Name: _____ Period: _____ Date: _____

Mutual Gravitation Practice
Astronomy

Introduction: The equation used to calculate mutual gravitation is shown below.

$$F_{grav} = \frac{G * m_1 * m_2}{d^2}$$

where G represents the universal gravitation constant

$(G = 6.67 \times 10^{-11}\ N \cdot m^2 / kg^2)$

The constant of proportionality (G) in the above equation is known as the universal gravitation constant. The value of G is found to be $G = 6.673 \times 10^{-11}\ N\ m^2/kg^2$

The units on G may seem rather odd; nonetheless they are sensible. When the units on G are substituted into the equation above and multiplied by $m_1 \bullet m_2$ units and divided by d^2 units, the result will be Newtons - the unit of force.

Example: Determine the force of gravitational attraction between the earth ($m = 5.98 \times 10^{24}$ kg) and a 70-kg physics student if the student is standing at sea level, a distance of 6.38×10^6 m from earth's center.

The solution of the problem involves substituting known values of G ($6.673 \times 10^{-11}\ N\ m^2/kg^2$), m_1 (5.98×10^{24} kg), m_2 (70 kg) and d (6.38×10^6 m) into the universal gravitation equation and solving for F_{grav}. The solution is as follows:

$$F_{grav} = \frac{(6.673 \times 10^{-11}\ N\ m^2/kg^2) \cdot (5.98 \times 10^{24}\ kg) \cdot (70\ kg)}{(6.38 \times 10^6\ m)^2}$$

$$F_{grav} = 686\ N$$

Practice:

1. Determine the force of gravitational attraction between the earth ($m = 5.98 \times 10^{24}$ kg) and a 70-kg physics student if the student is in an airplane at 40000 feet above earth's surface. This would place the student a distance of 6.39×10^6 m from earth's center.

2. Determine the force of gravitational attraction between the earth (Info in problem 1) and a 100 kg football player if he is on the surface (info also in problem 1).

3. Determine the force of gravitational attraction between the earth and a ballerina who is 40 kg on the surface of the earth.

4. Determine the force of gravitational attraction between the earth and a 78 kg astronomy student who is in low-height orbit (6.60×10^6 m).

5. Determine the force of gravitational attraction between two 65 kg students who are 1 m apart.

6. Determine the force of gravitational attraction between two 70 kg students who are .2 m apart.

7. Determine the force of gravitational attraction between an 80 kg student and a 1 kg textbook who are 1 m apart.

8. Determine the force of gravitational attraction between a 100 kg adult and the moon (7.34×10^{22} kg). The distance is 1.71×10^6 m.

9. Determine the force of gravitational attraction between a 70 kg student and Jupiter (1.901×10^{27} kg) with a distance of 6.98×10^7m.