Lesson: “Why is gravity different on other planets?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! The rocket company SpaceX made big news in 2018 when they announced their plans to send the first tourist on a trip around the Moon. Now, many people know that human beings have actually landed on the Moon, but it's getting to be a long time ago now since that happened. The first Moon landing took place back in July of 1969 when the American space agency NASA sent the first two human beings to walk on its surface. There's some great video footage from some of the missions that not many people have seen. Like some of the Moon landings where they actually took a car up to the Moon and drove it around the surface. Look at this. Or my personal favorite is this footage. It looks like the astronauts are bunny-hopping or bouncing around, just having a good time. They're actually trying to walk. You see, it's not that the Moon has no gravity. It does have gravity, enough gravity that, if you were standing on the Moon, you wouldn't float off into space. The Moon’s gravity still pulls things down, just like it does here on Earth. Like, if you toss something up on the Moon, as this astronaut is doing, you can see it falls back down to the surface. That's gravity. But the Moon has less gravity than we have down here on Earth, which means things don't get pulled down as much by the Moon’s gravity. Walking around, it feels more like you're bouncing. If the Moon has a different amount of gravity than Earth, what is gravity like in other places in our solar system? Like, what's the gravity like on Mars, or Saturn? Could there be places with more gravity than the Earth has? Or what about places with even less gravity than the Moon has? Like, could there be a planet with so little gravity that you could jump over a basketball hoop? What do you think?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to figure out how high you can jump on different planets and moons in our solar system. First, you'll calculate how high you can jump here on Earth. Then, you'll make a trip around our solar system, visiting different planets and moons. You'll figure out just how high you'd be able to jump at each place. I'll walk you through how to get started, step by step.

ACTIVITY STEP 1

Get your supplies. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Separate your three sticky notes and lay them out in front of you, like this. On the first one, write “Start.” On the middle one, write “Jump 1.” And on the third one, write “Jump 2.” You'll use these sticky notes in a minute.

ACTIVITY STEP 3

Find a partner. Decide who will be the Jumper and who will be the Ruler. Don't worry, you'll get to switch roles later. If you're working alone, that's okay too. Once you've done all this, gather all your materials and find a spot near a wall with enough space for you and your partner.

ACTIVITY STEP 4

Now you're going to measure how high you can jump here on Earth. Listen to these instructions before you start to jump. Jumper: get the Start sticky note. Keeping your feet on the ground, reach up and stick it on the wall as high as you can. Then, get the Jump 1 note. Make sure you're standing right underneath the Start sticky note and jump. Mark the top of your jump by sticking it on the wall. Repeat this using the Jump 2 sticky note.

ACTIVITY STEP 5

Now, let's measure how high you jumped. Ruler: find the zero centimeter mark on your ruler. Put this at the bottom of the Jump 1 sticky note. Jumper: find the nearest whole number in centimeters at the bottom of the Start sticky note. I measured 18 centimeters. Record your number on your worksheet, then repeat these steps to find the measurement between the Start sticky note and the Jump 2 sticky note. If your sticky note is crooked, measure from the bottom corner.

ACTIVITY STEP 6

Ruler: gently pull the sticky notes off the wall. Jumper: if your partner needs help, you can use your ruler to get the sticky notes that are harder to reach.

ACTIVITY STEP 7

Switch roles, so that the other person jumps now. Repeat the jumping, measuring, and worksheet steps. Then, gather all your supplies and return to your seats.

ACTIVITY STEP 8

Now you're going to calculate your Earth jump. That will be the average of your two jumps, and you're going to do that right here on your worksheet. For example, my jumps were 18 centimeters and 17 centimeters. So, to find the average, I'm going to add those two numbers together here. Then take the answer and divide that by two. If you need to, round that to the nearest whole number and that's your average Earth jump.

ACTIVITY STEP 9

Now we're going to make something called a bar graph. On your Gravity Graph, find Earth. Then, using your average Earth jump, move your finger up until you find that number on the graph. Then draw a straight line at that point. You might not find your exact number, but find the closest number. My average jump was 18, so I found 20 and then I went a little below that. On a bar graph, you'll color the bar you just created. That represents how high you can jump here on Earth.

ACTIVITY STEP 10

Now let's leave Earth and see how high we can jump in other places. Let's pretend that you've landed on the Moon. The Moon is less massive than the Earth and it has less gravity. In fact, if we were to measure it, we would find that the Moon actually has six times less gravity than the Earth does. Discuss these questions as a class.

ACTIVITY STEP 11

Now that you've figured out that you'd jump higher on the Moon, discuss this question.

ACTIVITY STEP 12

Here's what we came up with. The Moon has six times less gravity than the Earth. So if your jump on the Earth were this high, your jump on the Moon would be six times higher. That means you would need to multiply your Earth jump by six, because the distance of your jump on the Moon would be greater. Fill in columns B, C, D, and E for the Moon on your worksheet.

ACTIVITY STEP 13

Now you get to find out exactly how high you could jump on the Moon. You already have all the information you need to figure this out. Just pay attention to the letters on your worksheet. To do the math, you'll need these letters: A, that's your Earth jump; E, which tells you to multiply or divide; and C, which tells you what number to multiply or divide by. Let's walk through an example together. For example, I had 18 centimeters as my average Earth jump. So, I'm going to write that here. See how I'm matching A to A. I know that I need to multiply, so I'll circle the multiplication symbol. And then the number I need to multiply by is in column C right here. That's six. So, to figure out my Moon jump, I need to multiply 18 by six, which equals 108 centimeters. My jump on the Moon would be 108 centimeters. Now calculate your Moon jump. Yours will probably be different than mine.

