Name: _____ Date: _____

m_r^β Physics Practice: Gravity, distance, and mass

Given two masses, we have concluded the gravitational attraction force between the masses follows an inverse square law. In other words, given distance d between the masses, the force is proportional to the reciprocal of the squared distance:

$$F \propto \frac{1}{d^2}$$

or equivalently,

$$F = \frac{k}{d^2} \tag{1}$$

for some constant k.

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1. Suppose the two masses involved are m_1 and m_2. How would you modify equation (1) to accommodate the masses? Explain.

2. Suppose

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

where G is the universal gravitational constant, m_1 and m_2 are the masses of two objects, and d is the distance between the two objects.

If force is measured in Newtons, mass in kg, and distance in meters, explain how you can determine the units of G.

3. A person has a mass of 100kg, and is standing at the equator.

a. What do you need to know to use equation (2) to calculate the force Earth exerts on the person?

b. Find the information you need, and calculate the force.

c. Calculate the force using the Newton's 2nd Law. Are your answers similar?

d. Carry out these calculations again, but assuming the person is standing at the South Pole. Are your answers more or less similar?

4. A student notes that equation (2) implies that doubling the mass of one of the objects doubles the force exerted on each object. The student says that this means acceleration of the objects will double. What do you think?

5. The Mir space station orbits at about 400km. An astronaut on the Mir has a mass of 100kg.

a. What force does the astronaut exert on the earth? Assume an earth radius of 6371km.

b. Why do astronauts on the Mir feel weightless?