Motion

- Motion occurs when an object changes its position with time.
- When a body covers equal distance in equal interval of time, it is moving with uniform motion.
- When a body covers unequal distance in equal interval of time. it is moving with non-uniform motion.

Both **Distance and Time** are important in describing motion.

- Sometimes you know motion has occurred even if you didn't see it happen.
- Relative motion: when two objects are moving in a plane (either in same direction or opposite) each have relative motion with respect to second. e.g. a person sitting in a train and watching a tree, in this case tree is stable but is assumed to be moving but with respect to train.

Distance vs. Displacement

- **Distance:** How far an object has moved. It has only magnitude without direction.
- **Displacement:** How far and in what direction an object has moved from its start position. i.e. the direct distance between intial and final points.

Speed

- Speed = the distance an object travels in a given amount of time
- $Speed = \frac{distance}{time}$
- SI unit of speed is m/s

Types of Speed

- Constant speed: speed doesn't change
- Changing speed: Riding a bike for 5 km. Take off and increase speed, slow down up hill, speed up down hill, stop for stop sign. The trip took you 15 min (.25 h)

Q1 : 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?

Answer :

Radius of the circular orbit, r= 42250 km

Time taken to revolve around the earth, t= 24 h

Speed of a circular moving object, $v = \frac{2\pi r}{t}$

$= \frac{2 \times 3.14 \times 42250}{24} = 1.105 \times 10^4 \text{ km/h} = 3.069 \text{ km/s}$

Hence, the speed of the artificial satellite is 3.069 km/s.

Q2 : 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?

Answer :

Diameter of a circular track, d = 200 m

Radius of the track, $r = \frac{d}{2} = 100 \text{ m}$

Circumference = 2ÃƒÃ‚â€šÂ¬r = 2ÃƒÃ‚â€šÂ¬ (100) = 200ÃƒÃ‚â€šÂ¬ m

In 40 s, the given athlete covers a distance of 200ÃƒÃ‚â€šÂ¬ m.

In 1 s, the given athlete covers a distance = $\frac{200\pi}{40}$ m

The athlete runs for 2 minutes 20 s = 140 s

∴ Total distance covered in 140 s $= \frac{200 \times 22}{40 \times 7} \times 140 = 2200 \text{ m}$

Q3 : Distinguish between speed and velocity.

Answer :

Speed	Velocity
Speed is the distance travelled by an object in a given interval of time. It does not have any direction.	Velocity is the displacement of an object in a given interval of time. It has a unique direction.
Speed is given by the relation: $\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$	Velocity is given by the relation: $\text{Velocity} = \frac{\text{Displacement}}{\text{Time interval}}$
The speed of an object can never be negative. At the most, it can become zero. This is because distance travelled can never be negative.	The velocity of an object can be negative, positive, or equal to zero. This is because displacement can take any of these three values.

Q5 : What does the odometer of an automobile measure?

Answer :

The odometer of an automobile measures the distance covered by an automobile.

Q6 : What does the path of an object look like when it is in uniform motion?

Answer :

An object having uniform motion has a straight line path.

Q7 : 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 Ã—10^{8} m s^{-1}.

Answer :

Time taken by the signal to reach the ground station from the spaceship

= 5 min = 5 x 60 = 300 s

Speed of the signal = 3 x 10^{8} m/s

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

∴ Distance travelled = Speed x Time taken = 3 x 10^{8} x 300 = 9 x 10^{10} m

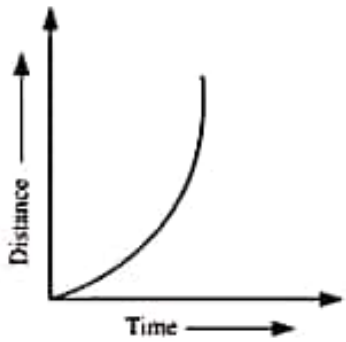
Hence,the distance of the spaceship from the ground station is 9 x 10^{10} m.

Q11 : What is the nature of the distance - 'time graphs for uniform and non-uniform motion of an object?

Answer :

The distance - 'time graph for uniform motion of an object is a straight line (as shown in the following figure).

The distance - 'time graph for non-uniform motion of an object is a curved line (as shown in the given figure).



Q8 : A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of 10 m s^{-2}, with what velocity will it strike the ground? After what time will it strike the ground?

Answer :

Distance covered by the ball, s= 20 m

Acceleration, a = 10 m/s^2

Initially, velocity, u= 0 (since the ball was initially at rest)

Final velocity of the ball with which it strikes the ground, v

According to the third equation of motion:

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

$v^2 = 0 + 2 (10) (20)$

v = 20 m/s

According to the first equation of motion:

$v = u + at$

Where,

Time, t taken by the ball to strike the ground is,

$20 = 0 + 10 (t)$

t= 2 s

Hence, the ball strikes the ground after 2 s with a velocity of 20 m/s.