CH-10
GRAVITATION

⇒ GRAVITATION - The earth attracts ~~each~~ (or pulls) all the objects towards its centre. The force with which the earth pulls the objects towards it is called the gravitational force of the earth or gravity (of earth).

Ex- A stone dropped from a height falls towards the earth exerts a force of attraction (called gravity) on the stone and the pulls its down.

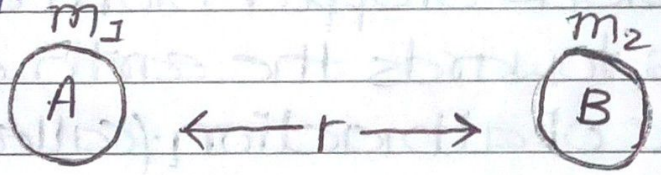
EVERY OBJECTS IN UNIVERSE ATTRACTS EVERY OTHER OBJECTS.

According to the Newton, every objects in the universe attracts every other object with a certain force. The force with two objects attracts each other is called gravity,

Note: The mass of the objects are small. then the gravitational force between them is very small (which can not be decteded easily.)

UNIVERSAL LAWS OF GRAVITATION

Every body in the universe attacts every other body with a force which is directly propertional to the products of their masses and universaly proportional to the square of the distance between them.



i) The Force between the two bodies is directly propertional to the products of their masses.

$$F \propto m_1 \times m_2$$

ii) The force between the two bodies is directly proportional to the square of the distance between them.

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

→ Combining the 1) and 2). We get:

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

⇒ Gravitational Force: $F = G \times \frac{m_1 \times m_2}{r^2}$

⇒ If We double the distance between two bodies. then the gravitational Force become Four times.

UNITS OF THE GRAVITATIONAL CONSTANT, G.

A/q to the universal law of the gravitati, the gravitational Force F between two bodies of masses m_1 and m_2 placed at a distance, r apparts is given by:

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

This can be rearranged to get an expression for the gravitational constant G as follows:

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

Value of Gravitational Constant, G

The gravitational constant G is numerically equal to the force of gravitation which is exerts between two bodies of unit masses kept at a unit distance From each other. The value of universal gravitational constant G has been found to be $6.67 \times 10^{-11} Nm^2/kg^2$.

Important point:

I) Gravitational Force is vector quantity.
II) Its S.I Unit = Newton
III) Its C.G.S Unit = DYNE
IV) Smallest unit of gravitational Force is known as ~~gravitation~~ graviton.
V) Radius of Earth = 6.4×10^3 km
VI) Mass of Earth = 6×10^{24} kg
VII) Mass of Sun = 2×10^{30} kg
VIII) Mass of Moon = 7.4×10^{22} kg

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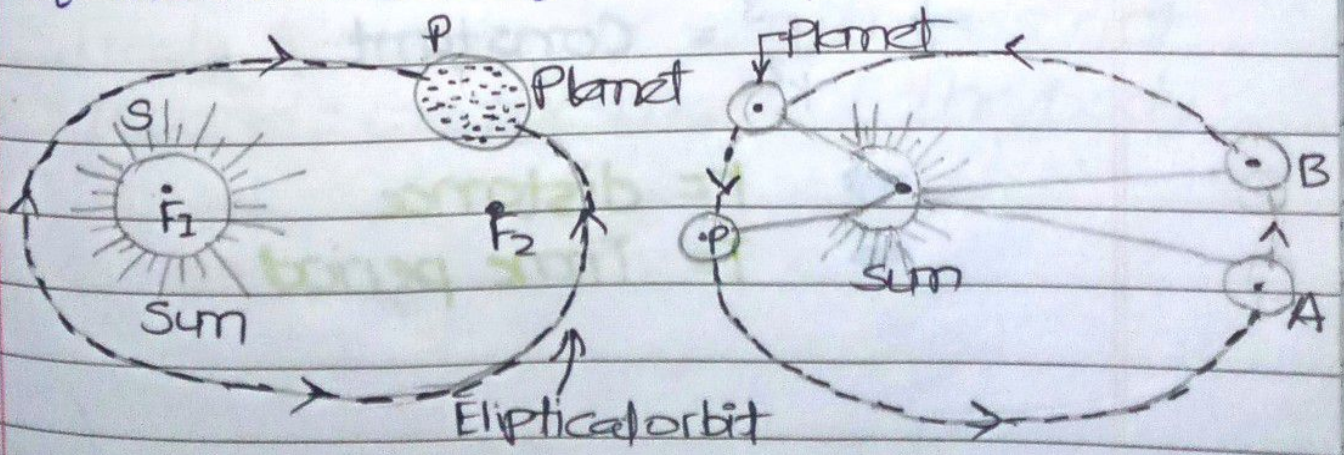
GRAVITATIONAL FORCE HOLDS SOLAR SYSTEM TOGETHER.

