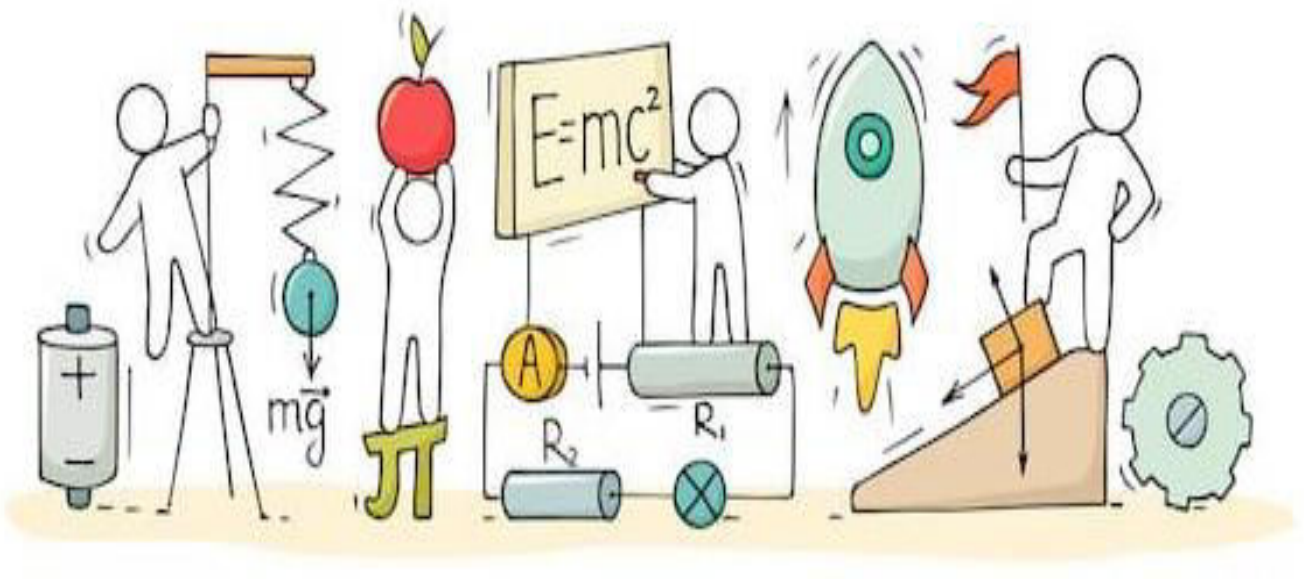
Shiksha CLASSES

PHYSICS

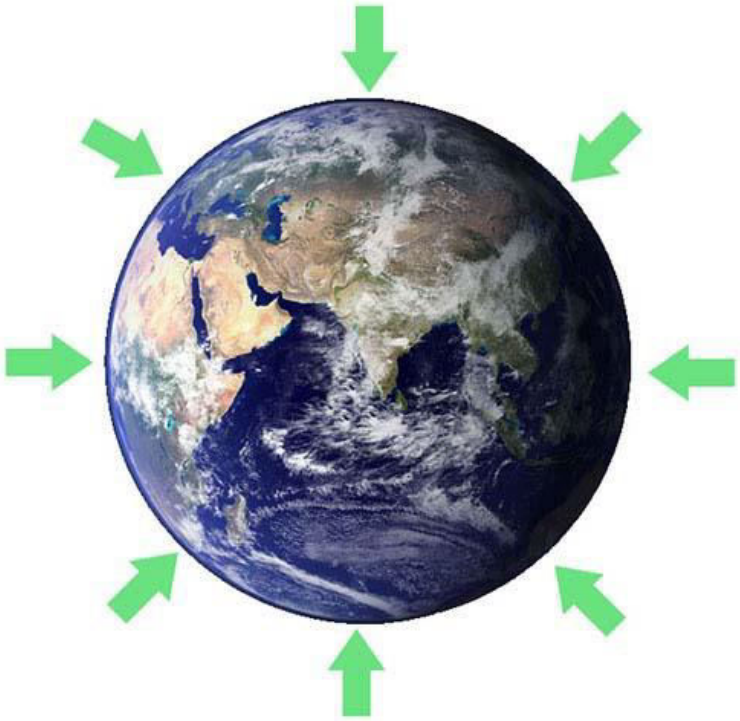
Chapter 9: Gravitation



Gravitation

- According to Newton, every object in this Universe attracts every other object with a certain force. This force with which two objects attract each other is called **gravitational force**.
- If the masses of two bodies are small, then the gravitational force between them is very small.
- The gravitational force holds the Solar System together.
- In our dairy life we have noticed things falling freely downwards towards earth when thrown upwards or dropped from some height.
- Fact that all bodies irrespective of their masses are accelerated towards the earth with a constant acceleration was first recognized by Galileo (1564-1642).
- The motion of celestial bodies such as moon, earth, planets etc. and attraction of moon towards earth and earth towards sun is an interesting subject of study since long time.
- Toss a stone from a great height. What are your observations?
- The stone, which was at first at rest, begins to move towards the ground and reaches its maximum speed right before it meets it.
- The stone is not travelling at a constant rate. Its speed fluctuates at all times, indicating that the stone is accelerating.
- A force is necessary to cause an acceleration in a body, according to Newton's second law of motion.
- The stone was not pushed or pulled in any way. What was the source of the force?
- Sir Isaac Newton came up with the solution to this dilemma after seeing an apple fall from a tree.
- His thesis was that the apple is attracted to the Earth, and the Earth is attracted to the apple The Earth's force on the apple is enormous, and as a result, the apple arrives on Earth.
- The apple, on the other hand, is unable to draw the Earth since the force it exerts on it is insignificant.
- As a result, we can deduce that the acceleration caused by Earth's immense force of attraction is the cause of the stone's acceleration.
- It is evident from the preceding example that this force of attraction ties our complicated universe together, keeps the moon revolving around the Earth, keeps all of the planets in their orbits around the Sun, and helps us walk correctly on the Earth's surface.

