Motion

Periodic Test

Q.1. Can a body have constant speed and still be accelerating?

Answer: Yes, a body can have a constant speed and still be accelerating.

Acceleration can be either due to change in speed or due to direction of motion or both.

Consider an example of uniform circular motion. In a uniform circular motion, the body moves with a constant speed but we still say that it is accelerating due to the change in direction.

This acceleration is called centripetal acceleration and is given as

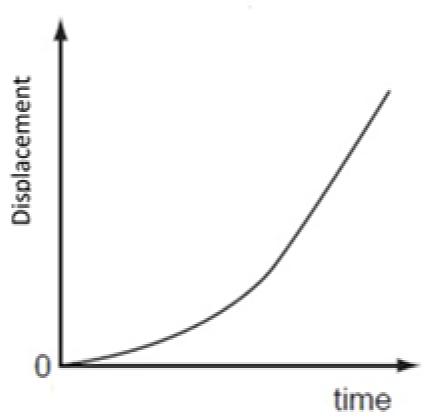
$$a_c = \frac{-v^2}{r}$$

Where, v = constant speed

And r = radius of circle

Q.2. What is the nature of the displacement-time graph of a body moving with constant acceleration?

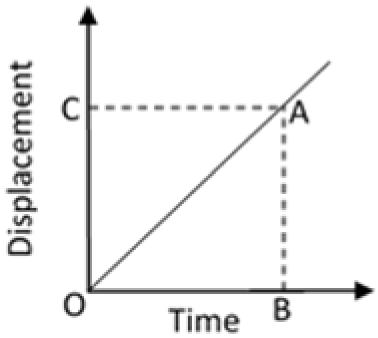
Answer: Displacement – Time graph of a body moving with constant acceleration is as shown in the right side.



Explanation:

Slope of displacement – time graph gives the velocity.

Consider the following graph:



Here AB = Displacement of Body

And OB = Time Taken

$$\text{Now, Velocity } = \frac{\text{AB}}{\text{OB}}$$

But $\frac{\text{AB}}{\text{OB}}$ is known as slope of line OA.

We know that in constant acceleration, velocity is changing with time at a constant rate.

$$\text{Since, Acceleration } = \frac{\text{Change in velocity}}{\text{Time}}$$

So, slope of displacement – time graph is changing at a constant rate and hence we get a graph like shown at the beginning.

Q.3. Can the speed of a body be negative?

Answer: No, speed of a body can never be negative. Speed is a scalar quantity given as:

$$\text{Speed} = \frac{\text{Distance Travelled}}{\text{Time Taken}}$$

Distance travelled by a body is always positive. It may be zero, but is never negative.

Time taken is also positive quantity.

So, speed being the ratio of two positive quantities can never be negative.

Q.4. What does the slope of a velocity – time graph represent?

Answer:

The slope of velocity – time graph represent acceleration. Since, Slope

$$= \frac{\Delta y}{\Delta x}$$

Δy = Change in y – axis

Δx = Change in x – axis

y = Velocity = v

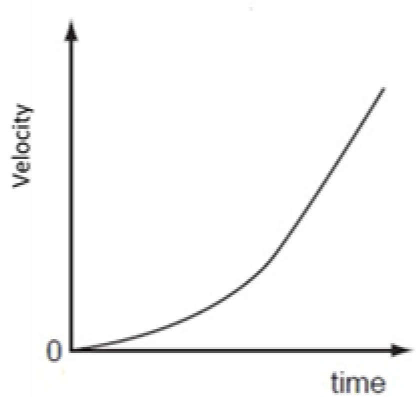
x = time = t

So, $\Delta y = \Delta v$ = Change in velocity

$\Delta x = \Delta t = \text{Change in time}$

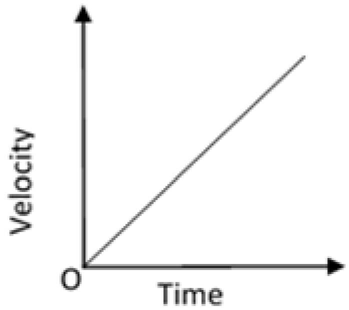
$$\text{So, Slope} = \frac{\Delta v}{\Delta t} = \frac{\text{Change in velocity}}{\text{Time Taken}}$$

$$\text{We know that Acceleration} = \frac{\text{Change in velocity}}{\text{Time Taken}}$$



Non – Uniform Acceleration

So, Slope of Velocity – Time graph is acceleration.



Constant Acceleration

Q.5. Can the distance travelled by a particle be zero when displacement is not zero?

Answer: Distance travelled by the particle cannot be zero when displacement is not zero.

Distance is the actual length of the path covered by a moving body irrespective of the direction in which body trace.

When a body moves from one position to another, then shortest (straight line) distance between initial and final positions of the body along with direction is displacement.

$$|\text{Displacement}| \leq |\text{Distance}|$$

The above-mentioned relation implies that the distance is always greater than or equal to displacement.

$\text{Hence, if } |\text{Displacement}| \neq 0, \text{then Distance} \neq 0$

Q.6. Give Reasons for the Following:

In a long-distance race, the athletes were expected to take four rounds of the track such that the line of finish was same as the line of start. The motion of the athlete is non-uniform. Why?

Answer: The athlete was expected to take four rounds such that: line of finish = line of start

This means, we are saying that athlete comes back to its initial position. This is only possible if there is change in direction.

Without the change in direction a person can never reach back the initial point.

Now, we know that change in direction means acceleration, hence motion is non uniform.

Q.7. Give Reasons for the Following:

If the reading on the odometer of a vehicle in the beginning of a trip and after 40 minutes were 1048 km and 1096 km respectively, will the reading on the speedometer show this velocity where the vehicle is moving? Support your answer with reason.

Answer: Odometer is used to measure the distance travelled by the vehicle.

