Solution

MOTION

Class 09 - Science

Section A

1.

(d) 6.36 km h^{-1}, 0

Explanation:

Time taken by the man to go from his home to the market, $t_1 = \frac{5.5 \text{ km}}{5.5 \text{ km h}^{-1}} = 1.0$ h

Time taken by the man to return back from the market to his home, $t_2 = \frac{5.5 \text{ km}}{7.5 \text{ km h}^{-1}} = 0.73$ h

$\therefore$ Total time taken = $t_1 + t_2$ = 1.0 h + 0.73 h = 1.73 h = 140 min

In t = 0 to 104 min, total distance travelled = 5.5 km + 5.5 km = 11 km

Displacement = 0 (As the boy returns back home)

$\therefore$ Average speed

$= \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{11 \text{ km}}{1.73 \text{ h}} = 6.36 \text{ km h}^{-1}$

Average velocity = $\frac{\text{Displacement}}{\text{Time taken}} = 0$

2.

(b) zero

Explanation:

The average velocity for the entire swing would be zero because its final position and initial position are identical.

3.

(b) equal or less than 1

Explanation:

We know, the magnitude of displacement is the straight line distance between the initial point and the final point of the path of the moving body.

Displacement could be negative, positive, or zero. but the distance is always positive or zero when there is no motion.

So, the ratio of displacement to distance for a moving object is equal to less than 1.

4.

(d) 3.75 m

Explanation:

Height of tap = 5 m

For the first drop, $5 = ut + \frac{1}{2}gt^2 = \frac{1}{2} \times 10t^2 = 5t^2$ or $t^2 = 1$ or t = 1 s. It means that the third drop leaves after one second of the first drop, or each drop leaves after every 0.5 s. Distance covered by the second drop in 0.5 s

$= \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times (0.5)^2 = 1.25$ m

Therefore distance of the second drop above the ground = 5 - 1.25 = 3.75 m.

5.

(d) The velocity of car P is increasing at a decreasing rate from 40 s to 45 s in same direction.

Explanation:

From 40 s to 45 s, direction of car P is same but velocity is increasing at a decreasing rate of acceleration.

6. **(a)** acceleration

Explanation:

We can find out the value of acceleration from the slope of the velocity-time graph of a moving body.

Acceleration = $\frac{Change\ in\ velocity}{time}$ = Slope of the velocity-time graph provided.

7. **(a)** a $\neq$ 0

Explanation:

The negative value of acceleration signifies deceleration or in other words, the velocity is decreasing.

8.

(c) 0.5 km/hr

Explanation:

Distance = speed $\times$ time

Distance travelled in first 2 min = 7.5 $\times$ $\frac{2}{60}$ = 0.25 km

Distance travelled in last 2 min = 7.5 $\times$ $\frac{2}{60}$= 0.25 km

Total distance = 0.25 + 0.25 = 0.5 km

Total time = 2 + 2 + 56 = 60 min = 1 hr

Average speed = $\frac{0.5}{1}$

= 0.5 km/hr

9.

(c) m

Explanation:

The area under the velocity-time graph gives the distance (magnitude of displacement) which has the unit: metre (m)

10. **(a)** uniform acceleration

Explanation:

Relation among velocity, distance, time, and acceleration is called equations of motion. There are three equations of motion. Equation of motion can be used for a body having uniform acceleration.

11.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The speedometer of a car measures the instantaneous speed of the car.

12.

(d) A is false but R is true.

Explanation:

A boy goes from A to B with a velocity of 20 m/min and comes back from B to A with a velocity of 30 m/min. The average velocity of the boy during the whole journey is 24m/min.

13.

(d) A is false but R is true.

Explanation:

If the position-time graph of a body moving uniformly in a straight line is parallel to the position axis, it means that the position of body is changing at constant time. The statement is abrupt and shows that the velocity of body is infinite.

14. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

A body has a non-uniform acceleration if its velocity increases by unequal amounts in equal intervals of time.

15. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Satellites revolve around their planets in almost circular orbits with constant speed. Thus, during their motion, the speed remains constant, while the direction of motion changes continuously. As a result, there is a change in their velocity. Therefore, the motion of satellites around their planets is considered as accelerated motion.

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Initial velocity (u) = 0 , acceleration (a) = 4 m/s^2

v = u + at

v = 0 + 4 × 10

v = 40 m/s

17. **(b)** Both A and R are true but R is not the correct explanation of A.

Explanation:

Uniform velocity means that speed and direction remain unchanged.

18. **(d)** A is false but R is true.

Explanation:

Speedometer measures instantaneous speed of automobile.