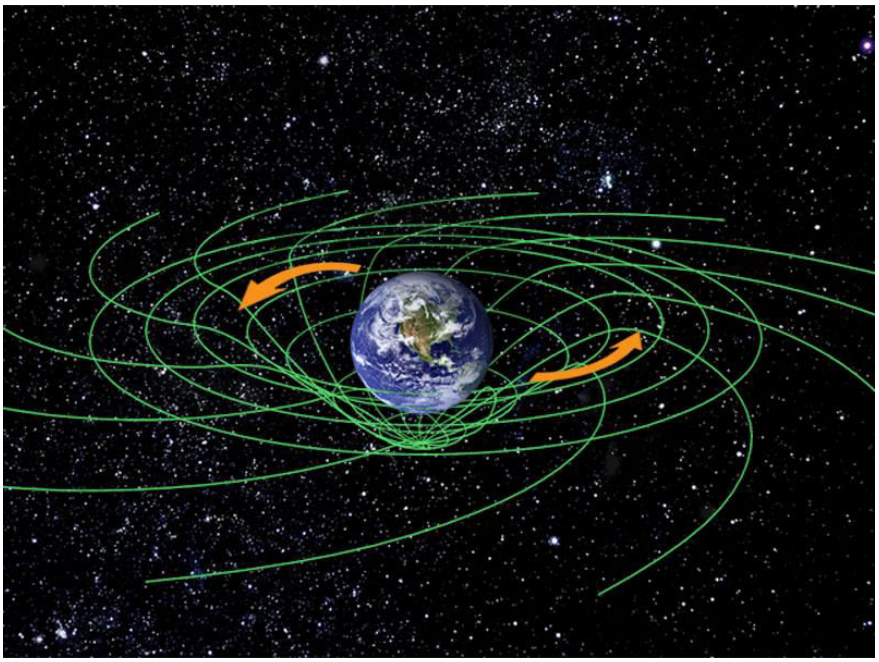
- The force of gravitation, or gravitation, is a form of attraction that exists between any two objects in the universe.
- The force of gravity or gravity is the attraction or gravitational force between Earth (or any planet) and any other material objects in the cosmos.



More About Gravitation

- You must have observed that whenever you throw any object upwards it reaches a certain height and then falls downward towards the Earth. So, these objects are acting under the gravitational pull of the Earth or gravitational forces which are forces of attraction.
- Gravitational force or gravity of earth is responsible for pulling you and keeping you on earth.
- Now each and every object in this universe that has mass exerts a gravitational force on every other mass and the size of that pull depends on how large or small are the masses of two objects under consideration.
- So for smaller masses like two human beings the gravitational force of attraction is very small and is negligible because two peoples are not very massive
- Now when you consider massive objects like planets, Sun, Earth, Moon or other celestial bodies, the gravitational pull becomes very strong.
- So here you must note that gravitational force depends on how massive objects under consideration are.
- Gravity is very important on earth. It is the gravitational pull of earth that keeps our planet orbiting round Sun.

- The motion of moon is also affected by both Sun and Earth.



Why don't Moon Fall down

The moon revolves around the Earth due to centripetal force, which is the force of gravity of the Earth. If the force of attraction between the Earth and moon ceases, then the moon will continue to travel in a straight-line path tangential to its orbit around the Earth.

Centripetal force

When a body undergoes circular motion, it experiences a force that acts towards the center of the circle. This center-seeking force is called a centripetal force.

- You must wonder If gravitational force is a force of attraction, then why does moon not fall into earth?
- To understand this consider a person whirling a stone tied to a thread along a circular path as shown below in the figure.

When an object is under free fall, acceleration due to gravity is constant at g = $9.8ms^{-2}$

Value of g does not depend on mass i.e any object big or small experiences the same acceleration due to gravity under free fall. All three equations of motion are valid for freely falling objects as it is under uniform motion.

The sign of convention → towards earth g is +ve / away from earth g is -ve.

Weight and Mass

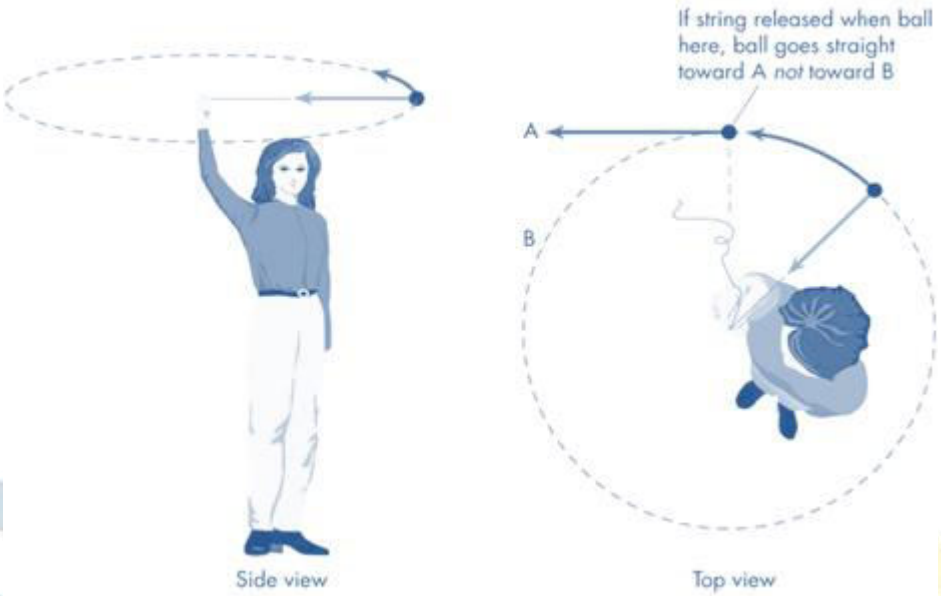
Mass of an object is the measure of its inertia and is constant throughout the universe. Weight of an object keeps changing as the value of g changes. Weight is nothing but a force of attraction of the Earth on an object = mg.

