Newton's Law of Universal Gravitation

- The force of gravity (F_g) between any two objects is directly proportional to the product of their masses
- F_g is inversely proportional to the square of the distance between the object's centres (inverse square law)

or … $F_g \alpha m_1 m_2$ and $F_g \alpha \frac{1}{r^2}$

so with a constant of proportionality (called the Universal Gravitational Constant, G):

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

This constant was measured experimentally by Henry Cavendish and is now know to be

$$6.67 \times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$$

Gravity

- is always attractive
- acts between every two masses in the known universe
- has infinite range
- is the weakest of the four fundamental forces

1. Neptune has a radius of 2.48×10^7 m and a mass of 1.03×10^{26} kg. What is

a) the gravitational field strength on the surface of Neptune?

b) Iggy's weight on the planet? (his mass is 85 kg)

a) By definition, gravitational field strength ("g") is the force of gravity acting on 1 kg of mass, so …

$$F_g = \frac{Gm_1 m_2}{r^2}$$

$$g = \frac{Gm_1}{r^2}$$ (taking m_2 to be 1 kg)

$$g = \frac{(6.67\times10^{-11})(1.03\times10^{26})}{(2.48\times10^{7})^2}$$

g = 11.2 N/kg

b) $$F_g = \frac{Gm_1 m_2}{r^2}$$

$$F_g = \frac{(6.67\times10^{-11})(1.03\times10^{26})(85)}{(2.48\times10^{7})^2}$$

F_g = 949.5 N

OR $F_g = mg = (85)(11.2)$

= 952 N (the values are equal when rounded off the same way)