Chapter – 8 Motion

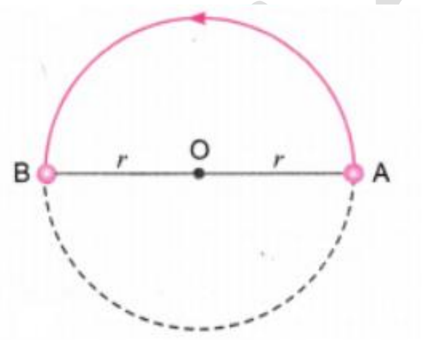
Multiple Choice Questions

Q1. A particle is moving in a circular path of radius r. The displacement after half a circle would be

a) Zero
b) πr
c) $2r$
d) $2\pi r$

Answer: Option c) 2r

After half the circle, a particle reaches the opposite point of diameter, I.e from point A to point B.



Displacement is the shortest path between initial and final point.

The displacement after the half circle $= AB = OA + OB$

$$OA = OB = r$$

$$= r + r = 2r$$

$$Hence, the\ displacement\ of\ half\ circle\ is\ 2r.$$

Q2. A body is thrown vertically upwards with velocity u, the greatest height h to which it will rise is

a) u/g
b) $u^2/2g$
c) u^2/g
d) $u/2g$

Answer: Option b)

Initial velocity $= u$

Height $= h$

$a = g$ (acceleration due to gravity)

As the body is thrown vertically upward, when the highest point is reached the final velocity becomes zero,

$$v = 0$$

Third equation of motion,

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

$$0 = u^2 - 2gh$$

$$2gh = u^2$$

$$h = \frac{u^2}{2g}$$

Negative sign is used because the body is travelling against the gravity.

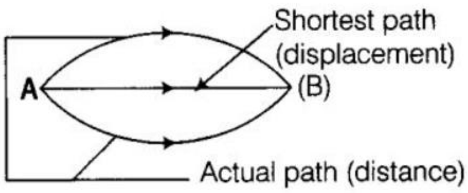
Q3. The numerical ratio of displacement and distance for a moving object is

a) **Always less than 1**
b) **Always equal to 1**
c) **Always more than 1**
d) **Equal or less than 1**

Answer: Option d)

Displacement of an object is less than or equal to the distance covered by the object, the magnitude of distance is not equal to displacement.

So, the ratio of displacement to distance is always equal to or less than 1.



Q4. If the displacement of an object is proportional to square of time, then the object moves with

a) **Uniform velocity**
b) **Uniform acceleration**
c) **Increasing acceleration**
d) **Decreasing acceleration**

Answer: Option b)

Second equation of motion,

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

If object starts from initial velocity or rest, $u = 0$ with acceleration (a) in time (t).

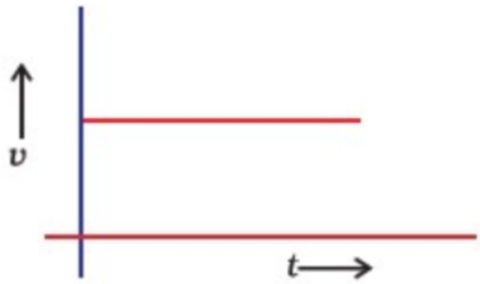
$$s = 0 \times t + \frac{1}{2}at^2$$

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

$$if\ a\ is\ \ equal\ to\ constant\ then\ \boldsymbol{s} \propto \boldsymbol{t^2}$$

So, the object moves with constant or uniform acceleration.

Q5. From the given v-t graph (see figure), it can be inferred that the object is



a) In uniform motion
b) At rest
c) In non-uniform motion
d) Moving with uniform acceleration

Answer: Option a)

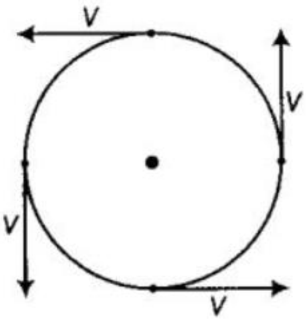
The v-t graph, the velocity of the object is constant, non-variable with respect to time, the object is in uniform motion.

Q6. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of 10 ms^{-1}. It implies that the boy is

a) At rest
b) Moving with no acceleration
c) In accelerated motion
d) Moving with uniform velocity

Answer: Option **c) In accelerated motion**

In merry-go-round, the speed remains constant but the velocity is variable because its direction goes on changing, i.e., there is acceleration in the motion. the boy is in accelerated motion.



Q7. Area under v-t graph represent a physical quantity which has the unit

a) m^2
b) m
c) m^3
d) ms^{-1}

Answer: Option b)

Area under v-t represent the displacement, the unit of displacement is meter or (m).

