The Great Escape: Crash Course Kids #13.1

Physical Science
https://youtube.com/watch?v=gWy2-o9uwrc
https://nerdfighteria.info/v/gWy2-o9uwrc

[intro music]

I really like living here - on Earth: All of my friends live here, there are lots of cool coffee shops, donuts. It has pretty much everything I need, which is great because it is terribly hard to leave.

I mean, just ask an astronaut. In order to get to the international space station or just go for a spin around the planet, they have to escape the pull of Earth's gravity - at least enough to get into Earth's orbit. And that is not easy. But why? What has to happen for astronauts to leave all of their friends and coffee shops and donuts and get all the way up into orbit?

Well, you already know that forces are all around us, and that gravity is the force that keeps everything from sailing off the ground and into space. And it's the mass of the Earth that's so great that pulls objects towards it.

So when we throw something into the air, no matter what, gravity pulls it back to Earth. And hopefully it won't break when it hits the ground. But astronauts have to overcome this pull of gravity in order to get away from the Earth's surface. To do this, their spaceship has to push against the Earth with a huge amount of force, and it has to reach a speed that will allow it to escape Earth's gravitational pull and get into orbit.

This speed is called it's escape velocity. Now, the larger an object is, like a planet or a moon, the bigger it's pull is, and a larger escape velocity is needed to get into orbit around it. The moon, for example, is much less massive than the Earth, so the escape velocity you need to take off from the moon is a lot less than the escape velocity you need to take off from Earth.

But wait, there's more! The greater the mass is of the object that's trying to reach escape velocity, the more force it needs to get into orbit. So a ping pong ball, for example, would reach escape velocity more easily than a bowling ball.

Here's why: Gravity is the force between any two objects made of matter, and the more mass the object has, the greater the force is between them. Since a bowling ball is much, much more massive than a ping pong ball, the pull between the Earth and a bowling ball is stronger than the pull between the Earth and the ping pong ball.

Now let's see if we can find evidence of how the force that an object needs to overcome gravity is related to it's mass. Let's say we do an experiment with a ping pong ball and a rock.

Now, clearly the ping pong ball has very little mass, while the rock is a lot more massive. Suppose we toss the ping pong ball up in the air and we measure how high it goes. With a gentle toss, it goes up about 30 centimeters.

What do you think would happen if we tossed it a little harder? Right, it would go higher. When we toss it with more force, it goes up about 100 centimeters. So a greater amount of force on the ball means that it went higher. The amount of force is the cause and the height of the ball is the effect.

Now let's try this massive rock. Let's see if we can get it to the height of 30 centimeters. It's a lot harder. In fact, it takes a lot more force to get the rock to the same height as the ping pong ball. So in order for it to get the same effect, we need to put more force on the object that has more mass.

This little experiment supports the argument that it takes more force to move objects further from the Earth's surface, and that it also takes more force to move more massive objects against the pull of gravity.

Okay but, so what does this have to do with astronauts? Well, astronauts have to overcome the force of gravity, just like the ball and the rock did. But to get all the way into orbit, the ship their in has to reach that certain speed called the escape velocity.

And escape velocity depends on the size of the planet, as well as the mass of the object trying to leave that planet. That's because gravity exists between any two objects that have mass.

All of that helps to explain why it's so hard for us to leave Earth. If we wanted to... Me, I'm happy right where gravity is keeping me.

[closing music and credits]