19. **(b)** Both A and R are true but R is not the correct explanation of A.

Explanation:

Displacement may be positive, negative or zero. Displacement is a vector quantity.

20. **(c)** A is true but R is false.

Explanation:

When a particle is in uniform motion, the magnitude of its velocity at each instant such as t = 0, t = 1s, t = 2s ... etc. is always constant. Hence the velocity versus time graph for a particle in uniform motion along a linear path is a straight line parallel to the time axis.

21. When the object has uniform motion then displacement and distance have the same magnitude.
22. Graphically the path of an object will be linear i.e. look like a straight line when it is in uniform motion.
23. Velocity of an object is uniform if it travels equal displacement in equal intervals of time.
24. We need to specify a reference point called the origin.
25. A fixed point with respect to which the given object changes its position.
26. The area occupied below the velocity-time graph measures the distance covered by any object.
27. Displacement is the quantity which is measured by the area under velocity time graph.
28. The graph is a parabola.
29. The reference point from which the distance of a body is measured is called origin.
30. Acceleration is defined as the change in velocity per unit time.
31. If the velocity of an object decreases, then the object is said to be moving with negative acceleration.
32. Velocity is defined as the ratio of the displacement to the time taken.
33. The object in motion is considered to be a point object if the distance it travels is very large as compared to the dimensions of the object.
34. Average velocity is the ratio of the total displacement to the total time taken.
35. Both (a) and (b) are false with respect to the concept of displacement.
    a- displacement can be zero.
    b- Its magnitude can't be greater than the distance traveled by the object.
36. When the change in velocity of a body takes place in the direction of motion of the body, then the acceleration is positive.
37. S.I. unit of acceleration is metre / $second^2$ (ms^{-2}).
38. A car travelling along a straight road having much traffic increases or decreases its speed by unequal amounts in equal intervals of time.
39. Straight line, passing through the origin is the nature of the displacement time graph of a body moving with constant velocity
40. The odometer measures the distance travelled of the automobile.

Section B

41. Given

Initial velocity, u = 0

Acceleration, a = 4 ms^{-2}

Time, t = 10 s

Distance covered, S = ?

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

$S = 0 \times 10 + \frac{1}{2} \times 4 \times (10)^2$

= 0 + 200 = 200 m

therefore, distance covered = 200 m

42. Let one way distance for his trip be S.

Let t_1 be the time for his trip from home to school and t_2 be the time for his return trip.

Then $t_1 = \frac{S}{V_1} = \frac{S}{20}h$ and $t_2 = \frac{S}{V_2} = \frac{S}{40}h$

Therefore total time of trip is $T = t_1 + t_2 = \frac{S}{20} + \frac{S}{40} = \frac{3S}{40}h$

Total distance covered = 2S

Therefore average speed of Abdul $V_{av} = \frac{\text{total distance}}{\text{total time}} = \frac{25 \times 40}{35}$ = 26.7 kmh^{-1}

43. We need to calculate the time taken in each of the trip. After that, we can calculate the average speed.

$average\ speed = \frac{total\ distance}{total\ time}$

$\therefore = \frac{s}{t_1}$

$\Rightarrow 20\ km/h = \frac{s}{t_1}$

$\Rightarrow t_1 = \frac{s}{20}h$

$\Rightarrow 30 km/h = \frac{s}{t_2}$

$\Rightarrow t_2 = \frac{s}{30}h$

$(t_1 + t_2) = \frac{s}{20} + \frac{s}{30}$

$\Rightarrow (t_1 + t_2) = \frac{5s}{60} = \frac{s}{12}h$

$average\ speed = \frac{total\ distance}{total\ time}$

$= \frac{2s}{\frac{s}{12}}$

$= 2 \times 12$

$= 24\ km/hr$

44. It is given that the total distance covered by Usha in 1 min is 180 m.

Displacement of Usha in1 min = 0m

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

$= \frac{180\text{m}}{\text{lmin}} = \frac{180\text{m}}{1\text{min}} \times \frac{1\text{min}}{60\text{s}}$

= 3 m s^{-1}

Average velocity $= \frac{\text{Displacement}}{\text{Total time taken}}$

$= \frac{0m}{60s}$

$= 0\text{ms}^{-1}$

The average speed of Usha is 3 m s^{-1} and her average velocity is 0 m s^{-1}

45. Given t = 5 s

Initial speed of bus

u = 80 kmh^{-1} = $80 \times \frac{5}{18}$ = 22.2 ms^{-1}

Final speed of the bus

v = 60 kmh^{-1} = $60 \times \frac{5}{18}$ = 16.7 ms^{-1}

Now acceleration is given by the relation $a = \frac{v-u}{t} = \frac{16.7 - 22.2}{5}$ = -1.1 ms^{-2}

46. Initial velocity of body, u = 0.5 m/s

Final velocity of body, v = 0

Negative acceleration, a = -0.05 m/s^2

Now, from the first equation of the motion, we have

v = u + at, Where t= time

Put the given values, we get

0 = 0.5 + (-0.05t) ⇒ 0.5 = 0.050t

∴ t = 0.5/0.05 = 10 s

Thus, the body will take 10 s to stop.

