Notes - The Inverse Square Law

- 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 two equations so far,

$$F_g = \frac{Gm_1m_2}{d^2} \qquad \text{and} \qquad g = \frac{Gm_{object}}{r^2_{object}}$$

- When a problem involves just changing the distance between two masses the change in Fg or g is simple to calculate because it only depends on change in the distance. The common mistake however is to forget that it depends on the square of the distance.

- A typical example question - A 30 kg object at earth's surface has a force of gravity (F_g) of 294 N [F_g = mg]. What is the force of gravity on this object at 3 earth radii from the center of the planet?

- There are 2 ways to find an answer to this, and we will compare both.

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

look up G (6.67 x 10^{-11} Nm^2/kg^2)

look up mass of earth (5.98 x 10^{24} kg)

look up radius of earth (6.38 x 10^{6} m)

multiply be 3 because you are three radii away

$$F_g = \frac{6.67\times10^{-11} \times 5.98\times10^{24} \times 30}{(19.14 \times 10^6)^2}$$

F_g = 32.7 N

Inverse Square Law

F_g at surface x $(1/3)^2$

because new distance is

3 time the old one.

$$Fg = 294 \times (\frac{1}{3})^2 = 32.7 \text{ N}$$

Which way requires less work?

- Another example - The gravitational field on the sun is known to be 272 N/kg. What is the gravitational field at double this distance?

$g = 272 \times (\frac{1}{2})^2 \quad => \quad \frac{272}{4} = 68\ N/kg$. Or you could look up data on the sun's mass and radius.