

RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Motion:- The motion of an object is perceived when its position changes continuously with respect to some stationary object.

Distance:- The distance travelled by an object is the length of the actual path traversed by the object during motion. Distance is a scaler quantity. Obviously during motion of the object, the value of distance can never be zero or negative.

Displacement:- The displacement of an object is the shortest distance between the initial position and final position of the object. Displacement is a vector quantity.

Uniform motion:- When an object travels equal distances in equal intervals of time, howsoever small the interval may be, the motion of the object is said to be uniform. For example, suppose a car covers 60 km in first hour, another 60 km in second hour, again 60 km in the third hour and so on, the motion of the car is uniform motion.

Non-uniform motion:- When an object travels unequal distances in equal intervals of time, howsoever small the interval may be, the motion of the object is said to be non-uniform. For example, suppose a car covers 40 km in first hour, 50 km in second hour 30 km in third hour, 70 km in fourth hour and so on. The motion of the car is non-uniform.

Speed:- Speed of the body is defined as the distance travelled by the body in unit time.

i.e , Speed = $\frac{Distance\ travelled}{Time\ taken}$

If s is the distance travelled by a body in time t, its speed v from eqn (1) is

 $v = \frac{s}{t}$

The S.I unit of distance is metre (m) and that of time is second (s)therefore SI unit of speed is metre/second. It is written as m/s or ms⁻¹. The Speed of a body is a scaler quantity. The speed can be zero or positive. It can never be negative.

Uniform speed:- When a body travels equal distances in equal intervals of time, howsoever small the intervals may be, the speed of the body is said to be uniform.

Non-uniform speed or variable speed:- When a body covers unequal distances in equal intervals of time, howsoever small the intervals may be, the speed of the body is said to be non-uniform or variable. In most of the cases, bodies move with variable speed or non-uniform speed. Therefore we describe the rate of motion of such bodies in terms of their average speed.



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

The average speed of a body is obtained by dividing the total distance travelled by the total time taken,

i.e., Average speed= $\frac{Total \ distance \ travelled}{total \ time \ taken}$

For example, in going from Delhi to Ambala, total distance travelled = 200 km. If total time taken= 4 hours, then average speed = $\frac{200km}{4h}$ = 50km/h

<u>Velocity:-</u> Velocity of a body is the distance travelled by the body in unit time in a given direction. In other words, velocity of a body is the speed of the body in a particular direction.

 $Velocity = \frac{Distance \ travelled \ in \ given \ direction}{Time \ taken}$ $v = \frac{s}{t}$

Velocity is a vector quantity whereas speed is a scalar quantity.

Uniform velocity:- When a body is moving along a straight line, covering equal distances in equal intervals of time, howsoever small the interval may be, the velocity of the body is said to be uniform or constant.For example, when a train travels over a straight horizontal track covering 60 km in every hour, the train is said to have uniform velocity of 60 km/h

Variable velocity (or non-uniform velocity):- Velocity of a body is said to be variable (or non-uniform) when it covers unequal distance in a particular direction in equal intervals of time or the direction of motion of the body changes even when it covers equal distances in equal intervals of time.

Average velocity:- When a velocity of a body is changing at a uniform rate over a period of time, then average velocity of the body for this period is arithmetic mean of initial velocity and final velocity of the body.

Average velocity=
$$\frac{Initial \ velocity + final \ velocity}{2}$$

$$v_{av} = \frac{u+v}{2}$$

Where u is the initial velocity, v is the final velocity and v_{av} is the average velocity.

Acceleration:- Acceleration of a body is defined as the rate of change of velocity of the body with time. Thus, acceleration of a body is a measure of change in velocity of the body per unit time.

Thus Accleration = $\frac{change in velocity}{time taken}$



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Change in velocity = final velocity- initial velocity

Acceleration= $\frac{Final \ velocity-Initial \ velocity}{Time \ taken}$ $a=\frac{v-u}{t}$ u= Initial velocity

v= Final velocity a= acceleration t= time taken

Unit of acceleration is metre per second square which is denoted by m/s⁻². Acceleration is a vector quantity. (i) When a body is moving along a straight line with a uniform velocity, change in its velocity (v-u) = 0. Therefore acceleration a = $\frac{v-u}{t}$ = 0.

