Al-Mustaqbal University College

Department of Radiation Techniques

General Physics

Lecture 3 and 4:

Mechanics and Newton s Laws of Motion

first stage

by

Assistant lecturer

Ansam Fadil Ali Showard

2022-2023

Mechanics:

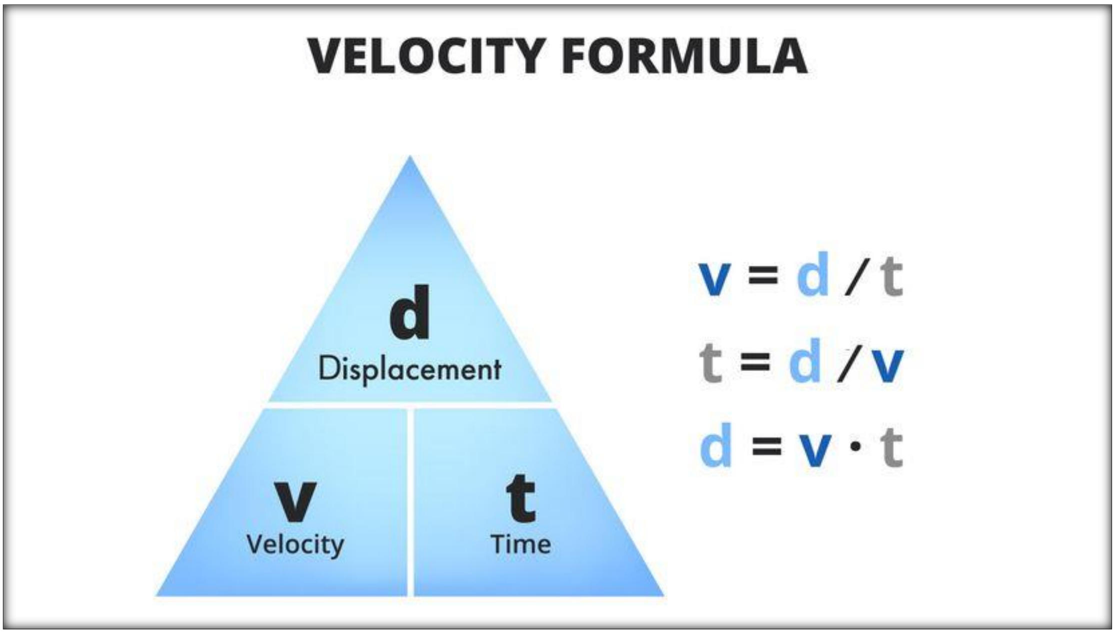
it is a science interested with the motion of bodies under the action of forces.

Velocity ($\vec{V}$):

is vector of displacement that an object (particle or body) through the time, (also known as speed), the unit of velocity is the meter per second (m/s) or centimeter per second (cm/s), it is a vector quantity.

Speed (S):

Define it as velocity but no need to mention direction. Because it is a scalar quantity. Also, it is limited to distance, not displacement.



H.W.// What's the Difference Between Speed and Velocity?

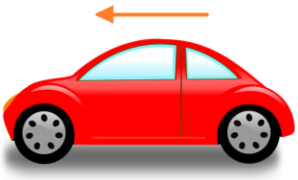
What is Velocity???

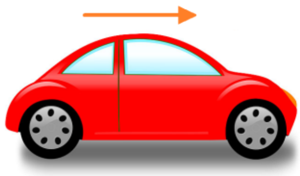
- The velocity of an object is defined as the displacement(covered by it) per unit time in a particular direction.
- The symbol used to represent Velocity is "v"(small character) or " $\vec{v}$ "

