Lesson: “How can you unlock a door using a magnet?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! In our last Mystery, we looked at some of the amazing ways that people use magnets. Let me show you another use of magnets that you might not have heard of: these—they're called cow magnets. A cow magnet is a magnet that farmers feed to their cows. Wait, what? Why would you feed magnets to a cow? Don't cows eat grass? Well, when you know a little about cows, I promise this will make more sense. You see, cows are not very picky eaters. Sometimes, they don't even pay attention to what they're eating. While they're eating grass, they might accidentally eat something like this: a piece of barbed wire from a fence. Ow. This could be really dangerous if it were loose inside of a cow's body. Those sharp points could cut or scrape a cow's insides. But if farmers feed a magnet to the cow, the magnet can pick up any bits of metal that the cow accidentally eats, like barbed wire or nails and screws that might have been on the ground. The metal sticks to the magnet and stays in the cow's stomach. That's actually a good thing. It keeps the metal from getting into the rest of the cow's body, where it could hurt the cow. Now, I hope it goes without saying, but cow magnets are made for cows, not for people. You should never swallow a magnet yourself. But you get the idea with cows. This ability to pick up bits of metal, it's one trait of magnets. It's what we call its *property*. A property describes how some material or thing looks, feels, tastes—something that it does. A property is a describing word. For example, one property of cake is that it's sweet. A property of

fireworks is that they're colorful. Another property is that they're loud. One property of cotton is that it feels soft. So, with magnets, the property of magnets that people are most familiar with is their ability to stick to things, like to the refrigerator door. People often say this: magnets are sticky. Now, that's probably not the best word. Magnets aren't sticky in the same way that tape or glue is sticky. They actually pull things toward them. So, we give this sticky property of magnets its own special name: *attraction*. We say magnets attract or pull things toward them. But not just anything—only certain materials, materials like other magnets and things made out of iron or steel. That includes things like barbed wire that cows eat accidentally. OK, so the attractive property of magnets is useful. What other properties do magnets have, and how could those properties be useful? See what ideas you can come up with.

EXPLORATION VIDEO 2

Here's another property of magnets that can be useful. You saw in the last Mystery that there's a special kind of train that uses magnets. There are magnets on the train and magnets on the train tracks. These magnets caused the train to hover or float above the rails. Because the train doesn't touch the rails, there's no friction between the train and the tracks, and so the train can go much faster than a normal train. With the magnetic train example, it's not attraction that's being used, it's a different property of magnets being used. What property is it?

EXPLORATION VIDEO 3

So, magnets can be useful to people because of two different properties. Magnets can attract or pull toward them, which makes them useful for things like picking up metal objects in this junkyard or attracting bits of metal in a cow's stomach. But magnets don't just attract. We saw in the second example they can also push away, or *repel*. We use the repelling property of

magnets to create things like high-speed trains that hover. OK, so magnets can attract and repel, but what else? Well, check this out. Maybe you've even tried this. It looks like the magnet is moving all by itself. But now, look here. You see? Really, there's another magnet underneath the table that someone is moving back and forth. It's fun. Try it out if you haven't done it before. But as you do, think about why it works. You'll soon realize that magnets have another property. This trick works because magnets don't have to be touching. They can push and pull on each other even when there's space between them or even when there's another object between them, like a table. Here, the magnet below the table still pushes and pulls on the magnet on top of the table. This property makes for great tricks. We call this property magnets' ability to work across a distance. Now, is this property good for anything? Can you think of anything we could do with this property to do something useful?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to design a lock to a secret room using a magnet and its properties. Imagine you have a secret room that you want to keep someone out of, maybe a sibling. Looking at the door to your room, they won't have any idea how to get inside. You see, the door will be locked, and there's no place for a key. But you, you are going to have a special key, a magnet key, that will let you unlock the door. Your magnet key will work through the door to unlock the lock on the other side. Now, rather than creating a real door, today you'll be working with a model of a door, made from paper. Your job will be to design a lock that you think works best. Now, don't worry about finding the one perfect idea. That's the fun part about coming up with your own design—there's always more than one way to solve a problem. You'll get to test a few different designs to see what works and what doesn't. I'll show you how to get started, step by step.

ACTIVITY STEP 1

To start with, you'll want to make a paper door. Get these materials. You'll get more supplies later. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Fold the piece of cardstock paper in half, and make sure you line up the edges. Then crease the fold by running your fingernail over it, like this.

ACTIVITY STEP 3

Make a small fold at one end of the cardstock paper, like this. Crease it with your fingernail. Then unfold everything when you're done.

ACTIVITY STEP 4

Rotate your sheet like this, so that the side without folds is facing you. Then, put your sticky note at the bottom of the page. Line up the edges with the bottom of the paper, like this. This is where you'll put your door.

ACTIVITY STEP 5

Trace the top and left side of the sticky note, like this. Then remove the sticky note and cut on the lines. Fold the flap to make a door. Be careful to line up the bottom edge before folding.