47. We know 1 kmh^{-1} =$\frac{5}{18}ms^{-1}$

Initial speed, u = 80 kmh^{-1} = $80 \times \frac{5}{18}ms^{-1}$

= $\frac{200}{9}ms^{-1}$

Final speed, $v = 60kmh - 1 = 60 \times \frac{5}{18}ms^{-1}$

= $\frac{50}{3}ms^{-1}$

Time, t = 5s

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

= $\frac{\frac{50}{3}ms^{-1} - \frac{200}{9}ms^{-1}}{5s}$

= $\frac{-50ms^{-1}}{9\times 5s}$

=$\frac{-10}{9}ms^{-2}$

[-ve acceleration means it is retardation i.e., speed of the body is decreasing]

48. Given u = 40 ms^{-1}, v = 0, a = -2 ms^{-2} , s = ?

Using equation v^2 - u^2 = 2aS we have

0 = $(40)^2$ + 2 (-2) S or 4S = 1600 or S = 400 m

Thus the train stops in 400 m. Since the platform is 400 m long therefore the train just stops in time.

49. Initial speed of bus (u) = 80 km h^{-1}= $\frac{80\times 100}{60\times 60}$ seconds = $\frac{200}{9}$ ms^{-1}= 22.22 ms^{-1}

final speed of bus (v)= 60 km h^{-1}= $\frac{60\times 100}{60\times 60}$seconds = $\frac{50}{3}$ ms^{-1}= 16.67 ms^{-1}time (t) = 5 s

acceleration (a) = $\frac{(v-u)}{t}$ = $\frac{(16.67-22.22)}{5}$=$\frac{-5.55}{5}$/5 = -1.11 ms^{-2}

50. Given v = 72 kmh^{-1}, t = 10 second, u = 0, a = ?, v_{av} = ?, S = ?

also v = 72 × $\frac{5}{18}$ = 20ms^{-1}

Using v = u + at we have

20 = 0 + a × 10, therefore a = 2 ms^{-2}

Using v^2 - u^2 = 2as we have

S = $\frac{v^2-u^2}{2a} = \frac{(20)^2 \ -0}{2\ \times 2} = \frac{400}{4} = \ 100\ m$

Also V_{av}= $\frac{s}{t} = \frac{100}{10} = \ 10\ ms^{-1}$

51. As the motion is uniform therefore the velocity of the body will remain same even after 10s. Therefore the velocity of the body will be 10 ms^{-1}.

52. Given

Initial speed of bus, u = 0 ms^{-1}

Final speed of bus, v = ?

Acceleration, a = 0.1 ms^{-2}

Time, t = 2 min = 120 s

Distance travelled, s = ?

i) We know, v = u + at

or v = 0 + 0.1 × 120 = 12 ms^{-1}

ii) To find distance travelled, we use the equation

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

or S = 0 × 120 + $\frac{1}{2}$× 0.1 × $(120)^2$ = 720 m

Therefore

Final speed acquired = 12 ms^{-1}

Distance travelled = 720 m

53. Here, Initial velocity of car, u = 0

By Using the relation, S = ut + $\frac{1}{2}$at^2

The distance travelled in first 8s, S_1 = ut + $\frac{1}{2}$at^2 = 0 + $\frac{1}{2} \times 5 \times 8^2$ = 160 m

At this point the velocity, v = u + at = 0 + 5 $\times$ 8 = 40 ms^{-1}.

Since the velocity remains constant, So, the distance covered in last four seconds, S_2= constant velocity $\times$ time = 40 $\times$ 4 = 160 m

Hence, total distance, S = S_1 + S_2= 160 m + 160 m = 320 m

54. Given total distance travelled = 200 km

Time taken for the first half = t_1 = $\frac{S}{V_1} = \frac{100}{50} = 2h$

Time taken for the second half = t_2 = $\frac{S}{V_2} = \frac{100}{V_2}$

Now v_{av} = 70 kmh^{-1}

Therefore V_{av} = $\frac{Total\ distance\ travelled}{Total\ time\ taken} = \frac{S}{t_1 + t_2} = \frac{200}{\frac{100}{50} + \frac{100}{V_2}} = 116.6\ kmh^{-1}$

Solving for v_2 we get 116.6 kmh^{-1}.

