Physicsaholics

DPP – 3 (Kinematics)

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Q 1. A ball is thrown vertically upwards in air. If the air resistance cannot be neglected (assume it to be directly proportional to velocity), then the acceleration of the ball at the highest point will be:

(a) 0 (b) g (c) > g (d) < g

Q 2. A ball is dropped from the roof of a tower of height h. The total distance covered by it in the last second of its motion is equal to the distance covered by it in first three seconds. The value of h in metres is: ($g = 10\ m/s^2$)

(a) 125 (b) 200 (c) 100 (d) 80

Q 3. A ball is thrown up with a certain velocity so that it reaches a height h. Find the ratio of the times in which it is at h/3.

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

Q 4. A particle is projected vertically upward with initial velocity 25 ms^{-1}. During third second of its motion, which of the following statement is correct? ($g = 10\ m/s^2$)
(a) displacement of the particle is 30 m
(b) distance covered by the particle is 30 m
(c) distance covered by the particle is 2.5 m
(d) none of these

Q 5. A stone is allowed to fall from the top of a tower and cover half the height of the tower in the last second of its journey. The time taken by the stone to reach the foot of the tower is ($g = 10\ m/s^2$)

(a) $(2 - \sqrt{2})$s (b) 4 s
(c) $(2 + \sqrt{2})$s (d) $(2 \pm \sqrt{2})$s

Q 6. A particle is projected in vertically upward direction its maximum height is H, and total time of flight is T. Find Its height after time $\frac{3T}{4}$ after projection

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

Q 7. A juggler maintains four balls in motion, making each of them to rise a height of 20 m from his hand. What time interval should he maintain, for the proper distance between them? (g = 10 m/s^2)

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

Q 8. A particle is dropped from point A at a certain height from ground. It falls freely and passes through three points B, C and D with BC =CD. The time taken by the particle to move from B to C is 2 s and from C to D is 1s. The time taken to move from A to B is

(a) 0.5 s (b) 1.5 s (c) 0.75 s (d) 0.25 s

Q 9. From the top of a tower of height 200 m, a ball A is projected up with 10 m/s and two seconds later another ball B is projected vertically down with the same speed. Then : (Take g = 10 m/s^2)
(a) both a and b will reach the ground simultaneously
(b) the ball a will hit the ground 2 seconds later than b hitting the ground
(c) both the balls will hit the ground with the same velocity
(d) both (a) & (c)

Q 10. A particle is released from rest from a tower of height 3h. The ratio of times to fall equal heights h, i.e., $t_1 : t_2 : t_3$ is

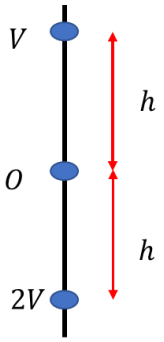
(a) $\sqrt{3}:\sqrt{2}:1$ (b) 3 : 2 : 1
(c) 9 : 4 : 1 (d) $1 : (\sqrt{2} - 1): (\sqrt{3} - \sqrt{2})$

Q 11. A body when projected vertically up, covers a total distance D during its time of flight. If there were no gravity, the distance covered by it during the same time is equal to
(a) 0 (b) D (c) 2D (d) 4D

Q 12. A particle is projected in vertically upward direction. In last two seconds of its downward motion it travels distance 60 m. Find total time of flight? (g = 10 m/s^2)
(a) 4 s (b) 6 s (c) 8 s (d) 10 s

Q 13. Two particles A & B are projected from same point with same speed 40 m/s in vertically upward direction. B is projected 2 seconds after A, find height of particles at the instant of their collision? (g = 10 m/s^2)
(a) 20 m (b) 35 m (c) 60 m (d) 75 m

Q 14. A ball is projected in upward direction. During its motion when ball is at h metre high from a point O, its velocity is v. When it is h m below O, its velocity is 2v. Find the maximum height from O it will acquire



(a) 2h/3 (b) 5h/3
(c) 3h/2 (d) 2h

Q 15. From a tap 10 m high drops fall at regular intervals. When the first drop reaches the ground, the 5th drop is about to leave the tap. Find the separation between 2nd and 3rd drops. (g = 10 m/s^2)
(a) 35/8 m (b) 31/8 m
(c) 27/8 m (d) none of these

