

Gravity Force Lab: Basics

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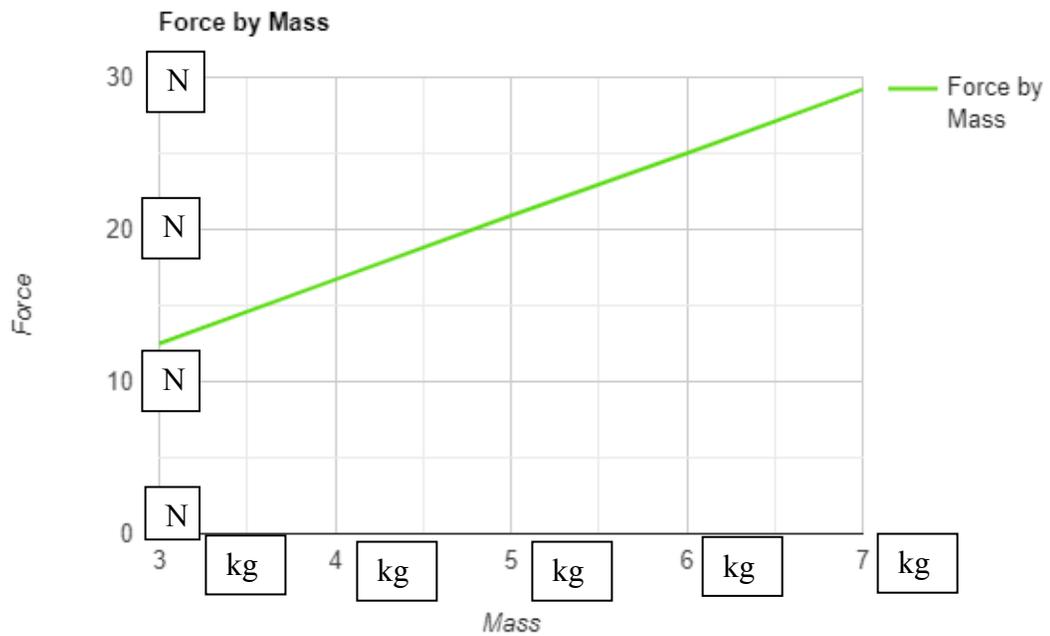
General Physics Lab – PHYS 211 L – 01

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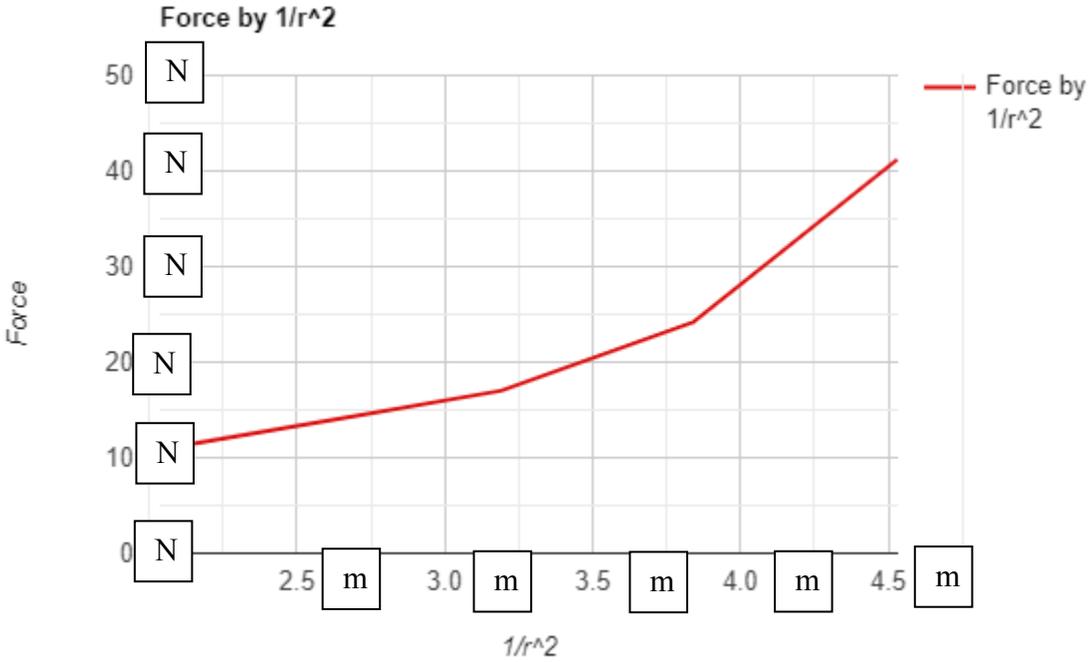
Gravity holds the planets in orbit around the sun and what keeps the Moon in orbit around Earth. The gravitational pull of the Moon pulls the seas towards it, causing the ocean tides. Gravity creates stars and planets by pulling together the material from which they are made. Gravity not only draws on mass but also on a light. English physician and mathematician Isaac Newton discovered the existence of gravity in the 1680s. The theories related to Newton's gravitation were based on the works done by Galileo Galilei in the 16th century. His works began with his desire to uncover the reason why light objects fall slower than heavy items. Newton discovered the relationship between the motion of the Moon and the motion of a body falling freely on Earth. He explained Kepler's laws and established the modern quantitative science of gravitation by his dynamical and gravitational theories. Newton assumed the existence of an attractive force between all massive bodies, one that does not require bodily contact, and that acts at a distance.

