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### **Galileo's Leaning Tower Experiment:**

*Do the results of Galileo's experiment make sense?*

Yes, they do.



It's true that gravity pulls on the more massive object with more force than it pulls on the less massive one. (We know this because the more massive object is heavier and harder to lift.) But the less massive object is easier to pull than the more massive one. It doesn't *need* as much force to make it move. So things balance out, and both objects fall at the same speed.

Galileo explained how things fell, but he couldn't explain *why* they should fall at all. The answer to that question came from the British mathematician Sir Isaac Newton, who was born in England in the year 1643, the same year that Galileo died.

According to his *Theory of Universal Gravitation*, every object in the universe exerts a gravitational pull—or force—on every other object. The size of the pull (force) depends on how massive the object is and how far away it is. More massive objects pull harder than less massive ones. And closer objects pull harder than those farther away.

You exert a gravitational force on all the objects around you, but that force is weak, since you aren't very massive. But with something really massive like the Earth, the gravitational pull is much, much stronger.

It is the sun's gravitational pull that holds the earth in its orbit around the sun. And it's the earth's gravitational pull that keeps the moon circling around the earth instead of flying off into space. The moon also pulls on the earth; this is what causes the tides to rise and fall as the moon passes over the ocean water.

### ***Afterword:***

*At the end of the story, Massimo wants to learn more about gravity. Let's look at some of his questions.*

*How fast do things fall? Do they keep getting faster?*

Galileo guessed that falling objects speed up (keep going faster and faster) on their way down. But falling objects move quickly, and the clocks in

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Galileo's day were not precise enough to measure very short times. So, in order to test his idea, Galileo had to slow things down.

He did this by letting balls roll down a ramp instead of dropping them and letting them fall. He measured the speed of the balls as they traveled down the ramp, and he found that the closer a ball got to the bottom of the ramp, the faster it went. (This change in speed is called *acceleration*.) And it didn't matter how heavy the ball was. Whatever it weighed, it always sped up (accelerated) at the same rate.

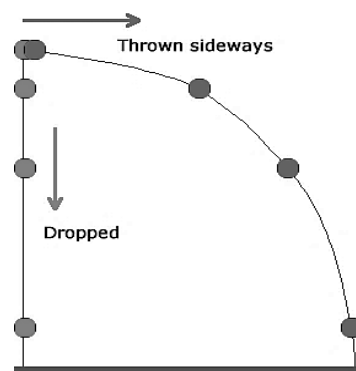
We now know that *all* falling objects speed up (accelerate) at a rate of about 10 meters per second. This means that one second after Galileo dropped the balls, they were falling at a speed of 10 meters per second. A second later, they were falling at 20 meters per second. And another second after that, they were falling at 30 meters per second.

The Tower of Pisa is about 60 meters tall. It would have taken the balls slightly more than 3 seconds to reach the bottom. At the end of those 3 seconds they would have been traveling at over 70 mph.

### What happens when you throw a ball into the air?

Suppose you throw a ball straight up into the air. What happens? It moves up for a while; then it stops for an instant and drops back down. It went up because the force of your push was stronger than the pull of gravity. But you stopped pushing when the ball left your hand. Once the ball was in the air, there was no longer anything forcing it upward. Gravity, on the other hand, never stopped pulling it downward.

What if you throw the ball sideways (horizontally)? What happens then? The ball wants to keep moving in the direction you threw it, but at the same time gravity is pulling it down. The result is that the ball moves along a curved path—it is moving both in the direction it was thrown and downward. It will reach the ground at the same time as a ball which was dropped from the same height.



### Vocabulary:

Force   Gravity   Orbit   Speed   Accelerate   Horizontal

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**Isaac Newton** *Video:*

<https://learnenglishkids.britishcouncil.org/en/short-stories/isaac-newton>



1. When he was a boy, Newton invented a windmill.  
What did it do?
2. According to legend, what caused Newton to start thinking about gravity?
3. Besides pulling things toward the earth, what else does gravity do?
4. What important discovery did Newton make about light?
5. Why do you think that Newton was buried in Westminster Abbey along with English kings and queens?