(ii) When the velocity of a body increases with time v>u. Therefore (v-u) is positive and as such $a = \frac{v-u}{t} = positive$

(iii) When the velocity of a body decreases with time v<u, Therefore (v-u) is negative and as such

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

The negative acceleration is called retardation.

Uniform acceleration:- The acceleration of a body is said to be uniform, when velocity of the body moving along a straight line changes by equal amounts in equal intervals of time, i.e, when velocity of a body changes at a uniform rate, it is said to have uniform acceleration. Eg., motion of a body falling freely under the action of gravity, motion of а ball rolling down а smooth inclined plane. Non-uniform acceleration:- When the velocity of a body changes at a non-uniform rate i.e., velocity changes by unequal amounts in equal intervals of time, the acceleration of the body is said to be variable or nonuniform.

Distance- Time graphs:-

The distance time graph represents the change in the position of a body with time. In this graph, we take time along the X-axis and the distance along the Y-axis. Three cases arise:

Case 1:- When the body is at rest.

Suppose the body is stationary at a distance of 10 m from the origin. The position of the body does not change with time. Its distance from the origin continues to be same at all instants of time. Therefore when we plot distanced at different instants of time and join these points, we obtain straight line parallel to X-axis



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Case 2:- When the body is in uniform motion:-

When a body moves with a uniform speed, it covers equal distances in equal intervals of time. Therefore distance travelled by the body is directly proportional to time taken. T

Solution of In Text Questions

Question : 1 - An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.

Ans:- Yes, zero displacement is possible if an object has moved through a distance.



Suppose a ball starts moving from point A and it returns back at same point A, then the distance will be equal to 20 meters while displacement will be zero.

Question : 3 - Which of the following is true for displacement?

(a) It cannot be zero.

(b) Its magnitude is greater than the distance travelled by the object.

Answer: None

Question : 4 - Distinguish between speed and velocity.

Speed	Velocity
1.Speed is the distance travelled by the object in a given interval of time.	 Velocity is the displacement of an object in a given interval of time.
2.Speed = Distance/Time	Velocity = Displacement/Time
3.Speed is a scaler quantity	3. Velocity is a vector quantity.

Question : 5 - Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

Answer: The magnitude of average velocity of an object will be equal to its average speed in the condition of uniform velocity.

Question : 6 - What does the odometer of an automobile measure?

Answer: In automobiles, odometer is used to measure the distance.



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Question : 7 - What does the path of an object look like when it is in uniform motion?

Ans:- In the case of uniform motion the path of an object will look like a straight line.

Question :- 8 - During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, 3×10^8 ms⁻¹.

Ans:-Here, we have, speed $=3 \times 10^8 \text{ ms} - 1 = 3 \times 10^8 \text{ ms} - 1$

Time = 5 minute

=5×60s=300=5×60s=300 second we know that, Distance = Speed x Time ⇒ Distance =3×10⁸ ms-1=3×10⁸ ms-1=1800×10⁸ m=1800×108 m=1.8×10¹¹ m **Question : 9 - When will you say a body is in**

(i) uniform acceleration?

(ii) non-uniform acceleration?

Ans:-(i) A body is said in uniform acceleration when its motion is along a straight line and its velocity changes by equal magnitude in equal interval of time.

(ii)A body is said in non-uniform acceleration when its motion is along a straight line and its velocity changes by unequal magnitude in equal interval of time.

Question : 10 - A bus decreases its speed from 80 km/h to 60 km/h in 5 s. Find the acceleration of the bus.

Answer:

Here we have, u=80 km/hu=80 km/hv=60 km/hv=60 km/h and t=5st=5s

 \therefore Acceleration (a) =? we know that v=u+atv=u+at

```
⇒60 km/h=80 km/h+a×5s⇒60 km/h=80 km/h+a×5s

⇒60 km/h-80 km/h=a×5s⇒60 km/h-80 km/h=a×5s

⇒-20 km/h=a×5s⇒-20 km/h=a×5s

⇒a=-20 km/h5s⇒a=-20 km/h5s

⇒a=-4 km/h/s⇒a=-4 km/h/s

∴ Acceleration =-4 km/h/sor-1.1 m/s<sup>2</sup>=-4 km/h/s or-1.1 m/s<sup>2</sup>
```

Question : 11 - A train starting from a railway station and moving with uniform acceleration attains a speed of 40 km/h in 10 minutes. Find its acceleration.