Given:

Initial Reading = 1048 km at t = 0 seconds

Final Reading = 1096 km at t = 40 minutes = $\frac{40}{60}$ hr

$$\text{Average Speed} = \frac{\textit{Total Distance Covered}}{\textit{Total Time Taken}} = \frac{1096 - 1048}{40/60} = \frac{48}{40/60}$$

= 72 $kmhr^{-1}$

Calculations using the readings of odometer gives the average speed.

Whereas, the speedometer gives the reading of instantaneous speed.

Thus, the two values, that is one calculated and one on the speedometer may not be the same.

Both can only be same if the vehicle has been moving with constant velocity throughout the measurement.

Q.8. Give Reasons for the Following:

Can a body move with constant acceleration but with zero velocity? If yes, why?

Answer: Acceleration is the rate of change of velocity. In order to have non-zero acceleration, rate of change of velocity should be non-zero.

Yes, it is possible to have non-zero acceleration at zero velocity. But it is only possible for a moment. A moment is a brief period that cannot be measured.

Let us understand it by following two examples:

(a) When we throw a ball in the air, it attains a maximum height and then comes down. At the maximum height velocity of the ball is zero, but a negative acceleration due to gravitation acts on it.

(b) When we apply brakes on a moving car, the car stops and the velocity of the car is zero at that moment but acceleration (retardation) is not zero.

Q.9. Give Reasons for the Following:

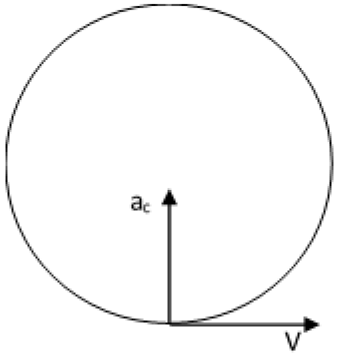
Can a body move horizontally with acceleration in vertical direction? If yes, why?

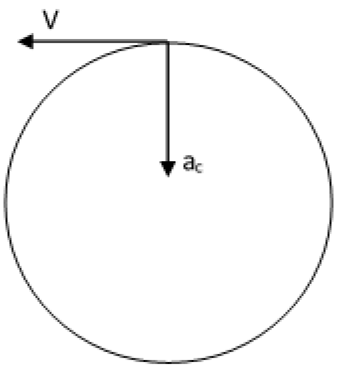
Answer: Yes, a body can move horizontally with acceleration in vertical direction.

Consider the application of centripetal acceleration on a body for an example.

When a body moves on a circular path, then centripetal acceleration is always in radial direction and towards the center.

So, consider a body moving on a vertical circle passing its highest and lowest point.





a_c acts vertically whereas v in both cases acts horizontally.

Q.10. Give Reasons for the Following:

Can a body move with a constant velocity in an accelerated motion? If yes, give reason.

Answer: Yes, a body can have a constant speed and still be accelerating.

Acceleration can be either due to change in speed or due to direction of motion or both.

Consider an example of uniform circular motion. In a uniform circular motion, the body moves with a constant speed but we still say that it is accelerating due to the change in direction.

This acceleration is called centripetal acceleration and is given as

$$a_c = \frac{-v^2}{r}$$

Where, v = constant speed

And r = radius of circle

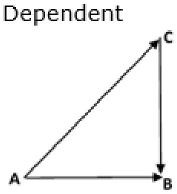
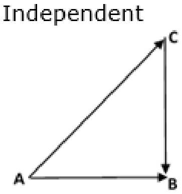
Q.11. Speed and velocity

Answer:

Speed	Velocity
Speed of a body is the distance travelled per unit time	Velocity of a body is the displacement produced per unit time
Speed is a scalar quantity, that is, speed does not tell anything about direction of motion	Velocity is a vector quantity, that is, it tells us that in which direction the body moves
Speed is always positive	Velocity can be negative
Speed is velocity without direction $\text{Speed} = \frac{\text{Distance Travelled}}{\text{Time taken}}$	Velocity is speed with direction $\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$
Speed is path dependent	Velocity is path independent

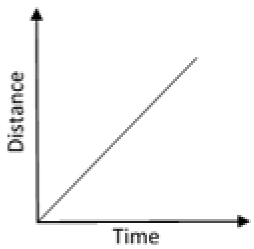
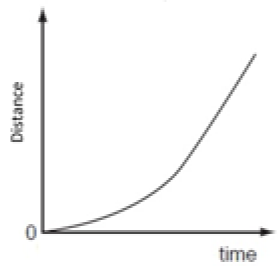
Q.12. Distance and displacement

Answer:

Distance	Displacement
Distance travelled by the body is the actual length of path covered by a moving body.	The shortest (Straight line) distance between the initial position and final position along with direction is called displacement.
Distance is scalar quantity, that is, distance travelled is only magnitude.	Displacement is vector quantity, that is, displacement is magnitude as well as direction.
Distance is always positive.	Displacement can be positive or negative.
Example: A car travels 30 km, then "30 km" is the distance.	Example: A car travels 30 km towards North is the displacement of the car.
Path Dependent  Distance = AC + CB	Path Independent  Displacement = AB

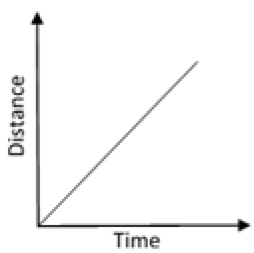
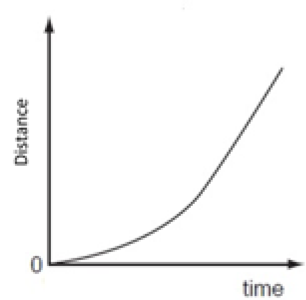
Q.13. Uniform and non-uniform motion

Answer:

Uniform Motion	Non-Uniform Motion
If the motion of a body has zero acceleration, then the motion is called uniform motion.	If the motion of a body has non – zero acceleration, then the motion is called non – uniform motion.
In uniform motion body moves with a constant speed and in same direction.	In a non – uniform motion, either speed or direction or both changes.
Average Speed = Instantaneous Speed	Average Speed ≠ Instantaneous Speed
	