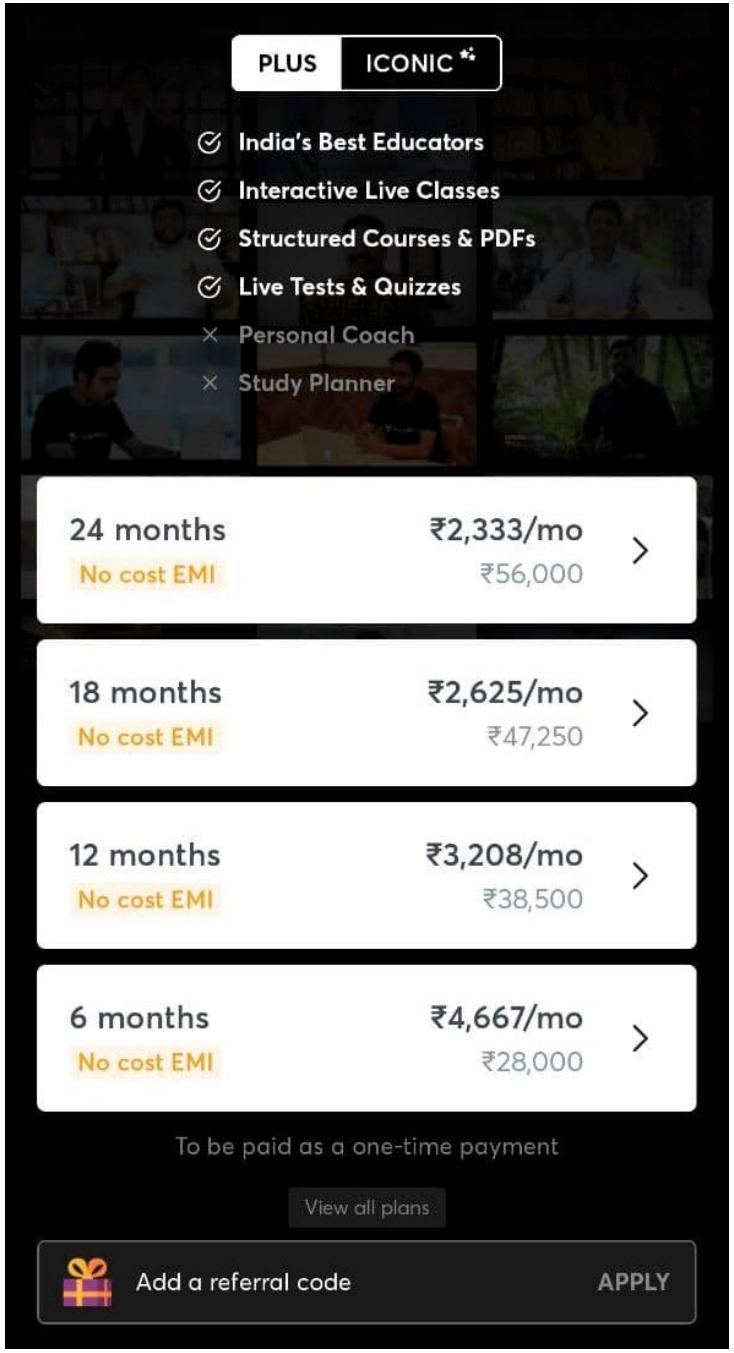
Q 16. If air provides a constant retardation 6 m/s^2 to a ball projected in vertically upward direction. Find ratio of time of ascent to time of descent ? (g = 10 m/s^2)
(a) $\frac{1}{2}$ (b) 2 (c) 1 (d) none of these

Q 17. A particle is thrown vertically upwards from ground. It takes time t_1 to reach a height h. It continues to move and takes time t_2, to reach the ground. Its maximum height is
(a) $\frac{g}{2}\frac{t_1+t_2}{2}$ (b) $\frac{g}{2}\sqrt{t_1^2+t_2^2}$
(c) $\frac{g}{8}(t_1+t_2)^2$ (d) g($t_1^2+t_2^2$)

Q 18. A ball is projected in upward direction at t = 0. At t = 6 sec and at t = 8 sec, it is at same height h from ground. Find h?
(a) 240 m (b) 350 m (c) 170 m (d) 420 m

Answer Key

Q.1 b	Q.2 a	Q.3 b	Q.4 c	Q.5 d
Q.6 d	Q.7 c	Q.8 a	Q.9 d	Q.10 d
Q.11 c	Q.12 c	Q.13 d	Q.14 b	Q.15 d
Q.16 a	Q.17 c	Q.18 a		



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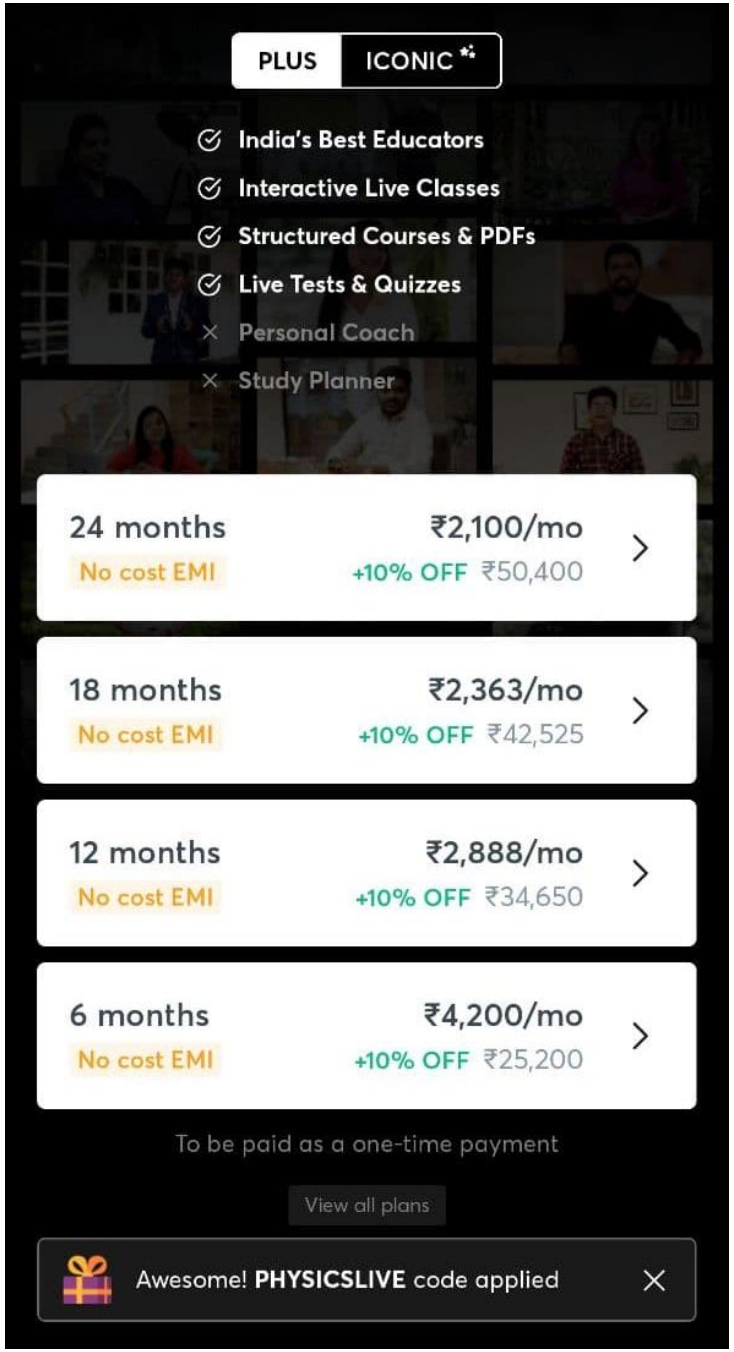
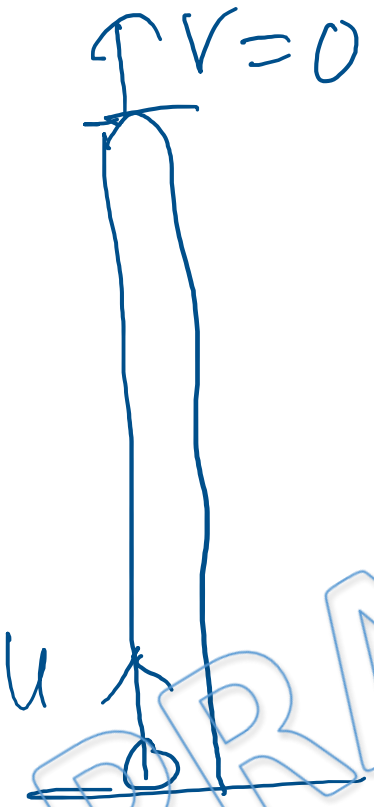


