# Question Bank

## CHAPTER 3- MOTION IN A STRAIGHT LINE

***Each question scores One***

1. If an object moves in a straight line , it is called as ----------dimensional motion.
   Ans: One dimensional Motion.

2. If an object moves in a plane , it is called as ----------dimensional motion.
   Ans: Two dimensional motion.

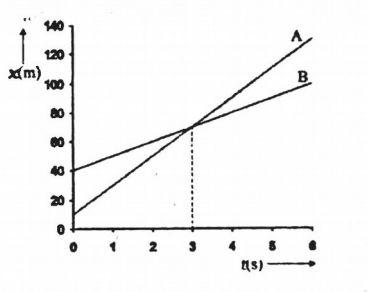
3. If an object moves in a space, it is called as ----------dimensional motion.
   Ans: Three dimensional motion.

4. For a moving body distance is always ----------
   a) equal to displacement.
   b) less than displacement.
   c) greater than or equal to displacement.
   d) less than or equal to displacement.
   Ans: c) Greater than or equal to displacement.

5. The ratio of distance to displacement of a moving body is always -------
   a) =1
   b) >1
   c) <1
   d) ≥1
   Ans: d) ≥ 1

6. For a moving body Speed is always ----------
   a) equal to velocity.
   b) less than velocity.
   c) greater than or equal to velocity.
   d) less than or equal to velocity.
   Ans: c) greater than or equal to velocity.

7. The ratio of speed to velocity of a moving body is always -------
   a) =1
   b) >1

| | |
|---|---|
| | c) <1<br>d) ≥1<br>Ans: d) ≥ 1 |
| 8 | What does the speedometer of the car measure?<br>Ans: Instantaneous speed. |
| 9 | Give the expression for distance covered in 'n'th second by a body moving with uniform acceleration.<br>Ans: Distance covered in 'n'th second<br>$S_{nth}=u+(2n-1)\frac{a}{2}$ OR $S_{nth}=u+(n-\frac{1}{2})a$ |
| 10 | Define acceleration due to gravity(g).<br>Ans: The uniform acceleration produced on a freely falling body is called acceleration due to gravity. |
| 11 | The slope of position – time graph of a particle gives.....<br>(Acceleration ,Displacement ,Velocity,Momentum )<br>Ans: Velocity |
| 12 | The area under the velocity -time graph gives ----------<br>(Displacement ,Velocity ,Acceleration ,None of the these)<br>**Ans**: Displacement |
| 13 | Four pairs of initial and final positions of a body along an x axis are given. Which pair gives a positive displacement of the body ?<br>(a) –10 m, +15 m (b) –5 m, –12 m<br>(c) 2 m, –5 m (d) 2 m, 1m<br>Ans: (a) –10 m, +15 m |
| 14 | Acceleration is the time rate of change of velocity. Give an example of a body possessing zero velocity and still accelerating.<br>Ans: If a body is thrown up , at the highest point the velocity is zero but there is an acceleration downwards. |
| 15 | Position (r) - time (t) graphs of two objects A and B are shown below. At what time the objects meet?<br>  <br><br>Ans: 3 s. |

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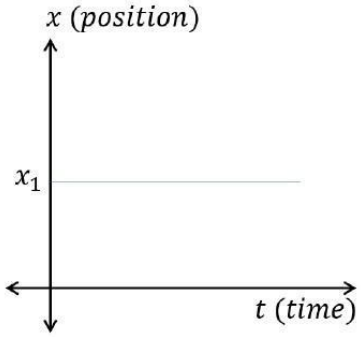
| 16 | An ant moving over an apple comes under .....dimensional motion<br><br>Ans: Two |
| 17 | An object travel towards east for 6m, then move towrds north for 8m. Find its distance and displacement<br><br>Ans : Distance 14m., Displacement 10m. |
| 18 | Area under acceleration -time graph is.....?<br>a) Displacement.<br>b) Force.<br>c) Change in velocity.<br>d) Retardation.<br><br>Ans:c) Change in velocity |
| 19 | From a height an object A thrown up with a speed 40m/s and other object B thrown downwards with same speed. Which one will reach the ground with more speed?<br>a) B<br>b) A<br>c) Same speed<br>d) We can't say.<br><br>Ans: c) Same speed |
| 20 | Write an example for a body moving with constant speed and variable velocity?<br>Ans: Circular motion |
| 21 | A boy starts from a point A, travels to a point B at a distance of 1.5 km and returns to A. If he takes one hour to do so, his average velocity is<br>(a) 3 km/h<br>(b) zero<br>(c) 1.5 km/h<br>(d) 2 km/h<br><br>Ans :( b) Zero |

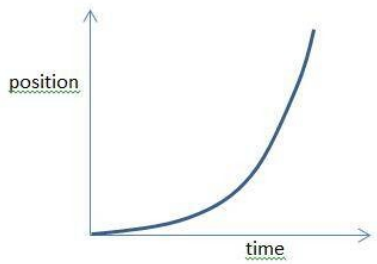
***Each question scores Two***

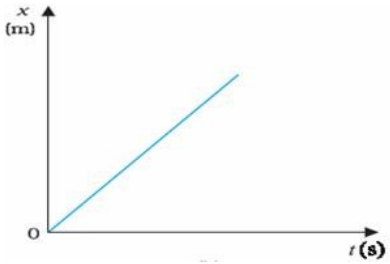
| | |
|---|---|
| 1 | State in the following cases whether the motion is one , two or three dimensions.<br>a) A butterfly flying around a flower.<br>b) A bus moving along a long and straight road.<br><br>Ans: (a)Three dimensional motion.<br>(b)One dimensional motion. |
| 2 | Draw the position time graph for -<br><br>a) State of rest<br><br>b) State of motion |