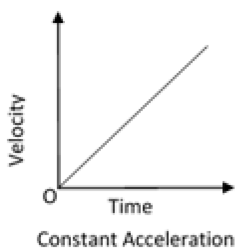
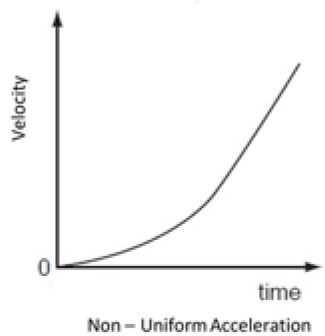
Q.14. Uniform and variable velocity

Answer:

Uniform Velocity	Variable velocity
If a body covers equal displacement in equal interval of time, then it is said to have uniform velocity.	If a body covers unequal displacement in equal interval of time, then it is said to have variable velocity.
Both the speed (magnitude) and direction remain constant.	The variable velocity may be due to change in speed (magnitude) or direction or both.
Example: A car moving at a constant speed of 30 $kmhr^{-1}$ in a straight road.  	Example: A fan rotating (change in direction). A freely falling body under gravitation (experiences acceleration due to gravity) 

Q.15. Uniform and non-uniform acceleration

Answer:

Uniform Acceleration	Non – Uniform Acceleration
A body has uniform acceleration if its velocity changes at a uniform rate.	A body has non – uniform acceleration if its velocity changes at a non – uniform rate.
Example: A freely falling body. Uniform Circular Motion  	Example: A speeding car accelerating at a non – uniform rate. Non – Uniform Circular Motion 

Q.16. What do you understand by displacement-time graph? Draw a displacement-time graph for a girl going to school with uniform velocity. How can we calculate uniform velocity from it?

Answer: Displacement – Time graph is a plot of points telling the position of particles at that instant of time.

Y – Axis: Displacement

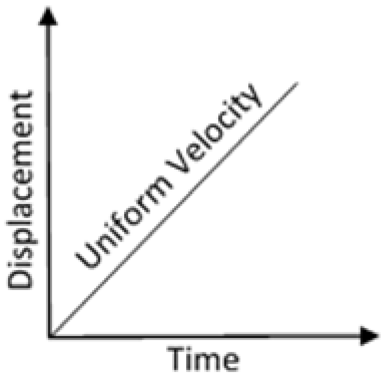
X – Axis: Time

We plot the points for different positions of particle at different times.

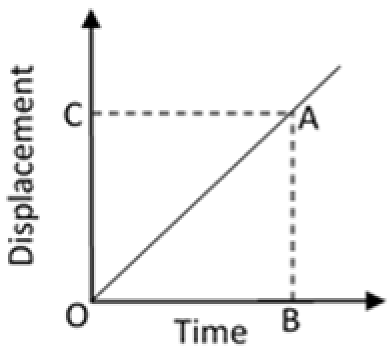
Slope of displacement – time graph gives the velocity.

Consider an example of a girl going to school with uniform velocity.

Uniform velocity means equal displacement in equal intervals of time. Thus, for uniform velocity the graph of displacement against time will be straight line as shown below:



To calculate uniform velocity from the graph,



The slope of displacement – time graph indicates velocity of the body. So, the slope of the displacement – time graph can be used to calculate the velocity of the body.

For calculating the slope of the displacement – time graph, we take a point A on the straight-line graph and drop a perpendicular AB on the time axis (x – axis).

AB = Distance travelled by the body

OB = Time interval

$\text{Now, Velocity} = \frac{\text{Displacment}}{\text{Time Taken}}$

$\text{Velocity} = \frac{\text{AB}}{\text{OB}}$

$\text{Where} \frac{\text{AB}}{\text{OB}} \text{ is the slope of line OA}$

Hence, we calculate uniform velocity from the displacement – time graph.

Q.17. What is velocity-time graph? Sate how it can be used to find:

i. acceleration of a body

ii. the displacement of a body, and

iii. the distance travelled in a given time

Answer: The Velocity – Time graph gives the change of velocity with the change in time.

Y – Axis: Velocity

X – Axis: Time

Now, slope of velocity – time graph is gives as

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta v}{\Delta t}$$

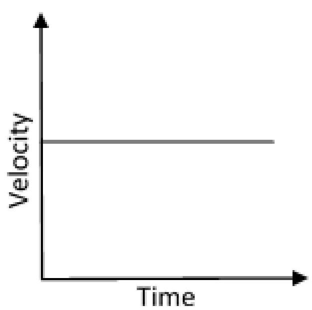
Since, y = v (Velocity)

And x = t (Time)

Now, there are three types of Velocity – Time graph.

(a) Velocity is constant – Uniform Motion

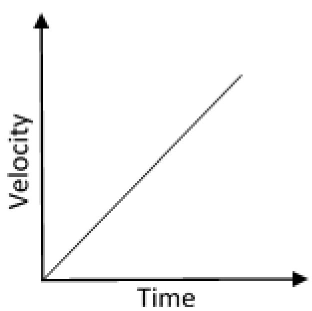
This means that velocity remains same for all time.



(b) Uniformly Accelerated Motion

This means that velocity changes at constant rate.

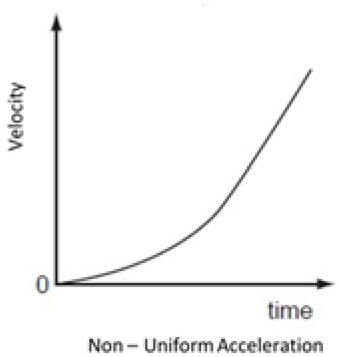
Slope = Constant and the graph is a straight-line graph



(c) Non – Uniformly Accelerated Motion

This means that velocity changes at a variable rate.

