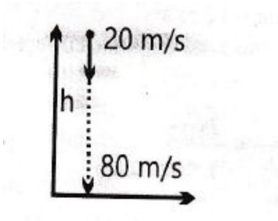
Motion in a Straight line Important Questions With Answers

NEET Physics 2023

1. A ball is thrown vertically downward with a velocity of 20m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is ___________

   a) 300m b) 360m c) 340m d) 320m

   Solution : -

   The initial velocity of the ball is = 20m/s.
   The final velocity of the ball is = 80m/s.
   The acceleration due to gravity is = $10m/s^2$.
   So, the height of the tower can be obtained from the expression:
   $V^2 = u^2 + 2gh$
   Substitute the values in above expression:
   $80^2 = 20^2 + (2 \times 10 \times h)$
   $h = \frac{6400-400}{20} m$
   $h = \frac{6000}{20} \Rightarrow 300m$

2. The speed of a swimmer in still water is 20 m/s. The speed of river water is 10 m/s and is flowing due east. If he is standing on the south bank and wishes to cross the river along the shortest path the angle at which he should make his strokes w.r.t. north is given by __________ .

   a) 0^o b) 60^owest c) 45^owest **d) 30^owest**

   Solution : -

   $\vec{\mathrm{V}}_{\mathrm{SG}} = \vec{\mathrm{V}}_{\mathrm{SR}} + \vec{\mathrm{V}}_{\mathrm{RG}}$
   $\sin\theta = \frac{|\vec{\mathrm{V}}_{\mathrm{RG}}|}{|\vec{\mathrm{V}}_{\mathrm{SR}}|}$
   $\sin\theta = \frac{10^\circ}{20}$
   $\sin\theta = \frac{1}{2}$
   $\theta = 30^\circ$ west

3. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be _________

   a) $\frac{t_1+t_2}{2}$ b) $\frac{t_1 t_2}{t_2-t_1}$ **c)** $\frac{t_1 t_2}{t_2+t_1}$ d) $t_1 - t_2$

Solution : -

$\text{Speed of walking } = \frac{n}{t_1} = v_1$

$\text{Speed of walking } = \frac{n}{t_2} = v_2$

Time taken when she walks over rurming escalator

$\Rightarrow t = \frac{h}{v_1 + v_2}$

$\Rightarrow \frac{1}{t} = \frac{v_1}{h} + \frac{v_2}{h} = \frac{1}{t_1} + \frac{t}{t_2}$

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

4. Two cars P and Q start form a point at the same time in a straight line and their positions are represented,by Xp(t) = at + bt^2 and Xq(t) = ft - t^2 . X wnat time do the cars have the same velocity?

a) $\frac{a-f}{1+b}$ b) $\frac{a+f}{2(b-1)}$ **c)** $\frac{a+f}{2(1+b)}$ **d)** $\frac{f-a}{2(1+b)}$

Solution : -

$V_\rho = \frac{dX_\rho(t)}{dt} = a + 2bt$

$and \quad V_Q = \frac{dX_Q(t)}{dt} = f - 2t$

$We\ have\ V_\rho = V_Q$

$\Rightarrow a + 2bt = f - 2t$

$\Rightarrow t = \frac{f-a}{2(b+1)}$

5. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to v(x) = b^{x-2n} where b and n are constants and x is the position of the particle. The acceleration of the particle as d function of x, is given by ________

a) $-2nb^2x^{-4n-1}$ b) $-2b^2x^{-2n+1}$ c) $-2nb^2e^{-4n+1}$ d) $-2nb^2x^{-2n-1}$

Solution : -

As per the question,

V(x) = bx^{-2n}

Differentiating w.r.t. x, we have

$\frac{dv}{dx} = -2nbx^{-2n-1}$

Acceleration of the particle as a function of x is given by

$a = v\frac{dv}{dx} = bx^{-2n}\left\{b(-2n)x^{-2n-1}\right\}$

$= -2nb^2x^{-4n-1}$

6. The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimensions under the action of a force, is related to time 't (in sec) by t = $\sqrt{3}$ + 3 . The displacement of the particle when its velocity is zero, will be ____________.

