KD EDUCATION ACADEMY [9582701166] STREET NO. 21 A-1 BLOCK BENGALI COLONY SANT NAGAR BURARI DELHI -110084

Time : 4 Hour | **STD 11 Science class 11 physics** | **Total Marks : 123**

kd 90+ questions ch- 2 motion an a straight line

*** Choose The Right Answer From The Given Options.[1 Marks Each]** **[71]**

1. Which of the following is not a vector quantity?

(A) Acceleration.

(B) Velocity.

(C) Speed.

(D) Displacement.

Ans. :

c. Speed.

2. An object thrown vertically upwards with a velocity of 25m/ s takes 4sec to reach the thrower. What is displacement of the object?

(A) 100m (B) 180m (C) 0m (D) 120m

Ans. :

c. 0m

Explanation:

Displacement is the minimum distance between the initial and final position of an object If a ball thrown from point A reaches point B and then return to point A, then a displacement of the ball becomes zero as it returns to its initial position.

3. A car is moving with a velocity of $30ms^{-1}$. On applying the brakes, the velocity decreases to $15ms^{-1}$ in 2s. The acceleration of the car is:

(A) $+7.5ms^{-2}$ (B) $-7.7ms^{-2}$ (C) $-75ms^{-2}$ (D) $+15ms^{-2}$

Ans. :

c. $-75ms^{-2}$

4. The changes in displacement in three consecutive instances are 5m, 4m, 11m, the total time taken is 5s. What is the average velocity in m/ s?

(A) 1 (B) 4 (C) 7 (D) 6

Ans. :

b. 4

Explanation:

The total change in displacement = 20m.

Total time taken = 5s. Average velocity = total change in displacement/total time taken $= \frac{20}{5} = 4\mathrm{m}/\mathrm{s}.$

5. A cyclist moving on a circular track of radius 40m completes half a revolution in 40s. Its average velocity is:

(A) Zero (B) 2ms^{-1} (C) $4\pi\text{ms}^{-1}$ (D) $8\pi\text{ms}^{-1}$

Ans. :

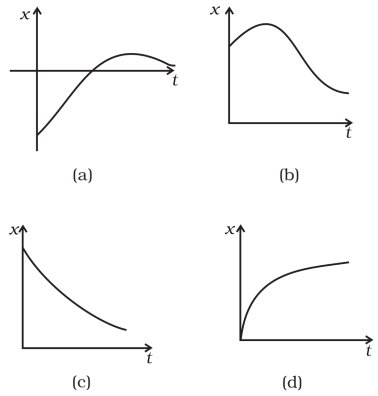
b. 2ms^{-1}

Explanation:

Average velocity $= \frac{\text{Displacement}}{\text{Time taken}} = \frac{2\text{R}}{\text{t}}$

$= \frac{2\times40}{40} = 2\text{ms}^{-1}$

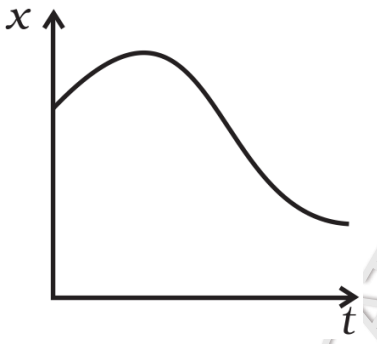
6. Among the four graphs Fig. there is only one graph for which average velocity over the time intervel (0, T) can vanish for a suitably chosen T. Which one is



it?

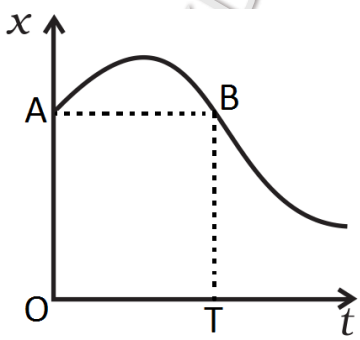
Ans. :

b.



Explanation:

We need to identify the graph in which there is one displacement for different timings. it means that these displacements would be in opposite directions and when we add these opposite displacements, net displacement would be zero or average velocity would be zero. This thing is only possible in the graph (b).



If we draw a line parallel to time axis from the point (A) on the graph at t = 0 sec. This line can intersect graph again at B. At this point, the change in displacement (O - T) time is zero i.e., displacement at A and B are equal so as the change in displacement is zero so the average velocity of body vanishes to zero.

7. A body is started from rest with acceleration 2m/ s^2 till it attains the maximum velocity then retards to rest with 3m/ s^2. If total time taken is 10 second then maximum speed attained is:

(A) 12m/ s (B) 8m/ s (C) 6m/ s (D) 4m/ s

Ans. :

a. 12m/ s

8. The displacement of a particle is represented by the following equation s = $2t^3$ + $7t^2$ + + 5t + 8 where s is in metres and t in seconds. The acceleration of the particle at t = ls is:

(A) 18m/s^2 (B) 32m/s^2 (C) zero (D) 14m/s^2

Ans. :

b. 32m/s^2

Explanation:

$s = 3t^3 + 7t^2 + 5t + 8;$

$v = \frac{ds}{dt} = 9t^2 + 14t + 5$

Acceleration, $a = \frac{dv}{dt} = 18t + 14$

$\therefore (a)_{t=1} = 18 \times 1 + 14$

$= 32 m/s^2$

9. Distance-time graph of a body at rest is:

(A) Parallel to time-axis.

(B) Parallel to distance-axis.

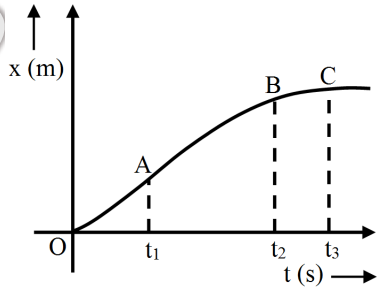
(C) Inclined to time-axis.

(D) Perpendicular to both axes.

Ans. :

a. Parallel to time-axis.

10. A car starts from rest from origin 0 and continues to move till point C as shown in the graph. Select the correct statement about the motion of car as shown in the graph.



(A) Part AB represents non-uniform motion.

(B) At instant time t = t_2, brakes must have been applied.

(C) At = t_3, the car must have accelerated.

(D) All of the above.

Ans. :

b. At instant time t = t_2, brakes must have been applied.

11. If the velocity of a body does not change, its acceleration is:

(A) Zero (B) Infinite (C) Unity (D) None of these

Ans. :

a. Zero

Explanation:

Acceleration of a body is defined as the rate of change of the velocity of the body.

Now since the velocity doesn't change at all, the rate of change will be zero.

So, acceleration = 0

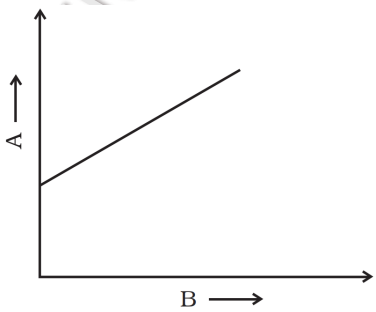
12. The displacement of an object at any instant is given by $x = 30 + 20t^2$, where x is in metres and t in seconds. The acceleration of the object will be:

(A) $40ms^{-2}$ (B) $50ms^{-2}$ (C) $30ms^{-2}$ (D) Zero

Ans. :

a. $40ms^{-2}$

13. The variation of quantity A with quantity B, plotted in Fig. describes the



motion of a particle in a straight line.

(A) Quantity B may represent time.

(B) Quantity A is velocity if motion is uniform.

(C) Quantity A is displacement if motion is uniform.

(D) Quantity A is velocity if motion is uniformly accelerated.

Ans. :

a. Quantity B may represent time.

c. Quantity A is displacement if motion is uniform.

d. Quantity A is velocity if motion is uniformly accelerated.

Explanation:

If B represents velocity then graph become (the v-t graph is a straight line so it is uniformly accelerated motion, so motion is not uniform. Verifies option (a), (d). If B represents time and A represents displacement, then graph become (s - t) graph. Here s - t graph is a straight line which represents uniform motion, so verifies the option (c).

14. An object may have:

I. varying speed without having varying velocity.

II. varying velocity without having varying speed.
III. non-zero acceleration without having varying velocity.
IV. non-zero acceleration without having varying speed.

(A) I and II are correct.

(B) II and III are correct.

(C) II and IV are correct.

(D) None of the above.

Ans. :

c. II and IV are correct.

Explanation:

Speed is a scalar quantity while velocity is a vector quantity.

An object can have constant speed but velocity will change since velocity is a vector quantity.