Weight of an object on the Moon is $\frac{1}{6}$

times the weight on Earth.

Thrust and Pressure

Force acting on an object perpendicular to the surface is called thrust. Effect of thrust depends on the area of contact. The pressure is thrust per unit area. SI unit is the pascal (Pa). Force acting on a smaller area applies more pressure than the same force acting on a larger area.



- If he releases the stone then it flies along the tangent, at that point on the circular path.
- Before the release of thread, it is centripetal force responsible for the motion of stone in the circular path where the stone moves with a certain speed and changes direction at every point.
- During this motion the change in direction involves change in velocity which produces acceleration. This force, which is called centripetal force, causes this acceleration, and keeps the body moving along the circular path is acting towards the center.
- Now when the thread is released the stone does not experience this force and flies off along a straight line that is tangent to the circular path.
- The motion of the moon around the earth is due to the centripetal force. The centripetal force is provided by the force of attraction of the earth. If there were no such force, the moon would pursue a uniform straight-line motion.

Pressure in fluids

The pressure exerted by a fluid in a container is transmitted undiminished in all directions on the walls of the container.

Archimedes' Principle – Why objects float or sink

The upward force exerted by a fluid on an object is known as upthrust or buoyant force.

The magnitude of buoyancy depends on the density of the fluid. If the density of an object is less than the fluid, it will float. If the density of the object is greater than the fluid, it will sink.

According to the Archimedes' principle, when a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

Relative Density

Relative density = Density of a substance/ Density of water

Elementary Idea Of Relative Density

In this article, we will understand what is relative density, calculations related to the relative density, and density of various substances. Let us start with the definition of density.

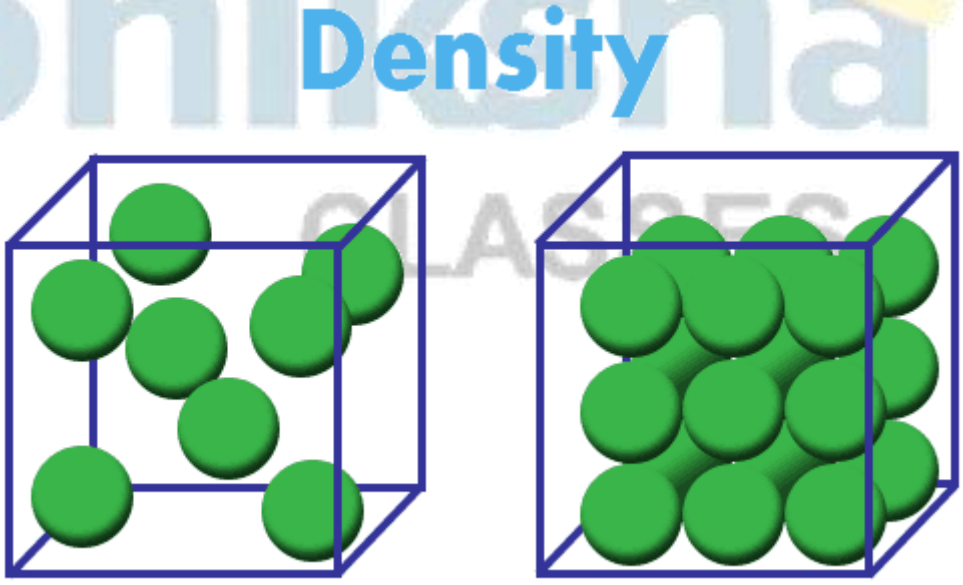
What is Density?

Density is the amount of mass in a unit volume of matter, every substance has a different density, to understand the idea of density let's conduct an experiment, we will need a tall glass cup, honey, water, coconut oil, and food coloring,

Step1: Pour a one-quarter cup of honey,

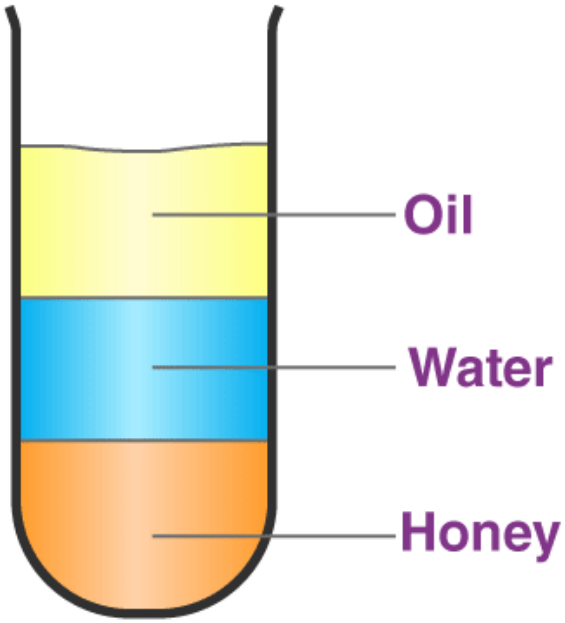
Step2: Pour a one-quarter cup of colored water gently on top of the honey.

Step3: pour a one-quarter cup of coconut oil on top of the colored water.



Notice how the different liquids from different layers, why is it so? The different substance has a different density, which means for the same volume different substances weigh differently, as they weigh differently heavier substances tend to settle at the bottom, like honey and lighter material like oil tend to float at the top which means.

What is Relative Density?



The difference between the specific gravity and density is that at room temperature and pressure is 1gram per 1 cubic cm is the density of water this density is treated as a standard and the density of any other material (usual liquids) is calculated relative to this is called relative density or specific gravity.

Hence, specific gravity is the ratio of the mass of a substance to that of a reference substance, let's consider the density of honey is approx. 1.42 grams/cm3, so its specific gravity would be 1.42/1 = 1.42. Notice that specific gravity is a ratio, therefore specific gravity does not have a unit, and hence specific gravity is a dimensionless physical quantity.

The specific gravity of a substance will let us know if it will float or sink, it gives us the idea about relative mass or relative density. If the specific gravity of a substance is below 1 then it will float and if it is greater than 1 it will sink.

