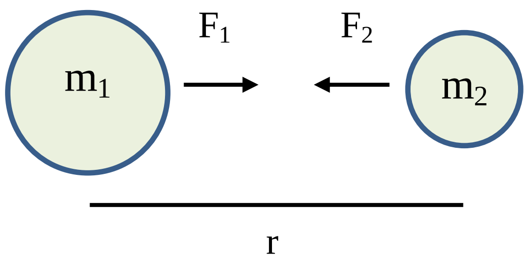
Lecture 5

The Gravitational Force

4.1 The Gravitational Force

Newton's law of the universal gravitation states, "Any two elements of mass in the universe attract each other with a force proportional to their masses and inversely to the square of the distance between them."



Newton's law can be written in a vectorial form as:

$$\vec{g} = -G\frac{m_1 m_2}{r^3}\,\vec{r}$$

where $\vec{g}$ is the attraction of m_1 on m_2 (force of gravitation)

$\vec{r}$ is the position vector from m_1 to m_2

G is the universal gravitational constant = 6.66×10^{-11} Nm^2kg^{-2}

If we assume m_2=1 kg ,

$$\vec{g} = -G\frac{m_1}{r^3}\,\vec{r}$$

If $m_1 = M$ "total mass of Earth is equal to 5.988×10^{24} kg"

The acceleration due to the gravitational force at the surface of Earth (r=a=6378 km):

$$\vec{g}_* = -G\frac{M}{a^2}\,\vec{r}$$

At some altitude Z above the surface of the earth, the acceleration due to the gravitational force is:

$$\vec{g}_* = -G\frac{M}{(a+z)^2}\,\vec{r}$$

$\vec{r}$ is the position vector from the center of Earth to the parcel in the atmosphere.

$\vec{g}_*$ is directed toward the center of Earth.