Without having a varying speed non - zero acceleration.

Uniform circular motion is an example of options B and D

15. A 50.0kg boy is sitting on an amusement park ride where he accelerates straight upward from rest to a speed of 30.0m/ s in 3.0s
What is his mass as he accelerates upward?

(A) 990.0kg (B) 100.0kg (C) 50.0kg (D) 5.00kg

Ans. :

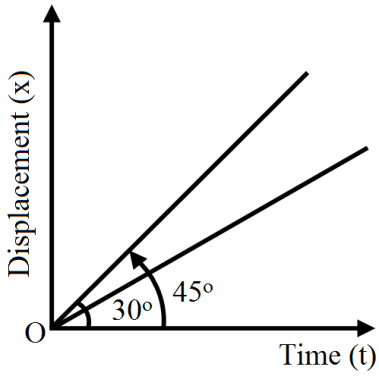
c. 50.0kg

Explanation:

The mass of a body is a universal constant which does not change with acceleration. It is a property of the object itself.

Hence the mass remains the same and equal to 50.0kg.

16. The displacement-time graphs of two moving particles make angles of 30° and 45° with the x-axis. The ratio of their velocities is:



(A) $1 : \sqrt{3}$ (B) $1 : 2$

(C) $1 : 1$

(D) $\sqrt{3} : 2$

Ans. :

a. $1 : \sqrt{3}$

Explanation:

In case x-t graph the graphs are a straight line, slope of the straight line gives velocity of the particle.

Slope $= \tan\theta$, where θ is the angle which the tangent to the curve makes with the horizontal in anti-clockwise direction.

$v_A = \tan 30^\circ = \frac{1}{\sqrt{3}}$,

$v_B = \tan 45^\circ = 1$

$\Rightarrow v_A : v_B = \frac{1}{\sqrt{3}} : 1$

$= 1 : \sqrt{3}$

17. A person is moving with a velocity of 10ms^{-1} towards North. A car moving with a velocity of 20ms^{-1} towards South crosses the person. The velocity of car relative to the person is:

(A) -30ms^{-1} (B) +30ms^{-1} (C) 10ms^{-1} (D) -10ms^{-1}

Ans. :

a. -30ms^{-1}

Explanation:

Let South to North direction be positive.

Velocity of car = v_c = -20ms^{-1}

Velocity of person = vp = +10 ms^{-1}

V_{cp} = vc - vp

= (-20) - (10)

= -30ms^{-1}

18. The velocity of a ship varies with time as v = 5t^3. What is the acceleration at t = 2?

(A) 60 (B) 56 (C) 40 (D) 100

Ans. :

a. 60

Explanation:

Acceleration of a body can be found out by differentiating the expression for velocity.

Here v = 5t^3. On differentiating, $a = \frac{dv}{dt} = 15t^2$. On putting t = 2, we get a = 60 units.

19. A particle moves along a straight line as s = u(t - 2) + a(t - 2)^2

(A) The acceleration of the particle is ‘a'.

(B) The initial velocity of the particle is ‘v'.

(C) At t = 2s, the particle is at rest.

(D) The acceleration of the particle is ‘2a'.

Ans. :

d. The acceleration of the particle is ‘2a'.

20. The trajectory of an object is defined as $x = (t - 4)^2$, what is the velocity at t = 5?

(A) 2 (B) 5 (C) 1 (D) 4

Ans. :

a. 2

Explanation:

The function for velocity can be derived by differentiating the equation with respect to t. v = 2(t - 4) is the required function. When t = 5, v = 2(5 - 4) = 2.

21. A body freely falling from the rest has a velocity v after his falls through a height h. The distance, it has to fall down further for its velocity to become double, is:

(A) 4h (B) 3h (C) h (D) 16h

Ans. :

b. 3h

Hint: Apply third equation of motion.

Explanation:

Step 1 - Use third equation of motion

If a body falls freely so its initial velocity is u = 0

Acceleration is a = −g and displacement s = −h

After travelling distance h velocity becomes v.

So $v^2 = u^2 + 2as$

$\Rightarrow v^2 = 0 + 2(-g)(-h) = 2gh$.....(1)

Step 2 - Calculate distance when velocity becomes double

After travelling distance h_1,velocity becomes double i.e.2v.

Again apply third equation of motion

$(2v)^2 = v^2 + 2(-g)(-h1)$

$\Rightarrow 4v^2 = v^2 + 2gh_1$.....(2)

Step 3 - Solve above equations to obtain answer

Put value from equation (1)

$4(2gh) = (2gh) + 2gh_1$

$\Rightarrow 2gh_1 = 6gh$

$\Rightarrow h_1 = 3h$

22. An object starts from rest and moves with uniform acceleration a. The final velocity of the particle in terms of the distance x covered by it is given as:

(A) $\sqrt{2ax}$

(B) $2ax$

(C) $\sqrt{\frac{ax}{2}}$

(D) $\sqrt{ax}$

Ans. :

a. $\sqrt{2ax}$

23. A ball is thrown upwards with a velocity of 25m/s. What is the time taken by the ball to return to the thrower (g = 10m/s^2)

(A) 5sec (B) 2.5sec (C) 3sec (D) 4.2sec

Ans. :

a. 5sec

Explanation:

Initial velocity of the ball final velocity = 0m/ s

acceleration due to gravity (g) = -10m/ s^2 (upward motion)

By using the formula,

v = u + at

O = 25 + $(-10) \times$ t

10t = 25

t = 2.5sec.

The time taken for upward journey is equal to the time taken for downward journey.

Therefore, total time taken by the ball = 2.5 + 2.5 = 5sec.

24. A man throws ball into the air one after the other. Throwing one when other is at the highest point. How high the balls rise if he throws twice a second?

(A) 2.45m (B) 1.225m (C) 19.6m (D) 4.9m

Ans. :

b. 1.225m

Explanation:

The time taken by each ball to go from starting point to highest point,

$t = \frac{1}{2}\text{sec}$, which is equal to time taken by each ball to fall back to starting point $\left(= \frac{1}{2}\text{sec} \right)$.

$\therefore s \times 9.8 \times \left(\frac{1}{2}\right)^2$

$= \frac{9.8}{8}\text{m} = 1.225\text{m}$

25. The driver of an express train suddenly sees the red light signal 50m ahead and applies the brakes. If the average deceleration during braking is 10.0ms^{-2} and the reaction time of the driver is 0.75sec, the minimum speed at which the train should be moving so as not to cross the red signal is:

(A) 27km/ hr (B) 144km/ hr (C) 72km/ hr (D) 83km/ hr

Ans. :

b. 144km/ hr

Explanation:

Let, Displacement of Train in 0.75sec will be

S1 = ut = 0.75u m

where, u - initial velocity of train.

$v^2 = u^2 + 2aS$

$v = 0ms^{-1}, S = 50 - S_1$

$u^2 - 2 \times 10 \times (50 - 0.75u) = 0$

solving for u we get

u = 144km/ hr

26. Area under velocity time graph represents:

(A) Acceleration. (B) Displacement.

(C) Retardation. (D) Average speed.

Ans. :

b. Displacement.

27. A and B start walking towards each other from the opposite ends of a 15km long straight road, at a speed of 5km/ hr and 7km/ hr respectively. How far apart will they be after one hour?

(A) 2km (B) 3km (C) 5km (D) 7km

Ans. :

b. 3km

Explanation:

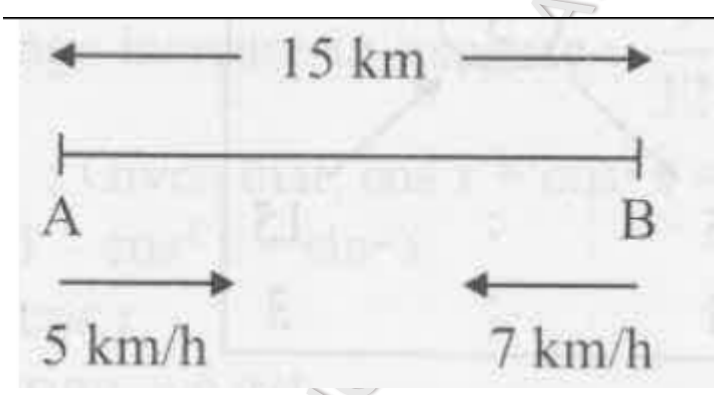
$x_A = v_A t = 5 \times 1 = 5km$

$x_B = v_B t = 7 \times 1 = 7km$

Total distance covered = 12km

Distance between A and B at time t = 1h

15 − 12 = 3km



28. Average speed of a car between points A and B is 20m/s, between B and C is 15m/s, between C and D is 10m/s. What is the average speed between A and D, if the time taken in the mentioned sections is 20s, 10s and 5s respectively?