Let's extend our experiment further for more liquids, this time, we will use several liquids with different specific gravities, use the table given below for reference.

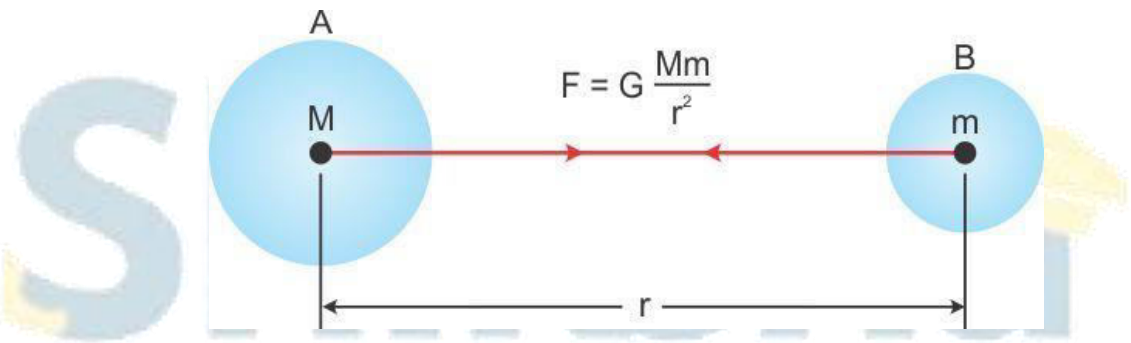
Material	Density(gram/cm^3)
Rubbing Alcohol	0.79
Lamp Oil	0.8
Baby Oil	0.83
Water	1.0
Milk	1.03
Liquid Soap	1.06

Corn Syrup	1.33
Maple Syrup	1.37
Honey	1.42

Universal Law of Gravitation

> Every object in the Universe attracts every other object with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them.

- This law was given by **Sir Isaac Newton**.
- Consider two objects A and B of mass 'M' and 'm' separated by a distance 'r'.



- According to Newton's law of gravitation, the force of attraction (F) between the two objects is given as

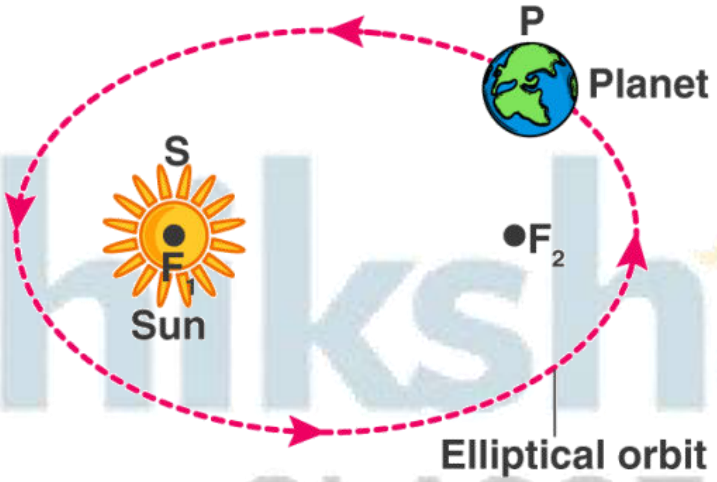
$$F = \frac{GMm}{r^2}$$

where **G** is the proportionality constant known as the **universal gravitation constant.**

- Universal gravitation constant 'G' is numerically equal to the gravitational force of attraction between the two bodies, each of unit mass kept at unit distance from each other.
- The value of G is $6.67 \times 10^{-11}\ Nm^2/kg^2$.
- The universal law of gravitation successfully explained several phenomena such as the motion of the Moon around the Earth, the motion of the planets around the Sun and the force which binds us to the Earth.

Kepler's Laws of Planetary Motion

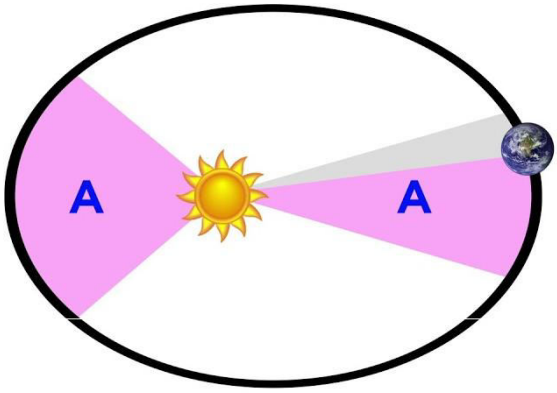
Kepler's First Law	• The planets move around the Sun in elliptical orbits, with the Sun at one of the two foci of the elliptical orbit.
Kepler's Second Law	• In an elliptical orbit of the planet, the line joining the centre of the planet to the centre of the Sun sweeps out equal areas in equal intervals of time.
Kepler's Third Law	• The cube of the mean distance 'r' of a planet from the Sun is directly proportional to the square of its orbital period 'T'. • i.e. $r^3 \alpha T^2$