ACTIVITY STEP 14

Add your Moon jump to your bar graph. Then, get ready to visit another planet. If you want to see an example, here was mine. Again, this represents how high I can jump on the Moon. Your jump will probably be different.

ACTIVITY STEP 15

All right, let's do one final example together: Jupiter. You might know that Jupiter is thought to be a planet made entirely of gas, so there's probably not any good place to land. But let's pretend you could land there. Jupiter is more massive than the Earth and it has four times more gravity than the Earth does. Discuss these questions.

ACTIVITY STEP 16

Here's what we came up with. Jupiter has four times more gravity than the Earth. So, if your jump on the Earth were this high, your jump on Jupiter would only be this high, four times lower. That means you'd need to divide because the height of your jump would be less. Go ahead and fill in columns B, C, D, and E for Jupiter on your worksheet.

ACTIVITY STEP 17

Now you get to find out the exact height of your jump on Jupiter. Take your average Earth jump and divide it by four.

ACTIVITY STEP 18

Add your Jupiter jump to your bar graph.

ACTIVITY STEP 19

In a moment, you'll visit four Planet and Moon Stations around the room. At each Station, you're going to work with a partner to fill in columns B, C, D, and E, on your worksheet. Listen for instructions from your teacher on when to visit each Station.

ACTIVITY STEP 20

Okay, you can return to your seats. Using the information you gathered at each Planet and Moon Station, calculate how high you could jump on each place. Then, complete your bar graph.

ACTIVITY STEP 21

Discuss question four. Write your answer on your worksheet. Then watch the next video.

WRAP-UP VIDEO 1

In the activity, you saw that it's not just Earth that has gravity; every planet does, even moons. Every planet and moon has gravity and each planet has its own amount of gravity. When you looked at your bar graph, hopefully, you noticed this pattern. The bigger or more massive planets like Jupiter and Neptune have more gravity. You wouldn't be able to jump very high on these massive planets. Since they have more gravity, it pulls you down more. But the smaller or less massive moons and planets like Titan and Mars have less gravity than Earth. On those, you can jump really high because their less gravity doesn't pull you down as much. Still, every planet and moon out there has some gravity. Today, we've actually landed robotic cameras on some of these planets like Mars and Venus. We know for sure that they have gravity, and different amounts than what we have here on Earth. But we didn't always know that other planets have different amounts of gravity. It was the scientist Isaac Newton who was the first to discover some of the secrets of what gravity is and how it works. There's a famous story that's told; you may or may not have heard it before. It's said that Newton discovered the concept of gravity when he saw an apple fall from a tree. Sometimes the way this story gets told, it's tempting to think, what do you mean someone discovered gravity? As if people didn't know things fall down to the ground? But it wasn't that Newton was the first to notice that things fall to the ground. After all, any toddler knows that. It's that Newton was one of the first people that we know of to wonder why the apple fell to the ground. Newton was curious. He asked himself, why does an apple fall downward? Why not sideways, or some other direction? And what is downward anyway? I mean, it's a simple question if you're standing say, here on the Earth. Down is like this, but what about someone standing here on the Earth? Now which way is down? Which way would an apple fall if you were standing here? Or what about people standing in other places on the Earth? Which way is down?

WRAP-UP VIDEO 2

So, which way would an apple fall if you were standing here on the Earth, like in the Southern Hemisphere? One of the things that really got Newton thinking about the direction things fall were these: magnets. If you've ever played with magnets, then you know just how strange and fun they are. You can feel this invisible pulling force, almost as if something's reaching out from the magnet and pulling things toward it. Newton wondered, what if the reason anything falls toward the Earth is because the Earth itself has some kind of invisible pulling force, kind of like a magnet does, reaching out and pulling things toward it? This is what Newton called the force of gravity. This idea could help explain why people can stand anywhere in the southern half of the

Earth and not fall off or feel like they're upside down. Imagine the Earth invisibly pulls things toward it, no matter where you are. If you were standing at the South Pole, you're still on the Earth. The Earth's force of gravity would pull you down, meaning this way, towards the ground. If you were to jump at the South Pole, you would still get pulled right back to the ground. You're not going to fall off the Earth. No matter where something is on the Earth, gravity will always pull things toward the ground. Of course, this invisible pulling force of gravity has some important differences from a magnet. It's not the same thing as the force of magnetism. For example, magnets only pull on materials that have the property of being magnetic, like bits of iron or steel, or other magnets. Gravity, on the other hand, seems to be a force that can pull on anything: apples, people, leaves, you name it. Newton realized, if gravity is this invisible pulling force, it's not limited to just metal or things that are magnetic. It's different from the force of a magnet. Gravity seems to be a force that can pull on every material. It's a property of matter itself, a property of what scientists call an object's mass. The more mass a thing has, the more gravity it has. That's why you notice the more massive the planet, the more gravity it has. It's harder to escape the pull of that much gravity. The smaller or less massive a planet is, the less gravity it has. Here's something fun to think about. In the activity, when you jumped on the tiny moon, Triton, that was the least massive moon in the activity. You could jump really high. But what if you jumped on the surface of a moon that's much, much smaller than even Triton? Could there be a moon or maybe an asteroid out there small enough that, when you jumped, you actually were able to jump right off of it, right into outer space? I'll leave you with that to think about. Have fun, and stay curious!