Written Solution

DPP-3 Motion under gravity

By Physicsaholics Team

Solution: 1



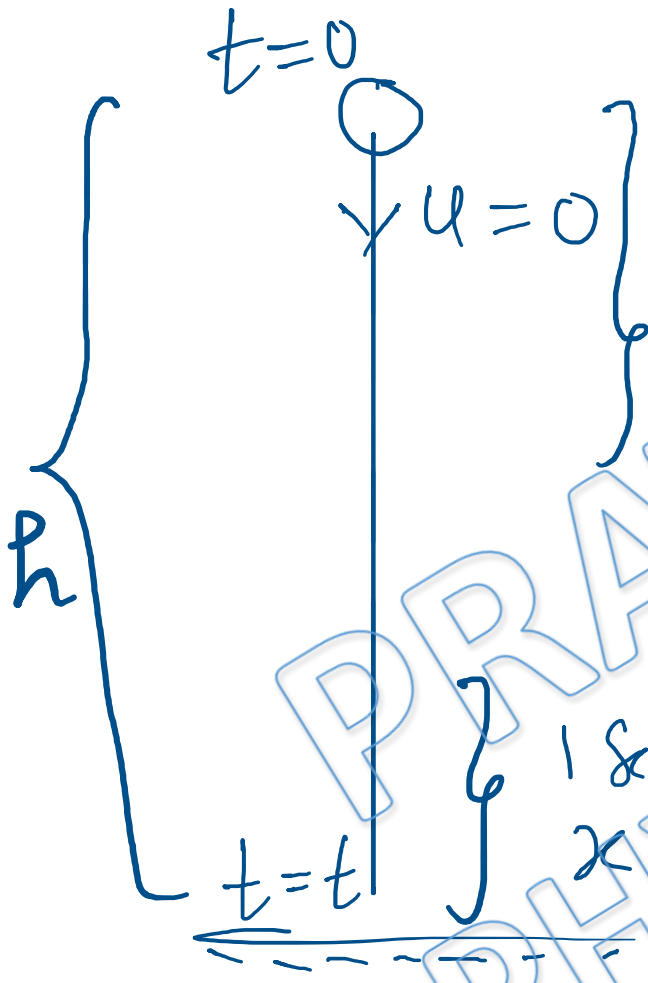
Air resistance on ball is directly proportional to it's velocity. At topmost point

$v = 0 \Rightarrow$ air resistance $= 0$

$\Rightarrow$ acceleration is $g \downarrow$

ANS : b

Solution: 2



If total time of fall is t

then last 1 Sec means t^{th} Second

$$\Rightarrow x = u + \frac{1}{2}a(2t-1)$$

$$\Rightarrow x = \frac{g}{2}(2t-1)$$

distance travelled in first 3 Sec

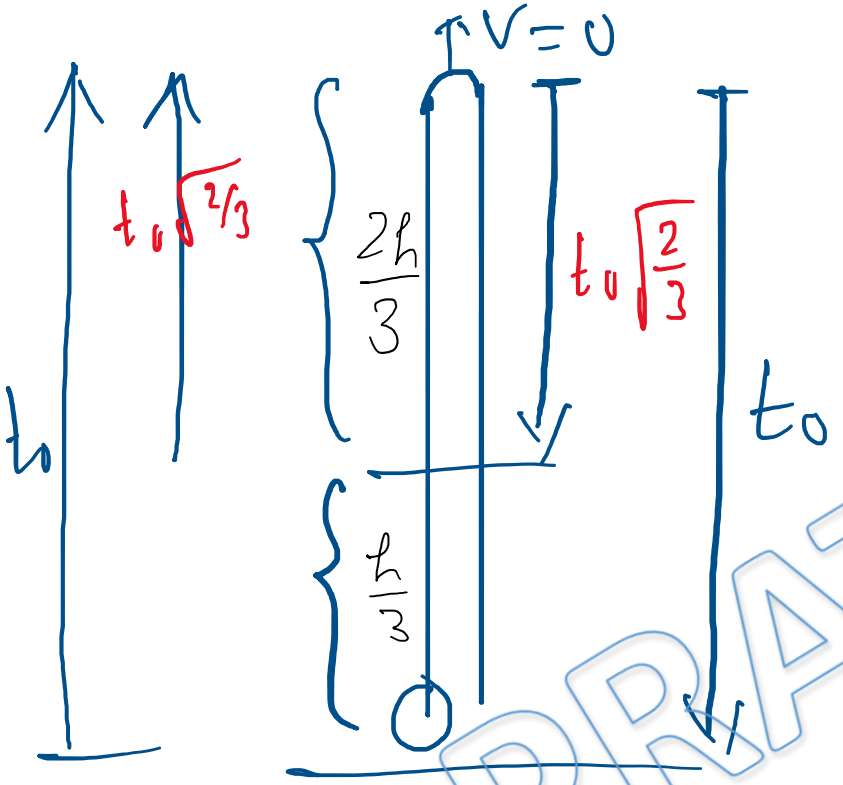
$$x = \frac{1}{2}g \times 3^2 = \frac{9}{2}g$$

