Grade IX

Lesson : 8 Motion

CHAPTER AT A CLANCE

MOTION

An object is said to be in motion if its position changes continuously with respect to a fixed reference point called origin.

Measurement of Motion

Speed

- Speed of a body is defined as the distance travelled by it per unit time

$$Speed = \frac{Distance\ travelled}{Time\ Taken} = \frac{s}{t}$$

- SI unit of speed is m/s
- When the body travels at varying speeds during a journey, then average speed is calculated as total distance travelled divided by the total time taken,

$$Average\ Speed = \frac{Total\ Distance\ travelled}{Total\ Time\ Taken}$$

Velocity

- Velocity of a body is defined as its displacement per unit time

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

- SI unit of velocity is m/s
- The average velocity of a body is defined as total displacement of a body divided by total time taken.

$$Average\ Velocity = \frac{Total\ Displacement}{Total\ Time\ Taken}$$

Acceleration

- Acceleration is defined as the rate of change of velocity of a body
- SI unit is m/s^2

$$Acceleration, \quad a = \frac{v-u}{t}$$

(i.e. $\frac{Change\ in\ velocity}{Time\ Taken}$)

Types of Motion

Distance

- The length of path covered by a moving object on a plane is called distance
- SI unit is metre (m)

Displacement

- The shortest distance from initial position of an object to its final position is called displacement.
- SI unit is metre (m)

Motion is a straight line

- When a body moves along a straight line. i.e. x- coordinate.
- It is known as one-dimensional motion or rectilinear motion of a particle.

Motion along circular path

- A body moving with uniform speed along a circular path is said to be in uniform circular motion.
- Angular velocity (ω) $= \frac{Angular\ displacement}{Time\ taken}$
- $\omega = \frac{\theta}{t}$

Types of motion in a straight line

Uniform motion: If a body covers equal distances in equal intervals of time in a straight line, then its motion is said to be uniform motion.

Non-Uniform motion: If a body covers unequal distances in given equal intervals of time, then its motion is said to be non-uniform

Graphical Representation of motion (Continued on next page)

EQUATION OF MOTION

- Equation for Velocity – Time relation or 1st equation of motion

$$v = u + at$$

- Equation for Position – Time relation or 2nd equation of motion

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

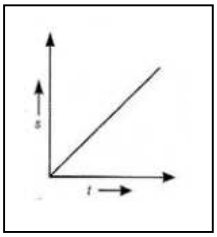
- Equation for Position – Velocity relation or 3rd equation of motion

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

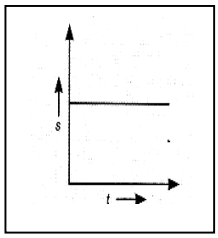
Continued from previous page

Graphical Representation of Motion.

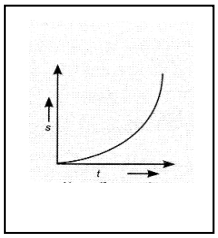
Motion can be represented graphically by plotting displacement – time (s-t) graph and velocity – time (v-t) graph.



Uniform velocity (uniform - motion)



Object at rest



Non- uniform motion

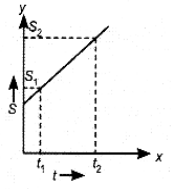
The slope of displacement – time graph gives the velocity of the object.

In time interval $(t_2 - t_1)$

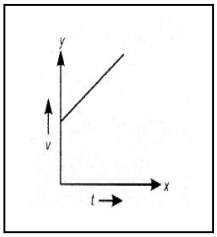
Displacement = $s_2 - s_1$

Slope = $\frac{Y\ intercept}{X\ intercept}$ = = $\frac{S_2 - S_1}{t_2 - t_1}$

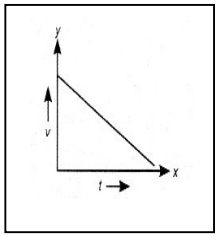
= $\frac{S_2 - S_1}{t_2 - t_1}$ = Velocity



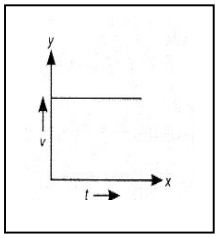
Velocity – time graph



Uniform acceleration



Uniform retardation



Zero acceleration or constant velocity

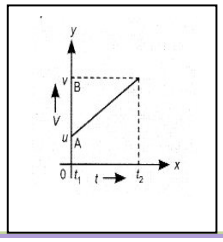
The slope of velocity – time graph gives the acceleration of the moving body.

Slope of v-t graph for time $(t_2 - t_1)$

= $\frac{Y\ intercept}{X\ intercept}$ = = $\frac{S_2 - S_1}{t_2 - t_1}$

= $\frac{OB - OA}{t_2 - t_1}$ = $\frac{v - u}{t}$

= Acceleration



Know the terms

Activity / Project 1

Objective : To plot s-t graph from observed quantities and calculate average velocity.

Materials Required : A stop watch, a car with driver, graph paper

Method :

1. Start from a point on the highway and set the odometer and stopwatch at zero
2. After every five minutes, note down the odometer reading. Note that once the stop watch is start, it does not stop till one hour is over.
3. Selecting appropriate scale, plot a displacement time graph with time on x – axis and displacement on y-axis
4. Find the slope of graph plotted by you.

Conclusion :

Slope of graph : _____

Type of motion : _____

Average velocity : _____

Activity / Project 2

Objective : To calculate the acceleration of a body by plotting graph from given data and interpret the graph.

Materials Required : Given data, graph, ruler, pencil

Method :

1. Collect the given data, table and graph sheet.
2. Select appropriate scale and plot time on X – axis and velocity of Y-axis
3. Plot a graph using the given data.
4. Calculate the slope of the graph for different time intervals.

Conclusion :

Nature of motion : _____

Slope of graph : _____

Total Displacement : _____

Objective Type Questions

I. Multiple choice questions

1. Equations of motion can be used for a body having

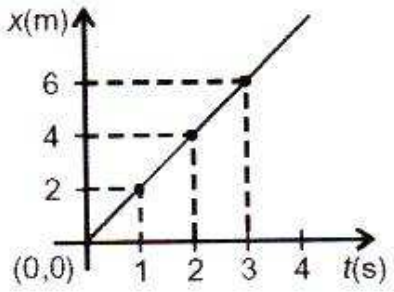
a) uniform motion

b) non uniform motion

c) uniform acceleration

d) non uniform acceleration

2. The slope of the x - t graph is a measure of



a) Velocity = $2ms^{-1}$

b) acceleration = $\frac{1}{2}\ ms^{-2}$

c) Velocity = $\frac{1}{2}\ ms^{-2}$

d) acceleration = 2 ms^{-2}

v = $\frac{(6-0)m}{(3-0)s}$ = 2 m/ s

3. For a body starting from rest the displacement in 10 second, when it acquires 4 ms^{-1} in 2 seconds is

a) 25 m

b) 50 m

c) 500 m

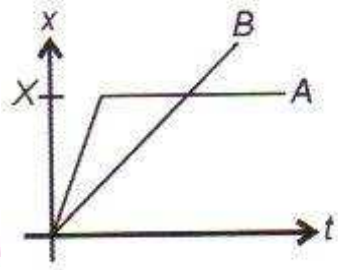
d) 100 m

v= u + at

or a = $\frac{v-u}{t} = \frac{4-0}{2} = 2m/s^2$

a = ut + $\frac{1}{2}$ at^2 = 0 + $\frac{1}{2}$ x 2 (10)^2)

4. Motion of bodies A and B is depicted by the x- t graph. Then which of the following is/are incorrect?



A: A has uniform motion

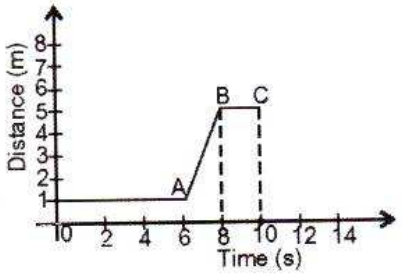
B : B has less velocity than A initially

C: B crosses A at X

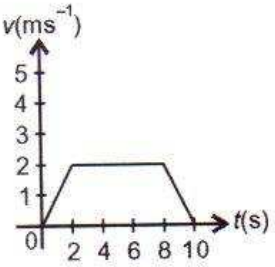
D : A comes to rest at X

a) Only A b) Only B and C c) Only B,C and D d) All of them

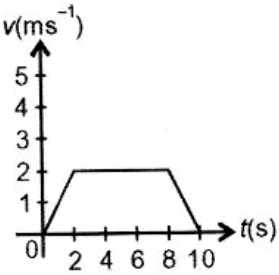
5. The v-t graph for x-t graph given here is best drawn as



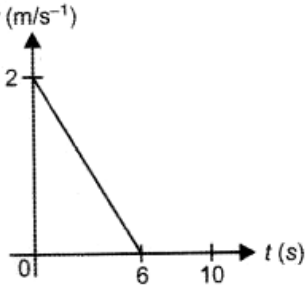
(a)



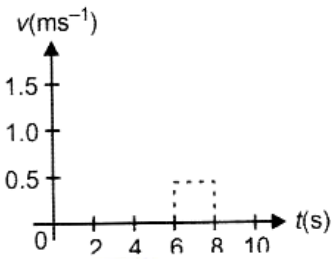
(b)



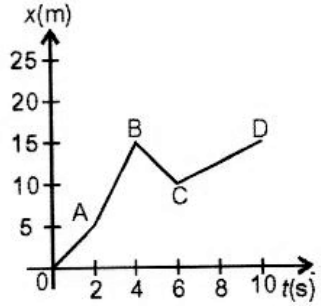
(c)