Velocity = Displacement / Time

$$v = d/t$$

- Velocity Dimensions are: $v = [LT^{-1}]$

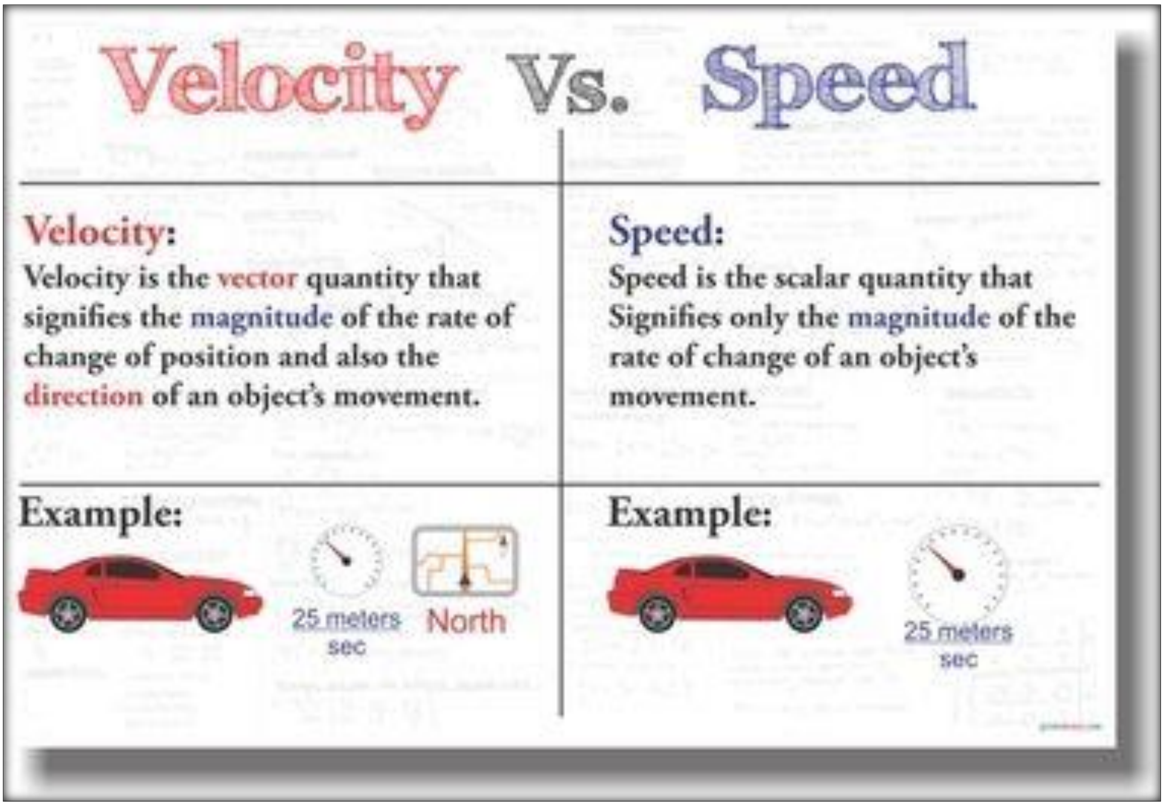




★ Speed = 18m/s
★ Velocity = 18m/s towards north.

★ Speed = 18m/s
★ Velocity = 18m/s towards south.

www.TheEngineeringProjects.com



Newton's laws of motion:

1- Newton's First Law:

states that "an object at rest will remain at rest and an object in motion will remain in motion with a constant velocity unless external force acted on it".

2- Newton's Second Law:

states that "the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass".

$$\vec{a} \propto \frac{\sum \vec{F}}{m} \rightarrow \sum \vec{F} = m\vec{a}$$

$\sum \vec{F}$ is the net force. May also be called the total force,

3- Newton's Third Law:

states that "For every action there is a reaction, an equal to it in magnitude and opposite in direction.

1. Newton's First Law of Motion **(Inertia)**	An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force
2. Newton's Second Law of Motion **(Force)**	The acceleration of an object depends on the mass of the object and the amount of force applied.
3. Newton's Third Law of Motion **(Action & Reaction)**	Whenever one object exerts a force on another object, the second object exerts an equal and opposite force on the first.

What is the force formula?