$$\Rightarrow \frac{9g}{2} = \frac{g}{2}(2t-1) \Rightarrow t = 5$$

$$\Rightarrow h = \frac{1}{2}gt^2 = \frac{10}{2} \times 25 = 125\ m$$

ANS : a

Solution: 3



Let time of ascent = time of descent = t_0

during descent $x = \frac{1}{2}gt^2$

$\Rightarrow t \propto \sqrt{x}$ $\Rightarrow$

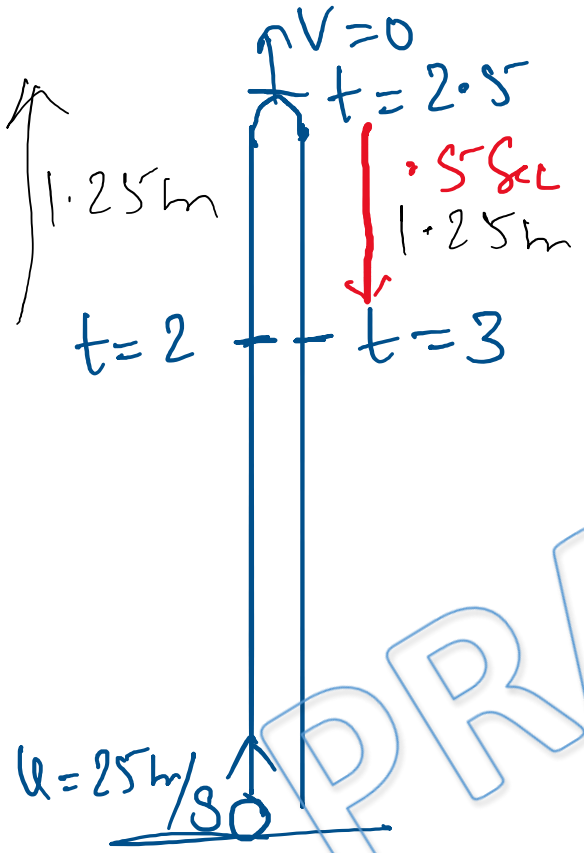
$\Rightarrow \frac{\text{time of fall of first } 2h/3}{\text{,, ,, ,, ,, } h} = \sqrt{\frac{2h/3}{h}}$

$\Rightarrow$ time of fall of first $2h/3 = t_0\sqrt{2/3}$

$$\text{Ratio} = \frac{t_0 - t_0\sqrt{2/3}}{t_0 + t_0\sqrt{2/3}} = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$$

ANS : b

Solution: 4



3rd Second $\Rightarrow$ $t=2$ to $t=3$

Displacement in 3rd Second

$= u + \frac{1}{2}a(2t-1) = 25 + \frac{1}{2}(-10)(6-1) = 0$

particle is at same position at $t=2$ & at $t=3$.

time of ascent $= \frac{u}{g} = 2.5$ Sec

Displacement from $t=2.5$ to $t=3$

$= \frac{1}{2} \times 10 \times (.5)^2 = 5 \times .25 = 1.25$ m

Distance travelled in 3rd Second

$= 1.25 + 1.25 = 2.5$ m

ANS : c

Solution: 5

Let time of fall is t.

$\Rightarrow$ last 1 sec means t^{th} second.

Displacement in last 1 sec $= \frac{1}{2}g(2t-1)$

height of tower $= \frac{1}{2}gt^2$

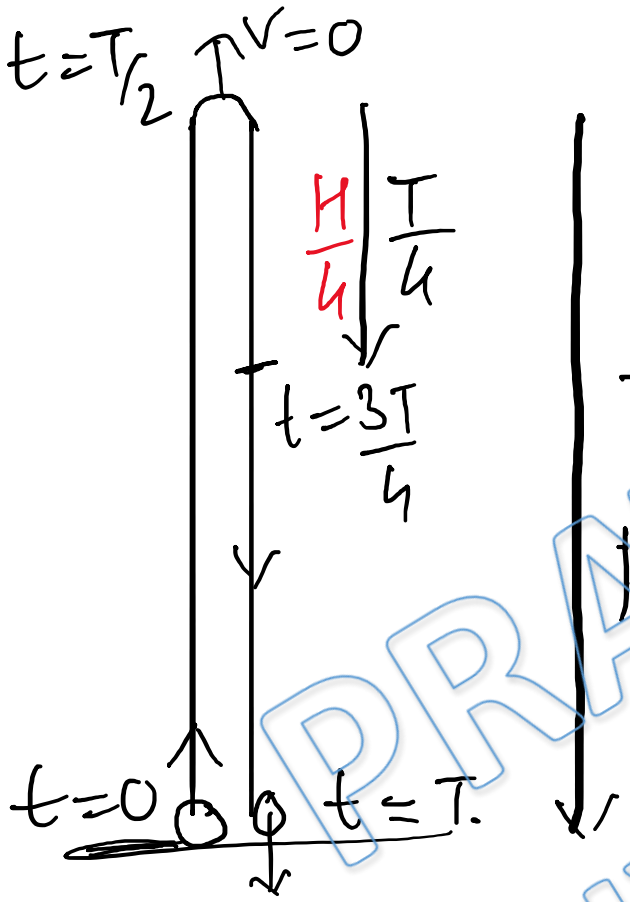
$\Rightarrow \frac{1}{2}\left(\frac{1}{2}gt^2\right) = \frac{g}{2}(2t-1) \Rightarrow t^2 = 4t-2$

$\Rightarrow t^2 - 4t + 2 = 0$

$\Rightarrow t = \frac{4 \pm \sqrt{16-8}}{2} = 2 \pm \sqrt{2}$

ANS : d

Solution: 6



time of descent = $T/2$

during fall

$x \propto t^2$

$\Rightarrow$ ball falls H in time $T/2$

$\Rightarrow$ it will fall $\frac{H}{4}$ in time $T/4$.