(d)



6. From x - t graph, one can draw the following conclusions :



A : $v_{OA} < v_{AB}$

B : v_{BC} is negative

C : v_{CD} is the least by magnitude

D : acceleration is uniform

a) Only A is correct

b) Only B and C are correct

c) Only A , B and C are correct

c) Only D is correct

7. For a uniformly accelerated body with initial and final velocities as u and v ms^{-1}, the average velocity is

a) $\frac{a}{2}$ b) $\frac{v}{2}$ c) $\frac{u+v}{2}$ d) $\frac{v-u}{2}$

8. In a uniformly accelerated motion,

A : v-t graph is a straight line not parallel to t or v axis

B : v-t graph is not a straight line

C: Slope of v - t graph varies

d) Slope of v-t graph is constant

a) Only A is correct

b) Only A and B are correct

c) Only A , B and C are correct

c) Only B,C, D is correct

9. Area below v - t graph is a measure of

a) Acceleration

b) Displacement

c) Angular speed

d) Angular acceleration

10. If the velocity of a body is reducing, it is said to have

a) Negative acceleration

b) Retardation

c) Positive Acceleration

d) Both (a) and (b)

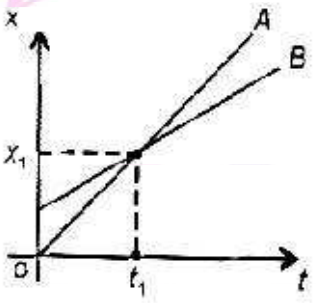
11. For a body moving in a straight line, there can be situations with

A: v = 0, a ≠ 0 B : a = 0, v ≠ 0

a) Only A is correct b) Only B is correct

c) Both A and B are correct d) Both are incorrect

12. One can conclude from the given x - t graph that



a) $V_A > V_B$ b) $V_A < V_B$

c) $V_A = V_B$ at x_1 d) $a_A = a_B$ 1

13. If the v –t graph is a straight line inclined to the time axis, then

a) a = 0 b) a ≠ 0

c) a = constant ≠ 0 d) a ≠ constant ≠ 0

14. A body starting at a point , say A, reaches, say B, ahead in a straight line and returns back to A . Then there is

a) Positive displacement b) negative displacement

c) zero displacement d) cannot be said

15. A car accelerate, uniformly from 15 km/ h to 36 km/ h in 5 minutes. The acceleration is

(a) 5 ms^{-2} (b) 1km/s^{-2} (c) 216ms^{-2} (d) 216km/s^{-2}

$u = 15km/h, v = 36km/h, t = 5\,\text{min} = \frac{1}{12}h$

$\boldsymbol{a = \frac{v-u}{t} = \frac{36-18}{\left(\frac{1}{12}\right)}} = 216km/s^2$

16. A body moves in a circle of radius 5 m with a speed of $5ms^{-1}$, Then it has

A : an acceleration of $\mathbf{5ms^{-2}}$,

B : an acceleration varying with direction alone

(a) Only A is correct

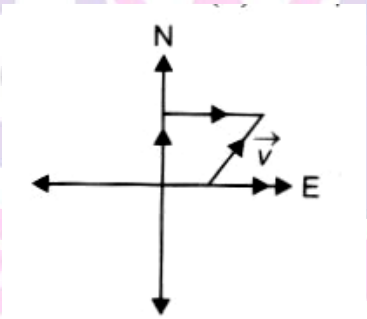
(b) Only B is correct

(c) Both A and B are correct

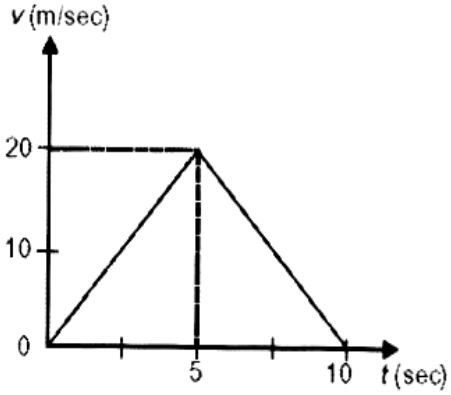
(d) Neither A nor B is correct

17. A man walks with a speed of $\mathbf{5ms^{-1}}$, northwards and then turns to his right to move with the same speed. The change in velocity is

(a) $5\sqrt{2}NE$ (b) $5\sqrt{2}SE$ (c) $5\sqrt{2}sw$ (d) $25\sqrt{2}SE$



18. The displacement of the body in 5 seconds from the beginning of the motion is



(a) 12.5m (b) 100 m (c) 87.5 m (d) 50 m

Displacement = Area of ΔABC

$A = \frac{1}{2}\ x\ 5\ x\ 20 = 50\ m$

19. Pranesh is in seat number 48 of a train moving with a speed of 18 km/h and Srinidhi is standing on the platform. Then

A : Pranesh is at rest according to another passenger in the train

B : Srinidhi is moving according to Pranesh

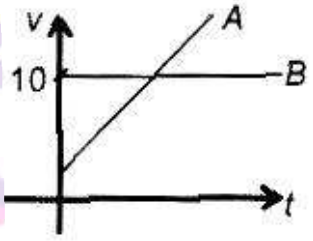
C : Pranesh is moving according to Srinidhi

D : Pranesh is moving according to the train

Then the incorrect options are

(a) A,D (b) B, C (c) B, D (d) Only D

20. The v-t graph shown here depicts the motion of A and B such that



(a) They collide when their velocity is $10ms^{-1}$

(b) velocity of A exceeds beyond $10ms^{-1}$

(c) both A and B have non-zero acceleration

(d) both A and B have zero acceleration.

21. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of $10ms^{-1}$, it implies that the boy is [NCRT Exemplar Problem]

(a) At rest

(b) moving with no acceleration

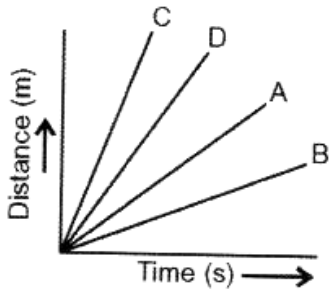
(c) in acceleration motion

(d) moving with uniform velocity.

22. Area under a v-t graph represents a physical quantity which has the unit [NCRT Exemplar Problem]

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

23. Four cars A,B,C and D are moving on a levelled road. Their distance versus time graphs are shown in figure. Choose the correct statement [NCRT Exemplar Problem]



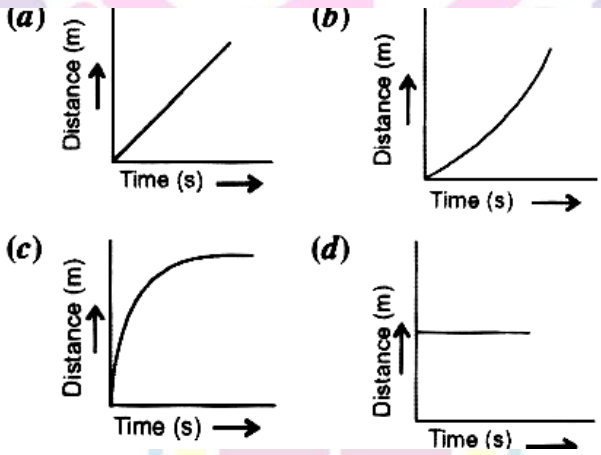
(a) Car A is faster than car D

(b) Car B is the slowest

(c) Car D is faster than car C

(d) Car C is the slowest.

24. Which of the following figures represent uniform motion of a moving object correctly? [NCRT Exemplar Problem]



25. Slope of a velocity-time graph gives [NCRT Exemplar Problem]

(a) the distance (b) the displacement

(c) the acceleration (d) the speed.

26. In which of the following cases of motion, the distance moved and the magnitude of displacement are equal? [NCRT Exemplar Problem]

(a) A car is moving on a straight road

(b) A car is moving in a circular path

(c) The pendulum is moving to and fro

(d) The earth is revolving around the Sun

1. c	2. a	3. d	4. d	5. d	6. c	7. c	8. b	9. b	10. d
11. b	12. a	13. d	14. c	15. d	16. b	17. a	18. d	19. a	20. b
21. c	22. b	23. b	24. a	25. c	26. a				

27.

I. Match the column

Column I	Column II
1. Displacement per second	A. Displacement
2. Distance per second	B. Uniform circular motion
3. Negative acceleration	C. Velocity
4. Constant acceleration	D. Retardation
5. Area under v-t graph	E. Speed

1. C	2. E	3. D	4. B	5. A

I Fill in the blanks

28. Equations of motion are applicable for _____ accelerated motion

29. The maximum displacement between two points in a circular path of radius r can be_____

30. Acceleration of a body whose r-t graph is paralled to time axis is _____

31. Usha swims in a 90 m long pool from one end to another and back. Her average velocity is _____

32. Displacement of a body which moves $(3/4)^{th}$ round of a circular path of radius r is _____

33. Acceleration and displacement are _____ quantities

28. Uniformly	29. 2r	30. zero	31. zero	32. $r\sqrt{2}$	33. vector

I. True or False

34. Motion of earth around the sun in non-uniformly accelerated.
35. The acceleration of a body in uniform circular motion is directed towards the centre of the circular path
36. Acceleration of a body is expressed in ms^2 in SI system
37. The negative slope of s-t indicates retarded motion
38. Motion is relative in nature.

34. True	35. False	36. False	37. True	38.True

Direction : (Q.39 to Q 41) : In the following Questions, the Assertion and Reason have been put forward . Read tje statements carefully and choose the correct alternative from the following :

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

c) Assertion is true but the Reason is false.

d) The statement of the Assertion is false but the Reason is true.

