CLASS SET DO NOT WRITE ON!!!!!(Please record responses in your science journal)

**Lab: Experimentally Deriving Universal Force of Gravity Equation**

**Pre-Lab Notes:**

In your journal record notes from class discussion to help with this lab activity.

Directly Proportional Inversely Proportional Exponential

**Purpose:**

The purpose of this lab is to experimentally determine the general form of the force of gravity equation by exploring the effects of the mass of objects and the distance between objects has on the force.

**Hypothesis:**

Create a hypothesis on the relationship between Fg (force of gravity) , m (mass) , and r (distance between objects) . If \_\_\_\_\_\_\_\_ Then \_\_\_\_\_\_\_\_\_\_\_, because\_\_\_\_\_\_\_\_\_\_\_\_.

**Materials:**

At least two laptops per lab group (one for running the simulation and one for collecting

 and analyzing data) gravitation PHET simulation (<http://phet.colorado.edu/en/simulation/gravity-force-lab>)

lab notebook

**Procedure:**

Take a moment to try out the simulation. Discuss the questions with your group.

1. What variables can you manipulate and/or measure?
2. a) If you move the masses closer together the force between them becomes (**Greater/Less/the same)**

b) If you move the masses further abpart the force between them becomes **(Greater/Less/the same)**

1. a) Double the mass of m1. When m1 is doubled the force between them becomes **(Greater/Less/the same)**

b) Cut the mass of m2 in half. When the mass is reduced the force between them becomes **(Greater/Less/the same)**

1. What is the relationship between the forces of gravity on each mass? (hint: strength of force? Direction of force?)
2. What physics law explains question 4?

Part 1. An examination of the effect of **Mass 1** on Force of Gravity (Fg)

1. Separate m1 and m2 so that their centers of mass (*black dots*) are 6 meters apart.
2. Set m2 to 30.0 kg and m1 to zero kg (0.01kg is as low as it will go).
3. Collect at least 7 data points by increasing the mass of m1 by intervals. Record you data by creating a table in your notebook like **table 1**. Complete the table using scientific notation for the forces.
4. **Use Microsoft Excel** to create a graph with Force of gravity as your dependent variable (y-axis) and the mass of m1 as your independent variable (x-axis). **Show the teacher your graph before continuing. Sketch the graph in your journal results section after the table.**

Part 2. An examination of the effect of **Mass 2** on Force of Gravity (Fg)

1. Repeat the steps from part 2 but this time leave the mass of m1 at 30.0kg and change mass of m2. Use Table 2 in your journal and sketch the graph.

Part 3 An examination of the effect **DISTANCE** has on the Force of Gravity (Fg)

1. Set both masses to 30.0 kg.
2. Collect 7 data points by changing the distance between the masses. Note: the ruler is movable to allow for easier measuring) **(use Table 3)**
3. **Use Microsoft Excel** to create a graph of Force vs. Distance (F vs. r). sketch this graph in your journal after checking with the teacher.

**Results:**

**Table 1:** Effect of changing Mass 1 on the force of gravity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mass 1** | **Mass 2** | **r (distance)** | **Fg Mass 1** | **Fg Mass 2** |
| **0 kg** | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |

**Graph 1**: Effect of changing Mass 1 on the force of gravity

(sketch your graph from Excel)

**Table 2**: Effect of changing Mass 2 on the force of gravity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mass 2** | **Mass 1** | **r (distance)** | **Fg Mass 1** | **Fg Mass 2** |
| **0 kg** | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |
|  | **30 kg** |  |  |  |

 **Graph 2**: Effect of changing Mass 2 on the force of gravity

(sketch your graph from Excel)

**Table 3**: Effect of changing distance between objects on the force of gravity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **r (distance)** | **Mass 1** | **Mass 2** | **Fg Mass 1** | **Fg Mass 2** |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |
|  | **30 kg** | **30 kg** |  |  |

 **Graph 3**: Effect of changing distance between objects on the force of gravity

(sketch your graph from Excel)

**Conclusion:** (answer each of the following in complete sentences)

1. Does it matter which of the masses you increase? Justify your answer.
2. In words and mathematically: What type of relationship is there between Mass and force of gravity?
3. In words and mathematically: What type of relationship is there between distance and force of gravity?
4. See if you can write out the proportions between Mass 1 (**m1**), Mass 2 (**m2**) distance (**r**) to the Force of gravity (**Fg**).

Fg 

1. Gravitational force is always *attractive/repulsive*.
2. IF a gravitational force exists between two objects, one very massive and one less massive, then the force on the less massive object will be *greater than/equal to/ less than* the force on the more massive object.
3. As the distance between masses decreases, force *increases/decreases*.
4. Complete your conclusion statement:

My hypothesis that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(fill in your hypothesis)\_\_\_\_\_\_\_\_\_\_was supported / not supported because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(justify your conclusion by using your results from the lab)\_\_\_\_\_\_\_\_\_\_\_\_\_\_.