#20

Can't Touch This! (Non-Contact Forces)

To continue our focus on the types of forces, we will now discuss non-contact forces. Non-contact forces act on objects at a distance and DO NOT require physical contact to affect them. The name makes sense! A non-contact force is invisible and can seem quite mysterious or magical, much like the fictional force in Star Wars. However, we know it is not really magic, it is the perfect design of how God made everything in our Universe work together and non-contact forces are extremely important in that Design.

In more advanced physics classes you will learn that there are four fundamental forces called the strong force, the weak force, the electromagnetic force (a combination of magnetic force and electrostatic force), and the gravitational force. We are going to keep it more simple for this class and just focus on **gravitational force.**

You've probably heard the phrase, "What goes up, must come down!" You experience this truth everyday. You know, with confidence, that if you jump into the air, you will come back down. You know, with confidence, that if you throw a ball high into the air, it will come back down. You know, with confidence, that if you are at the top of a steep hill with your bike and you push off with your foot towards the edge, you will roll down to the bottom of the hill. So, why are you so confident? You have been an observer of the force of gravity at work since you were a baby! If the primary job of a scientist is observation, as you learned last semester, then all children are natural scientists! Children are constant observers and then like to ask the question "Why?" with the things they observe. I take the time to remind you of this because of the three fathers of physics that we are learning about. They observed. Then they questioned. And those questions led to great discoveries! Albert Einstein said that "the important thing is to not stop questioning, curiosity has its own reason for existing." I just love that thought! God created us and made us curious for a reason.

Sir Isaac Newton was a very talented observer as you have learned. The legend is that he was sitting under an apple tree and an apple fell down on his head. It made him question why when anything falls, it falls down to the earth. He was observing gravity at work. **Gravity is a force of attraction between objects that have mass.** You might be surprised to know that this means that every object in the Universe attracts every other object. There is an attraction happening right now, because of gravity, between you and the paper or computer you are holding to read this lesson. Its just not a force you can feel because gravity is the weakest of all the fundamental forces by far. That might also surprise you but is very true. This brings us back to Newton and his falling apple… Newton's observations and questions about falling objects led to his discovery of another law, the **law of universal gravitation**! This law has to do with mass and distance. The strength of the gravitational force depends on both the mass of the objects and the distance between them. The greater the mass of the objects, the stronger the gravitational force. The greater the distance between the two objects, the weaker the gravitational force, and vice versa. However, there is another surprising truth that you need to know. There is no such thing as zero gravity!

There will always be some attraction of gravity between two objects, but in a place like space, it is so weak that you feel as if you are weightless. If you remember from last semester, weight is actually the pull of gravity on an object's mass.

So, if gravity is such a weak force, why do we not float into space and why does gravity keep the Earth, moon, and other planets in their orbits? It goes back to Newton's law of universal gravitation, the mass of the objects and the distance between them. We are minuscule compared to the mass of the earth, as is everything else on the earth. We are held down by the earth's gravitational pull. It has a strong pull on everything because it is so much bigger. And it is important to note that gravity does not actually pull DOWN, it pulls us TOWARDS the earth. We are pulled towards earth's center of gravity, which is its core. If we had enough distance from earth's center of gravity it would not have the same effect to pull us towards it. The planets, the moon, and most everything else in space has a much bigger mass than anything on earth. We will learn more about this next year when we study astronomy but I want you to understand now that the planets, their moons, the sun, and everything else in our solar system has the PERFECT mass and are the EXACT distance from each other to keep a perfectly balanced system of gravitational forces that keeps our Universe moving, in orbit, without colliding into each other! Now, that took a talented Designer!

There is another famous scientist, and a father of physics, that studied gravity named Galileo Galilei. Like Newton, Galileo is known for many scientific contributions. What is interesting is that Galileo died the year that Newton was born and Newton studied the works of Galileo and used them to develop his ideas on motion and gravity. Galileo was even put in jail for one of his scientific observations saying that the planets revolve around the sun, instead of the earth because it went against the ideas of a very popular philosopher named Aristotle.

Galileo was Italian and was born in Pisa, Italy. Pisa is known for its famous leaning tower. Galileo conducted an experiment from the top of the leaning tower of Pisa to see if Aristotle, was correct that heavier objects fall faster than lighter objects. Did Galileo have it out for Aristotle? Not necessarily. It wasn't a personal thing against Aristotle. Galileo was able to observe things that Aristotle wasn't and he tested his theories and found that many long-held beliefs were not necessarily true. Galileo believed that all objects fell at the same rate and after his Pisa experiment, he found that he was right! Gravity accelerates all objects at the same rate. You saw this in our class demonstration of the two water bottles. One was full and the other only half full. The two water bottles had different masses, but you saw that both bottles hit the floor at the same time. Gravity pulled them down at the same time.

But a feather does not hit the ground at the same time as a bowling ball when dropped from the same height. No, but if they were in a vacuum chamber they would! What causes some objects to fall at a different rate is due to air resistance or drag. **Air resistance** is the contact, frictional force that air exerts against a moving object. As an object moves, **air resistance** slows it down. The faster the object's motion, the greater the **air resistance** exerted against it. Without air resistance, you would always observe that all objects would hit the ground at the exact same time. A vacuum chamber proves this.

Through the last several lessons you have definitely learned the way of God's many forces and how it affects motion in our Universe. Now we will get to work exploring more about energy!