→ It is the gravitational force between the sun and the earth which keeps the earth in uniform circular motion around the sun.

→ The tides in the sea Formed by the rising and Falling of water leval in the sea, are due to the gravitational Force of attraction which the moon and the sun exerts on the water surface in the sea.

KEPER'S LAWS OF PLANETARY MOTION.

I) The planets moves in elliptical orbits arounds the sun, with the sun at one of the two foci of the elliptical orbit.



2. Kepler's second laws states that: Each planets resolves around the sun in such a ways thats the line joining the planet to the sun sweeps over equal interval of time.

⇒ A planet moves Faster when it is closer to the sun, and moves slowly when it is Farther From the sun.

⇒ A planet does not moves with constant speed around the sun. The speed is greater ~~with~~ When the planets is nearer the sun and less when the planet is Farther away From the sun.

3. ⇒ The cube of the mean distance of a planet From the sun is directly proportional to the square of time it takes to move around the sun.

$\Rightarrow r^3 \propto T^2$

$\Rightarrow r^3 = \text{Constant} \times T^2$

$\Rightarrow \frac{r^3}{r^2} = \text{Constant}$

⇒ r = distance

⇒ T = Time period

IMPORTANCE OF THE UNIVESAL LAWS OF GRAVITATION.

The universal law of gravitation successfully explained several phenomena which were believed to be unconnected:

i) The Force that binds ~~the~~ us to the earth.
ii) The motion of the moon around the earth;
iii) The motion of planets around the sun and;
iv) The tides due to the moon and the sun.

FREE FALL :-

The falling of the body (an object) from a height towards the earth under the gravitational Force of earth (With ~~the~~ no other Forces acting on it) is called Free Fall.

⇒ Acceleration of an object Falling Freely towards the earth does not depends on the mass of the body.

Acceleration due to the Gravity (g)

→ When a body Freely Falls under gravity then acceleration produced in the body is known as acceleration due to the gravity;

It is denoted by 'g'.

Note: I) Its a vector quantity

II) Its S.I Unit is N/kg or m/sec^2

III) Its C.G.S Unit is DYNE/gm or cm/sec^2.

IV) Its average value on the surface of earth is $9.8\ m/sec^2$

V) Value of g is different on different places of earth.

VI) Value of g is maximum at pole and minumim and equator.

⇒ TO CALCULATE THE VALUE OF G.

To calcute the value of g, we should put the value of G, M, and R in Eq. namly, universal gravitational constant $G = 6.7 \times 10^{-11}\ Nm^2 kg^2$, Mass of the Earth

NOTE:- The value of g on the moon is about one-sixth $(\frac{1}{6})$ of the value of g on the earth.

Equations of Motion For Freely Falling Bodies.

General equations of motion.		Equations of motion For Freely Falling bodies.
i) $v = u + at$	change to	$v = u + gt$
ii) $s = ut + \frac{1}{2}at^2$	change to	$h = ut + \frac{1}{2}gt^2$
iii) $v^2 = u^2 + 2as$	change to	$v^2 = u^2 + 2gs$

When a body is Falling vertically downwards, its velocity is increasing. so the acceleration due to gravity. g is taken as positive.

⇒ Acceleration due to gravity $= +9.8\ m/s^2$ For Freely falling bodies.

b) When a body is thrown vertically upwards, its velocity is decreasing, so the acceleration due gravity, g, is taken as negative.

⇒ Acceleration due to gravity for a body thrown upwards ⇉ $-9.8 m/s^2$

c) When a body is dropped freely from a height, its initial velocity 'u' is zero.

d) When a body is thrown vertically upward its final velocity 'v' becomes zero.

e) The time taken by a body to rise to the highest point is equal to the time it takes to fall from the same height.

MASS:-

⇒ The mass of a body is the ~~height~~ quantity of matter (or materials) contained in it.

→ Mass is the scalar quantity.
→ The S.I Unit of mass is kilogram.
→ The mass of a body is constant and does not change from place to place.
→ The mass of a body cannot be zero.

WEIGHT

The weight of body is the force is the ~~weight~~ with which it is attracted towards the centre of the earth.

Force = Mass x Acceleration due to the gravity.

'W' Weight is place in the above equation.

We get:- ∴ Weight = m x g

→ The S.I Unit of weight is also newton.
→ The weight of 1kg mass is 9.8 newton.
→ Weight is a vector quantity.
→ The weight of body changes to place to place. Thus, the gravity Weight of a body is not constant.
→ Weight cannot be zero.

