Mass & Weight

Mass – **(m)** is the amount of material is an object**. The unit used is kg**. Mass does not change as you move throughout the universe .

Weight – **(F_g)** is the measure of the force of gravity on an object. **The unit is Newtons**. Since gravity varies throughout the universe, so does the weight of an object. Ie: The force of gravity on the moon is 1/6 of that on Earth, so your weight on the moon is 1/6 of that on earth. You lose weight simply by going to the moon!

Newton's Law of Universal Gravitation

In 1665, when he was only 23, Sir Isaac Newton proposed the law of universal gravitation. The legend has it that an apple falling on his head helped! He figured that the moon was constantly falling towards the Earth as it orbited. It was 'falling' because of Earth's gravity. He did some calculations using the known radius of the Earth and distance between Earth and Moon. His calculations were 12% off (percent deviation!) from the known values of the Moon's orbit, so he felt he was incorrect. He later revisited the problem & finally published the (mathematical) Law of Universal Gravitation.

Newton theorized that the force of gravity

varied directly with the mass of each object and

inversely proportional with the square of the distance between them.

Therefore:

$$F_g = \frac{G m_1 m_2}{\Delta d^2}$$

** formula & constant on pg. 68 of text

G = gravitational constant = 6.67×10^{-11} N•m^2/kg^2

Newton's initial thoughts were based on **proportionality**. ie: if the mass of the Earth doubles, then the force of gravity must double. If the distance between 2 objects doubles, then the force of gravity is ¼ of its original value. In order to create an equality, an equal sign (=), a constant value (G) was needed.

Gravitational Field Intensity

If we plot the Force of Gravity (F_g) vs. Mass (kg) we get the 'intensity' of gravity or ($\vec{g}$). **On earth it is on average, 9.8 (N/kg [down]**). ie: The earth pulls down with 9.8 Newtons on every kg of mass. There are some variations in the intensity of gravity. Based on the above formula, if 2 objects move farther apart (Δd), the force of gravity diminishes. Since the earth is 'bulgy' at the equator, gravity is a little less at the equator than at the poles. Also….way on top of Mount Everest, $\vec{g}$ is less.

Applications: **Geology:** Gravimeters can measure very minute changes in gravitational field intensity that occur due to variations in ground composition. Deposits of oil and natural gas decrease gravitational field intensity and gold & silver deposits of increase gravitational field intensity.

Olympics – less $\vec{g}$ means it is easier to break some records. ie: javelin can be thrown farther in Banff, Alberta than Brussells, Belgium!