Slope = Variable and the graph is as shown below



Velocity – Time Graph can be used to find the following as:

(a) Acceleration:

Slope of Velocity – Time Graph = Acceleration

$\text{Since, Slope } = \dfrac{\Delta v}{\Delta t}$

$\text{So, Acceleration } \dfrac{\Delta v}{\Delta t}$

And hence, Slope = Acceleration

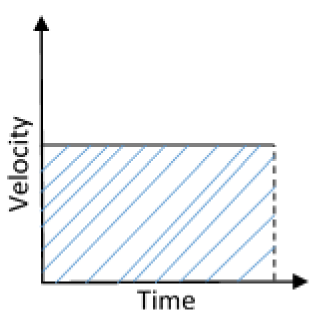
(b) Displacement of a body:

The area under the velocity – time graph gives the displacement of the body.

Displacement = Velocity × Time

Area under the graph = Displacement of Body

For finding the area, we multiply the velocity and time.



(c) Distance of a body:

Distance = Speed × Time

Now, Speed is magnitude of velocity.

Hence, as long as velocity is positive,

Area under the curve = Distance

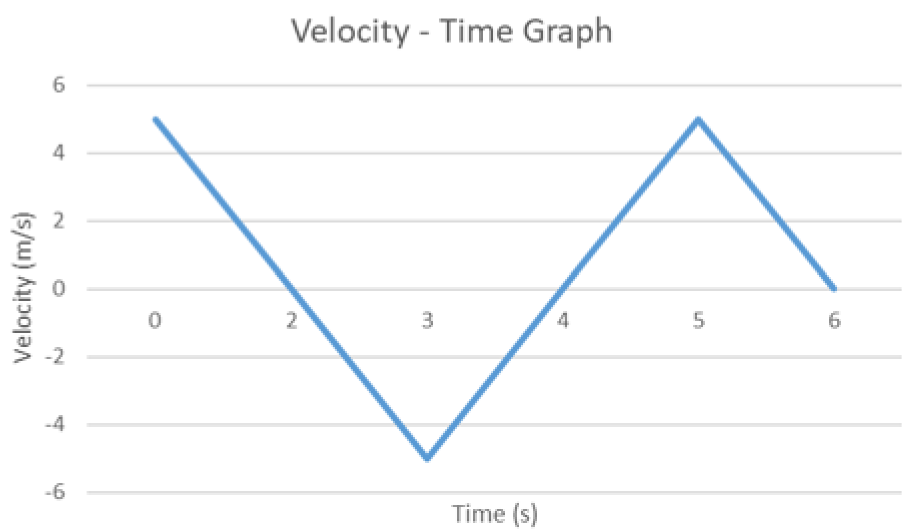
NOTE:

If velocity is negative, then the area under the curve is negative and then the total area gives displacement. So, in that case,

$\text{Distance} \neq \text{Displacement}$

Example:

Let the velocity – time graph be as shown below:



Now, Displacement = Area under the curve

$= \frac{1}{2} \times 5 \times 2 \times -\frac{1}{2} \times 5 \times 2 + \frac{1}{2} \times 5 \times 2$

$= 5\text{m}$

Whereas, Distance =

$\frac{1}{2} \times 5 \times 2 + \frac{1}{2} \times 5 \times 2 + \frac{1}{2} \times 5 \times 2$

= 15 m

For displacement we have considered the area below the time axis as negative whereas for distance, we have considered all areas as positive.

Q.18. The driver of a train travelling at 40 ms^{-1} applies the brakes as a train enters a station. The train slowsdown at a rate of 2 ms^{-2}. The platform is 400 m long. Will the train stop in time?

Answer: Initial Speed = u = 40 ms^{-1}

Acceleration = a = - 2 ms^{-2} (Retardation, hence negative)

Final Speed = v

Now, s = Distance train travels before stopping

Now, we know from the equations of motion that,

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

$$0 = 40^2 + 2 \times (-2) \times s$$

$$4s = 1600$$

s = 400 m

So, the train covers 400 m before stopping.

Also, the length of platform = 400 m.

So, the train stops in time.

Q.19. A girl running a race accelerates at 2.5 ms^{-2} for the first 4 s of the race. How far does she travel in this time?

Answer: Acceleration = a =2.5 ms^{-2}

Time of Acceleration = t = 4 s

Initial velocity = u = 0 ms^{-1}

Now, from the equations of motion we know that,

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

$$s = 0 \times 4 + \frac{1}{2} \times 2.5 \times 4^2$$

$$s = 2.5 \times 8$$

s = 20 m

Hence, the girl travels 20 m in this time.

Q.20. Two trains A and B of length 400 m each are moving on two parallel tracks with uniform speed of 72 kmh^{-1} in the same direction with A ahead of B. The driver of B decides to overtake A and accelerate by 1 ms^{-2}. If after 50 s, the guard of B just passes the driver of A, what was the original distance between them?

Answer: Train A

Initial Velocity = U_A = 72 kmh^{-1} = 20 ms^{-1}

Time Taken = t = 50s

Acceleration = a_A = 0 ms^{-2}

Now, from the equations of motion, we know that,

$$s_A = u_A t + \frac{1}{2} a_A t^2$$

$$s_A = 20 \times 50$$

$$s_A = 1000 \text{ m}$$

Driver is at starting of Train A

Train B

Initial Velocity = U_A = 72 kmh^{-1} = 20 ms^{-1} Time Taken = t = 50 s

Acceleration = a_B = 1 ms^{-2}

Now, from the equations of motion, we know that,

$$s_B = u_B t + \frac{1}{2} a_B t^2$$

$$s_B = 20 \times 50 + \frac{1}{2} \times 1 \times 50^2$$

$$S_B = 2250 \text{ m}$$

Guard is at the end of Train B

Now, length of both trains = 400 m + 400 m = 800 m

Now, Original distance between Train A and B is S, which can be obtained as given below:

S = 2250 m – 1000 m – 800 m

= 450 m

Q. 21. The velocity of car is 18 ms^{-1}. Express this velocity in kmh^{-1}.

Answer: Velocity of Car = 18 ms^{-1}

To express this velocity in $kmhr^{-1}$ we need the conversion factor which is calculated as under:

1 km = 1000 m

$$\text{So, } 1 \text{ m } = \frac{1}{1000} \text{ km}$$

Now, 1 hr = 60 minutes = 60 × 60 s = 3600 s

$$\text{So, } 1 \text{ s } = \frac{1}{3600} \text{ hr}$$

$$\text{Now, Velocity of car } = 18\frac{\text{m}}{\text{s}}$$

$$= 18\frac{\text{km}}{1000} \times \frac{3600}{\text{hr}}$$

$$= \frac{18 \times 36}{10} \text{kmh}^{-1}$$

$$= 64.8 \text{ kmh}^{-1}$$

Q.22. An electric engine has a velocity of 120 kmh-1. How much distance will it travel in 30s?

