqrt{3}} = -\frac{1}{\sqrt{3}}$

$\theta = 30°$ i.e. E – 30° – S

2.



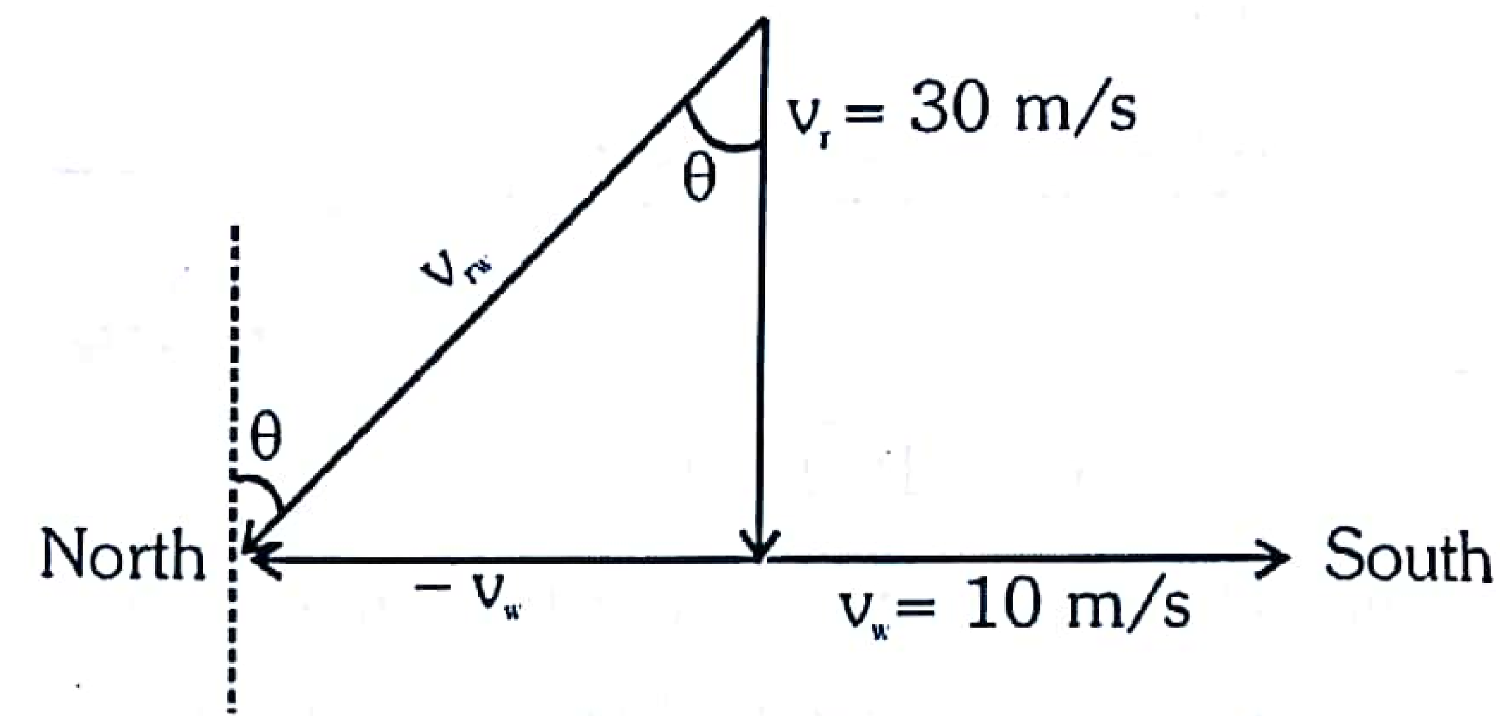
$\overrightarrow{v_{AB}} = \overrightarrow{v_A} - \overrightarrow{v_B}$

$\overrightarrow{v_{AB}} = (5\sqrt{3}\hat{i} + 5\hat{j}) - (5\sqrt{3}\hat{i} - 5\hat{j})$

$= 10\hat{j}$ m/s i.e. 10 m/s in north direction

3. Same as Q.33 (Ex.-2)

4.