(A) 17.14 m/s (B) 15 m/s

(C) 10 m/s (D) 45 m/s

Ans. :

a. 17.14 m/s

Explanation:

Average speed is the total distance divided by total time taken.

Total displacement (d = vt) = 20 × 20 + 15 × 10 + 10 × 5 = 600m.

Total time = 20 + 10 + 5 = 35s.

Therefore, average speed $= \frac{600}{35} = 17.14\text{m/ s}$.

29. If the velocity of a particle is v = At + Bt^2, where A and B are constants, then the distance travelled by it in 1s is:

(A) $3\text{A} + 7\text{B}$ (B) $\frac{3}{2}\text{A} + \frac{7}{3}\text{B}$

(C) $\frac{\text{A}}{2} + \frac{\text{B}}{3}$ (D) $\frac{3}{2}\text{A} + 4\text{B}$

Ans. :

c. $\frac{\text{A}}{2} + \frac{\text{B}}{3}$

30. A body falling from a high Minaret travels 40m in the last 2 seconds of its fall to ground. Height of Minaret in metres is:

(take g = 10m/ s^2)

(A) 60 (B) 45 (C) 80 (D) 50

Ans. :

b. 45

Explanation:

Taking the height of minaret is H and time taken by body to fall from top to bottom be T.

$\therefore \text{H} = \left(\frac{1}{2}\right)\text{gT}^2 \ldots\ldots (1)$

In last two second body travels a distance of 40m, henc ein (T - 2)sec body will travel (H - 40)m.

$(\text{H} - 40) = \left(\frac{1}{2}\right)\text{g}(\text{T} - 2)^2 \ldots\ldots (2)$

$\therefore$ solving (1) and (2),

T = 3sec, H = 45m

31. A stone is thrown vertically up from a bridge with velocity 3ms^{-1} if it strikes the water under the bridge after 2s, the bridge is at a height of (g = 10m/s^2)

(A) 26m (B) 16m (C) 14m (D) 20m

Ans. :

c. 14m

32. The displacement of a particle is given by x = $(t - 2)^2$ where x is in metres and t in seconds. The distance covered by the particle in first 4 seconds is:

(A) 4m. (B) 8m. (C) 12m. (D) 16m.

Ans. :

b. 8m.

Explanation:

Key concept: Instantaneous velocity : Instantaneous velocity is defined as the rate of change of position vector of particles with time at a certain instant of time.

Instantaneous velocity $\vec{\text{v}} = \lim_{\Delta\text{t}\to 0} \frac{\Delta\vec{\text{r}}}{\Delta\text{t}} = \frac{\text{d}\vec{\text{r}}}{\text{dt}}$

Instantaneous acceleration $= \vec{\text{a}} = \lim_{\Delta\text{t}\to 0} \frac{\Delta\vec{\text{v}}}{\Delta\text{t}} = \frac{\text{d}\vec{\text{v}}}{\text{dt}}$

By definition $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{x}}{dt^2}\left[\text{As } \vec{v} = \frac{d\vec{x}}{dt}\right]$

i.e., if x is given as a function of time, second time derivative of displacement gives acceleration.

In such type of problems we have to analyze whether the motion is accelerating or retarding. When acceleration is parallel to velocity, velocity of particle increases with time, i.e. motion is accelerated. And when acceleration is anti-parallel to velocity, velocity of particle decreases with time, i.e. motion is retarded. During retarding journey, particle will stop in between.

According to the problem, displacement of the particle is given as a function of time.

$x = (t-2)^2$

By differentiating this equation w.r.t. time we get velocity of the particle as a function of time.

$v = \frac{dx}{dt} = \frac{d}{dt}(t-2)^2 = 2(t-2)m/s$

If we again differentiate this equation w.r.t. time we will get acceleration of the particle as a function of time.

Acceleration, $a = \frac{dv}{dt} = \frac{d}{dt}[2(t-2)]$

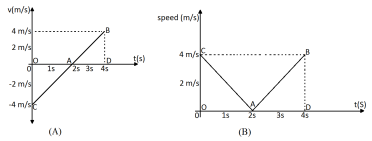
$= 2[1-0] = 2m/s^2$

When $t = 0;\ \ v = -4m/s$

$t = 2s;\ \ v = 0m/s$

$t = 4s;\ \ v = 4m/s$

That means particle starts moving towards negative axis, then at = 0, with a speed 4m/s, at t = 2 it stops and start coming backward. At t = 4 its speed is +4m/s.



v - t graph is shown in graph (a) and speed-time graph of the same situation is shown in graph (b).

Distance travelled = Area of the speed-time graph

= area OAC + area ABD

$= \frac{4\times2}{2} + \frac{1}{2}\times2\times4 = 8m$

33. A stone is thrown with an initial speed of 4.9m/s from a bridge in vertically upward direction. It falls down in water after 2 seconds. The height of the bridge is:

(A) 4.9m (B) 9.8m (C) 19.8m (D) 24.7m

Ans. :

b. 9.8m

Explanation:

Talking vertical downward motion of stone, we have

u = -4.9m/s, a = 9.8m/s^2, t = 2s. s = ?

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

$= -4.9 \times 2 + \frac{1}{2} \times 9.8 \times 2^2$

$= 9.8\text{m}$

34. A particle is dropped from a tower. It is found that it travels 55m in the last second of its journey. Then height of the tower is (g = 10m/s^{2}g = 10m/s^2)?

(A) 125m (B) 180m (C) 100m (D) 55m

Ans. :

b. 180m

35. A parachutist after bailing out falls 50m without friction. When parachute opens, it decelerate at 2m/ s^2. He reaches the ground with a speed of 3m/ s. At what height, did he bail out nearly.

(A) 298m (B) 111m (C) 91m (D) 182m

Ans. :

a. 298m

36. A ship is moving due east with a velocity of 12 m/ sec. A truck is moving across on the ship with a velocity of 4m/sec. A monkey is climbing a vertical pole mounted on the truck, with a velocity of 3m/ sec. Find the velocity of the monkey, as observed by a man on the shore. (m/ sec).

(A) 10 (B) 15 (C) 13 (D) 16

Ans. :

c. 13

37. A particle moving with a uniform acceleration travels 24 metre and 64 metre in first two consecutive intervals of 4 seconds each. Its initial velocity is:

(A) 1m/ sec. (B) 2m/ sec. (C) 5m/ sec. (D) 10m/ sec.

Ans. :

a. 1m/s

Explanation:

$24 = \text{u} \times 4 + \frac{1}{2}\text{a} \times 4^2$

$= 4\text{u} + 8\text{a}$

$6 = \text{u} + 2\text{a}$

$(24 + 64) = \text{u} \times 8 + \frac{1}{2}\text{a} \times 8^2$

$= 8\text{u} + 32\text{a}$

$11 = \text{u} + 4\text{a}$

On solving (i) and (ii), we get u = 1m/s

38. From a 200m high tower, one ball is thrown upwards with speed of 10m/ s and another is thrown vertically downwards at the same speed simultaneously. The time difference of their reaching the ground will be nearest to:

(A) 12s (B) 6s (C) 2s (D) 1s

Ans. :

c. 2s

Explanation:

The ball thrown upward will have zero velocity in1s. It returns back to thrown point in another 1s with the same velocity as second.

Thus the difference will be 2s.

39. A vehicle travels half the distance L with speed V_1 and the other half with speed V_2, then its average speed is:

(A) $\frac{v_1+v_2}{2}$

(B) $\frac{2v_1+v_2}{v_1+v_2}$

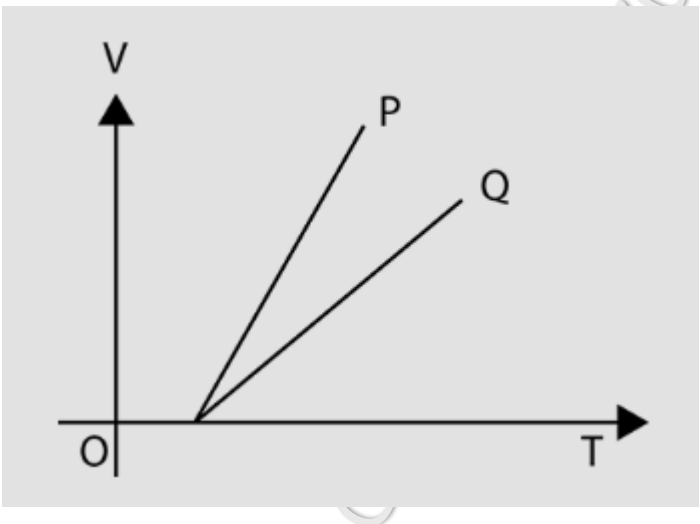
(C) $\frac{2v_1v_2}{v_1+v_2}$

(D) $\frac{L(v_1+v_2)}{v_1v_2}$

Ans. :

c. $\frac{2v_1v_2}{v_1+v_2}$

40. Figure shows the V−T graph for two particles P and Q. The relative velocity of P w.r.t. Q is:



(A) Is zero.

