Newton's Universal Law of Gravitation

Newton concluded that just as the Earth attracts any mass, any two objects with mass attract each other.

Universal Law of Gravitation:

Any two objects with mass have a gravitational force between them that is directly proportional to the product of the masses and inversely proportional to the distance between their centers squared:

Newton did not know the constant between these proportions, but later Henry Cavendish calculated it using experimental values of the force between lead spheres. He found the constant to be:

$$G = 6.67 \text{ X } 10^{-11} \text{ Nm}^2/\text{kg}^2$$

The force of attraction between any two objects with mass is:

where: m = masses (kg)
r = distance between masses centers (m)
$G = 6.67 \text{ X } 10^{-11} \text{ Nm}^2/\text{kg}^2$
F = force (N)

The force is equal and opposite on both masses.

The force is very small unless one of the objects is very large in mass, such as a planet.

ex.
Find the force between you (70kg) and your book (2kg) when 1.5 m apart.

ex.
Find the force between you (70kg) and the Earth.

This force is really your weight. Find the weight of a 70 kg object.

ex.
If the gravitational force between two masses is 100 N and you double mass one, triple mass two, and double the distance, what is the new force?

ex.
If the gravitational force between two masses is 100 N and you double both masses and cut the distance to one third its original value, what is the new force?