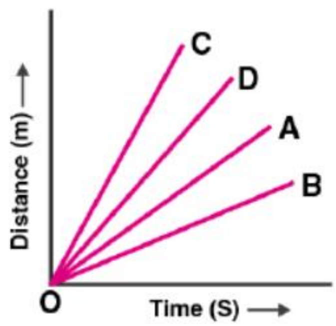
the unit of velocity $v = m/s$

Unit of time (T) $= s$.

$$Unit\ of\ v - t\ graph = \frac{m}{s} \times s = m$$

So, the unit of v-t graph is meter (m).

Q8. Four cars A, B, C and D are moving on a levelled road. Their distance versus time graphs is shown in figure. Chose the correct statement.



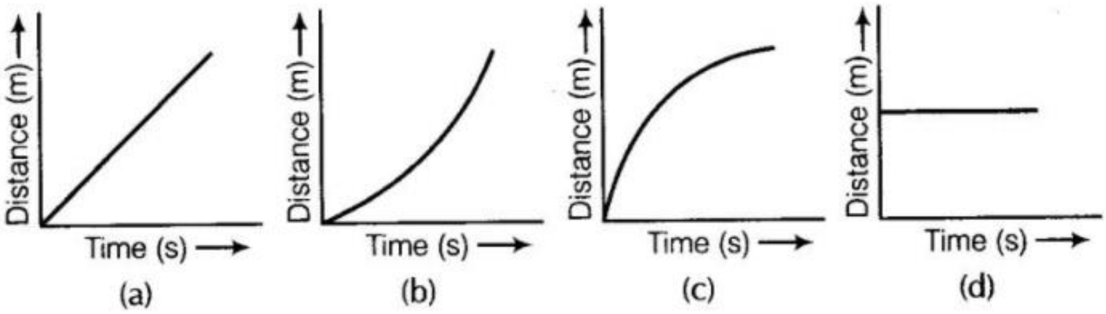
a) **Car A is faster than car D**
b) **Car B is the slowest**
c) **Car D is faster than car C**
d) **Car C is the slowest**

Answer: Option b)

The speed is shown by the slope in distance-time graph. From the graph, the slope of distance-time graph for car B is less compared to all other cars.

the slope is minimum for car B, which means the car B is the slowest of all.

Q9. Which of the following figures represents uniform motion of a moving object correctly?



Answer: Object a)

For uniform motion, the distance-time graph is a straight constant line, as in uniform motion object covers equal distance in equal interval of time.

Q10. Slope of a velocity-time graph gives

a) **The distance**
b) **The displacement**
c) **The acceleration**
d) **The speed**

Answer: Option c)

Acceleration is shown by velocity-time graph, because –

$$slope\ of\ the\ curve = \frac{v}{t}\ (acceleration)$$

Q11. In which of the following cases of motions. The distance moved and the magnitude of displacement are equal?

a) **If the car is moving on straight road.**
b) **If the car is moving in circular path.**
c) **The pendulum is moving to and fro.**
d) **The earth is revolving around the sun.**

Answer: Option a) If the car is moving on straight road.

The motion along a straight line is distance moved and magnitude of displacement are equal, because displacement is the shortest path between initial path and final path.

For car moving on straight road, distance moved and magnitude of displacement are equal.

Short Answer Type Questions

Q12. The displacement of a moving object in a given interval of a time is zero. Would the distance travelled by the object also be zero? Justify your answer?

Answer:

The displacement of a moving object in a interval is zero, it means the object comes back to initial position in the given time period.

In this case the distance is not equal to zero as distance is the total length of the path travelled by the body. As the object comes back to its initial position, the length of path travelled is not be zero.

Q13. How will the equations of motion for an object moving with a uniform velocity change?

Answer:

The equations of uniformly accelerated motion are –

i) $v = u + at$

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

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

$u = initial\ velocity$

$v = final\ velocity$

$a = acceleration$

$t = time$

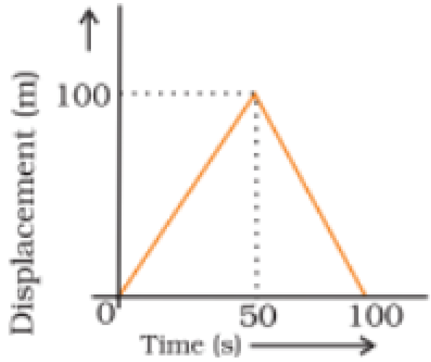
$s = distance$

for an object moving with uniform velocity, the acceleration, $a = 0$

equations of motion, after substituting $a = 0$ in above equations.

i) $v = u$
ii) $s = ut$
iii) $v^2 = u^2$

Q14. A girl walks along a straight path to drop a letter in the letter box and comes back to her initial position. Her displacement-time graph is shown in figure. Plot a velocity-time graph for the same.



