Gravitation - The earth attracts all the object toward its centre known as the force according to Netwon every object in this univers attract every other object with the certain force, the force with which two object attract each other Gravity.

OR

The earth attracts all the object towards its centre the force with which the Earth pulls the object toward it, it is called Gravitational force of earth.

Example :- Rain is falling

If the mass of object is smaller then the Gravitational force is small.

If the mass of object is lareger then the Gravitational force is lareger.

Centripetal force

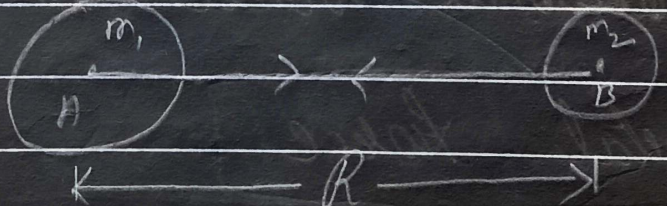
- It is defined as the force acting on a body that is moving in a circular path is directed towards the centre around which the body moves. OR
- It is defined as the force acting on a body that is moving in a circular path

Centrifugal force

- This force is also a pfforce that acts when the object in circular motion. This force has some magnitude as centripetal force but is in the opposite direction of the force.
- Ex:- Car experince an outward push to the ~~the~~ right

Netwon universal law of Gravitation

- Every object in this universe attract every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them



Consider two bodies A and B having masses m_1 and m_2 respectively, let the distance between these bodies is R

According to the law of Gravitation

$$F \propto m_1 m_2 \quad \ldots (i)$$

$$F \propto \frac{1}{R^2} \quad \ldots (ii)$$

combining equation (i) and (ii) we get

$$F \propto \frac{m_1 m_2}{R^2}$$

$$F = G \frac{m_1 m_2}{R^2} \quad \ldots (iii)$$

where G is constant and is known as Universal gravitation constant.

SI unit of 'G' is Nm^2Kg^{-2}

$$\boxed{F = \frac{G m_1 m_2}{R^2}}$$

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

$$G = \frac{Nm^2}{Kg^2} \Rightarrow Nm^2Kg^{-2}$$

The value of G is $6.67 \times 10^{-11} Nm^2Kg^{-2}$ and it is a vector quantity

According to the inverse square law

$$F \propto \frac{1}{R^2}$$

If the distance between two particles is doubled then the gravitation force is one - forth.

If the distance between two particle is half then the gravitational force become four times

Importance of Universal law of Gravitation

The gravitational force is one of the fundamental force in nature. The gravitational force is responsible for the following :-

(i) the existance of solar system
(ii) Holding the almosphere near the surface of earth.
(iii) The flow of water in river
(iv) Motion of moon around the earth.

Numerical

1 (Q) A sphere of mass of 4kg is attracted by 2nd sphere of mass 15 kg when the centres are 20 cm with the force of 0.1 mg wt. Calculate the value of G.

Free fall

- Galielo Galilei experimented on a free ball of an object when two stones of different masses droped from the top of the tower they hit the ground at the same time this shows that the acceleration of freely falling object does not depend upon the masses of the object.
- when an object fall down towards the earth under the influence of gravitational force alone we say that the object is free falling.
- The velocity of freely falling body changes during its free fall but their acceleration is no change in direction occur and it is said to be a accelerated this acceleration is called acceleration due to gravity
- It is denoted by 'g' and SI unit is ms^{-2}

Calculate the value of acceleration due to gravity

- According to the universal law of gravitation

$$F = \frac{GMm}{R^2} \quad \ldots\ldots (i)$$

where 'm' is the mass of the body and 'M' is the Mass of earth and 'R' is the radius of the earth.

According to the Newton's second law of motion.

$$F = m \times a$$

Replace 'a' with 'g'.

$$F = m \times g \quad \text{..... (ii)}$$

combining eqn (i) and (ii)

$$mg = \frac{GMm}{R^2}$$

$$\boxed{g = \frac{GM_e}{R_e^2}}$$

$G = 6.67 \times 10^{-11} \ Nm^2 Kg^{-2}$

$M_e = 6 \times 10^{24} \ Kg$

$R_e = 6.4 \times 10^6 \ m$

$$g = \frac{GM_e}{R_e^2}$$

$$= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.4 \times 10^6)^2}$$

$$= \frac{6.67 \times 6 \times 10^{-11+24}}{6.4 \times 6.4 \times 10^{6+6}}$$

$$= \frac{6.67 \times 6 \times 10^{18} \times 10}{6.4 \times 6.4 \times 10^{12}}$$

$$= \frac{400.2 \times 10}{40.96}$$

$$= \frac{4002 \times 100}{4096} \quad \begin{matrix} 2001 \\ 50 \\ 1023 \end{matrix}$$

$$= 9.8 \ ms^{-2}$$

- The value of 'g' is not constant at all the pla on the surface of the earth this is due to the fact that the earth is not perfectly sphere the radius of the earth is minium at the poles du and to the flattening of the earth and hence t value of 'g' is minium at the poles and on t other hand the radius of the earth is maxi at the equator and hence the value of 'g' is maxium at the equator

$$g \propto \frac{1}{R^2}$$

The value of 'g' is the maxium on the surface of the earth. The value of 'g' decreases going above the surface of the earth as well as going below the surface of the earth.