Ans:- Here we have, Initial velocity, u = 0, Final velocity, v = 40km/h = 11.11m/s

```
Time (t) = 10 minute = 60x10=600sAcceleration (a) =?
```

```
We know that v=u+atv=u+at
\Rightarrow40 km/h=0 km/h+a×10m\Rightarrow40 km/h=0 km/h+a×10m
```



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

⇒11.11 m/s=a×600s⇒11.11 m/s=a×600s ⇒a=11.11 m/s600s=0.0185 m/s²⇒a=11.11 m/s600s=0.0185 m/s²

Question : 12 - What is the nature of the distance-time graphs for uniform and non-uniform motion of an object?

Ans:- The slope of the distance-time graph for an object in uniform motion is straight line.

Question : 13 - What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?

Ans:- When the slope of distance-time graph is a straight line parallel to time axis, the object is moving with uniform motion.

Question : 14 - What can you say about the motion of an object if its speed-time graph is a straight line parallel to the time axis?

Ans:-When the slope of a speed time graph is a straight line parallel to the time axis, the object is moving with uniform speed.

Question : 15 - What is the quantity which is measured by the area occupied below the velocity-time graph?

Answer:-The quantity of distance is measured by the area occupied below the velocity time graph. The slope of the distance-time graph for an object in non-uniform motion is not a straight line.

Question :- 16 - A bus starting from rest moves with a uniform acceleration of 0.1 m s⁻² for 2 minutes. Find (a)the speed acquired, (b) the distance travelled.

Ans:-Here we have, Initial velocity (u) = 0 ,Acceleration (a) = 0.1ms-2 Time (t) = 2 minute = 120 second

(a) The speed acquired: We know that, v = u + at

 \Rightarrow v = 0 + 0.1m/s² x 120 s \Rightarrow v = 120 m/s

Thus, the bus will acquire a speed of 120 m/s after 2 minute with the given acceleration.

(b) The distance travelled: We know that, $s=ut+1/2at^2s=ut+1/2at^2$ $\Rightarrow s=0\times120s+12\times0.1 \text{ m/s}^2\times(120s)^2 \Rightarrow s=0\times120s+12\times0.1 \text{ m/s}^2\times(120s)^2$

=12×14400m=7200mor7.2km=12×14400m=7200mor7.2km

Thus, bus will travel a distance of 7200 m or 7.2 km in the given time of 2 minute.

Question : 18 - A trolley, while going down an inclined plane, has an acceleration of 2 cm s⁻². What will be its velocity 3 s after the start?

Ans:- Here we have, Initial velocity, u = 0 Acceleration (a) = $2 \text{ cm/s}^2 = 0.02 \text{ m/s}^2$

Time (t) = 3s Therefore, Final velocity, v =?



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Class : 9th

We know that, v=u+at v=u+at \therefore v=0+0.02 m/s²×3s \therefore v=0+0.02 m/s²×3s \Rightarrow v=0.06 m/s \Rightarrow v=0.06 m/s

Therefore, the final velocity of trolley will be 0.06m/s after start

Question : 19 - A racing car has a uniform acceleration of 4 m s⁻². What distance will it cover in 10 s after start?

Ans:-Here we have, Acceleration, a = 4m/s2 Initial velocity, u = 0 Time, t = 10s

Therefore, Distance (s) covered =? We know that, $s=ut+1/2at^2$ $\Rightarrow s=0\times10s+1/2\times4 \text{ m/s}^2\times(10s)^2 \Rightarrow s=0\times10s+1/2\times4 \text{ m/s}^2\times(10s)^2$

 $\Rightarrow s=12\times4 \text{ m/s}^2 \times 100s^2 \Rightarrow s=1/2\times4 \text{ m/s}^2 \times 100s^2$ $\Rightarrow s=2\times100\text{m}=200\text{m} \Rightarrow s=2\times100\text{m}=200\text{m}$

Thus, racing car will cover a distance of 200m after start in 10 s with given acceleration.

Q.No 1:- An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?

Ans:- As shown in figure, diameter of circular track AB= 200 m.

Time taken to complete one round = 40s Total time = 2 min 20 s = $(2 \times 60 + 20) = 140$ s Number of rounds completed = $\frac{140}{40} = 3.5$ Distance covered = $2\pi r \times 3.5$ $= 2 \times (22/7) \times (200/2) \times 3.5$ m = 2200 m If the athlete starts from A, on completion of 3.5 rounds he will be at B. Thus displacement = AB = 200 m (in magnitude)



Q.No 2:- Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 30 seconds and then turns around and jogs 100m back to point C in another 1 minute. What are Joseph's average speeds and velocities in jogging A to B and (b) from A to C?