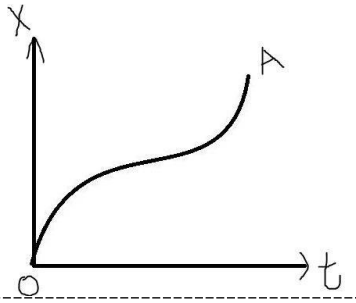
Ans: a) State of rest




b) State of Motion



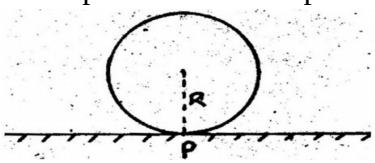




3 What are the differences between distance and displacement ?

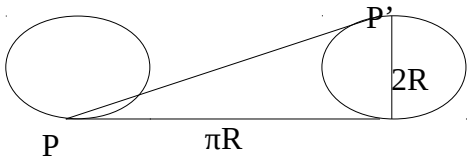
Ans:

| **DISTANCE** | **DISPLACEMENT** |
|---|---|
| Actual length of the path | Shortest distance from initial position to final position. |
| Scalar | Vector |
| Always positive | Can be positive ,zero and negative |

4 In the figure the point 'P' on a wheel of radius 'R' is in contact with the ground . What is the distance and displacement of the point 'P' wheel rolls a half revolution?




Ans:



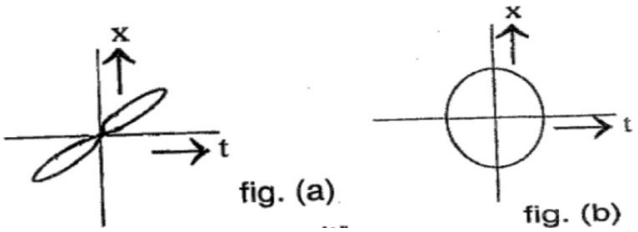
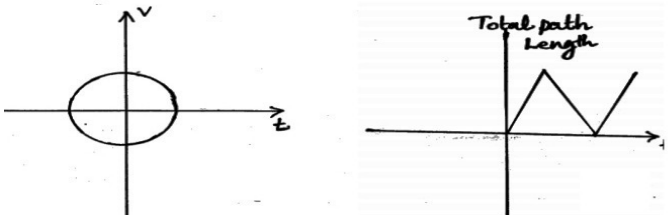

Distance=πR

Displacement = $PP' = \sqrt{(\pi R^2)+(2R^2)} = R\sqrt{\pi^2+4}$

5 A car is moving along the circumference of a circle of radius 'r'.

a) What is the distance travelled in one revolution?

b) What is the displacement in one revolution?

| | |
|---|---|
| | Ans:a) Distance travelled in one revolution = 2πr<br><br>b) Displacement in one revolution = zero. |
| 6 | Look at the graph in fig. (a) and fig.(b) carefully and state which of these can't possible represent one-dimensional motion with reasons<br>  <br><br>Ans: Both the graphs do not represent one dimensional motion.<br>Because for a moving body two positions at the same time is impossible. |
| 7 | Graph representing the motion of two bodies are shown below.. State with reason whether it can represent one-dimensional motion.<br>  <br><br>Ans:<br>i) Can not represent one dimensional motion. Because velocity can not have two values at the same time.<br>ii) Can not represent one dimensional motion. Because path length can not be decreased with time. |
| 8 | Mention the differences between Speed and Velocity.<br>Ans:<br>**SPEED** — **VELOCITY**<br>The rate of change of distance. — The rate of change of displacement.<br>Scalar — Vector<br>Always positive. — Can be positive , zero or negative. |
| 9 | Distinguish between the average speed and average velocity.<br><br>Ans: Average speed: It is the ratio of total distance travelled to the total time taken.<br>Average velocity: It is the ratio of total displacement travelled to the total time taken. |
| 10 | Distinguish between instantaneous speed and instantaneous velocity.<br>Ans: Instantaneous speed: The speed at any instant. $V_i = \frac{dx}{dt}$<br>Instantaneous velocity: The velocity at any instant. $\vec{V}_i = \frac{\vec{dx}}{dt}$ |
| 11 | What is the condition for positive and negative acceleration?<br><br>Ans:<br>Positive Acceleration:If the velocity of the body increases with time then its acceleration is positive. |

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|---|---|
| | Negative acceleration (Deceleration OR Retardation): If the velocity of the body decreases with time then its acceleration is negative. |
| 12 | Give example for positive and negative acceleration.<br><br>Ans: Example for Positive acceleration: A bus starting from rest.<br>Example for Negative acceleration : A bus coming to rest after applying breaks. |
| 13 | What do you mean by deceleration or retardation? Give example.<br><br>Ans: If the velocity of a body decreases with time then the acceleration is negative. This negative acceleration is called deceleration or retardation.<br>Example: A bus coming to rest. |
| 14 | Show that the slope of position-time graph gives velocity.<br><br>Ans: The slope is given by $Slope = \tan\theta$<br>$= \frac{\Delta x}{\Delta t}$<br>= velocity.<br><br>That is the slope of position time graph gives the Velocity. |
| 15 | Draw the velocity-time graph for an object in uniform motion. Show that area under the velocity – time graph gives displacement.<br><br>Ans: From the graph<br>Area under the graph = v x t<br>= Displacement.<br><br>That is the area under the Velocity – time graph represents the displacement. |
| 16 | Draw the velocity -time graph for uniformly accelerated motion. Show that the slope of velocity-time graph gives acceleration.<br><br>Ans: The slope of the graph = tan θ<br>$= \frac{\Delta V}{\Delta t}$<br>= acceleration.<br><br>That is the slope of velocity-time graph gives the acceleration of the body. |
| 17 | Show that area under the velocity-time graph of an object moving with constant acceleration in a straight line in certain time interval is equal to the distance covered by the object in that interval.<br><br>Ans: Area under the velocity-time graph = |

