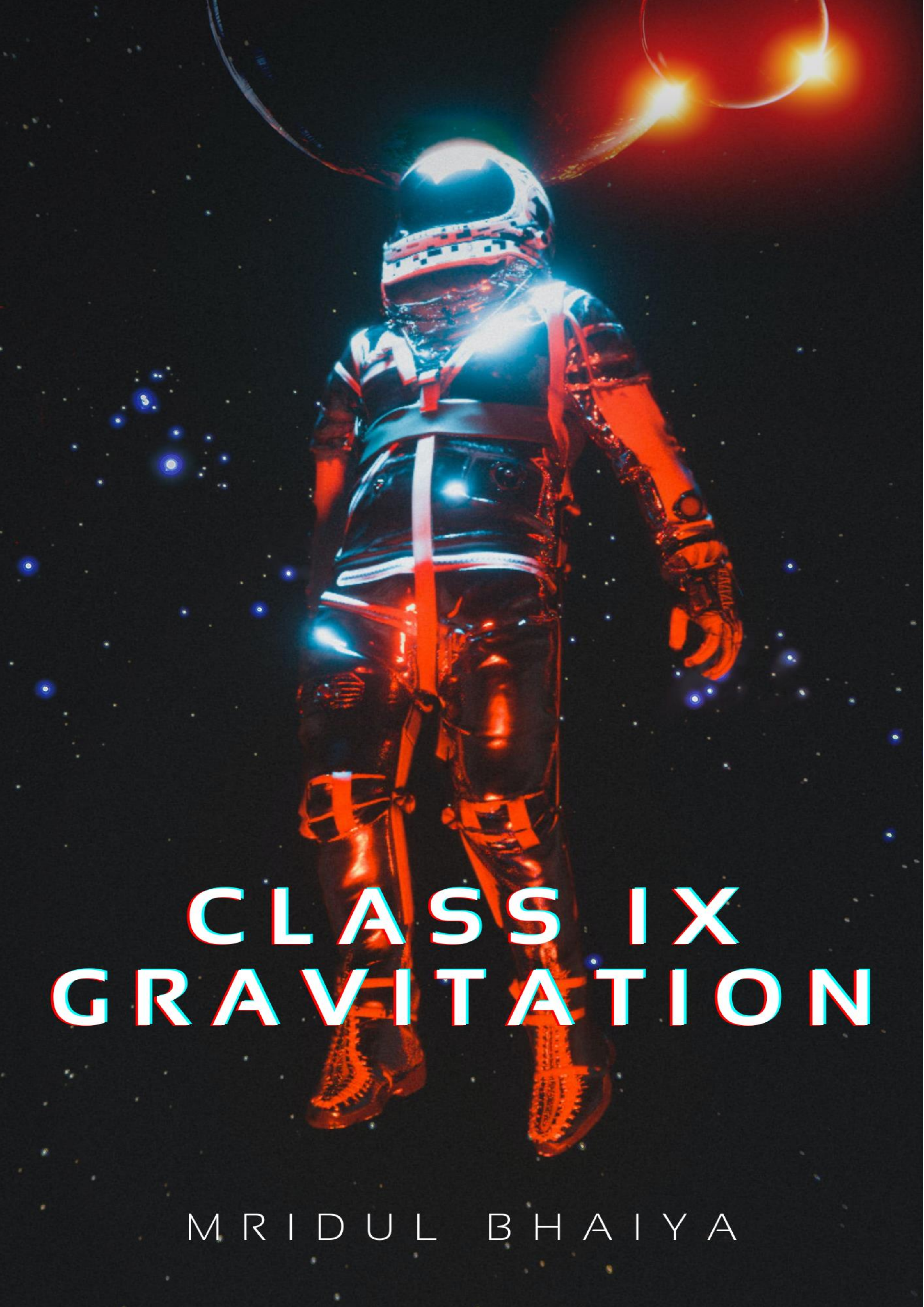


CLASS IX
GRAVITATION

MRIDUL BHAIYA

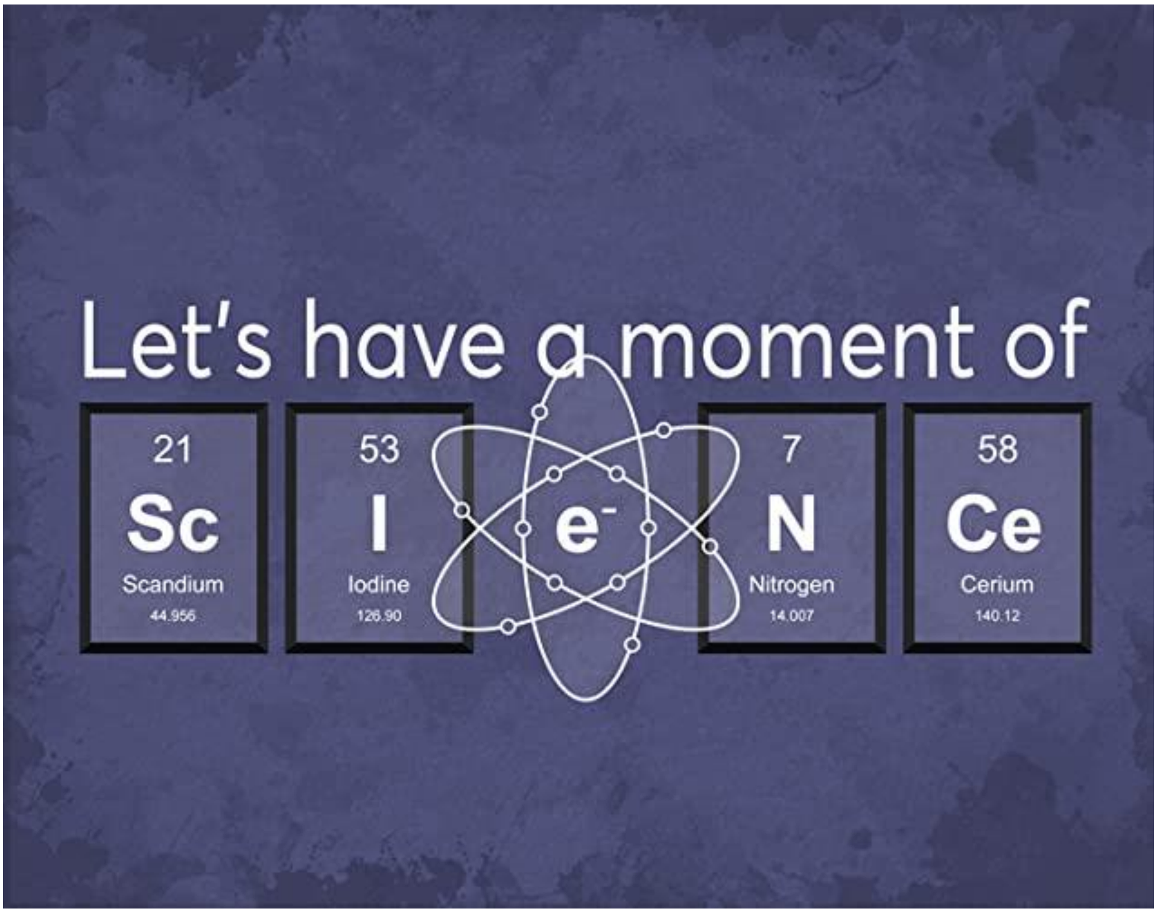
MBC – Mridul Bhaiya Classes

CLASS IX

SCIENCE NOTES

GRAVITATION AND FLOATATION

- ✓ **Detailed notes**
- ✓ **PYQs with answers**
- ✓ **Graphics included**



GRAVITATION

Definition : The force of attraction between any two particles in the universe Is called **gravitation** or **gravitational force**.

Newton gave *Newton's law of gravitation* to calculate gravitational force between two objects placed at certain distance from each other.

KEPLER'S LAWS OF PLANETARY MOTION

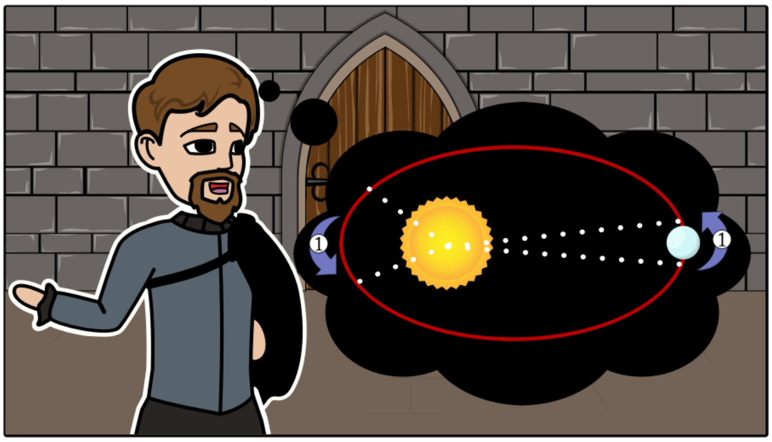
Kepler's laws. Johannes Kepler gave the following three laws to explain the motion of the planets.

(i.) Law of Orbits : Each planet moves around the sun in an elliptical orbit with the sun at one of the foci* of the orbit.

(ii.) Law of areas : The line joining the sun and a planet sweeps out equal areas in equal intervals of time.

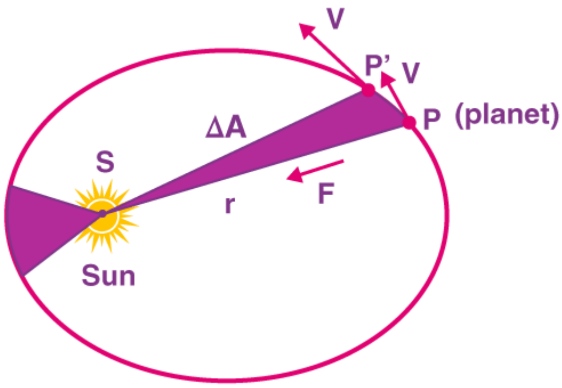
(iii.) Law of Periods : The square of the time taken by a planet to complete a revolution round the sun is directly proportional to the cube of semi-major axis of the elliptical orbit.

i.e $T^2 \propto r^3$



Johannes Kepler (1571-1630)