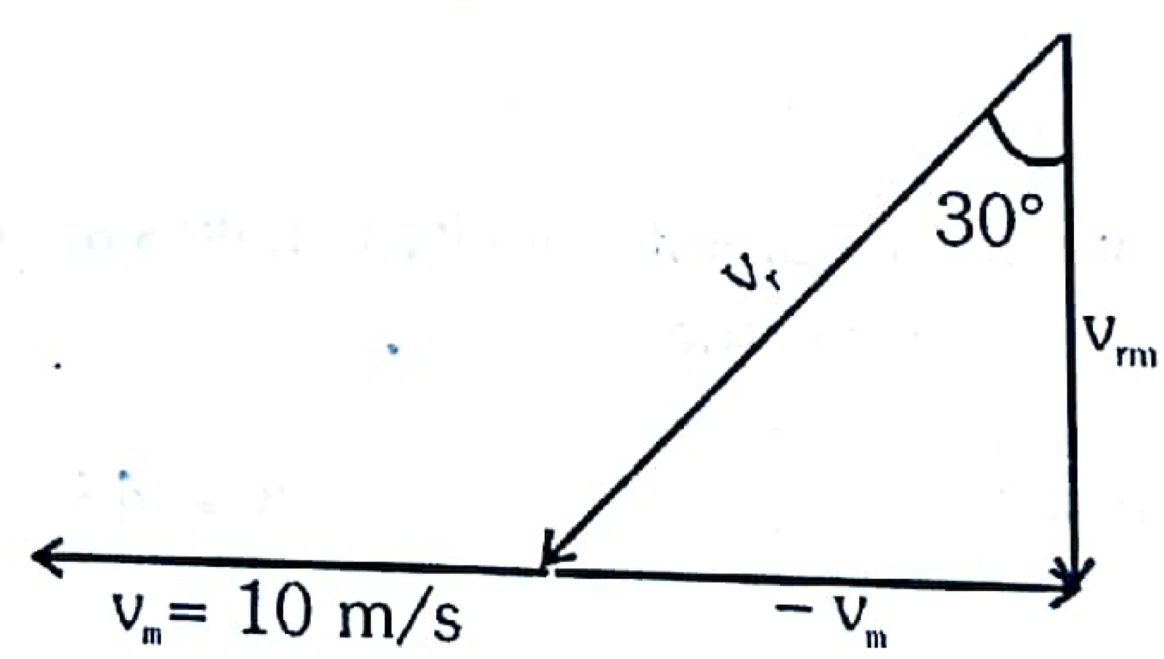


From the diagram

$\tan\theta = \frac{10}{30} = \frac{1}{3}$

So $\theta = \tan^{-1}\left(\frac{1}{3}\right)$ from vertical towards south

5. When stationary person holds umbrella, the direction of umbrella denotes velocity of raindrops with respect to ground.



From the triangle $\tan30° = \frac{10}{v_{rm}}$

$\Rightarrow v_{rm} = 10\sqrt{3}$ km/h

$\sin 30° = \frac{10}{v_r} \Rightarrow v_r = 20$ km/h

6. $\overrightarrow{v_m} = 2\hat{i} + 3\hat{j}$; $\overrightarrow{v_{rm}} = -4\hat{j}$

$\overrightarrow{v_r} = \overrightarrow{v_{rm}} + \overrightarrow{v_m} = 2\hat{i} - \hat{j}$

Now velocity of man $\overrightarrow{v_{m'}} = -2\hat{i} - 3\hat{j}$

$\overrightarrow{v_{rm'}} = \overrightarrow{v_r} - \overrightarrow{v_{m'}} = 4\hat{i} + 2\hat{j}$

$\left|\overrightarrow{v_{rm'}}\right| = \sqrt{20}$ m/s

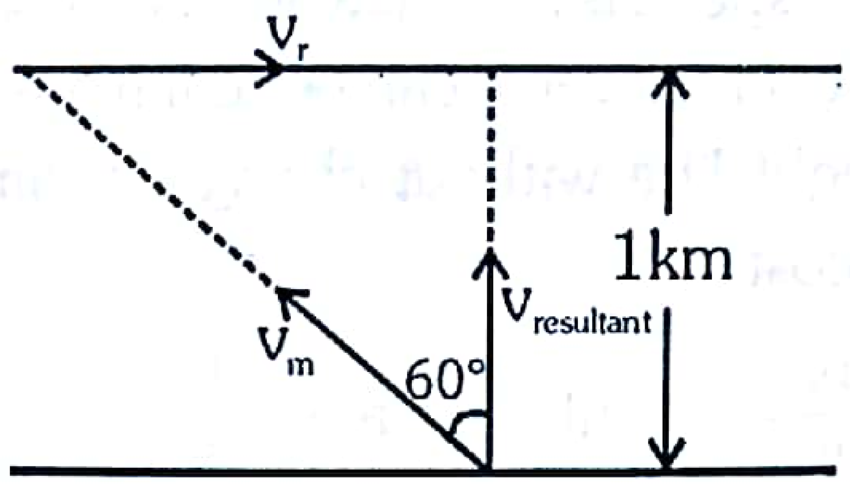
7. For bodies to collide the vertical velocities should be same

$\Rightarrow \quad u_1 \sin 60° = u_2$

$\Rightarrow \quad \frac{u_1}{u_2} = \frac{2}{\sqrt{3}}$

BEGINNER'S BOX-11

1. (a) $\sin 60° = \frac{v_r}{v_m}$



$\Rightarrow v_r = \frac{2\sqrt{3}}{2} = \sqrt{3}$ m/s

(b) $t = \frac{1000}{2\cos 60°} = 1000$ sec.

