MOTION

Rest and motion

Rest

A body is said to be at rest if it does not change its position with respect to its immediate surroundings and with respect to time.

EXAMPLES FOR THE STATE OF REST

Tools lying on the floor

Bench in the Park

Books on the table

Example

The chairs of the dining table are at rest unless and until they are moved, and the flower vase, table, and the blackboard in the classroom are all at the position of rest.

Motion

A body is said to be in motion if it changes its position with respect to its immediate surroundings and with respect to time.

EXAMPLES FOR THE STATE OF MOTION

Sea Surfing

High Speed Train

Snowboarding

Example

The blades of a rotating fan, the hands of a working wall clock, a moving car, a spinning top and satellites are all in motion. Rest and motion are relative terms, A body seems to be at rest with respect to one object, but may appear to be in motion with respect to some other object.

A person on a railway platform is at rest with respect to another person on the same platform, but is in motion with reference to a person looking at him from a train crossing that platform. Similarly, a passenger sitting in the train will appear at rest to another passenger on the same train.

Rest and motion are relative

An object can be in motion relative to one set of objects while at rest relative to some other set of objects. Thus, rest and motion are relative terms.
This can be understood by following examples.

Examples: These two states i.e. (rest and motion) are relative, relative means they are related to

fig. 1

fig. 2

each other, because all the observation about an object in rest and motion depend upon frame of reference in which we are doing observation, these states varies according to frame of reference.

Person sitting in a bus is in rest according to his fellow passengers, inside the bus, but he is in motion according to the person standing on bus station observing the moving bus. So this is just the matter of frame of reference in which we are observing.

Types of Motion

Various objects can have different types of motion. They can be classified into translatory motion, rotatory motion, oscillatory motion, vibratory motion, periodic motion, non-periodic motion, uniform motion and non-uniform motion.

Translatory Motion

The motion in which all the particles of a body move through the same distance in the same time is called translatory motion. This is further classified into

a. Rectilinear motion
b. Curvilinear motion.

Examples for Translatory Motion

A train moving on a track, a parade, coins tossed in the air are all in rectilinear motion.

a. Rectilinear Motion

If a body moves along a straight line path, it is said to be in rectilinear motion.

Examples For Rectilinear Motion

- An athlete running on a straight path;
- A freely falling apple

b. Curvilinear Motion

If a body moves along a curved path, it is said to be in curvilinear motion.

Examples For Curvilinear Motion

- A car running on a curved road
- A stone thrown at an angle

Rotatory Motion

The motion in which a body moves about a fixed axis without changing the radius of its motion is called rotatory motion.

Examples For Rotatory Motion

- Potter's wheel
- A ceiling fan

Circular Motion

Circular motion is the movement of a body along a circular path. It is a special type of curvilinear motion. It is the motion of an object that moves at a fixed distance from a fixed point. Here, all objects rotate in circular motion. So, circular motion is motion in which the body traverses a circular path.

Note

Circular motion is a special case of rotatory motion.

Examples For Circular Motion

The hands of a clock, a merry-go-round, the blades of a fan, the wheel of a moving vehicle, satellites, a spinning top, are all good examples of circular motion.

Oscillatory Motion

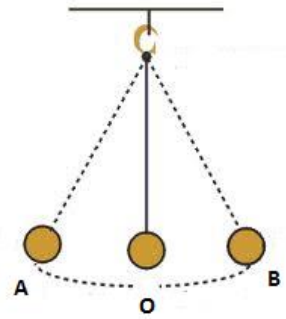
The to-and -fro or back and forth motion described by an object as a whole, along the same path, without any change in the shape of the object is called oscillatory motion.

Examples For Oscillatory Motion

- The pendulum of a clock
- A child on a swing.

Simple Pendulum

If the bob of a simple pendulum is pulled and released, the bob of a pendulum moves to and fro along the same path and passes through the mean position. This type of motion is called oscillatory motion.



Vibratory Motion

This is a kind of oscillatory motion in which the moving object undergoes change in shape or size. In this motion the body does not move as a whole.

Examples For Vibratory Motion

- The stretched membrane of a drum
- The plucked string of a guitar.

Periodic Motion

Periodic motion is the motion that repeats itself at regular intervals of time. Every object executing uniform circular motion can be said to be executing periodic motion.

Examples For Periodic Motion

- Earth revolving around the Sun.
- Needle of a sewing machine running at constant speed.
- The motion of the pendulum in a pendulum clock, the motion of a swinging cradle and the motion of the needle in a sewing machine are some examples of periodic motion.

Non - Periodic Motion

A repetitive motion which repeats itself at irregular intervals of time is called non-periodic motion. It cannot repeat itself at regular intervals of time. The different types of motion we observe in our daily need not be periodic.

Examples of bodies undergoing non-periodic motion: (i) A footballer running on a field; (ii) tides in a sea.