Johannes Kepler was a German scientist who dedicated his life trying to understand the movement of celestial bodies. He is most famous for his three laws of planetary motion. These laws state that planets move in ellipses not circles, that the fastest part of their orbit is when the planet is closest to the Sun, and that planets that are further away from the Sun move more slowly than those that are closer.

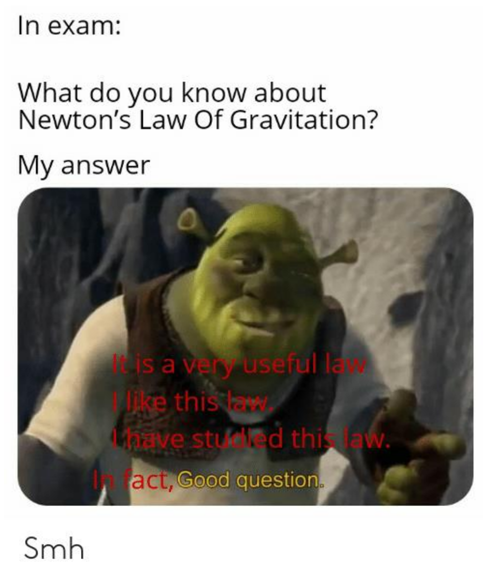


UNIVERSAL LAW OF GRAVITATION

According to this law, *the force of attraction between two particles or bodies is (i.) directly proportional to the product of their mass and (ii.) inversely proportional to the square of distance between these particles or bodies.*

Mathematically,

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



Where, F = Gravitational force

G = Universal gravitational constant.

m = mass of the objects.

r = distance between objects

Definition of universal gravitational constant (G)

We know, $F = G\frac{m_1 m_2}{r^2}$ or $G = \frac{Fr^2}{m_1 m_2}$

If m_1 and m_2 = 1 unit, and r = 1 unit, then G = F

Thus, *universal gravitational constant (G) is defined as the force of attraction between two bodies of unit masses separated by a unit distance.*

Units of universal gravitational constant (G)