Height at $t = 3T/4$

$= H - H/4 = 3H/4$

ANS : d

Solution: 7

Time of flight of ball $= \frac{2u}{g} = \frac{2\times 20}{g} = 4\,Sec$

let t_0 is time difference b/w successive throw.

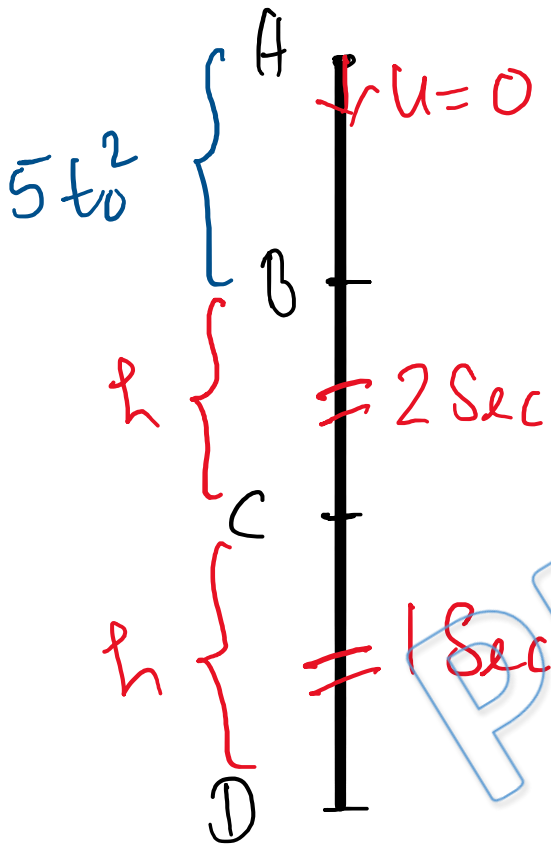
first throw	Second throw	Third throw	forth throw
$t=0$	$t=t_0$	$t=2t_0$	$t=3t_0$

5th throw $t=4t_0$ but there is no 5th ball. first ball must come back at the instant of 5th through.

$\Rightarrow \quad 4t_0 = 4\,Sec \quad \Rightarrow \quad t_0 = 1\,Sec$

ANS : c

Solution: 8



let time taken to move from A to B is t_0.

$\Rightarrow AB = \frac{1}{2} g t_0^2 = 5t_0^2$

for motion from A to C (using $h = \frac{1}{2} g t^2$)

$h + 5t_0^2 = 5(t_0+2)^2$ — (I)

for motion from A to D

$2h + 5t_0^2 = 5(t_0+3)^2$ — (II)

