in air. ... weighed in air will be heavier than 100 kg of iron weighed ... much lesser mass of cotton

Q.1. How does the force of gravitation between two objects change when the distance between them is reduced to half ?

Ans. The force of gravitation between two objects is inversely proportional to the square of distance between them. That is, $F \propto \dfrac{1}{r^2}$. Now, when the distance between two objects is reduced to half, that is, made $\dfrac{1}{2}$, then the force between them will become 4 times $\left[\text{because}\left(\dfrac{1}{\frac{1}{2}}\right)^2 = 4\right]$.

Q.2. Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object ?

Ans. We know that : Force = mass × acceleration. Now, it is given to us that gravitational force acts on all objects in proportion to their masses, that is, Force ∝ mass. This is possible only if the acceleration (due to gravity) is constant for a heavy object as well as a light object. Since the acceleration is constant, therefore, all the objects (heavy or light) fall at the same speed.

Q.3. ...

Q.4. 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 ?

Ans. The earth attracts the moon with the same force with which the moon attracts the earth. This is because according to Newton's third law of motion, the forces of action and reaction are always equal and opposite. So, when earth attracts the moon with a certain gravitational force, then the moon attracts the earth with an equal and opposite gravitational force.

Q.5. If the moon attracts the earth, why does the earth not move towards the moon ?

Ans. From Newton's second law of motion, it can be concluded that the acceleration produced in a body is inversely proportional to the mass of the body $\left(\text{because } a = \dfrac{F}{m}\right)$. Now, due to the very large mass (m) of the earth, the gravitational force (F) between the moon and the earth produces very small acceleration (a) in the earth. Actually, the acceleration produced in the earth (by the attraction of moon) is so small that it cannot be observed. And hence we do not see the earth move towards the moon.

Q.6. What happens to the force between two objects, if :
(i) the mass of one object is doubled ?
(ii) the distance between the objects is (a) doubled, and (b) tripled ?
(iii) the masses of both objects are doubled ?

Ans. (i) The gravitational force between two objects is directly proportional to the product of masses of the two objects. So, if the mass of one of the objects is doubled, then the force also gets doubled (it becomes 2 times).

(ii) The gravitational force between two objects is inversely proportional to the square of distance between them.

(a) If the distance between the objects is doubled (made 2 times), the force between them becomes

$$\left(\frac{1}{2}\right)^2 \text{ or } \frac{1}{4} \text{ (one-fourth).}$$

(b) If the distance between the objects is tripled (made 3 times), the force between them will become

$$\left(\frac{1}{3}\right)^2 \text{ or } \frac{1}{9} \text{ (one-ninth).}$$

(iii) The gravitational force between two objects is directly proportional to the product of their masses. So, if the masses of both the objects are doubled (made 2 times each), the force between them will become $2 \times 2 = 4$ times.

Q.7. What is the importance of the universal law of gravitation ?

Ans. The importance of universal law of gravitation is that it explains the motion of planets around the sun; the motion of moon around the earth; and the motion of artificial satellites around the earth. It also explains the phenomena of rainfall, snowfall, and flow of water in rivers on the earth.

Q.8. What is the acceleration of free fall ?

Ans. The falling of an object from a height towards the earth under the gravitational force of earth (with no other forces acting on it) is called free fall. The gravitational force of earth produces a uniform acceleration in the freely falling object due to which its speed goes on increasing. This is called the acceleration of free fall (which is commonly known as acceleration due to gravity). The value of acceleration of free fall is 9.8 m/s².

Q.9. What do we call the gravitational force between the earth and an object ?

Ans. The gravitational force between the earth and an object is called 'earth's gravity'.

Q.10. Amit buys few grams of gold at the poles as per the instructions of one of his friends. He hands over the

same when he meets him at the equator. Will his 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).

Ans. No, the friend at equator will not agree with the weight of gold bought at the poles. This can be explained as follows : We know that weight, $W = m \times g$. Now, since the value of g is greater at the poles, so the weight of a certain mass of gold will be greater at the poles (where it is bought). When the same mass of gold is brought to equator, then its weight will be found to be less because the value of g is less at the equator. Thus, a certain mass of gold bought at the poles will have lesser weight at the equator.

Q.11. Why will a sheet of paper fall slower than one that is crumpled into a ball ?

Ans. A sheet of paper has a larger area. Due to its large area, when a sheet of paper is dropped from a height, it experiences more resistance from air, its speed decreases and it falls at a slower rate. On the other hand, a sheet of paper crumpled into a ball has a smaller area. Due to its smaller area, when a ball made from crumpled sheet of paper is dropped from a height, it experiences less resistance from air, its speed increases and it falls at a faster rate.

Q.19. In what direction does the buoyant force on an object immersed in a liquid act ?

Ans. The buoyant force on an object immersed in a liquid acts in the vertically upward direction. In other words, buoyant force acts in a direction opposite to the direction in which weight of the object acts.

Q.20. Why does a block of plastic released under water come up to the surface of water ?

Ans. A block of plastic released under water comes up to the surface of water because the buoyant force (or upthrust) acting on the block of plastic due to water is greater than its weight. The buoyant force is greater because the density of water is greater than the density of plastic.