a) 2m b) 4m c) 6m **d) zero**

Solution : -

$\because\ t = \sqrt{x} + 3$

$\Rightarrow \sqrt{x} = t - 3 \Rightarrow x = (t-3)^2$

$v = \frac{dx}{dt} = \frac{d(t-3)^2}{dt} = 2(t-3) = 0$

$\Rightarrow\ t = 3$

$\therefore\ x = (3-3)^2 = 0$

7. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the nxet 5 seconds respectively. The relation between h_1, h_2 and h_3 _________

a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ b) $h_2 = 3h_1\ and\ h_3 = 3h_2$ c) $h_1 = h_2 = h_3$ d) $h_1 = 2h_2 = 3h_3$

Solution : -

$\because h = \frac{1}{2}gt^2$

$\therefore h_1 = \frac{1}{2}g(5)^2 = 125$

$h_1 + h_2 = \frac{1}{2}g(10)^2 = 500$

$\Rightarrow h_2 = 375$

$h_1 + h_2 + h_3 = \frac{1}{2}g(15)^2 = 1125$

$\Rightarrow h_3 = 625$

$h_2 = 3h_1, h_3 = 5h_1$

or $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

8. The motion of a pticle almg a straight line is described by equation x = 8+12t-t^3 where x is in metere and t and second. The reterdation of the particle when its velocity becomes zero, is ____________

a) 24ms^{-1} b) zero c) 6ms^{-2} **d) 12ms^{-2}**

Solution : -

x = 8+12t-t^3

Due to retardation, the final velocity of the particle will be zero,

V = 0+12-3t^2 =0

3t^2 =12

t =2sec

Now, the retardation

$a = \frac{dv}{dt} = 0 - 6t$

$a[t = 2] = -12\ \mathrm{m/s^2}$

$\therefore$ Retardation $= 12\ \mathrm{m/s^2}$

9. A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2. Its average speed during the cmplete journey is _______

a) $\frac{v_1 v_2}{v_1+v_2}$ **b)** $\frac{2v_1 v_2}{v_1+v_2}$ c) $\frac{2v_1^2 v_2^2}{v_1^2+v_2^2}$ d) $\frac{v_1+v_2}{2}$

Solution : -

Suppose, the total distance covered by the particle be 2s. Then

$V_{av} = \frac{2s}{\frac{s}{v_1}+\frac{s}{v_2}} = \frac{2v_1 v_2}{v_1+v_2}$

10. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 mis towards north. The average acceleration of the body is __________

a) 1m/s^2 b) 7m/s^2 c) 7m/s^2 **d) 5m/s^2**

Solution : -

$\therefore$ acceleration $= a = \frac{\text{Change in velocity}}{\text{Total time}}$

$= \frac{|40\hat{j}-30\hat{i}|}{10-0}$

$= \sqrt{4^2 + (-3)^2}$

$= 5\ \mathrm{m/sec^2}$

11. A boy standing at the top of a tower of 20 m height drops a stone. Assuming g : 10 ms^{-2}, the velocity with which it hits the ground is ____________ .

a) 10.0 m/s **b) 20.0 m/s** c) 40.0 m/s d) 5.0 m/s

Solution : -

When there in a free fall, we can directly use the equation = Here, z = 0

$v^2 = u^2 + 2gh$

$\Rightarrow v = \sqrt{2gh}$

$\Rightarrow \sqrt{2 \times 10 \times 20}$

$= 20 \text{ m/s}$

12. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floorwill be _____________ .

a) 9.9m **b) 10.1m** c) 10m d) 20m

Solution : -

No external force is acting on the body, therefore momentum is consened. By the principle of conservation of momentum,

50μ+0.5x^2=0

where μ is the velocity of man.

