Lab: Confirm that Newton's Law of Universal Gravitation is an inverse square law

Given: the following data

Average Earth - Moon Distance (m)	Radius of Moon (m)	Radius of Earth (m)	Mass of Earth (kg)	Mass of Moon (kg)	Mass of Sun (kg)	Average Earth -Sun Distance (m)	Radius of the Sun (m)
3.84×10^{6}	1.74×10^{6}	6.38×10^{6}	5.98×10^{24}	7.35×10^{22}	$1.99 \text{ X } 10^{30}$	1.496×10^{11}	6.96×10^{8}

Task: use graphical techniques to confirm that Newton's Law of Universal Gravitation is an inverse square law.

Solution:

Note: The center-to-center distance between the Moon and the Earth is the distance between the two celestial bodies plus their respective radii. i.e.

Gathering and Compiling additional Information:

For The Moon -Earth System

$R_1 = 1.74 \times 10^6 \text{ m} + 6.38 \times 10^6 \text{ m} + 3.84 \times 10^6 \text{ m} = 1.196 \times 10^7 \text{ m}$

For the Sun -Earth System

$R_2 = 1.496 \times 10^{11} \text{ m} + 6.38 \times 10^6 \text{ m} + 6.96 \times 10^8 \text{ m} = 1.50 \times 10^{11} \text{ m}$

Procedure:

Use the Equation for the Law of Universal Gravitation

1. Find the forces for Moon -Earth System
   $F_1 = 2.05 \times 10^{23}$ N
2. Find the forces for the Sun -Earth System
   $F_2 = 3.53 \times 10^{22}$ N
3. Compile the data in a chart and Plot the data on a graph

System	Forces (N)	Distances (R) (m)	Distances-squared $(R)^2$, (m^2)	Product of Masses (kg^2)
Earth-Moon	2.05×10^{37}	1.196×10^{7}	1.430×10^{14}	4.57×10^{47}

Earth-Sun	3.53×10^{22}	1.50×10^{11}	2.25×10^{22}	1.19×10^{55}

Here is the same data and its analysis using spreadsheets

System	Forces (N)	Distances (R) (m)	Distances-squared $(R)^2$, (m^2)	Product of Masses (kg^2)	Inverse Distances-squared $(1/R)^2$, $(1/m^2)$
Earth-Moon	2.05E+37	1.20E+07	1.43E+14	4.57E+47	6.99E-15
Earth-Sun	3.53E+22	1.50E+11	2.25E+22	1.19E+55	4.44E-23

This shows that in the relationship F α $1/R^2$,Force is inversely proportional to the distance squared

To confirm the inverse square relationship we can plot F vs. $1/R^2$

Note: F vs. $1/R^2$ gives us a linear relationship.

Conclusion: the Law of Universal Gravitation is a an inverse square law