Uniform Motion

A body is said to have a uniform motion if it covers equal distances in equal intervals of time. Examples of bodies undergoing uniform motion:(i) A train moving straight in a particular direction at constant speed(ii) a boy walking on a straight road at constant speed.

Non-uniform Motion

A body is said to have a non-uniform motion if it covers unequal distances in equal intervals of time. Examples of bodies undergoing non-uniform motion:(i) A stone falling freely under gravity.(ii) A car moving in a crowded road.

Multiple Motion

Sometimes an object can display combinations of different types of motion.

Example

A moving car which moves straight on the road displays rectilinear motion but at the same time the wheels of the car which are moving in circles display circular motion. So a moving car displays both rectilinear and circular motion.

In a sewing machine, the needle is in periodic motion whereas the wheels of the sewing machine are in circular motion. So a sewing machine displays circular and periodic motions.

Scalar and Vector Quantities

A physical quantity which has only magnitude but no specific direction is called a scalar quantity.

Examples: length, distance, area, mass, time, energy, etc.

A physical quantity which has both magnitude and direction is called a vector quantity.

Examples: displacement, velocity, acceleration, force, weight, etc.

SPEED

The distance travelled by a body per unit time is called the speed of the body.

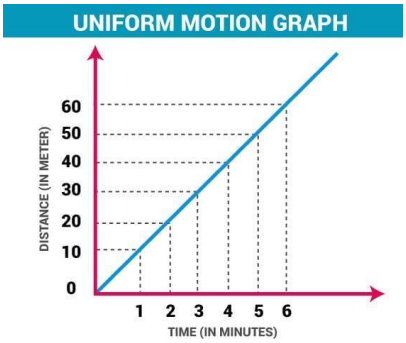
Speed is a scalar quantity.

The SI unit of speed is m/s.

Speed = Distance travelled/Time taken.

Uniform Motion: A body is said to have a uniform motion if it covers equal distances in equal intervals of time.

This uniform motion is defined as the motion of an object in which the object travels in a straight line and its velocity remains constant along that line as it covers equal distances in equal intervals of time, irrespective of the duration of the time.

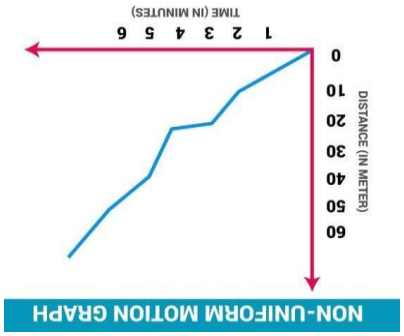


Example of Uniform Motion:

1. If the speed of a car is 10 m/s, it means that the car covers 10 meters in one second. The speed is constant in every second.
2. Movement of blades of a ceiling fan.

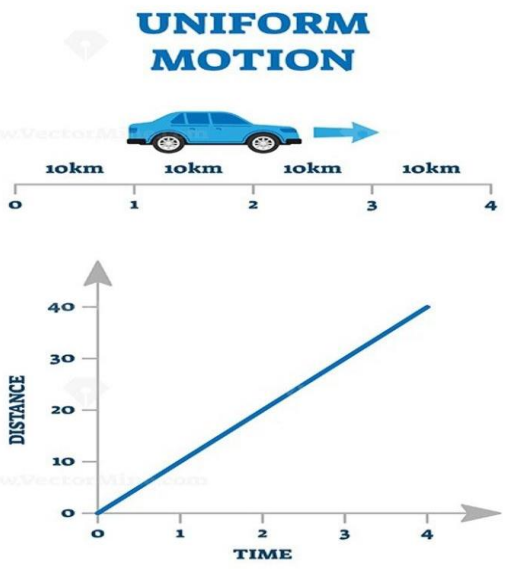
Non-uniform Motion: A body is said to have a non-uniform motion if it covers unequal distances in equal intervals of time.

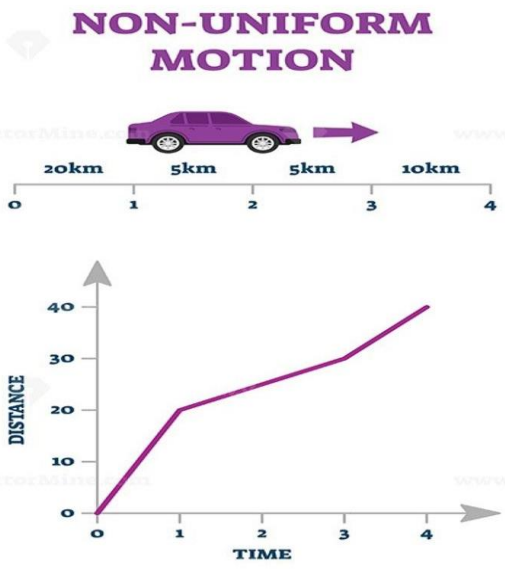
This non uniform of motion is defined as the motion of an object in which the object travels with varied speed and it does not cover same distance in equal time intervals, irrespective of the time interval duration.



