Lesson 1: Uniformly accelerated motion in 1D

Acceleration

- **Acceleration: -** is the rate of change of velocity or change in velocity per unit time.
- An object is said to accelerate when its velocity changes in magnitude, in direction or both in magnitude and direction.
- Acceleration is a vector quantity, and
- The SI unit of acceleration is m/s. 2
- Negative acceleration may or may not be deceleration, and deceleration may or may not be considered negative acceleration.
- If the velocity and acceleration have the same sign whether positive or negative it is speeding up.
- If the velocity and acceleration have different signs, then the object is slowing down.
- Acceleration can be positive, negative or zero.
- When an object's velocity increases with time, it can be termed **Positive Acceleration.**
- When an object's velocity decreases with time, it can be termed **Negative Acceleration or Retardation.**
- When the velocity is zero, it is termed **Zero Acceleration.**
- A few examples of acceleration are the falling of an apple, the moon orbiting around the earth, or when a car is stopped at the traffic lights.
- Through these examples, we can understand that when there is a change in the direction of a moving object or an increase or decrease in speed, acceleration occurs.

Average acceleration

- The average acceleration: - the total change in velocity in the given interval divided by the total time taken for the change.

Examples 3.1

A truck accelerates from 6 m/s to 10 m/s in a time period of 10 s. What will be its acceleration?

Solution

- Initial Velocity (u) = 6 m/s
- Final Velocity (v) = 10 m/s
- Time taken (t) = 10 s

Using the Acceleration Formula,

Acceleration a = (v – u) / t

a = (10 m/s – 6 m/s) / 10 s

a = 0.4 m/s^2

Thus, the acceleration of the tr

Instantaneous Acceleration

Instantaneous acceleration:-is the rate at which velocity changes using both speed and direction with respect to time such that the time interval goes to zero.

$$a = \lim_{t \longrightarrow 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

Example 3.2

The position of a particle is $x(t) = 2t + 0.7t^3$ m. Find the instantaneous acceleration at t= 3 sec?

Solution

$x(t) = 2t + 0.7t^3$

So,

$v(t) = dx(t)/dt = 2+2.1t^2$ m/s

Now,

$a(t) = dv(t)/dt = 4.2t$ m/s^2

Therefore,

At t = 3 sec instantaneous acceleration is;

$4.2t = 4.2 \times 3 = 12.6$ m/s^2 (Answer)

Examples 3.3

A particle is in motion and is accelerating. The position of the velocity is $v(t) = 10t - 3t^2$ m/s

- Find the functional form of acceleration.
- Find the instantaneous velocity at t= 1,3,4,5 s
- Find the instantaneous acceleration at t= 1,3,4,5s.
- Analyze the results of © in terms of acceleration and velocity vectors directions.

Solution

$v(t) = 10t - 3t^2$ m/s

1. $a(t) = dv(t)/dt = 10 - 6t$ m/s²
2. $v(1s) = 7$ m/s

$v(3s) = 3$ m/s

$v(4s) = -8$ m/s

$v(5s) = -25$ m/s

$a(1s) = 4$ m/s²

Motion with Constant Acceleration

- If an equal amount of velocity increases in equal intervals of time, then the object is said to be in **uniform acceleration motion**
- In this case, the average acceleration equals the instantaneous acceleration, and the average velocity is the average of the initial and final velocities.
- If the velocity of the object changes by unequal amounts in equal intervals of time, the object is said to be **non-uniform acceleration.**