Ans:- Here as shown in the figure AB= 300m

Time taken in jogging from A to $B = t1 = 2 min 30 s = (2 \times 60 + 30) s = 150 s$ BC= 100m

Time taken in jogging from B to C, t2 = 1 min = 60 s

(a) From A to B Average speed = $\frac{Total \ distance}{total \ time} = \frac{300 \ m}{150 \ s} = 2.0 \ m/s$



Average velocity = $\frac{Displacement (AB)}{Time} = \frac{300 m}{150 s} = 2.0 m/s$



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Class : 9th

(b) Average speed = $\frac{Total \ distance}{total \ time} = \frac{AB+BC}{t1+t2}$ $= \frac{(300+100)m}{(150+60)s} = \frac{400}{210} \text{ m/s} = 1.9 \text{ m/s}$ Average velocity = $\frac{\text{Displacement (AC)}}{Displacement (AC)} = \frac{(300-100)m}{(150+60)s}$

Average velocity =
$$\frac{Displacement (HS)}{Time} = \frac{(300 - 100)}{(150 + 60)}$$

 $=\frac{200}{210}$ m/s = 0.95 m/s

Q.No 3:- Abdul while driving to school, computes the average speed for his trip to be 20 km h-1. On his return trip along the same route, there is less traffic and the average speed is 30 kmh-1. What is the average speed for Abdul's trip?

Ans:- Let the school be at a distance of x km. If t1 is time taken to reach the school then

$$t_1 = \frac{distance}{average \ speed} = \frac{x}{20}$$

if t_2 is the time taken to reach back then

$$t_2 = \frac{distance}{average speed} = \frac{x}{30}$$

Total time t, = t1+ t2 = $\frac{x}{20} + \frac{x}{30} = [\frac{1}{20} + \frac{1}{30}] = \frac{5x}{60} = \frac{x}{12}$

Total distance = x+x = 2x

Average speed = $\frac{\text{total distance}}{\text{total time}} = \frac{2x}{x/12} = 24 \text{ km/h}$

Q.No. 4:- A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3.0 m/s² for 8.0 s. How far does the boat travel during this time?

Ans:- Here we have, Initial velocity (u) = 0 Acceleration (a) = $3.0m/s^2$ Time = 8 s Therefore, distance (s) covered =? We know that, s=ut+1/2at²s=ut+1/2at² \Rightarrow s=0×8+1/2 3m/s²×(8s)² \Rightarrow s=0×8+1/2 3m/s²×(8s)² \Rightarrow s=12×3×64m \Rightarrow s=1/2×3×64m

⇒s=3×32 m⇒s=3×32 m⇒s=96 m⇒s=96 m

Therefore, boat travel a distance of 96 m in the given time.

Q.No. 7:- A ball is gently dropped from a height of 20m. If its velocity increases uniformly at the rate of $10m/s^2$. With what velocity will it strike the ground? After what time will it strike the ground? Ans:- Here height= Distance = s = 20m, acceleration, a = 10 m/s²

Final velocity, v = ? Time taken, t= ?

As the ball is gently dropped its initial velocity, u = 0From v^2 - $u^2 = 2as$ $v^2 = u^2 + 2as = 0 + 2$ (10) ×20 = 400

$$/=\sqrt{400} = 20 \text{ m/s}$$

This is the velocity with which the ball will hit the ground



RAWALPORA SRINAGAR KASHMIR

Sub: Science

Topic: Motion

Class: 9th

From v = u+at 20= 0 + 10t or t = 20/10 = 2s

Question: 10. An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Ans:-Here we have, Radius, r = 42250km Time, t = 24 hours Speed =?

We know that velocity along a circular path $=2\pi rtime=2\pi rtime$

$$V = 2 \times \frac{22}{7} \times 42250 \text{ km}$$

24h

 $V = \frac{2 \times 22 \times 42250 \text{ km/h}}{7 \times 24}$

 \Rightarrow v=11065.47 km/h \Rightarrow v=11065.47 km/h Thus, speed of the given satellite =11065.47 km/h