ACTIVITY STEP 6

Make two tiny cuts on the edge of the door, like this. Then, fold it over to create a handle, like this.

ACTIVITY STEP 7

Choose something to write on your door, so that you'll always know which side of the door is the front. Don't spend too long on it. Just take 30 seconds or so. I'll start a timer. Go ahead and think about something to write and write it now. OK, your door is done now. Turn the page over. This is the inside of your room where you'll build your lock. Go to the next step.

ACTIVITY STEP 8

Before we build a lock, let's observe how different locks work. This is a sliding lock. How does it keep a door closed? Discuss the different parts and how they help the lock work.

ACTIVITY STEP 9

Look at this other kind of lock on the left. It's called a *turning lock*. How does this lock work differently from a sliding lock on the right? And do you see any similarities?

ACTIVITY STEP 10

Here's what we noticed. A sliding lock works by having a bar slide from one side of the door and go into something attached to the wall. With these parts connected, the door is locked. When you slide it back, the door opens. A turning lock has an arm that moves in a circle around a

point on the door. When the arm turns, it catches on to the part of the lock attached to the wall. Then the door is locked. When you turn it back, it's unlocked. The door can open. OK, now that you've observed a bit about locks, go to the next step.

ACTIVITY STEP 11

Get your lock-building materials.

ACTIVITY STEP 12

Before you design a lock, you need to test which materials are magnetic. How could you test which materials are magnetic? We'll show an idea we came up with in the next step.

ACTIVITY STEP 13

Here's how we tested which materials are attracted by a magnet. We moved a magnet underneath each object with the object placed on top of the cardstock, like this. You can try it too. What happens?

ACTIVITY STEP 14

You probably noticed that the magnet can move the paper clip and the brad, but not anything else. You need to figure out how to move a piece of paper using a magnet. What could you do? Discuss, and try out some ideas. Here's a hint: you can use other materials to help you.

ACTIVITY STEP 15

Here's what we figured out. Behold the amazing power of magnets. This notecard is being moved using a magnet underneath. Do you get why? The secret is in the paper clip that we attached to the notecard. It's magnetic, so now when the magnet moves the paper clip, the notecard moves too. Now that you've figured this out, you're ready to try designing a lock. Go to the next step.

ACTIVITY STEP 16

It's time to experiment. Try to make a magnetic version of a lock using only your materials. Remember, your lock should hold the door closed and only open with a magnet from the other side. If you get really stuck as you work on this, you can go to the next slide for help, but try, for at least a few minutes, without any help from us.

ACTIVITY STEP 17

Here are some more tips and inspiration. In most locks, one side of the lock is on the door and one side is on the wall. Again, part is on the door and part is on the wall, and there's some kind of bar that moves between them. Try building your lock like that with one part on the door and one part on the wall. You don't have to make your lock look exactly like these. These are just suggestions. You can create any kind of lock you want. If it's helpful, you can try drawing your ideas on paper before building anything. Have fun. When you're done designing a lock, go to the next slide for instructions on how to test it.

ACTIVITY STEP 18

Make your door stand up. See if a partner can unlock it with a magnet. Take turns trying to unlock each other's doors. When you're done, go to the next slide to watch the final video.

WRAP-UP VIDEO

Today, you solved the problem of how to use magnets to create a lock for a secret room. You experimented with different designs, and you had to test things to figure out what worked and what didn't work to solve the problem. There are many different solutions that could've worked. Here are a few ideas that we came up with. I showed you the outside of this door before and how it opens with a magnet. But what was going on on the other side? Well, let's see. It has two channels that a piece of paper can slide into. Now it's locked. But that piece of paper has a paper clip on it that a magnet can pull from the other side of the door, you see? Now it's unlocked. Does this look familiar? This is an example of a sliding lock. Here's another example of a sliding lock. It has a piece of paper going into a channel on the wall, keeping it closed, and a paper clip on the end, just like the last lock we saw. But instead of another channel on this side, it has a brad that the piece of paper slides along. Watch. There we go, now it's open, see how that works? Here's another solution you'll recognize. You see that? It's a turning lock. There's a brad down here that lets the piece of paper rotate around this point. So these were model locks. They're made out of paper, so you couldn't actually use them on a door. But could you create a real lock based on these designs? Absolutely. Take a look at this real example of a treasure chest that can only be unlocked using a magnet. There's no place on the outside for a key to go. Right now, you can see here it's locked. But watch what happens when a magnet gets passed over the top of the chest in a special pattern. Right there, now it opens. Have a look

at what's going on underneath the lid here inside the chest. Right there. Does any of that look familiar? All of those are sliding locks. Some of them lock on the right side and some of them lock on the left side. They're made of metal. So a magnet can move through the wooden chest and move them. That's all for today, but I'll leave you with this to think about. What other problems could you solve using magnets? Have fun and stay curious!