The Inverse Square Law

Note Title 4/15/2016

In Physics, many formulas act as a function of $\frac{1}{x^2}$ where x is some variable in an equation.
We have seen this in our gravitation equation:

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

The Inverse Square means, for us, that the force of gravity (F_g) is inversely proportional to the square of the distance between 2 objects

When a problem involves changing the distance between two masses, the new F_g is simple to calculate since it only depends on the change in distance.

Example 1 : A 30 kg object at Earth's surface has a force of gravity of 294 N. What is the force of gravity on this object at 3 Earth radii away from the centre of the planet ?

↳ 3 times as far

$$F_g = 294 \text{ N}$$

Yesterday, we would have used :

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

m_2 ↙ mass of Earth

$$= \frac{(6.67 \times 10^{-11})(30)(5.98 \times 10^{24})}{(3 \cdot 6.38 \times 10^{6})^2}$$

↖ radius of Earth

$$= \frac{1.196598 \times 10^{16}}{3.663396 \times 10^{14}}$$

$$= 32.664 \text{ N}$$

$$= \text{33 N or 32.7 N}$$

Today, we will use the Inverse Square Law to find new F_g.

$$F_{g_{new}} = (F_g \text{ at surface})\left(\frac{1}{x^2}\right)$$

$$= (294)\left(\frac{1}{3^2}\right)$$

distance between objects has increased 3 times

$$= 294 \cdot \frac{1}{9}$$

$$= 32.7 \text{ N}$$

Example 2: The force of gravity on a mass is known to be 15,000 N at the Earth's surface. What is the new F_g at a distance of 2 Earth radii away?

$$F_{g\,(new)} = (F_g \text{ at surface})\left(\frac{1}{x^2}\right)$$

$$= (15{,}000)\left(\frac{1}{2^2}\right)$$

← object is twice as far

$$= 15000\left(\frac{1}{4}\right)$$

= 3750 N