Motion in a Straight Line

Question1

The ratio of times taken by a freely falling body to travel first 5 m , second 5 m , third 5 m distances is

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

$1 : \sqrt{2} : \sqrt{3}$

B.

$1 : \sqrt{2-1} : \sqrt{3-2}$

C.

$1 : \sqrt{3} : \sqrt{5}$

D.

$1 : \sqrt{2} - 1 : \sqrt{3} - \sqrt{2}$

Answer: D

Solution:

Time taken (t_1) by freely falling body to travel first 5 m is given as,

$$s = ut_1 + \frac{1}{2} g t_1^2$$

$$5 = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2$$

$$\Rightarrow \quad t_1 = 1 \text{ s}$$

Time taken (t') to travel 10 m .

$$10 = 0 \times t_1' + \frac{1}{2} \times 10 \times t'^2$$
$$\Rightarrow \quad t' = \sqrt{2}\ \mathrm{s}$$

$\therefore$ Time taken (t_2) to travel next 5 m ,

$t_2 = t' - t_1 = (\sqrt{2} - 1)\mathrm{s}$

Time taken (t'') to travel 15 m ,

$$15 = 0 \times t'' + \frac{1}{2} \times 16 \times (t'')^2$$
$$15 = 5(t'')^2$$
$$\therefore \quad t'' = \sqrt{3}\ \mathrm{s}$$

Thus, time taken (t_3) to travel lost 5 m

$$t_3 = t'' - t' = \sqrt{3} - \sqrt{2}$$
$$\therefore t_1 : t_2 : t_3 = 1 : (\sqrt{2} - 1) : (\sqrt{3} - \sqrt{2})$$

Question2

A body projected vertically up with an initial speed of $10\ \mathrm{ms}^{-1}$ reaches the point of projection after sometime with a speed of $8\ \mathrm{ms}^{-1}$. The maximum height reached by the body is(Acceleration due to gravity $= 10\ \mathrm{ms}^{-2}$)

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

5 m

B.

3.2 m

C.

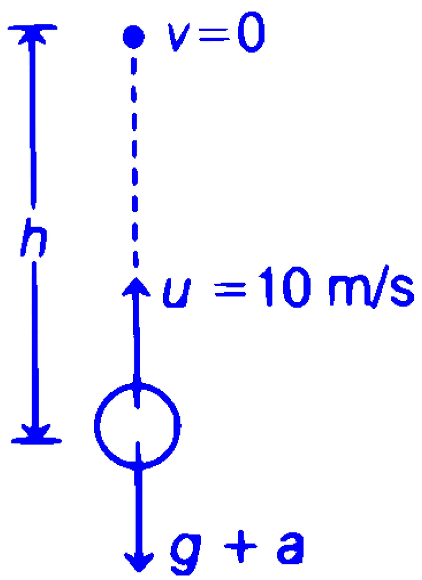
4.1 m

D.

4.5 m

Answer: C

Solution:



As object return with smaller speed that means there is a loss of energy. This loss of energy occurs due to viscous drag of atmosphere. While object is moving up let viscous drag produces an deceleration ' a '.

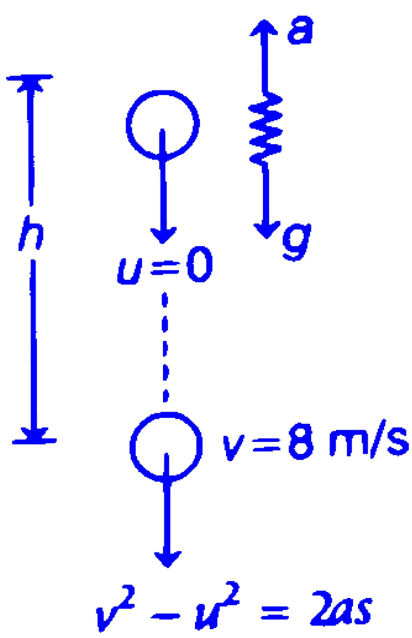
Then,

$$v^2 - u^2 = 2as$$

$$\Rightarrow \quad 0-(10)^2 = 2(-(g+a))h$$

$$\text{or} \quad 100 = 2(g+a)h \qquad \ldots(i)$$

While coming down,



$$\Rightarrow \quad 64-0=2(-(g-a))(-h)$$
$$\Rightarrow \quad 64=2(g-a)h \qquad \ldots(ii)$$

Dividing (i) and (ii) we get

$$\frac{100}{64}=\frac{g+a}{g-a}$$
$$\Rightarrow \quad 100g-100a=64g+64a$$
$$36g=164a \text{ or } a=\frac{36}{164}g$$

Substituting ' a ' in either (i) or (ii) we get ' h.