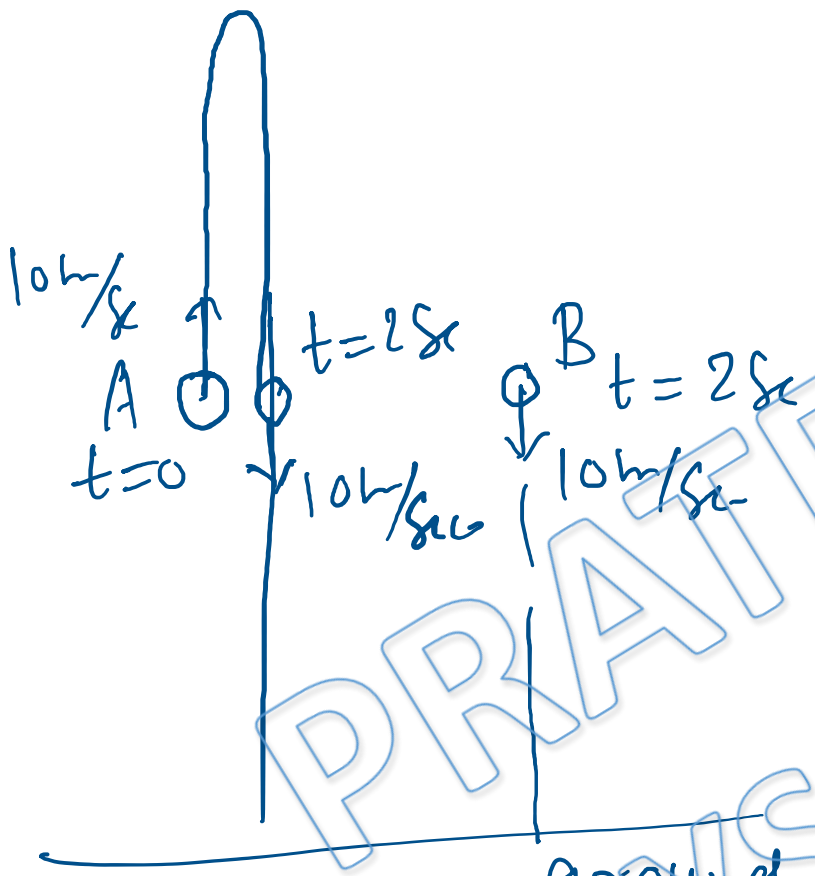
Eq(II) − 2Eq I

$\Rightarrow -5t_0^2 = 5(t_0+3)^2 - 10(t_0+2)^2$

on solving this equation $t_0 = .5$ Sec

ANS : a

Solution: 9



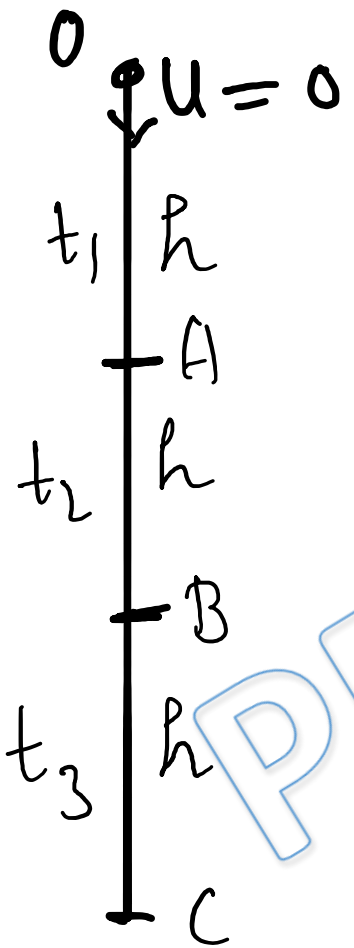
ball A is projected at $t=0$ at $t=2$ Sec, A will again be at its initial position with velocity 10m/sec.

At same time ($t=2$) B is projected down with same velocity 10m/sec.

$\Rightarrow$ after $t=2$ Sec motion of B & A is identical

ANS : d

Solution: 10



formula of time of fall $t = \sqrt{\frac{2h}{g}}$ (if $u=0$)

from O to A $\quad t_1 = \sqrt{\frac{2h}{g}}$

from O to B $\quad t_1 + t_2 = \sqrt{\frac{4h}{g}}$

from O to C $\quad t_1 + t_2 + t_3 = \sqrt{\frac{6h}{g}}$

$\Rightarrow t_2 = \sqrt{\frac{4h}{g}} - \sqrt{\frac{2h}{g}}$ & $t_3 = \sqrt{\frac{6h}{g}} - \sqrt{\frac{4h}{g}}$

$\Rightarrow t_2 = \sqrt{\frac{2h}{g}}(\sqrt{2}-1)$ & $t_3 = \sqrt{\frac{2h}{g}}(\sqrt{3}-\sqrt{2})$

$\Rightarrow t_1 : t_2 : t_3 = 1 : (\sqrt{2}-1) : (\sqrt{3}-\sqrt{2})$

ANS : d

Solution: 11

If initial velocity is u.

$$D = 2(\text{maximum height}) = 2 \times \frac{u^2}{2g} = \frac{u^2}{g}$$

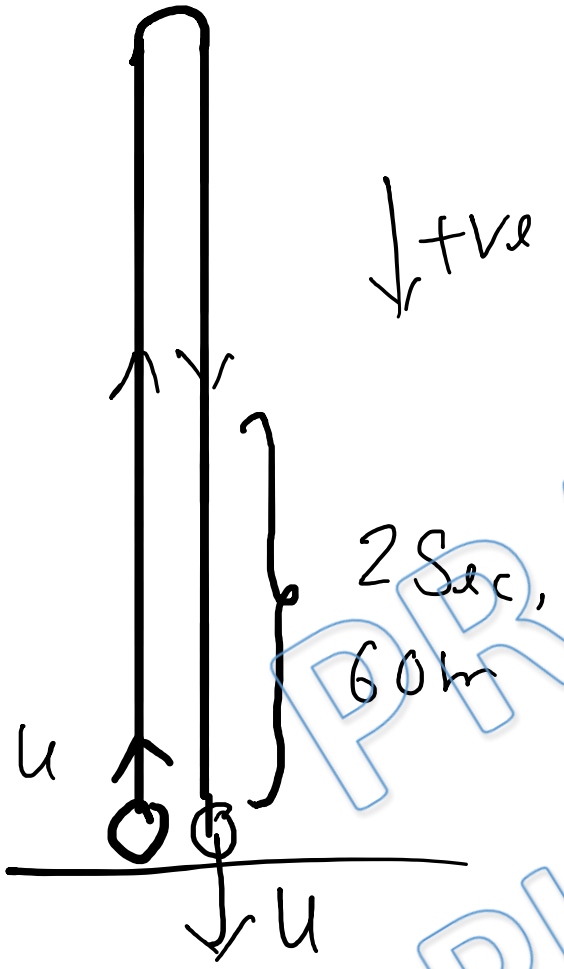
Distance covered in same time in the absence of gravity