Answer:

Observations are: -

i) the displacement and time is zero, so the initial velocity is,

$$Initial\ velocity, u = 0$$

ii) Velocity after 50 sec,

$$v = \frac{Displacement}{Time}$$

displacement = 100 sec

$$v = \frac{100}{50} = 2ms^{-1}$$

iii) Velocity after 100 sec,

$$v = \frac{Displacement}{Time}$$

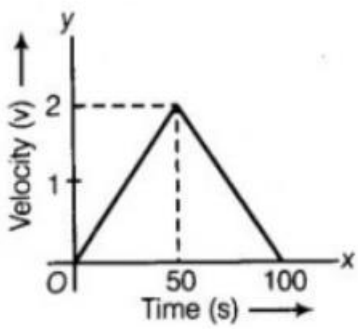
the displacement = 0 and time = 100 sec

$$v = \frac{0}{100} = 0$$

Tabulating,

v	0	2	0
t	0	50	100

On plotting the above table as velocity-time graph



Q15. A car starts from rest and moves along the X-axis with constant acceleration $5ms^{-2}$ for 8 sec. If it then continues with constant velocity. What distance will the car over in 12 sec, since it started from rest?

Answer:

the car starts from rest, so its initial velocity, $u = 0$

Acceleration, $a = 5ms^{-2}$

Time, $t = 8\ sec$

From first equation of motion.

$$v = u + at$$

on substituting, $a = 5ms^{-2}$ and t = 8 in the above equation,

$$v = 0 + 5 \times 8 = 40ms^{-1}$$

final velocity, $v = 40ms^{-1}$

From second equation of motion,

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

on substituting, t = 8 sec and a = $5ms^{-2}$

$$s = 0 \times 8 + \frac{1}{2} \times 5 \times (8)^2$$

$$s = \frac{1}{2} \times 5 \times 64$$

$$s = 5 \times 32 = 160\ m$$

the distance covered in 8 sec is 160 m.

total time, t = 12 sec

After 8 sec, the car continues with constant velocity of $40ms^{-1}$.

Remaining time $t' = 12\,sec - 8sec = 4sec$

The distance covered in the last 4 sec $= Velocity \times Time$

$$= 40 \times 4 = 160m$$

total distance travelled in 12 sec from the start

$$D = s + s' = 160 + 160 = 320\ m$$

Q16. A motorcyclist drives from A to B with a uniform speed of $30\ kmh^{-1}$ and returns back with a speed of $20\ kmh^{-1}$. Find its average speed.

Answer:

Assuming the distance between A and B be $x\ km$.

Time taken in driving from A to B

$$t_1 = \frac{Distance}{Speed} = \frac{x}{30}\ h$$

Time taken in returning from B to A

$$t_2 = \frac{Distance}{Speed} = \frac{x}{20}\ h$$

$$Average\ speed = \frac{Total\ distance}{Total\ time} = \frac{x + x}{t_1 + t_2}$$

$$= \frac{x + x}{\frac{x}{30} + \frac{x}{20}}$$

$$= \frac{2x}{\frac{2x + 3x}{60}}$$

$$= \frac{2x + 60}{5x} = 2 \times 12 = 24kmh^{-1}$$

average speed of a motorcyclist is $24\ kmh^{-1}$

Q17. The velocity-time graph shows the motion of a cyclist. Find:

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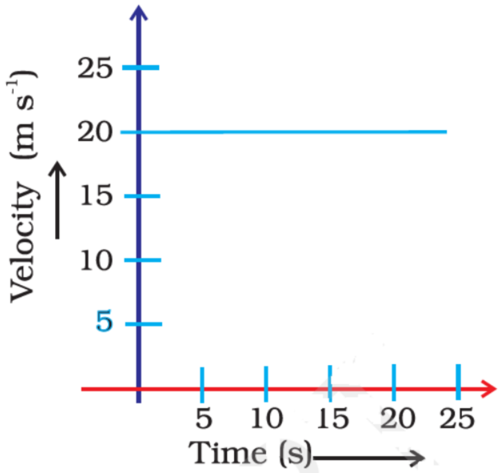


i) **Its acceleration**
ii) **Its velocity**
iii) **The distance covered by the cyclist in $15\ sec$.**

Answer:

The graph shows,

i) The velocity is not changing with time, i.e, acceleration is zero.
ii) There is no change in the velocity with time, so velocity after 15 sec is same = $20ms^{-1}$.
iii) Distance covered in 15 sec $= Velocity\ \times Time = 20 \times 15 = 300\ m$

Q18. Draw a velocity versus time graph of a stone thrown vertically upwards and then coming downwards after attaining the maximum height.