39. Assertion : Displacement is the shortest distance from one point to another

Reason : Displacement can never be greater than distance travelled.

b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

40. Assertion : Uniform circular motion is also called accelerated motion.

Reason : Direction of motion changes at every point. So velocity is not constant

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion

41. Assertion : Sun appears to rise in the east and set in the west.

Reason : The earth revolves around the sun in uniform circular motion.

b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

42. " An object may appear moving to one person and at rest to another person at the time". Justify giving an example.

An object appearing at rest to one person may appear to be moving to another person. For example, for a boy standing on the ground, a tree or a building appears to be at rest. But for another person sitting in a moving bus, the same object appear to be moving in opposite direction to that of motion of the bus.

43. How are the states of rest and motion relative?

States of rest and motion ore relative because they are interpreted according to the change in position of the object with respect to the origin. For example, mountains trees etc. Are at rest with respect to us. But to an astronaut in outer space, they are in motion as the earth is rotating.

44. Distinguish between scalar quantity and vector quantity.

Scalar quantities have magnitude only. For example speed and distance.

Vector quantities have magnitude as well as direction. For example velocity and displacement.

45. The motion of water in a dam serves human beings by generating electricity as it is a controlled motion. Give one example of an controlled motion. What effects could it cause?

The motion of water during a hurricane or tsunami is uncontrolled. It could cuse mass scale devastation and a severe loss to life and property. Thus motion should occur in a controlled manner.

46. Is it possible that the train in which you are sitting appears to move while it is at rest?

The train in which we are sitting appears to move when the relative position of a point on adjacent train changes. This happens when we are at rest and adjacent train on next track starts moving.

47. What causes the phenomena of sunrise, sunset and change of seasons. How do we perceive this cause?

The motion of earth around the sun causes change of seasons. We perceive the motion of earth by observing the change in positions of stars, moon, planets etc., located in outer space.

48. The walls of your classroom are in motion but appear stationary. Explain.

The walls of classroom are at rest w.r.t. us because their relative position remains constant. But to a person in outer space they appear moving as the earth rotates.

49. Define uniform motion.

When a body covers equal distances in equal intervals of time, then it has uniform motion.

50. Between two given positions, distance travelled can never be less than the displacement. Why?

Distance is the actual length of path between two points which could be curved. Zig zag or straight line. However, displacement is the straight line path which is the shortest possible distance between two points. Thus displacement can never be more than distance. If actual path traversed between two points is a straight line, then distance is equal to displacement.

51. Define speed.

Speed is defined as the distance travelled per unit time by a body.

52. Define velocity.

Displacement per unit time of a body is called velocity.

53. The length of minute hand of a clock is 14 cm; Calculate the speed at which the tip of minute hand moves.

Radius of clock dial = Length of minute hand = 14 cm

It completes 1 round in 1 h = (60 x 60) s.

Speed of the tip of minute hand

$= v = \frac{2\pi r}{t} = \frac{2 X \frac{22}{7} X 14}{60 X 60} = \frac{11}{450}$ cms^{-1}

54. A particle is moving in a circle of diameter 5m. What is its displacement when it covers one and a half revolutions?

After one and a half revolution, the particle reaches the diametrically opposite end. Thus displacement = 5 m

55. A body is thrown vertically upwards and rises to height h. Calculate (a) total distance travelled (b) displacement of the body when it is caught back.

a) Distance = 2 h (ascend + descend)

b) Displacement = zero (the body returns back)

56. What is the numerical ratio of average velocity to average speed of an object moving along a straight line path?

In a straight line motion, average velocity = average speed.

Thus their ratio is 1 : 1

57. An electric train is moving with a velocity of 30 m/s. How much distance will it travel in 30s?

Velocity, v = 30 ms^{-1} ; time, t = 30 s

Distance = vt = 30 x 30 = 900 m

58. Mohan travels at 20 m/s from home to market and returns back at 25 m/s. Find his average velocity for the entire journey.

Displacement of the Mohan over the journey = zero

Thus, average velocity = zero

59. Define acceleration

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

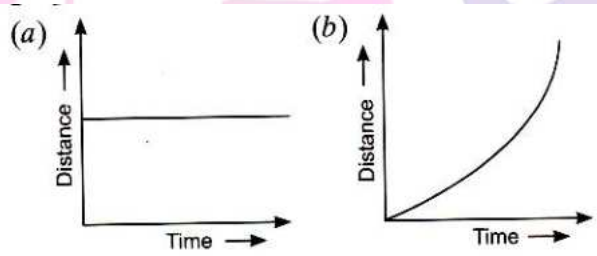
60. Define uniform acceleration.

The acceleration of a body is said to be uniform if its velocity changes by equal amount in equal intervals of time.

61. Why in a graph plotted between distance and time, we always put time on $x-axis$ and distance on y – $axis$?

When a graph is plotted between two variable quantities, then the quantity which varies independently, is plotted on y – $axis$. Since time is an independent variable, it is plotted on $x-axis$.

62. What type of motion is described by the following graphs?

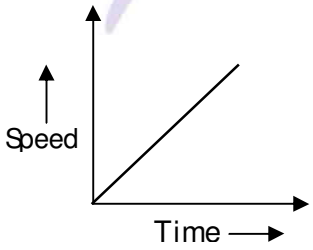


a) Object is at rest

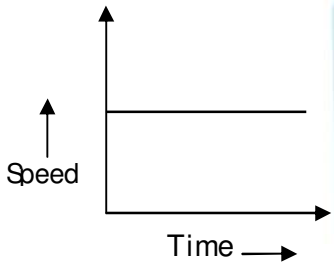
b) Object is in non uniform motion

63. Out of the following, identify the graph which corresponds to a motion with (i) Uniform retardation. (ii) Zero acceleration.

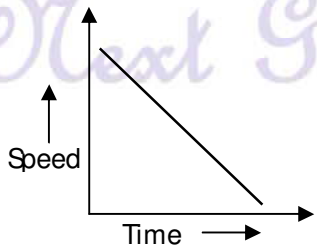
(A)



(B)



(C)

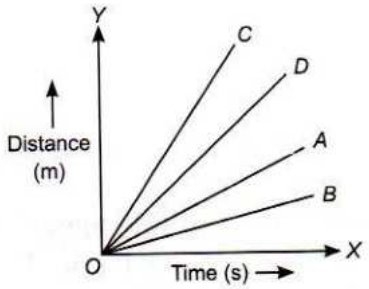


i) Uniform retardation: graph C as it has negative slope.

ii) Zero acceleration: graph B as it has zero slope.

64. The motion of four cars A, B, C and D is represented below. Which of the cars is travelling.

a) the fastest **b) the slowest?**



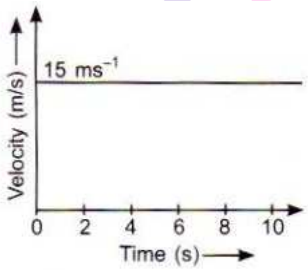
a) C is travelling the fastest as it has the highest slope

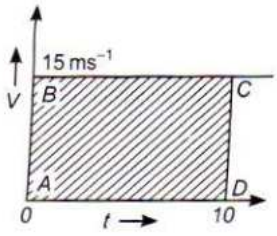
b) B is travelling the slowest as it has the lowest slope

65. Which physical quantity is given by the area under the velocity – time graph ?

Displacement of the body.

66. Find the displacement of the body in first 10 seconds in the following graph.





Displacement = Area under the vt graph

= Area of rectangle ABCD

= AB x AD

= 15 ms^{-1} x 10 s

= 150 m

67. A car acceleration non-uniformly over a path for time t. Do equation of motion hold true in the case? Why/ Why not?

No, because the equation of motions are valid for uniformly accelerated motion only.

68. A van accelerates uniformly and its velocity changes from 5 m/s. in time t. Find its average velocity.

Initial velocity , u = 5 ms^{-1}, final velocity v = 25 ms^{-1}

For uniform acceleration, average velocity $= \frac{u+v}{2} = \frac{5+25}{2} = 15\ ms^{-1}$

69. A body is thrown vertically upward with velocity u. Derive an expression for height 'h' to which it rises.

Final velocity at the highest point, v = 0

Let acceleration, a (negative as the body travels against gravity). From third equation of motion.

$H = \frac{v^2-u^2}{2a} \Longrightarrow \frac{o-u^2}{-2a} = \frac{u^2}{2a}$

70. What type of motion is described by a stone which moves in a circular path with constant speed?

Uniform circular motion

71. Find the angular velocity of a satellite which revolves in a circular orbit of radius 35000 km and completes one round in 12 hours.

Angular velocity, $\omega = \frac{2\pi}{t} = \frac{2\ X\ \pi}{12} = \frac{\pi}{6}$

72. A car travels a distance of 360 km in 5 hours. What is the speed in ms^{-1}

Distance = 360 km = 360 x 10^3 m ;

Times 5 h = 5 x 3600 s

Speed $= \frac{Distance}{Time} = \frac{360 \times 10^3}{5\ X\ 3600} = 20$ m/ s.

73. Define displacement of a particle in linear motion. Does it depend upon the origin?

The shortest distance measured from initial position of the particle to its final position is called displacement.

No, displacement of a particle does not depend upon the choice of origin.

74. A cyclist once goes round a circular track of diameter 105 m in 5 minutes. Calculate his speed.

$$V = \frac{Circumference}{Time}$$

$$= \frac{\pi d}{t} = \frac{\left(\frac{22}{7} X\ 105\right)m}{(5\ X\ 60)s} = \frac{330}{5\ X\ 60}$$

$$= 1.1\ ms^{-1}$$

75. Define (a) average speed (b) average velocity

Average speed is defined as the total distance covered by a body per unit time

Average velocity is defined as the total displacement of a body per unit time.