$u = \frac{1}{50} \text{ ms}^{-1}$

Distance moved by the man

$= 5 \times \frac{1}{50} = 0.1 \text{ m}$

When the stone reaches the floor, the distance of the man move the floor = 10.1m

13. A particle moves a distance x in time t according to equation x : (t + 5)$^{-1}$. The acceleration of particle is proportional to ____________

a) (a) (velocity)$^{3/2}$ b) (distance)^2 c) (distance) ^{2} d) velocity$^{2/3}$

Solution : -

$x = \frac{1}{t+5}$

v = rate change of displacement

$= \frac{dx}{dt} = \frac{-1}{(t+5)^2}$

$a = rate\ of\ change\ of\ velocity$

$= \frac{d^2x}{dt^2} = \frac{2}{(t+5)^3} = 2x^3$

$\text{Now, } \frac{1}{(t+5)} \propto v^{\frac{1}{2}}$

$\frac{1}{(t+5)^3} \propto \frac{3}{2} \propto a$

14. A particle has initial velocity $(3\hat{i} + 4\hat{j})$ and has acceleration $(0.4\hat{i} + 0.3\hat{j})$. It's speed after 10 s is _____________ .

a) 7 units **b) 7$\sqrt{2}$ units** c) 8.5 units d) 10 units

Solution : -

$\vec{u} = 3\hat{i} + 4\hat{j}, \vec{a} = 0.4\hat{i} + 0.3\hat{j}$

$\Rightarrow u_x = 3$ units, $u_y = 4$ units

$a_x = 0.4$ units, $a_y = 0.3$ units

$\therefore\ v_x = u_x + a_x \times 10 = 3 + 4 = 7\ \mathrm{ms}^{-1}$

$v_y = 4 + 0.3 \times 10 = 4 + 3 = \mathrm{ms}^{-1}$

resultant velocity $= v = \sqrt{v_x^2 + v_y^2}$

$= 7\sqrt{2}\ \mathrm{ms}^{-1}$

15. A ball is dropped from a high rise platform at r = 0 starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 18s. What is the value of v? (take g: 10 m/s^2)

a) 75 m/s b) 55 m/s c) 40 m/s d) 60 m/s

Solution : -

Obviously distance covered by first ball in 18s = distance covered by second batl in l2s. Now, distance covered in 18s by first ball

$= \frac{1}{2} \times 10 \times 18^2$

$= 90 \times 18 = 1620$ m.

Distance covered in 12 s by second ball

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

$\therefore 1620 = 12v + 5 \times 144$

$\Rightarrow v = 135 - 60 = 75\ \mathrm{ms}^{-1}$

16. A particle starts its motion from rest under the action ola constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2 then ____________

a) $\mathrm{S}_2 = 3\ \mathrm{S}_1$ **b)** $\mathrm{S}_2 = 4\ \mathrm{S}_1$ c) $\mathrm{S}_2 = \mathrm{S}_1$ d) $\mathrm{S}_2 = 2\ \mathrm{S}_1$

Solution : -

Using the relation, $\mathrm{S} = ut + \frac{1}{2}at^2$

$S_1 = \frac{1}{2}a \times t_1^2, S_2 = \frac{1}{2}a \times t_2^2$

$\therefore \frac{S_1}{S_2} = \left(\frac{t_1}{t_2}\right)^2 = \left(\frac{10}{20}\right)^2 = \frac{1}{4}$

$S_2 = 4S_1$

17. A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

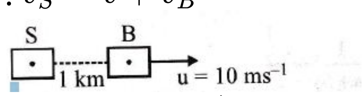
a) 40 ms^{-1} b) 25 ms^{-1} c) 10 ms^{-1} **d) 20 ms^{-1}**

Solution : -

Suppose v be the relative velocity of scooter with respect to bus as v = v_S -v_B

$v = \frac{1000}{100} = 10\ \mathrm{ms}^{-1} v_B = 10\ \mathrm{ms}^{-1}$

$\therefore v_S = v + v_B$



= 10 +10 = 20 ms^{-1}

Velocity of scooter= 20 ms^{-1}

18. The distance havelled by particle starting from rest and moving with an acceleration $\frac{4}{3}$ms^{-1} in the second is ____________

a) 6m b) 4m **c)** $\frac{10}{3}$ m d) $\frac{19}{3}$ m

Solution : -

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

$Putting\, u = 0, a = \frac{4}{3}\ \mathrm{ms}^{-2}, n = 3$

$\therefore d = 0 + \frac{4}{3\times 2}(2\times 3 - 1) = \frac{4}{6}\times 5 = \frac{10}{3}\ \mathrm{m}$

