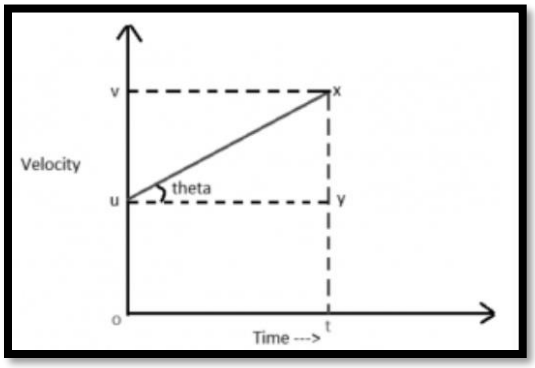
MOTION

EQUATION OF MOTION

motion is the phenomenon in which an object changes its position. Motion is represented in terms of displacement, distance, velocity, acceleration, speed, and time. Let us know the equations of motion, and applications of the equations of motion.

Introduction to Equations Of Motion

In this article, we will learn how we can relate quantities like velocity, time, acceleration and displacement provided the acceleration remains constant. These relations are collectively known as the equation of motion. There are three equations of motion. There are three ways to derive the equation of motion and here we are going to derive with the help of a graph.



First Equation of Motion

First equation of motion relates velocity, time and acceleration. Now in Δuxy,

$$\tan\theta = \frac{xy}{vy}$$

$$\tan\theta = \frac{v-u}{t}$$

We also know that tanθ is nothing but the slope and slope of the v – t graph represents acceleration.

$\Rightarrow v = u + at$

This is the first equation of motion where,

v = final velocity

u = initial velocity

a = acceleration

t = time taken

Second Equation of Motion

Now coming to the second equation of motion, it relates displacement, velocity, acceleration and time. The area under the v – t graph represents the displacement of the body.

In this case,

Displacement = Area of the trapezium (ouxt)

$S = \frac{1}{2}$

x sum of parallel sides x height

$S = \frac{1}{2}$

$x(v + u) \times t$ ... (2)

We can substitute v in terms of others and get the final equation as:

$S = ut + \frac{1}{2}at^2$

Where symbols have their usual meaning.

Third Equation of Motion

The third equation of motion relates to velocity, displacement, and acceleration. Using the same equation (2),

$$S = \frac{1}{2}$$

Using equation (1) if we replace t we get,

$$S = \frac{1}{2} \times \left(v + u\right) \times \frac{\left(v - u\right)}{a}$$

$$S = \frac{\left(v^2 - u^2\right)}{2a}$$

$$v^2 = u^2 + 2a$$

The above equation represents our third equation of motion.

Applications of Equations Of Motion

So now that we have seen all the three equations of motion we can use them to solve kinematic problems. We just have to identify what all parameters are given and then choose the appropriate equation and solve for the required parameter.

The equations of motion are also used in the calculation of optical properties.

Free Fall Formula

Freefall as the term says, is a body falling freely because of the gravitational pull of our earth.

Imagine a body with velocity (v) is falling freely from a height (h) for time (t) seconds because of gravity (g).

Free Fall Formulas are articulated as follows:

$h = (1/2)\ gt^2$

$v^2 = 2gh$

$v = gt$

Free fall is independent of the mass of the body

Underneath are given questions on free fall which may be useful for you.

Q: Calculate the body height if it has a mass of 2 kg and after 7 seconds it reaches the ground?

Ans: Given: Height h =?

Time t = 7s

We all are acquainted with the fact that free fall is independent of mass.

Hence, it is given as

$$h = \frac{1}{2}gt^2$$

$$h = 0.5 \times 9.8 \times (7)^2$$

$$h = 240.1\text{m}$$

Q: The cotton falls after 3 s and iron falls after 5 s. Which is moving with higher velocity?

Ans: The Velocity in free fall is autonomous of mass.

V (Velocity of iron) = gt = 9.8 m/s^2 × 5s = 49 m/s

V (Velocity of cotton) = gt = 9.8 m/s^2 × 3s = 29.4 m/s.