

Gravitation

Important Information

1. Newton's Law of Gravitation

The magnitude of the gravitational force of attraction between two particles of masses m_1 and m_2 separated by a distance r is given by

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

Where G is called universal gravitational constant.

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

2. The magnitude of the acceleration due to gravity (g) at the surface of the earth is given by

$$g = \frac{GM}{R^2}$$

Where M is the mass of the Earth of radius R

3. The magnitude of the acceleration due to gravity (g^1) at a point at a distance r ($r > R$) from the centre of the earth is given by

$$g^1 = \frac{GM}{r^2} = \frac{GM}{(R+h)^2}$$

Where h = altitude or the height of the point from the surface of the earth.

$$\frac{g^1}{g} = \left(\frac{R}{r}\right)^2 = \left(\frac{R}{R+h}\right)^2$$

4. The critical or orbital velocity (V_C) of a satellite, (moving in a circular orbit of a radius $r = R + h$), is given by

$$V_C = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{R+h}} = \sqrt{\frac{gR^2}{R+h}} = \sqrt{g^1 R+h}$$

If the satellite is orbiting very close to the surface of the earth, i.e. if $h \ll R$, then

$$V_C = \sqrt{\frac{GM}{r}} = \sqrt{gR}$$

The radius of the orbit

$$R+h = \frac{GM}{V_C^2}$$

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