76. Observe the signboards on roads indicating the speed –limit. What does this indication mean? Why over speeding is a hazard?

Speed limits indicate the maximum distance a vehicle running on that road can safely cover in one hour. Over speeding could lead to sever accidents and even pose threat to ones life.

77. A body can have zero average velocity but not zero average speed. Why?

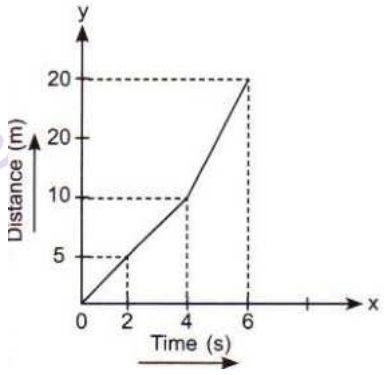
The average velocity of a body is zero if its displacement is zero, i.e. the object comes back to its initial position. However, the distance covered by the body is not zero, hence average speed is non-zero.

78. Why is the motion of a train starting from one station stopping at the other is non- uniform?

When the train starts from rest from a station, it accelerates to attain a maximum velocity. Thereafter, on reaching the next station, brakes are applied and it retards before it finally comes to rest. Thus, the motion of the train is non-uniform.

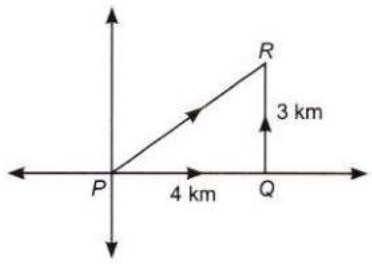
79. Represent the given data graphically

Time (in sec)	0	2	4	6
Distance (in m)	0	5	10	20



80. A cyclist travels a distance of 4 km from P to Q and then moves a distance of 3 km at right angle to PQ. Find his displacement.

PQ = 4 km, QR = 3 km



Displacement PR = $\sqrt{PQ^2 + QR^2}$

(Pythagoras theorem)

$= \sqrt{4^2 + 3^2} = 5$ km

81. The brakes applied to a train moving at 90 km/h produces a retardation of 5 m/s^2. What distance will it cover before coming to a stop?

u = 90 km/h = 90 x $\frac{5}{18} ms^{-1}$

V = 0, a = -5 ms^{-2}

Distance, s = $\frac{v^2-u^2}{2a} = \frac{0-(25)^2}{2\,X\,(-5)}$

= 62.5 m

82. A train starting from rest moves with uniform acceleration of 5 m/s^2. Find its velocity when it has travelled a distance of 1 km.

Initial velocity, u = 0

Acceleration a = 5 ms^{-2}

Displacement s = 1 km = 1000 m

Final velocity v = ?

By third equation = $v^2 = u^2 + 2$ as

$\Rightarrow$ v = $\sqrt{2\,as}$

$= \sqrt{2\,X\,5\,X\,1000}$

= 100 m/s.

I. Short Answer questions

83. Distinguish between displacement and distance covered by a body in given time.

Distance	Displacement
1. The length of path covered by a moving object irrespective of the direction in which object is moving	1. The shortest distance from initial position of an object to its final position
2. It is a scalar quantity	2. It is a vector quantity
3. It cannot be zero for a moving body	3. It can be zero if object comes back to its starting point.
4. It is always greater than or equal to displacement	4. It can be equal to distance only if the body travels in straight line, otherwise is always smaller than distance
5. It is always positive	5. It can be positive, negative or zero.

84. (a) If you divide the total distance travelled on a car trip, are you calculating average speed or magnitude of average velocity?

b) Under what circumstances are the two quantities same? Illustrate with the help of an example.

a) Average speed

b) When a body, say a car, travels 100 km on a straight highway, then the distance travelled is equal to displacement. In such a situation, average speed equals the magnitude of average velocity.

85. A train covers half of its journey with a speed of 30 ms^{-1} and other half with a speed of 40 ms^{-1}. Calculate its average speed for the entire journey.

Let length of each half of journey $= x$

Time taken for each half $= t_1$ and t_2 respectively

$\therefore\ t_1 = \frac{x}{30}s,\ \ t_2 = \frac{x}{40}s,$ (time $= \frac{distance}{speed}$)

Total time, t $= t_1 = \frac{x}{30} + \frac{x}{40} = \frac{2x}{120}$

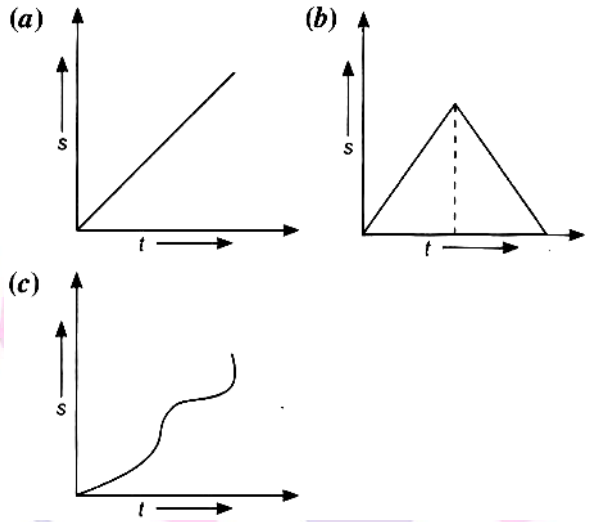
Total distance $= 2x$

Average speed $= \frac{distance}{time} = \frac{2x}{7x/120}$

$= \frac{2\ x\ 120}{7} = 34.3$ m/s.

Speed of the entire journey is 34.3 m/s.

86. What type of motion is represented by following displacement – time graph:



a) Linear motion with constant velocity

b) Linear motion with constant velocity after which the direction of motion reverses and body moves with constant velocity.

c) Non-uniform motion.

87. Starting from a stationary position, Anil paddles his bicycle to attain a velocity of 10 ms^{-1} in 25 s. Then, he applies brakes such that he again comes to rest after next 50 s. Calculate the acceleration of the bicycle in both cases. Also find the total distance covered by Anil.

Initial velocity $u_1 = 0$ final velocity

$v_1 = 10ms^{-1}$, and time, $t_1 = 25$ s

Acceleration, $a_1 = \frac{v_1 - u_1}{t_1} = \frac{10-0}{25} = \frac{2}{5}$ ms^{-2}

Distance $s_1 = u_1t_1 + \frac{1}{2}a_1t_1^2$

$= 0 + \frac{1}{2}$ x $\frac{1}{2}$ x 25 x 25

= 125 m

Again, $u_2 = v_1 = 10$ ms^{-1}, $v_2 = 0$, $t_2 = 50$ s

Acceleration, $a_2 = \frac{v_2 - u_2}{t_2} = \frac{0-10}{50} = \frac{-1}{5}$ ms^{-2}

Distance, $s_2 = u_2t_2 + \frac{1}{2}a_2t_2^2$

$= 10$ x 50 $+ \frac{1}{2}$ $(-\frac{1}{5})$x 50 x 50

= 500 - 250 = 250 m

Total distance $= s_1 + s_2 = 125\text{ m} + 250\text{ m}$

= 375 m

Total distance covered by Anil is 375 m.

88. Rajeev went from Delhi to Chandigarh on his motorbike. The odometer of bike reads 4200 km at the start of the trip and 4460 km at the end of his trip. If Rajeev took 4h 20 min to complete his trip, find the average speed and average velocity in kmh^{-1} as well as ms^{-1}

Distance covered = 4460 km – 4200 km

= 260 km

Time taken = 4 h 20 min = $4\frac{1}{3}$ h = $\frac{13}{3}$ h

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

$= \frac{260\ km}{\left(\frac{13}{3}\right)h} = 60$ km / h

= In m/s, average speed = $\left(60 \times \frac{5}{18}\right) = 16.67$ m/s.

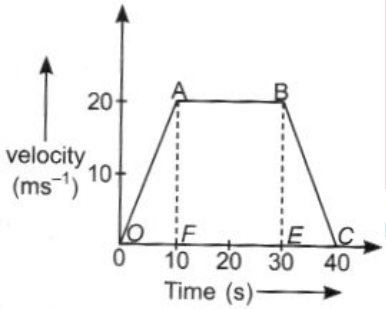
89. The velocity –time graph of a body is shown below :

a) State the kind of motion represented by OA and AB.

b) Find the velocity of the body after 10 s and after 40 s.

c) What is the negative acceleration of the body?

d) Find the distance travelled between 10^{th} and 30^{th} second.



a) OA : Uniform acceleration ; AB : Constant velocity

b) Velocity after 10s = 20ms^{-1} ; velocity after 40s = zero

c) Negative acceleration = slope of BC = $\frac{0-20}{40-30}$ = -2 ms^{-2}

d) Distance travelled between 10^{th} and 30^{th} second

= Area of rectangle ABEF

= AB x AF = (30 – 10) (20) = 400 m

90. While arriving Jayant travels 30 km with a uniform speed of 40 km / h and next 30 km with a uniform speed of 20 km / h. Find his average speed.

