mystery science

Lesson: “How can the Sun help us explore other planets?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Jay from the Mystery Science Team. When I was a kid, one of my favorite things to do when I visited my grandparents was watch this.

- Zero and lift off! The final lift-off of Atlantis.

This is a rocket launching into outer space. The U.S. space program NASA has a base not too far from where my grandparents lived in Florida.

- Roger roll, Atlantis.

If I got lucky, sometimes my family would be visiting around when NASA was planning a launch, and we got to go watch spacecraft blasting up into the sky. I still love space exploration and space explorers. So a few years back, I was sorry to hear NASA announce that a member of their team had gotten stuck on a faraway planet. Her name was Oppy. Oppy wasn't an astronaut or even a person. This is Oppy. Oppy was a robot, a special kind of remote-controlled robot called a rover. NASA uses rovers to explore the surfaces of other planets. NASA scientists built Oppy with all kinds of special gear: all-terrain wheels, cameras, measuring instruments, communication equipment. They made up a name for her too—Opportunity, or Oppy for short. Then they blasted her off into space.

-Rocket with Opportunity. A chance to explore.

Oppy's mission was to travel to a far-off planet, gather information, and send that information back to Earth. And that's just what Oppy did for many years until she finally ran out of power and broke down. Now, you might be wondering, why does Oppy get to explore faraway planets? Why don't we just go ourselves? To understand that, it might help to take a closer look at where Oppy was exploring. What do you know about outer space? What exists out there that Oppy might have encountered in her travels?

EXPLORATION VIDEO 2

There's more to outer space than just what we can see in the sky with our eyes. Like, take a look at this. A sky full of twinkly stars, right? Well, that's mostly right. Most of these are stars, but there's something else hidden amongst these stars, too. If you use a telescope to look at this light a little bit closer, it looks like this. And this one looks like this up close, and this looks like this. These aren't stars at all. They're planets. There are seven major planets hidden in our night sky. Along with the Earth beneath our feet, that makes eight major planets in our space neighborhood: Mercury, Venus, Earth Mars, Jupiter, Saturn, Uranus, and Neptune. And those are just the eight major planets. There are many other smaller things that we've discovered in our night sky, too. Dwarf planets, asteroids, other moons, and more. And of all of these incredible objects in space beyond our planet, human beings have traveled to exactly one of them. Humans have been to our moon. We took pictures, we made measurements. We even drove a car around. But as of 2022, no human has ever traveled to another planet. Why do you think that is? What might be difficult about sending a human being to another planet?

EXPLORATION VIDEO 3

Sending a person to the moon is complicated, but sending a human to another planet is even more complicated. For starters, there's this. It takes about three days for a spacecraft to reach the moon. To send astronauts to another planet, like let's say, the planet Mars, that might take about a year just to get there, and another year to get back. Think about everything you'd miss on Earth if you were gone for that long, and think of all the supplies you'd need to bring with you just to survive an almost two-year journey into space. You'd need two years' worth of snacks and water and air to breathe. That's a lot of stuff. Rovers like Oppy help us solve this problem. Using robotic spacecraft, we can explore way farther into outer space than we can go in person, without having to pack a single astronaut snack or miss a single birthday on Earth. Okay, so let's send rovers everywhere, right? There's so much we want to explore and learn about. Let's go! Sounds great, but there is one problem. Rovers don't need food like astronauts do, but they do need something else: power. A rover runs on energy, just like a laptop or a phone does. It will eventually run out of power and need to be recharged. Here on Earth, we have lots of ways of keeping our machines powered. When a phone runs out of power, we plug it into a wall to charge. When the batteries in a flashlight run out of power, we buy new batteries. When a car runs out of power, we go to a gas station or charging station. But now think from an astronaut's perspective. Imagine you're hanging out outside a spacecraft. There are certainly no wall plugs or stores or gas stations nearby. So what do you have to work with if you need to recharge a machine in space?