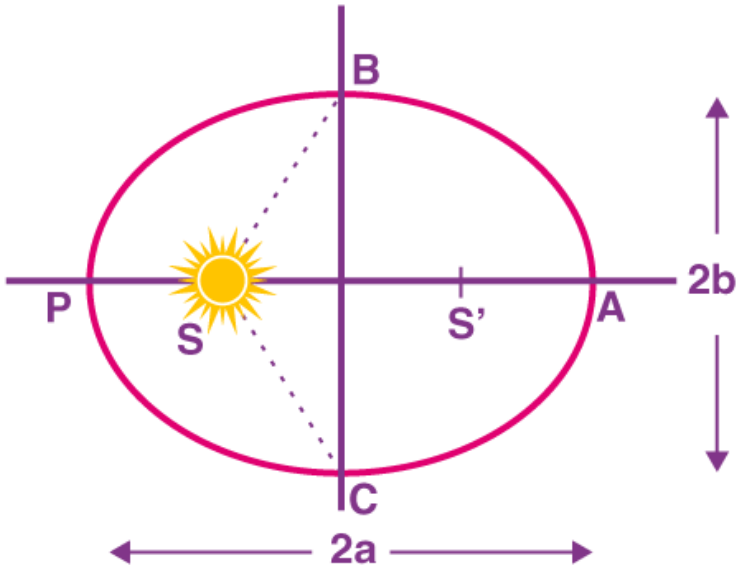
Kepler's First Law

Second Law of Kepler

a planet sweeps out equal areas of the ellipse over equal time intervals



Kepler's Second Law



Kepler's Third Law

Free Fall

- Whenever objects fall towards the Earth under the influence of gravitational force alone, the objects are said to be in a state of free fall.
- The uniform acceleration produced in a freely falling body because of the gravitational force of the Earth is known as **acceleration due to gravity**. It is denoted by **g**, and its value on the surface of the Earth is 9.8 m/s^2.
- During free fall, there is no change in the direction of motion of the object, but the magnitude of the velocity of the falling object changes.
- The relation connecting the acceleration due to gravity **g** and universal gravitational constant **G** is

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

  where M is the mass of the Earth and R is the radius of the Earth.
- The value of 'g' is maximum at the **poles** (where R is minimum) and minimum at the **equator** (where R is maximum).
- The value of 'g' is maximum on the surface of the Earth; it decreases as we move above or go beneath the surface of the Earth.

Motion of Objects under the Influence of Gravitational Force of the Earth

- The equations of motion for freely falling bodies are

$v = u + gt$

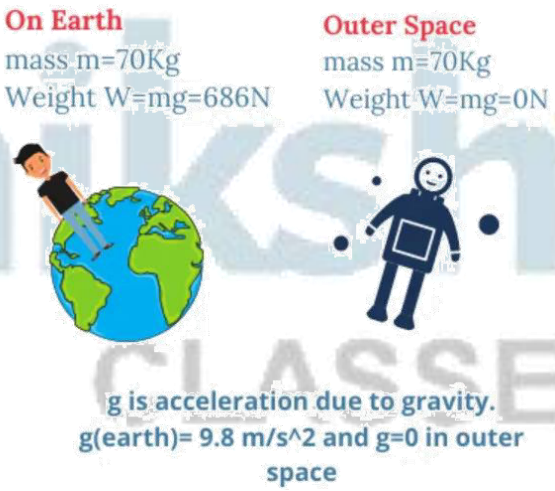
$h = ut + (1/2)\, gt^2$

$v^2 - u^2 = 2gh$

where '**u'** is the **initial velocity**, '**v'** is the **final velocity** after 't' sec and '**h'** is the **height** covered in 't' sec.

- Here, g should be positive if the acceleration due to gravity is in the direction of motion, and it should be negative if it is in the direction opposite to the motion.

Mass and Weight



- Mass of an object is the measure of its inertia.
- The force with which an object is attracted towards the Earth is the **weight** (W) of the object. It is equal to the product of mass (m) and acceleration due to gravity (g).

  W = mg
- SI unit of weight is Newton, same as that of force.
- The weight of an object on the Moon is one-sixth its weight on the Earth.

Differences between Mass and Weight

Mass	Weight

1. Mass of a body is the quantity of matter contained in it.	1. Weight of a body is the force with which the body is attracted towards the centre of the Earth.
2. Mass of a body is a constant quantity.	2. Weight of a body varies from place to place.
3. It is a scalar quantity.	3. It is a vector quantity.
4. SI unit of mass is kilogram (kg).	4. SI unit of weight is newton (N).

Thrust and Pressure

- Thrust is the force acting perpendicularly on an object.
- Pressure is the force acting perpendicularly on a unit area of the object.

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

- SI unit of thrust is newton (N) and that of pressure is pascal (Pa), where 1 Pa = 1 N/m^2

Density

- Density (d) of a substance is defined as mass (M) per unit volume (V).

$$d = \frac{M}{V}$$

- The relative density of a substance is the ratio of its density to the density of water at 4°C.

$$\text{Relative density} = \frac{\text{Density of a substance}}{\text{Density of water at } 4^{\circ}C}$$

- Relative density has no units as it is the ratio of similar quantities.

Pressure in Fluids

- A fluid exerts pressure in all directions, even upwards.
- According to **Pascal's law**, pressure exerted in any confined mass of fluid is transmitted uniformly in all directions.

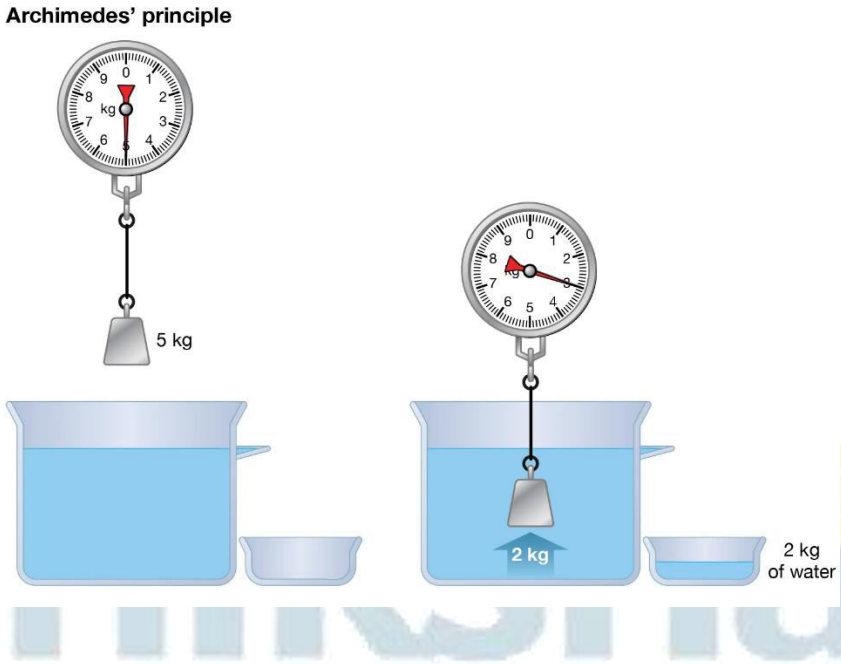
Buoyancy

- When an object is partially or wholly immersed in a fluid, an upward force acts on it, which is called upthrust or **buoyant force**.
- The magnitude of buoyant force depends on
  - ✓ The volume of the object immersed in the liquid.