19. A particle moving along x-axis has acceleration f at time t, given by $f = f_0\left(1 - \frac{t}{\mathrm{T}}\right)$ where f_o and T are constant. The particle at t = 0 has zero velocity. In the time interval between t = 0 and the instant when f= 0, the particle's velocity (v_x) is ________

a) $\frac{1}{2} f_0\ \mathrm{T}^2$ b) $f_0\ \mathrm{T}^2$ **c)** $\frac{1}{2} f_0\ \mathrm{T}$ d) $f_0\ \mathrm{T}$

Solution : -

$Here, f = f_0\left(1 - \frac{t}{T}\right)$

$\Rightarrow \frac{dv}{dt} = f_0\left(1 - \frac{t}{T}\right)$

$\Rightarrow dv = f_0\left(1 - \frac{t}{T}\right) dt$

$\therefore v = \int dv = \int \left[f_0\left(1 - \frac{t}{T}\right)\right] dt$

$\text{or, } v = f_0\left(t - \frac{t^2}{2T}\right) + C$

where C is the constant of integration. At t = 0, v = 0.

$\therefore 0 = f_0\left(0 - \frac{0}{2T}\right) + C \Rightarrow C = 0$

$\therefore v = f_0\left(t - \frac{t^2}{2T}\right)$

$\text{If } f = 0, \text{ then}$

$0 = f_0\left(1 - \frac{t}{T}\right) \Rightarrow 1 - \frac{t}{T} = 0$

$\Rightarrow T - t = 0$

$\Rightarrow t = T$

Hence, the velocity of particle in the time interval r= 0 and t = 7 is given by

$v_x = \int_{t=0}^{t=T} dv = \int_{t=0}^{T}\left[f_0\left(1 - \frac{t}{T}\right)\right] dt$

$= f_0\left[\left(1 - \frac{t^2}{2T}\right)\right]_0^T$

$= f_0\left(T - \frac{T^2}{2T}\right) = f_0\left(T - \frac{T}{2}\right)$

$= \frac{1}{2} f_0 T.$

20. A car moves from X to y with a uniform speed Vu and, returns to Y with a uniform speed vr. The average speed for this round trip is ____________.

a) $\sqrt{v_u v_d}$ b) $\frac{v_d v_u}{v_d + v_u}$ c) $\frac{v_u + v_d}{2}$ **d)** $\frac{2 v_d v_u}{v_d + v_u}$

Solution : -

Average speed

$= \frac{\text{Total distance travelled}}{\text{Total time taken}}$

$Let\ s\ be\ the\ distance\ from\ X\ to\ Y.$

$\therefore \text{ Average speed } = \frac{s+s}{t_1+t_2} = \frac{2s}{\frac{s}{v_u} + \frac{s}{v_d}}$

$= \frac{2 v_u v_d}{v_d + v_u}$

21. The position x of a particle with respect to time t along x-axis is given by $x = 9t^2 - t^3$ where x is in metres and t in second. What will be the position of this particle when it achieves maximum speed along the +ve x direction ____________

a) 54m b) 81m c) 24m d) 32m

Solution : -

$\text{Speed } v = \frac{dx}{dt} = \frac{d}{dt}\left(9t^2 - t^3\right)$

$= 9\frac{dt^2}{dt} - \frac{dt^3}{dt} = 18t - 3t^2$

For the maximum speed,

$\frac{dv}{dt} = 0 \Rightarrow 18 - 6t = 0 \Rightarrow t = 3$

$\Rightarrow x_{\max} = 81 - 27 = 54 \text{ m}$

22. Two bodies,Aofmass 1 kg and B of mass 3 kg, are dropped from heights of l6 m and 25 m, respectively. The ratio of the time taken by them to reach the ground is ___________

a) 12/5 b) 5/12 **c) 4/5** d) 5/4

Solution : -

Suppose, t_1 and t_2 be the time taken respectively to reach the ground. We have,

