Grade 5
Unit: Spaceship Earth
Mystery 1: "How fast does the Earth spin?"

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! I've got a question for you: have you ever been on a train? Well, I want you to imagine that you're boarding one. You find a seat, maybe start taking a little nap. And then, at some point, you wake up and look out the window and see this other train on the track next to you just zipping past. It's going 70, maybe 80 miles an hour. You think, wow, that train is moving really fast. But then you realize — wait a second, maybe that train is standing still and *your* train is the one that's actually moving. Whoa. Now, it seems like it should be easy to know when one thing is moving and the other thing is standing still. But, as this train example shows, there are times when it's not easy. Here's a similar example — this time, something that happens every day. Every morning, the Sun rises in the east and follows this arc across the sky. Then, in the evening, it sets in the west. It's the sun's daily pattern. Now, is the Sun actually moving as it does this, or are you moving and the Sun is standing still? I know, I know — you might think you already know the answer to this question. It's the Earth that moves, right? You've probably read in a textbook or heard your teacher say the Earth spins, or rotates, around its axis once each day, making the Sun appear to move across the sky. The Sun isn't actually moving. But don't just assume something is true just because someone told you so. Really think about this for yourself. I mean, think about what a strange idea that really is. After all, if the Earth is moving, wouldn't we be able to feel that? For most of history we've assumed just the opposite: that the reason it looks like the Sun is moving across the sky each day is because maybe the Sun actually *is* moving. That's way easier to assume. It looks like it's moving. How do we know that the Earth is moving and not the sun? What do you think?

EXPLORATION VIDEO 2

A long time ago, back in ancient times, when people saw the Sun moving across the sky, everyone would have told you, "That's because the Sun is actually moving." For example, the ancient Greeks assumed that the Sun was going in a circle around the Earth once each day, like you see in this diagram. We could call this the "Sun moving idea.” People accepted this idea for thousands of years. But then, around the 1400s and the 1500s, two early scientists by the names of Copernicus and Galileo came along and said that they figured out some reasons for thinking that the Earth is what's moving, not the Sun. These were some of the first people who came up with this idea, that the Earth spins once each day around an imaginary pole, the Earth's axis, and that the Sun stays completely still. We could call this the "Earth spinning idea", or scientists today call it the Earth's rotation. At the time, many people disagreed with them. After all, it doesn't feel like the Earth is moving. They started a big debate. Both ideas definitely would explain why the Sun appears to move across the sky. So how do we know which of these ideas is true? How did we figure this out? Well, almost no one agreed with these scientists at the time, only a handful of people. And you can kind of understand, right? I mean, to those people, it seemed like such a weird idea, to look at this and say that the Sun isn't moving. People would say to Copernicus, and Galileo, "Look at it, it looks like the Sun is moving. "And besides, if the Earth were moving, "wouldn't we notice that here on the ground." But remember the train example. It's not always easy to tell when something's moving, even when you're on it.

Copernicus and Galileo had collected a lot of evidence, and done a lot of thinking to figure out, that the Earth moves. The details, if you're curious, involve part of science called physics, and also some high school level math called trigonometry. But today, since we're living in the 21st century, there's a much easier way to prove that the Earth is what's moving and not the Sun. And that's to get off the Earth to go into space. If we were to get far enough away from the Earth, we should be able to actually see the Earth spinning. And we've done that. This is a robotic spacecraft launched by NASA back in 1995. In fact, they even named it Galileo after the famous scientist. it was sent to study the planet Jupiter. But just a few hours after it launched from Earth, NASA turned its cameras back towards the Earth and had to take this video, which we've shown sped up. You can see the Earth rotating. If you look closely there, you might even notice the continent of Australia go by. Here are a few recent snapshots taken by a NASA spacecraft. This one beyond the orbit of the moon. You can notice the moon moving by in each image. But behind it, you can clearly see that's the Earth spinning. So there you have it, video proof that the Earth spins. By going up into space and looking back at the Earth, we can see direct evidence that the Earth is moving, not the Sun. Galileo and Copernicus would be proud. Just like the train example, we may not feel the Earth spinning, because it's moving so smoothly. Still, in order for the entire Earth to do one complete spin in a day, that must mean the Earth is moving pretty fast. How fast exactly do you think the Earth is spinning? What do you think?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to be a human model of the Earth. You'll spin around and model what the Earth looks like while it's rotating. You and a partner will make some observations to understand how this spinning explains why it looks like the Sun is rising and setting. But you'll also discover that the speed of the spin affects how many hours are in a day. I'll show you how to get started, step by step.

ACTIVITY STEP 1

Find a partner. If you're working alone, that's okay too. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

You'll need to get these supplies.

ACTIVITY STEP 3

You and a partner are going to color the Sun yellow. This will help you notice the Sun as you spin during the activity. Now, you don't need to spend too long on this, so I'll start a timer for one minute in case that's helpful. Go ahead and get started now. Okay, it's been one minute. Go to the next step when you're ready.

ACTIVITY STEP 4

Cut along the dotted lines on both of your maps, like this. You'll have two strips of leftover paper, which you'll use in a moment. But for now, put these strips of paper to the side.

ACTIVITY STEP 5

Okay, place your two maps next to one another so that it looks like a complete map of the Earth. Looking at these maps, locate where you live. Then, use your crayon to color in a circle that marks your location. The circle should be pretty big, about the size of your thumb. I'm marking over here in the United States, since I live in California.

ACTIVITY STEP 6

Okay, let's also find the location that's on the other side of the world from where you live. Place the map with the colored circle underneath the other map. Hold both of them up to the light and locate the circle. Keep track of where it is by placing your finger on that spot. Then use your crayon to color in another circle about the same size as the one on the other page, like this.

