# Lesson: “How long can people (and animals) survive in outer space?”

## VIDEO TRANSCRIPT

### EXPLORATION VIDEO 1

Hi, it's Doug! It seems like being an astronaut might be one of the coolest jobs there is, doesn't it? Check this out—what I'm gonna show you are clips of real astronauts on board the International Space Station. Imagine what it would be like to get to do things like this. Even simple things, like using a fidget spinner, get a whole lot more interesting in space. Or imagine even getting to play soccer in space. And it's not just all the fun things you can do when you're weightless—think of the views too. Seeing the Earth out your window. But, you might have heard that being an astronaut is a dangerous job too, that outer space is a surprisingly dangerous place to be. Why is that? What things do you know about outer space that make it so dangerous?

### EXPLORATION VIDEO 2

Space is a surprisingly dangerous place to be. For one, you've probably thought about the fact that there's no air, no oxygen. So, without any kind of oxygen to breathe, you'd suffocate. But you might also have heard about the extreme temperatures of space—and they are extreme. If you're floating out in space in the sunlight, it's so hot it's boiling. Temperatures can reach over 350 Fahrenheit. But as soon as you're in darkness, like over on the nighttime side of the Earth, it's so cold it's -250 degrees Fahrenheit, way colder than Antarctica. And these are just some of

the dangers of space. There are other dangers too, like harmful rays from the sun. We've solved these problems by having astronauts stay inside the safety of their spacecraft, like the International Space Station, which is built of strong metal walls and windows made of four layers of super-strong glass. When astronauts do need to go outside the spacecraft, of course they wear spacesuits, made of special materials that protect them from the extreme temperatures. Without their spacesuits and spacecraft, astronauts wouldn't survive more than a few seconds. There's a different kind of danger, though, one that comes not from being outside the spacecraft, but inside of it. What dangers do you think there might be living inside the spacecraft?

## EXPLORATION VIDEO 3

Today it may seem obvious that human beings can go up to space and do just fine. Lots of astronauts, more than 500 of them, have gone to space and survived. And, as you saw, they even seem to be having a really good time while they're there, floating and flipping around. But scientists have continued to study astronauts who spend longer and longer amounts of time in space, and they've discovered some strange things that start to happen. Just recently, scientists at NASA studied what happened to astronaut Scott Kelly after he spent a year in space. That's one of the longest times anyone has ever stayed in space. To study what happened to Scott, scientists looked at his *traits*, or physical characteristics, and they compared what he was like before and after he went to space. Traits include all of the things that you notice about someone when you look at them, like what kind of hair they have, if they have hair, the color of their eyes and color of their skin, and how tall they are. Traits can also include things you can't see directly, but that you might be able to measure. Like, you can measure how strong someone is by testing how many weights they can lift. Or you can test how fast they run by timing them with a

stopwatch. Scientists noticed changes in some of Scott Kelly's traits after he'd been in space. If you had to guess, which traits do you think might change from being in space?

## ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to discover how spending time in space could change some of your traits. Now, we can't send you to space for a year, I wish I could help you there, but you can measure some of your own traits just as scientists measure the traits of astronauts. Then, you can think about whether being in space might change those traits. You'll take a look at how astronaut Scott Kelly's traits changed during his year in space. We'll show you how to get started, step by step.

## ACTIVITY STEP 1

Find a partner. You'll work together to make some measurements and predictions. 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

Get these supplies. You'll get more supplies later.

## ACTIVITY STEP 3

If you're working with a partner, decide who will be Astronaut A and who will be Astronaut B. Write your name and letter at the top of your worksheet and on a sticky note. Set your sticky note aside for now.

## ACTIVITY STEP 4

One of the traits that scientists measure is the strength of astronauts before they go into space. To measure the strength of your arm muscles, you're going to do as many push-ups as you can for 30 seconds. But before doing anything, watch how to do a push-up. You'll start by lying on your stomach and then you'll push with your arms. If that's too hard, you can leave your knees on the floor rather than your toes. One of you will do push-ups while the other partner counts. Okay, go to the next step to get started.

## ACTIVITY STEP 5

Find a place where Astronaut A has room to lie down. Astronaut A, get ready to do push-ups. Astronaut B, get ready to count. And remember, this isn't a competition—you're just collecting data like a scientist. So you don't need to share your numbers with others. I'll set a timer for 30 seconds. Are you ready? Get set. Go! Okay, stop. Remember the number of push-ups you did and go to the next slide.

## ACTIVITY STEP 6

Astronaut A, write how many push-ups you did on your worksheet. Astronaut B, get ready to do push-ups. Astronaut A will count. Again, I'll set the timer for 30 seconds. Are you ready? Get set. Go! Okay, stop. Astronaut B, write down your number on your worksheet. Then, go to the next slide.

## ACTIVITY STEP 7

Now we're going to try to do push-ups in outer space. Now, we can't really go to space. But astronauts say that doing push-ups against a wall like this is similar to doing push-ups in low gravity like on the moon. So, let's try it. Both of you, find a spot where you can lean against a wall like this. Do five push-ups against the wall. How does it feel to do push-ups on the moon? When you're done, go back to your desk.

## ACTIVITY STEP 8

You found out that push-ups are easier to do on the moon. Here are two predictions about what might happen to your muscles in space. Discuss.

