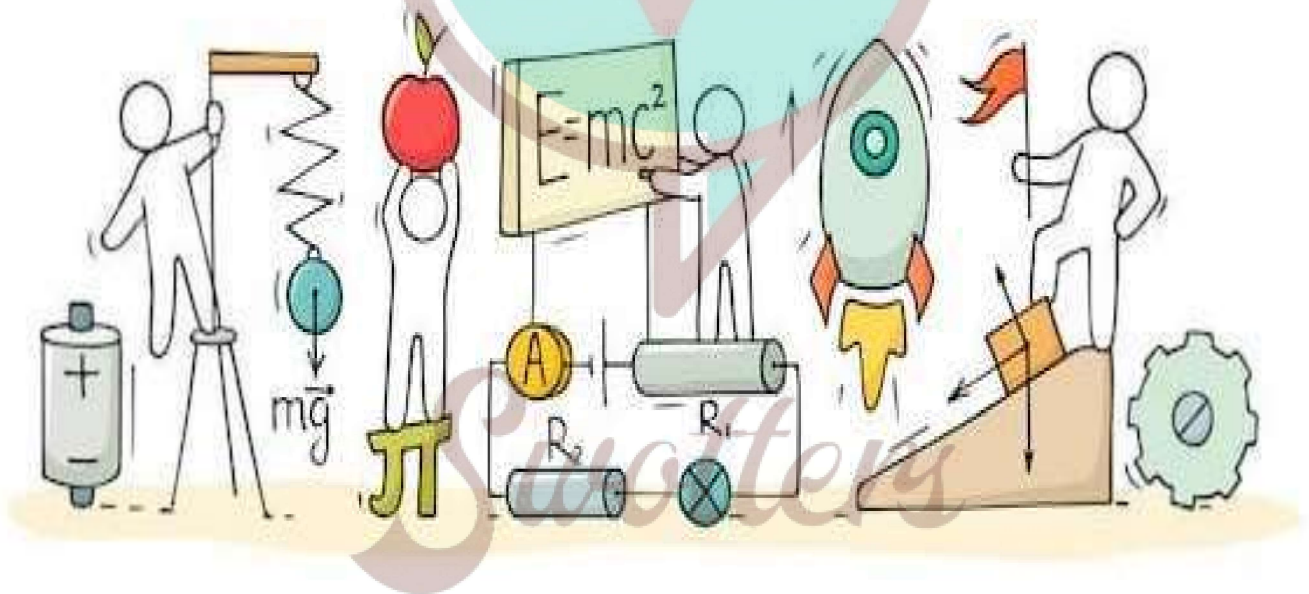# PHYSICS

Chapter 10: Gravitation

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.
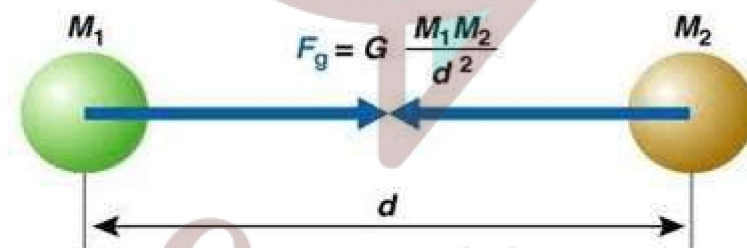
Mathematically,
$$F = G\frac{M_1 * M_2}{d_2}$$
Where,
M_1 = mass of one object.
M_2 = mass of another object
d = distance between two objects
G = universal gravitational constant
The value of G was found out by Henry Cavendish (1731 – 1810) by using a sensitive balance. The accepted value of G is $6.673 * 10^{-11}$ 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 ∝ 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:

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

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.
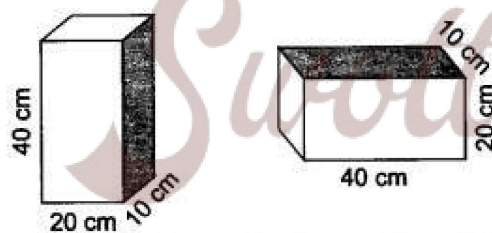
The mass of the wooden block = 5 kg

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

∴   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 cm × 10 cm

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

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

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

        Area = length × breadth

            = 40 cm × 20 cm

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

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

∴ 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 ∝ 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,

$$F = G\frac{M1*M2}{d2}$$
$$\text{Here } M1 = 10kg$$
$$M2 = 20kg$$
$$D = 10m$$
$$\text{Then, force is given by}$$
$$F = 6.67*10^{-11} * 20*10/100$$
$$F = 13.34*10^{-11}N.$$

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.