- ✓ The density of the liquid.

- Let W be the weight of a body and F_B be the buoyant force acting on it.
  - ✓ If $W > F_B$, then the body sinks.
  - ✓ If $W < F_B$, then the body floats.
- An object with density less than the liquid floats on the liquid. If the object is denser than the liquid, then it sinks in the liquid.

Archimedes' Principle



When an object is immersed wholly or partially in a fluid, it experiences an upward force which is equal to the weight of the fluid displaced by it.

- The buoyant force acting on an object = Weight of fluid displaced by that object

Applications of Archimedes' Principle

- In designing ships and submarines
- In determining the purity of milk with a lactometer
- In determining the density of liquids with a hydrometer

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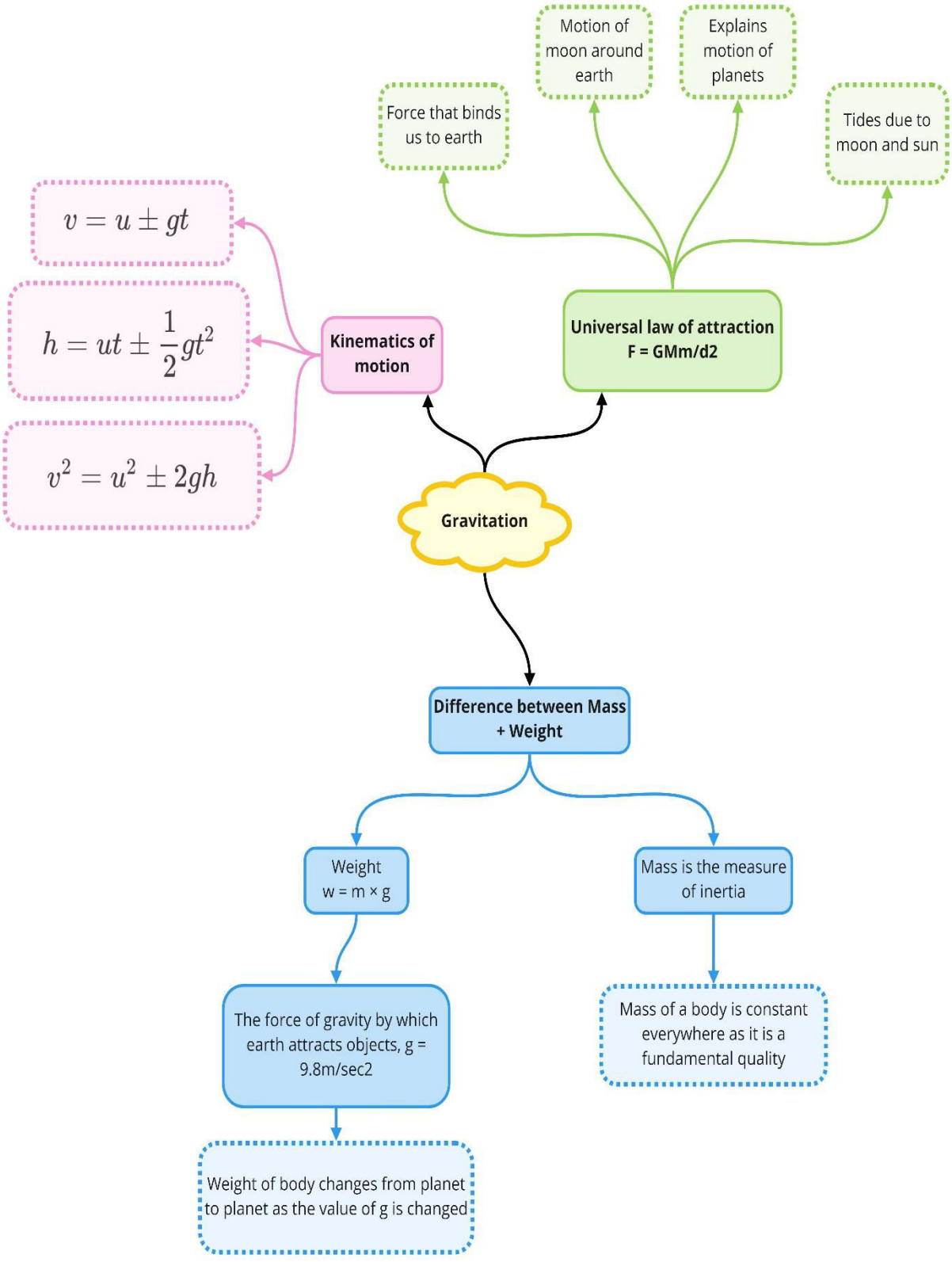


Important Question

➢ Multiple Choice Questions:

1. Two objects of different masses falling freely near the surface of the moon would

(a) have same velocities at any instant

(b) have different acceleration

(c) experience forces of same magnitude

(d) undergo a change in their inertia

2. The value of acceleration due to gravity

(a) is same on equator and poles

(b) is least on poles

(c) is least on equator

(d) increases from pole to equator

3. The gravitational force between two objects is F. If masses of both objects are halved without changing the distance between them, then the gravitational force would become

(a) F/4

(b) F/2

(c) F

(d) 2F

4. A boy is whirling a stone tied to a string in a horizontal circular path. If the string breaks, the stone

(a) will continue to move in the circular path

(b) will move along a straight line towards the centre of the circular path

(c) will move along a straight line tangential to the circular path

(d) will move along a straight line perpendicular to the circular path away from the boy

5. An object is put one by one in three liquids having different densities. The object floats with $\frac{1}{9}$, $\frac{2}{11}$ and $\frac{3}{7}$ parts of their volumes outside the liquid surface in liquids of densities d_1, d_2 and d_3 respectively. Which of the following statement is correct?