Answer:

Now, |**Velocity**| = 120 kmh^{-1}

$= \frac{120 \times 1000}{3600} ms^{-1}$

$= \frac{100}{3} ms^{-1}$

Now, time = 30 s

Hence, Distance = |**Velocity**| × time

$= \frac{100}{3} \times 30$

= 1000 m

= 1 km

Hence, the distance travelled by the electric engine in 30 s is 1 km.

Q.23. A man is sitting in a train which is moving. Is he at rest or in motion?

Answer: In Classical Mechanics, we deal with relative motion, that is, we study motion with respect to an observer.

So, first thing that we need to do is to set an observer and study motion with respect to this observer which is at rest.

(a) A man sitting in a train is at rest with respect to a man sitting in the train next to him.

(b) A man sitting in a train is in motion with respect to a man standing on ground outside the train, because the train is moving with respect to the observer and so is the man sitting in it.

Q.24. When you return to your home from your school, what is your displacement?

Answer: When I return to home from school, then my displacement = 0.

Displacement = Final Position – Initial Position

Now, initially I was at home and finally also I am at home only. Hence, the displacement = 0

Q.25. When you apply brakes to a car, in which direction is its acceleration?

Answer: When we apply brakes to the car, then the direction of the acceleration is opposite to that of the motion of car.

Let the car is moving in positive x direction. Now, we apply brake to stop the car. Now for stopping the car force must act on it (Newton's First Law) in opposite direction. Hence acceleration is in negative x direction. We may also call it as retardation.

Q.26. Which can produce more acceleration; a car or a motorcycle?

Answer: If we apply same force on a car and a motorcycle, then the motorcycle will produce more acceleration.

We know that, Force = Mass × Acceleration

Now, force is same on both, but

Mass of Car > Mass of Motorcycle

Now, using above equation of force,

F = m × a

Now, F = Constant

$$\text{So}, \mathrm{a} = \frac{\mathrm{f}}{\mathrm{m}}$$

$$a \propto \frac{1}{m}$$

So, acceleration of car < acceleration of motorcycle

Q.27. Give an example of negative acceleration from daily life situation.

Answer: Negative acceleration is nothing but retardation.

Acceleration is rate of change of velocity.

But negative acceleration means that the rate of change of velocity is negative or velocity decreases.

Example:

(1) When we apply brakes in a moving car, then negative acceleration acts on it and the car stops.

(2) When we throw a ball upwards, then also negative acceleration acts on it. Thus, when the ball reaches the highest point, velocity of the ball becomes zero.

Comprehensive Exercises (MCQ)

Q.1. The branch of Physics which deal with the motion of objects while taking into consideration the cause of motion is:

A. dynamics

B. kinematics

C. statics

D. None of These

Answer: Dynamics is the branch of physics and a sub branch of Mechanics. Dynamics is concerned with the motion of material objects and also concerns with the cause of motion. It deals with the factors that affect motion such as force, mass, momentum and energy.

Whereas, Statics deals with objects at rest and Kinematics deals with objects in motion without considering the cause of motion.

Q. 2. There is an argument about uniform acceleration between Mr X and Mr Y. Mr X says "acceleration means that farther you go faster you go". Mr Y says "acceleration means that longer you go the faster you go". Whose statement is correct?

A. Mr X

B. Mr Y

C. Both

D. None

Answer: Mr. X is right, since he says "the farther you go the faster you go", which implies, the more distance we travel in a given time the more is our velocity and thus he is right.

Whereas Mr. Y says "the longer you go the faster you go". Now, longer means more time. Hence, he is saying that more time you take, more the velocity you have, which is completely wrong.

Q.3. Starting from rest at the top of an inclined plane a body reaches the bottom of the inclined plane in 4 second. In what time does the body cover one-fourth the distance starting from rest at the top?

A. 1 second

B. 2 second

C. 3 second

D. 4 second

Answer: Let "s" be the total distance and "a" be the acceleration.

Now, we know that initially the body is at rest.

Now, from the equations of motion, we get,

$s = ut + \frac{1}{2}at^2$ …………1

$s = \frac{1}{2}a \times 4^2$ …………2

To find the time taken for covering $\frac{s}{4}$, we put $s = \frac{s}{4}$ in equation 1 above.

So, $\frac{s}{4} = \frac{1}{2}a \times t^2$ ……….3

Now, dividing equation 2 by 3, we get,

t = 2 s

Hence, option B is correct.