55. Velocity = $\frac{Distance}{time}$ or distance = velocity × time

Therefore S = $\frac{120 \times 1000}{3600} \times 30 = 1000\ m$

56. Here,

Acceleration of car, a = -6 ms^{-2}; Time taken to stop the car, t = 2 s and final velocity, v = 0 ms^{-1} (finally, body is at rest).

Let 'u' be the initial velocity of car.

We know that; v = u + at ....(1)

Put the given values in equation (1), we get

0 = u + (-6ms^{-2}) $\times$ 2s or u = 12 ms^{-1}

Now , Distance covered,S = ut +$\frac{1}{2}$at^2 = (12 ms^{-1}) $\times$ (2s) + $\frac{1}{2}$(-6ms^{-2}) (2s)^2 = 24 m - 12 m = 12 m

Thus, the car will move 12 m before it stops after the application of brakes.

57. Given t = 10 min = 10 × 60 = 600 s

Initial speed of train, u = 0 ms^{-1}

Final speed of train v = 40 kmh^{-1} = 40 × $\frac{5}{18}$ = 11.1 ms^{-1}

Now acceleration is given by the relation a = $\frac{v-u}{t} = \frac{11.1-0}{600}$ = 0.0185 ms^{-2}

58. Let us assume, the final velocity with which ball will strike the ground be 'v' and time it takes to strike the ground be 't'

Initial Velocity of ball u = 0

Distance or height of fall s = 20m

Downward acceleration a = 10 ms^{-2}

As we know,

2as = v^2 - u^2

v^2 = 2as + u^2

= 2 $\times$ 10 $\times$ 20 + 0

v^2 = 400 ms^{-1}

$\therefore$ Final velocity of ball, v = 20 ms^{-1}

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

$\therefore$ Time taken by the ball to strike= $\frac{20-0}{10}$

= $\frac{20}{10}$

= 2 seconds

59. Using the equation of motion s = $ut + \frac{1}{2}at^2$

Distance travelled in 5 seconds, s = $u \times 5 + \frac{1}{2}a \times 5^2$

or $5u + \frac{25}{2}a$

Similarly, distance travelled in 4 seconds, s' = $4u + \frac{16}{2}a$

Distance travelled in the interval between 4th and 5th seconds = $(s - s') = (u + \frac{9}{2}a)m$

60. Given v_1 = 50 kmh^{-1} and v_2 = 490 kmh^{-1}

Let S be the distance. Therefore total distance travelled by the body is = S + S = 2S

Now time taken for the first motion $t_1 = \frac{S}{V_1} = \frac{S}{50}$

Time taken for the second motion $t_2 = \frac{S}{V_2} = \frac{S}{40}$

Total time taken t = t_1 + t_2 = $\frac{S}{50} + \frac{S}{40}$

Hence average speed V_{av} = $\frac{Total\ distance\ travelled}{Total\ time\ taken} = \frac{2S}{t} = \frac{2S}{\frac{S}{40} + \frac{S}{50}} = 44.5\ kmh^{-1}$

61. Initially, the piece of cloth and the loose water in it are in a state of rest. When the cloth is shaken, it is suddenly set into motion, but the loose water in it, on account of inertia of rest continues in its state of rest. Thus water comes out of cloth in the form of fine particles.

62. Side of square = 10 m

Perimeter of square = 4 × Side = 4 × 10 m = 40 m

Let farmer start moving from A which is treated as a reference point. He covers 40 m in 40 s. Therefore, distance travelled by farmer in 2 minutes and 20 seconds i.e., 140 seconds = 140 m. The farmer, therefore completes 3 rounds of field and 20 metres more distance.

Thus, position of farmer at the end of 140 seconds will be C.

Therefore, the magnitude of displacement of the farmer at the end of 140 s = Shortest distance between initial and final position = AC = $\sqrt{AB^2 + BC^2}$ .... (pythagorus theorem)

= $\sqrt{10^2 + 10}$

= $\sqrt{200}$

= $10\sqrt{2}$ m = 10 x 1.414 = 14.14m

63.

Speed	Velocity
(i) It is the rate of change of distance.	(i) It is the rate of change of displacement.
(ii) It is a scalar quantity.	(ii) It is a vector quantity.
(iii) It is always positive.	(iii)It can be positive negative or zero.

64. Speed = Slope of distance-time graph.

The smaller the slope, the smaller is the speed. From the figure, slope is minimum for car D. So, D is the slowest car.