→ Whatever be the weight of a body on the surface of the earth its weight becomes zero when it is taken to the centre to the earth.

→ it is the gravitational Force acting on the object which operates a spring balance and not its mass.

Weight of object on the moon.

The weight of an object on the moon will be about one-sixth of what it is on the earth.

THRUST

The effect of a Force depends on the area of the object on which it acts.

Plase note that:

The weight of a body is also a Force. And it always acts in the downward direction.

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THRUST - The force acting on a body perpendicular to its surface called thrust.

⇒ The S.I Unit of Pressure is 'PASCAL'. And it denoted by symbol 'Pa'.

PRESSURE :-

The Thrust Per Unit Area is called Pressure.

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}}$$

⇒ The S.I Unit of Thrust is Newton (N).

⇒ The same force produces less pressure if it acts on a large area but it can produce high pressure if it acts on a small area.

⇒ It is denoted by 'P'.

Note (i) It is scalar quantity.

(ii) Its S.I Unit is N/m^2 or Pascal.

(iii) Its C.G.S Unit is $DYNE/cm^2$.

PRESSURE IN FLUIDS

→ Those substance which can flow easily are called Fluids.

⇒ All the liquids and gases are Fluids.

⇒ A Fluid (liquid or gases) exerts

⇒ pressure in all the directions - even upwards!

BUOYANCY

⇒ Those substances which can flow easily are called fluilds. All the liquid and gasses are Fluilds.

→ A Fluid exerts pressure in upwards directions - ever upwards.

BOYANTANT FORCE.

The upward Force acting on the objects immesed in a liquid called Boyantant Force.

→ The upward Force exerted by liquid called upthrust.

→ It is the buyantant force makes the heavy objects seems lighter in water.

Archeimedes' Principle

When an objects is wholly immersed in a liquid, it experiences than a buoyant force (or upthrust) which is equal to the weight of liquid displaced by the objects.

Buoyant force (or upthrust) = Weight of liquids displaced by acting on the objects that objects

→ The magnitude of bouyantant force acting on an objects immersed in a liquid is equal to the weight of liquid displaced by the immersed objects.

Note → even gases (like air) exerts an upward force (or buyant force) on the objects placed in them.

Why objects float or sink in a liquid.

When an objects is put in a liquid, then two forces act on it :-

1) Weight of the object acting downwards (which tends to pull down the objects.

11) Buoyant force (up thrust) acting upwards (which tends to push up the objects.)

An objects will float on liquid if the upwards buyant forces it recives from the liquid is great enough to overcome the downward force of its weights.

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The Principle of Floatation.

An objects Will Float in a liquid if the Weights of the objects is equal to the Weight of liquids displaced by it.

Weight of body = Weight of a liquid displaced by it.

Density

The density of a substance is define as mass of the substance per unit voloum.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

→ The S.I Unit of density is Kilogram per cubic meter.

Density of some common substance

Substances	Density	also Written
1) Cork	240 kg/m^3	0.24×10^3 kg/m^3
2) Wood	800 kg/m^3	0.8×10^3 kg/m^3
3) Ice	920 kg/m^3	0.92×10^3 kg/m^3
4) Water	1000 kg/m^3	1.0×10^3 kg/m^3
5) Glycerine	1260 kg/m^3	1.26×10^3 kg/m^3
6) Glass	2500 kg/m^3	2.5×10^3 kg/m^3
7) Aluminium	2700 kg/m^3	2.7×10^3 kg/m^3
8) Iron	7800 kg/m^3	7.8×10^3 kg/m^3
9) Mercury	13600 kg/m^3	13.6×10^3 kg/m^3
10) Gold	19300 kg/m^3	19.3×10^3 kg/m^3

→ The density of the substances is one of its characteristic properties.

→ If the density of a substance is more than the density of water, then the substance will be heavier than water and hence sink in water. In the other, the density of a substances is less than the density of water, then the substances will be lighter than water and hence float in water.

Relative density

The relative density of a substance is the ratio of its density to that of water.

$$\text{Relative density} = \frac{\text{Density of sub}}{\text{Density of water.}}$$

The relative density of substances is the ratio of the mass of any volum of the substances to the mass of an equal volume of water.

⇒ As the relative density is the ratio of two similar quantities (masses). it has no unit.

Relative density of some substanc

Substances	relative density
I.) Cork	0·24
II. Wood	0·8
III. ICE	0·92
IV. Water	1
V. Glycerine	1·26
VI. Glass	2·5
VII. Iron	7·8

→ Relative density is very important in the accurate determination of density.

→ The relative desity of a substances expresses the heavingss (or density) of the substances in comparision to water.

By saying that relative density of Iron is 7.8 m we mean iron is 7.8 times as heavy as an equal voloume of water.