(B) Is non-zero but constant

(C) Continuously decreases

(D) Continuously increases

Ans. :

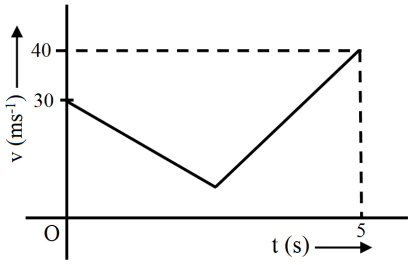
d. Continuously increases

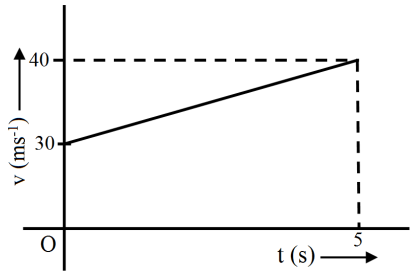
Explanation:

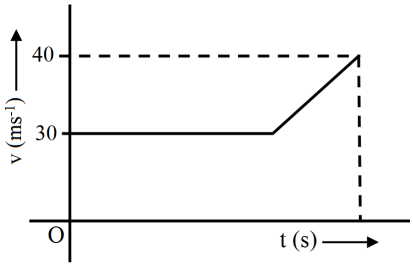
The difference in velocities is increasing with time as both of them have more constant but different acceleration.

41. An object is moving with an initial velocity of $30ms^{-1}$ with uniform acceleration. The velocity of object increases to $40ms^{-1}$ in next 5s. The v-t graph which least represents this situation is:

(A)



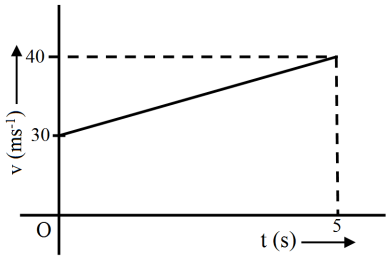
(B) 

(C) 

(D) None of the above.

Ans. :

b.



42. A gun is fired at a target. At the moment of firing, the target is released and allowed to fall freely under gravity. Then the bullet: (Assume zero air resistance)

(A) Misses the target by passing above it

(B) Hits the target

(C) Misses the target by passing below it

(D) May or may not hit

Ans. :

b. Hits the target

Explanation:

Initial vertical component of the velocities (in downward direction) of both the bullet and the target are zero. So, the bullet and the target fall down by equal amount and thus the bullet hits the target.

43. A stone falls from a balloon that is descending at a uniform rate of 12m/ s. the displacement of the stone from the point of release 10sec is:

(A) 490m (B) 510m (C) 610m (D) 725m

Ans. :

a. 490m

44. A body released from the top of alls through a height of 5m during the first second of its fall and 35m during the last second of its fall. The height of the tower is:

(A) 80m (B) 60m (C) 40m (D) 20m

Ans. :

a. 80m

45. A car moves for 60s covering a distance of 3600m with zero initial velocity. What is the acceleration in m/ s^2?

(A) 2 (B) 2.5 (C) 3 (D) 4.5

Ans. :

a. 2

Explanation:

Here we will use the second equation of motion, $s = ut + \left(\frac{1}{2}\right)at^2$.

Here, u = 0, s = 3600, t = 60s. On solving, we will get a = 2 m/s2.

46. An iron sphere of mass 10kg has the same diameter as an aluminium sphere of mass is 3.5kg. Both spheres are dropped simultaneously from a tower. When they are 10m above the ground, the have the same:

(A) Acceleration

(B) Momenta

(C) Potential energy

(D) Kinetic energy

Ans. :

a. Acceleration

Explanation:

Momentum, potential energy and kinetic energy depend on the mass of the object; as well as on some other factors. But acceleration, in this case, is the acceleration due to gravity; which does not depend on mass or velocity.

47. A ball dropped from some height coves half of its total during the last second of its free fall. Find:

(A) Time of flight

(B) Height of its fall

(C) Speed with which it strikes the ground.

(D) None of these

Ans. :

a. Time of flight

48. A balloon is going upwards with velocity 12m/sec. It releases a packet when it is at a height 65m from the ground. How much time the packet will take to reach the ground? (g = 10m/s^2):

(A) 5 sec (B) 6 sec (C) 7 sec (D) 8 sec

Ans. :

a. 5 sec

Explanation:

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

$\therefore 65 = -12t + \frac{1}{2} \times 10 \times t^2$

$= -12t + 5t^2$

$5t^2 - 12t - 65 = 0$

On solving, t = 10s or -26s

49. A stone is dropped into well in which the level of water is at a distance h below the top of well. If y is the velocity of sound, the time T after which the splash is heard is given by:

(A) $T = \frac{2h}{v}$

(B) $T = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

(C) $T = \sqrt{\frac{2h}{v}} + \frac{h}{g}$

(D) $T = \sqrt{\frac{h}{2g}} + \frac{2h}{v}$

Ans. :

b. $T = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

Explanation:

$T = t_1 + t_2 = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

50. The velocity of a truck changes form 3m/ s to 5m/ s in 5s. What is the acceleration in m/s^2?

(A) 0.4 (B) 0.5 (C) 4.0 (D) 5.0

Ans. :

a. 0.4

Explanation:

Acceleration is the rate of change of velocity. Here, the velocity changes form 3m/ s to 5m/ s in 5s.

Hence, acceleration $= \frac{(5-3)}{5} = 0.4 m/s^2$.

51. In case of a freely falling body, the ratio of kinetic energy at the end of the third second increase in kinetic energy in the next three seconds is:

(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 9

Ans. :

c. 1 : 3

52. In a uniformly accelerated motion, the speed varies from 0 to 20m/ s in 4s. What is the average speed during the motion?

(A) 10m/ s (B) 20m/ s (C) 0m/ s (D) 15m/ s

Ans. :

a. 10m/ s

Explanation:

From first equation of motion we have, v = u + at, which implies that a = 5m/s^2. From second equation of motion we have $s = ut + \left(\frac{1}{2}\right)at^2$, which implies that s = 40m.

Average speed $= \frac{s}{t} = \frac{40}{4} = 10 m/s.$

53. How does the displacement v/s time graph of a uniformly accelerated motion look like?

(A) A straight line

(B) A parabola

(C) A hyperbola

(D) An ellipse

Ans. :

b. A parabola

Explanation:

Here we use the second equation of motion. $s = ut + \left(\frac{1}{2}\right)at^2$. In a uniformly accelerated motion, the acceleration remains constant.

Therefore, the equation for displacement becomes the equation of a parabola.

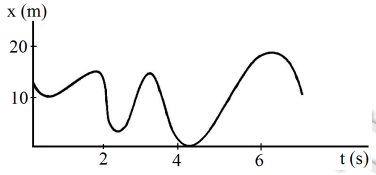
54. A driver takes 0.20s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54km/ h and the brakes causes a deceleration of 6.0 m/ s^2, find the distance traveled by the car after he sees the need to put the brakes on.

(A) 18.63m (B) 20m (C) 26.85m (D) 27.67m

Ans. :

a. 18.63m

55. Figure shows the position of a particle moving on the X-axis as a function of time.



(A) The particle has come to rest 6 times.

(B) The maximum speed is at t = 6s.

(C) The velocity remains positive for t = 0 to t = 6s.

(D) The average velocity for the total period shown is negative.

Ans. :

a. The particle has come to rest 6 times.

Explanation:

a. The slope of the x-tgraph gives the velocity. Here, 6 times the slope is zero. So, the particle has come to rest 6 times.

b. As the slope is not maximum at t = 6s, the maximum speed is not at t = 6s.

c. As the slope is not positive from t = 0s to t = 6s, the velocity does not remain positive.

d. Average velocity $\frac{\text{Total displacement}}{\text{Total time taken}} = \frac{\text{x final} - \text{x initial}}{t}$

For the shown time (r = 6s), the displacement of the particle is positive. Therefore, the average velocity is positive.

