Motion

Motion of a body

A body is said to be in a state of rest w.r.t. a stationary body if its position does not change with time as seen by the stationary body. Similarly, it is in the state of motion w.r.t a stationary body if its position changes with time as seen by the stationary body.

Relative motion of a body

A body is in a state of motion w.r.t. a moving body if its position changes with time as seen by the moving body, else it is at a state of rest w.r.t the moving body. This occurs if and only if the velocity of the two bodies are equal at all instances of time. For example, two people standing on the surface of the earth see each other to be at rest. Actually, they are both moving as the earth is rotating.

Scalar Quantities

A scalar quantity is a quantity which is defined by only magnitude. Some examples of scalar quantities are Mass, Charge, Pressure, etc.

Vector quantities

Vector quantities are those which have both magnitude and direction and obey vector laws of addition. Some examples of vectors are displacement, velocity, force, etc.
A quantity is called a vector only if it follows all the above three conditions. For example, current is not a vector despite having both magnitude and direction because it does not follow vector laws of addition.

Scalar

Scalar Quantities:

1. A physical quantity which is having magnitude only but not direction those are scalar quantities
2. These are one-dimensional quantities.
3. It follows ordinary rules of algebra.
4. The scalar can be divided by any other scalar quantity.
5. It changes due to change in their magnitude only.
6. e.g. mass, work etc

vector

Vector Quantity:

1. A vector quantity is one, that has both magnitude and direction.
2. Are multi-dimensional quantities.
3. It changes with the change in their direction or magnitude or both.
4. Follow rules of vector algebra.
5. Two vectors can never divide.

Speed

Speed is rate of change of distance,it is the measurement of how fast or slow objects move, can be given by formula,

Speed=DistanceTime

S.I unit of speed is m/s

Speed by distance moved and time taken by an object

Example : During inter school running race competition , Shivam completed the race of 200 m in 120 seconds, where as the winner of the race Anubhav completed it in just 80 seconds.What would be the required speed of Shivam to beat Anubhav?

Solution: Speed of Shivam s1=distancetime=200120=1.67 m/s

Speed of Anubhav s2=distancetime=20080=2.5 m/s

Hence to win the race speed of shivam should have been more than 2.5 m/s

Velocity

Velocity is defined as the rate of change of displacement with time.

It is a vector quantity and has units m/s.

The direction of a velocity vector is same as the direction of the motion of body at that instant of time. Magnitude of instantaneous velocity is same as the speed at the instant.

Average speed

Average speed is defined as the total distance travelled by the body in total time i.e.

Average Speed=Total distance/Total time

It is a scalar quantity. Its unit is m/s.

Average velocity

Average Velocity=Total Displacement/Total time

It is a vector quantity and has units of m/s.

Magnitude of average velocity is always less than or equal to the average speed because displacement is always smaller than or equal to distance.

Instantaneous speed

Instantaneous speed can be defined as the rate of change of distance with respect to time.

v=ds/dt

Note:

1. Instantaneous speed is always greater than or equal to zero and is a scalar quantity.
2. For uniform motion, instantaneous speed is constan

Uniform Circular motion

Definition:

Uniform circular motion is defined as the motion of a particle along the circumference of a circle with constant speed.

UCM can also be defined as periodic motion of a particle moving along the circumference of a circle with constant speed.

e.g.

1. Motion of earth around the sun.
2. Motion of moon around the earth.

Examples of Circular Motion

Following are the examples of circular motion:

1. Motion of an artificial satellite orbiting the Earth.
2. A stone which is tied to a rope and is being swung in circles.
3. A car turning through a curve in a road.
4. Electrons moving perpendicular to a uniform magnetic field
5. A gear turning inside a gear-train.
6. Motion of a clock hand.
7. Motion of bicycle wheels.

Uniform motion

A body is said to be in uniform motion if its velocity does not change with time. For a body in uniform motion, net external force is always equal to zero. An example of uniform motion is a body sliding on a frictionless surface with a constant velocity.

Non-uniform Motion

A body is said to have non-uniform motion if its velocity changes with time. Such a body is necessarily under the influence of an external force. An example of non-uniform motion is a body rotating at a constant speed. Its velocity is not constant because its direction of motion changes every instant.

Acceleration

Acceleration is defined as the rate of change of velocity with time. It is a vector quantity. Its unit is m/s2.

Constant speed does not guarantee that acceleration is zero. For example a body moving with constant speed in a circle changes its velocity every instant and hence its acceleration is not equal to zero.

Retardation

Retardation (or deceleration) of a body whose velocity is decreasing with time is defined as the negative of acceleration. In other words, it is equal to the magnitude of acceleration of a body whose velocity is decreasing with time.

For a decelerating body, direction of velocity and acceleration is always opposite in direction.

Example: When a body is thrown vertically upwards, during the upward motion, its velocity decreases and at the highest point it becomes zero. This is a case of retardation.

Unit of Acceleration

Acceleration is defined as the rate of change of velocity or velocity per unit time.Its unit is m/s2, can also be expressed as N/kg.

Centripetal acceleration:Centripetal acceleration is the rate of change of tangential velocity.