EXPLORATION VIDEO 4

What's out there in space that could help power a machine? Well, there's lots of open space, that's for sure. And we know there are planets, asteroids, and moons out there. And maybe you've thought of something else, an enormous source of light, heat, and power that we see every day: the Sun. While the Sun is hard to ignore on Earth, it's easy to forget how important it is to Earth's outer space neighbors, too. The Sun is the center of our space neighborhood. Those eight major planets we discovered near our Sun—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune—they all travel around or orbit the Sun. We call our space neighborhood the solar system. The word solar basically just means related to the Sun. So the solar system is made up of all the planets and moons and more that orbit the Sun like we do. The word solar might be familiar to you, especially if you've seen one of these before. This is what's called a solar panel. Our Sun is a giant ball of heat and light. Solar panels turn light from the Sun, solar energy, into energy we can use to power machines. Like, check out this tiny solar-powered toy car. Watch what happens when this person nudges it out of a dark shadow. While the car is in the shadow, it doesn't move. But as soon as sunlight reaches the tiny solar panel on the top, it zooms away. If we can power a toy car using solar panels, maybe we could power our rover using solar panels, too. But would a solar panel work everywhere in outer space like it works here on Earth? I wonder what you think.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you and a partner are going to decide where to send a solar-powered rover so that it can help us learn more about the mysteries of our solar system. Your challenge today is to choose one planet in our solar system that your rover will explore. Now, choosing where to

send a rover is a big decision. We can't actually travel to all the planets today. The real solar system is huge. That's why you and your partner are going to make a scale model. This is a tiny version of the solar system that's shrunk down so that it can fit inside your classroom. Your rover needs to be powered by the Sun. If your rover solar panels don't get enough sunlight, the rover won't work. But how do we know how bright the Sun looks on each planet? To help you figure it out, you're going to use your tiny solar system. You and your partner will also use a flashlight as a model for the Sun. With these, you can test how bright the Sun looks from each planet in our solar system. After gathering your evidence, you and your partner will be able to make a strong argument for where you want to send your rover and why. We'll show you how to get started, step by step.

ACTIVITY STEP 1

Today, you'll be working with a partner to decide where to send your rover. Decide who will get the codename Cosmo and who will get the codename Rocket. If you're working alone, you can do both jobs. Once you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Get your supplies. You'll get more supplies later. Each person needs a pencil and scissors, and each pair needs a Solar System Scale Model, a Brightness Test worksheet, and 11 label stickers.

ACTIVITY STEP 3

Every rover needs a name. The team at NASA named their rover Opportunity, or Oppy for short. Talk with your partner and decide on a name for your team’s rover together. Write the name of

your team's rover on your Brightness Test worksheet. You will have 30 seconds to decide. Okay, time's up. Go to the next step.

ACTIVITY STEP 4

Now it's time to start making your very own mini solar system that you'll use to figure out where to send your rover. Look at these printouts. Notice that there are letters in gray boxes. Cosmo, take the piece of paper that has the gray letters A through F. Rocket, take the piece of paper with the gray letters G through K. Each of you, cut on the dotted lines, like this. When you're done, each of you should have six pieces of paper.

ACTIVITY STEP 5

Now you'll get your stickers ready. Peel the backs off your stickers and stick them on the edge of your desk. Stick only a small part of the sticker on your desk and leave most of it hanging off, like this. This will make it easy to grab and use them in the next step. Cosmo and Rocket, do this for all your stickers.

ACTIVITY STEP 6

Now you're going to build your solar system model. Make sure to listen to all the instructions before you get started. Cosmo: Find the paper with the letter A in the gray box and the paper with the letter A on the white background. Put the white A on top of the gray A, like this. Then tape them together with a sticker. Rocket: Do the same for the paper with the letter G in the gray box and the paper with the letter G on the white background. Put the white G on top of the gray G. Then tape them together with a sticker, like this. Try to tape your pieces of paper together in a straight line, but it's okay if it's a little crooked. Each of you, do this for all six of your pieces of

paper, taping the white letters on top of the gray letters. When you're done, you'll each have a long piece of paper, like this.

ACTIVITY STEP 7

Your solar system is almost complete. To finish it, tape together both of your pieces. Each of you has the letter F on one end of your piece. Find that end. Then just like before, put the white F on top of the gray F, so that they overlap, and tape them together using a sticker. Now you should have one long piece of paper with the Sun at the beginning and planet number eight at the end.