56. Acceleration of a particle which is at rest at x = 0 is $\vec{a} = (4 - 2x)\hat{i}$. Select the correct alternative(s):

(A) Maximum speed of the particle is 4 units.

(B) Particle further comes to rest at x = 4.

(C) Particle oscillates about x = 2.

(D) Particle will continuously accelerate along the x-axis.

Ans. :

b. Particle further comes to rest at x = 4.

c. Particle oscillates about x = 2.

57. A body thrown vertically up with a velocity 'u' reaches the maximum height 'h' after 'T' second. The correct statement among the following is:

(A) At a height $\frac{h}{2}$ from the ground its velocity is $\frac{u}{2}$.

(B) At a time T its velocity is 'u'.

(C) At a time '2T' its velocity is -u.

(D) At a time 2T its velocity is -6u.

Ans. :

c. At a time '2T' its velocity is -u.

Explanation:

Time taken by the body to reach the maximum height is given as T and the velocity of the body at the time of throw is u (upwards).

After further time T, the body reaches to the ground having same velocity u in the downward direction as that of initial velocity at the time of throw.

Thus, at the instant 2T, the velocity of the body is −u (where minus sign represents the velocity to be in downward direction).

58. An object is sliding down on an inclined plane. The velocity changes at a constant rate from 10cm/s to 15cm/s in 2 seconds. What is its acceleration?

(A) 5cm/ s^2 (B) 7.5cm/ s^2

(C) 2.5cm/ s^2 (D) 12.5cm/ s^2

Ans. :

c. 2.5cm/ s^2

Explanation:

$a = \frac{v-u}{t} = \frac{15-10}{2} = 2.5 cm/s^2$

59. A man of mass 60kg and a boy of mass 30kg are standing together on frictionless ice surface. If they push each other apart man moves away with a speed of 0.4m/ s relative to ice. After 5sec they will be away from each other at a distance of.

(A) 9.0m (B) 3.0m (C) 6.0m (D) 30,

Ans. :

c. 6.0m

Explanation:

The man and the boy move in opposite directions.

Momentum of man = momentum of boy

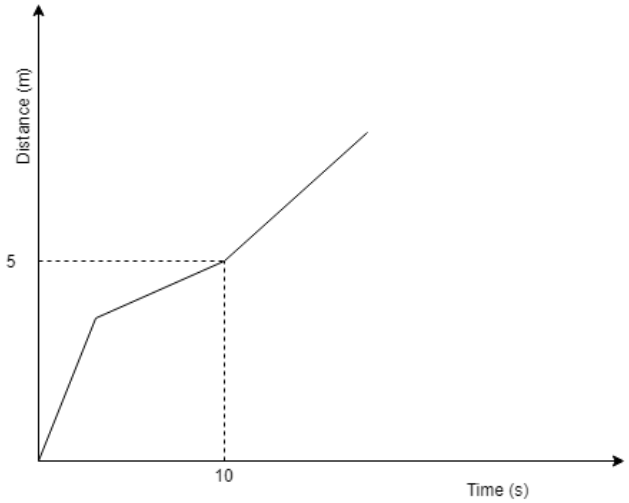
60 × 0.4 = 30 × v

or velocity of the boy v = $0.8 ms^{-1}$

∴ Relative velocity = 0.4 + 0.8 = $1.2 ms^{-1}$

∴ Distance between them in 5sec = 1.2 × 5 = 6.0m.

60. What is the velocity for a body following the graph below at 10s?



(A) 1m/ s (B) 2m/ s

(C) 0.5m/ s (D) 0.1m/ s

Ans. :

c. 0.5m/ s

Explanation:

At time = 10s, the distance covered is 5m. Velocity = distance/ time.

Hence, velocity v at $10s = \frac{5}{10} = 0.5 m/s.$

61. Find the odd one out and give the reason: speed, distance, mass, velocity:

(A) Mass (B) Speed (C) Distance (D) Velocity

Ans. :

a. Mass

62. A bomb is released from a horizontal flying aeroplane. The trajectory of bomb as observed from ground is:

(A) A parabola (B) A straight line

(C) A circle (D) A hyperbola

Ans. :

a. A parabola

Explanation:

When thrown from aeroplane, it will have velocity in horizontal direction.

Thus angle between velocity and acceleration (i.e. gravity) is neither 0 nor 180 so, it wil be pprojectile motion (i.e. parabola in shape).

63. Which of the following types of motion cannot describe the motion of a clock's hands?

(A) Rectilinear
(B) Circular
(C) Periodic
(D) Harmonic

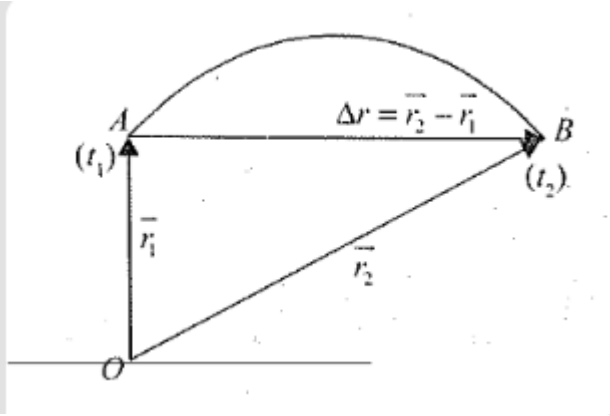
Ans. :

a. Rectilinear

Explanation:

The hands of a clock move in a circular manner. Hence, the motion exhibited is circular motion. Moreover, it happens periodically, so it is also periodic motion. But its is not rectilinear motion.

64. Which of the following statements regarding motion of particle is true?



(A) The motion between A and B is known.
(B) The motion between A and B is erratic.
(C) The motion between A and B may have been steady or erratic.
(D) The motion between A and B is steady.

Ans. :

c. The motion between A and B may have been steady or erratic.

Explanation:

The motion between A and B is steady if the velocity of the particle is constant and erratic if it is variable. From the question it is not clear what happens with the particle during the motion so we cannot say whether the particle is in erratic or steady motion.

65. A vehicle travels half the distance L with speed V_1 and the other half with speed V_2, then its average speed is:

a. $\frac{V_1+V_2}{2}$
b. $\frac{2V_1+V_2}{V_1+V_2}$
c. $\frac{2V_1V_2}{V_1+V_2}$
d. $\frac{L(V_1+V_2)}{V_1V_2}$

Ans. :

c. $\frac{2V_1V_2}{V_1+V_2}$

Explanation:

Time t_1 taken in half distance $= t_1 = \frac{L}{v_1}$

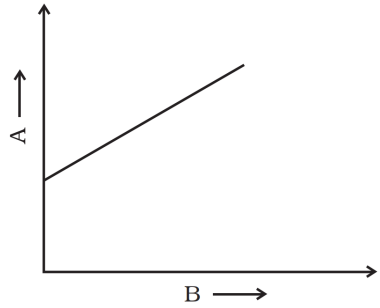
Time t_2 taken in half distance $= t_2 = \frac{L}{v_2}$

Total time (t) taken in distance $(L + L) = \frac{L}{v_1} + \frac{L}{v_2} = \frac{L(v_2+v_1)}{v_1v_2}$

Total distance $= L + L = 2L$

$\therefore$ Average speed $v_{av} = \frac{\text{Total distance}}{\text{Total time}} = \frac{2L}{\frac{L(v_2+v_1)}{v_1v_2}} = \frac{2v_1v_2}{(v_1+v_2)}$

66. The variation of quantity A with quantity B, plotted in Fig. describes the



motion of a particle in a straight line.

a. Quantity B may represent time.
b. Quantity A is velocity if motion is uniform.
c. Quantity A is displacement if motion is uniform.
d. Quantity A is velocity if motion is uniformly accelerated.

Ans. :

a. Quantity B may represent time.
c. Quantity A is displacement if motion is uniform.
d. Quantity A is velocity if motion is uniformly accelerated.

Explanation:

If B represents velocity then graph become (the v-t graph is a straight line so it is uniformly accelerated motion, so motion is not uniform. Verifies option (a), (d). If B represents time and A represents displacement, then graph become (s - t) graph. Here s - t graph is a straight line which represents uniform motion, so verifies the option (c).

67. The displacement of a particle is given by $x = (t - 2)^2$ where x is in metres and t in seconds. The distance covered by the particle in first 4 seconds is:

a. 4m.
b. 8m.
c. 12m.
d. 16m.

Ans. :

b. 8m.

Explanation:

Key concept: Instantaneous velocity : Instantaneous velocity is defined as the rate of change of position vector of particles with time at a certain instant of time.