65. Uniform velocity = A body is said to have uniform velocity if it covers equal distance in equal intervals of time in a particular direction, however the time intervals may be small.

Uniform acceleration = A body is said to possess uniform acceleration if its velocity increases by equal amount in equal intervals of time, however the time intervals may be small.

66. If distance travelled by an object is equal to its displacement then the magnitude of average velocity of an object will be equal to its average speed.

67. When the velocity of a body changes at a non-uniform rate, its average velocity is found by dividing the net displacement covered by the total time taken.

i.e., Average Velocity = $\frac{\text{Netdisplacement}}{\text{Totaltimetaken}}$

In case the velocity of a body changes at a uniform rate, then the average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time.

i.e., Average velocity = $\frac{\text{Initialvelocity}+\text{Finalvelocity}}{2}$

68. The distance time-graph for uniform motion is a straight line not parallel to the time axis. The distance time graph for non uniform motion is not a straight line. It can be a curve or a zigzag line not parallel to time axis.

69. The magnitude of average velocity of an object is equal to its average speed when the velocity of an object changes at uniform rate. i.e. the body is in uniformly accelerated motion. If a body is moving with uniform acceleration.

Initial velocity = u, Final velocity = v

Average speed = Average velocity = $\frac{u\ +\ v}{2}$

70. Yes, an object which has moved through a distance can have zero displacement.

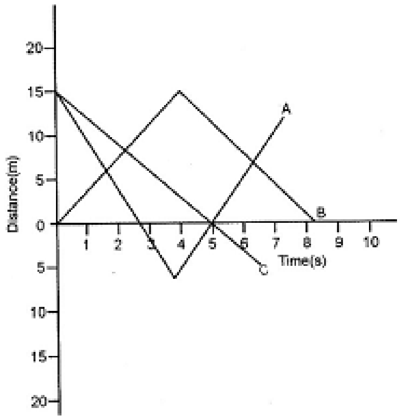
Example. When a person, walking along a circular path, returns back to the starting point, after completing a circle, his displacement is zero. But he covers a distance {tex}\begin{array}{l}2\mathrm{πr}\\\end{array}{/tex} where 'r' is the radius of circular path.

The displacement is zero, as the shortest distance between the initial and final position of the person is zero.

Section C

71. Speed = Slope of distance - time graph. The smaller the slope, the smaller is the speed.

72. i. GRAPH A: The displacement of the body is 12 m and the distance travelled is 37 m
    ii. GRAPH B: Displacement is zero and the distance travelled is 15 + 15 = 30 m
    iii. GRAPH C: Displacement is about 5 m and distance travelled is about 20 m.

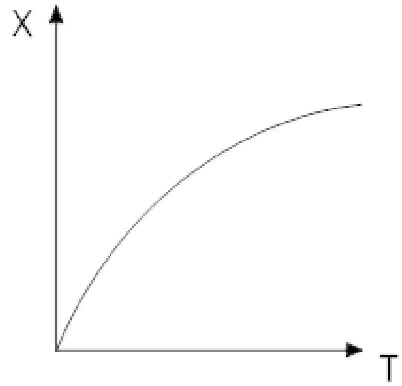


Graph C represents a motion with negative acceleration.

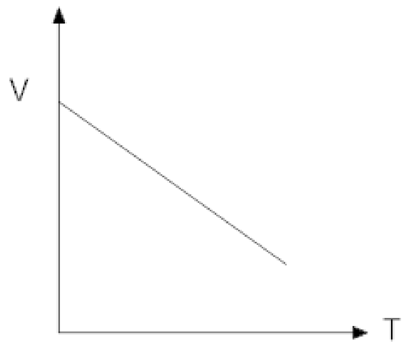
73. The shape of the path followed by the ball is parabolic.
    Vertically downward motion is due to gravitational acceleration. Horizontal motion is due to zero acceleration.

74. (a)An object with a constant acceleration can still have the zero velocity. For example an object which is at rest on the surface of earth will have zero velocity but still being acted upon by the gravitational force of earth with an acceleration of 9.81 ms^{-2} towards the center of earth. Hence when an object starts falling freely can have contant acceleration but with zero velocity.
    (b)When an athlete moves with a velocity of constant magnitude along the circular path, the only change in his velocity is due to the change in the direction of motion. Here, the motion of the athlete moving along a circular path is, therefore, an example of an accelerated motion where acceleration is always perpendicular to direction of motion of an objectat a given instance. Hence, it is possible when an object moves in a circular path.

75. i. Position – time



ii. Velocity – time



iii. Acceleration- time