Answer:

When a stone is thrown upwards, it has initial velocity, u. As the stone goes upwards its velocity decreases, as stone is moving against the gravity and at the highest point the velocity becomes zero.

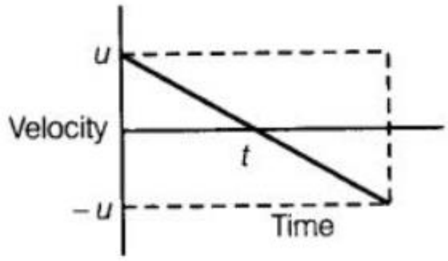
Suppose time taken is 't' sec to reach the highest point.

As the stone falls with zero initial velocity and its velocity increases and it reaches its initial point of projection with the velocity, v in the same time. So,

Velocity	u	0	$-u$
Time	0	t	$2t$

$-u$ is taken because the stone is travelling in uniform motion in upward direction and in the downward motion, the velocity is in downward direction.

The velocity-time graph for upward and downward path of stone –



Long Answer Type Questions

Q19. An object is dropped from rest at a height of 150 m and simultaneously another object is dropped from rest at height 100 m. what is the difference in their heights after 2 sec, if both the objects drop with same accelerations? How does the difference in heights vary with time?

Answer:

for first object,

$$u = 0 \text{ and } t = 2\ sec$$

By second equation of motion, the distance travelled by the first object is $2\ sec$

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

$$h = 0 \times 2 + \frac{1}{2} \times 10 \times (2)^2$$

$$h = 0 + \frac{1}{2} \times 10 \times 4 = 20\ m$$

Height of the first object from the ground after 2 sec $(h_1) = 150\ m - 20m = 130\ m$

For second object $u = 0$ and time $(t) = 2\ sec$

By second equation of motion, the distance covered by second object in 2 sec is

$$h = ut + \frac{1}{2}gt^2 = 0 \times 2 + \frac{1}{2} \times 10 \times (2)^2$$

$$= 0 + \frac{1}{2} \times 10 \times 4 = 20\ m$$

Height of second object from the ground after 2 sec then $h_2 = 100\ m - 200m = 80m$

difference in the height after $2\,\text{sec} = h_1 - h_2 = 130 - 80 = 50\ m$

The difference in the heights of the objects is same with time as both the objects is dropped from rest and are falling with same acceleration, that is, acceleration due to gravity.

Q20. An object starting from rest travels $20\,m$ in first $2\,sec$ and $160\,m$ in next $4\,sec$. What will be the velocity after $7\,sec$ from the start?

Answer:

object starts from rest,

$u = 0$, $t = 2\,sec$ and $s = 20\,m$

Using second equation of motion,

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

Substituting, $u = 0$ in above equation,

$$20 = 0 \times 2 + \frac{1}{2} \times a(2)^2 = 0 + \frac{1}{2} \times a \times 4$$

$$20 = 2a$$

$$a = \frac{20}{2}$$

$$a = 10\,m/s$$

From first equation of motion, velocity after $7\,sec$ from the start

$$v = u + at$$

$$= 0 + 10 \times 7$$

$$= 70\,m/s$$

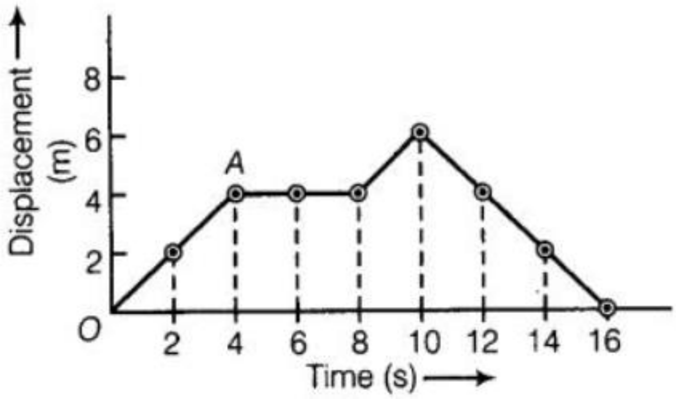
Q21. Using following data, draw time-displacement graph for a moving object.

