Forever Falling

Overview: If I toss a ball horizontally at the exact same instant that I drop another one from my other hand, which one reaches the ground first?

What to Learn: Gravity accelerates all things equally and objects near the Earth fall to the ground unless something holds them up.

Materials

- rulers or paint sticks (2, anything wide and flat)
- coins or poker chips (2)
- sharp eye and ear
- partner

Lab Time

1. Place one of the rulers flat so that it is diagonal across the edge of a table with half the ruler on the table and half sticking off.
2. Place one coin on the table, just in front of the ruler and just behind the edge of the table. Place the other coin on the ruler on the side that's hanging off the table.
3. Put your finger right in the middle of the ruler on the table so that you are holding it in such a way that it can spin a bit under your finger. Now, with the other ruler you are going to smack the end of the first ruler so that the first ruler pushes the coin off the desk and the coin that's resting on the ruler falls to the ground.
4. Now, before you smack the ruler, make a prediction. Will the coin that falls straight down or the coin that is flying forward hit the ground first?
5. Try it. Do the test and look and listen carefully to what happens. It's almost better to use your ears here than your eyes. Do it a couple of times in order to confirm your findings.

Forever Falling Data Table

Coin A	Coin B	What did you observe?

Reading

Did you read the first sentence at the top of this lab? What do you think will happen?

The balls will hit the ground at the exact SAME time.

Is that odd or what?

Gravity doesn't care if something is moving horizontally or not. Everything falls toward the center of the Earth at the same rate.

Let me give you a better example: A bullet fired parallel to the ground from a gun and a bullet dropped from the same height at the same time will both hit the ground at the same time, even though the one fired lands a mile away! It seems incredible, but it's true.

Gravity doesn't care what size something is or whether or not it is moving, Gravity treats all things equally and accelerates them the same.

Notice that I say gravity accelerates all things equally, not gravity *pulls* on all things equally. Gravity does pull harder on some things than on other things. This is why I weigh more than a dog. I am made of more stuff (I have more atoms) than the average dog, so gravity pulls on me more.

Weight is nothing more than a measure of how much gravity is pulling on you. This is why you can be "weightless" on a scale in space. You are still made of stuff, but there's a balance of the gravity that is pulling on you and the outward force due to the acceleration since you're moving in a circle (which you do in order to remain in orbit), so it looks like you have no weight.

The larger a body is, the more gravitational pull or the larger a gravitational field it will have.

The Moon has a fairly small gravitational field (if you weighed 100 pounds on Earth, you'd only be 17 pounds on the Moon), the Earth's field is fairly large and the Sun has a HUGE gravitational field (if you weighed 100 pounds on Earth, you'd weigh 2,500 pounds on the sun!).

As a matter of fact, both the dog and I both have gravitational fields! Since we are both bodies of mass ,we have a gravitational field which will pull things towards us. All bodies have a gravitational field. However, my mass is sooooo small that the gravitational field I have is miniscule. Something has to be very massive before it has a gravitational field that noticeably attracts another body.

So what's the measurement for how much stuff you're made of? Mass. Mass is basically a weightless measure of how much matter makes you, you. A hamster is made of a fairly small amount of stuff so she has a small mass. I am made of more stuff, so my mass is greater than the hamster's. Your house is made of even more stuff so its mass is greater still.

So, here's a question. If you are "weightless" in space, do you still have mass? Yes, the amount of stuff you're made of is the same on Earth as it is in your space ship. Mass does not change, but since weight is a measure of how much gravity is pulling on you, weight will change.

Did you notice that I put weightless in quotation marks? Wonder why?

Weightlessness is a myth! Believe it or not, one is never weightless. A person can be pretty close to weightless in very deep space but the astronauts in a space ship actually do have a bit of weight.

Think about it for a second. If a space ship is orbiting the Earth, what is it doing? It's constantly falling! If it wasn't moving forward at tens of thousands of miles an hour it would hit the Earth. It's moving fast enough to fall around the curvature of the Earth as it falls but, indeed, it's falling as the Earth's gravity is pulling it to us.

Otherwise the ship would float out to space. So what is the astronaut doing? She's falling, too! The astronaut and the space ship are both falling to the Earth at the same rate of speed and so the astronaut feels weightless in space. If you were in an elevator and the cable snapped, you and the elevator would fall to the Earth at the same rate of speed. You'd feel weightless! (Don't try this at home!)

Exercises Answer the questions below:

1. True or false? Gravity pulls on all things equally.

2. True or false? Gravity accelerates all things equally.

3. In your *own* words, why do the coins hit the ground at the same time? Is this what you'd expect to happen on Mars?

Answers to Exercises: Forever Falling

1. True or false? Gravity pulls on all things equally. (False!)
2. True or false? Gravity accelerates all things equally. (True!)
3. In your *own* words, why do the coins hit the ground at the same time? Is this what you'd expect to happen on Mars? (Yes!)