2. For shortest path

(a) $\sin\theta = \frac{v_r}{v} = \frac{1}{2} \Rightarrow \theta = 30°$

So direction from downstream = 90° + 30° = 120°

(b) crossing time $T = \frac{d}{v\cos\theta} = \frac{2}{10\cos 30°}$

$T = \frac{2}{5\sqrt{3}}$ h

3. (a) Speed of the child running in the direction of motion of the belt

= 9 + 4 = 13km/h

(b) Speed fo the child in opposite direction of the motion of the belt

= 9 – 4 = 5km/h

(c) Since both the parents and child are on the moving belt. So their relative position and speed remain unchanged.

speed of child $= 9 \times \frac{5}{18} = 2.5$ m/s,

time taken $= \frac{\text{distance}}{\text{speed}} = \frac{50}{2.5} = 20$s

if the motion is viewed by one of the parents answer to (a) and (b) are altered while answer to (c) remain unchanged.

EXERCISE-I (Conceptual Questions) — Build Up Your Understanding

1. $\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$

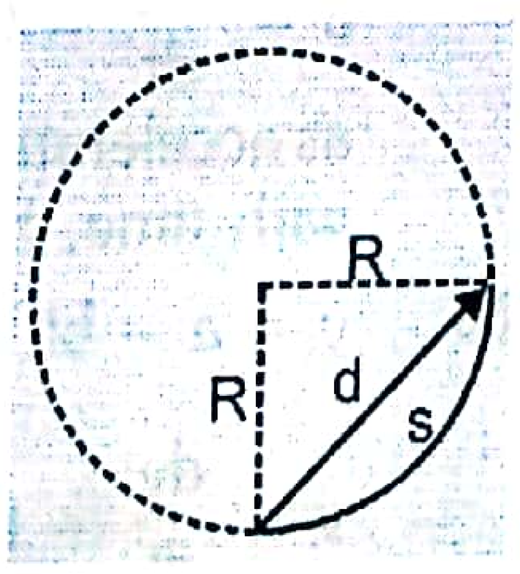
$\vec{d} = 30\hat{j} + 20\hat{i} + 30\sqrt{2}\left(\frac{-\hat{i}-\hat{j}}{\sqrt{2}}\right)$

$\vec{d} = 30\hat{j} + 20\hat{i} - 30\hat{i} - 30\hat{j}$

$\vec{d} = -10\hat{i}$

$\vec{d}$ = 10 m towards west

2. Displacement $d = R\sqrt{2}$



distance $s = \frac{\pi R}{2}$

$\therefore \frac{s}{d} = \frac{\pi R}{2R\sqrt{2}}$

$= \frac{22}{7 \times 2\sqrt{2}} = \frac{11}{7\sqrt{2}}$

3. $\frac{s_P}{s_Q} = \frac{\frac{3}{2}\pi r}{2r} = \frac{3}{4}\pi$

7. T = 20 s

In 140 sec. number of rotation =7

Displacement = 0

8. $\vec{d} = \vec{d}_1 + \vec{d}_2$

$\vec{d} = (vt)\hat{i} + (vt)\hat{j}$

$|\vec{d}| = vt\sqrt{2}$

$v_{avg} = \frac{|\vec{d}|}{\text{Total time}}$

$v_{avg} = \frac{\sqrt{2}vt}{2t} = \frac{v}{\sqrt{2}}$

9. Let 1 cycle = 5 step forward & 3 step backwards

then net displacement in 1 cycle = (+5) + (–3) = +2m

Net displacement in 3 cycle = 6m

So he will fall down in the pit after completing 3 cycles & 5 forward steps.

Total time = 3(5 + 3) + 5(1) = 29 sec.