From (ii)

$$64=2\left(g-\frac{36}{164}g\right)h$$
$$\Rightarrow \quad 32=\left(\frac{164-36}{164}\right)gh \Rightarrow$$
$$\Rightarrow \quad h=4.1 \text{ m}$$

Question3

The driver of a bus moving with a velocity of 72 km/h observes a boy walking across the road at a distance of 50 m in front of the bus and decelerates the bus at 5 ms^{-2} by applying brakes and is just able to avoid an accident. The reaction time of the driver is

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

4 s

B.

3.5 s

C.

0.5 s

D.

4.5 s

Answer: C

Solution:

$u=72 \mathrm{~km} / \mathrm{h}=72 \times \frac{3}{18}=20 \mathrm{~m} / \mathrm{s}$

$$a=-5 \mathrm{~m} / \mathrm{s}^2$$
$$\therefore \text{ using }, v^2=u^2+2 a s$$
$$\Rightarrow 0=20^2+2(-5) s$$
$$\Rightarrow s=\frac{400}{10}=40 \mathrm{~m}$$

Distance travelled during reaction time

$$\begin{aligned} & =\text { Total distance }-s \\ & =50-40=10 \mathrm{~m}\end{aligned}$$

If t be the reaction time, then

$$s=u t$$
$$t=\frac{s}{u}=\frac{10}{20}=0.5 \mathrm{~s}$$

Question4

The initial and final velocities of a body projected vertically from the ground are $20 \mathrm{~ms}^{-1}$ and $18 \mathrm{~ms}^{-1}$ respectively. The maximum height reached by the body is (Acceleration due to gravity $= 10 \mathrm{~ms}^{-2}$)

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

20 m

B.

16.2 m

C.

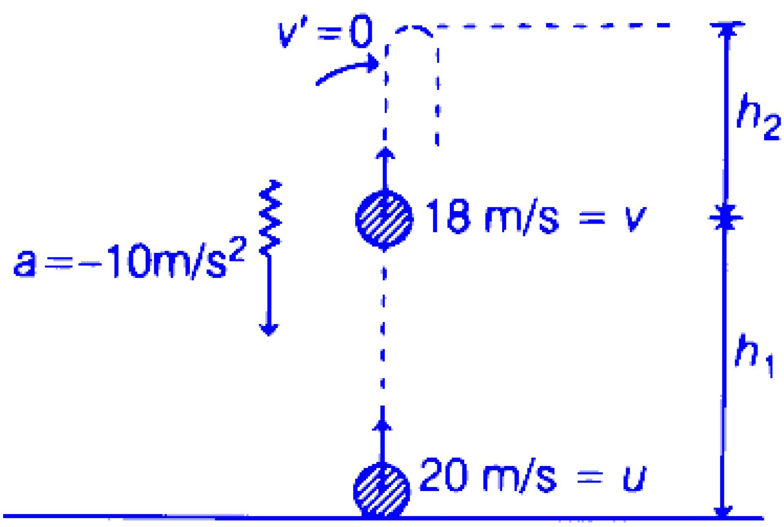
19 m

D.

18.1 m

Answer: A

Solution:



Using $v^2 - u^2 = 2gh$

We have for h_1 (see figure)

$$\begin{aligned} & 18^2 - 20^2 = 2(-10) \times h_1 \\ \Rightarrow \quad & h_1 = 3.8 \text{ m} \end{aligned}$$

Now for h_2,

$$\begin{aligned} & 0 - 18^2 = 2(-10) \times h_2 \\ \Rightarrow \quad & h_2 = 16.2 \text{ m} \end{aligned}$$

Maximum height attained

$$\begin{aligned} & = h_1 + h_2 = 3.8 + 16.2 \\ & = 20 \text{ m} \end{aligned}$$

Question5

The position x (in metre) of a particle moving along a straight line is given by $x = t^3 - 12t + 3$, where t is time (in second). The acceleration of the particle when its velocity becomes 15 ms^{-1} is

TG EAPCET 2024 (Online) 11th May Morning Shift

Options:

A. 15 ms^{-2}

B. 24 ms^{-2}

C. 18 ms^{-2}

D. 12 ms^{-2}

Answer: C

Solution:

The positive of a particle moving along X-axis is given by,

$x = t^3 - 12t + 3$

We know that,

$v(t) = \frac{d}{dt}(x)$

$v(t) = \frac{d}{dt}\left(t^3 - 12t + 3\right)$

$v(t) = 3t^2 - 12$

Given, $v(t) = 15 \text{ m/s}$

So, $3t^2 - 12 = 15 \Rightarrow t = 3 \text{ s}$

$\therefore \quad a(t) = \frac{d}{dt} v(t)$

$a(t) = \frac{d}{dt}\left(3t^2 - 12\right)$

$a(t) = 6t$

at $t = 3 \text{ s}, a(t) = 6 \times 3$

$a(t) = 18 \text{ ms}^{-2}$

Question6

A body is thrown vertically upwards with a velocity of 35 ms^{-1} from the ground. The ratio of the speeds of the body at times 3 s and 4 s of its motion is (acceleration due to gravity $= 10 \text{ ms}^{-2}$)

TG EAPCET 2024 (Online) 10th May Evening Shift

Options:

A. 3 : 4

B. 1 : 1

C. 2 : 1

D. 3 : 2

Answer: B

Solution:

A body is thrown vertically upwards with an initial velocity of 35 m/s. Given that the acceleration due to gravity is 10 m/s^2 acting downwards, let's find the ratio of the speeds at 3 seconds and 4 seconds after it begins its motion.

Initial Conditions

Initial velocity $u = 35\,\mathrm{m/s}$

Acceleration (gravity) $g = -10\,\mathrm{m/s}^2$ (since it's downwards)

Speed at 3 seconds

To calculate the speed of the body at 3 seconds (v_3), use the equation of motion:

$v_3 = u + at = 35 - 10 \times 3 = 5\,\mathrm{m/s}$

Speed at 4 seconds

Similarly, calculate the speed at 4 seconds (v_4):

$v_4 = u + at = 35 - 10 \times 4 = -5\,\mathrm{m/s}$

Ratio of Speeds

Since speed is the magnitude of velocity, consider the absolute values:

At 3 seconds, the speed is $|v_3| = 5\,\mathrm{m/s}$.

At 4 seconds, the speed is $|v_4| = 5\,\mathrm{m/s}$ (since $-5\,\mathrm{m/s}$ is negative, but speed is always positive).

Thus, the ratio of the speeds at 3 seconds and 4 seconds is:

$\frac{|v_3|}{|v_4|} = \frac{5}{5} = 1 : 1$

The ratio of the speeds is 1 : 1.

Question7

A body moving with uniform acceleration, travels a distance of 25 m in the fourth second and 37 m in the sixth second. The distance covered by body in the next two seconds is

TG EAPCET 2024 (Online) 10th May Morning Shift

Options:

A. 63 m

B. 84 m

C. 49 m

D. 92 m

Answer: D

Solution:

Distance travelled by uniform accelerated body in nth second,

$s_n = u + \frac{1}{2}a(2n-1)$

In 4th second, distance travelled,

$s_4 = 25 \text{ cm}$

$25 = u + \frac{7a}{2}$

In 6th second, distance travelled,

$s_6 = 37 \text{ cm}$

$$37 = u + \frac{11}{2}a$$

Eq. (ii) and Eq. (i) $a = 6 \text{ m/s}^2$ and substituting a in Eq. (ii)

$u = 4 \text{ m/s}$

Now we have to find velocity at $t = 6 \text{ s}$

$v = u + at$

$v = 4 + 6 \times 6$

$= 40 \text{ m/s}$

Distance travel in next 2 s

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

[Note now $u = 40 \text{ m/s}$]

$s = 40 \times 2 + \frac{1}{2} \times 6 \times (2)^2$

$s = 92 \text{ m}$

Question8

A stone is thrown vertically up from the top end of a window of height 1.8 m with a velocity of 8 ms^{-1}. The time taken by the stone

to cross the window during its downward journey is (acceleration due to gravity $= 10 \text{ ms}^{-2}$)

TG EAPCET 2024 (Online) 9th May Evening Shift

Options:

A. 0.8 s

B. 1.6 s

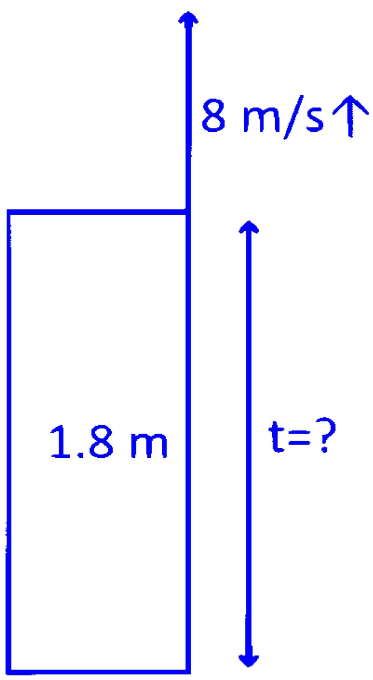
C. 1.0 s

D. 0.2 s

Answer: D

Solution:

Given, height of window, $h = 1.8 \text{ m}$ Initial velocity, $u = 8 \text{ m/s}$