- The value of 'g' changes going deep inside the earth so the value of 'g' is zero at the centre of the earth. It goes on decreasing as we go from the earth surface towards the the centre of the earth.

Numerical

6 Q) Find the gravitational force between the sun and the earth. The mass of the sun is 2.0×10^{30} Kg and the mass of the earth is 6.0×10^{24} Kg the distance between the sun and the earth is 1.5 / times 10^{11} m. ($G = 6.67 \times 10^{-11}\ Nm^2Kg^{-2}$)

Difference between 'g' and 'G'

g	G
• it is the acceleration secured by a body due to the earth's gravitational pull on it	• It is equal to the force of attraction between two mass of 1 Kg is seperated by a distance of 1 m
• its value is $9.8 ms^{-2}$	• its value is $6.67 \times 10^{-11} Nm^2 Kg^{-2}$
• its value varies various place	• its value remain constant everywhere
• it is a vector quantity	• it is a scaller quantity
• SI unit is ms^{-2}	• SI unit $Nm^2 Kg^{-2}$
• The value of g is zero at the centre is zero	• The value of G is not zero at the at the centre of the earth

Equation of Motion for freely falling objec

we know that about the equation of motion for freely falling object the acceleration due to gravity (g) to be replace the acceleration (a) of the equation by 'g'. The vertical distance of a freely falling object is known as h.

$v = u + at \rightarrow v = u + gt$

$s = ut + \frac{1}{2}at^2 \rightarrow h = ut + \frac{1}{2}gt^2$

$v^2 = u^2 + 2as \rightarrow v^2 = u^2 + 2gh$

(i) When a body is falling vertically downward its velocity is increasing so the value of g is taken as +ve $(+9.8\ ms^{-2})$

(ii) When a body is falling vertically upward its velocity is decreasing so the g is taken as -ve $(-9.8\ ms^{-2})$

(iii) When a body is dropped freely from a height its initial velocity is zero.

(iv) When a body is thrown vertically upward its final velocity (v) is zero.

(v) The time taken by a body to rise the heighest point is equal to the time it taken its fall from the same height.

Mass

- The mass of a body is the quantity of matter contain in it. Mass is a scaller quantity.
- Mass is remain constant
- The SI unit of mass is Kg.
- It is denoted by m.

The characteristic of Mass of a body are as follow:

- Mass of a body does not depend on the shape size and state of the body.
- Mass of the body is directly proportional to the quantity of matter contain in it.
- Mass of a body can be measured by the help of common balance.

weight

- The weight of a body is the force with which it is attracted towards the centre of the earth.
- According to Newton 2nd law

$$F = ma$$

The acceleration produce by the force of attraction of the earth is known as acceleration due to gravity (g)

- It is denoted by 'w'

$F = m \times a$

$F = m \times g$

$w = mg$

- SI unit of force is Newton (N).

$w = 1kg \times 9.8 ms^{-1}$

$w = 9.8 N$

The characteristics of weight of a body are as follow:

- weight is a vector quantity.
- weight is measured on Spring balance or weighing machine.
- The weight of the body is directly proportional to the mass
- The weight of a body changes with the value of g. When 'g' decrease the weight of the body also decrease.
- The value of 'g' at the pole is higher that at the equator.
- The value of g on the surface of different planet of the solar System is different therefore the weight of the body is different on different planet.