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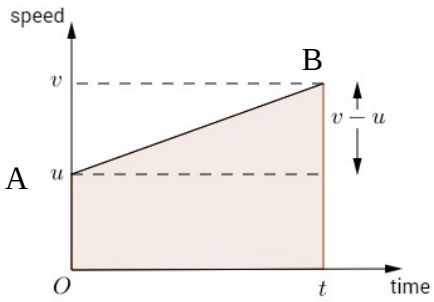
Area of trapezium OABD

$= \frac{1}{2}(OA+BD)\times OD$

$= \frac{1}{2}(u+v)\times t$

= Average velocity x time interval

= Distance travelled.

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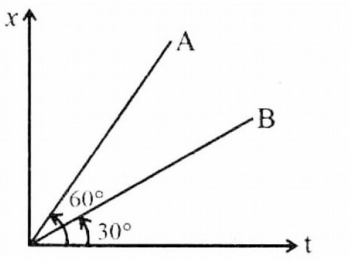
18 The position - time graph of two objects A and B are shown below.

(a) Which body has greater velocity?

(b) Find the ratio of velocities of A and B.




Ans: a) Body A.[The slope of position time graph gives the velocity. Higher the slope greater the velocity]

b) Ratio of velocities $\frac{V_A}{V_B}=\frac{Slope\ of\ A}{Slope\ of\ B}$

$\frac{V_A}{V_B}=\frac{\tan 60}{\tan 30}$

$\frac{V_A}{V_B}=\frac{\sqrt{3}}{1/\sqrt{3}}$

$= 3$

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19 A car travelling at a speed 54 km/hr is brought to rest in the 90s. Find the distance travelled by car before coming to rest.

Ans: The initial velocity(u) of the car is =54km/hr = 15m/s

The final velocity(v) of the car is = 0 m/s

The time taken(t) by the car to come to rest = 90 seconds

We must find the acceleration(a) and displacement(s) covered by the car

From v= u+at .we find acceleration of the car .

By substituting in the equation we get

0 = 15 + a(90)

a = - 15/90

a = -1/6 m/s²

The displacement of the car is given by

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

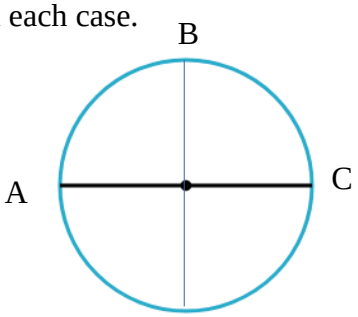
$0^2-15^2 = 2 \times (-1/6)s$

$225 = (1/3)s$

s= 225x3 =675 m.

***Each question scores Three***

**1** A particle moves along a circle of radius 'R'. It starts from 'A' and moves in clockwise direction. Calculate the distance and displacement of the particle in each case.




a) From 'A' to 'C'

b) From 'A' to 'B'

c) In one complete revolution.

Ans: a) From 'A' to 'C'

Distance = πR (2πR /2 )

Displacement = 2R

b) From 'A' to 'B'

Distance = $\frac{2\pi R}{4}=\frac{\pi R}{2}$

Displacement = $\sqrt{R^2+R^2}=\sqrt{2R^2}=\sqrt{2}R$

c) For one complete revolution

Distance =2πR Displacement =0

**2** A car travels from A to B at 60 km/hr and returns to A at 90 km/hr. What is its average velocity and average speed?

Ans: Average velocity = 0 (because total displacement =0)

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

$$=\frac{S+S}{t_1+t_2}$$

$$=\frac{2S}{\frac{S}{V_1}+\frac{S}{V_2}}$$

$$=\frac{2V_1V_2}{V_1+V_2}$$

$$=\frac{2\,x\,60\,x\,90}{150}=72\ km/hr$$

**3** Velocity is defined as the rate of change of displacement.

a) Distinguish between average velocity and instantaneous velocity.

b) When does the average velocity becomes equal to the instantaneous velocity?

Ans: a) Average velocity: It is the ratio of total displacement travelled to the total time taken.

Instantaneous velocity: The velocity at any instant. $\vec{V}_i=\frac{\vec{dx}}{dt}$

b) When the velocity is uniform or constant.

**4** Write the equations of motion for a freely falling body.

Ans: For a freely falling body u=0 and a=g

There fore v=gt

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

$$v^2=2gS$$

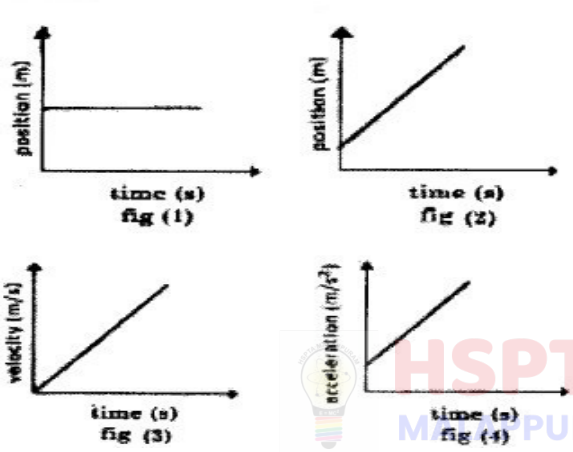
$$S_{nth}=(2n-1)\frac{g}{2} \quad \text{OR} \quad S_{nth}=(n-\frac{1}{2})g$$

5 A body falling under the effect of gravity is said to be in free fall.

a. Draw the velocity-time graph for a freely falling object.

b. Define uniform acceleration.

c. From the given figures, identify the figure which represents uniformly accelerated motion.