Q. 4. A car travels 100 km east and then 100 km south. Finally, it comes back to the starting point by the south-east route. Throughout the journey the speed is constant at 60 kmh^{-1}. The average velocity for the whole journey if time taken is 3.3 hours is:

A. 60 kmh^{-1}
B. 90 kmh^{-1}
C. 0 kmh^{-1}
D. 180 kmh^{-1}

Answer:

We know that, Velocity = $\frac{\text{Displacement}}{\text{Time taken}}$

Now, Displacement = Final Position – Initial position

Since, the car comes back to its starting point, so, displacement = 0

Therefore, Velocity = $\frac{0}{3.3\text{ hr}}$ = 0 kmh^{-1}

Hence, option C is correct

Q.5. The displacement of a body is proportional to the cube of the time lapsed. The magnitude of the acceleration is:

A. increasing with time

B. decreasing with time

C. constant

D. zero

Answer: We know that,

Displacement $\propto \text{time}^3$ …….1

Now, Velocity = $\frac{\text{Displacement}}{\text{Time}}$ …….2

From equations 1 and 2, we get,

Velocity $\propto \text{time}^2$ …….3

Now, we also know that,

Acceleration = $\frac{\text{Change in Velocity}}{\text{Time}}$ …….4

From equations 3 and 4, we get,

Acceleration $\propto$ time

Since, acceleration is directly proportional with time, so it increases with time.

Hence option A is correct.

Q.6. A particle accelerates from rest at a constant rate for some time and attains a constant velocity of 8 ms^{-1}. Afterwards it decelerates with a constant rate and comes to rest. If the total time taken is 4 second, the distance travelled is:

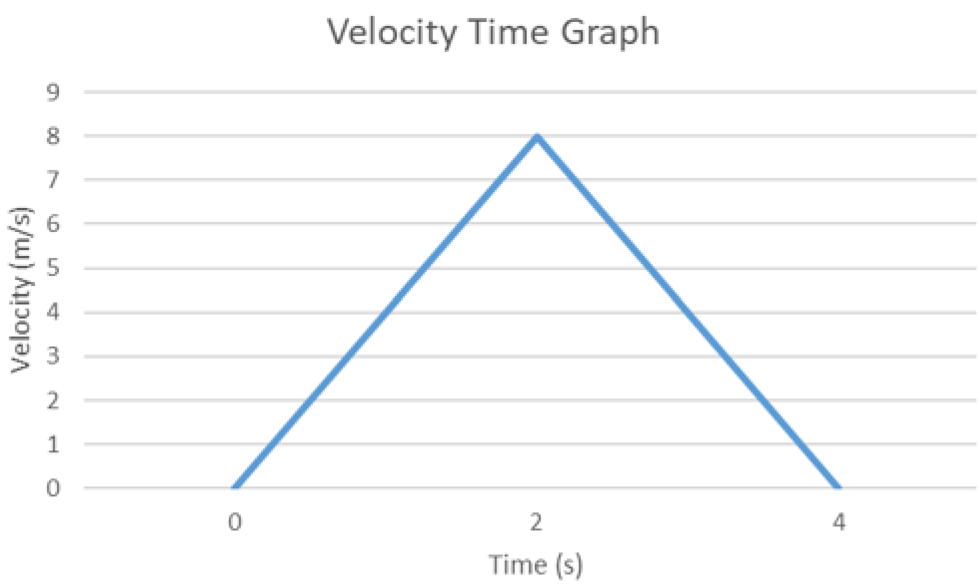
A. 32 metre

B. 16 metre

C. 4 metre

D. insufficient data

Answer: Now, from the given velocity – time graph we can calculate the distance by calculating area under the graph.



Distance Travelled = Area under the graph

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

= 16 m

Hence option B is correct

Q.7. A body moves on three quarters of a circle of radius r. The displacement and distance travelled by it are:

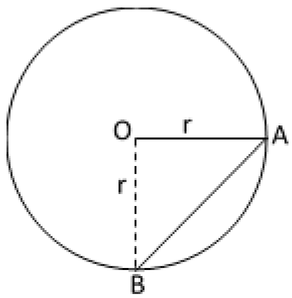
A. displacement = r, distance = 3r

B. displacement = $\sqrt{2}$**r, distance =** $\frac{3\pi r}{2}$

C. distance = 2r, displacement = $\frac{3\pi r}{2}$

D. displacement = -, distance = $\frac{3\pi r}{2}$

Answer:



From the diagram,

Circumference = $2\pi r$

$\frac{3}{4}$ × Circumference = $\frac{3}{4} \times 2\pi r$

$= \frac{3}{2}\pi r$

Now,

Distance = Total path covered by the body

$= \frac{3}{4} \times$ Circumference

$= \frac{3}{4} \times 2\pi r = \frac{3}{2}\pi r$

Whereas,

Displacement = Shortest Distance (Straight line) AB

$= \sqrt{OA^2 + OB^2}$

$= \sqrt{r^2 + r^2}$

$= \sqrt{2}r$

Q. 8. For the motion on a straight-line path with constant acceleration the ratio of the magnitude of the displacement to the distance covered is:

A. = 1

B. ≥ 1

C. ≤ 1

D. < 1

Answer: Now, Distance = Total Path Covered

And Displacement = Shortest distance between initial and final point

So, Clearly Distance ≥ Displacement

Or, Displacement ≤ Distance

So, $\frac{\text{Displacement}}{\text{Distance}} \leq 1$

But Distance = Displacement is valid only on a straight-line path where direction does not change.

Hence option A is correct.

Q.9. A body moving with uniform acceleration has velocities 20 ms^{-1} and 30 ms^{-1} when passing two points A and B. Then the velocity midway between A and B is:

A. 25 ms^{-1}

B. 24 ms^{-1}

C. 25.5 ms^{-1}

D. 10√6 ms^{-1}

Answer:

Velocity at A = u = 20 ms^{-1}

Velocity at B = v = 30 ms^{-1}

Acceleration = a

Let AB = x

Now, from the equations of motion, we know that,

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

$$30^2 = 20^2 + 2ax$$

$$a = \frac{30^2 - 20^2}{2x}$$

$$a = \frac{250}{x}$$

Now, at mid – point M, Velocity = v_m

$$\text{Also, AM} = \frac{x}{2}$$

So, $v_m{}^2 = u^2 + 2a\frac{x}{2}$

$$v_m{}^2 = 20^2 + 2 \times \frac{250}{x} \times \frac{x}{2}$$

$$v_m{}^2 = 650$$

$$v_m = 25.5 \text{ ms}^{-1}$$

Hence, option C is correct.