ACTIVITY STEP 8

In a moment, you and your partner are going to set up your testing site. You'll need a flat surface big enough to lay your solar system model on, such as the floor or a few desks pushed together. Make sure that you have room to move forward and backward next to your solar system. When your teacher tells you it's time, you'll bring all of your materials with you to your space. Once you're there, help each other lay your solar system model down flat and in a straight line like this.

ACTIVITY STEP 9

We need to label the planets in our solar system. Cosmo, find planet number one on your Brightness Test worksheet. This is Mercury. Rocket, find planet number one on your model solar system. Write Mercury on the line underneath that planet. Do this for all eight planets.

ACTIVITY STEP 10

Get the rest of your supplies. You're going to use this flashlight as a model for the Sun. Just like you would never look directly into the real Sun, be careful to not look directly into your flashlight either. Teachers, dim the lights so that your classroom is darker, just like in outer space. When you're ready, click the arrow on the right and we will do our first test together.

ACTIVITY STEP 11

You and your partner are going to use your flashlight and mini solar system to measure how bright the Sun looks from each planet. Let's get started by testing our home planet, Earth, together. Cosmo, you're going to be the test rover first. Hold your test rover sheet flat against the back of a notebook or folder, like this. This will make sure that no light shines through the back. Then, hold your test rover on the top of Earth, like this. Rocket, you're going to be the Sun first. Hold your flashlight above the line that says Sun, like this. Now, both of you look at the light shining on your test rover. Discuss: which of the five options on your Brightness Test worksheet best describes how bright the Sun looks from Earth? Don't circle your answer yet. After you've discussed, go to the next step to hear what we thought.

ACTIVITY STEP 12

Here's what we thought about how bright the Sun's light looked on Earth. At first, we weren't totally sure and both had different answers. One of us thought it was very bright and the other thought it was just bright. After talking about it and sharing our reasons, we came to an agreement and decided to choose the option Bright. Brightness can be difficult to measure with just our eyes. There isn't always one clear answer. That's why it's important to talk with your

partner at each step in your testing. Try your best to come to an agreement. On your worksheet, circle the option Bright for Earth. Now that we've called this bright, we can use it to help us figure out how bright the Sun looks from the other planets.

ACTIVITY STEP 13

Now it's time for you and your partner to explore the innermost planets in the solar system, Venus and Mercury. Cosmo, move your test rover to Venus next. Rocket, shine the light on the test rover and both of you talk about how bright you think it is. After your discussion, circle the option you decide on together on your Brightness Test worksheet. Then, repeat this process for Mercury.

ACTIVITY STEP 14

Switch jobs with your partner. That means Cosmo, you'll be holding the Sun, and Rocket, you'll be moving your test rover. Then, explore how bright the Sun looks on Mars. Follow the same process as before of shining the light at your rover, talking about how bright the Sun looks, and circling your answer on your Brightness Test worksheet. Then repeat this process for Jupiter, Saturn, Uranus, and Neptune.

ACTIVITY STEP 15

Now that you've done your test on each planet, go through your solar system quickly one more time. As you do this, discuss, what pattern do you notice as the rover moves further away from the Sun?

ACTIVITY STEP 16

Here's what we noticed. When we started our tests with the rover at Earth, we said that the Sun looked bright. As we moved to the planets closer to the Sun, we saw that the light looked even brighter. And as we moved to the planets farther from the Sun, we saw that the light looked much dimmer. This made us realize that the farther we send our rover from the Sun, the less light or energy it will get. Let's take a closer look at how this affects where you send your rover.

ACTIVITY STEP 17

Now you use the information you gathered to narrow down your options. Planets that you decided were barely visible aren't the best choice to send your solar-powered rover to. Cross out the names of any planets where you said the Sun's light looked barely visible.

ACTIVITY STEP 18

You still need a little more information before you decide which planet to send your rover to. Take all of your supplies back to your desk. Make sure you have your Brightness Test worksheet in front of you. When you're ready, click the arrow on the right to gather more data about the planets in the solar system.