10. Average speed

$$= \frac{\text{Total distance}}{\text{Total time}} = \frac{2\pi r}{6.28} = 10\ m/s$$

Average velocity

$$= \frac{\text{Total displacement}}{\text{Total time}} = 0$$

11. Average speed in last half $= \frac{4.5+7.5}{2} = 6\ m/s$

Average speed in total journey $= \frac{2(12)(6)}{12+6}$

$= 8\ m/s$

13. $v_{avg} = \dfrac{d}{\frac{d}{3v_1}+\frac{d}{3v_2}+\frac{d}{3v_3}}$

$v_{avg} = \dfrac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$

14. Average speed $= \dfrac{\text{total distance}}{\text{total time}} = \dfrac{2d}{2+3} = \dfrac{2d}{5}$

15. $v_{avg} = \dfrac{2v_1v_2}{v_1+v_1} = \dfrac{2\times40\times60}{40+60} = 48\ km/h$

16. $t_1 = \dfrac{\frac{d}{3}}{20} = \dfrac{d}{60}$ and $t_2 = \dfrac{\frac{2d}{3}}{60} = \dfrac{d}{90}$

total time $t = t_1 + t_2$

average speed $= \dfrac{d}{t} = \dfrac{d}{\frac{d}{60}+\frac{d}{90}} = \dfrac{60\times90}{90+60}$

$= \dfrac{60\times90}{150} = 36\ km/h$

17. Average speed $= \dfrac{15\times2+5\times8}{2+8} = 7\ m/s$

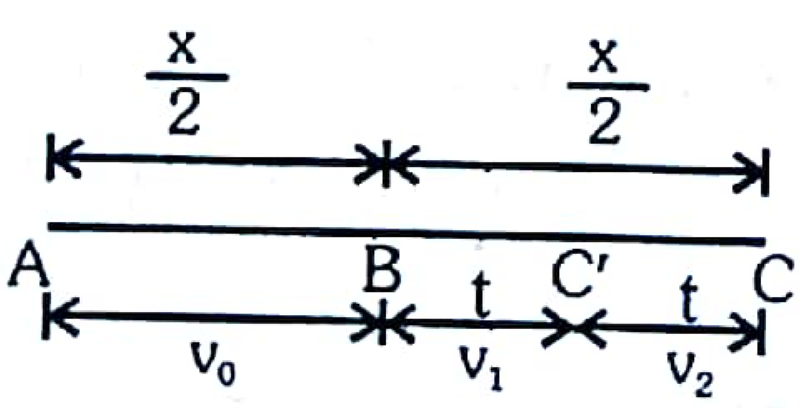
18. Displacement $\le$ distance

19. Average velocity $= \dfrac{3\times20+4\times20+5\times20}{20+20+20}$

$= 4\ m/s$

20. Average speed $= \dfrac{2\times100\times50}{100+50} = 66.7\ m/s$

21.



v_{avg} for second half $= \dfrac{v_1+v_2}{2}$

v_{avg} for total $= \dfrac{2(v_0)\left(\frac{v_1+v_2}{2}\right)}{v_0+\frac{v_1+v_2}{2}}$

$v_{avg} = \dfrac{2v_0(v_1+v_2)}{2v_0+v_1+v_2}$

22. Average velocity $= \dfrac{\text{Displacement}}{\text{Time interval}}$

A particle moving in a given direction with non-zero velocity cannot have zero speed.In general, average speed is not equal to magnitude of average velocity. However, it can be so if the motion is along a straight line without change in direction.

23. $x = a\cos t$

$v = \dfrac{dx}{dt} = -a\sin t \Rightarrow a = \dfrac{dv}{dt} = -a\cos t$

24. $u = kt \Rightarrow \dfrac{ds}{dt} = kt$ ($\because k = 2\ m/s^2$)

$\Rightarrow \int_0^s ds = 2\int_0^3 t\,dt \Rightarrow s = 2\left|\dfrac{t^2}{2}\right|_0^3 \Rightarrow s = 9\ m$

25. $x = at^2 - bt^3$

$v = \dfrac{dx}{dt} = 2at - 3bt^2$

$a = \dfrac{dv}{dt} = 2a - 6bt = 0 \Rightarrow t = \dfrac{a}{3b}$

26. $s = t^3 - 6t^2 + 3t + 4$

$v = \dfrac{ds}{dt} = 3t^2 - 12t + 3$

$a = \dfrac{dv}{dt} = 6t - 12$ If $a = 0 \Rightarrow t = 2$

So $v = 3(2)^2 - 12(2) + 3 = -9 m/s$

27. $s = 6t^2 - t^3$

$v = \dfrac{ds}{dt} = 12t - 3t^2$

$v = 0 \Rightarrow t = 0,\ 4 sec.$

28. $v = 20 + 0.1\ t^2$

$a = \dfrac{dv}{dt} = 0.1 \times 2\ t = 0.2\ t$

as acceleration depends on time and it is increasing with time, hence it is non uniform acceleration.

29. $y = a + bt + ct^2 - dt^4$

$v = \dfrac{dy}{dt} = b + 2ct - 4dt^3$

at $t = 0$ $v = b$

$a = \dfrac{dv}{dt} = 2c - 12\ dt^2$

at $t = 0$ $a = 2c$

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