Instantaneous velocity $\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$

Instantaneous acceleration $= \vec{a} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t} = \frac{d\vec{v}}{dt}$

By definition $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{x}}{dt^2} \left[\text{As } \vec{v} = \frac{d\vec{x}}{dt} \right]$

i.e., if x is given as a function of time, second time derivative of displacement gives acceleration.

In such type of problems we have to analyze whether the motion is accelerating or retarding. When acceleration is parallel to velocity, velocity of particle increases with time, i.e. motion is accelerated. And when acceleration is anti-parallel to velocity, velocity of particle decreases with time, i.e. motion is retarded. During retarding journey, particle will stop in between.

According to the problem, displacement of the particle is given as a function of time.

$x = (t-2)^2$

By differentiating this equation w.r.t. time we get velocity of the particle as a function of time.

$v = \frac{dx}{dt} = \frac{d}{dt}(t-2)^2 = 2(t-2) m/s$

If we again differentiate this equation w.r.t. time we will get acceleration of the particle as a function of time.

Acceleration, $a = \frac{dv}{dt} = \frac{d}{dt}[2(t-2)]$

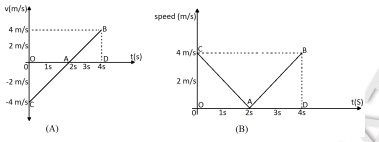
$= 2[1-0] = 2 m/s^2$

When $t = 0; \quad v = -4 m/s$

$t = 2s; \quad v = 0 m/s$

$t = 4s; \quad v = 4 m/s$

That means particle starts moving towards negative axis, then at = 0, with a speed 4m/s, at t = 2 it stops and start coming backward. At t = 4 its speed is +4m/s.



v - t graph is shown in graph (a) and speed-time graph of the same situation is shown in graph (b).

Distance travelled = Area of the speed-time graph

= area OAC + area ABD

$= \frac{4 \times 2}{2} + \frac{1}{2} \times 2 \times 4 = 8m$

68. A ball is bouncing elastically with a speed 1m/s between walls of a railway compartment of size 10m in a direction perpendicular to walls. The train is moving at a constant velocity of 10m/s parallel to the direction of motion of the ball. As seen from the ground,

a. The direction of motion of the ball changes every 10 seconds.
b. Speed of ball changes every 10 seconds.
c. Average speed of ball over any 20 second interval is fixed.
d. The acceleration of ball is the same as from the train.

Ans. :

b. Speed of ball changes every 10 seconds.

c. Average speed of ball over any 20 second interval is fixed.

d. The acceleration of ball is the same as from the train.

Explanation:

As the motion is observed from ground, time to strike ball with walls will be after every 10 seconds. As, the ball is moving with very small speed in the moving train,the direction of ball is same as that of train. Hence direction of motion of ball does not change with respect to observer on Earth.

But, speed of ball changes after collision so option (a) is incorrect and (b) is correct.

As speed of ball is uniform so average speed at any time remain same or 1m/s with respect to train or ground. So option (c) is correct.

Speed of ball changes when it strike to wall initial speed of ball in the direction of moving train with respect to ground $\mathrm{V_{TG}} = 10 + 1 = 11\mathrm{m/s}$.

Speed of ball after collision with side of train = VBG (opposite to the direction of train) = 10 - 1 = 9m/s.

Change in velocity on collision will be in magnitude = 11 - 9 = 2m/s. So magnitude of acceleration on both walls of compartment is same but direction will be opposite.

Hence, right option are (b, c, d).

69. Which of the sets given below may represent the magnitudes of three vectors adding to zero?

a. 2, 4, 8

b. 4, 8, 16

c. 1, 2, 1

d. 0.5, 1, 2

Ans. :

c. 1, 2, 1

Explanation:

1, 2 and 1 may represent the magnitudes of three vectors adding to zero. For example one of the vector of length 1 should make an angle of 135° with x-axis and the other vector of length 1 makes an angle of 225° with x-axis. The third vector of length 2 should lie along x-axis.

70. The radius of a circle is stated as 2.12cm. Its area should be written as:

a. $14\mathrm{cm}^2$.

b. $14.1\mathrm{cm}^2$.

c. $14.11\mathrm{cm}^2$.

d. $14.1124\mathrm{cm}^2$.

Ans. :

b. $14.1\mathrm{cm}^2$.

Explanation:

Area of a circle, $\mathrm{A} = \pi \mathrm{r}^2$

On putting the values, we get:

$A = \frac{22}{7} \times 2.12 \times 2.12$

$\Rightarrow A = 14.1 cm^2$

The rules to determine the number of significant digits says that in the multiplication of two or more numbers, the number of significant digits in the answer should be equal to that of the number with the minimum number of significant digits. Here, 2.12cm has a minimum of three significant digits. So, the answer must be written in three significant digits.

71. Let the angle between two nonzero vectors $\vec{A}$ and $\vec{B}$ be 120° and its resultant be $\vec{c}$:

a. C must be equal to $|A - B|$
b. C must be less than $|A - B|$
c. C must be greater than $|A - B|$
d. C may be equal to $|A - B|$

Ans. :

b. C must be less than $|A - B|$

Explanation:

Here, we have three vector A, B and C.

$|\vec{A} + \vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2 + 2\vec{A}.\vec{B} \ldots (i)$

$|\vec{A} - \vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2 - 2\vec{A}.\vec{B} \ldots (ii)$

Subtracting (i) from (ii), we get:

$|\vec{A} + \vec{B}|^2 - |\vec{A} - \vec{B}|^2 = 4\vec{A}.\vec{B}$

Using the resultant property $\vec{C} = \vec{A} + \vec{B}$, we get:

$|\vec{C}|^2 - |\vec{A} - \vec{B}|^2 = 4\vec{A}.\vec{B}$

$\Rightarrow |\vec{C}|^2 = |\vec{A} - \vec{B}|^2 + 4\vec{A}.\vec{B}$

$\Rightarrow |\vec{C}|^2 = |\vec{A} - \vec{B}|^2 + 4|\vec{A}|.|\vec{B}| \cos 120^\circ$

Since cosine is negative in the second quadrant, C must be less than $|A - B|$.

*** Given Section consists of questions of 2 marks each. [26]**

72. What are uses of a velocity-time graph?

Ans. : From a velocity-time graph, we can find out:

i. The velocity of a body at any instant.
ii. The acceleration of the body and
iii. The net displacement of the body in a given time-interval.

73. Find the area bounded by the curve $y = e^{-x}$, the X-axis and the Y-axis.

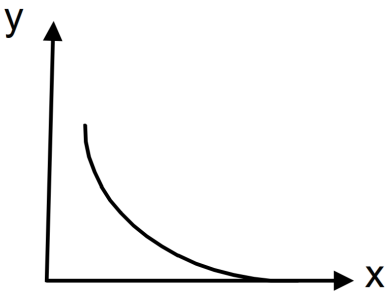
Ans. : The given function is $y = e^{-x}$

When $x = 0$, $y = e^{-0} = 1$

x increases, y value deceases and only at $x = \infty, y = 0$.

So, the required area can be found out by integrating the function from 0 to ∞.

So, $\text{Area} = \int_0^\infty e^{-x}dx = -[e^{-x}]_0^\infty = 1.$



74. A monkey climbs up a slippery pole for 3 seconds and subsequently slips for 3 seconds. Its velocity at time t is given by v(t) = 2t(3 - t); 0 < t < 3 and v(t) = -(t - 3)(6 - t) for 3 < t < 6s in m/s. It repeats this cycle till it reaches the height of 20m. At what time is its velocity maximum?

Ans. : Given velocity

$v(t) = 2t(3-t) = 6t - 2t^2$

For maximum velocity $\frac{dv(t)}{dt} = 0$

$\Rightarrow \frac{d}{dt}(6t - 2t^2) = 0$

$\Rightarrow 6 - 4t = 0$

$\Rightarrow t = \frac{6}{4} = \frac{3}{2}s = 1.5s$

75. The velocity of a particle is v = 5 + 2 (a_1 + a_2t) where a_1 and $_{a2}$ are constants and t is the time. What is the acceleration of the particle?

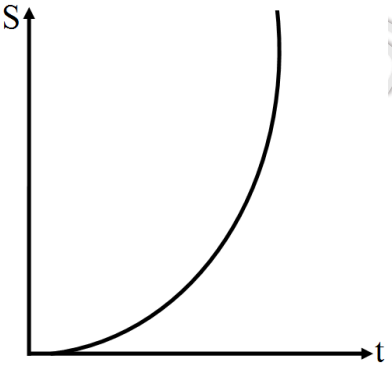
Ans. : $v = 5 + 2(a_1 + a_2t)$

$a = \frac{dv}{dt} = \frac{d}{dt}[5 + 2(a_1 + a_2t)]$

$a = 2a_2$

76. A body is travelling in a straight line with a uniformly increasing speed. Plot a graph which represents the change in distance (s) travelled with time (t).

