Gravitation

Non uniform circular motion

Definition:
Non- uniform circular motion is defined as the motion of a particle along the circumference of a circle with changing speed. The net acceleration of particle is inside the circle.

Definition
Non Uniform Circular Motion
In non uniform circular motion magnitude of velocity changes with time.
Direction of the particle changes at every point of time in circular motion.
Definition
Uniform Circular motion
Definition:
Uniform circular motion is defined as the motion of a particle along the circumference of a circle with constant speed.
UCM can also be defined as periodic motion of a particle moving along the circumference of a circle with constant speed.

e.g.
1. Motion of earth around the sun.
2. Motion of moon around the earth.
Example
Examples of Circular Motion
Following are the examples of circular motion:
1. Motion of an artificial satellite orbiting the Earth.
2. A stone which is tied to a rope and is being swung in circles.
3. A car turning through a curve in a road.
4. Electrons moving perpendicular to a uniform magnetic field
5. A gear turning inside a gear-train.
6. Motion of a clock hand.
7. Motion of bicycle wheels.

Definition
Centripetal Acceleration

Centripetal Acceleration = v^2/r

The direction of the centripetal acceleration is always inwards along the radius vector of the circular motion.

Centripetal Force

A body moving in a circle of constant radius with a constant speed has a non-zero force acting on it. This force is known as Centripetal force. It is directed towards the center of the circle. Its value is given by the formula:

$F=mv2/R$

Note: Centripetal force for uniform circular motion is constant in magnitude. However, its direction is continuously changing as it is always directed towards the center of the circle.

Definition:

Centripetal force is a force acting on particle performing the circular motion, which is a long radius of circle and directed towards the center of circle.

Centripetal force acts at right angles to the tangential velocity of the particle, there is no displacement in the direction of force, hence no work is done by centripetal force.

Examples of Centripetal Force

Examples of Centripetal Force:

1. When an object tied at the end of a string is whirled in a horizontal circle, the necessary centripetal force for maintaining circular motion is provided by tension in the string.
2. If a car is traveling round a circular horizontal road with uniform speed, the necessary centripetal force for negotiating the curve is provided by force of friction between tyres of vehicle and road surface.
3. The necessary centripetal force is provided by push due to rails on the wheels of train during taking turn.
4. Moon revolves around the earth in circular orbit. Here the necessary centripetal force is provided by gravitational force of attraction between moon and earth.

Gravitational Constant

The gravitational constant (G) is a proportionality constant that appears in the equation for Newton's law of gravitation. The value of G is approximately equal to $6.67\times10-11\ Nm2kg-2$.

Definition

Universal Law of Gravitation

Newton's law of universal gravitation states that any two bodies in the universe attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Mathematically, $Fg=Gm1m2r2$

where, Fg = Gravitational Force

G = Universal Gravitational Constant

m1, m2 are masses of bodies

r = distance between their centre

Definition

Importance of Universal Law of Gravitation

Following are the importance of the universal law of gravitation:

It explains the force of gravitation acting between two bodies.

It describes the phenomenon of revolution of heavenly bodies.

Gravitational Force

Gravitational force is defined by Newton's law of gravity which states that gravitational forces between two bodies is directly proportional to product of their masses and inversely proportional to the square of distance between them. It is always attractive in nature.

Mathematically, $F_g \propto m_1 m_2$

$F_g \propto \frac{1}{r^2}$

Example: An apple falling from a tree to earth is due to gravitational force.

Pull of Earth

Every object in the universe attracts every other object with a pull, so as the earth.Earth attracts every objects towards itself, this is the reason we are able to walk and stand on the ground.Have you ever thought why the moon moves around the earth in a circular manner,this happens because earth is pulling the moon towards itself.

Have you ever thought that why any object thrown in air always come to fall on the ground? This is because earth is applying a gravitational force to pull in back on the surface of earth.

Weight and Mass

Weight is the force on an object due to gravity. It is given by $W=mg$.

Mass is a measure of amount of matter contained in a body. It is a fundamental property of the object and is hence a constant quantity.

Example: A body of mass $m=5$ kg has a weight of $W=5\times9.8=49$ N on the earth's surface.

Centre of Gravity

The centre of gravity (C.G.) of a body is the point about which the algebraic sum of moments of weights of all the particles constituting the body is zero. The entire weight of the body can be considered to act at this point howsoever the body is placed.

Definition

Shift of center of gravity and its effect

The location of the center of gravity is important for stability. If we draw a line straight down from the center of gravity of an object of any shape and it falls inside the base of the object, then the object will be stable.

If the line through the center of gravity falls outside the base then the object will be unstable.

For example:When you stand erect the center of gravity is somewhere near to your stomach and your body is balanced but when you try to lean forward or backward the center of gravity shifts outside the base the and your body gets unstable.

Definition

Centre of Gravity of irregular lamina

Take a lamina with three holes near the periphery of the lamina, now suspend the lamina through them, one by one. Draw a line of equilibrium for each suspension point. The point of intersection of these three lines would be the centre of gravity.

dentification of centre of gravity

A solid body can be balanced by supporting it at its centre of gravity. For example, a uniform metre rule has its centre of gravity at the mark 50cm. It is possible because the algebraic sum of moments of the weights of all particles of rule about any point is zero. This point where the rule is supported is its centre of gravity.