$h = \frac{1}{2}gt^2$

For the first body, $16 = \frac{1}{2}gt_1^2$............ i

For the second body, $25 = \frac{1}{2}gt_2^2$ ii

On dividing equation (i) by (ii) we have

$\therefore \frac{16}{25} = \frac{t_1^2}{t_2^2} \Rightarrow \frac{t_1}{t_2} = \frac{4}{5} = 4:5$

23. A particle along a straight line OX. At a time t (in seconds) the distance x (in metres) of the particle from O is given by $x= 40+12t-t^3$. How long would the particle fiavel before coming to rest?

a) 40m **b) 56m** c) 16m d) 24m

Solution : -

$\text{Here, } x = 40 + 12t - t^3$

$v = \frac{dx}{dt} = 12 - 3t^2$

$v = 0; 12 - 3t^2 = 0$

$\Rightarrow 3t^2 = 12$

$\Rightarrow t^2 = \frac{12}{3} = 4$

$\therefore\ t = 2 \text{ seconds}$

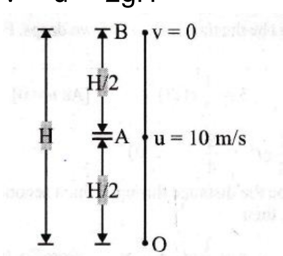
24. A ball is thrown vertically upward. It has a speed of 10 m/sec when it has reached one half of its maximum height. How high does the ball rise?

a) 10m b) 5m c) 15m d) 20m

Solution : -

For part AB From the equation of motion.

$v^2 = u^2 - 2gH$



$0 = u^2 - 2g(\mathrm{H}/2) = u^2 - g\mathrm{H}$

$\mathrm{H} = \frac{u^2}{g} = \frac{10^2}{10} = 10 \text{ metre}$

25. The displacement x of a particle varies with time t as x = $ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constant j. The velocity of the particle will __________ .

a) be independent of a and b b) drop to zero when a = b c) go on decreasing with time

d) go on increasing with time

Solution : -

$It\ is\ given\ that\ x = ae^{-\alpha t} + be^{\beta t}$

$Velocity, v = rate\ of\ change\ of\ displacement$

$= \frac{dx}{dt} = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

$= -\frac{a\alpha}{e^{\alpha t}} + b\beta e^{\beta t}$

So, velocity will go on increasing with time.

26. A man throws balls with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time? [Given g: 9.8 m/s^2]

a) Only with speed 19.6 m/s **b) More than 19.6 m/s** c) At least 9.8 m/s d) Any speed less than 19.6 m/s

27. If a ball is thrown vertically upwards with speed a, the distance covered during the last seconds of its ascent is ______________

a) $(u+gt)t$ b) ut **c)** $\frac{1}{2}gt^2$ d) $ut - \frac{1}{2}gt^2$

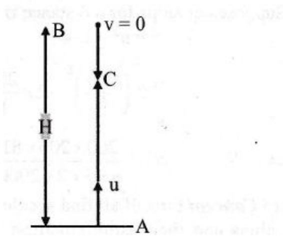
Solution : -

Let body take T seconds to reach the maximum height.

We have, v = u - gT

v = 0, we heigest point,

$T = \frac{u}{g}$



Body attained the velocity in (T-t) seconds

$v = u - g(T - t)$

$= u - gT + gt = u - g\frac{u}{g} + gt$

$\Rightarrow v = gt$

Distance travelled in last t seconds of its ascent

$s = (gt)t - \frac{1}{2}gt^2 = \frac{1}{2}gt^2$

28. A stone is thrown vertically upward with kinetic energy K. The kinetic energy at the highest point is ____________

a) $\frac{K}{2}$ b) $\frac{\sqrt{\mathrm{K}}}{2}$ c) K **d) zero**

Solution : -

At the highest point, velocity of a particle is zero. Thus, Kinetic energy is zero.

29. A car moving with a speed of 40 km/h can be stopped after 2 m by applying brakes. If the same car is moving with a speed of 80 km/h. What is the minimum stopping distance?

a) 8m b) 2m c) 4m d) 6m

Solution : -

According to conservation of energy, the kinetic energy ofcar: work done in stopping the i.e, $\frac{1}{2}mv^2$

Fs where, F is the retarding force and s is the stopping distance.

