Weightlessness in a Satellite.

A satellite, which does not produce its own gravity moves around the earth in a circular orbit under the action of gravity. The acceleration of satellite is $\dfrac{GM}{r^2}$ towards the center of earth.

If a body of mass m placed on a surface inside a satellite moving around the earth. Then force on the body are

(i) The gravitational pull of earth $= \dfrac{GMm}{r^2}$
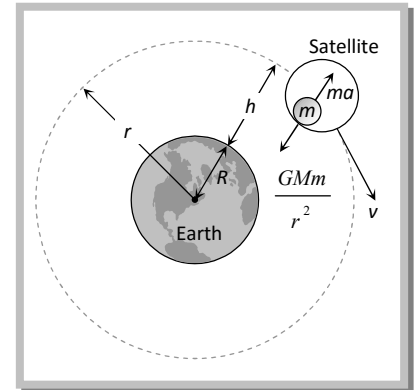
(ii) The reaction by the surface $= R$

By Newton's law $\quad \dfrac{GmM}{r^2} - R = m\ a$

$$\dfrac{GmM}{r^2} - R = m\left(\dfrac{GM}{r^2}\right)$$

$\therefore \qquad\qquad\qquad R = 0$

Thus the surface does not exert any force on the body and hence its apparent weight is zero.

A body needs no support to stay at rest in the satellite and hence all position are equally comfortable. Such a state is called weightlessness.

Important points

(i) One will find it difficult to control his movement, without weight he will tend to float freely. To get from one spot to the other he will have to push himself away from the walls or some other fixed objects.

(ii) As everything is in free fall, so objects are at rest relative to each other, i.e., if a table is withdrawn from below an object, the object will remain where it was without any support.

(iii) If a glass of water is tilted and glass is pulled out, the liquid in the shape of container will float and will not flow because of surface tension.

(iv) If one tries to strike a match, the head will light but the stick will not burn. This is because in this situation convection currents will not be set up which supply oxygen for combustion

(v) If one tries to perform simple pendulum experiment, the pendulum will not oscillate. It is because there will not be any restoring torque and so $T = 2\pi\sqrt{(L/g')} = \infty$. $\qquad$ [As $g' = 0$]

(vi) Condition of weightlessness can be experienced only when the mass of satellite is negligible so that it does not produce its own gravity.

E.g. Moon is a satellite of earth but due to its own weight it applies gravitational force of attraction on the body placed on its surface and hence weight of the body will not be equal to zero at the surface of the moon.