Ans. : Let a body is travelling with initial speed 'u' in a straight line, then using relation,



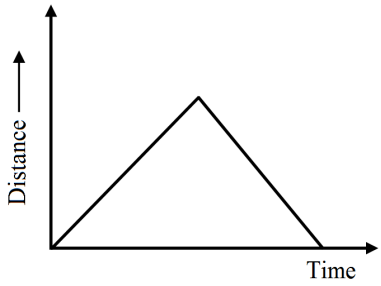
$s = ut + \frac{1}{2}at^2$

For u = 0;

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

$s \propto t^2$

77. The graph between total path length and time for a particle moving along a straight line as shown in figure is not possible. Explain why?



Ans. : The graph shows that with the passage of time, total path length first increases and then decreases.

The path length always increases or remains constant with passage of time and it does not decrease with time as shown in figure. Thus, this graph is not possible.

78. Acceleration is called as rate of change of velocity. Suppose we call rate of change of acceleration SLAP, what is the unit of SLAP?

Ans. : SLAP $= \frac{\text{Acceleration}}{\text{Time}}$

$= \frac{ms^{-2}}{s} = ms^{-3}$

79. A body goes from A to B with a velocity of 40m/s and comes back from B to A with a velocity of 60m/s. What is the (i) average velocity during the whole journey and (ii) average speed during the whole journey?

Ans. : Average velocity $= \frac{\text{Total displacement}}{\text{times}} = 0$

Since, there is no net displacement

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

$= \frac{2AB}{\frac{AB}{40}+\frac{AB}{60}} = 48 m/s$

80. An object moving on a straight line covers first half of the distance at speed v and second half of the distance at speed 2v. Find:

i. Aaverage speed.

ii. Mean speed.

Ans. : Let total distance be x.

Distance of first half $= \frac{x}{2}$, Speed = v

Time taken $t_1 = \frac{\frac{x}{2}}{v} = \frac{x}{2v}$

Distance of second half $= \frac{x}{2}$, Speed = 2v

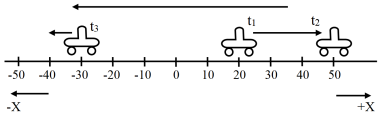
Time taken $t_2 = \frac{\frac{x}{2}}{2v} = \frac{x}{4v}$

i. Average speed $= \frac{\text{Total distance travelled}}{\text{Total time taken}}$

$= \frac{x}{\frac{x}{2v}+\frac{x}{4v}} = \frac{4v}{3}$

ii. Mean speed $= \frac{v+2v}{2} = \frac{3v}{2}$

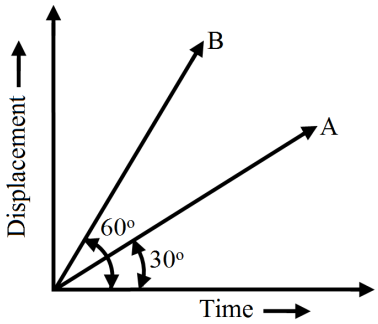
81. For the motion shown in the figure, find the displacement of car between the time intervals t_1 and t_3.



Ans. : Car moving towards +x-axis. At time t_1 it is at +20m. It turns at +50m and starts moving towards - x-axis. At time t_3, it reached at -30m.

The displacement of car in the interval $(t_3 - t_1) = \Delta t$ is -30-(+20) = -50m (negative sign shows the direction of displacement is towards - x-axis).

82. The two straight rays OA and OB on the same displacement - time graph make angle 30° and 60° with time axis respectively as shown in figure.



i. Which ray represents greater velocity?
ii. What is the ratio of two velocities represented by OA and OB?

Ans. :

i. OB, because the slope has greater angle.
ii. Ratio of two velocities

$$\frac{v_A}{v_B} = \frac{\tan 30^\circ}{\tan^\circ}$$

$$= \frac{\frac{1}{\sqrt{3}}}{\sqrt{3}} = \frac{1}{3}$$

83. The position of an object is given by $x = 2t^2 + 3t$. Find out that its motion is uniform and non-uniform.

Ans. : As given, $x = 2t^2 + 3t$

By differentiating x w.r.t. t, we get

Velocity, $v = \frac{dx}{dt} = \frac{d}{dt}(2t^2 + 3t)$

$v = (4t + 3)$

As velocity is time dependent, it means that motion is non-uniform.

84. From the given example, find if the motion is one or two or three-dimensional.

i. A kite flying in the sky.
ii. A cricket ball hit by a player.
iii. Moon revolving around the earth.
iv. The motion of a stone in a circle.

Ans. :

i. A flying kite in the sky comes under three-dimensional motion.
ii. A cricket ball hit by a player comes under two-dimensional motion.

iii. Moon revolving around the sun-earth comes under two-dimensional motion.

iv. The motion of the stone in circular motion comes under two-dimensional motion.

*** Given Section consists of questions of 3 marks each.** **[6]**

85. A particle executes the motion described by $x(t) = x_0(1 - e^{-\gamma t}); t \geq 0, x_0 > 0$. Where does the particle start and with what velocity?

Ans. : $x(t) = x_0[1 - e^{-\gamma t}] \quad \ldots(i)$

$v(t) = \frac{dx(t)}{dt} = \frac{d}{dt}[x_0(1 - e^{\gamma t})] = +x_0\gamma e^{-\gamma t} \quad \ldots(ii)$

$a(t) = \frac{dv}{dt} = \frac{d[+x_0\gamma^2 e^{-\gamma^4}]}{2} = -x_0\gamma^2 e^{-\gamma t} \quad ..(iii)$

$(i) At, t = 0 \;\; x(0) = x_0[1 - e^0] = x_0(1 - 1) = 0$

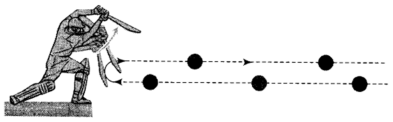
$v(0) = x_0\gamma e^0 = x_0\gamma$

Hence, the particle start from x = 0 with velocity $v_0 = x_0\gamma$.

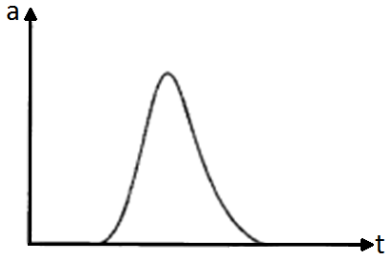
86. A uniformly moving cricket ball is turned back by hitting it with a bat for a very short time interval. Show the variation of its acceleration with time. (Take acceleration in the backward direction as positive).

Ans. : Impulsive Force is generated by the bat: If we ignore the effect of gravity just by analyzing the motion of ball in horizontal direction only, then ball moving uniformly will return back with the same speed when a bat hits it.

Acceleration of the ball is zero just before it strikes the bat. When the ball strikes the bat, it gets accelerated due to the applied impulsive force by the bat.



The variation of acceleration with time is shown in the graph.

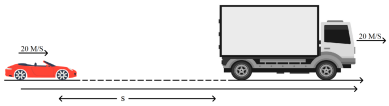


*** Given Section consists of questions of 5 marks each.** **[20]**

87. A motor car moving at a speed of 72km/h can not come to a stop in less than 3.0s while for a truck this time interval is 5.0s. On a higway the car is behind the truck both moving at 72km/h. The truck gives a signal that it is going to stop at emergency. At what distance the car should be from the truck so that it does not bump onto (collide with) the truck. Human response time is 0.5s.

Ans. : According to the problem, speed of car as well as truck = 72km/h

$= 72 \times \frac{5}{18} m/s = 20 m/s$



Time required to stop the truck = 5s

Finally the truck comes to rest, so final velocity of truck will be zero.

Retardation produced by truck:

$v = u + a_t t$

$0 = 20 + a_t \times 5$

Or $a_t = -4 m/s^2$

Time required to stop the car = 3s

Finally the car comes to rest just behind the truck in the same time to avoid collision, so final velocity of car will also be zero.

Retardation produced by car is

$v = u + a_c t$

$0 = 20 + a_c \times 3$

Or $a_c = -\frac{20}{3} m/s^2$

Let car be at a distance s from the truck, when truck gives the signal and t be the time taken to cover this distance.

