**Discovering Newton’s Law of Universal Gravitation**

Using the Gravity Force Lab simulation at phet.colorado.edu, you will determine Newton’s Law of Universal Gravitation.

**Part 1:**

* Set the mass of person 1 to be 10 kg, and the mass of person 2 to be 10 kg. The two people may be any distance apart. Make note of the force between them. *This is the* ***initial condition***.
* Now, double the mass of person 1, keeping the distance constant, and make note of the force between them.

*How does this compare to the initial condition?*

* Now, set the mass of person 1 to 30 kg, keeping the distance constant, and make note of the force between them.

*How does this value compare to the initial condition?*

* Now, set the mass of person 1 to 40 kg, keeping the distance constant, and make note of the force between them.

*How does this value compare to the initial condition?*

*What does this indicate about the proportionality of person 1 to the force of gravity?*

* Graph the Force of Gravity vs. the Mass of person 1
* Set the mass of person 1 to be 10 kg, and the mass of person 2 to be 20 kg, keeping the distance constant, and make note of the force between them.

*How does this compare to the initial condition?*

* Now, set the mass of person 2 to 30 kg, keeping the distance constant, and make note of the force between them.

*How does this value compare to the initial condition?*

* Now, set the mass of person 2 to 40 kg, keeping the distance constant, and make note of the force between them.

*How does this value compare to the initial condition?*

*What does this indicate about the proportionality of person 2 to the force of gravity?*

* Graph the Force of Gravity vs. the Mass of person 2
* Put person 1 and person 2’s masses into one proportionality.

**Part 2:**

* Set the mass of person 1 to be 10 kg, and the mass of person 2 to be 10 kg. Put their centers of mass (the black dots) to be 1 m apart. Make note of the force between them. *This is the* ***initial condition*** *for part 2.*
* Now, move one of the two masses so that they are now 2 m apart. Make note of the force between them.

*How does this compare to the initial condition?*

* Now, move the other mass so that they are now 3 m apart. Make note of the force between them.

*How does this compare to the initial condition?*

* Finally, move one of the masses another meter so that they are now 4 m apart. Make note of the force between them.

*How does this compare to the initial condition?*

* Graph the Force of Gravity vs. the Distance between the two masses

*What does this indicate about the proportionality of the distance between the centers of mass of the objects to the force of gravity?*

* Based on your force values, how does the force of gravity relate to the distance between the objects involved?

**Part 3:**

* From Parts 1 and 2, you have relationships between the force of gravity, the masses involved, and the distance between the masses. Put all of these together in one proportionality.
* Now, plug in values for force of gravity, mass 1, mass 2, and the distance into the proportion. You should now be finding the proportionality constant, which makes your proportion an equality.
* Write Newton’s Law of Universal Gravitation.

**Questions:**

* What did you notice about the forces between the two masses?
* From where did you measure the distance between the two masses?
* How does the force between two objects change if the distance between them is *halved?*