Distances, s_1 = 30 km ; s_2 = 30 km

Speeds, v_1 = 40 km/ h; v_2 = 20 km / h

To find average speed (v_{av})

Average speed $= \frac{Total\ distance}{Total\ time} = \frac{s_1 + s_2}{t_1 + t_2}$

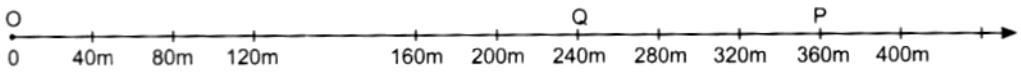
$s_1 + s_2$ = 30 km + 30 km = 60 km

$t_1 = \frac{s_1}{v_1} = \frac{30}{20}$ = 0.75 h + 1.5 = 2.25 h

$\therefore t_1 + t_2$ = 0.75 + 1.5 = 2.25 h

$\therefore v_{av} = \frac{60\ km}{2.25\ h}$ = 16.67 km / h.

91. A car is moving along a straight line. It moves from 0 to P in 18 s and returns from P to Q in 6s. Find its average velocity and average speed in going from (i) 0 to P and back to Q.



Distance OP = 360 m, PQ = 360 - 240 = 120 m and OQ = 240 m

ii) Distance OP + PQ = 360 + 120 = 480 m

Time = 18 s + 6s = 24 s

Displacement = OQ = 240 m

$\therefore$ Average velocity = $\frac{240\ m}{24\ s}$ = 10 m/ s.

92. A powerful motorcycle can accelerate from rest to 20 m/ x in only 4s.

a) what is its average acceleration? b) How far does it travel in that time?

Initial velocity, u = 0, final velocity v = 28 mS^{-1}, time t = 4 s.

a) Acceleration, a = $\frac{v-u}{t} = \frac{28-0}{4}$ = 7 mS^{-2}

b) Distance, s = ut + $\frac{1}{2}at^2$

= 0 + $\frac{1}{2}$ x 7 x $[4]^2$ = 56 m

93. Name a device that measures distance travelled by automobiles. A body travels a distance of 15m from A to B and then moves a distance of 20 mat right angle to AB. Calculate the total distance travelled and the displacement.

An odometer measures the distance travelled in automobiles.

Let body moves 20 m from B to C

Distance = AB + BC

= 15 m + 20 m = 35 m

Displacement = AC = $\sqrt{AB^2 + BC^2}$

= $\sqrt{(15)^2 + (20)^2}$

= $\sqrt{625}$ = 25 m

94. a) A train 100 m along is moving with a constant velocity of 60 kmh^{-1}. Find the time it takes to cross the bridge 1 km long.

b) The slope of the line on a position time graph reveals information about an object's velocity. What conclusion can you draw regarding the motion of an object, if the position – time graph is a :

i) horizontal line parallel to time axis

ii) straight line at 45^0 to time axis

iii) curve

a) Distance travelled by train = length of bridge + length of train = 1000 m + 100 m = 1100 m.

V = 60 km/h = 60 x $\frac{5}{18} = \frac{50}{3}\ ms^{-1}$

Time taken, t = $\frac{1100\ m}{(\frac{50}{3})ms^{-1}}$ =66s

b) i) The object is at rest

ii) The object is moving at constant velocity

iii) The motion of the object is non-uniform.

95. The brakes applied to a car produce as acceleration of $6ms^{-2}$ in the opposite direction to the motion. If the car takes 2s to stop after the application of brakes, calculate the distance it travels during this time.

Acceleration a = - $6ms^{-2}$

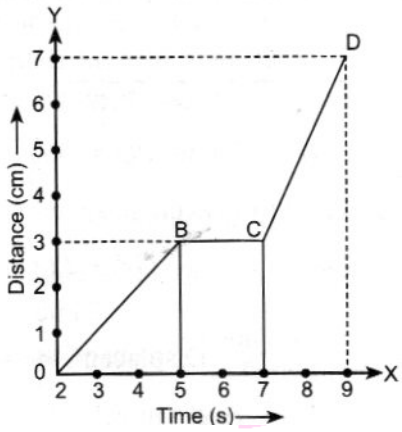
Final velocity v = 0

Time, t = 2 s

Initial velocity, u = v – at = 0 – (-6) (2) = 12 ms^{-1}

Distance travelled, $x = \frac{v^2 - u^2}{2a} = \frac{0-(12)^2}{2\times(-6)}$ = 12m

96. The graph given below shows the position of a body at different times. Calculate the speed of the body as it moves from :



i) A to B b) B to C c) C to D

i) Speed from A to B = Slope AB

$= \frac{(3-0)\,cm}{(5-2)\,s}$ = 1 cm/ s.

ii) Speed from B to C = slope BC = zero

iii) Speed from C to D = slope CD $\frac{(7-3)\,cm}{(9-7)\,s}$ = 2 cm / s

97. a) Define average speed

b) A bus travels a distance of 120 km with a speed of 40 km/h and returns with a speed of 30 km/h. Calculate the average speed for the entire journey.

a) Average speed is the total distance travelled by a body divided by the total time taken.

b) s = 129 km, u_1 = 40 km/h

t = $\frac{s}{u_1}$ = $\frac{120}{40}$ = 3h

u_2 =30 km/h, t_2 = $\frac{s}{u_2}$ = $\frac{120}{30}$ = 4h

[t = $t_1 + t_2$ = 3 + 4 = 7 hr]

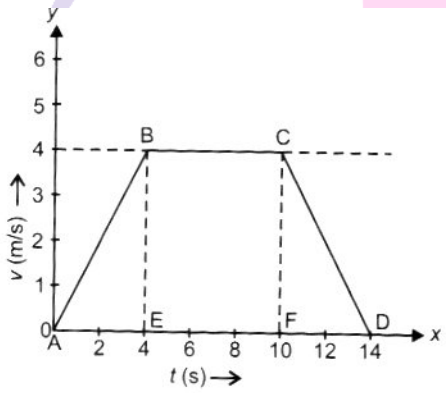
Average speed = $\frac{120km}{7h}$ = 17.14 km/ h

98. Study the given graph and answer the following questions.

i. Which part of the graph shows accelerated motion?

ii. Which part of the graph shows retarded motion?

iii. Calculate the distance travelled by the body in first 4 seconds of journey graphically.



i) AB shows uniformly accelerated motion.

ii) CD shows uniformly retarded motion.

iii) Distance = area of Δ ABE

= $\frac{1}{2}$ X AE x BE = $\frac{1}{2}$ X 4 X 4 = 8 m

99. A boy runs for 10 min at a uniform speed of 9 kmh. At what speed should be run for the next 20 min so that the average speed comes to 12 km/hr?

Speeds v_1 = 9km / h, v2 =?

Times t_1 = 10 min = (1/ 6)h, t_2 = 20 min = $\frac{1}{3}$ h

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

$v_{av} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$

$12 = \frac{\left(9 \times \frac{1}{6}\right) + \left(\frac{v_2}{3}\right)}{\left(\frac{1}{6} + \frac{1}{3}\right)}$

$12 = 2\left[\frac{3}{2} + \frac{v_2}{3}\right]$

$\Rightarrow 6 = \frac{9 + 2v_2}{6}$

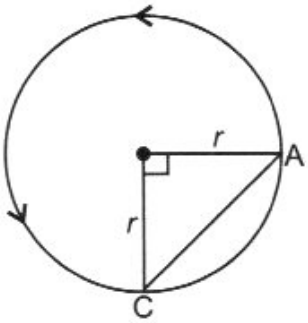
Or $v_2 = \frac{27}{2}$ = 13.5 km / h

100. a) Define uniform acceleration. What is the acceleration of a body moving with uniform velocity?

b) A particle moves over three quarters of a circle of radius r. What is the magnitude of its displacement?

a) The acceleration of a body is said to be uniform if its velocity increases or decreases by equal amounts in equal intervals of time. When a body moves with uniform velocity, its acceleration is zero.

b) If a particle starts from A and stops at C, then displacement = AC



By Pythagoras Theorem, AC = $r\sqrt{2}$

101. Velocity – time graph for the motion of an object in a straight line parallel to the time axis.

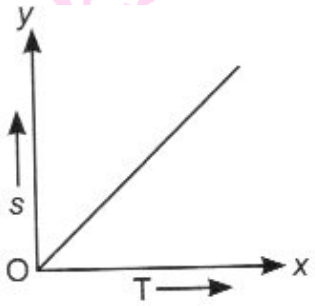
a) Identify the nature of motion of the object.

b) Find the acceleration of the object.

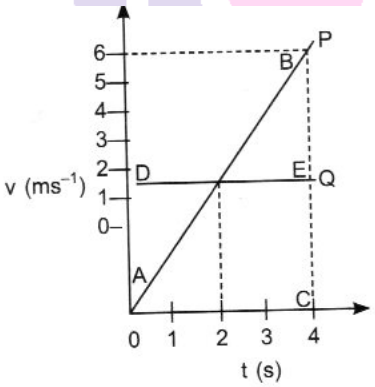
c) Draw the shape of distance –time graph for this type of motion.

a) Uniform motion b) Zero

c)



102. The speed – time graphs of two cars are represented by P and Q as shown below.



a) Find the difference in the distance travelled by the two cars (in m) after 4s

b) Do they ever move with the same speed? If so when?

c) What type of motion car P and Q are undergoing?

a) Distance travelled by P = area of Δ ABC

$= \frac{1}{2}$ x BC x AC

$= \frac{1}{2}$ x 6 x 4

= 12 m

Distance travelled by P = area of Δ ABC

= AD x AC

= 1.5 x 4 = 6 m

Difference = 12m – 6 m = 6m

b) Their speed is same at t = 2.8

c) P : Uniform acceleration

Q : Constant speed

103. A boy runs for 10 min at a uniform speed of 9km/h. At what speed should be run for the next 20 min so that the average speed comes to 12 km/h?

