

8

Law of Universal Gravitation

8-1 Gravitational Force

Vocabulary

Law of Universal Gravitation: Every particle attracts every other particle with a force that is proportional to the mass of the particles and inversely proportional to the square of the distance between them.

$$F \propto \frac{mM}{d^2}$$

The sign $\propto$ means “proportional to.” To make an equation out of the above situation, insert a quantity called the **universal constant of gravitation**, G .

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

Now the magnitude of this gravitational force can be represented as

$$\text{Force} = \frac{(\text{universal constant of gravitation})(\text{mass 1})(\text{mass 2})}{(\text{distance})^2}$$

$$\text{or} \quad F = \frac{GmM}{d^2}$$

Like all other forces, the gravitational force of attraction between two objects is measured in newtons.

Solved Examples

Example 1: The gravitational force of attraction between Earth and the sun is $1.6 \times 10^{23} \text{ N}$. What would this force have been if Earth were twice as massive?

Solution: The gravitational force of attraction between two bodies is proportional to the mass of each of the two bodies. As one mass increases, the gravitational force between the two bodies increases proportionally. Therefore, if Earth's mass were doubled, the gravitational force between the sun and Earth would double as well.

Therefore, $F = 2F_o = 2(1.6 \times 10^{23} \text{ N}) = 3.2 \times 10^{23} \text{ N}$

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