$$S = uT = u \times \frac{2u}{g} = \frac{2u^2}{g} = 2D$$

T ↓ time of flight

ANS : c

Solution: 12



Using formula

$$x = vt - \frac{1}{2}at^2 \quad \text{for last 2 Sec}$$

$$60 = u \times 2 - \frac{1}{2}(+10) \times 2^2$$

$$60 = 2u - 20$$

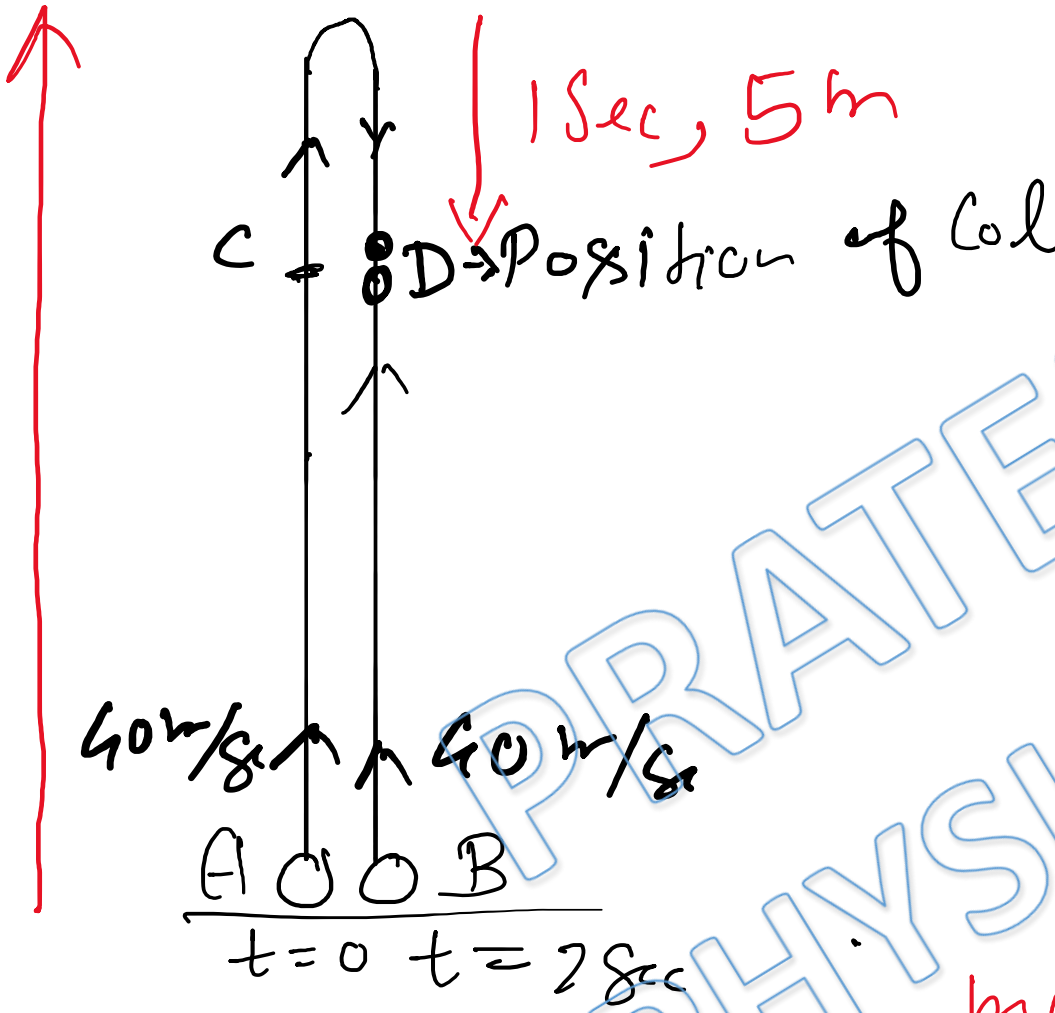
$$u = 40 \text{ m/Sec}$$

$$\Rightarrow T = \frac{2u}{g} = \frac{80}{10}$$

$$= 8 \text{ Sec}$$

ANS : c

Solution: 13



time taken by A to reach C = ,, ,, B ,, ,, D

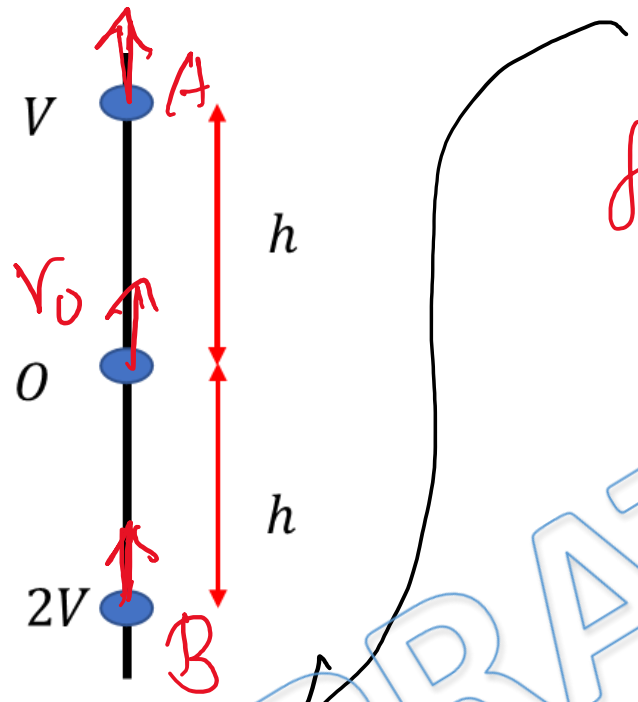
upto Collision A has taken extra 2 Sec. means ⇒ time taken by A to move from C to D is 2 Sec ⇒ time taken by A to move from top to D = 1 Sec

maximum height $= \frac{u^2}{2g} = \frac{40 \times 40}{2 \times 10} = 80\,m$

height of point B = 80 − 5 = 75 m

ANS : d

Solution: 14



from O to A $\rightarrow$ $v^2 = v_0^2 - 2gh$

from B to O $\rightarrow$ $v_0^2 = 4v^2 - 2gh$

$v^2 - v_0^2 = v_0^2 - 4v^2$

$5v^2 = 2v_0^2$

$v_0^2 = \frac{5v^2}{2}$

$v^2 = \frac{5v^2}{2} - 2gh$

$\frac{3}{2}v^2 = 2gh$

$v^2 = 4gh/3$

max height from O $= \frac{v_0^2}{2g} = \frac{5v^2}{2\times 2g} = \frac{5v^2}{4g} = \frac{5h}{3}$

ANS : b

Solution: 15

Time of fall of 1st drop $= \sqrt{\frac{2h}{g}} = \sqrt{2}$ Sec

If time interval is t_0, $4t_0 = \sqrt{2}$

$t_0 = \frac{1}{2\sqrt{2}}$ Sec.