Difference between mass and weight

Mass	weight
• The mass of an object is the quantity of matter contain in it.	• The weight of an object is the force with which it is attracted towards the centre of the earth.
• SI unit of mass is Kg.	• SI unit is N
• The mass of an object is constant everywhere.	• The weight of an object is not constant it changes with the change of g
• The mass of an object can never be zero.	• The weight of an object can be zero.
• it can be measured by common balance.	• It can be measured by ~~optic~~ spring balance.

weight of an object on the moon

The weight of an object on the earth is the force with which the earth attracts the object in the same way the weight of an object on the moon is with which the the Moon attracts the object. The mass of the moon is less then that of the earth due to

this the Moon exert less force of attraction on object.

let the mass of the moon be M_m and Radius be R_m. Mia is the mass of the object and w_m is the weight of the moon and w_e is the weight of earth and R_e is the Radius of earth and M_e is the Mass of the earth

$$w = mg \quad \text{—(i)}$$

$$g = \frac{GM}{R^2}$$

Putting the value of g in eq^n (i)

$$w = \frac{GMm}{R^2}$$

$$w_e = \frac{GMm_e}{R_e^2}$$

$$w_m = \frac{GMm_m}{R_m^2}$$

$$\frac{W_m}{W_e} = \frac{G M m_m}{R_m^2} \times \frac{R_e^2}{G M m_e}$$

$$\frac{W_m}{W_e} = \frac{M_m}{R_m^2} \times \frac{R_e^2}{m_e}$$

We know that Mass of the earth 100 times the mass of the moon. So,

$$M_e = 100\, m_m$$

and Radius of earth is 4 times the of Radius of moon

$$M_e = 4 \times M_m$$

$$\frac{W_m}{W_e} = \frac{m_m}{100\, m_m} \times \frac{16 R_m^2}{R_m^2}$$

$$\frac{W_m}{W_e} = \frac{16}{100} = 0.16$$

$$W_m = 0.16 \approx \frac{1}{6}$$

$W_m = \frac{1}{6}$ weight of earth

Thrust

- The force operating on a body perpendicular to its surface is known as Thrust. The SI unit of Thrust is N. It is vector quantity.

- Ex:- If we stand on loose sand then we will observe that our feet go deep into the sand it is because of our body weight we have learn that weight is the force acting vertically downward the force is acting perpendicular to the surface of the sand.

Pressure

- The thrust per unit area is called pressure.

- The effect of thrust depend on the area on which it act

$$P = \frac{F}{A} \quad / \quad P = \frac{T}{A}$$

- The SI unit of pressure is Nm^{-2}.
- It is also measured by pascal (Pa) pascal is a very small unit the ~~re~~ pressure is usually expressed in KPa
& 1 Kpa = 1000 Pa
1 Kpa = 1000 Nm^2
- It is a scaller quantity
- More area of contact leading to the less pressure less area of contact leading to a high pressure
- Ex: why school bags have wide spip so that the weight of bags may spread over a large area of which solders producing less pressure.

Pressure in fluids

Pure All liquid & gases are fluid a solid exert pressure on a surface due to its weight

Liquid also have weight those substances which can flow easily are called fluids & fluid exert pressure in all direction & even upwards

The molecules of liquid & gases are in a state of random motion when these molecules collide with the walls of the container or with the surface of any object placed in it, the molecules either a change in momentum. Because of this change in Momentum the molecule exert a force on the bulk or surface this force exerted per unit area is called pressure exerted by fluids

Buoyancy

Buoyant force

The upward force experienced by a body when a partially or fully emerged in a liquid is called upthrust or Buyont force

The phenomenon responsible for this is called Buyoncy. Due to the Buyoant force the heavy object seems lighter in water.

ex:- Due to Boyant force exerted by water that we are able to swim in water and the Ship float in water. If there were no upward force of water we will not able to swim. Ship would also drink.

All object experience a force of Buoy when they are emerge in a fluid. The magnitude of this buyont force depends on the density of the fluid. You ex:- Sea water have more density then fresh water sea water has more Buyont force so we can easily swim in sea water.

Archimedes' Principle

It states that when a body is partially or fully emerged in a fluid it experience

an upthrust force which is equal to the weight of the fluid displaced by the emergen ~~by~~ part of the fluid

According to the principle of flotation an object will float on a liquid if the weight of the object is equal to the weight of liquid displace by it.

weight of object = weight of liquid displace by it

why object float or sink on a liquid?

When an object ~~put~~ is put in a liquid then two forces act on it

- weight of the object acting downward
- Buyont force acting upward

* If the Buyont force exerted by the liquid is less then the weight of the object the object will sink in the liquid

* If the Buyont force exerted by the

liquid is equal to the weight of the object then the object will float on liquid

* If the Buyont force force exerted by the liquid is more then the weight of the object the object will rise on liquid and then float

Density

Density of a substance is defined as its mass per unit volume.

The SI unit of Density is Kgm^{-3} / $\frac{Kg}{m^3}$.

Magnitude of Buyont force depend upon the density of the fluid in which the body is emerged If a body is put in water then 3 different situations

(i) If the density of the body more then the density of water the object will sprink in water.

(ii) If the density of the object is equal to the density of water the object will

remain submerged completely at any level in the water

(14) If the density of object is less then the density of water then the object will float