

1. State the universal law of gravitation.

Ans. The universal law of gravitation states that every object in the universe attracts every other object with gravitational force. The force acting between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

For two objects of masses, m_1 and m_2 , and the distance between them r , the universal law of gravitation gives the force (F) of attraction acting between them.

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

Where G is the universal gravitation constant given by.

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

2. Write the formula to find the magnitude of the gravitational force between the Earth and an object on the surface of the Earth.

Ans. Let M_E be the mass of the Earth and m be the mass of an object on its surface. Suppose R is the radius of the Earth, then according to the universal law of gravitation. In that case, the relation gives the gravitational force (F) acting between the Earth and the object.

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

3. What do you mean by free fall?

Ans. The gravity of the Earth attracts every object towards its centre. When an object is released from a height, it falls towards the surface of the Earth under the influence of gravitational force. The motion of the object is said to have a free fall.

4. What do you mean by the acceleration due to gravity?

Ans. When an object falls towards the ground from a height, then its velocity changes during the fall. This changing velocity produces acceleration in the object. This acceleration is known as acceleration due to gravity (g). Its value is given by 9.8 m/s^2 .

5. What are the differences between the mass of an object and its weight?

Ans.

S. No.	Mass	Weight
I.	Mass is the quantity of matter contained in the body.	Weight is the force of gravity acting on the body.
II.	It is the measure of inertia of the body.	It is the measure of gravity.
III.	Mass is a constant quantity.	Weight is not a constant quantity. It is different at different places.
IV.	It only has magnitude.	It has magnitude as well as direction.
V.	Its SI unit is kilogram (kg).	Its SI unit is the same as the SI unit of force, i.e., Newton (N).

6. Why is the weight of an object on the moon $\frac{1}{6}$ th its weight on the Earth?

Ans. Let M_E be the mass of the Earth and m be an object on the surface of the Earth. Let R_E be the radius of the Earth. According to the universal law of gravitation, the weight W_E of the object on the surface of the Earth is given by,

$$W_E = \frac{GM_E m}{R_E^2}$$

Let M_m and R_m be the mass and radius of the moon. Then, according to the universal law of gravitation, the weight W_M of the object on the moon's surface is given by.

$$W_M = \frac{GM_m m}{R_m^2}$$

$$\frac{W_M}{W_E} = \frac{M_m R_E^2}{M_E R_m^2}$$

Where, $M_E = 5.98 \times 10^{24} \text{ kg}$, $M_m = 7.36 \times 10^{22} \text{ kg}$

$R_E = 6.4 \times 10^6 \text{ m}$, $R_m = 1.74 \times 10^6 \text{ m}$

$$\therefore \frac{W_M}{W_E} = \frac{7.36 \times 10^{22} \times (6.37 \times 10^6)^2}{5.98 \times 10^{24} \times (1.74 \times 10^6)^2} = 0.165 = \frac{1}{6}$$

Therefore, the weight of an object on the moon is $\frac{1}{6}$ of its weight on the Earth.

7. Why is it difficult to hold a school bag having a strap made of a thin and strong string?

Ans. It is difficult to hold a school bag having a thin strap because the pressure on the shoulders is quite large. This is because the pressure is inversely proportional to the surface area on which the force acts. The smaller is the surface area, the larger will be the pressure on the surface. In the case of a thin strap, the contact surface area is very small. Hence, the pressure exerted on the shoulder is very large.

8. What do you mean by buoyancy?

Ans. The upward force exerted by a liquid on an object immersed in it is known as buoyancy. When you try to immerse an object in water, you can feel an upward force exerted on the object, which increases as you push the object deeper into the water.

9. Why does an object float or sink when placed on the surface of the water?

Ans. If the density of an object is more than the density of the liquid, then it sinks in the liquid. This is because the buoyant force acting on the object is less than the force of gravity. On the other hand, if the object's density is less than the density of the liquid, then it floats on the surface of the liquid. This is because the buoyant force acting on the object is greater than the force of gravity.

10. You find your mass to be 42 kg on a weighing machine. Is your mass more or less than 42 kg?

Ans. When you weigh your body, an upward force acts on it. This upward force is the buoyant force. As a result, the body gets pushed slightly upwards, causing the weighing machine to show a reading less than the actual value.

11. You have a cotton bag and an iron bar, each indicating a mass of 100 kg when measured on a weighing machine. In reality, one is heavier than the other. Can you say which one is heavier and why?

Ans. The bag of cotton is heavier than the iron bar. This is because the surface area of the cotton bag is larger than the iron bar. Hence, a more buoyant force acts on the bag than that on an iron bar. This makes the cotton bag heavier than its actual value. For this reason, the iron bar and the cotton bag show the same mass on the weighing machine, but actually, the mass of the cotton bag is more than that of the iron bar.

Actual weight = Measured Weight + Buoyant Force