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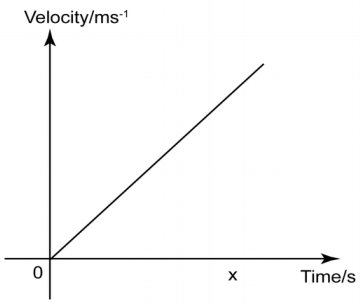
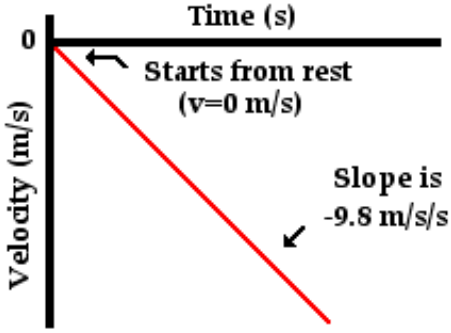
Ans: (a)

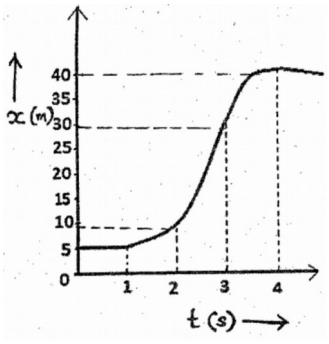



(b) If a body travels with equal change in velocity in equal intervals of time then it is said to be in uniform acceleration.

(c) Fig 3

6 Position – time graph of a body is given.




a)Estimate the velocity during the time interval t = 2s to t = 3s.

b)Displacement of an object is proportional to $t^3$ . Show that its acceleration is increasing with time.

Ans: a)Velocity during the time interval t = 2s to t = 3s.

$$v=\frac{\Delta x}{\Delta t}=\frac{30-10}{3-2}=\frac{20}{1}=20\,m/s.$$

b) Given $S \alpha t^3$

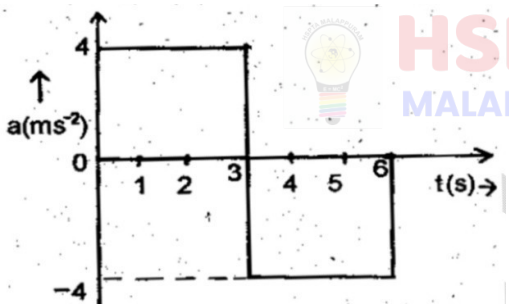
velocity $v=\frac{ds}{dt}=3t^2$

acceleration $a=\frac{dv}{dt}=6t$

Thus acceleration $a \alpha t$

That is acceleration increases with time.

7 Acceleration – time graph of a body starts from rest as shown below:

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a)What is the use of the acceleration-time graph?

b)Draw the velocity – time graph using the above graph.

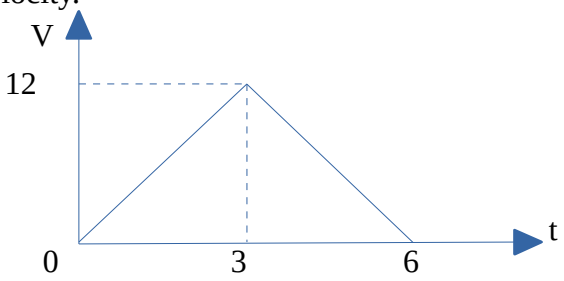
c)Find the displacement in the given interval of time from 0 to 3 seconds.

Ans: a) Uses of acceleration-time graph:

(i) To find acceleration at any instant.

(ii) To find velocity.

b)




c) Displacement = Area under the graph.

$$= \frac{1}{2} x 12 x 3 = 18\,m.$$

8 When breaks are applied on a moving vehicle, it stops after travelling a distance. This distance is called stopping distance.

a) Derive an expression for stopping distance in terms of initial velocity (u) and retardation (a).
b) If the initial speed is doubled keeping the retardation same, by how much will the stopping distance change?
Ans:

a) By the equation of motion, $v^2 = u^2 + 2as$

Here v=0 a=-a retardation , S--> Stopping distances

Therefore $0 = u^2 - 2as$

Stopping distance $S = \frac{u^2}{2a}$

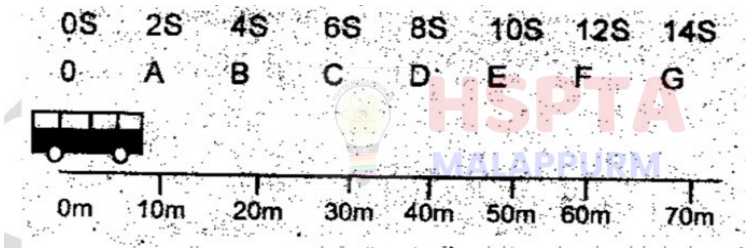
b) Stopping distance $S = \frac{u^2}{2a}$

If u = 2u, then $S' = \frac{(2u)^2}{2a} = \frac{4u^2}{2a} = 4S$

That is Stopping distance becomes four times.

***Each question scores Four***

1 Figure given below shows the motion of a school bus starting from the point 'O' and travels along a straight line.




a) Complete the following table:

| Time taken | Displacement from 0 | Velocity |
|---|---|---|
| 2s | 10-0=10m | ..... |
| 10s | ..... | 5m/s |

b) Is the motion of the bus uniform or non-uniform? Justify your answer.

c) Draw the position – time graph of the above motion.