Displacement of 2nd drop $= \frac{1}{2} \times 10 (3t_0)^2$

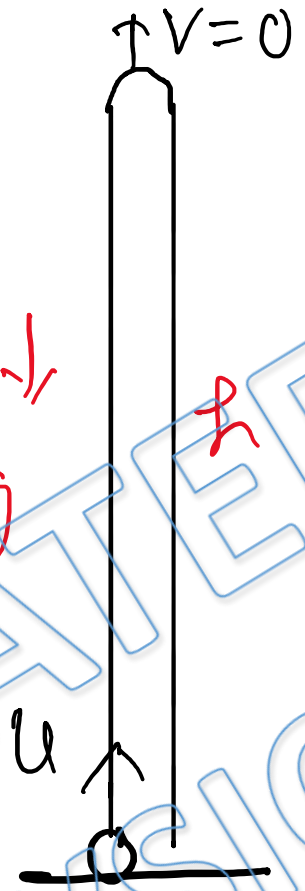
" " 3rd " $= \frac{1}{2} \times 10 (2t_0)^2$

distance b/w 2nd & 3rd drop

$= 45t_0^2 - 20t_0^2 = 25 \times \frac{1}{4 \times 2} = \frac{25}{8}$ m

ANS : d

Solution: 16



acceleration during ascent = 10+6 = 16 m/sec² ↓

acceleration during descent = 10−6 = 4 m/sec² ↓

Using $x = vt - \frac{1}{2}at^2$ for ascent

$h = \frac{1}{2} \times 16 t_1^2$

during ascent acceleration due to air is doconcaved & during descent it is upward as air friction always acts in just opposite direction of velocity.

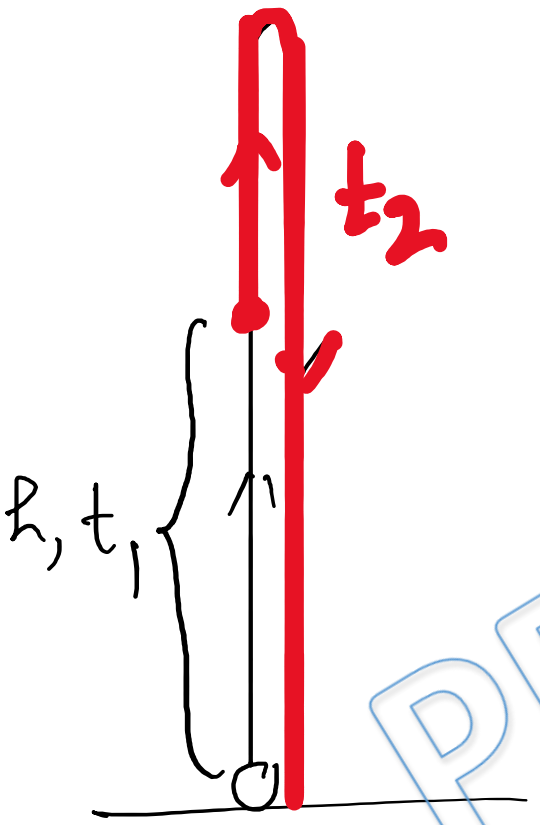
Using $x = ut + \frac{1}{2}at^2$ for descent

$h = \frac{1}{2} \times 4 t_2^2$

$\Rightarrow 8t_1^2 = 2t_2^2 \Rightarrow \frac{t_1}{t_2} = \frac{1}{2}$

ANS : a

Solution: 17



total time of motion $= t_1 + t_2$

time of descent $= \frac{t_1 + t_2}{2}$

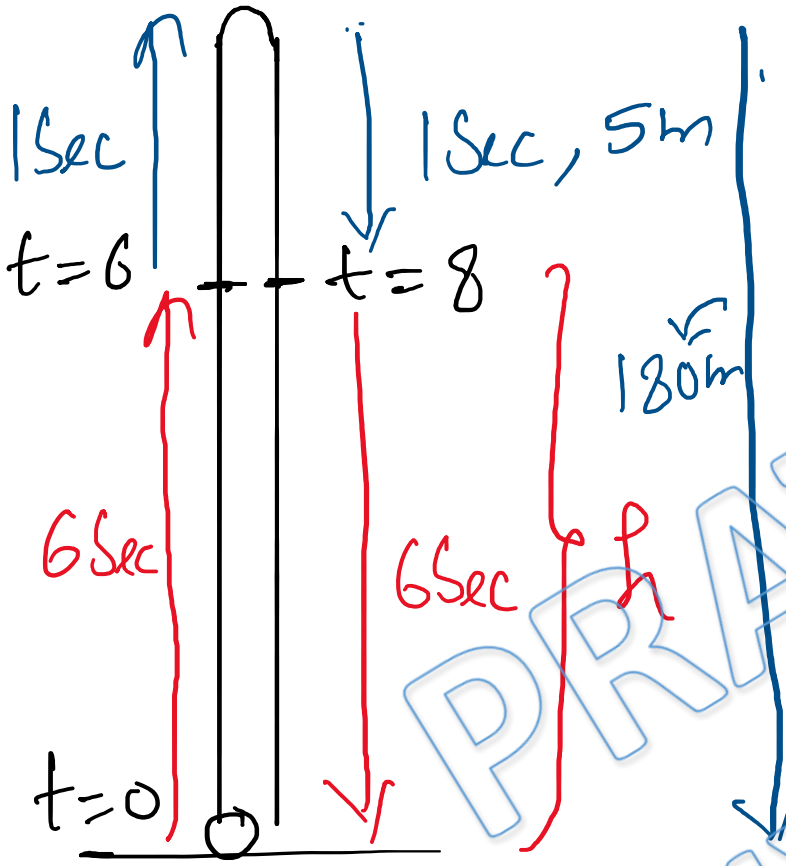
maximum height

= distance of descent

$$= \frac{1}{2} g \left(\frac{t_1 + t_2}{2} \right)^2 = \frac{g}{8} (t_1 + t_2)^2$$

ANS : c

Solution: 18



during descent ball is at height h at $t = 8$, after that it will take 6 Sec to reach ground.

$\Rightarrow$ total time of flight $= 8 + 6 = 14$

$\Rightarrow$ time of descent $= 7$ Se

max height $= \frac{1}{2} g (7)^2 = 245$ m

distance travelled in 1 Sec after reaching top $= \frac{1}{2} g (1)^2 = 5$ m

$h = 245 - 5 = 240$ m

ANS : a

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