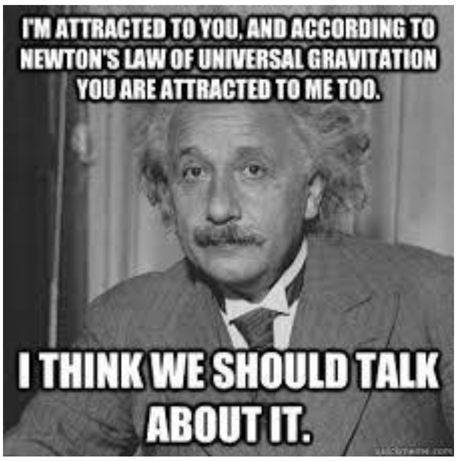
We know, $F = G\frac{m_1 m_2}{r^2}$ or $G = \frac{Fr^2}{m_1 m_2}$

$$\text{Unit of G} = \frac{Unit\ of\ force \times (Unit\ of\ distance)^2}{Unit\ of\ mass \times Unit\ of\ mass}$$

S.I unit of force = **Newton (N)**

S.I unit of distance = **Metre (m)**

S.I unit of mass = **Kilogram (kg)**

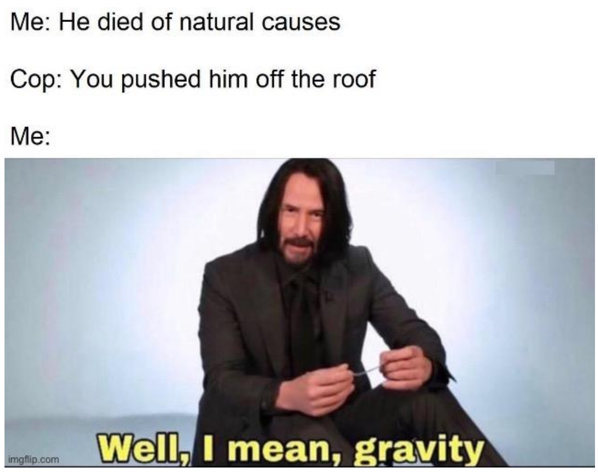


$\therefore \quad G = \dfrac{Nm^2}{kg^2}$ or $Nm^2\ kg^{-2}$

The Value of **$G = 6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$**

Characteristics of Gravitational force

1. Only valid for Point mass and Spherical Mass Bodies.
2. Can't be proved but can be verified only.
3. Always attractive
4. Weakest force in nature
5. Follow inverse square law
6. Long-range (within infinite distance)
7. Central force
8. Conservative in nature
9. Does not depend on medium
10. Reason of stability of universe
11. Forms action-reaction pair



IMPORTANCE OF UNIVERSAL LAW OF GRAVITATION

The gravitational force plays an important role in nature.

(i.) Gravitational force is responsible for the existence of the solar system.

(ii.) Tides in the oceans are formed due to gravitatinal force between the planet, the moon and the sun.

(iii.) Artificial and natural satellites revovle around the earth due to gravitational force.

(iv.) The atmosphere (envelope of gases) is possible only due to gravitational force of earth.

(v.) Rainfall and snowfall is possible only due to gravitational force of the earth.

(vi.) We stay on the earth due to the gravitational force between the earth and us.

NUMERICALS

Formula used = F = G $\frac{m_1 m_2}{r^2}$; **Units :** F = N, m = kg, r = m **G =** 6.673×10^{-11} Nm^2 kg^{-2}

Q. The gravitational force between two objects is 200N. How should the distance between the objects be changed so that force between them becomes 100 N ? (CBSE 2011, 2012)

Q. The mass of the sun is 2×10^{30} kg and that of the earth is 6×10^{24} kg. If the average distance between the sun and the earth is 1.5×10^{11} m, calculate the force exerted by the sun on the earth and also by the earth on the sun. (CBSE 2010, 2014)

Q. A sphere of mass 40kg is attracted by another sphere of mass 80kg by a force 2.5×10^{-6} N, when their centers are 30mm apart. Find the value of G. (CBSE 2012)

Q. A body weighs 30kg on earth. Given that the mass of earth is 6×10^{24} kg, its radius if 6.4×10^{6} m, G = 6.673×10^{-11} Nm^2 kg^{-2}. What will be :

(a) The force of attraction between the earth and the body.

(b) Acceleration produced in body

(c) Acceleration produced in earth (CBSE 2015)

FREE FALL

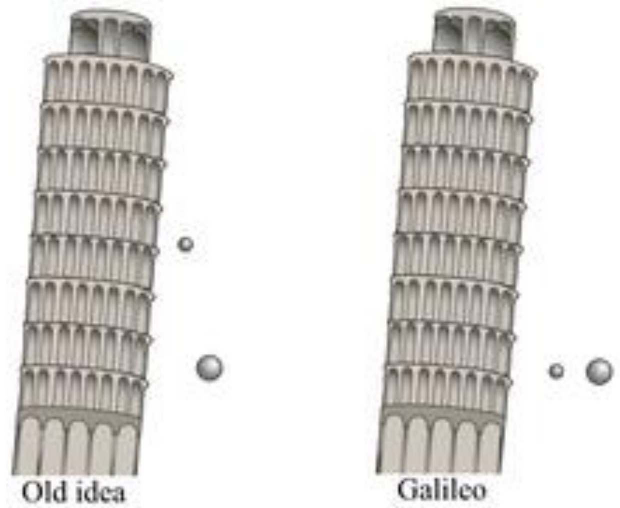
Galelio dropped three iron balls of different masses simultaneously from the top of the tower of Pisa and found that all three balls reached ground at the same time.

Q. Why different masses (feather and stone) dropped from same height take different times to reach the ground ?

A. Feather sufferend much air resistance during fall because of its large suface area. Due to this opposing force, feather takes longer time to reach the ground than the stone.

EXPERIMENTAL VERIFICATION

The free fall was verified experimentally by Robert Boyle, by using his newly invented vaccum pump he evacuated the air from a long jar containing a lead bullet and feather. Then he inverted the jar and found that both the bullet and feather reached the bottom of the jar at the same time.



Conclusion : *the bodies of different masses dropped simultaneoulsy from the same height hit the ground at the same time, if air resistance is neglected.*

Definition of free fall : *The falling body on which only force of gravitation of earth acts is known as freely falling body and such fall of body is known as free fall.*

A falling body has constant acceleration equal to acceleration due to gravity (g), irrespective of its mass.