ACTIVITY STEP 7

Okay, turn the two maps like this, with the arrows facing one another. Then move the pages apart from each other, like this. Take one of those paper strips you cut earlier and line up the ends to cover the two boxes labeled "A," like this. Connect those ends with stickers. Then, repeat this on the boxes labeled "B" with the other paper strip.

ACTIVITY STEP 8

Okay, pick up the maps, like this, and hold them up so that your location is facing forward. Gently put the maps over your head, like this. If you look down, you should be able to see where you live. Now you're the Earth.

ACTIVITY STEP 9

Find a space behind a desk or table where you and your partner can spin in place. Try keeping an arm's length between the two of you so that there's enough room for both of you. But don't start spinning yet. Once you've done this, go to the next step.

ACTIVITY STEP 10

All right, before you start spinning, put the Sun model on the desk between you and your partner. Each of you should make sure that you're now turned to face the Sun. Then, discuss this question with your partner.

ACTIVITY STEP 11

Both of you slowly spin to the left until your back is towards the Sun. Because you're pretending to rotate like the Earth on its axis, you want to make sure that you just move your feet. Don't turn your head. Then, discuss this question.

ACTIVITY STEP 12

Now that you know how to spin like the Earth, here's your first challenge. Slowly spin to show your partner what it would look like for three days on Earth to go by. Make sure you take turns.

ACTIVITY STEP 13

Discuss these questions.

ACTIVITY STEP 14

Now for your second challenge. Model how the Earth spins when the Sun rises where you live.

ACTIVITY STEP 15

Here's what we did to model sunrise. Start where you can't see the Sun model. It's night for you when you stand like this. Then, slowly spin to the left until you can just see the Sun. When the Sun starts to come into view, that's sunrise.

ACTIVITY STEP 16

Okay, for your third challenge, once again, model a sunrise where you live. But this time, think about this: what do you think people on the opposite side of the world are seeing? Discuss this with your partner.

ACTIVITY STEP 17

Here's what we noticed. When your face spins towards the sun, your back just spun away from the Sun. Watch that again. Your back is going to spin away from the Sun. It goes from day to night for that side. So your backside just saw the Sun set. So when sunrise is happening for one side of the world, sunset is happening for the other side of the world. Does that make sense?

ACTIVITY STEP 18

All right, for your final challenge, spin to model the Sun rising on the other side of the world from where you live. Once you and a partner have figured out how to do this, you can go ahead and take a seat.

ACTIVITY STEP 19

Okay, now that you have a pretty good idea of what it's like to spin as the Earth, pretend you found another planet in a distant galaxy. The planet is called Swiftia. Discuss this question.

ACTIVITY STEP 20

Pretend you found another planet called Slowglobe. Discuss. Then be sure to watch the final video.

WRAP-UP VIDEO

So, how fast does the Earth spin? Well, in the activity, you created a model of the Earth and the Sun, and by spinning once in place, you modeled the Earth's spin around its axis. Since a full day is 24 hours long, you know that one spin takes 24 hours — but how fast is that exactly? If we were to put that in miles per hour, the way we measure the speed of a thing like a car, what speed would that be? Well, to do that, we'd have to figure out how many miles the Earth turns per hour. There are 24 hours in a day, but how many miles are there in one spin? Put that question another way: how many miles around is the Earth? The Earth is huge. Measuring it is not easy. But scientists have been able to figure out exactly how large it is. We know that the circumference of the Earth — that's the distance all the way around the equator of the Earth — is about 24,000 miles. So then we can just do some simple math: If it takes the Earth 24 hours to do one spin all the way around itself, that's 24,000 miles divided by 24 hours in one spin. If you do the math, that equals 1,000 miles an hour. Whoa, wait a second. The Earth is spinning at over 1,000 miles an hour? Now you can understand why people a long time ago had such a hard time accepting this idea. If the Earth is moving at 1,000 miles an hour, why wouldn't we feel that? But, as Galileo figured out, this movement is a constant movement. Everything around us here on Earth moves at this same speed. The clouds, the air, the ground, the buildings, even you as you sit there in your seat. We're all moving together at almost 1,000 miles an hour, which is why we don't really notice it. Now, that said, you can notice the movement of the Earth's spin. It's not something you can feel. It's something you can see: this. What otherwise looks like the Sun moving is actually the Earth spinning. You created a model of this in the activity. As you stood with your back to the Sun, you modeled nighttime for this side of the Earth, the side not lit up by the Sun. But as you spun this way, now, the Sun appeared to move into your view, just as what happens at sunrise in the morning. As you continued spinning all the way to this side, now the Sun appeared to move out of our view, just as what happens at sunset in the evening. The Sun looks like it's moving, but it's really the Earth that's moving. Here's one more thing we can do to help us picture this. We use a globe for the Earth, a lamp for the sun, and then to represent you or me, we stuck a Lego man on the globe. We can call him Lego Man Joe. Then we filmed what Lego Man Joe would see as the Earth did one complete rotation. Let me show you. First, let's move the camera behind Lego Man Joe so we can see what he sees. There we go. Now, in a second, I'm going to start spinning the globe, like this, just like the real Earth spins, but I'm not going to move the Sun. Okay, let's watch what Lego Man Joe sees. Here we go. There we go, he sees sunrise. That's actually the lamp. And he's turning. The Sun is going up, up, up. Earth is turning. And I'm going to turn Lego Man Joe around on the globe here, so that he can continue to watch the Sun. Okay, now I'm spinning the globe again. And you can see, here's sunset about to happen. There you go. Sunset. So, next time you see the sunrise or the sunset, think of the Earth's rotation. It's not the Sun that's moving. It's you, me, and the Earth. Have fun and stay curious!