#### Conceptual Physics POGIL: Universal Gravitational

We have learned about weight as the gravitational force exerted on you by the planet you're standing on, usually the Earth. But gravity is a force exerted by all masses on each other, not just you and the Earth. In this sense, we say that the gravitational force is universal. In this POGIL we will learn about what influences the magnitude of the gravitational force.

#### Newton's Law of Universal Gravitation

All masses in the universe are attracted to each other by a gravitational force: planets, stars, people, doughnuts...everything that has mass. In the diagram below, we see two masses, labeled m<sub>2</sub> and m<sub>2</sub>, separated by a distance d.



The gravitational force between the two masses is always attractive\_just like love.

The magnitude of the gravitational force F between two masses is directly proportional to the product of the masses  $m_2$  and  $m_2$  and inversely proportional to the square of the distance d between the masses. This relationship is summed up by the equation

$$F = G \frac{m_1 m_2}{d^2}.$$

G is a constant of proportionality, called the Universal Gravitational Constant, equal to  $6.67 \times 10^{-13}$  N-m<sup>2</sup>/kg<sup>2</sup>. This equation is known as Newton's Law of Universal Gravitation. It was discovered by the same Newton who gave us our trusty three laws of motion.

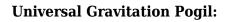
The diagram below shows a 10 kg mass and a 70 kg mass separated by a distance of 1 m.



- (a) On each mass above, draw arrows indicating the direction of the force on each mass.
  - Arrows should be drawn towards the other mass equal in length
- (b) Determine the magnitude of the gravitational force on the 10 kg mass.
  - F = 4.7 x 10-7 N
- (c) Determine the magnitude of the gravitational force on the 70 kg mass.
  - . F = 4.7 x 10-7 N
- (d) Which mass exerts the greater gravitational force on the other? Why is this so?
  - According to Newton's 3<sup>rd</sup> Law, they exert the same force on each other.

# **Universal Gravitation Pogil**

Jiyuan Zhang



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