## Data Presentation

Force by Mass	
Mass 1 * Mass 2	Force
$3*1 = 3*10^{12}$ kg	12.5 N
$4*1 = 4*10^{12}$ kg	16.7 N
$5*1 = 5*10^{12}$ kg	20.9 N
$6*1 = 6*10^{12}$ kg	25.0 N
$7*1 = 7*10^{12}$ kg	29.2 N



Force by $\frac{1}{r^2}$	
$\frac{1}{r^2}$	Force
$1/7000^2 = 2.04 \cdot 10^{-8} \text{ m}$	10.9 N
$1/6100^2 = 2.69 \cdot 10^{-8} \text{ m}$	14.3 N
$1/5600^2 = 3.19 \cdot 10^{-8} \text{ m}$	17.0 N
$1/5100^2 = 3.84 \cdot 10^{-8} \text{ m}$	20.5 N
$1/4700^2 = 4.35 \cdot 10^{-8} \text{ m}$	24.2 N



Calculations

For this lab, the objective was to find constant G with two different graphs and slopes. A table for Force by Mass was created in the first part, and the virtual lab was utilized. There were five different masses that were used, and each mass gave a force in Newtons.  $R^2$  was constant at 4000m. Once each data point was collected, a line graph was made titled Force by Mass, and the information was plotted. The next step was to find the slope of the chart. The two points used were.

$$\frac{20.9N - 16.7N}{5 \times 10^{12}kg - 4 \times 10^{12}kg} = 4.2 \times 10^{-12}$$

G, slope =  $g/r^2$ . The equation was rearranged, and the slope was multiplied by  $r^2$  to give constant G.  $4.2 \times 10^{-12}(4000m^2) = 6.72 \times 10^{-5} N \cdot m^2/kg^2$ . To validate the constant G, all variables were plugged into the equation  $F = GmM/r^2$  shown in Image 1. For the second part, a table for Force by  $1/r^2$  was created. Instead of changing the mass of the objects, the distance between them was changed with the mass being constant at  $8 \times 10^{12} kg$ . Five different distances were accumulated with the corresponding Force, displayed in the table named Force by  $1/r^2$ . Then a second line graph was created titled Force by  $1/r^2$ . The slope was determined to be  $5.36 \times 10^8$ . Once this was found, it was multiplied by the constant mass  $8 \times 10^{12}$  to give constant G  $6.67 \times 10^{-5}$ . As stated before, to confirm the constant G, all variables were plugged into the equation  $F = GmM/r^2$ , and it was verified shown in Image 1.

$$\frac{(6.72 \times 10^{-5})(3 \times 10^{12}kg)}{(4000m)^2} = 12.6 N$$

~~recorded 12.5 N~~

$$\frac{(6.67 \times 10^{-5})(8 \times 10^{12}kg)}{(7000m)^2} = 10.9 N$$

Image 1

The mass of the two objects is the first factor that affects the amount of gravity that acts on each of the objects. The larger the masses, the more gravitational force each object exerts on the other. The second factor that affects the amount of gravity on each object is the distance between the two objects. The larger the distance, the less gravitational force each object exerts on the other. The mass of most objects is too small to cause a force large enough to move objects toward one another. With two different masses, the force that the smaller mass exerts on the large mass and vice versa is the same. The forces are both the same. The formula for the universal law of gravitation is  $g = \frac{Mm}{d^2}$ . Here,  $g$  is inversely proportional to  $d$ . So, if the distance between the two masses is doubled, the force of attraction will decrease. With the mass being large and continuing to get bigger in size, the gravitational force is constantly getting bigger.

## Conclusion

In conclusion, this experiment was designed to allow the user to gain more knowledge and better understand different ways to find constant  $G$ .  $F=GmM/r^2$  is the equation used for this lab. The gravitational constant is the proportionality constant that is used in the Newton's Law of Gravitation. The force of attraction between any two-unit masses separated by a unit distance is called universal gravitational constant denoted by  $G$  measured in  $Nm^2/kg^2$ . Using the slope from the two different graphs gave a constant  $G$  of  $6.72 \cdot 10^{-5}$  for Force by Mass and  $6.67 \cdot 10^{-5}$  for Force by  $1/r^2$ . The force by Mass constant  $G$  is bigger than the other. When plotting the graph for Force by  $1/r^2$  there could have been a user error since the graph was not a complete straight line. Following the experiment, there is a better understanding of how to solve for constant  $G$  and the different tools that can be utilized.