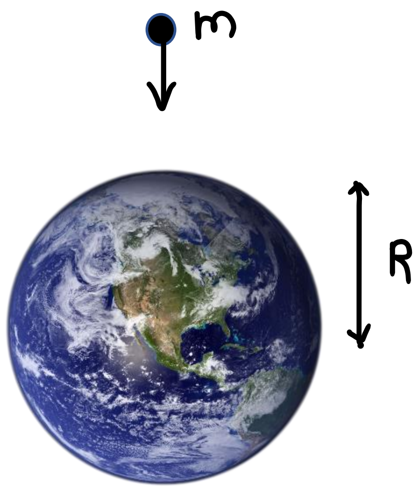
Definition of acceleration due to gravity : *The acceleration with which a body falls towards the earth due to earth gravitational pull is known as acceleration due to gravity irrespective of its mass.*

It is denoted by ‘g’.

NOTE : Motion of a freely falling body is uniformly accelerated motion.

EXPRESSION FOR THE ACCELERATION DUE TO GRAVITY

Consider a body of mass ‘m’ near the surface of the earth.



The magnitude of the gravitational force is

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

Where,

M = Mass of the earth

R = Radius of the earth

[Here, height of the body from the surface of earth is neglected as compared to the radius of the earth because because R = 6400 km]

We know,

F = ma (From Newton's second law of motion)

And a = g (acceleration produced by gravitational force)

Equating both equations

- $mg = G\frac{Mm}{R^2}$

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

This is the expression for **acceleration due to gravity**

It shows that **acceleration due to gravity does not depend on the mass of the object or body.**

FACTORS ON WHICH ACCELERATION DUE TO GRAVITY (g) DEPENDS

Acceleration due to gravity (g) is

(i.) directly proportional to the mass of the earth and

(ii.) invesely proportional to the square of radius of the earth

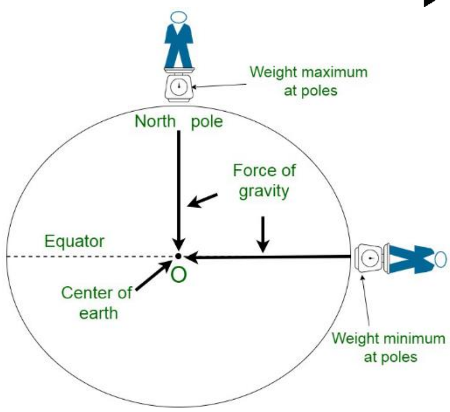
Value of acceleration due to gravity (g) on the earth

We know, $g = \frac{GM}{R^2}$

Now, $G = 6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$

$M = 6 \times 10^{24}$ kg

$R = 6.4 \times 10^{6}$ m



$$g = \frac{6.673 \times 10^{-11}\ Nm^2\ kg^{-2} \times 6 \times 10^{24}\ kg}{(6.4 \times 10^6)^2} = 9.8\ ms^{-2}$$

Thus, **value of 'g' on the surface of the earth = 9.8 ms^{-2}.**

Value of 'g' on the surface of moon

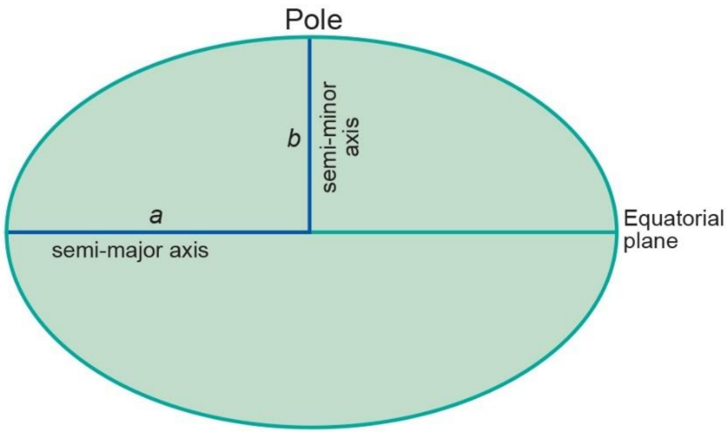
$$g_{moon} = \frac{1}{6}\, g_{earth}$$

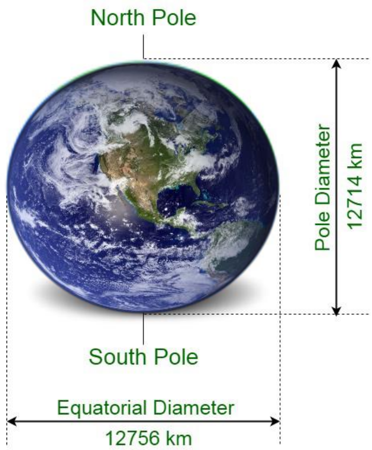
Thus, acceleration due to gravity on the surface of moon is $\frac{1}{6}th$ times the acceleration due to gravity on the surface of earth.

VARIATION IN THE VALUE OF 'g'

1. Variation in the value of 'g' with the shape of the earth.

Due to the fact that, the earth is not spherical in shape but it's shape is oblate spheroid (egg shaped).





Therefore, the radius of the earth (R) is not constant throughout. Hence, the value of 'g' is different for different points on earth.

The value of equatorial radius (R_e) of Earth is about 21km longer than its polar radius (R_p).

Thus, ***value of 'g' is more at poles than at equator.***

2. Variation in the value of 'g' with the altitude (or height) above the surface of the earth.

If the object is placed at a distance h above the surface of the earth, the force of gravitation on it due to the earth is

$$F = \frac{GMm}{(R+h)^2}$$

where M is the mass of the earth and R is its radius.

Thus, $$g = \frac{F}{m} = \frac{GM}{(R+h)^2}.$$

Thus, ***value of 'g' decreases with height from the surface of the earth***.

3. Variation in the value of 'g' with the depth below the surface of the earth.

The *value of 'g' decreases as we go deep into the crest of the earth.*

NOTE : The value of g at the centre of the earth is zero.

