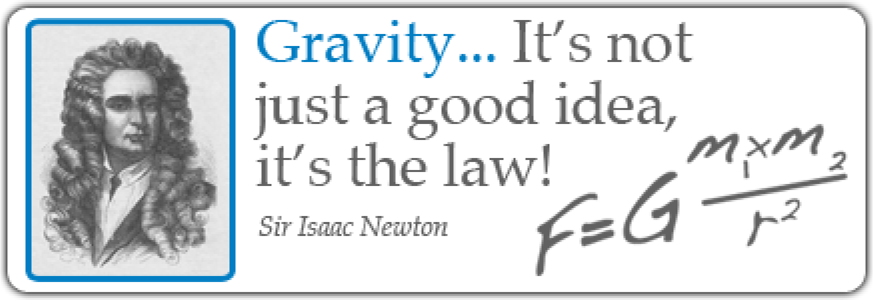
Gravity: The Law



The force of gravity exists between any two masses. Contrary to popular belief, it is the weakest of the four fundamental forces.

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

Where G is the Newton's Universal Gravitational Constant and is equal to $6.67x10^{-11}\frac{Nm^2}{kg^2}$.

For a comparison let's look at the force of gravity from a proton to an electron (think H).

Mass of proton = $1.67x10^{-27}kg$
Mass of electron = $9.11x10^{-31}kg$
Distance of electron orbit in H = $1.0x10^{-10}m$

∴ the F_g keeping the electron in orbit around the proton is:

$$F_g = \frac{(6.67x10^{-11})(1.67x10^{-27})(9.11x10^{-31})}{(1.0x10^{-10})^2}$$

$$= 1.01x10^{-47}N$$

If we compare this the the electric force (next unit!) F_e=8.2x10^{-8}N. This is almost 6 times greater. This is why we disregard gravity when talking about particle physics. However, gravity is cumulative (the more mass you have the greater gravity is) so it is the driving force at a cosmological scale.

Find the F_g on the Earth's surface for a 60kg mass.
m_{Earth}=5.98x10^{24}kg
r_{Earth} =6.38x10^{6}m

F_g= 588N

$F_g = \frac{Gm_1m_2}{r^2}$ if m_1 is you, and all the other stuff is constant, we can just assign that a different variable name. How about g for gravity? $g = \frac{Gm_2}{r^2}$ What does g equal?

This is going to hold true for anywhere on Earth and anywhere near Earth. Even if you went to the International Space Station you would still feel a gravity of roughly 9m/s^2.

$\vec{g}$ is called the Gravitational Field Strength and it is the bending of space time for a mass. A different planet will have a different $\vec{g}$.

Look up the mass of the moon, and the radius of the moon. Find $\vec{g}$ on the moon.

$$\vec{g}_{moon} = 1.62\ \frac{N}{kg}$$

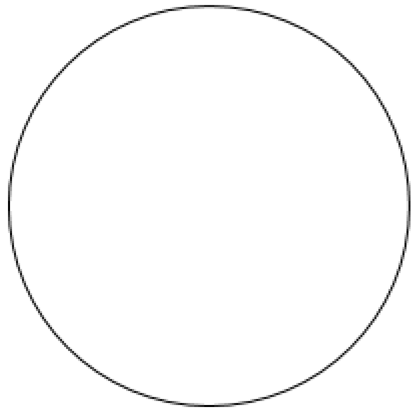
Prove there is only one radial distance from the Earth which allows for *geosynchronous* orbit.

$$F_c = F_g$$

$$4\pi^2 r f^2 = \frac{Gm_1 m_2}{r^2}$$

… solve for period…

When in orbit an object is in free fall towards the center of the Earth. It just has a velocity that is big enough that as it falls towards the center of the Earth, its v_x is large enough that it 'misses'.



This is no different than what happens on the 'vomit comet'.

[Music video by Ok Go in weightless environment.]