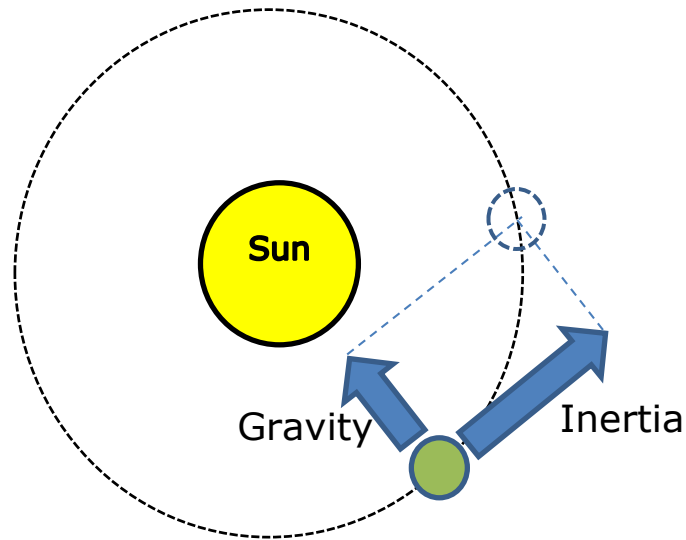


## **STAAR Science Tutorial 33** **TEK 6.11B: Gravity**

***TEK 6.11B: Understand that gravity is the force that governs the motion of our solar system.***

- **Gravity** is a long-range force of attraction that acts between any two objects with mass. Unlike the electromagnetic force, gravity does not have an opposite “anti-gravity” force of repulsion. The force of gravity is only attractive.
- Gravity was first described in mathematical terms by Isaac Newton in his Law of Universal Gravitation. This law states that “every mass in the universe attracts every other mass with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.”
- In practice, the actual attractive force of gravity between two objects depends on their combined mass, but decreases rapidly with distance. Only very large (planet sized or above) objects can create a significant gravitational force at any distance. While two dust particles floating in space should have some gravitational attractive force, the combined mass of the particles would be so small that the attraction would not be measureable, unless they were very close to one another. On the other hand, galaxies can attract one another gravitationally, even though separated by millions of light years.
- It is gravity that makes objects fall towards the Earth. On Earth, **acceleration due to gravity** is a constant:  $9.8 \text{ m/s}^2$ . What this means is that an object falling freely in a vacuum (where there is no air resistance) will accelerate by 9.8 meters per second for every second that it falls. Of course, on the surface of Earth there is an atmosphere, so the acceleration is slowed somewhat by air resistance. The so called “terminal velocity” is the maximum speed that a body of a certain shape can fall through the atmosphere (at a certain elevation above sea level), because the downward pull of gravity is balanced by the resisting force of air resistance, stopping any further acceleration.
- It is gravity that causes tides on Earth. See *Tutorial 29: Tides* for a further discussion of how the Moon’s and the Sun’s gravity causes tides.
- In a sense, it is gravity that allows the Sun to exist. The force of gravity compressing the great mass of the Sun created the initial heat of 10 to 15 million degrees Celsius that was necessary to start the Sun’s fusion process. It is gravity that holds the Sun together against the outward force of fusion.
- It is gravity that caused the formation of our solar system, including the Sun, and its planets and moons. The Sun and the solar system were formed from an inwardly revolving disk of gas that was compressed by gravity into the Sun, planets and their moons. This revolution still exists today in the orbits of the planets and moons, and the rotation of the Sun, planets and moons.
- If gravity were the only force acting between the planets and the Sun (or between the Moon and the Earth), the planets would simply fall directly towards the Sun.

Another force, **inertia**, keeps the planets orbiting the Sun, and moons orbiting their planets. Inertia (from Newton's 1<sup>st</sup> Law of Motion, stating that an object in motion stays in motion) is the forward motion of the planets left-over from their creation.



- As the Earth orbits around the Sun, it is constantly falling towards the Sun because of gravity, but also constantly moving forward because of inertia. When these two motions are added together, second by second, over and over again, the resulting motion is the nearly circular orbit of the Earth around the Sun.

### **Practice Questions**

1. \_\_\_\_\_ is the long range force of attraction between any two objects with mass.
2. The Law of Universal Gravitation was first described mathematically by \_\_\_\_\_.
3. The force of gravity between two objects is directly proportional to the product of the objects' \_\_\_\_\_ and inversely proportional to the square of the \_\_\_\_\_ between the objects.
4. On Earth, acceleration due to gravity is \_\_\_\_\_ m/s<sup>2</sup>.
5. \_\_\_\_\_ on Earth is caused by the \_\_\_\_\_ and \_\_\_\_\_ gravity acting on the oceans.
6. \_\_\_\_\_ caused our solar system to form by pulling together gases and dust in a nebula.
7. The Earth orbits the Sun because of the competing forces of \_\_\_\_\_ and \_\_\_\_\_.