Universal Gravitation Lab   Name: _____

Purpose: to learn how the distance between objects affects the force of gravity between the objects.

NOTE: Make sure you measure distance from the center of mass m_1 to the center of mass m_2.

Procedure:

1. Open the PhET Gravity Force Lab found here: https://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_en.html.

2. Set up object m_1 and object m_2 to any mass that you want, but once they are set, you cannot change them for the remainder of the lab. Note the values: m_1 = _____, m_2 = _____

3. Set the Force Values to "Scientific Notation". What do you notice about "force on m_1 by m_2" compared to "force on m_2 by m_1", no matter the distance apart?

4. Move the objects around to test 10 different distances apart and record the distance (centre to centre!) and the corresponding force in a table like the one started below

Distance, r (m)	Force, F (N)	

5. Graph your data (F vs r) on graph paper. Is it a straight line? (It should NOT be.) Change one of the variables (square, cube, inverse, ...??) and graph again until you get a straight line (use excel or other for trial and error if you like). Find the slope and write an equation of the straight line that relates force of gravity to the distance between the objects. (y=mx+b)

6. If the formula for the force of gravity is: $F = \frac{Gm_1m_2}{r^2}$ What does the slope of the line represent? Calculate a value for G using your slope and compare the value to 6.67 x 10^{-11}.

Sections to have in your lab:

- Title & Purpose: as given above.
- Procedure, Data, Observations (integrated with each other):
    - A sketch of the PhET lab set up.
    - A brief summary of what you did. (Do NOT re-write the whole procedure!)
    - A data table.
    - Graphs, at least 2, with all the things a good graph should contain. The straight-line graph should have a "line of best fit" – not connect the dots!
    - Answer to question in procedure 3.
    - The equation of the graph. Discussion of slope. Calculation of G.
- Analysis, Conclusion:
    - Summarize _what_ you learned or would have learned if you didn't already know it. Do NOT say that "the lab was fun and you learned lots." Refer to the purpose.
    - Explain the physics involved.
    - No errors in this lab, being online. ☺