(a) $d_1 > d_2 > d_3$

(b) $d_1 > d_2 < d_3$

(c) $d_1 < d_2 > d_3$

(d) $d_1 < d_2 < d_3$

6. In the relation F = GM mld^2, the quantity G

(a) depends on the value of g at the place of observation

(b) is used only when the Earth is one of the two masses

(c) is greatest at the surface of the Earth

(d) is universal constant of nature

7. Law of gravitation gives the gravitational force between

(a) the Earth and a point mass only

(b) the Earth and Sun only

(c) any two bodies having some mass

(d) two charged bodies only

8. The value of quantity G in the law of gravitation

(a) depends on mass of Earth only

(b) depends on radius of Earth only

(c) depends on both mass and radius of Earth

(d) is independent of mass and radius of the Earth

9. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be

(a) $\frac{1}{4}$ times

(b) 4 times

(c) $\frac{1}{2}$ times

(d) unchanged

10. The atmosphere is held to the Earth by

(a) gravity

(b) wind

(c) clouds

(d) Earth's magnetic field

➢ Very Short Question:

1. What is the S.I. unit of thrust?

2. What is the S.I. unit of pressure?

3. Define thrust.

4. Define pressure.

5. Why is it easier to swim in sea water than in river water?

6. Why a truck or a motorbike has much wider tires?

7. Why are knives sharp?

8. Why is the wall of dam reservoir thicker at the bottom?

9. Why do nails have pointed tips?

10. While swimming why do we feel light?

➢ Short Questions:

1. State the difference in balanced and unbalanced force.

2. What change will force bring in a body?

3. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side. Explain why?

4. Explain why it is dangerous to jump out of a moving bus.

5. Why do fielders pull their hand gradually with the moving ball while holding a catch?

6. In a high jump athletic event, why are athletes made to fall either on a cushioned bed or on a sand bed?

7. How does a karate player breaks a slab of ice with a single blow?

8. What is law of conservation of momentum?

➢ Long Questions:

1. With the help of an activity prove that the force acting on a smaller area exerts a larger pressure?

➢ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

   d. Both Assertion and Reason are false.

   Assertion: Universal gravitational constant G is a scalar quantity.

Reason: The value of G is same through out the universe.

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

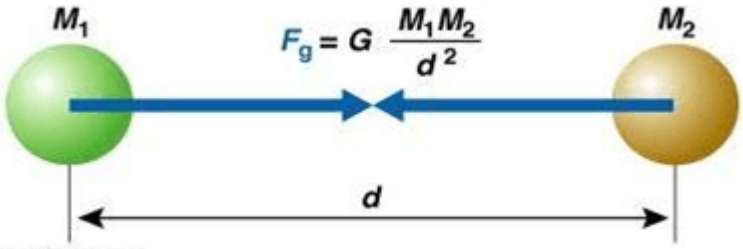
   d. Both Assertion and Reason are false.

   Assertion: When distance between two bodies is doubled and also mass of each body is doubled, then the gravitational force between them remains the same.

   Reason: According to Newton's law of gravitation, product of force is directly proportional to the product mass of bodies and inversely proportional to square of the distance between them.

➢ Case Study Questions:

1. Every object in the universe attracts every other object with a force which is proportional to the product of their masses (m1*m2) and inversely proportional to the square of the distance (d^2) between them. The force is along the line joining the centers of two objects.



Mathematically,
$F = G\frac{M1*M2}{d2}$
Where,
M_1=mass of one object.
M_2 =mass of another object
d = distance between two objects
G= universal gravitational constant
The value of G was found out by Henry Cavendish (1731 – 1810) by using a sensitive balance. The accepted value of G is $6.673*10^{-11}$ N-m^2/kg^2. Answer the following questions from above case.

(i) Gravitational force does not depend on

(a) Masses of objects

(b) Separation between objects

(c) Charges on objects

(d) None of these

(ii) Force of gravitation varies with masses of object as:

(a) Product of masses

(b) Sum of masses

(c) Difference of masses

(d) None of these

(iii) When mass of one body is doubled then force of gravitation will become:

(a) Force will remain same

(b) Force will become double

(c) Force will become halved

(d) None of these

(iv)What is universal gravitational constant? What is its SI unit?

(v) Two objects of masses 10kg and 20kg separated by distance 10m. What is gravitational force between them?

2. We know that the earth attracts every object with a certain force and this force depends on the mass (*m*) of the object and the acceleration due to the gravity (*g*). The weight of an object is the force with which it is attracted towards the earth.

Mathematically

W = m x g

Where, W= weight of object

m= mass of object

g= acceleration due to the gravitational force

As the weight of an object is the force with which it is attracted towards the earth, the SI unit of weight is the same as that of force, that is, Newton (N). The weight is a force acting vertically downwards; it has both magnitude and direction. We have learnt that the value of g is constant at a given place. Therefore at a given place, the weight of an object is directly proportional to the mass, say m, of the object, that is, W αm. It is due to this reason that at a given place, we can use the weight of an object as a measure of its mass. Answer the following questions.

(i) Unit of acceleration due to the gravity (*g*) is:

(a) m/s

(b) m/s^2

(c) Newton(N)

(d) None of these

(ii) Direction of weight of any object is:

(a) Always towards centre of earth

(b) Always away from centre of earth

(c) Weight don't have direction

(d) None of these

(iii) Which of the following has same unit:

(a) Mass and weight

(b) Weight and force

(c) Velocity and acceleration

(d) None of these

(iv) Whether weight is scalar quantity or vector quantity? Justify your answer.

(v) Differentiate between mass and weight.