DIFFERENCE BETWEEN 'g' AND 'G'

Universal Gravitational constant	Gravitational acceleration of earth
1. The gravitational force acting between unit masses kept at a unit distance away from each other equals gravitational constant (G).	1. The acceleration produced in a body under the influence of the force of gravity alone is called gravitational acceleration of earth or acceleration due to gravity (g).
2. Gravitational constant is a scalar quantity.	2. Acceleration due to gravity is a vector quantity.
3. The value of gravitational constant is a constant.	3. The value of acceleration due to gravity varies with height, depth and shape of the earth.
4. The value of G = 6.67 x 10^{11} Nm^2/kg^2.	4. The value of g = 9.8 m/s^2 on earth's surface.
5. The S.I. unit of gravitational constant is Nm^2/kg^2	5. The S.I. unit of acceleration due to gravity is m/s^2.

NUMERICALS

Formula Used : g = $\frac{GM}{R^2}$ **Unit** : g = m/s^2, M = kg, R = m and **G** = 6.673 × 10^{-11} Nm^2 kg^{-2}

Q. An imaginary planet has a mass 5 times and radius 3 times that of earth. What is the acceleration due to gravity on the planet, if the acceleration due to gravity on earth is 10 ms^{-2}. (CBSE 2012)

Q. Calculate the height above the surface of earth, at which the value of acceleration due to gravity is half of what is on the surface.

Q. A space traveller determins the radius of a planet to be half that of the earth. After landing on its surface, he finds the acceleration due to gravity to be twice of that the surface of the earth. Find the ratio of the mass of planet to the earth.

Q. An object has mass 60kg, find its i. Weight on Earth ii. Weight on Moon (Given g on moon is 1/6th times of g on earth)

MOTION OF OBJECTS UNDER THE INFLUENCE OF GRAVITATIONAL FORCE OF THE EARTH

The equations of motion of body moving with uniform acceleration in a straight line are

- **The first equation of motion:** v = u + at
- **Second equation of motion:** s = ut + 12 at^2
- **Third equation of motion:** $v^2 = u^2 + 2as$

where,

s = displacement

u = initial velocity

v = final velocity

a = acceleration

t = time of motion

When any body falls freely under gravitational force of earth, then a = g.

① **v = u + gt**
② **s = ut + $\frac{1}{2}gt^2$**
③ **$v^2 = u^2 + 2gs$**

u = Initial velocity | g = Acceleration due to gravity

t = Time | s = Displacement | v = Final velocity

Remember :

- To solve problems pertaining to a freely falling body, take $u = 0$, if body is dropped from a certain height.
- Take $v = 0$ at the highest point when body is thrown upward.

Sign Convention :

The value of 'g' is taken as **positive** in downward direction (i.e when body falls towards the earth)

The value of 'g' is taken as **negative** in upward direction (i.e when body moves away from earth in vertical direction.)

IMPORTANT

If a body is thrown vertically upwards, then time of ascent is equal to time of descent.

Prove (CBSE 2011) :

Let a body is thrown vertically upward with initial velocity u. Let the body attains maximum height in time t_1.

Final velocity = $v = 0$

Using $v = u + gt_1$

We get, $0 = u - gt_1$

$t_1 = u/g$

After attaining maximum height, body begins to fall down i.e $u = 0$. Let time = t_2 to reach the ground

Using $v = u + gt_2$

$v = 0 + gt_2$

$t_2 = v/g$

Since $v = u$ because the body hits the ground with same velocity with which it is thrown upwards.

Therefore $t_1 = t_2$ i.e Time of ascent = Time of descent.

NUMERICALS

Formula Used : g = $\frac{GM}{R^2}$

Unit : g = 10 m/s^2 ; S = m, v and u = ms^{-2}, t = s

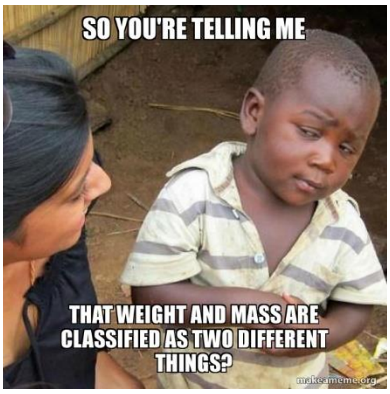
Q. A stone is dropped from the roof of a building. It takes 4s to reach the ground. Find the height of the building. (CBSE 2011,2012)

Q. An object is thrown vertically upwards and rises to a height of 20 m. Calculate
(i) the velocity with which the object was thrown upwards,
(ii) the time taken by the object to reach the highest point.
(CBSE 2010, 2011, 2012, 2013)

Q. A stone is dropped from the top of a tower 100m high and instantly a second stone is projected vertically upward from the bottom with a velocity of 25 ms^{-1}. Find when and where the stones meet. (CBSE 2010)

Q. A stone is thrown vertically upwards with speed of 29.4 ms^{-1}. Find
(i) the time taken by the stone to reach the reach the maximum height
(ii) maximum height reached by the body
(iii) Show that time of ascent is equal to time of descent. (CBSE 2011,2010)

MASS



Mass of the body is defined as *the quantity of matter contained in the body.*

Mass is also known as **inertial mass.**

Mass is a scalar quantity and is calculated using beam balance.

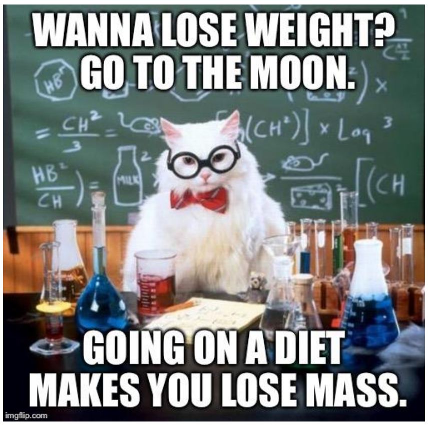
UNIT of Mass : S.I unit of mass = **kilogram (kg)**

Characteristics of mass of a Body

1. Mass of a body is proportional to the quantity of matter contained in it.
2. Mass of a body does not depend on the shape, size and the state of the body.
3. Mass of a body remains the same at all places. This means, the mass of a body will be same throughout the universe.
   Reason : the quantity of matter contained in the body does not change throughout the universe.
4. Mass of a body does not change in presence of other bodies near it.
5. Mass of a body is a scalar quantity.
6. Mass of a body can be measured with the help of a beam balance.
7. Masses of objects or bodies are added algebrically.

WEIGHT

Definition : *The force with which a body is attracted by the earth is known as the weight of the body.*



$$F = mg$$

The force is known as the **Weight** of the body.

