Gravitation
NCERT In-Text Questions

1. **Page 134:** State the universal law of gravitation.

2. **Page 134:** Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth.

3. **Page 136:** What do you mean by free fall?

4. **Page 136:** What do you mean by acceleration due to gravity?

5. **Page 138:** What are the differences between the mass of an object and its weight?

6. **Page 138:** Why is the weight of an object on the moon $\frac{1}{6}^{th}$ its weight on the earth?

7. **Page 141:** Why is it difficult to hold a school bag having a strap made of a thin and strong string?

8. **Page 141:** What do you mean by buoyancy?

9. **Page 141:** Why does an object float or sink when placed on the surface of water?

10. **Page 142:** You find your mass to be 42 *kg* on a weighing machine. Is your mass more or less than 42 *kg*?

11. **Page 142:** You have a bag of cotton and an iron bar, each indicating a mass of 100 *kg* when measured on a weighing machine. In reality, one is heavier than other. Can you say which one is heavier and why?

Answers

1. The universal law of gravitation says that the force of gravitation between two objects of mass M and m respectively, separated by a distance r is:

   (a) Directly proportional to the product of their masses, and

   $$F \propto Mm$$

   (b) Inversely proportional to the square of the distance between them.

   $$F \propto \frac{1}{r^2}$$

2. Consider two bodies, A and B, of mass M and m respectively, which are separated by a distance of r m. Then by the Universal law of the Gravitation, the force of gravity is,

   $$F = G\,\frac{Mm}{r^2}$$

   where G is the universal contant of gravitation which is equal to $6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$.

3. We have learnt that the earth attracts objects towards it. This is due to the gravitational force. Whenever objects fall towards the earth under this force alone, we say that the objects are in free fall.

4. Whenever an object falls towards the earth, an acceleration is involved. This acceleration is due to the earth's gravitational force. Therefore, this acceleration is called the acceleration due to the gravitational force of the earth (or acceleration due to gravity). It is denoted by g. The unit of g is the same as that of acceleration, that is, $m\ s^{-2}$ and its value is $9.8\ m\ s^{-2}$.

5. Difference between mass and weight:

Mass	Weight
Mass is an intrinsic property of an object which is a constant.	Weight is the force experienced by the object under a gravitational field.
The mass of an object remains the same everywhere, that is, on the earth and on any planet.	Weight depends on its location because g depends on location.
Mass of an object is a direct measure of its inertia.	Weight of an object is a measure of the planet's gravitational attraction or gravity.

Mass has only magnitude, hence it is an scalar quantity.	Weight has both magnitude and direction, hence it is a vector quantity.
The SI unit of mass is *kg*.	The SI unit of weight is *N*.

6. Because the moon weighs way less than the earth (about 81.25 times less), and also it's much smaller that the earth (about 3.66 times smaller). This results in a samller gravitational pull which is about six times less than that of the earth. If we want to calculate, we can simply argue that the having mass 81.25 times less decreases the gravitational pull by 81.25 times but, having a radius 3.66 times less increases the gravitaitonal pull by 3.66^2 times. This means the gravitational pull of the moon when compared to earth's is $\frac{1}{81.25} \times 3.66^2 = \frac{1}{6}$

7. The amount of weight that your shoulder has to support is the weight of the bag, but the bag is supported by a thin strap. This means that the force will be distributed over the area of the thinly, but strongly, made strap. As the area of the strip is small, this concentrates the whole, heavy, weight of the bag on such a small area which makes it very difficult to carry.

8. When an object is immeresed in a fluid, it experiences a force which always opposes gravity. This force is called the buoyant force, and the phenomenon of experiencing this is called buoyancy.

9. If the force of gravity or weight is more than the buoyant force, the object will sink, else it will float.

10. It is more than 42 *kg* as we displace certain volume of air which exerts a force equal to the weight of the air displaced. This decrases the reading on the weighing machine.

11. The bag of cotton is heavier because it has larger volume hence, displaces larger amount of air than the iron bar. The weight of the displaced air is far more greater than the air displaced by the iron bar. This means that the upward force experienced by the cotton bag is more and hence if we add this to the reading of the weighing machin, we get the actual mass which is greater than the iron bar.