For same retarding force.

$$\frac{s_2}{s_{10}} = \left(\frac{v_2}{v_1}\right)^2 = \left(\frac{80}{40}\right)^2 = 4$$

$$s_2 = 4s_1 = 4 \times 2 = 8\ \mathrm{m}$$

30. If a car at rest, accelerates uniformly to a speed of 144 km/h in 20 s, it covers a distance of ___________ .

a) 2880m b) 1440m **c) 400m** d) 20m

Solution : -

Concept First of all find acceleration from the given values and then using equation of motion calculate distance travelled.

Given,

Initial velocity u = 0, time t = 20s

Final velocity v = 144km/h = 40m/s

From Ist equation of motion,

v = u+ at

$$v = u + at$$

$$a = \frac{v-u}{t} = \frac{40-0}{20} = 2\ \mathrm{m/s^2}$$

Now from second equation

$$\text{distance covered, } s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 2 \times (20)^2$$

$$= 400\ \mathrm{m}$$

31. The position x of a particle varies with time t, as x = $at^2 - bt^3$. The acceleration of the particle will be zero time t equals to _________

a) zero **b)** $\frac{a}{3b}$ c) $\frac{2a}{3b}$ d) $\frac{a}{3}$

Solution : -

Acceleration $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$

$$Velocity\ v = \frac{dx}{dt}$$

$$The\ given\ equation\ is\ x = a\,t^2 - bt^3$$

$$Velocity,\ v = \frac{dx}{dt} = 2at - 3bt^2$$

$$Acceleration\ a = \frac{dv}{dt} = 2a - 6bt$$

$$but\ a = 0(given)$$

$$\therefore 2a - 6bt = 0\ or\ 6bt = 2a\ or\ t = \frac{2a}{6b} = \frac{a}{3b}$$

32. If a ball is thrown vertically upwards with a velocity of 40 m/s, then velocity of the ball after 2s will be (g = 10 m/s^2)

a) 15m/s **b) 20m/s** c) 25m/s d) 28m/s

Solution : -

$$v = u + at$$

$$v = 40 - 10 \times 2$$

$$v = 20\ \mathrm{m/s}$$

33. The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far above the ground is the second drop at that instant? (Takeg:10m/s^2)

a) 1.25m b) 2.50m **c) 3.75m** d) 5.00m

Solution : -

Let t be the time interval oftwo drops. For third drop to fall

$5=\frac{1}{2} g(2 t)^2 \ [As\ u=0]$

$or\ \frac{1}{2} g t^2=\frac{5}{4}$

Let x be the distance through which second drop falls for time t, then

$x=\frac{1}{2} g t^2=\frac{5}{4} \mathrm{~m}$

Thus, height of second drop from ground

$=5-\frac{5}{4}=\frac{15}{4}=3.75 \mathrm{~m}$

34. A body is thrown vertically upwards from the ground. It reaches a maximum height of 20 m in 5s. After what time it will reach the ground from its maximum height position?

a) 25s **b) 5s** c) 10s d) 20s

Solution : -

Time taken by the body to reach the ground from some height is the same as taken to reach that height. Hence, time to reach the ground from its maximum height is 5s.

35. A stone released with zero velocity from the top of a tower, reaches the ground in 4s. The height of the tower is ___________(g = 10 m/s^2)

a) 20 m b) 40 m **c) 80 m** d) 160 m

Solution : -

Initial velocity of stone u = 0

Time to reach at ground t = 4 s

Acceleration due to gravity g = 10 m/s^2

As motion of body is along the acceleration due to gravity

Height of tower $h=u t+\frac{1}{2} g t^2=(0 \times 4)+\frac{1}{2} \times 10 \times 4^2=80 \mathrm{~m}$