Time (s)	0	2	4	6	8	10	12	14	16
Displacement (m)	0	2	4	4	4	6	4	2	0

Use this graph to find average velocity for first $4\,sec$, for next $4\,sec$ and for last $6\,sec$.

Answer:

The displacement-time graph is shown below: -



$$Average\ velocity\ for\ first\ 4\ s = \frac{Change\ in\ displacement}{Total\ time\ taken}$$

$$v = \frac{4-0}{4-0}$$

$$v = \frac{4\ m}{4\ s} = 1\ ms^{-1}$$

$$Average\ velocity\ for\ next\ 4\ s\ (in\ the\ interval\ of\ 4\ s\ to\ 8\ s), v = \frac{4-4}{8-4} = \frac{0}{4} = 0$$

$$Average\ velocity\ for\ lost\ 6\ s = \frac{(0-6)m}{(16-10)s}$$

$$= \frac{-6}{6} = 1\ ms^{-1}$$

So, the average velocity for lost 6 se = $1\ ms^{-1}$.

Q22. An electron moving with a velocity of $5 \times 10^4\ ms^{-1}$ enters into a uniform electric field and acquires a uniform acceleration of $10^4\ ms^{-2}$ in the direction of its initial motion.

i) Calculate the time in which the electron would acquire a velocity double of its initial motion.

ii) How much distance the electron would cover in this time?

Answer:

initial velocity, $u = 5 \times 10^4\ ms^{-1}$

acceleration, $a = 10^4\ ms^{-2}$

i) Final velocity, $v = 2u$, $t = ?$

From the first equation, $v = u + at$

$$2u = u + 10^4 \times t$$
$$2u - u = 10^4 \times t$$
$$10^4 \times t = u$$

$$t = \frac{(u)}{10^4} = \frac{5 \times 10^4}{10^4} = 5\ s$$

After $5\ sec$ electron acquire a velocity double of its initial velocity.

ii) From second equation of motion,

Distance covered in t seconds,

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

$$= 5 \times 10^4 \times 5 + \frac{1}{2} \times 10^4\ (5)^2$$

$$Subsituting, u = 5 \times 10^4 \frac{m}{s}, t = 5\ s\ and\ a = 10^4\ m/s^2$$

$$= 25 \times 10^4 + \frac{1}{2} \times 10^4 + 12.5 \times 10^4$$

$$= 25 \times 10^4 + 12.5 \times 10^4$$

$$= 10^4\ (25 + 12.5)$$

$$= 37.5 \times 10^4\ m = 37.5 \times 10 \times 10^3 m$$

$$= 375 \times 10^3\ m$$

$$= 375\ km$$

Q23. Obtain a relation for the distance travelled by an object moving with a uniform acceleration in the interval between 4th and 5th second.

Answer:

From second equation of motion,

Distance travelled in t,

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

Distance travelled in 4 s

$$s_4 = u \times 4 + \frac{1}{2}a\ (4)^2$$

$$= 4u + \frac{1}{2} \times a \times 16$$

$$= 4u + 8a$$

s_4 is the distance travelled in 4th seconds

Distance travelled in 5 sec

$$s_5 = s_5 - s_4$$

$$= \left(5u + \frac{25}{2}a\right) - (4u + 8a)$$

$$= 5u - 4u + \frac{25}{2}a - 8a$$

$$= u + \frac{25a - 16a}{2} = u + \frac{9}{2}a$$

So, the relation is $(u + \frac{9}{2}a)$

Q24. Two stones are thrown vertically upwards simultaneously with their initial velocities u_1 and u_2 respectively. Prove that the height reached by them would be in the ratio of $u_1^2 : u_2^2$ (assume upward acceleration is $-g$ and downward acceleration to be $+g$).

Answer:

For 1st stone, given initial velocity $u = u_1$

Let height obtained be h_1.

From third equation of motion,

$$v^2 = u^2 - 2gh \; for \; upward \; motion$$

At the highest point the velocity becomes zero, that is, $v = 0$

$$0 = u_1^2 - 2gh_1$$

$$2gh_1 = u_1^2$$

$$h_1 = \frac{u_1^2}{2g}$$

For 2nd stone, the initial velocity, $u = u_2$

Assuming the height obtained by it be $= h_2$

Using third equation of motion,

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

Since, at highest point velocity becomes zero, that is, $v = 0$

$$0 = u_2^2 - 2gh_2$$

$$2gh_2 = u_2^2$$

$$h_2 = \frac{u_2^2}{2g}$$

So, the ratio of height reached by the two stones

$$h_1 : h_2 = \frac{u_1^2}{2g} : \frac{u_2^2}{2g}$$

$$h_1 : h_2 = u_1^2 : u_2^2$$