Example of Non Uniform Motion:

1. If a car covers 10 meters in first two seconds, and 15 meters in next two seconds.
2. The motion of a train.





Average Speed-

It is defined as the total path length travelled divided by the total time interval during which the motion has taken place.

The average speed of a body in a certain time interval is the distance covered by the body in that time interval divided by time. So if a particle covers a certain distance s in a time t1 to t2, then the average speed of the body is:

$V_{av} = s/t_2\text{-}t_1$

In general, average speed formula is:

Average Speed = Total Distance/Total Time

Now let us look at some of the examples to understand this concept easily

1.) In travelling from Pune to Nagpur, Rahul drove his bike for 2 hours at 60 km/h and 3 hours at 70 km/h.

Sol 1) We know that, Distance = Speed × Time

So, in 2 hours, distance covered = 2 × 60 = 120 km

in the next 3 hours, distance covered = 3 × 70 = 210 km

Total distance covered = 120 + 210 = 330 km

Total time = 2 + 3 = 5 hrs

Avg. Speed = Total distance covered/Total Time taken

Avg. Speed = 330/5 = 66 km/h

Mass & Weight

Mass

It defined mass as the measure of the amount of matter in a body.

It is represented by the symbol m.

The SI unit of mass is Kilogram (kg).

Weight

It is the measure of the force of gravity acting on a body.

It is represented by the symbol W.

The formula for weight is given by:

w = mg

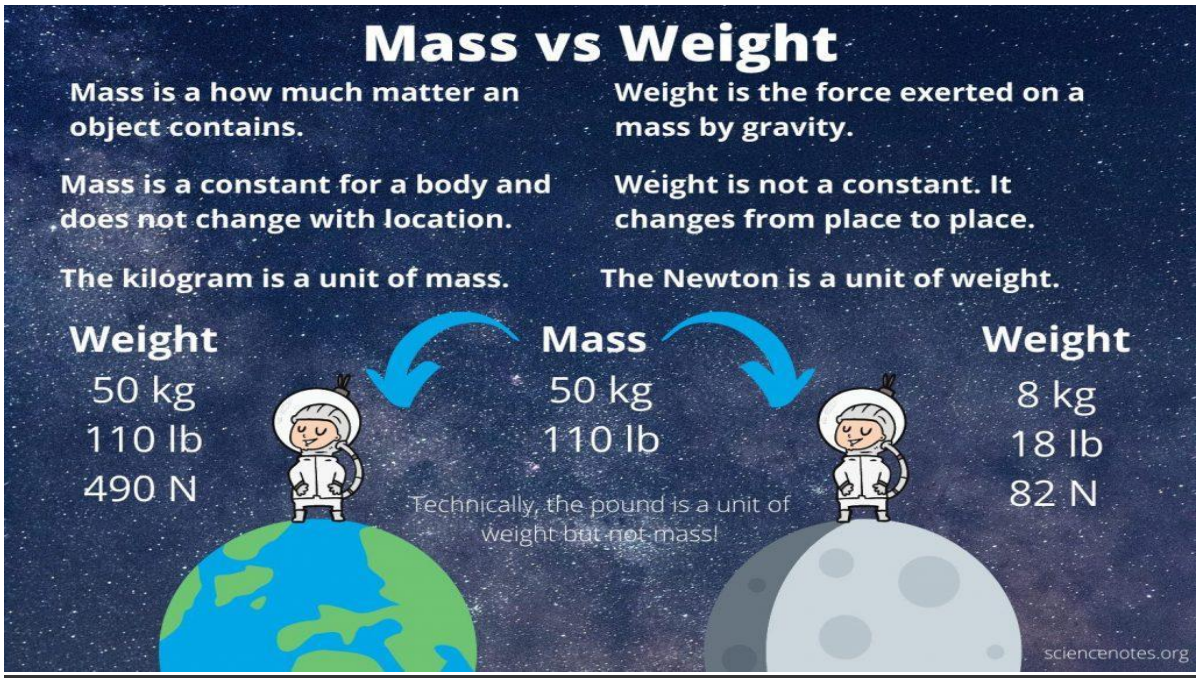
As weight is a force its SI unit is also the same as that of force, SI unit of weight is Newton (N).

What is the Difference between Mass and Weight?

Mass	Weight
Mass can never be zero.	Weight can be zero. As in space if no gravity acts upon an object, its weight becomes zero.
Mass is a scalar quantity. It has magnitude.	Weight is a vector quantity. It has magnitude and is directed toward the center of the Earth or other gravity well.
Mass is commonly measured in kilograms and grams.	Weight is commonly measured in Newtons.
Mass doesn't change according to location.	Weight varies according to location.
The mass may be measured using an ordinary balance.	Weight is measured using a spring balance.

EFFECT OF CHANGE IN PLACE ON MASS AND WEIGHT

The mass of a body remains constant everywhere on the surface of earth or on any other heavenly body. But the weight of the body changes from place to place because it depends on the force of attraction of earth on the body which differs from place to place.



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