UNIVERSAL LAW OF GRAVITATION

- **Every particle in the universe attracts every other particle with a force proportional to the product of their masses and inversely proportional to square of the distance between them.**

$$F_g = G\frac{M_1 M_2}{R^2}$$

F_g = Force of gravity

G = Gravitational constant ($6.67 \times 10^{-11} Nm^2/kg^2$)

M_1 = mass of object 1

M_2 = mass of object 2

R = distance between the *CENTER* of the two masses

What is the force of gravity between a gazelle with a mass of 100 kg and a lion with a mass that is 250 kg if the lion is lying in wait 100 meters from the gazelle?

$$F_g = G\frac{M_1 M_2}{R^2}$$

$$F_g = 6.67*10^{-11}\,\mathrm{Nm^2/kg^2}\,\frac{(100kg)(250kg)}{(100m)^2}$$

$$\boxed{F_g = 1.67*10^{-10}\,\mathrm{N}}$$

- What would happen to the force of gravity between the gazelle and the lion if the distance increased to 200 meters?
- The masses and G have not changed.
- The only change has been to the distance.

$$F_g = (1.67*10^{-10}\,\mathrm{N})/2^2$$

$$\boxed{F_g = 4.18*10^{-11}\,\mathrm{N}}$$

The force of gravity is also known as **WEIGHT** so:

$$mg = G\frac{M_1 M_2}{R^2}$$

You can cancel out one mass from each side of the equation so you have:

$$g = \frac{GM}{R^2}$$

g = acceleration due to gravity m/s^2

M = mass of planet (Kg)

r = radius of planet (m)

Practice

What is the force of gravity between the Earth and the International Space Station (4.19 E 5 kg) when the ISS is 330 km above the Earth's surface?

M_{ISS} = 4.19 E 5 kg

M_{earth} = 5.98 E 24 Kg

R = (3.30 E 5 m + 6.38 E 6 m) = 6.71 E 6 m

Practice

$$F_g = G\frac{M_1 M_2}{R^2}$$

$$F_g = 6.67*10^{-11}\text{Nm}^2/\text{kg}^2\,\frac{(5.98E24kg)(4.19E5kg)}{(6.71E6m)^2}$$

$$F_g = 3.71E6\text{N}$$

Practice

What is the acceleration of gravity on Jupiter's moon Io?

M_{Io} = 8.93 E 22 kg

R = 1.82 E 6 m

$$\text{g} = \frac{\text{GM}}{\text{R}^2}$$

$$g = \frac{6.67E-11Nm^2/kg^2(8.93E22kg)}{(1.82E6m)^2}$$

$$g = 1.80m/s^2$$