

Lab 15-1: Universal Gravitation

- Purpose:**
- To gain a conceptual feel for how mass and distance affect gravitation.
 - To make and interpret graphs of Force vs Mass and Force vs Distance.

Procedure:

Part 1: Getting familiar with the software.

- Start the simulation software "Gravity Force" by doing what your teacher told you to do. If you wish to avoid sarcastic comments, check the board before asking your teacher for help.
- The simulation allows one to measure the gravitational force between two masses. Experiment with the program to see what you can control. What three things are you able to change?
- Why are there so many zeros in the forces?
- How can you measure the distance between the masses?
- How can you reset everything to the original settings?

Part 2: Qualitative investigation.

- What happens to the forces if you make m_1 bigger? How about smaller?
- What happens to the forces if you make m_2 bigger? How about smaller?
- What happens to the forces if you move the masses farther apart? How about closer?
- Why are the two forces on the screen always equal and opposite?

Part 3: Quantitative investigations.

- Reset everything to the original settings. Then change m_2 to 10 kg and record the force.
- Fill out the rest of the data table by continuously adding 10 kg to the red mass and measuring the force. Make sure you don't change anything other than the red mass.
- Reset everything, then repeat the above, but this time change m_1 instead of m_2 .
- Now make both masses 10 kg. Slide the blue mass to the left of the screen. Place the red mass 2 meters away from the blue one and record the force.
- Fill out the rest of the data table by increasing the distance between the masses by 1 meter and recording the resulting force.

Data:

$m_1 = \underline{\hspace{2cm}}$ $d = \underline{\hspace{2cm}}$

$m_2 = \underline{\hspace{2cm}}$ $d = \underline{\hspace{2cm}}$

$m_1 = \underline{\hspace{2cm}}$ $m_2 = \underline{\hspace{2cm}}$

Mass 2 (kg)	Force (N)
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

Mass 1 (kg)	Force (N)
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

Distance (m)	Force (N)
2	
3	
4	
5	
6	
7	
8	
9	
10	

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Graphs: Make the following three graphs from your three sets of data: Force vs Mass 2, Force vs. Mass 1, Force vs. Distance.

Questions:

1. Compare the graphs you made with your answers from Part 2 on the other side. Do the graphs support what you thought was true?
2. How does the gravitaional force between the two masses depend on Mass 2?
3. How does the gravitaional force between the two masses depend on Mass 1?
4. Examine your data carefully - what happens to the gravitational force when you double the distance between the masses?
5. What happens if you triple the distance between the masses?
6. This is hard, but make an attempt at combining all those answers to come up with an expression that describes how the gravitational force between two masses depends on the actual masses and the distance separating them.
7. When you measure the distance between the masses, where exactly are you measuring to on the masses?