Total time = 10 min + 20 min

= 30 min = 0.5 h

Let speed for second interval = v

Total distance = (9 km / h x $\frac{10}{60}h$) + (v x $\frac{20}{60}$ h)

$= \left(\frac{3}{2} + \frac{v}{3}\right)$ km

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

$\Longrightarrow$ 12 km / h = $\frac{\frac{3}{2}+\frac{v}{3}}{0.5}$

$\Longrightarrow$ v = 13.5 km / h

104. What does the odometer of an automobile measure? Which of the following is moving faster ? Justify your answer

i) A scooter moving with a speed of 300m per minute

ii) A car moving with a speed of 36 km per hour.

The odometer of an automobile measures the distance travelled by it.

a) Speed of scooter = 300 m/min

$= \frac{300m}{60s} = 5\ mS^{-1}$

b) Speed of car = 36 km / h

$= \frac{300m}{60s} = 5\ mS^{-1}$

$= 36 \times \frac{5}{18}\ mS^{-1} = 10\ mS^{-1}$

Thus , car is moving faster.

105. A car travels from stop A to shop B with a speed of 30 km / h. Find

i) displacement of the car **ii) distance Travelled By The Car**

iii) Average speed of car

i) Displacement of the car = zero, as it returns back to initial point.

ii) Let distance from A to B = x

Thus total distance from A to B and B to A = $2x$

iii) Time taken from A to B = $\frac{x}{30}\ h$ and from B to A = $\frac{x}{50}\ h$

$$\text{Total time} = \frac{x}{30} + \frac{x}{50} = \frac{8x}{150}\ \text{h}$$

$$\text{Average speed} = \frac{Total\ distance\ travelled}{\text{Time taken from}}$$

$$= \frac{2x}{\frac{8x}{150}}\ \text{h} = 37.5\ \text{km}h^{-1}$$

106. A car moves with a speed of 30 km/h for half an hour. 25km/h for one hour and 40 km / h for two hours. Calculate the average speed of the car

$$\text{Average speed} = \frac{Total\ distance\ travelled}{\text{Time taken from}}$$

Time = 0.5 h + 1 h + 2 h = 3.5 h

Distance = (30 x 0.5) + (25 x 1) + (40 x 2)

[as distance = speed x time]

= 15 + 25 + 80 = 120 km

$$\text{Average speed} = \frac{120km}{3.5\ h} = 34.28\ \text{km / h}$$

107. A bus accelerates uniformly from 54 km/h to 72 km/h in 10 seconds, calculate

i) acceleration in m/s^2

ii) distance covered by the bus in metres during this interval.

u = 54 km/h = 54 x $\frac{5}{18}$ m/s.

= 15 m/s, v=72 km/h

= 72 x $\frac{5}{18}$ m/s = 20 m/s, t = 10s

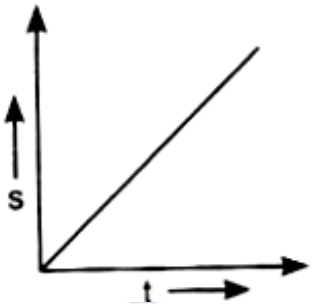
i) $a = \frac{v-u}{t} = \frac{20-15}{10} = 0.5\ \text{m}/s^2$

ii) $s = \frac{v^2-u^2}{2a} = \frac{(20)^2-(15)^2}{(2\times 0.5)} = 175m$

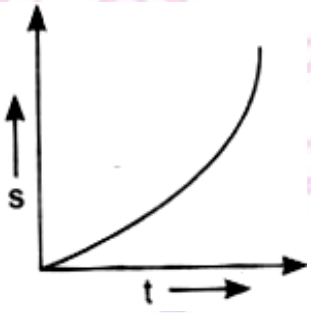
108. Draw the shape of the distance- time graph for uniform and non- uniform motion of object, A bus starting from rest moves with uniform acceleration of 0.1 ms^{-2} for 2 minutes. Find.

a) the speed acquired **b) the distance travelled**

u = 0, a = 0.1 ms^{-2} , t = 120 s



Uniform motion



Non Uniform motion

a) v = u + at = 0 + 0.1 x 120 = 120.1 ms^{-1}

b) s = $\frac{v^2-u^2}{2a}$ = $\frac{(12)^2-0}{2\ x\ 0.1}$ = 720 m

109 A car travels at 54 km/h for first 20s, 36 $\frac{km}{h}$ for next 30s and finally 18 km/h for next 10 s. Find its average speed.

Speeds : $v_1 = \frac{54km}{h} = \frac{15m}{s}$: $v_2 = \frac{36km}{h}$

= $10\frac{m}{s}$. v_3 = $18\frac{km}{h}$ = $5\frac{m}{s}$

Time : t_1 = 20s , t_2 = 30s, t_3 = 10s

Distance : s_1 = 15 × 20 = 300m

s_2 = 10 × 30 = 300m

s_3 = 5 × 10 = 50m

Total Distance : $s = s_1 + s_2 + s_3$

= 300 + 300 + 50

= 650 m

Total time = $t_1 + t_2 + t_3$

= 20s + 30s + 10s = 60s

Average speed = $\frac{650}{60}$ = $10.83\frac{m}{s}$

110. Distinguish between uniform motion and non-uniform motion. Is uniformly accelerated motion uniform motion? Give one example each of uniform and non-uniform motion.

i) When a body travels equal distance in equal intervals of time. Its motion is uniform. When the body travels unequal distance in equal intervals of time. Its motion is non-uniform.

ii) No

iii) Example of Uniform motion: A car moving on a straight road with constant speed.

Example of Non-uniform motion : A car moving in a crowded market.

111. The speedometer readings of a car are shown below. Find the acceleration of the car and its displacement.

Time	Speedometer
9.25 am	36 km/h
9.45 am	72 km/h

u = 36 km/h = 10 m/s. V = 72 km/h = 20 m/s, t = 20 min = 1200s

$a = \frac{v-u}{t} = \frac{20-10}{1200} = \frac{10}{1200} = \frac{1}{120}\ ms^2$

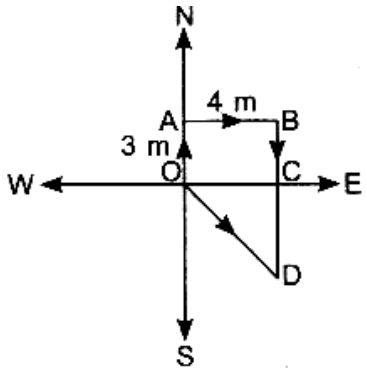
$s = ut + \frac{1}{2}at^2$

$= 10 \times 1200 + \frac{1}{2} = \frac{1}{120} \times 1200 \times 1200$

= 12000 + 6000 = 18000 m = 18 km

112. A particle moves 3 m north then 4 m east and finally 6m south. Calculate the displacement. [CBSE 2012]

The particle starts from 0, moves to A, then to B, then reaches D,



OA = 3 m

AB = 4 m

BD = 6 m

Since, BC = AO = 3 m

$\Rightarrow \quad CD = 3\,m$

OC = AB = 4 m

Displacement = OD = $\sqrt{OC^2 + CD^2}$ [Pythagoras theorem]

Thus, OD = $\sqrt{(4)^3 + (3)^2} = \sqrt{16 + 9} = 5m$

I. LONG ANSWER TYPE QUESTIONS

113. Answer the following questions:

i) An object moves on a circular path of radius r. What will be the distance and displacement when it completes half revolution?

ii) Give the name of physical quantity that corresponds to the rate of change of velocity and write its SI unit

iii) Why is the motion in a circle with constant speed called accelerated motion?

(i) Distance = $\frac{1}{2}$ of circumference = πr

Displacement = Diameter = 2r

(ii) Acceleration

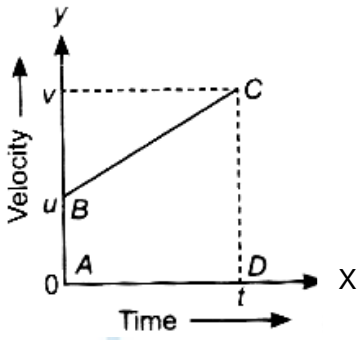
Unit : m/s^2

(iii) Velocity of object changes due to change in direction. So, it is called accelerated motion.

114. Draw velocity time graph for a body that has initial velocity 'u' and is moving with uniform acceleration 'a'. Use it to derive v = u + at ;

$S = ut + \frac{1}{2}at^2$ and $v^2 = u^2 + 2as$

Slope of graph = a = acceleration



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

Or v = u + at

s = area of ABCD

$s = \frac{1}{2}$ (AB + CD) (AD)

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

$s = \frac{1}{2}$ (u + u + at) (t)(from list equation)

$s = \frac{1}{2}$ (2u + at) t

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

$s = \frac{1}{2}$ (u + v) $\frac{(v-u)}{a} = \frac{(v^2-u^2)}{2a}$

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

115. Define uniform circular motion. Is it an accelerated motion? If yes, what is the direction of acceleration? Give an example of this type of motion?

Uniform circular motion :

i) A body moving with uniform speed along a circular path is said to be in uniform circular motion.

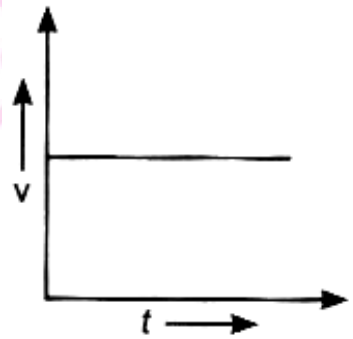
ii) Direction of motion changes at every point. Thus, velocity changes though speed is constant. Thus it is also called accelerated motion.

iii) Acceleration is directed towards centre of circular path. Direction of velocity is given by a tangent drawn at any point of the path

Example : A stone tied to a thread and whirled around, rotating fan etc.

