Types of forces

1. Gravitational force: Is an attractive force existing between two objects which have masses
2. Electromagnetic force: Is an attractive force that exists between electrically charged particles that make up atoms and molecules
   i. Normal.
   ii. Tension.
   iii. Compressive forces.
   iv. Frictional forces
3. Weak nuclear force: force responsible for radioactive decay.
4. Strong force: Is the force that exists within a nucleus, it hold protons and neutrons together.

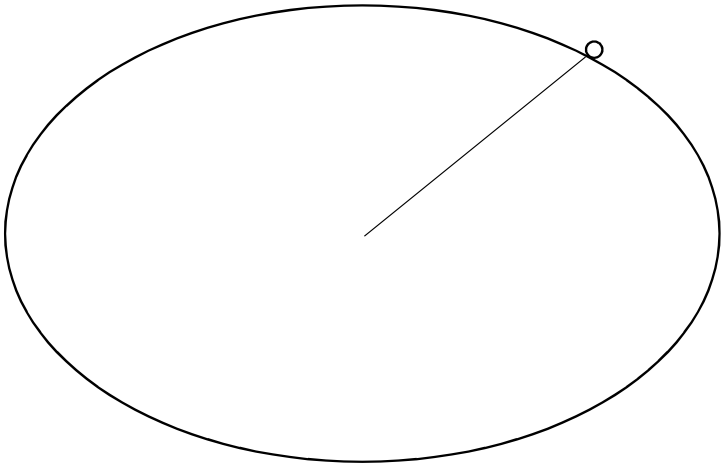
Gravitational force and weight

Every particle in the universe attracts every other particle. The attractive force acting on each of two particles of mass *m*, separated by a distance *r*, is given by

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

where $G = 6.67 \times 10^{-11} Nm^2\, kg^{-2}$ is the **universal gravitational constant**.

By a particle we understand something so small that it may be regarded as a mathematical **point**. Although the above Equation is for **'point' particles**, it can be used with good accuracy when the masses are small compared to the distance separating them. For objects that are not particles, *r* in the above Equation is the **distance between the centres of the objects**.



The gravitational force between the earth and a small object on it is given by

$$F = \frac{GM_Em_2}{R_E^2}$$

where $R_E = 6.38 \times 10^6\ m$

Gravitational force and weight cont.

The weight of an object is the gravitational force the earth exerts on it. The weight always acts downward, towards the centre of the earth. If the mass of an object is *m*, its weight is given by

$$W = \frac{GM_E m}{R_E^2}$$

According to Newton's second law: $W = mg$

$$mg = \frac{GM_E m}{R_E^2}$$

$$g = \frac{GM_E}{R_E^2} = 9.8 \text{ ms}^2$$

This is the gravitational acceleration on earth, it depends on its mass and its radius. The gravitational acceleration on another planet will never be the same as that on earth. It depends on the mass and the radius of that planet.

Example

What is the gravitational acceleration on the planet, whose mass is twice the mass the earth, but its radius is equal to the earth's radius.

Gravitational force and weight cont.

Example 3.2: The mass of the earth

Calculate the mass of the earth given that the radius of the earth is $R_E = 6.38 \times 10^6$ m, g = 9.8 ms^{-2} and G = 6.67×10^{-11} $Nm^2 kg^{-2}$.

Example 3.3: Acceleration due to gravity for a satellite in orbit

Determine the acceleration due to gravity for a satellite in orbit 200 km above the surface of the earth. Use the same data given in Example 3.2.