Force: equal to mass multiplied by acceleration.

$$F = m.\ a$$

Where:

m = mass

a = acceleration a is given by: $a = \Delta v/\Delta t$

v = velocity

t = time taken

So: Force can be expressed as:

$$F = m.\ \Delta v/\Delta t$$

Q.1) How much net force is required to accelerate a 1000 kg car at 4 m/s^2?

Solution:

$a = 4\ m/s^2$, and m = 1000 kg

Therefore:

$F = ma = 1000 \times 4 = 4000$ N

Q.2) A hammer having a mass of 1 kg going with a speed of 6 m/s hits a wall and comes to rest in 0.1 sec. Compute the obstacle force that makes the hammer stop?

Solution:

Mass of Hammer m = 1 kg, and Initial Velocity, u = 6 m/s, and Final Velocity v = 0 m/s, and Time Taken t = 0.1 s, and The acceleration is: $a = \Delta v/ \Delta t = (vf – vi)/t$

Therefore, $a = -60\ m/s^2$

Thus, the retarding Force $F = ma = 1 \times 60 = 60$ N

Q.3) A 60 Kg person walking at 1 m/sec bumps into a wall and stops in about 0.05 Sec. what is the force؟

Sol.

$F = ma = m\Delta v/\Delta t$

$\Delta(mv) = (60\ Kg)\ (1 m/sec) – (60\ Kg)\ (0\ m/sec) = 60\ Kg\ m/sec$

the force developed on impact is

$F = \Delta\ (mv)/\Delta t = 60 Kg\ m/sec\ /\ 0.05\ sec = 1200\ Kg\ m/sec^2$

F = 1200 Newton

Gravitational Force:

is the force that the earth exerts on an object. This force is directed toward the center of the earth,

gravity = Earth's surface the acceleration = about 9.8 meters per second

$$\vec{F}_g = m\vec{g}$$

$$F = \frac{GM\ m}{r^2}$$

This equation describes the force between any two objects in the universe:

In the equation:

- F is the force of gravity (measured in Newtons, N)
- G is the gravitational constant of the universe and is always the same number
- M is the mass of one object (measured in kilograms, kg)
- m is the mass of the other object (measured in kilograms, kg)
- r is the distance those objects are apart (measured in meters, m)

So if you know how massive two objects are and how far they are apart, you can figure out the force between them.

Additional Activities

Practice Questions (You May Use a Calculator)

Using Newton's Universal Law of Gravitation and the gravitational constant G = 6.67 x 10^(-11) please answer the following questions:

1. Find the force between the earth and sun, given the mass of the earth, is 6 x 10^(24) kg and the mass of the sun is 2 x 10^(30). The distance between the earth and the sun is 1.5 x 10^(11) m.

2. Find the approximate distance between the earth and the planet Mars given the force between the two planets is 10^(16) Newtons (N). Also, the mass of the earth can be used from question 1 above, while the mass of Mars is 6.4 x 10^(23) kg.

Answers

1. From the question we have mass of the earth m1 = 6 x 10^(24) kg, mass of the sun m2 = 2 x 10^(30) kg and distance between the two bodies is r = 1.5 x 10^(11) m. Then using Newton's Law we have the force as follows:

$$F = \frac{G \times m_1 \times m_2}{r^2}$$

$$= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 2 \times 10^{30}}{(1.5 \times 10^{11})^2} = 3.6 \times 10^{22} \text{ N}$$

2. Again using Newton's Law, with F = 10^(16) N, mass of earth m1 = 6 x 10^(24) kg and mass of Mars m2 = 6.4 x 10^(23) kg, we use the formula from part 1 above to get us

$$10^{16} = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 6.4 \times 10^{23}}{r^2}$$

Using cross multiplication and taking square roots of both sides yields

$$r^2 = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 6.4 \times 10^{23}}{10^{16}} = 2.56 \times 10^{22}$$

or

r = 1.6 x 10^(11) m.

So the distance between the two planets is 1.6 x 10^(11) m.