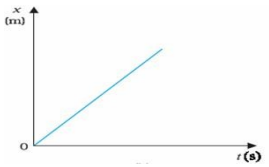
d) A student in the school bus notices the speedometer of the bus. Which type of speed is shown by the speedometer?

Ans: (a)

| Time Taken | Displacement from 'O' | Velocity |
|---|---|---|
| 2s | 10-0=10m | 5 m/s |
| 10 s | 50 m | 5 m/s |

b) Uniform motion. Bus travels equal displacements in equal intervals of time.

c)




d) Instantaneous speed.

2 A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 kmph . Finding market closed he instantly turns and walks back home with a speed of 7.5 kmph.

a) How long does the man take to reach the market from his home?

b) Calculate the time taken to return back to home from the market.

c) Find the average speed and magnitude of average velocity.

Ans: a) $time = \frac{distance}{speed}$

$= \frac{2.5}{5}$

$= \frac{1}{2}$ hour

=30 minutes.

b) $time = \frac{distance}{speed}$

$= \frac{2.5}{7.5}$

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

=20 minutes.

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c) $Average\ speed = \frac{total\ distance}{total\ time}$

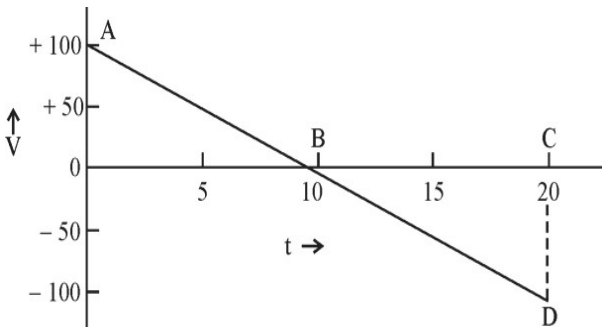
Total distance = 5 km.

$total\ time = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$ hour

Average speed= $\frac{5}{5/6}$ = 6 kmph.

Average velocity =0. (Because total displacement =0).

3 Velocity-time graph of a ball thrown vertically upwards with an initial velocity is shown in figure.



(a) What is the magnitude of initial velocity of the ball ?

(b) Calculate the distance travelled by the ball during 20 s, from the graph.

(c) Calculate the acceleration of the ball from the graph.

Ans: a)Magnitude of initial velocity = 100m/s.

b) Distance = Area under the graph.

$$= 2\times\frac{1}{2}bh$$

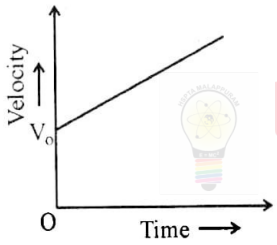
$$= 2\times\frac{1}{2}10\times100 \qquad = 1000\text{m}.$$

c) Acceleration a = Slope of the graph.

$$a=\frac{-100}{10}$$

$$a=-10\ \text{m/s}^2$$

4 The velocity - time graph of an object is given below.

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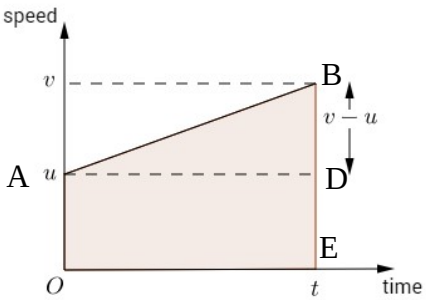
Ans: (a) Displacement.

(b)Second equation of motion OR Displacement time relation:




From the graph

Displacement S = Area under the graph AB

= Area of rectangle OADE + Area of triangle ADB

$$= OA \times OE + \frac{1}{2} DB \times AD$$

$$= u \times t + \frac{1}{2}(v-u) \times t$$

$$= ut + \frac{1}{2} at \times t$$

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

This is the displacement – time relation.

5 An object moving along a straight line covers equal distances in equal intervals of time, it is said to be in uniform motion along a straight line.

a) The position - time graph of an object in uniform motion is.....

i) a straight line parallel to the time axis.
ii) a straight line parallel to the position axis.
iii) a straight line inclined to the time axis.
iv) a parabola.

b)Derive the relation $S = ut + \frac{1}{2} at^2$ for uniformly accelerated motion with the help of velocity-time graph.

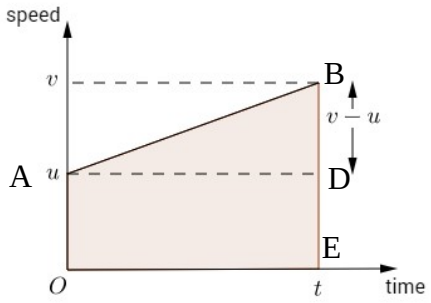
c)Which of the following statements is/are TRUE?

i) An object with constant velocity has always constant speed.
ii) An object with constant speed has always constant velocity.
iii) An object with zero velocity has always zero acceleration.
iv) An object with zero acceleration has always zero velocity

Ans: a) iii) a straight line inclined to the time axis.

b) Second equation of motion OR Displacement time relation:
From the graph

Displacement S = Area under the graph AB




= Area of rectangle OADE + Area of triangle ADB

$$= OA \times OE + \frac{1}{2} DB \times AD$$

$$= u \times t + \frac{1}{2}(v-u) \times t$$

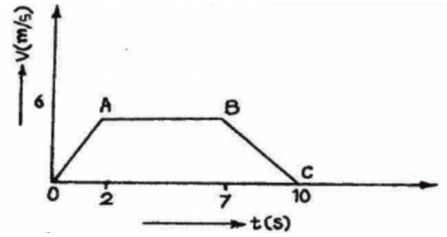
$$= ut + \frac{1}{2} at \times t$$

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

This is the displacement – time relation.

c) i) An object with constant velocity has always constant speed.