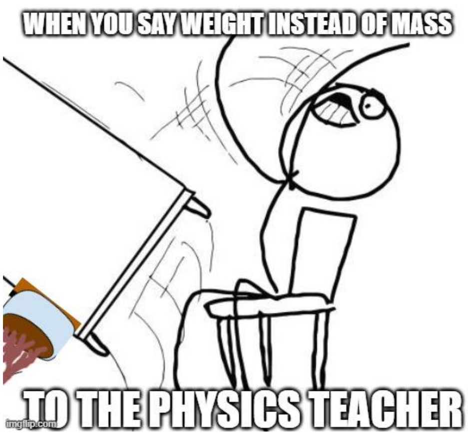
It is denoted by W

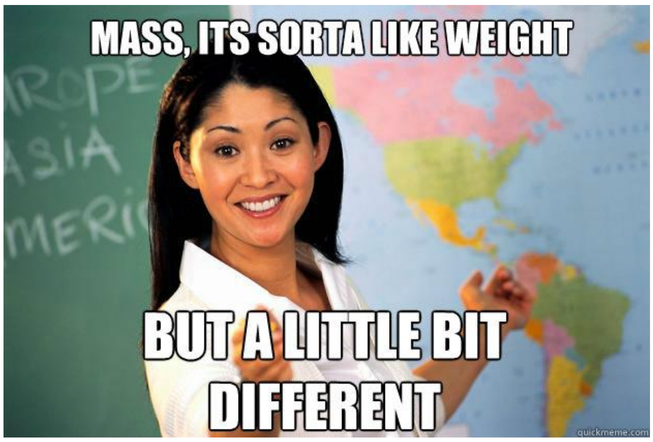
$$\text{Weight, } W = mg$$

Weight has both magnitude and direction. Hence weight is a **vector quantity**.

S.I Unit of weight is **newton (N)**

Spring Balance is used to measure the weigh t of an object.



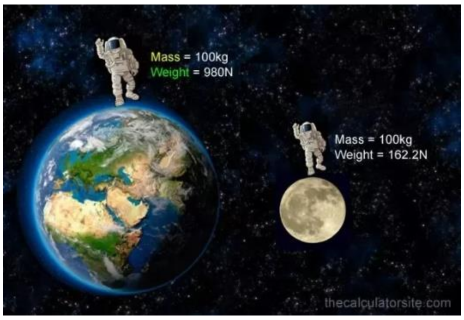


WEIGHT OF AN OBJECT ON THE SURFACE OF MOON

weight of object of mass m on earth = mg_{earth}

weight of object of mass m on moon = mg_{moon}

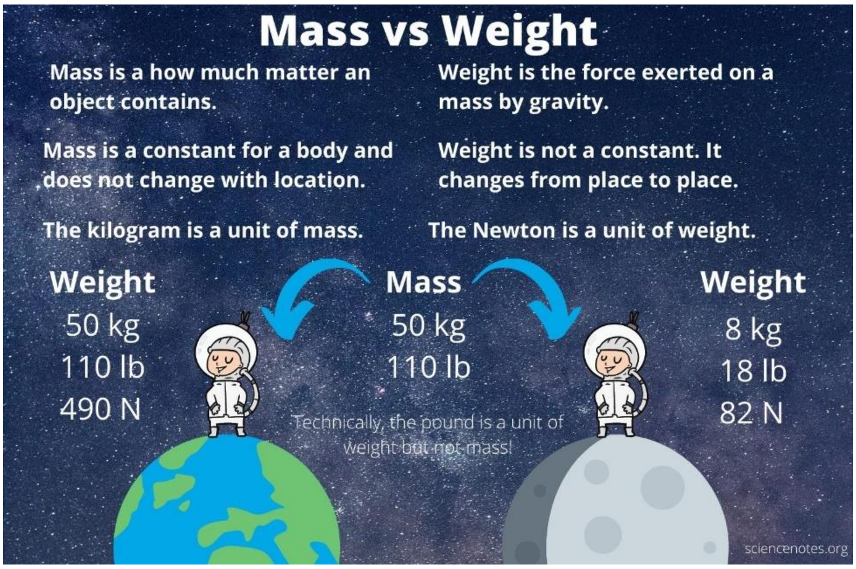
$$\frac{W_m}{W_e} = \frac{g_{moon}}{g_{earth}} = \frac{1}{6}$$

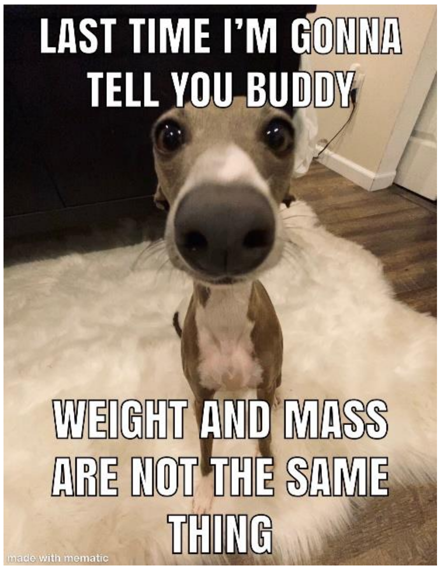


Thus, weight of an object on the surface of moon = 1/6 times weight of the object on the surface of the earth

DIFFERENCE BETWEEN MASS AND WEIGHT

Sl. No.	Mass	Weight
1.	The mass is a scalar quantity.	The weight is a vector quantity.
2.	Mass of a rigid body is regular everywhere in the universe.	The weight of a rigid body alters from place to place and inclines zero at the center of the earth.
3.	Mass can be resulted by a traditional balance.	Weight can be defined as spring balance
4.	The unit of mass is kg or g.	The unit of weight is Newton.
5.	Mass can never be zero.	Weight can be zero based on the gravity acting upon it.
6.	Mass does not change based on location.	Weight changes based on location, depending on the gravity it experiences.
7.	Mass is measured using an ordinary weighing scale.	Weight is measured using spring balance.





NUMERICALS

Formula Used : $g = \frac{GM}{R^2}$; W = mg

Unit : g = 10 m/s^2 ; S = m, v and u = ms^{-2}, t = s

Q. Find the weight of a stone on the surface of the earth if its mass is 10kg.

Q. The weight of a boy on the surface of the earth is 294 N. Find his mass.

Q. The weight of a body on the surface of the earth is 392 N. What will be the weight of this body on a planet whose mass is double than that of the earth and radius is four times the radius of the earth ?