✓ Answer Key-

➢ Multiple Choice Answers:

1. (a) have same velocities at any instant
2. (c) is least on equator
3. (a) F/4
4. (c) will move along a straight line tangential to the circular path
5. (d) $d_1 < d_2 < d_3$
6. (d) is universal constant of nature
7. (c) any two bodies having some mass
8. (d) is independent of mass and radius of the Earth
9. (b) 4 times
10. (a) gravity

➢ Very Short Answers:

1. Answer: Newton.
2. Answer: The S.I. unit of pressure = N/m^2 = Pascal.

3. Answer: The net force exerted by a body in a particular direction is called thrust.
4. Answer: The force exerted per unit area is called pressure.
5. Answer: The density of sea water is more due to dissolved salts in it as compared to the density of river water. Hence the buoyant force exerted on the swimmer by the sea water is more which helps in floating and makes swimming easier.
6. Answer: The pressure exerted by it can be distributed to more area, and avoid the wear and tear of tires.
7. Answer: To increase the pressure, area is reduced,

   As pressure $\propto$ 1/Area hence the pressure or force exerted on a body increases.
8. Answer: The pressure of water in dams at the bottom is more, to withstand this pressure the dams have wider walls.
9. Answer: The force exerted when acts on a smaller area, it exerts larger pressure. So the nails have pointed tips.
10. Answer: The swimmer is exerted by an upward force by water, this phenomenon is called buoyancy and it makes the swimmer feel light.

➢ Short Answers:

1. Answer: The iron rod sinks due to high density and less buoyant force exerted by the water on it, but in case of ship the surface area is increased, the upthrust experienced by the body is more. So it floats on water
2. Answer: Camels feet are broad and the larger area of the feet reduces the force/ pressure exerted by the body on the sand. But when we have to walk on the same sand, we sink because the pressure exerted by our body is not distributed but is directional.
3. Answer: Lactometer is a device used to find the purity of a given sample of milk. Hydrometer is a device used to find the density of liquids.
4. Answer: It means that the density of silver is 10.8 times more than that of water. T
5. Answer:

$$\text{Relative density of gold} = 19.3$$

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

$$\therefore \text{Density of gold} = \text{Relative density of gold} \times \text{Density of water}$$
$$= 19.3 \times 10^3 \text{ kg/m}^3$$
$$= 19300 \text{ kg/m}^3.$$

6. Answer: Archimedes' principle- When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by

it.

It is used in designing of ships and submarines.

floats on water but another sink in oil. Why?

7. Answer: The cork floats on water because the density of cork is less than the density of water, and another cork sinks in the oil because the density of cork is more than the oil.
8. Answer: Fluids are the substances which can flow e.g., gases and liquids are fluids. Archimedes' principle is based on the upward force exerted by fluids on any object immersed in the fluid.

   Hence it is applicable only for fluids.

   Applications of Archimedes' principle:

   - It is used in designing of ship and submarine.
   - It is used in designing lactometer, used to determine the purity of milk,
   - To make hydrometers, used to determine the density of liquids.

➢ Long Answers:

1. Answer: Consider a block of wood kept on a table top. The mass of the wooden block is 5 kg. Its dimension is 40 cm x 20 cm x 10 cm.

   Now, we have to find the pressure exerted by the wooden block on the table top by keeping it vertically and horizontally.

The mass of the wooden block = 5 kg

Weight of the wooden block applies a thrust on the table top

$\therefore$ Thrust = $F = m \times g$

$= 5 \text{ kg} \times 9.8 \text{ m/s}^2 = 49 \text{ N}$

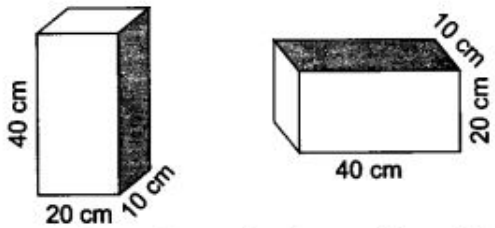
(case *a*)—When the wooden box is kept vertically with sides 20 cm × 10 cm.

Area of a side = length × breadth

$= 20 \text{ cm} \times 10 \text{ cm}$

$= 200 \text{ cm}^2 = 0.02 \text{ m}^2$

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{49 \text{ N}}{0.02 \text{ m}^2} = 2450 \text{ N/m}^2$$



(case *b*)—When the block is kept horizontally with side 40 cm × 20 cm.

Area = length × breadth

$= 40 \text{ cm} \times 20 \text{ cm}$

$= 800 \text{ cm}^2 = 0.08 \text{ m}^2$

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{49 \text{ N}}{0.08 \text{ m}^2} = 612.5 \text{ N/m}^2$$

$\therefore$ The pressure exerted by the box in case (a) is more as compared to the pressure exerted in case (b).

The area is reduced and the pressure exerted is more.

This shows that pressure $\propto$ 1/area.

Pressure will be larger if the area is reduced.

Application:

- Nails have pointed tips.
- Knives have sharp edges.
- Needles have pointed tips.

➢ Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

➢ Case Study Answers:

1.

(i) (c) Charges on objects

(ii) (a) Product of masses

(iii) (b) Force will become double

(iv) The force of attraction between any two unit masses separated by a unit distance is called universal gravitational constant denoted by G measured in Nm^2/kg^2.

(v) Mathematically,

$$F = G\frac{M1*M2}{d2}$$

Here M1=10kg

M2=20kg

D=10m

Then, force is given by

$F= 6.67*10^{-11} *20*10/100$

$F= 13.34*10^{-11}N.$

2.

(i) b

(ii) a

(iii) b

(iv) Weight is vector quantity as it has magnitude as well as direction which is always towards centre of a earth.

(v) Difference between mass and weight is given below

No.	mass	weight
1	Mass is amount of matter in a body.	Weight is the measure of force acting on a mass due to acceleration due to gravity.
2	it is a scalar quantity	it is a vector quantity
3	SI unit of mass is Kilogram (Kg).	SI unit of weight is Newton (N).

4.	Mass can never be zero	Weight can be zero where gravity is zero.