6 Velocity – time graph of a body is given below.




a) Which portion of the graph represents uniform retardation?

(i) OA (ii)AB (iii) BC (iv) OC

b) Find the displacement in time 2s to 7s.

c) A stone is dropped from a height h. Arrive at an expression for the time taken to reach the ground.

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Ans: a) BC

b) Displacement = Area under the line AB(from 2s to 7s);

= 6 x 5 =30 m.

c) We have $S = ut + \frac{1}{2} at^2$

Here S=-h u=0 a=-g

$$-h = 0 + \frac{-1}{2} g t^2$$

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

Therefore $t = \sqrt{\frac{2h}{g}}$

7 Velocity – time graph of an object is given below.

a)What type of motion is indicated by the above graph?

b)Derive a relation connecting the displacement and time for this type of motion.

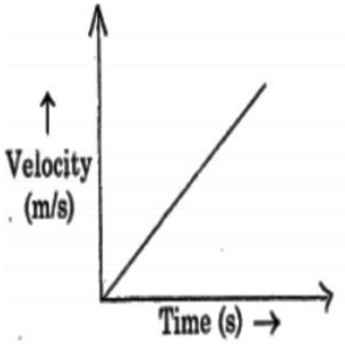
c)The ratio of velocity to speed of an object is.....

i. One

ii. Greater than one

iii. Less than one

iv. Either less than one or equal to one.




Ans: a)Uniformly accelerated motion.

b)Displacement-time relation: $S = ut + \frac{1}{2}at^2$

Let S--> Displacement u-->initial velocity v--> final velocity a-->acceleration t-->time.

We have $Average\ velocity = \frac{Total\ displacement}{Time}$

$$V_{av} = \frac{S}{t}$$

Also $$V_{av} = \frac{v+u}{2}$$

Therefore $$\frac{s}{t} = \frac{v+u}{2}$$

$$S = \frac{(v+u)t}{2}$$

$$S = \frac{(u+at+u)t}{2}$$

$$S = \frac{(2u+at)t}{2}$$

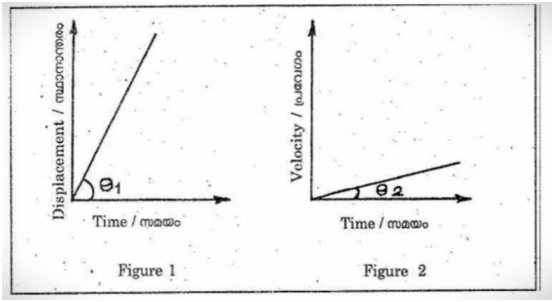
$$S = \frac{2ut}{2} + \frac{at^2}{2}$$

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

This is the displacement-time relation.

c) iv. Either less than one or equal to one.

8 Figure 1 shows displacement-time graph of runner A. Figure 2 shows velocity-time graph of runner B.

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a) Identify the type of motion the runner A has.---------

i) Uniform motion

ii) Non-uniform motion

iii) Accelerated motion

iv) Jerking motion

b)Derive a mathematical relation that connects displacement, velocity and time for runner A.

c)Analysing the above two graphs, find which runner will win the race. Why? (Here $\theta 1 > \theta 2$ ).

Ans: a) i) Uniform motion

b) Velocity -Displacement relation: $v^2 = u^2 + 2as$

Let S--> Displacement u-->initial velocity v--> final velocity a-->acceleration t-->time.

We have $Average\ velocity = \frac{Total\ displacement}{Time}$

$$V_{av} = \frac{S}{t}$$

Also $V_{av} = \frac{v+u}{2}$

Therefore $\frac{s}{t} = \frac{v+u}{2}$

That is $v+u = \frac{2S}{t}$ ---------(1)

But $v-u = at$ ---------(2)

Multiplying (1) and (2) $(v+u)(v-u) = \frac{2S}{t}at$

$$v^2 - u^2 = 2aS$$

$$V^2 = u^2 + 2as$$

This is the velocity-displacement relation.

c) Data insufficient.

9 Acceleration is defined as the rate of change of velocity.

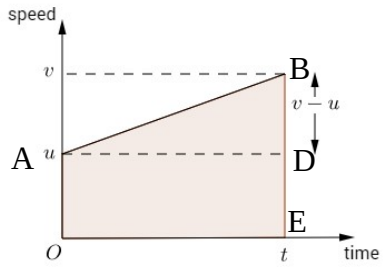
a) Is it possible for a body to have acceleration without velocity? Explain.

b) Draw the velocity–time graph of a body moving with uniform acceleration 'a' and initial velocity $V_0$.

c) Using the above graph, obtain the equation for displacement in time 't'.

Ans: a)Yes. For example if a body is thrown up , at the highest point the velocity is zero but there is an acceleration downwards.

b)




c)Second equation of motion OR Displacement time relation:

From the graph

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Displacement S = Area under the graph AB

= Area of rectangle OADE + Area of triangle ADB

$= OA \times OE + \frac{1}{2} DB \times AD$

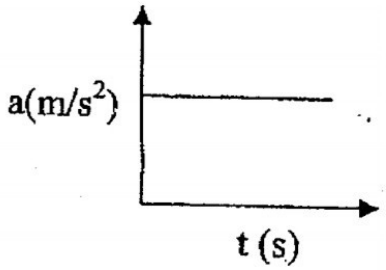
$= u \times t + \frac{1}{2}(v-u) \times t$

$= ut + \frac{1}{2} at \times t$

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

This is the displacement – time relation.