116. a) Draw a velocity –time graph for an object in uniform motion. Show that the slope of velocity time- graph gives acceleration of the body.

b) An aeroplane starts from rest with an acceleration of 3 ms^{-2} and tasks a run for 35s before taking off. What is the minimum length of runway and with what velocity the plane took off?



Acceleration $= \frac{Velocity\ change}{Time\ interval}$

Or $a = \frac{y-intercept\ in\ v-t\ graph}{x-intercept\ in\ v-t\ graph}$

Or a = Slope of v – t graph

Hence, proved

b) Initial velocity u = 0

Acceleration a = 3 ms^{-2}

Time t = 35 s

Velocity of taken off = 105 v = u + at

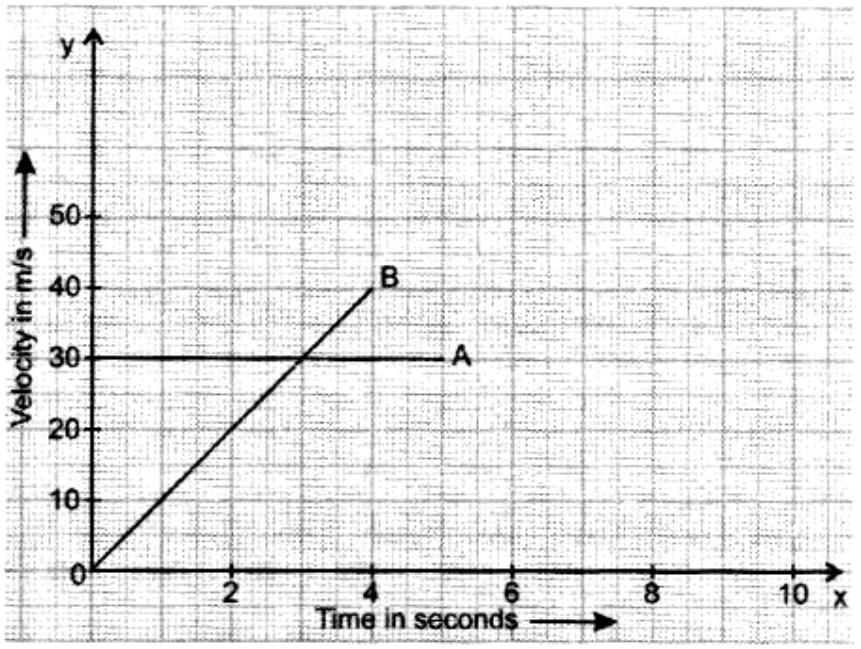
0 + 3 x 35 = 105 ms^{-1}

Length of runway,

S = ut $+\frac{1}{2}at^2$ $= 0 + \frac{1}{2}$ x 3 x 35 x 35

= 1837.5 m

117. The velocity – time graph for motion of two bodies A and B is shown. Read the graph carefully and answer the following questions:



a) Which of the two bodies has a higher velocity at time (a) t =2s (b) t = 4s?

b) Which of the two bodies has (a) constant velocity (b) increasing velocity?

c) At what time is the velocity of the two bodies same?

d) What are the velocities of A and B at time t = I s?

e) What is the change is the velocity of body R in an interval of 2s?

a) At t = 2s, velocity of A, $v_a = 30\ ms^{-1}$

Velocity of B, $v_a = 20\ ms^{-1}$

$\therefore v_A > v_B$

At t = 4s, $v_A = 30\ ms^{-1}$, $v_b = 40\ ms^{-1}$,

$\therefore v_B > v_A$

b) A has constant velocity and B has increasing velocity.

c) At $t = 3s$, velocity of both A and B is same,

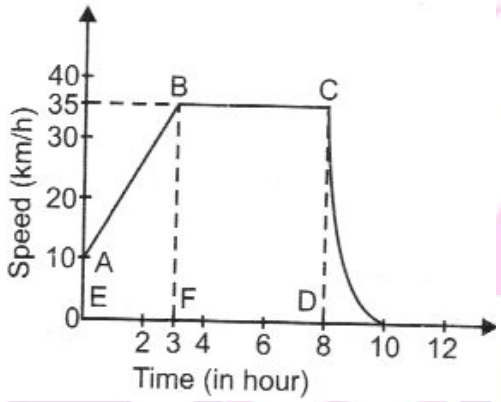
i.e.. $30\ ms^{-1}$

d) At $t = 1s$, $v_A = 30\ ms^{-1}$, and $v_B = 10\ ms^{-1}$

e) In 2s, velocity of B changes from 0 to $20\ ms^{-1}$

$\therefore \triangle v_B = 20\ ms^{-1}$

118. The graph given alongside shows how the speed of a car changes with time.



(i) What is the initial speed of the car?

(ii) What is the maximum speed attained by the car?

(iii) Which part of the graph shows zero acceleration?

(iv) Which part of the graph shows varying retardation?

(v) Find the distance travelled in first 8 hours.

(i) 10km/h (at A) (ii) 35 km/h (iii) BC (iv) CD

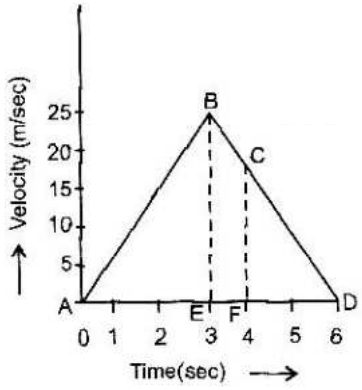
(v) Area of the graph as shown shaded

= Area of trapezium ABEF + Area of rectangle BCDF

$$= \left[\frac{1}{2}\,(EA + FB \times EF) \times EF\right] + (BC \times FB)$$

$$= \left(\frac{1}{2} \times 45 \times 3\right) + (5 \times 35) = 242.5\,m$$

119. Study the velocity – time graph and calculate.



a) The acceleration from A to B

b) The acceleration from B to C

c) The distance covered in the region ABE

d) The average velocity from C to D

e) The distance covered in the region BCFE

(a) $a = \frac{v_A - v_B}{t} = \frac{25}{3} = 8.33 m/s^2$

b) $a = \frac{17-25}{4-3} = \frac{-8}{1} = 8 m/s^2$

c) $s = area\ of\ \triangle ABE = \frac{1}{2} \times 3 \times 25 = 37.5 m$

d) $v_{avg} = \frac{area\ of\ \triangle ACFD}{FD} = \frac{\frac{1}{2} \times 2 \times 17}{2}$

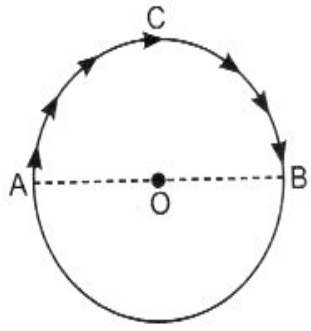
$= 8.5$ m/s

e) s = Area of trapezium BCFE

$= \frac{1}{2}(CF + BE) \times EF = \frac{1}{2} \times 42 \times 1$

$= 21\ m$

120. An Insect moves along a circular path of radius 10cm with a constant speed. It takes 1 min to move from a point on the path to the diametrically opposite point, find (i) the distance covered (ii) the speed (iii) the displacement (iv) the average velocity. [CBSE 2014]



(i) Distance covered = Length of arc AB

$= \pi r$

$= 3.14 \times 10 cm$

$= 31.4$ cm

(ii) Speed = $= \frac{Distance}{Time} = \frac{31.4cm}{60s}$

$= 0.52cm/s$

(iii) Displacement = Diameter

$= 2r = 20cm$

(iv) Average velocity = $\frac{Displacement}{Time}$

$= \frac{20cm}{60s}$ $0.3\ cm/s$

121. The following table gives the data about motion of a car

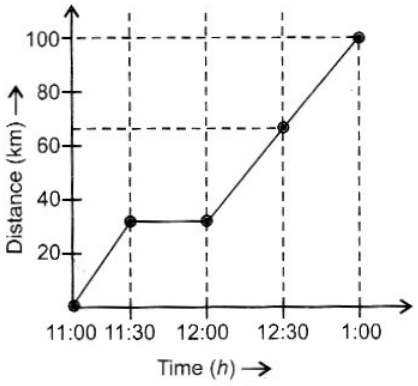
Time (h)	11:00	11:30	12:00	12:30	1:00
Distance (km)	0	30	30	65	100

Plot the graph.

(i) Find the speed of the car between 12:00 hours and 12:30 hours

(ii) What is the average speed of the car?

(iii) is the car's motion an example of uniform motion ? Justify [CBSE 2011]



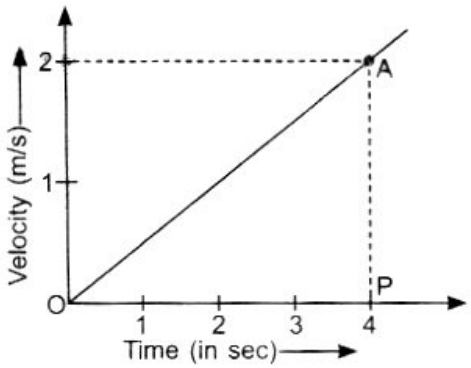
(i) Speed = Slope between 12:00 – 12:30

$= \frac{65-30}{30} = 1.17km/min$

(ii) Average speed = $\frac{100km}{2h} = 50km/h$

(iii) No. because it covers unequal distance in equal time intervals.