36. A car accelerates from rest at a constant rate a for some time, after which it decelerates at a constant rate b and comes to rest. If the total time elapsed is I, then the maximum velocity acquired by the car is ________

a) $\left(\frac{\alpha^2+\beta^2}{\alpha \beta}\right) t$ b) $\left(\frac{\alpha^2-\beta^2}{\alpha \beta}\right) t$ c) $\frac{(\alpha+\beta) t}{\alpha \beta}$ **d)** $\left(\frac{\alpha \beta t}{\alpha+\beta}\right)$

Solution : -

$v_{\max }=a t_1=b t_2$

$t=t_1+t_2=\frac{v_{\max }}{\alpha}+\frac{v_{\max }}{\beta}$

$=v_{\max }\left(\frac{1}{\alpha}+\frac{1}{\beta}\right)=v_{\max }\left(\frac{\alpha+\beta}{\alpha \beta}\right)$

$v_{\max }=t\left(\frac{\alpha \beta}{\alpha+\beta}\right)$

37. A particle moves along a straight line such that its displacement at any time t is given by s = $\left(t^3-6 t^2+3 t+4\right)$ m. The velocity when the acceleration is zero, is __________

a) 3ms^{-1} b) -12ms^{-1} c) 42ms^{-1} **d) -9ms^{-1}**

Solution : -

$Given, s = t^3 - 6t^2 + 3t + 4$

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

Acceleration a is given by

$a = \frac{dv}{dt}$

$\therefore\ a = 6t - 12$

$\text{For } a = 0, \text{ we have } 0 = 6t - 12$

$\text{or } t = 2 \text{ s}$

Hence, at t = 2 s the velocity will be

$v = 3 \times 2^2 - 12 \times 2 + 3 = -9 \text{ ms}^{-1}$

38. A body starts from rest, what is the ratio of the distance travelled by the bOdy during the 4th and 3rd s?

a) $\frac{7}{5}$ b) $\frac{5}{7}$ c) $\frac{7}{3}$ d) $\frac{3}{7}$

Solution : -

Distance travelled by the body in nth second is given by

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

$Here, u = 0 \therefore\ For\ 4th\ s, s_4 = \frac{a}{2}(2 \times 4 - 1)$

$and\ For\ 3th\ s, s_3 = \frac{a}{2}(2 \times 3 - 1)$

$Hence, \frac{s_4}{s_3} = \frac{(2 \times 4 - 1)}{(2 \times 3 - 1)} = \frac{7}{5}$

39. A train of 150 m length is going towards North direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards South direction parallel to the railways track. The time taken by the parrot to cross the train is ___________ .

a) 12s b) 8s c) 15s **d) 10s**

Solution : -

Concept Velocity of Aw.r.t. B is given by $V_{AB} = V_A - V_B$

Relative velocity of parrot wr.t the train $\Rightarrow [10 - (-5)]\text{ms}^{-1} = 15 \text{ ms}^{-1}.$

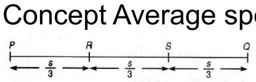
Time taken by the parrot to cross the train = $\frac{150}{15} = 10 \text{ s}$

40. A bus travelling the first one-third distance at a speed of 10 km/h, the next one-third at 20 krn/h and the last one-third at 60 km/h. The average speed of the bus is _________ .

a) 9 km/h b) 16 km/h **c) 18 km/h** d) 48 km/h

Solution : -

Concept Average speed can be calculated as the total distance travelled divided by the total time taken.



Let t_1, t_2, t_3 are covering the distance

$\therefore\ t_1 = \frac{(s/3)}{10}, t_2 = \frac{(s/3)}{20} \text{ and } t_3 = \frac{(s/3)}{60}$

$\therefore \text{Average speed } = \frac{\text{Total distance}}{\text{Total time}} = \frac{s}{t_1 + t_2 + t_3}$

$= \frac{s}{\frac{(s/3)}{10} + \frac{(s/3)}{20} + \frac{(s//3)}{60}}$

$= \frac{s}{(s/18)} = 18 \text{ km/h}$

41. A car moves a distance of 200 m. It covers the first-half of the distance at speed 40 km/h and the second half of distance at speed v km/h. The average speed is 48 km/h. Find the value of v __________ .

