Gravitation

The gravitational attraction between two objects depends on their masses and their distance apart.

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

Where: $G = 6.674 \times 10^{-11}\ \frac{N\cdot m^2}{kg^2}$

m_1 and m_2 are masses

r is distance between centres

EXAMPLE: Calculate the force of gravity between two 75 kg students if their centers of mass are 0.95m apart.

$$F_g = 6.674\times10^{-11}\ \frac{N\cdot m^2}{kg^2} \times \frac{75kg \times 75kg}{0.95m^2}$$

$$= 4.15\times10^{-7}$$

EXAMPLE: Calculate the force of gravity between a 1.0 kg mass on the surface of our planet and the Earth. The mass of the Earth is 5.972×10^{24} kg and the radius of the Earth is 6,371 km.

6371000 m

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

$$= \frac{6.674\times10^{-11} \times 1 \times 5.972\times10^{24}}{6371000^2}$$

$$= 9.82$$

$$\approx 9.8\ N$$

EXAMPLE: Two objects have a gravitational attraction of 60.0 N.

What is their gravitational attraction if you double the ~~weight~~ mass of one of the objects?

double = 120 N

What is their gravitation attraction if you double the distance between them?

$$\frac{1}{2^2} = \frac{1}{4} = 15\,N$$

What is their gravitational attraction if you triple the ~~weight~~ mass of one of the objects and triple the distance between them?

3 times mass = $3 \times F_g$

3 times d = $\frac{1}{3^2} = \frac{1}{9} F_g$

$$\frac{3}{9} = \frac{1}{3} = 20\,N$$

EXAMPLE: A 4500 kg Earth satellite has an orbital radius of 8.50×10^7 m from the Earth's center. At what speed does it travel?

$$F_c = F_g$$

$$\frac{v^2 \cancel{m}}{\cancel{r}} = \frac{G \cancel{m_{sat}} m_{Earth}}{r^{\cancel{2}}}$$

$$v = \sqrt{\frac{G m_{Earth}}{r}} = \sqrt{\frac{6.674 \times 10^{-11} \times 5.972 \times 10^{24}}{8.50 \times 10^7}}$$

$= 2165\,m/s$

$= $ ~~[illegible]~~ $2170\,m/s$