## ACTIVITY STEP 9

Here's what happened to Scott Kelly. After his year in space, Scott's arms were weaker than they were when he left Earth and he couldn't do as many push-ups. He had to do many push-ups on Earth to make them strong again. Knowing this, what do you think would happen to your strength and why? Fill in this question on your worksheet.

## ACTIVITY STEP 10

Before astronauts go to space, scientists measure astronauts' balance. You're going to try that test now. With your partner, find a spot where Astronaut A has room to walk in a straight line for 15 small steps.

## ACTIVITY STEP 11

Fold your arms like this. Astronaut A, you're gonna walk heel-to-toe for as many steps as you can without losing your balance. Now, you should stop when you've reached 10 steps. Astronaut B, while they're doing this, go ahead and count out the steps to help them. Now, if you have to put your foot out to catch yourself, then you've lost your balance.

## ACTIVITY STEP 12

Astronaut A, write how many steps you took without losing your balance. Astronaut B, now you walk, while Astronaut A counts. Then, fill in your worksheet.

## ACTIVITY STEP 13

You're going to predict whether your balance will get better or worse during a year in space. Discuss.

## ACTIVITY STEP 14

Before Scott Kelly left for space, he could walk 10 steps with no problem. But look at this video of when he got back to Earth. Discuss.

## ACTIVITY STEP 15

On your worksheet, predict what your balance would be like after a year in space.

## ACTIVITY STEP 16

One trait that scientists always measure is how tall an astronaut is, so you'll wanna measure your height, Astronaut A. Find a place by the wall with your back against the wall and your feet flat on the floor. Put Astronaut A's sticky note on the wall to mark the top of Astronaut A's head. Then, switch roles so that Astronaut A marks the top of Astronaut B's head.

## ACTIVITY STEP 17

Working together and using your rulers, measure the distance from the floor to the mark for Astronaut A, like this. Write that number that you get on Astronaut A's worksheet. Then, do the same for Astronaut B.

## ACTIVITY STEP 18

Discuss.

## ACTIVITY STEP 19

Scientists measured Scott Kelly's height before he went to space and after. When he came back after a year in space, he was two inches taller than when he left. Discuss.

## ACTIVITY STEP 20

On your worksheet, predict what your height could be after a year in space. This one is a little tricky, but give it a try. When you're done, don't forget to watch the final video.

## WRAP-UP VIDEO

Today, it's pretty unusual for astronauts to spend a long time in outer space. But in the future, we're probably gonna want to spend longer and longer amounts of time in space. For example, a trip to the planet Mars and back, that takes longer than a year. And what if we just want to live in outer space? Or travel to faraway planets? We could be in space for a long time. On journeys like that, we might even want to take our pets with us too. How will living in space a long time affect our bodies, let alone those of our pets? Well, as you saw in the activity, when astronauts spend a long time in space, some really strange things start to happen. We saw that when astronaut Scott Kelly spent a year in space, his muscles got weaker, his balance got worse, and he got taller, even though he was an adult and was finished growing. These traits changed while Scott was in space. But why? If we look closely, we'll find that all of these traits have something in common. All of them are traits affected by gravity. For example, consider your muscles. Back on Earth, your muscles are always working against gravity, whether jumping rope, picking up your feet to run, or lifting heavy things off the ground. Gravity is always a force that pulls things down. The more your muscles work against that force, the stronger they get. But in space, there's practically no gravity that your muscles have to work against. You just float around. Life in space is easy. In fact, it's too easy. When your muscles aren't doing any work, they start to shrink and get weaker. And this same thing is true for your bones. Just like your muscles, they get weaker too because they don't have to support your body against the pull of gravity. After a year of taking it easy, the muscles that kept Scott Kelly standing up and walking had gotten very weak. Scott's strength and balance had both gotten worse, as you can see in this video, taken shortly after he returned to the Earth. Scott also got taller in space, even though he was an adult and his body didn't grow anymore. That might seem really weird, but it also has to do with

gravity. Scientists have studied the human body and found that, in between the bones of your spine, there are squishy pads that act like cushions. On Earth, those squishy pads get squeezed down because of gravity. But when you're in space, it's like your spine is always relaxed and stretched out. There's no gravity to smoosh those squishy pads like there would be on Earth. So, in space, you actually get a little taller. It doesn't last forever. Once you return to Earth, gravity will quickly make you go back to your normal height. So, we can see from astronauts like Scott Kelly that traits can change based on the environment you live in and the experiences that you have. Some changes won't hurt you, like getting taller, but other changes—like losing your muscle and bone strength—those can be dangerous for your health. In the future, if we start sending people and even animals to space for a long period of time, we're going to have to solve the problem of how to keep ourselves and our pets healthy. What kinds of things could we do to make sure that our bones and muscles stay strong? Well, astronauts, like this astronaut running on a treadmill, exercise for two to three hours every day while they're in space to try not to lose their strength. They have to work out on special equipment, like this treadmill that has a harness to keep them from floating away. It might be tricky to get a dog to go for a run on this thing. And a cat? Forget about it. And even with all this exercise, without gravity, astronauts still come back to the Earth weaker than when they left. It may take months or years for them to fully recover, for their traits to go back to normal. Some people have said, "If only we could come up with some way to create some kind of artificial gravity in space, then we could avoid these problems." But so far, that's not something anyone has figured out how we could easily do. All of this might seem like a problem for the distant future, but maybe it's something you'll grow up and solve one day. Have fun and stay curious!