10 Acceleration – time graph of a body is shown below:

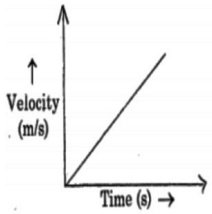



a)Draw the corresponding velocity-time graph.

b)What does the area under the velocity – time graph represent?

c)Arrive at a relation connecting velocity (v) and time (t) for a uniformly accelerated body.

Ans: a)




b) Displacement.

c)<u>Velocity -time relation:</u> $v = u + at$

Let u--> initial velocity

v-->final velocity

a-->acceleration

t-->time.

We have $acceleration = \frac{Change\ in\ velocity}{time}$

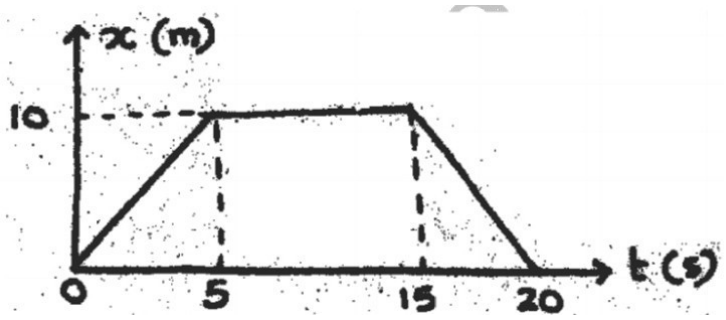
$a = \frac{v-u}{t}$

$v - u = at$

$v = u + at$

This is the velocity -time relation.

11 a) The figure shown the position – time graph of a body moving along a straight line.

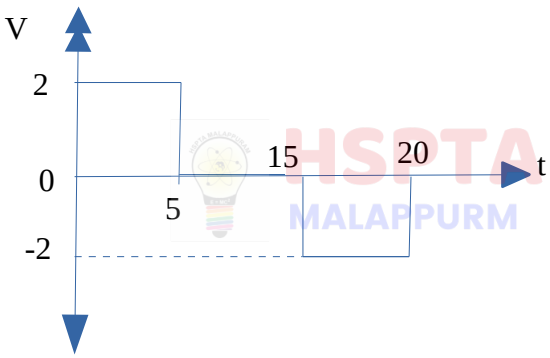



i) Draw the velocity-time graph of the body.

ii) From the graph, find the displacement in 20 seconds.

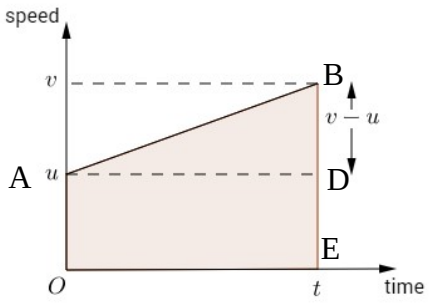
b) From the velocity-time graph of a body moving with uniform acceleration, deduce the velocity-time relation and the velocity-displacement relation.

Ans: a) (i)




(ii) Displacement = Area under the graph
=2 x 5 + (-2x5)
=0

b)



**First equation of motion (velocity-time relation)**

From the graph ,

Acceleration a = Slope of velocity time graph AB.

$$a=\frac{DB}{AD}=\frac{(v-u)}{t}$$

$$v - u = at$$

$$v=u+at$$

This is the first equation of motion or velocity-time relation.

**Third equation of motion OR Velocity-Displacement relation:**

From the graph

Displacement travelled S = Area of trapezium OABE

$$= \frac{1}{2}(EB+OA)\times OE=\frac{1}{2}(EB+ED)\times OE \qquad \text{--------(1)}$$

acceleration a = slope of the graph AB

$$a=\frac{DB}{AD}=\frac{EB-ED}{OE}$$

Therefore $$OE=\frac{EB-ED}{a} \qquad \text{----------(2)}$$

Substituting eqn (2) in eqn (1)

$$S=\frac{1}{2}(EB+ED)\times\frac{(EB-ED)}{a}$$

$$S=\frac{1}{2}\frac{(EB^2-ED^2)}{a}$$

$$(EB^2-ED^2)=2as$$

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

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

This is the velocity -Displacement relation.

12 If v is the velocity and a is the acceleration, give an example of a physical situation for each of the following cases.

a) V ≠ 0, a = 0
b) V = 0, a ≠ 0
c) V > 0, a < 0
d) V < 0, a > 0

Ans: a)A ball moving with uniform velocity.
b)A ball thrown up to reach the highest point.
c)A ball moving upward.
d)A ball dropped from height , moving down ward.

***Each question scores Five***

1 Derive the following equations of motion for a body moving with uniform acceleration in a straight line.

a) $v=u+at$

b) $S=ut+\frac{1}{2}at^2$

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

Ans: a) Velocity -time relation: $v=u+at$

Let u--> initial velocity

v-->final velocity

a-->acceleration

t-->time.

We have $acceleration=\frac{Change\,in\,velocity}{time}$

$$a=\frac{v-u}{t}$$

$$v-u=at$$

$$v=u+at$$

This is the velocity -time relation.

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b) Displacement-time relation: $S=ut+\frac{1}{2}at^2$

Let S--> Displacement u-->initial velocity v--> final velocity a-->acceleration t-->time.

We have $Average\,velocity=\frac{Total\,displacement}{Time}$

$$V_{av}=\frac{S}{t}$$

Also $V_{av}=\frac{v+u}{2}$

Therefore $\frac{s}{t}=\frac{v+u}{2}$

$$S=\frac{(v+u)t}{2}$$

$$S=\frac{(u+at+u)t}{2}$$

$$S=\frac{(2u+at)t}{2}$$

$$S=\frac{2ut}{2}+\frac{at^2}{2}$$

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

This is the displacement-time relation.

c) Velocity -Displacement relation: $v^2 = u^2 + 2as$

Let S--> Displacement u-->initial velocity v--> final velocity a-->acceleration t-->time.