We know that, $v^2 - u^2 = 2$ as

$0 - (8)^2 = 2 \times (-10)s$

$\Rightarrow \quad s = 3.2 \text{ m}$

Total distance $= 3.2 + 1.8 \text{ m}$

Time for total descent,

$$v = u + at$$

$$10 = 0 + (10)T$$

$$\Rightarrow \quad T = 1\text{ s}$$

Time taken for the stone to reach the height of window,

$$v = u + at$$

$$0 = 8 - 10(t)$$

$$\Rightarrow \quad t = 0.8\text{ s}$$

$\Rightarrow$ Time to cross the window, $t_2 = T - t_1$

$= 1 - 0.8$

$= 0.2\text{ s}$

Question9

A body is falling freely from the top of a tower of height 125 m . The distance covered by the body during the last second of its motion is $x\%$ of the height of the tower. Then, x is (Acceleration due to gravity $= 10\text{ ms}^{-2}$)

TG EAPCET 2024 (Online) 9th May Morning Shift

Options:

A. 9

B. 36

C. 25

D. 49

Answer: B

Solution:

Height of a tower $= 125\text{ m}$

The distance s_n covered in the nth second is given by

$s_n = ut + \frac{1}{2}g(2n-1) \quad \ldots \text{(i)}$

where u is the initial velocity, which is zero for a body falling from rest.

Using the 2 nd equation of motion,

$$s = ut + \frac{1}{2}gt^2$$

$$125 = \frac{1}{2} \times 10 \times t^2$$

$$T = \sqrt{\frac{2 \times 125}{10}} = 5 \text{ s}$$

For Eq. (i),

$$s_5 = 0 + \frac{1}{2} \times 10(2 \times 5 - 1)$$

$$= \frac{1}{2} \times 10(10-1) = \frac{1}{2} \times 10(9)$$

$$= 5 \times 9$$

$$s_5 = 45 \text{ m} \quad \ldots \text{(ii)}$$

The percentage of the height of the tower at this distance,

$$x = \frac{s_5}{125} \times 100$$

$$\Rightarrow \frac{45}{125} \times 100$$

$$x = \frac{9}{25} \times 100 = 36\%$$

Question10

The ratio of the displacements of a freely falling body during first, second and third seconds of its motion is

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

A. 1 : 1 : 1

B. 1 : 3 : 5

C. 1 : 2 : 3

D. 1 : 4 : 9

Answer: B

Solution:

Given that a body is freely falling, we need to find the ratio of the displacements during the 1st, 2nd, and 3rd seconds of its motion.

Let's use the formula for distance covered in the nth second:

$s_n = u + \frac{1}{2}g(2n - 1)$

For the 1st second:

$s_1 = \frac{g}{2}(2 \times 1 - 1) = \frac{g}{2} \quad \ldots(i)$

For the 2nd second:

$s_2 = \frac{g}{2}(2 \times 2 - 1) = \frac{3g}{2} \quad \ldots(ii)$

For the 3rd second:

$s_3 = \frac{g}{2}(2 \times 3 - 1) = \frac{5g}{2} \quad \ldots(iii)$

From equations (i), (ii), and (iii), we can see that the ratio of distances covered in the 1st, 2nd, and 3rd seconds is:

$s_1 : s_2 : s_3 = 1 : 3 : 5$

Question11

The relation between time t and distance x of a particle is $t = ax^2 + bx$, where a and b are constants. If v is the velocity of the particle, then its acceleration is

TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. $-2abv^2$

B. $2bv^3$

C. $-2av^3$

D. $2av^2$

Answer: C

Solution:

Given:

The relation between time t and distance x of a particle is given by:

$t = ax^2 + bx$

where a and b are constants.

Step 1: Differentiate with respect to x:

From the given equation, differentiate with respect to x:

$\frac{dt}{dx} = 2ax + b$

Step 2: Express velocity:

The velocity v is defined as $\frac{dx}{dt}$. Thus, rearrange the differentiated equation:

$\frac{dx}{dt} = \frac{1}{2ax+b} = v$

Step 3: Differentiate again with respect to t:

To find the acceleration, which is the derivative of velocity with respect to time, differentiate the expression for velocity:

$\frac{d^2x}{dt^2} = -\frac{2a}{(2ax+b)^2} \cdot \frac{dx}{dt}$

Substitute the velocity $v = \frac{1}{2ax+b}$ into the equation:

$\frac{d^2x}{dt^2} = -2a\left(\frac{1}{2ax+b}\right)^3$

Simplifying gives the acceleration:

$\frac{d^2x}{dt^2} = -2av^3$

Thus, the acceleration of the particle is $-2av^3$.
