GRAVITATION

INTRODUCTION

❖ *Galileo was the first who recognize the fact that all bodies, irrespective of their masses, fall towards the earth with a constant acceleration.*

❖ *The value of acceleration due to gravity obtained by Galileo is close to the more accurate value obtained later.*

❖ *Kepler who formulated three laws known as Kepler's laws of planetary motion.*

❖ *After that Newton proposed his universal law of gravitation which was proved, later on, of a greater importance.*

THEORY OF PLANETARY MOTION

According to this theory, all the heavenly bodies like sun, stars, planets, moon etc. are moving around the earth which is stationary and was taken as the center of universe.

This theory was challenged by Copernicus.

KEPLER'S LAWS OF PLANETARY MOTION

1) Kepler's First Law (law of orbit):- _Every planet revolves around the sun in an elliptical orbit. The sun is situated at one foci of the ellipse._

It is based on "Inverse Square Law"

2) kepler's Second Law (law of area):- _The line joining a planet to the sun sweeps out equal areas in invertal of time. i.e. the areal velocity of the planet around the sun is constant._
it is based on law of conservation of angular momentum.

3) Kepler's third law (law of periods):- _The square of the time period of revolution of a planet around the sun is directly proportional to the cube of semi major axis of its elliptical orbit i.e_

GRAVITATION

Gravitation is the name given to the force of attraction between any bodies of the universe.

PROPERTIES

❖ It is the weakest force among the four fundamental forces of nature.

❖ It is the most important force because it is played an important role in initiating the birth of stars, and controlling the entire structure of the universe.

NEWTON'S LAW OF GRAVITATION

It states that every body in this universe attracts every other body with a force which is directly proportional to the product of their masses and is inversely proportional to the square of the distance between them.

$$F = G\,M1\,M2/r^2$$

Where G= **Universal Gravitational Constant**

PROPERTIES

❖ 'G' is a scalar quantity.
❖ S.I unit is $N\,m^2\,kg^{-2}$

IMPORTANT CHARACTERISTICS OF GRAVITATIONAL FORCE

According to Newton's law of gravitation, the gravitational force of attraction between two bodies
  1) is independent of nature of intervening medium.
  2) is independent of presence or absence of any other bodies.
  3) is independent of nature and size of the bodies, till their masses remain same and the distance between their centers is fixed.
  4) form action and reaction pair i.e. the gravitational forces are equal in magnitude and opposite in direction and hence obey Newton's third law of motion.

GRAVITY

Gravity is the force of attraction exerted by earth towards its center on a body lying on or near the surface of earth. Gravity is merely a special case of gravitation and also called earth's gravitational pull.

Force of gravity acting on a body is the measure of weight of the body. Thus, weight of a body is defined as the force of attraction exerted by the earth on the body towards its centre.

If 'm' is the mass of a body placed on the surface of earth, where acceleration due to gravity is 'g' , then, gravity pull= weight of body= mg.

DIFFERENCE BETWEEN GRAVITATION AND GRAVITY

1) Gravitation is the force of attraction acting between any two bodies of the universe.
  Gravity is the earth's gravitational pull on the body lying on or near the surface of earth.
2) The gravitational force on body A of mass m1 to a body B of mass m2 placed at a distance 'r' apart is F= Gm1m2/r2; where G= universal gravitational constant.
    The force of gravity on a body of mass 'm' is F=mg, where 'g' is the acceleration due to gravity.

3) The direction of gravitational force on body A due to the body B is along AB.

The direction of force of gravity on a body is along the line joining the body and the centre of the earth and is direction towards the centre of the earth.

4) The force of gravitation between two bodies can be zero if the separation between two bodies becomes infinity.

The force of gravity on a body is zero at the centre of earth.

ACCELERATION DUE TO GRAVITY

It is defined as the force of gravity acting on unit mass of the body placed on or near the surface of earth.

If the body is falling freely, under the effect of gravity, then the acceleration in the body is also called acceleration due to gravity. Thus, acceleration due to gravity is the acceleration set up in the body when it falls freely under the effect of gravity alone. It is denoted by 'g' . SI unit of acceleration due to gravity or $m\ s^{-2}$

RELATION BETWEEN 'g' AND 'G'

Consider earth to be a spherical body of mass M, radius R with centre O. suppose a body of mass m placed on the surface of earth, where acceleration due to gravity is g.

The force on the of mass m, outside the surface of earth is due to earth whose mass M is concentrated at the centre O.

Let F be the force of attraction between body and earth.
According to Newton's law of gravitation $F = GMm/R^2$

From gravity pull, F=mg
Therefore, $mg = GMm/R^2$
$$g = GM/R^2$$

GRAVITATIONAL POTENTIAL

Gravitational Potential at a point in a gravitational field of a body is defined as the amount of work done in bringing a body of unit mass from infinity to that point without acceleration.

CENTRE OF GRAVITY

Centre of gravity of a body placed in the gravitational field ia that point where the net force of the field acts.

ESCAPE SPEED

Escape speed on earth is defined as the minimum speed with which the body has to be projected vertically upwards from the surface of earth so that it just crosses the gravitational field of earth and never returns on its own.