a) 56 km/h **b) 60 km/h** c) 50 km/h d) 48 km/h

Solution : -

$b) Average\ speed\ = \frac{\text{Total distance}}{\text{Total time}}$

$Let\ t_1, t_2\ be\ time\ taken\ during\ first - half\ and\ second - half\ espectively.$

$t_1 = \frac{100}{40}\ \mathrm{s}$

$t_2 = \frac{100}{v}\ \mathrm{s}$

so, according to average speed formula

$48 = \frac{200}{\left(\frac{100}{40}\right)+\left(\frac{100}{v}\right)}$

$\frac{1}{40} + \frac{1}{v} = \frac{2}{48} = \frac{1}{24}$

$\frac{1}{v} = \frac{2}{120} = \frac{1}{60}$

$v = 60\ \mathrm{km/h}$

42. A body dropped from top of a tower fall through 40 m during the last two seconds of its fall. The heigt of tower is__________ (g = 10 m/s^2)

a) 60 m **b) 45 m** c) 80 m d) 50 m

Solution : -

Let the body falls through the height of tower in t seconds

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

Total distance travelled in last 2 s of fall is

$s = s_t + s_{(t-1)}$

$= \left[0 + \frac{g}{2}(2t - 1)\right] + \left[0 + \frac{g}{2}(2(t - 1) - 1)\right]$

$= \frac{g}{2}(2t - 1) + \frac{g}{2}(2t - 3)$

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

$40 = 20(t - 1)\ \text{or}\ t = 2$

Distance travelled in t sec is

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

$= 0 + \frac{1}{2} \times 10 \times 3^2 = 45\ \mathrm{m}$

43. A car covers the first-half of the distance between two places at 40 km/h and other half at 60 km/h. The average speed of the car is ___________ .

a) 40 km/h **b) 48 km/h** c) 50 km/h d) 60 km/h

Solution : -

Let the distance between two places be d and t, is time taken by car to travel first-half length, tris time taken by car to travel second-half length. Time taken by car to travel fi rst-half length.

$t_1 = \frac{\left(\frac{d}{2}\right)}{40} = \frac{d}{80}$

Time taken by car to travel second-half length

$t_2 = \frac{\left(\frac{d}{2}\right)}{60} = \frac{d}{120}$

$\therefore\ \text{Total time}\ = t_1 + t_2$

$= \frac{d}{80} + \frac{d}{120}$

$= d\left(\frac{1}{80} + \frac{1}{120}\right) = \frac{d}{48}$

$\therefore\ \text{Average speed}\ = \frac{d}{t_1+t_2} = \frac{d}{\left(\frac{d}{48}\right)} = 48\ \mathrm{km/h}$

44. What will be the ratio of the distance moved by a freely falling body from rest in 4th and 5th second of journey?

a) 4:5 **b) 7:9** c) 16:25 d) 1:1

Solution : -

As distance travelled in nth sec is given by

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

$Here, u = 0,\ acceleration\ due\ to\ gravity$

$a = 9.8\ \mathrm{m/s^2}$

$\therefore\ For\ 4^{\text{th}}\ s, s_4 = \frac{1}{2} \times 9.8(2 \times 4 - 1)$

$and\ for\ 5^{\text{th}}\ s, s_5 = \frac{1}{2} \times 9.8(2 \times 5 - 1)$

$\therefore \frac{s_4}{s_5} = \frac{7}{9}$

45. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between p and Q is ___________ .

a) 33.3 km/h b) $20\sqrt{2}$ km/h **c) $25\sqrt{2}$ km/h** d) 0.35 km/h

Solution : -

Let r be the total distance between points P and Q and v be the velocity of car while passing a certain middle point of PQ. If a is the acceleration of the car, then

$For\ part\ PQ,$

$or\ 40^2 - 30^2 = 2ax$

$a = \frac{350}{x}$

$For\ part\ RQ$

$40^2 - v^2 = \frac{2ax}{2}$

$40^2 - v^2 = 2\left(\frac{350}{x}\right)\frac{x}{2}$

$40^2 - v^2 = 350 \text{ or } v^2 = 1250$

$v = 25\sqrt{2}\ \mathrm{km/h}$