Q.10. A moving body is covering a distance directly proportional to the square of time. The acceleration of the body is:

A. increasing

B. decreasing

C. zero

D. constant

Answer: We know that, Distance $\propto \text{time}^2$ ….1

Now, Velocity = $\frac{\text{Distance}}{\text{Time}}$ ….2

From equations 1 and 2, we get,

Velocity $\propto$ Time ….3

Now, we also know that, Acceleration = $\frac{\text{Velocity}}{\text{Time}}$ ….4

So, from equations 3 and 4, we get,

Acceleration $\propto \text{time}^0$

Acceleration = Constant

Hence, option D is correct

Q.11. The area under the velocity – time graph gives the value of:

A. distance travelled

B. velocity

C. acceleration

D. none of these

Answer: Area under the Velocity – Time graph gives the displacement.

Now, Displacement = Velocity × time

Also, area under the graph is calculated by multiplying velocity and time. Thus, displacement is obtained in that process. Hence option A is correct.

Q.12. Which of the following is not a vector?

A. displacement

B. velocity

C. speed

D. acceleration

Answer: Speed is not a vector quantity. Speed is distance travelled per unit time. It has only magnitude and no direction. Whereas for velocity, displacement and acceleration, all have magnitude as well as direction.

Hence option C is correct.

Q.13. If the average velocity of a body is equal to mean of its initial velocity and final velocity, then the acceleration of the body is:

A. variable

B. zero

C. negative

D. uniform

Answer: If the velocity of the body is always changing with a uniform rate (uniform acceleration), then the average velocity is given by,

Average Velocity = $\frac{\text{Initial Velocity + Final velocity}}{2}$

$$\bar{v} = \frac{u+v}{2}$$

Hence option D is correct.

Q.14. The speed-time graph of a body is straight line parallel to time axis. The body has:

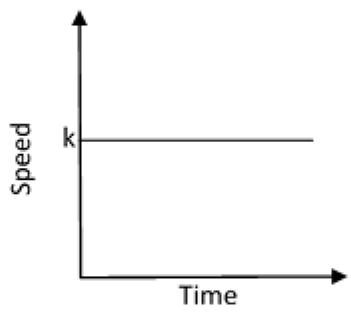
A. uniform acceleration

B. uniform speed

C. variable speed

D. variable acceleration

Answer:



If speed – time graph is parallel to time axis, then this means that the body has same speed at all time.

Thus, Speed = Constant

Hence the body has uniform speed and thus option B is correct.

Q.15. The velocity-time graph of a body has a negative slope. The body is undergoing:

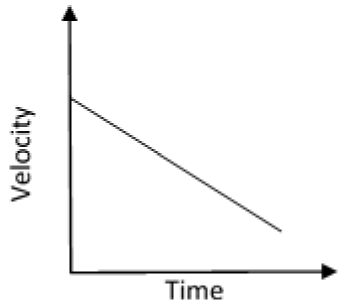
A. uniform acceleration

B. uniform retardation

C. variable acceleration

D. variable retardation

Answer:



The graph says that the velocity is decreasing with time. Now, slope of velocity – time graph gives acceleration.

Hence acceleration is the rate of change of velocity. Since velocity is decreasing, hence acceleration is also negative. Now, negative acceleration is also called retardation.

Since the slope is constant, hence the body has uniform retardation. Hence option B is correct.

Q.16. The distance-time graph of a body is parallel to time axis. The body is:

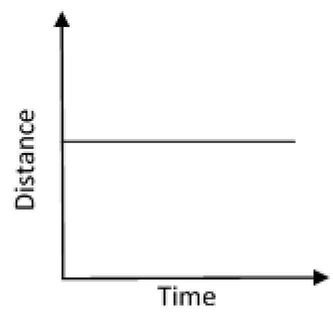
A. at rest

B. in uniform motion

C. variable motion

D. cannot say

Answer:



The body does not move as the body is at same position at all times.

Thus, body is at rest.

Hence option A is correct.

Q. 17. The distance-time graph of a body is a straight line inclined to time axis. The body is in:

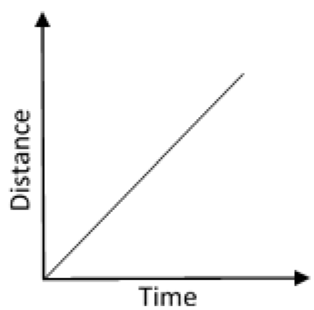
A. uniform motion

B. uniformly accelerated motion

C. uniformly retarded motion

D. rest position

Answer:



Slope of the distance – time graph gives speed.

Here in the adjoining graph, slope is constant.

Now, since slope is constant, then it means that the body is moving with constant velocity or speed. Hence body is in uniform motion and thus option A is correct.

Q.18. Area under velocity-time graph is equal to the:

A. speed of the body

B. distance travelled by the body

C. magnitude of the displacement of the body

D. none of these

Answer: We know that,

Displacement = Velocity × Time

So, the area under the curve of Velocity – Time graph of a body will give the magnitude of displacement of the body. Hence option C is correct.

Q.19. Area under speed-time graph is equal to the:

A. velocity of the body

B. magnitude of the displacement

C. distance travelled by the body

D. none of these

Answer: We know that,

Distance = Speed × Time

So, area under the Speed – Time graph will give the distance covered by the particle. Hence the option C is correct.

Q. 20. The direction of acceleration of an object moving in a circular path is:

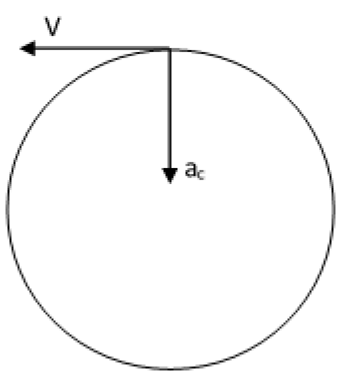
A. directed away from the centre of the circle

B. directed towards the centre of the circle

C. directed upward in the plane of the circle

D. none of these

Answer:



The direction of acceleration of an object having a circular path is directed towards the center of circle.

