Universal Gravitation

Read from **Lesson 3** of the **Circular and Satellite Motion** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/circles/u6l3a.html
http://www.physicsclassroom.com/Class/circles/u6l3b.html
http://www.physicsclassroom.com/Class/circles/u6l3c.html

MOP Connection: Circular Motion and Gravitation: sublevels 6 and 7

1. The evidence that stimulated Newton to propose the law of universal gravitation emerged from a study of ____.
   a. the motion of the moon and other celestial or heavenly bodies
   b. the fall of an apple to the Earth
   c. the gravitational interaction of smaller objects upon the Earth
   d. ...nonsense! There was no evidence; it was just proposed as a theory.

2. The *universal* of Newton's law of universal gravitation is a common source of confusion. The *universal* means that _____.
   a. the amount of gravitational forces is the same for all objects.
   b. the acceleration caused by gravity is the same for all objects.
   c. the force of gravity acts between all objects - not just between the Earth and an object, but also between two people. All objects with mass attract.

3. According to Newton's gravitation law, the force of gravitational attraction between a planet and an object located upon the planet's surface depends upon _____. Choose all that apply.
   a. the radius of the planet b. the mass of the planet
   c. the mass of the object d. the volume of the object
   e. … nonsense! None of these variables affect the force of gravity.

4. The more massive that an object is, the ______ (more, less) that the object will be attracted to Earth.

5. The more massive the Earth is, the ______ (more, less) that another object will be attracted to Earth.

6. The greater that Earth's radius is, the ______ (more, less) that another object will be attracted to Earth.

7. In the mathematical form of Newton's law of universal gravitation (see equation at right), the symbol **G** stands for _____.

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

   a. gravity b. the acceleration of gravity c. the gravitational constant

8. **TRUE** or **FALSE**:

   The value of **G** (in the equation above) is an enormously large number; that explains why (at least in part) the force of gravitational attraction between the Sun and the very distant Earth is such a large number.

9. **TRUE** or **FALSE**:

   Two lab partners attract each other with a gravitational force. However, it is impossible to calculate such a force since it is only an unproven theory.

10. **TRUE** or **FALSE**:

    The notion that any two objects attract each other gravitationally is a theory. There is no empirical evidence for such a notion.

11. Orbiting astronauts on the space shuttle do not have weight in space because _____.
    a. there is no gravity in space b. there is no air resistance in space
    c. there are no scales in space d. the food is terrible and they work all the time
    e. ... nonsense! The astronauts do have weight in space.

12. Use the gravitational force equation to fill in the following table ($G = 6.673 \times 10^{-11}\ N \cdot m^2/kg^2$).

Mass of Object 1 (kg)	Mass of Object 2 (kg)	Distance of Separation* (m)	F_{grav} (N)	Significance of Numbers
60.0	60.0	1.0		Two typical students in physics class
60.0	5.98×10^{24}	6.37×10^{6}		A typical student on the surface of the Earth
60.0	11.96×10^{24}	6.37×10^{6}		A typical student on *an Earth* with twice the mass
60.0	5.98×10^{24}	3.18×10^{6}		A typical student on *an Earth* with half the radius
60.0	5.98×10^{24}	6.47×10^{6}		A *typical* student in orbit 60 miles above the Earth
60.0	1.2×10^{22}	1.15×10^{6}		A *typical* student on the surface of the Pluto
60.0	1.901×10^{27}	6.98×10^{7}		A *typical* student on the "surface" of the Jupiter

*The distance of separation means the distance between the centers of the two masses (NOT the distance between the two objects' edges.)

13. Use the gravitational acceleration equation to fill in the following table ($G = 6.673 \times 10^{-11}\ N \cdot m^2/kg^2$).

Mass of Object Creating the Field (kg)	Distance of Separation* (m)	g (m/s^2)	Significance of Numbers
5.98×10^{24}	6.37×10^{6}		On earth's surface
5.98×10^{24}	6.48×10^{6}		60 miles above earth's surface
5.98×10^{24}	42.3×10^{6}		Above earth's surface in a geosynchronous orbit
1.2×10^{22}	1.15×10^{6}		On Pluto's surface
1.901×10^{27}	6.98×10^{7}		On Jupiter's "surface"

*The distance of separation means the distance between the centers of the two masses (NOT the distance between the two objects' edges.)

Identify the following statements as being **True** or **False**.

______ 14. Astronauts on the space station do not weigh anything.

______ 15. There is no gravity on the space station.

______ 16. There is no gravity anywhere in space.

______ 17. There is no gravity in a vacuum.

______ 18. Orbiting astronauts are not accelerating.

______ 19. If the Earth were not spinning, then there would be insufficient gravity to hold us on its surface.

______ 20. The gravitational acceleration of a free-falling object depends upon its mass.