Newtons Law of Gravitation Lab

Measure how gravitational force changes with distance

Name _____ Period _____ Date _____

Investigate gravitational force at different separations. Linearize the results and determine the gravitational constant from the graph.

Time 50 minutes • Open buildphysics.com/?experiment=newtons-gravitation

Model and measurements

The source mass is fixed. Use center-to-center separation. Reference G = 6.6743 × 10^{-11} N m²/kg².

$$\Sigma F = ma$$

M is source mass, m is test mass, r is center-to-center distance, and F is gravitational-force magnitude.

Predict before running

If the test mass doubles at the same distance, what happens to its gravitational force and acceleration? Predict and explain.

Part A Compare test masses

1. In Explore this setup, set Central mass to 1.00 (10^{12} kg) and Center-to-center distance to 4.0 m. Test the Moving masses below.
2. Keep the simulation at its starting position. Read Gravitational force and Acceleration directly in Explore this setup; no run is needed.
3. Record force and acceleration for each test mass.

Test mass m (kg)	Force F (N)	Acceleration (m/s²)
1.0		
2.0		
4.0		

A1. Use two trials to compare force and acceleration as test mass changes. Include numerical evidence.

A2. Explain how the test mass can feel a greater gravitational force but have the same acceleration.

Part B Design and collect

Suggested time 16 minutes

Investigation question How does gravitational force depend on center-to-center separation?

Choose at least five separations from 2.0 to 8.0 m, spread across the range. Keep Central mass at 1.00 (10^{12} kg) and Moving mass at 2.0 kg.

B1. Identify the independent and dependent variables.

B2. What will you keep constant? How will you do this?

B3. List your separations. Why is this set useful?

B4. How will you read force at the chosen separation without allowing the test mass to move?

B5. Write a procedure another group could follow.

Record your measurements

Source mass M = 1.00 × 10^{12} kg Test mass m = 2.0 kg

Trial	Distance r (m)	Force F (N)
1		
2		
3		
4		
5		
Extra		

Part C Build and analyze a linear graph

Suggested time 14 minutes

C1. The relationship is $F = \frac{GMm}{r^2}$. Describe how F depends on r when both masses are fixed.

C2. Choose quantities for a straight-line graph. Label the table with your choices and units, and calculate the transformed values.

Trial	_____ Units _____	_____ Units _____
1		
2		
3		
4		
5		
Extra		

C3. Plot your transformed data and draw a best-fit line. Label both axes with quantities and units.



C4. Calculate your line's slope with units. Use it and the masses in kilograms to determine G. Write the fitted equation and interpret the intercept.

Part D Explain and predict

Suggested time 8 minutes

D1. A student claims, “Doubling separation halves gravitational force.” Evaluate this claim using the model and measured values.

D2. Does your graph support the inverse-square model? Compare your graph-based G with the reference value and discuss the intercept.

D3. Choose an unused separation within your measured range. Predict F from your fit before changing the setting. Read F at that separation and compare.

New r (m)	Predicted F (N)	Measured F (N)

Comparison