As human response time is 0.5s, in this car will cover some distance with uniform velocity. Therefore, time of retarded motion of car is (t - 0.5)s. Velocity of truck after time t,

$v_c = u - at = 20 - \left(\frac{20}{3}\right)(t - 0.5)$

Velocity of truck after time t,

$v_t = 20 - 4t$

To avoid the car bump onto the truck

$20 - \frac{20}{3}(t - 0.5) = 20 - 4t$

$4t = \frac{20}{3}(t - 0.5)$

$\Rightarrow t = \frac{2.5}{2} = \frac{5}{4} s$

Distance travelled by the truck in time t,

$s_t = u_t t + \frac{1}{2} a_t t^2$

$\Rightarrow s_t = 20 \times \frac{5}{4} + \frac{1}{2} \times (-4) \times \left(\frac{5}{4}\right)^2 = 21.875 m$

Distance travelled by car in time t = Distance travelled by car in 0.5s (without retardation) + Distance travelled by car in (t - 0.5)s (with retardation)

$s_c = (20 \times 0.5) + 20\left(\frac{5}{4} - 0.5\right)$

$- \frac{1}{2}\left(\frac{20}{3}\right)\left(\frac{5}{4} - 0.5\right)^2 = 23.125 m$

$\therefore s_c - s_t = 23.125 - 21.875 = 1.250 m$

Therefore, to avoid the collision with the truck, the car must maintain a distance from the truck more than 1.250m.

88. A man runs across the roof-top of a tall building and jumps horizontally with the hope of landing on the roof of the next building which is of a lower height than the first. If his speed is 9m/s, the (horizontal) distance between the two buildings is 10m and the height difference is 9m, will he be able to land on the next building? (take g = 10m/s^2).

Ans. : Key concept: Horizontal Projectile:

When a body is projected horizontally from a certain height 'y' vertically above the ground with initial velocity u. If friction is considered to be absent, then there is no other horizontal force which can affect the horizontal motion. The horizontal velocity therefore remains constant and so the object covers equal distance in horizontal direction in equal intervals of time.

Time of flight: If a body is projected horizontally from a height h with velocity u and time taken by the body to reach the ground is T, then.

$\mathrm{h} = 0 + \frac{1}{2}\mathrm{gT}^2$ (for vertical motion)

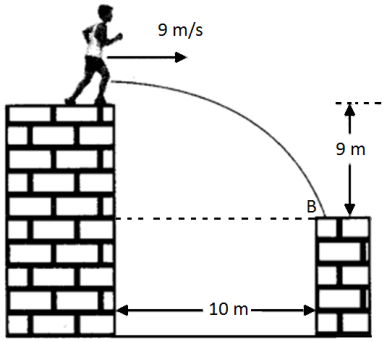
$\mathrm{T} - \sqrt{\frac{2\mathrm{h}}{\mathrm{g}}}$

Horizontal range: Let R be the horizontal distance travelled by the body

$\mathrm{R} = \mathrm{uT} + \frac{1}{2}0\mathrm{T}^2$ (for horizontal motion a = 0)

$\mathrm{R} = \mathrm{u}\sqrt{\frac{2\mathrm{h}}{\mathrm{g}}}$

We will apply kinematic one by one along downward and along horizontal. We first consider motion along horizontal and there is no horizontal force which can affect the horizontal motion. The horizontal velocity therefore remains constant and so the object covers equal distance in horizontal direction in equal intervals of time.



According the problem, horizontal speed of the man (u_x) = 9m/s Horizontal distance between the two buildings = 10m

Height difference between the two buildings = 9m and g = 10m/s^2

and g = 10ms^2

Let the man jumps from point A and land on the roof of the next building at point B.

Taking motion in vertical direction,

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

$9 = 0 \times \mathrm{t} + \frac{1}{2} \times 10 \times \mathrm{t}^2$

$9 = 5\mathrm{t}^2$

or $\mathrm{t} = \sqrt{\frac{9}{5}} = \frac{3}{\sqrt{5}}$

$\therefore$ Horizontal distance travelled

$= u_x \times t = 9 \times \frac{3}{\sqrt{5}} = \frac{27}{\sqrt{5}} m = 12m$

Horizontal distance travelled by the man is greater than 10m, therefore, he will land on the next building.

89. Add vectors $\vec{A}, \vec{B}$ and $\vec{C}$ each having magnitude of 100 unit and inclined to the X-axis at angles 45°, 135° and 315° respectively.

Ans. : x component of $\vec{A} = 100 \cos 45^\circ = \frac{100}{\sqrt{2}}$ unit

x component of $\vec{B} = 100 \cos 135^\circ = \frac{100}{\sqrt{2}}$

x component of $\vec{C} = 100 \cos 315^\circ = \frac{100}{\sqrt{2}}$

Resultant x component $= \frac{100}{\sqrt{2}} - \frac{100}{\sqrt{2}} + \frac{100}{\sqrt{2}} = \frac{100}{\sqrt{2}}$

y component of $\vec{A} = 100 \sin 45^\circ = \frac{100}{\sqrt{2}} unit$

y component of $\vec{B} = 100 \sin 135^\circ = \frac{100}{\sqrt{2}}$

y component of $\vec{C} = 100 \sin 315^\circ = \frac{100}{\sqrt{2}}$

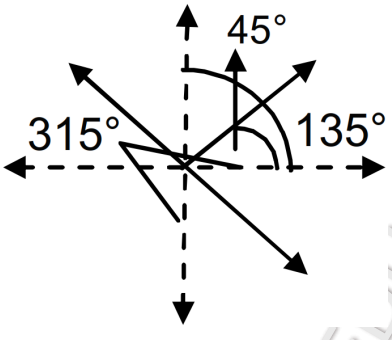
Resultant y component $= \frac{100}{\sqrt{2}} + \frac{100}{\sqrt{2}} - \frac{100}{\sqrt{2}} = \frac{100}{\sqrt{2}}$

Resultant $= 100$

$\tan \alpha = \frac{\text{y component}}{\text{x component}} = 1$

$\Rightarrow \alpha = \tan^{-1}(1) = 45^\circ$

The resultant is 100 unit at 45° with x-axis.

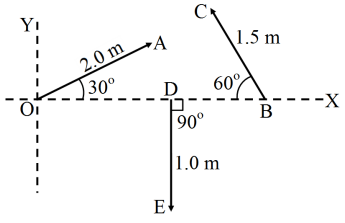


90. Refer to figure. Find

a. The magnitude.

b. x and y components

c. The angle with the X-axis of the resultant of $\overrightarrow{OA}, \overrightarrow{BC}$ and $\overrightarrow{DE}$.



Ans. : x component of $\overrightarrow{OA} = 2\cos 30^\circ = \sqrt{3}$

x component of $\overrightarrow{BC} = 1.5\cos 120^\circ = -0.75$

x component of $\overrightarrow{DE} = 1\cos 270^\circ = 0$

y component of $\overrightarrow{OA} = 2\sin 30^\circ = 1$

y component of $\overrightarrow{BC} = 1.5\sin 120^\circ = 1.3$

y component of $\overrightarrow{DE} = 1\sin 270^\circ = -1$

R_x = x component of resultant $= \sqrt{3} - 0.75 + 0 = 0.98\text{m}$

R_y = resultant y component $= 1 + 1.3 - 1 = 1.3\text{m}$

$\therefore$ Resultant, $R = \sqrt{(R_x)^2 + (R_y)^2}$

$= \sqrt{(0.98)^2 + (1.3)^2}$

$= \sqrt{0.96 + 1.69}$

$= \sqrt{2.65}$

$= 1.6\text{m}$

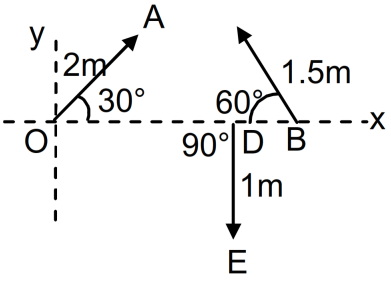
So, R = Resultant $= 1.6\text{m}$

If it makes and angle α with positive x-axis

$\tan\alpha = \frac{\text{y component}}{\text{x component}}$

$\Rightarrow \tan\alpha = \frac{1.3}{0.98} = 1.332$

$\Rightarrow \alpha = \tan^{-1} 1.32$



----- नजर को बदलो तो नजारे बदल जाते हैं , सोच को बदलो तो सितारे बदल जाते हैं !!कश्तियां बदलने की जरुरत नहीं दिशाओं को बदलो तो किनारे खुद ब खुद बदल जाते हैं! -----