EXPLORATION VIDEO 5

During your brightness test, the closer the paper was to the flashlight, the brighter the light looked on your test rover. And the farther the paper was from the flashlight, the dimmer the light looked on your test rover. The same is true for the Sun in our real solar system. Planets that are closer to the Sun get more sunlight, while planets that are farther from the Sun get less sunlight.

Uranus and Neptune get the least sunlight in the whole solar system because they're the farthest from the Sun. This is how big and bright the Sun might look to a spacecraft hovering around Mercury. But to a spacecraft near Neptune, the Sun might only look like a tiny, dim speck. But when we decide where to send our rover, we have to consider more than just distance from the Sun. For instance, all planets in our solar system rotate like this. These rotations are what give us bright sunlit days and dark sunless nights. During the nighttime, a solar panel isn't going to collect any energy from the Sun. On Earth, nighttime is about 12 hours on average, but some planets rotate faster or slower than Earth does. That means that on some planets, nighttime can be much shorter or much longer. Let's take a look at how long nighttime is on other planets in our solar system. That will give us more information to figure out where to send our rover.

ACTIVITY STEP 19

This picture shows how long one night is on each planet in our solar system. For example, one night on Mercury is 2,112 hours, so you'll add that number here on your worksheet. Go ahead and fill in the data for the rest of the planets, like this.

ACTIVITY STEP 20

Discuss: how does this new information change your thinking about where to send your rover?

ACTIVITY STEP 21

It's time for you and your partner to make your final decision. There isn't one perfect answer. Each planet has pros and cons. Pick the planet that you and your partner think is the best place to send your solar-powered rover. Write that in question number one on your worksheet. Then

explain how the evidence supports your choice in question number two. This is called a scientific argument.

WRAP-UP VIDEO 1

Space travel is complicated. So many things can make each planet a uniquely appealing and challenging place to explore. When you focus on just their distance from the Sun, Mercury and Venus look like fantastic places to send a solar-powered rover. As the two planets closest to the Sun, during the day, both planets get plenty of sunlight to charge a solar panel. But nights on Mercury and Venus are dark, and those nights last a long time. One night on Mercury or Venus can last for hundreds and hundreds of hours. A solar-powered rover is likely to run out of power in a night that long. So maybe Mercury and Venus aren't as good ideas as they first seemed. On the other hand, maybe the extra light available during the day could still make Mercury and Venus good places to send rovers, even if those rovers had to get through some long dark nights. Using the evidence we have so far, both of these planets have pros and cons. Okay, so the distance from the Sun matters, and the length of the night on a planet matters. But getting enough light isn't the only thing that can challenge a rover. What else would be good to know about a planet before we land a rover there?

WRAP-UP VIDEO 2

So many different things can impact a rover's mission. Like maybe you chose Mars as the best planet to send your rover to. There's lots of evidence to support that choice. It's close enough to the Sun that it gets plenty of sunlight, and its nights are about the same length as nights on Earth. Plus, it has a rocky surface to land on, and it's one of our next-door neighbor planets—much easier to get to than Neptune. But even Mars poses challenges, like these dust

storms. Huge winds on Mars's dusty surface can sometimes create dust storms that cover nearly the entire planet. One of these dust storms is what finally took down Oppy the rover. NASA sent Oppy to the planet Mars, just like your test rover. Oppy was powered using solar panels. When Oppy got caught in a dust storm, all that dust blocked Oppy's solar panels from the Sun's light. Without a source of energy, she eventually ran out of power for good. Still, NASA considers Oppy a huge success, not in spite of the obstacles she faced on Mars, but because of them. Even when she finally broke down. Oppy helped scientists learn more about the challenges of exploring space. In 2020, NASA sent a brand new rover to Mars. Her name is Perseverance. The scientists who built her learned lessons from Oppy’s challenges. They outfitted Perseverance with a special set of cameras and sensors that can help her recognize and study Mars's dust storms. And the challenges that rovers face today will help us learn more about how to navigate even trickier space exploration challenges in the future. Just because space is big, and its challenges even bigger, doesn't mean we won't find a way to overcome them. Maybe one day you will solve a problem that will help humans explore a part of the solar system we never thought we could visit. Keep exploring, and stay curious.