Q. Find the ratio of the weight of an object of mass 50kg on the earth and on moon.

Q. Mass of an object is 20 kg. Find its weight on the earth ? What will be its weight measured on the surface of the moon ?

Q. A body weighs 30 N on the surface of the earth. How much will it weigh on the surface of moon.

Q. The mass of a body is 40 kg. Find the weight of the body on the surface of a planet whose mass is double than the mass of the earth and radius is 4 times the radius of the earth.

THRUST AND PRESSURE

THRUST

Definition : *the total force exerted by the body perpendicular to the surface is known as thrust.*

S.I unit = Newton (N)

PRESSURE

Definition : *Pressure is defined as the force acting perpendicular on unit area of the surface.*

$$\text{Pressure} = \frac{thrust}{area} \qquad P = \frac{F}{A}$$

S.I unit = Unit of pressure = $\frac{Unit\ of\ force}{Unit\ of\ area} = \frac{Newton}{m^2}$ = Nm^{-2}

1 Nm^{-2} is also known as **1 Pascal** (Pa)

CONSEQUENCE OF PRESSURE

1. Railway tracks are laid on large sized wooded or iron sleepers.

Reason : Increase in surface area reduces the pressure. This prevents the sinking of ground under the weight of train.

2. A sharp knife is more effective in cutting the objects than a blunt knife.

Reason : Area under sharp knife is less than the area under the blunt knife.

3. A camel walks easily on the sandy surface than a man inspite of fact that camel is much heavier than a man.

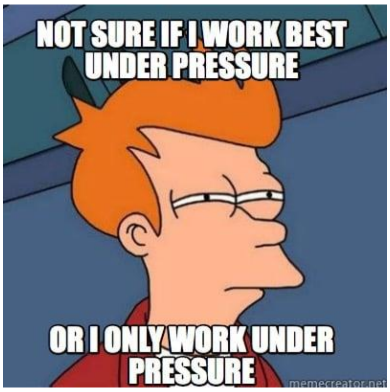
Reason : Area of camel's feet is large as compared to human's feet.

4. A sharp needle pierce the skin easily but not a blunt needle although the force applied on both needles is same.

Reason : area under pointed end of sharp needle is very small as compared to area under pointed end of blunt needle.

5. It is painful to hold a heavy bag having strap made of a strong and thin string.

Reason : Area under bag having strap made of strong and thin string is small.



NUMERICALS

Formula Used : $P = \frac{F}{A}$

Unit : F = N ; A = m^2, P = Pa or Nm^{-2}

Q. Find pressure, when a thrust of 20 N is applied on a surface area of 10 cm^2.

Q. An iron cube of side 10cm is kept on a horizontal table. If density of iron is 8000 kg m^{-3}. Find the pressure on the portion of the table, where the cube is kept.

Q. a rectangular iron block of mass 10 kg is placed on the top of the table. The dimensions of the block are 20cm × 10 cm × 5cm . find the pressure exerted by the block on the table if the block lies on the table with its sides of dimensions (i) 20cm × 10 cm (ii) 10 cm × 5cm. what do you learn from this example.

Q. A pressure of 1000 Pa acts on a surface of area 15 cm^2 by a block of mass 'm'. calculate 'm'. Also calculate the new pressure exerted by the same block if the area of contact with the surface becomes 10 cm^2.

Q. Find the ratio of the pressure exerted by a block of 200N when placed on a table top along its two different sides with dimensions 20cm × 15 cm and 30cm × 15 cm.

Q. A pressure of 100Pa acts on surface of area 15 cm^2 by a block of mass 'm'. Calculate the value of 'm'.

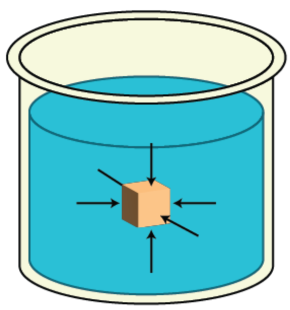
PRESSURE IN FLUIDS

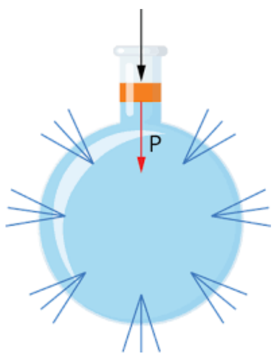
Fluid : *A substance which can flow under the action of external force is called fluids.*

Since liquids and gases can flow, they are known as fluids.

A great french physicist and mathematician, Blaise Pascal gave a law regarding the pressure exerted by a fluid enclosed in container.

Pascal Law : *" Pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid a nd the walls of the containing vessel "*





PRESSURE EXERTED BY A LIQUID AT A POINT INSIDE IT

P = $\frac{F}{A}$

F = mg (weight of liquid)

And, m = Vol. × density = area × height × density = $Ah\rho$

Therefore, P = $\frac{F}{A} = \frac{Ah\rho g}{A}$

Or, $\boxed{P = h\rho g}$

Thus, **the pressure exerted by a liquid at a point inside the liquid is directly proportional to**

(i) the depth of the point from the surface of the liquid and
(ii) density of the liquid and
(iii) acceleration due to gravity.

NUMERICALS

Formula Used : P = $\frac{F}{A} = h\rho g$

Unit : F = N ; A = m^2, P = Pa or Nm^{-2} ; ρ = kg m^{-3} ;g = 10 ms^{-2}

Q. A column of water of length 50 cm is in a tube of uniform area of cross section. Calculate the pressure exerted by the water in the column at the bottom of the tube. (density of water = 1000 kg m^{-3})

Q. Column of mercury of mass (10.2 g) is in a tube of uniform area of cross section of 0.1 cm^2. Calculate the length of column. (Density of mercury = 13.6 g cm^{-3}).