We have $Average\ velocity = \frac{Total\ displacement}{Time}$

$$V_{av} = \frac{S}{t}$$

Also $V_{av} = \frac{v+u}{2}$

Therefore $\frac{s}{t} = \frac{v+u}{2}$

That is $v+u = \frac{2S}{t}$ ---------(1)

But $v-u = at$ ---------(2)

Multiplying (1) and (2) $(v+u)(v-u) = \frac{2S}{t}at$

$$v^2 - u^2 = 2aS$$

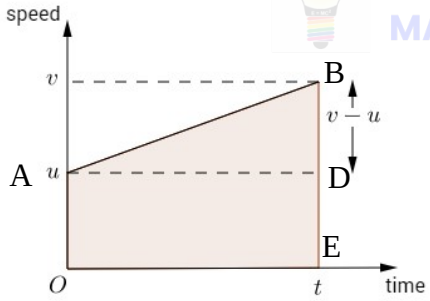
$V^2 = u^2 + 2as$

This is the velocity-displacement relation.

2 Derive the equations of motion for a uniformly accelerating body from velocity-time graph.

Ans: a)First equation of motion (velocity-time relation)

From the graph ,




Acceleration a = Slope of velocity time graph AB.

$$a = \frac{DB}{AD} = \frac{(v-u)}{t}$$

$$v - u = at$$

$$v = u + at$$

This is the first equation of motion or velocity-time relation.

b) Second equation of motion OR Displacement time relation:

From the graph

Displacement S = Area under the graph AB

= Area of rectangle OADE + Area of triangle ADB

$$= OA \times OE + \frac{1}{2} DB \times AD$$

$$= u \times t + \frac{1}{2}(v-u) \times t$$

$$= ut + \frac{1}{2} at \times t$$

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

This is the displacement – time relation.

c) Third equation of motion OR Velocity-Displacement relation:

From the graph

Displacement travelled S = Area of trapezium OABE

$$= \frac{1}{2}(EB + OA) \times OE = \frac{1}{2}(EB + ED) \times OE \qquad \text{--------(1)}$$

acceleration a = slope of the graph AB

$$a = \frac{DB}{AD} = \frac{EB - ED}{OE}$$

Therefore $$OE = \frac{EB - ED}{a} \qquad \text{----------(2)}$$

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Substituting eqn (2) in eqn (1)

$$S = \frac{1}{2}(EB + ED) \times \frac{(EB - ED)}{a}$$

$$S = \frac{1}{2} \frac{(EB^2 - ED^2)}{a}$$

$$(EB^2 - ED^2) = 2as$$

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

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

This is the velocity -Displacement relation.

3 Free fall is a uniformly accelerated motion.

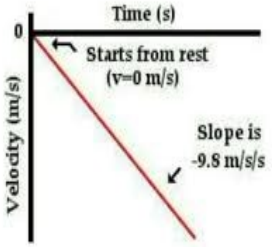
a) Draw the velocity – time graph of free fall.

b) A ball is thrown vertically upwards with a velocity of 20 $ms^{-1}$ from the top of a building. The height of the point from where the ball is thrown is 25.0 m from the ground.

i) How high will the ball rise?

ii) How long will it be before the ball hits the ground?

Ans: (a)




(b) (i) Here u= +20 m/s.

$a=g=-10\ m/s^2$

At the highest point v=0

By equation of motion $v^2=u^2+2aS$

$0=20^2-2\,x\,10\,xS$

$20\,S=400$

S=20 m

(ii) Net displacement S = -25 m

u=+20m/s.

a=g=-10m/s2

By equation of motion $S=ut+\frac{1}{2}at^2$

$-25=20t-5t^2$

$5t^2-20t-25=0$

$t^2-4t-5=0$

(t+1)(t-5)=0

therefore t=5 s.

4 An object released near the surface of the earth is said to be in free fall. (Neglect the air resistance)

a). Choose the correct alternative from the clues given at the end of the statement.
"Free fall is an example of..... accelerated motion"(uniformly/non-uniformly)

b). The incomplete table shows the velocity (v) of a freely falling object in a time interval of 1s. (Take g=10 m/s 2 ).

Complete the table and draw the velocity time graph.

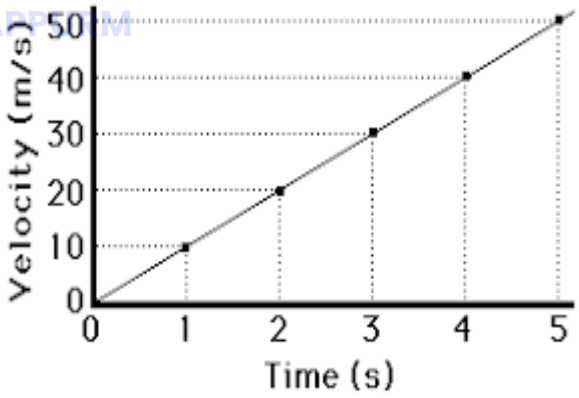
| Time (t) s<br>സമയം | Velocity (υ) m/s<br>പ്രവേഗം |
|---|---|
| 0 | 0 |
| 1 | ... |
| 2 | ... |
| 3 | 30 |
| 4 | 40 |
| 5 | 50 |

c). Area under velocity-time graph gives .....

Ans: a)"Free fall is an example of uniformly accelerated motion"

b)

| Time (t) s<br>സമയം | Velocity (υ) m/s<br>പ്രവേഗം |
|---|---|
| 0 | 0 |
| 1 | ... |
| 2 | ... |
| 3 | 30 |
| 4 | 40 |
| 5 | 50 |




c)Displacement.

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