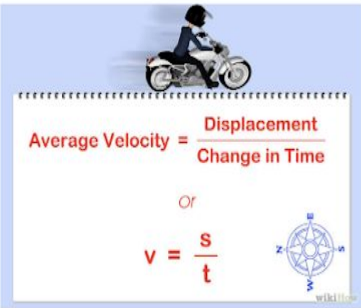
Velocity



The velocity of the body is the distance travelled by it in unit time in a certain direction. It is the rate of change of the distance of an object in a particular direction.If a body travels a distance of S-meter in t seconds in a given direction, then,

Velocity = Distance travelled in a given direction/ time taken=S/T (meters per second)

Average Velocity

Average velocity can be defined as the distance travelled divided by the time elapsed.

average velocity= displacement/time taken

$$v = \frac{s}{t}$$

here, v= velocity

s= displacement

t= time taken

Example: If a car travels 10 meters in 2 seconds and travels 32 meters in another 5 seconds then calculate its' average velocity.

Solution here,

distance (d_1) = 10 m

distance (d_2) = 32 m

time (t_1) = 2 s

time (t_2) = 5 s

$$\text{Average velocity}(av) = \frac{d_1 + d_2}{t_1 + t_2}$$

$$av = \frac{10 + 32}{5 + 2} = 42/7 = 6 \text{ m/s.}$$

Therefore, the average velocity is m/s.

If initial velocity of an object is u and final velocity of an object is v then,

$$\text{Average velocity of an object } (av) = \frac{\text{initial velocity (u) + final velocity (v)}}{2}$$

$$av = \frac{v + u}{2}$$

Example: If a tempo travels with a speed of 5 m/s. How far will it reach in one more hour?

Here,

Speed (v) = 5 m/s

Time (t) = 1 hour

= 60 x 60 sec

= 3600 sec

Distance(s) =?

We have,

$$v = \frac{s}{t}$$

Or, s = v x t

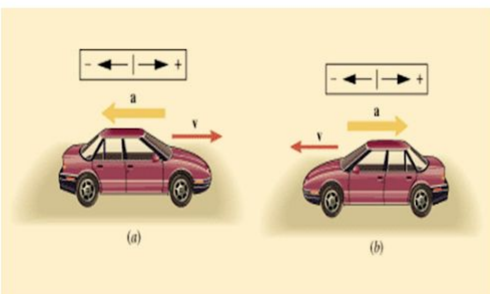
= 5 m/s x 3600 s

= 18000 m

= 18 km

Thus, the tempo travels 18 km in one hour.

The unit of velocity is the same as that of speed, namely, meter per second. Velocity has magnitude as well as direction, therefore, velocity is a vector quantity.The velocity of a car shows its definite direction.

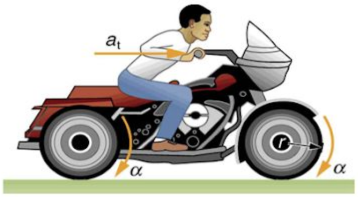


- **Uniform velocity:** In uniform velocity, a moving body covers the equal distance in equal interval of time, then the body is said to have uniform velocity.
- **Variable velocity:** If a moving body covers the different distance in unit time then the body is said to have variable velocity.
- **Relative velocity:** The laws of physics which apply when you are at rest on the earth also apply when you are in any reference frame which is moving at a constant velocity with respect to the earth. The motion may have the different appearance as viewed from a different reference frame, but this can be explained by relative point.

For example, People in running vehicle is at rest with respect to the vehicle but at motion with respect to the road.

Acceleration and Retardation

Acceleration



Acceleration is defined as the change in velocity per unit time. Acceleration is measured in m/s^2.

$$\text{Acceleration (a)} = \frac{\text{Change in velocity}}{\text{Time taken (t)}}$$

$$= \frac{\text{Final velocity (v)} - \text{Initial velocity (u)}}{\text{Time taken (t)}}$$

Retardation

The negative acceleration is called retardation or deceleration. Its unit is same as acceleration.

Example:

1. Car starts from rest. After 5 seconds, its velocity becomes 10 m/s. Then find its acceleration.

Initial velocity (u) = 0

Final velocity (v) = 10 m/s

Time taken (t) = 5 s

Acceleration (a) =?

Or, $a = \frac{v-u}{t}$

Or, $a = \frac{10-0}{5}$

∴ a = 2m/s^2

Equation of motion of uniform acceleration

$$v = u + at \qquad s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u+v)t \qquad v^2 = u^2 + 2as$$

a = acceleration
v = final velocity
u = initial velocity
t = time taken
s = displacement

Equations involving displacement, initial velocity, final velocity, acceleration and time of the motion of a moving body are equations of motion.

Considering a body moving in a straight line with uniform acceleration is shown in the figure.

Let,

Displacement = s

Initial velocity = u

Final velocity = v

Acceleration = a

Time taken = t

Relation between u, v, a and t

$$\text{Acceleration (a)} = \frac{\text{Change in velocity}}{\text{Time taken (t)}}$$

$$= \frac{\text{Final velocity (v)} - \text{Initial velocity (u)}}{\text{Time taken (t)}}$$

Or, $a = \frac{v-u}{t}$

Or, at = v-u

∴ v= u + at ………….. (i)

This is the first equation of motion.

Relation between u,s, v and t

$$\textbf{Average velocity (Av)} = \frac{\textbf{Final velocity (v)+ Initial velocity (u)}}{\textbf{2}}$$

Or, $\mathbf{Av = \frac{v+u}{2}}$

Or, $\text{Average Velocity} = \frac{\text{Total Displacement(s)}}{\text{Total Time Taken(t)}}$

Or, $\mathbf{Av = \frac{s}{t}}$

As both, equation is equal

Or, $\frac{v+u}{2} = \frac{s}{t}$

Or, $2s = (u + v) \times t$

$\therefore \mathbf{s = \left(\frac{v+u}{2}\right) \times t}$................. (ii)

This is the second equation of the motion.

Relation between s, u, a and t

We already have,

$V = u + at$.............. (i)

$s = (u + v) \times t$.............. (ii)

Putting value of v from equation (i) in (ii)

Or, $\mathbf{s = \frac{(u+(u+at))}{2} \times t}$

Or, $s = \frac{(2u+at)}{2}$

Or, $s = 2u \times t + at \times t \times ½$

$\therefore s = ut + ½\, at^2$.................. (iii)

This is the third equation of motion.