FOCUS POINTS ARE HIGHLIGHTED

Motion means movement. In ever day life we see some objects at rest and some others in motion. Rotation and revolution of Earth, continuous expansion of the Universe, ball rolling down the hill, a train travelling along the tracks etc are all examples of motion.

Motion is a continuous change in the position of an object with respect to a stationary object. It is described in terms of displacement, distance, velocity, acceleration, time and speed.

Motion:

A body is said to be in motion when it changes its position with reference to a fixed reference point called the origin.

- Uniform Motion is a motion in which equal distance is covered in equal time intervals.
- Non- Uniform Motion is a motion in which unequal distance is covered in equal intervals of time.

Distance:

It is the actual path travelled by an object from its initial position to final position.

- It is a scalar quantity.
- It has only magnitude without direction

Displacement:

It is the shortest straight line path between the initial and final position

- If the initial and final points are same, the displacement will be zero.
- A particle is a point-like object, has mass but infinitesimal size.

- The object's position is its location with respect to a chosen reference point.

Relative Motion:

When two objects are moving in a plane (either in the same direction or opposite) each has relative motion with respect to the second.

Example: A person sitting on a train and watching a tree. In this case, the tree is stable but is assumed to be moving with respect to the train.

Motion along a straight line:

When an object moves in straight line with respect to the observer, then the motion is called a straight line motion.

If a body starts from C, goes to A and comes back to C, then distance covered is 35 km + 35 km = 70 km, and it's displacement = 0 km

A moving object may not always be in a uniform motion. The rate at which an object moves can be different. Objects moving with different rate will take a different amount of time to cover a given distance.

One of the ways of measuring the rate of motion of an object is to find out the distance traveled by the object in unit time.

- As the distance is to displacement, so speed is to velocity: the crucial difference between the two is that speed is a scalar and velocity is a vector quantity.
- In everyday conversation, we usually say speed when we talk about how fast something is moving. However, in physics, it is often important to determine the direction of this motion, so one finds velocity come up in physics problems far more frequently than speed.
- A common example of speed is the number given by the speedometer in a car. A speedometer tells us the car's speed, not its velocity because it gives only a number and not a direction. Speed is a measure of the distance an object travels in a given length of time:
- Speed: Distance traveled per unit time. SI unit: m/s

- Average Speed: Total distance travelled divided by the total time taken. Formula: Total Distance /TotalTime SI unit: m/s
- Velocity: It is speed in a specific direction (or) displacement per unit time. SI unit: m/s
- Average Velocity: Arithmetic mean of initial and final velocity (if acceleration is constant) Formula: $V_{av} = (u+v)/2$, SI unit: m/s

The velocity of an object is the speed of an object moving in a definite direction.

The rate of change in the velocity of an object per unit time is referred as acceleration and the kind of motion is known as accelerated motion.

To compute the rate of change in velocity, or acceleration, of an object, the initial speed is subtracted from the final speed. This rate is then divided by the total length of the time period for the acceleration

Acceleration

Acceleration is a vector quantity that is defined as the rate at which an object changes its velocity. An object is accelerating if it is changing its velocity.

- Acceleration = ChangeinVelocity/Timetaken
- Mathematical Expression: $a = (v–u)/t$
- SI unit: $m\ s^{-2}$

Types of Straight-line Motion:

1. Uniform motion:

- A body moving along a straight line (without changing direction) covers equal distances in equal intervals of time. Thus, it moves with a constant velocity.

2. Non-uniform motion:

- The velocity of body changes with time.
- The velocity of an object can change if:
  - Its speed changes
  - Its direction changes

- Both speed and direction change

3. Uniformly accelerated motion:

- The body is in motion with constant acceleration. Thus, the speed of the body moving in a straight line increases or decreases by the same amount at equal intervals of time.
- Acceleration can be;
  - Positive if it is in the direction of the velocity
  - Negative if it is opposite to the direction of the velocity
- A freely falling object is moving freely under the influence of gravity alone, under free fall its acceleration is directed downwards, regardless of the initial direction of motion.
- The magnitude of free fall acceleration is a constant known as G, whose value is 9.8 ms^{-2}.

Graphs are very useful and effective methods to provide information.The motion of an object can be represented by line graphs.

Distance: Time graphs are employed under various conditions where objects move with uniform speed, non-uniform speed, remain at rest etc.

Velocity: Time graphs are used to know the variation in velocity with time for an object moving in a straight line.

Distance-time Graph (Uniform Motion)

- A motion is said to be uniform if an object covers equal distances in equal intervals of time, however small these intervals may be.
- Distance-time graph of uniform motion is a straight line
- The distance traveled by the object is directionally proportional to the time taken.
- In this example, it covers 10 km every 15 minutes; 40 km/h

Distance-time Graph (Non-uniform Motion):

- Distance-time graph of non-uniform motion cannot be a straight line
- The object covers unequal distances in equal intervals of time

Velocity-time Graph (Uniform Motion):

- Uniform motion means constant velocity.
- Velocity-time graph of uniform motion is a straight line parallel to the time axis.

Velocity-time Graph (Non-uniform Motion):

- The velocity-time graph is a ‘sloping’ straight line.

In circumstances of constant acceleration, the equations of motions, usually referred to as the "SUVAT" equations, arise from the definitions of kinematic quantities: displacement (s), initial velocity (u), final velocity (v), acceleration (a), and time (t).

First equation of motion

Acceleration $a = (v-u)/t$

Hence, $v- u = at.$

Second equation of motion

Distance covered in time t.

S = Area of ΔABC + Area of rectangle ACDO

$S = (1/2)\ (v - u)/\ t + ut.$

$S= ut + 1/2\ at^2.$

Third equation of motion

Distance covered in time t.

S = Area of ΔABC + Area of rectangle ACDO

$S = 1/2\ (v - u)t + ut = (v + u)t/2$, But, $v = u + at$ which means $t = (v - u)/a$

Hence, $S = (V + u)\ (V - u)/\ (2a) = (v^2–u^2)/\ (2a)$ or $2as = V^2–u^2$