CHAPTER-10

GRAVITATION

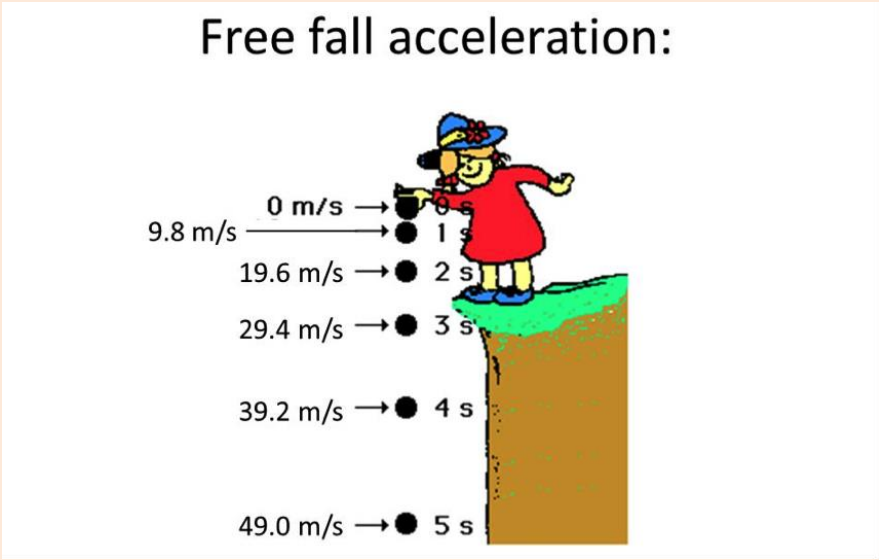
Module-2
Class-IX (PHYSICS)

Free Fall:

Whenever objects fall towards the earth under the force of gravitation, we say that the objects are in free fall.

Is there any change in the velocity of falling objects? There will be a change in the magnitude of the velocity. Any change in velocity involves acceleration. Whenever an object falls towards the earth, 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}.

During the free fall velocity of an object linearly increases with time. It means free fall is an example of Non uniform velocity.



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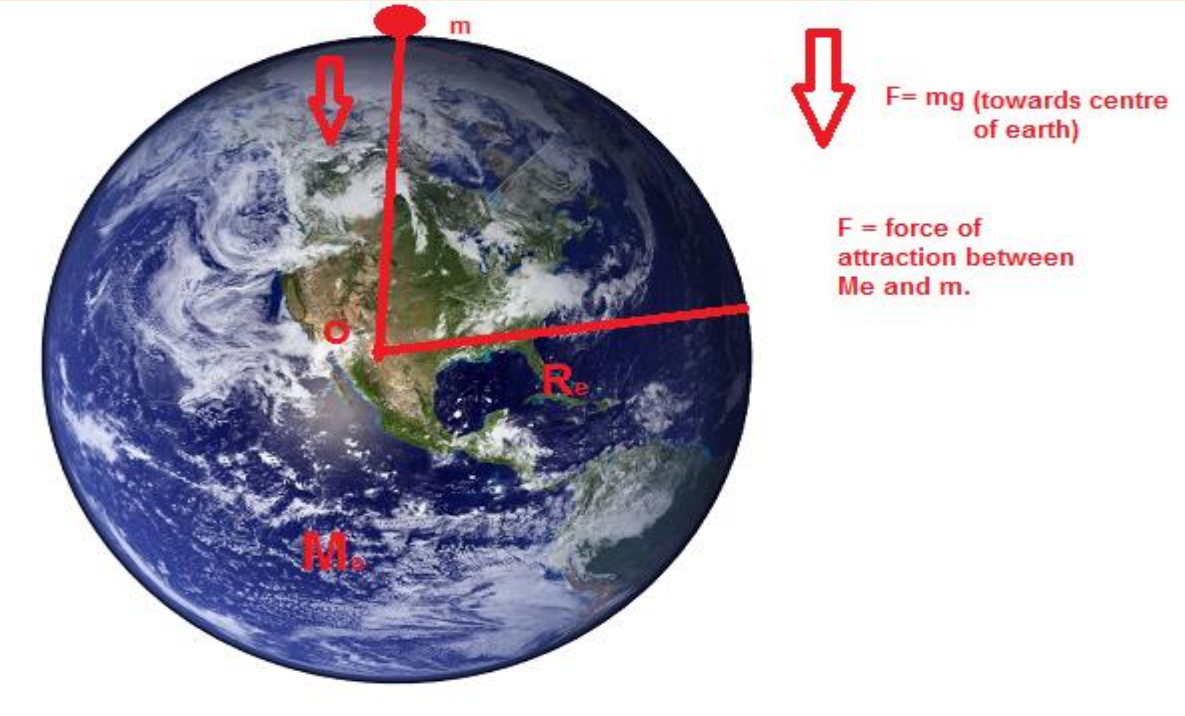
Relation between 'g' and 'G':

Let an small object having placed over the surface of Earth.If mass of small object is 'm' Then according to Newton second law, force acting on the small object mass(m) is given by

F= mg .....(1)

If Mass of the Earth is 'M_e'

And distance between Earth and small object (m) will be equivalent to radius of earth R_e^2



According to Universal law of gravitation

$$F = G\frac{M_e.m}{R_e^{\,2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

From equation one and two,

$$mg = G\frac{M_e.m}{R_e^{\,2}}$$

$$g = \frac{GM_e}{R_e^{\,2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

That is g is inversely proportional to radius of Earth.

Calculation of the value of g:

$G = 6.7 \times 10^{-11}$ N m^2 kg^{-2}, mass of the earth, $M = 6 \times 10^{24}$ kg, and radius of the earth, $R = 6.4 \times 10^6$ m.

$$g = G\frac{M}{R^2}$$

$$= \frac{6.7 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2} \times 6 \times 10^{24}\ \text{kg}}{(6.4 \times 10^6\ \text{m})^2}$$

$$= 9.8\ \text{m s}^{-2}.$$

Thus, the value of acceleration due to gravity of the earth, $g = 9.8$ m s^{-2}.

Difference between ‘g’ and ‘G’ :

Acceleration due to Gravity (g)	Universal Gravitational Constant (G)
An acceleration produced on a freely falling body due to the gravitational force of earth is known as acceleration due to gravity.	Gravitational constant G is numerically equal to the force of gravitation that exists between two bodies of unit mass kept at a unit distance from each other.
Value of g near earth's surface is 9.8 ms^{-2}. It may vary from place to place.	Value of G is 6.67×10^{-11} Nm^2kg^{-2} and it is an universal constant
Depends upon the distance between the masses	Independent of the distance between the masses
SI unit is ms^{-2}	SI unit is Nm^2kg^{-2}

Mass and Weight: Mass is a measure of the number of atom or amount of matter containing in an object. SI unit of Mass is Kg.
While weight is a Force of attraction provided by Earth on unit mass object.

Weight = Mass x Acceleration due to gravity

Or $w = m.g$

SI unit of weight is Newton.