**Universal Gravitation**

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

 http://www.physicsclassroom.com/class/circles/Lesson-3/Gravity-is-More-Than-a-Name

**MOP Connection:** Universal 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* part 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 \_\_\_\_\_.

**Fgrav =**

**G•m1•m2 d2**

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 x 10-11 N•m2/kg2).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mass of****Object 1 (kg)** | **Mass of****Object 2 (kg)** | **Distance of****Separation\* (m)** | **Fgrav****(N)** | **Significance of Numbers** |
| 60.0 | 60.0 | 1.0 |  | Two typical students inphysics class |
| 60.0 | 5.98x1024 | 6.37x106 |  | A typical student on thesurface of the Earth |
| 60.0 | 11.96x1024 | 6.37x106 |  | A typical student on *an Earth*with twice the mass |
| 60.0 | 5.98x1024 | 3.18x106 |  | A typical student on *an Earth*with half the radius |
| 60.0 | 5.98x1024 | 6.47x106 |  | A *typical* student in orbit 60miles above the Earth |
| 60.0 | 1.2x1022 | 1.15x106 |  | A *typical* student on thesurface of the Pluto |
| 60.0 | 1.901x1027 | 6.98x107 |  | 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 information about free fall acceleration for other planets to fill in the missing information in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| Mass of object (kg) | Location of object | Gravitational Accel. (m/s2) \*\**fill in from notes* | Grav. Force, Fg (N) |
|  | Earth |  | 725.9  |
| 25  |  |  | 280  |
| 12,342  | Mars |  |  |
|  |  | 24.79 | 1363.5 |

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

|  |  |  |
| --- | --- | --- |
|   | 14. | A person in an elevator with the cable cue does not weigh anything. |
|   | 15. | The terminal velocity of an object depends solely on its mass.  |
|   | 16. | If you were to visit the moon, you would feel lighter because you have less mass. |
|   | 17. | There is no gravity in a vacuum. |
|   | 18. | If the distance between two objects doubles, then gravitational *decreases* by a factor 4.  |
|   | 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. |