UPTHRUST OR BUOYANT FORCE (BUOYANCY)

Definition : *The upward force exerted by a liquid on a body which is immersed in the liquid is known as the upthrust and buoyant force.*

Expression for Buoyant force :

$\boxed{F = V\rho g}$

This is the expression for **buoyant force or upthrust.**

Factors on which buoyant force or upthrust depends

Buoyant force is directly proportional to

(i) the volume (V) of the object or body immersed in liquid.
(ii) the density (ρ) of the liquid in which the object or body is immersed.
(iii) the acceleration due to gravity (g) at the given place

Buoyancy : *The tendency of an object to float in a liquid or the power of liquid to make an object float in it is called buoyancy*.

DO IT YOUSELF !!!

Why objects float or sink when placed on the surface of water ?

ARCHIMEDES' PRINCIPLE

When a body or an object is immersed partially or completed in a liquid or a gas, it experiences an upthrust or buoyant force.

STATEMENT OF ARCHIMEDES' PRINCIPLE

When a body is immersed partially or completely in a fluid it experiences an upthrust or buoyant force which is equal to the weight of the fluid displaced by body.

The weight of the body decreases due to the buoyant force acting on the body, when immersed in a fluid.

In other word, *A body loses its weight, when immersed completely or partially in a fluid. The loss of weight of a body in a fluid is equal to the upthrust or buoyant force.*

Upthrust or Buoyant Force = weight of fluid displaced by a body.

= weight of body in air – weight of body in fluid.

APPLICATION OF ARCHIMEDES' PRINCIPLE

Archimedes' principle is used to design :

(i) the ships and submarines
(ii) the hydrometers to find the densities of liquids
(iii) the lactometers to test the purity of milk.

RELATIVE DENSITY

Definition : *relative density of a substance is defined as the ratio of the density of the substance to the density of water in 4˚C.*

i.e Relative density of substance = $\frac{Density\ of\ substance}{Density\ of\ water\ at\ 4^\circ C}$

$= \frac{Mass\ of\ substance\ of\ any\ volume}{mass\ of\ water\ of\ same\ volume\ at\ 4^\circ C}$

$= \frac{Weight\ of\ solid\ in\ air}{Loss\ of\ weight\ of\ solid\ in\ water}$

Relative density has no unit. It is just a number

Physical meaning of relative density :

Relative density of a substance is a number of times the given substance is heavier than the equal volume of water.

For ex : R.D of Silver = 10.5 ; it means, silver is 10.5 times heavier than equal volume of water.

Important NCERT Questions

Q1. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Sol. Gravitation force between two objects, $F = \frac{Gm_1m_2}{r^2}$

When, $r' = r/2$ then $F' = \frac{4Gm_1m_2}{r^2} = 4F$. Thus, the force of gravitation becomes 4 times its original value.

Q2. Gravitational force acts on all objects in proportion to their masses. Why, then, a heavy object does not fall faster than a light object?

Sol. The acceleration with which a body falls towards the earth is constant (= 9.8 ms^{-2}) and independent of the mass of the body. Thus, all bodies fall with the same acceleration irrespective of their masses. That is why, a heavy body does not fall faster than the light body.

Q3. What is magnitude of the gravitational force between the earth and a 1 kg object on its surface? Mass of the earth is 6 × 10^{24} kg and radius of earth is 6.4 × 10^6 m

Sol. $F = \frac{GMm}{R^2} = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 1}{(6.4 \times 10^6)^2} = 9.77N \simeq 9.8$

Q4. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

Sol. Gravitational force with which a body A attracts another body B is equal in magnitude and opposite in direction to the gravitational force with which a body B attracts the body A. Thus, the magnitude of force with which the earth attracts the moon is equal to the magnitude of the force with which the moon attracts the earth. Thus, both the earth and the moon attract each other with equal forces.

Q5. If the moon attracts the earth, why does the earth not move towards the moon?

Sol. Moon and earth exert equal in magnitude on each other. The acceleration $\left(a = \frac{F}{m}\right)$ Produced in the earth due to the force exerted on it by the moon is very small is very small as the mass of the earth is very large. Hence, the movement of the earth towards the moon is not noticed.

Q6. What happens to the force between two object, if

(i) the mass of one object is doubled?

(ii) the distance between the object is doubled and tripled?

(iii) the masses of both the objects are doubled?

Sol. $F = \frac{Gm_1m_2}{r^2}$

(i) F is doubled if m_1 or m_2 is doubled.

(ii) F becomes $\frac{1}{4}$ times the original value if distance (r) is doubled and F becomes $\frac{1}{9}$ times the original value if r is tripled.

(iii) F becomes four times the original value if both m_1 and m_2 are doubled.

Q7. Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with the weight of gold bought? If not, why?

(Hint : The value of g is greater at the poles than at the equator.)

Sol. Weight = mg

Since value of g is greater at the poles than at the equator, so the weight of gold at the poles will be greater than the weight of gold at the equator. Hence, his friend will say that the weight of the gold is less than as told by Amit.

Q8. Why will a sheet of paper fall slower than one that is crumpled into a ball?

Sol. Since the area of a sheet of paper is more than the area of the paper crumpled into a small, therefore, a sheet of paper will experience a large opposing force due to air than the ball, while falling down. Hence, a sheet of paper falls slower than one that is crumpled into a ball.

Q9. Gravitational force on the surface of the moon is only $\frac{1}{2}$ as strong as gravitational force on the earth. What is the weight in newton's of a 10 kg object on the moon and on the earth?

Sol. Weight of the object on earth = mg = $10\text{kg} \times 9.8\ \text{ms}^{-2} = 98\text{N}$

Weight of the object on moon = $\frac{mg}{6} = \frac{98N}{6} = 16.33N.$

Q10. A stone is released from the top of a tower of height 19.6 m. Calculate its final velocity just before touching the ground.

Sol. Here, $u = 0$, $s = 19.6$ m, $a = g = 9.8\ \text{ms}^{-2}$, $v = ?$

Using, $v^2 - u^2 = 2gh$, we get

$v^2 - 0 = 2 \times (9.8) \times (19.6) = 348.16$

$\therefore\ v = \sqrt{348.16} = \pm 19.6\,\text{ms}^{-1}.$

or $v = 19.6\ \text{ms}^{-1}$.

This Chapter Ends here !! But not your work

Go to Practice Questions, Solve Dpps attend MCQs and revise the notes after some 2^{nd} 4^{th} and 7^{th} day

To get 95+ you have to keep on revising what you studied.

[Remember Consistency and HardWork Gives Great Result]

NOTES MADE BY

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