This acceleration is called the centripetal acceleration. This centripetal acceleration produces centripetal force to change the direction of the object, so that it moves on a circular path.

In the above figure: a_c = Centripetal Acceleration and v = Speed of Object.

Hence option B is correct.

Comprehensive Exercises (T/F)

Q.1. Write true or false for the following statements:

The motion in animals is called locomotion. Mechanics deals with the motion of non-living objects.

Answer: True

Mechanics is a branch of physics that deals with motion of non – living objects.

The motion of animals is locomotion and the laws of mechanics cannot be applied to it. Locomotion is a complex phenomenon of movement of different body parts and transition from one place to another.

Q.2. Write true or false for the following statements:

Kinematics deals with the motion of non-living objects without taking into account the cause of their motion.

Answer: True

Kinematics is a branch of physics that deals with motion without taking into consideration the cause of motion.it deals with only position, velocity and acceleration. It does not talk about the cause of motion, like Force.

Q. 3. Write true or false for the following statements:

Motion along a curved line is called translator or rectilinear motion.

Answer: False

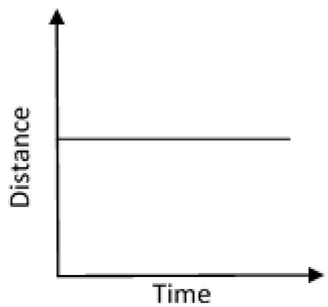
Motion along a curved path is not called translator or rectilinear motion.

Motion along a curved path is called a curvilinear motion. A curvilinear motion is accelerated motion as direction changes.

Q.4. Write true or false for the following statements:

A body is said to be at rest, if it does not change its position with respect to the reference point.

Answer: True



Whenever we talk about the motion of a body, we talk with respect to a reference frame that is at rest. So, if particles' position does not change with time, which means that the velocity of the particle is zero, then the body can be considered at rest. This can also be depicted via the distance – time graph, where velocity = $\frac{\Delta d}{\Delta t} = 0$.

Q. 5. Write true or false for the following statements:

A quantity which can be represented completely by magnitude alone is called a vector quantity.

Answer: False

A quantity which can be represented completely by magnitude alone is not a vector quantity, but a scalar quantity.

A scalar quantity has only magnitude.

Example can be distance, speed, etc.

Q.6. Write true or false for the following statements:

A quantity which can be completely specified by magnitude as well as direction is called a scalar quantity.

Answer: False

A quantity which can be completely specified by magnitude as well as direction is not a scalar quantity, but a vector quantity.

A vector quantity has both magnitude and direction.

Examples can be displacement, velocity, etc.

Q.7. Write true or false for the following statements:

Velocity and speed are measured in different units.

Answer: False

Velocity and Speed are not measured in different units. They both have same unit that is ms^{-1}.

Velocity = $\frac{\text{Displacement (m)}}{\text{Time (s)}}$

Speed = $\frac{\text{Distance (m)}}{\text{Time (s)}}$

Thus, from above we can clearly infer that both velocity and speed have same units of measurement.

Q.8. Write true or false for the following statements:

In one-dimensional motion, the average velocity and the instantaneous velocity are unequal.

Answer: False

In one dimensional motion average velocity and instantaneous velocity are not always unequal.

They are equal when motion of the body is a uniform motion that is if the velocity remains constant.

Q. 9. Write true or false for the following statements:

A motion is said to be uniform, if a body undergoes equal displacements in equal intervals of time.

Answer: True

Velocity = $\frac{\text{Displacement}}{\text{Time}}$

Now, equal displacement in equal interval of time means $\frac{\text{Displacement}}{\text{Time}}$ = Constant

Thus, Velocity = Constant and hence the motion is uniform motion.

Q.10. Write true or false for the following statements:
A motion is said to be uniform, if $x \propto t2$

Answer: False

A motion is said to be uniform if velocity is constant.

Velocity is constant means velocity does not change with time.

Now, we know that,

Displacement = x $\propto \text{time}^2$ ….1

Also, we know that,

Velocity = $\frac{\text{Displacement}}{\text{Time}}$ ….2

From equations 1 and 2, we get,

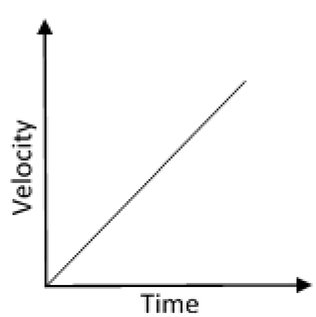
Velocity ∝ Time

So, velocity increases with time and hence not constant. So, if x ∝ time^2 , then motion is not uniform.

Q.11. Write true or false for the following statements:

Acceleration is defined as the rate of change of velocity.

Answer: True



Yes, acceleration is defined as the rate of change of velocity.

Acceleration = $\frac{\Delta \text{ Velocity}}{\Delta \text{ Time}}$

From the V – T Graph shown here; we get slope of the graph as:

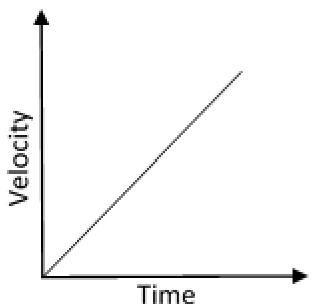
Slope = $\frac{\Delta v}{\Delta t}$

Slope = Acceleration

Q.12. Write true or false for the following statements:

The graph between velocity and time for uniform acceleration is a curved line.

Answer: False



Slope of Velocity – Time graph gives acceleration.

Acceleration = $\frac{\Delta v}{\Delta t}$ = Slope

Now, for uniform acceleration, acceleration should be constant, which would imply that the slope will be constant and hence the velocity – time curve should be straight line as shown in the above figure.