122. The velocity- time graph of a particle of mass 50g moving in a definite direction is shown in the following figure. Answer the questions based on this figure.



a) What is the velocity of the particle at point 'A'?

b) Find the momentum of the particle at time $t = 4s$

c) What does the slope of a graph represent?

d) Calculate the distance travelled in 4 seconds. [CBSE 2011]

a) Velocity at A = 2 m/s

b) At $t = 4s, p = mv = \frac{50}{1000}\ kg \times 2\frac{m}{s}$

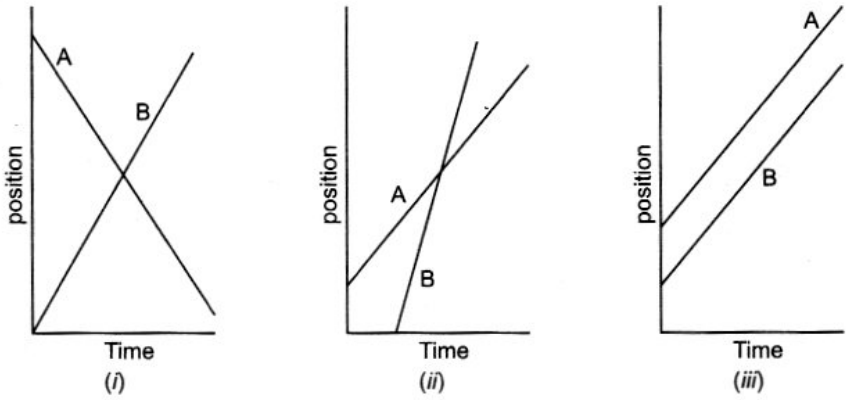
$= 0.1$ kg m/s

c) Acceleration

d) Distance = Area of ΔOAP

$= \frac{1}{2} \times 4 \times 2 \quad = 4$m

123. The position- time graphs of two objects A and B in three different situations for a particular duration are as shown below.



a) In which situation the distance between them will remain same?

b) In which situation they are moving in opposite directions?

c) Are they crossing each other in any situation (s)?, If so, how is it possible is occur?

a) In (iii) as the graphs are parallel to each other

b) in (i) point A moves towards the origin in opposite direction to B.

c) They cross in (i) and (ii) at point where graphs intersect each other.

NCERT BASED ACTIVITIES

Short Answer Type Questions

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

No the object might have travelled some distance, provided the initial position and final position of the body coincide.

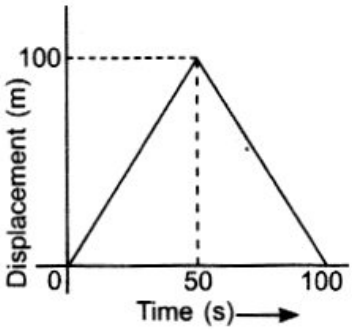
2. How will the equations of motion for an object moving with a uniform velocity then v= u and a = 0.

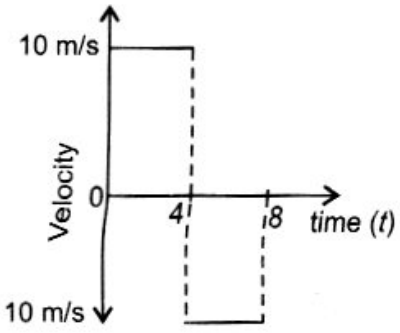
$\therefore v = u + at \implies v = u$

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

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

3. 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.





4. A car starts from rest and moves along the x-axis with constant acceleration of $5ms^{-2}$ for 8 seconds. It then continues with constant velocity. What distance will the car cover in 12 seconds since it started from rest?

$u = o,\ a = 5ms^{-2}, t = 8s$

$\therefore \quad s_1 = ut + \frac{1}{2}at^2 = \frac{1}{2} \times 5 \times 8 \times 8$

= 160m [for first 8 s]

Velocity at the end of 8s,

v = u + at = 0 + 5 x 8

$= 40\ ms^{-1}$. **(for last 4 s)**

$\therefore \quad s_2 = vt = 40 \times 4 = 160m$

Total Distance = $s_1 + s_2 = 160m + 160m$

= 320m

5. A motorcyclist drives from A to B with a uniform speed of $30km/h^{-1}$ and returns back with a speed of $20km/h^{-1}$, Find its average speed.

Let distance travelled from A to B = x

$\therefore \ Total\ Distance = x + x = 2x$

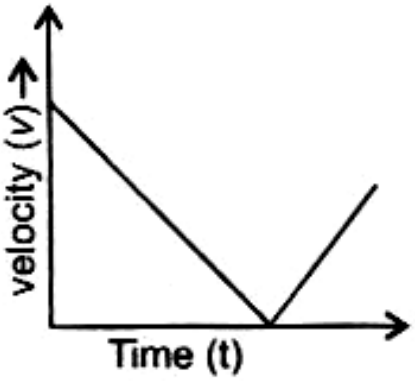
Time taken to travel from A to B = $t_1 = \frac{x}{30}h$

Time taken to travel from B to A = $t_2 = \frac{x}{20}h$

Total time , $t = t_1 + t_2 = \frac{x}{30} + \frac{x}{20} = \frac{x}{12}h$

Average speed = $\frac{2x}{x/12} = \mathbf{24}km/h$

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



Long Answer Type Questions

1. **An object is dropped from rest at a height of 150m and simultaneously another object is dropped from rest at a height 100m. What is the difference in their heights after 2s if both the objects drop with the same acceleration? How does the difference in heights vary with time?**

Object 1 :

$u = o, h = 150m,\ t = 2s, a = 10\ m/s^2$

After 2s, v = u + at = 20m/s

Distance, s = $\frac{v^2-u^2}{2a} = \frac{400}{20} = 20m$

Height $h_1 = 150m - 20m = 130m$

Object 2

$u = o, h = 100m, t = 2s, a = 10\ m/s^2$

V = u + at = 20m/s

s = $\frac{v^2-u^2}{2a} = \frac{400}{20} = 20m$

$h_2 = 100m - 20m = 80m$

Difference = $h_1 - h_2 = 50m$

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

$u = o, s_1 = 20m, s_2 = 160m$

u = 0, s = 20m t = 2s

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

or $a = 2s/t^2 = \frac{2\times 20}{2\times 2} = 10ms^2$

v = u + at = 10 x 2 = $20ms^{-1}$

For second interval,

u = $20ms^{-1}, s = 160m, t = 4s$

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

160 = 20 x 4 + $\frac{1}{2} \times a \times 16$

a = $10ms^{-2}$

i.e. 'a' is constant

∴ Velocity after 7 seconds = v = u + at

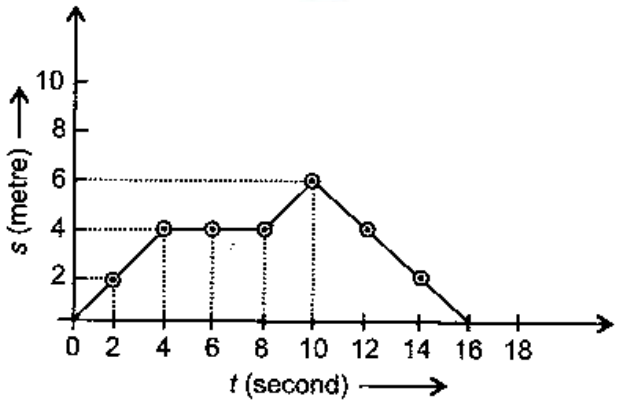
= 0 + 10 x 7

= 70 m/s

3. Using following data, draw time – displacement graph for a moving object:

Time (h)	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 4s, for next 4s and for last 6s



v_{avg} for first 4s = Slope from t = 0s to t = 4s

$= \frac{4-0}{4} = 1$ m/s

v_{avg} (for t = 4s to t = 8s) is 0 as slope is zero,

v_{avg} (for t = 10s to t = 16s) $= \frac{-6}{6} = -1\ m/s$

Or the body is moving towards the origin.

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

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

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

u = 5 x $10^4 ms$, $a = 10^4 m/s^2$, $v = 2u$

(i) v = u + at

2u = u + $10^4 t$.

u x 10^{-4} = t

5 x 10^4 x $10^{-4} = t$

Or t = 5 s

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

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

$= 3.75 \times 10^5 m$

5. Obtain a relation for the distance travelled by an object moving with a uniform acceleration in the interval between 4^{th} and 5^{th} seconds.

If u = initial velocity, then final velocity = 2u.

For acceleration a.

At t = 4s, $s_1 = ut + \frac{1}{2}at^2 == 4u + 8a$

At t = 5s, $s_2 = ut + \frac{1}{2}at^2 = 5u + \frac{25a}{2}$

$s_2 - s_1 = (5-4)u + \frac{a}{2}(25-16) = u + \frac{9a}{2}$

6. **Two stones are thrown vertically upwards simultaneously with their initial velocities $u_1 and\ u_2$ respectively, Prove that the ratio of heights reached by them would be in the ration of heights reached by them would be in the ratio of $u_1^2 : u_2^2$ (Assume upward acceleration is –g and downward acceleration is –g and downward acceleration to be +g)**

Given : velocities $u_1\ and\ u_2$

Height $h_1 and\ h_2$

Accelerations – g and – g

At highest points, velocities $v_1 = v_2 = 0$

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

$\Rightarrow \quad v_1^2 = u_1^2 - 2gh_1$

And $v_2^2 = u_2^2 - 2gh_2$

$\Rightarrow \quad 0 = u_1^2 - 2gh_1$

And $0 = u_2^2 - 2gh_2$

$\Rightarrow \quad u_1^2 = 2gh_1$

And $u_2^2 = 2gh_2$

$$\frac{u_1^2}{u_2^2} = \frac{2gh_1}{2gh_2}$$

$or \quad u_1^2 : u_2^2 = h_1 : h_2$