OK GO SANDBOX

MICROGRAVITY

ABOUT THIS CHALLENGE

To create the music video for "Upside Down and Inside Out," OK Go filmed inside a plane that was flying in parabolic maneuvers. This gave the impression of weightlessness. This guide discusses gravity and microgravity.

CONTENT AREA

Grade Levels: 6-8

Content Area(s): Physical Science, Earth Science

TOPICS	ACADEMIC LANGUAGE
Gravity	Gravity
Microgravity	Microgravity
Zero Gravity	Zero gravity
Buoyancy	Buoyancy

STANDARDS

NGSS Standards:

5-PS2-1 Motion and Stability: Forces and Interactions - Support an argument that the gravitational force exerted by Earth on objects is directed down.

Note: This lesson plan may align with other sets of standards not included here.

LEARNING OBJECTIVES

Students will be able to:

Understand and discuss gravity and microgravity.

Describe the effects that gravity and microgravity have on the human body.

INSTRUCTIONAL DELIVERY

OPENING ACTIVITIES/MOTIVATION

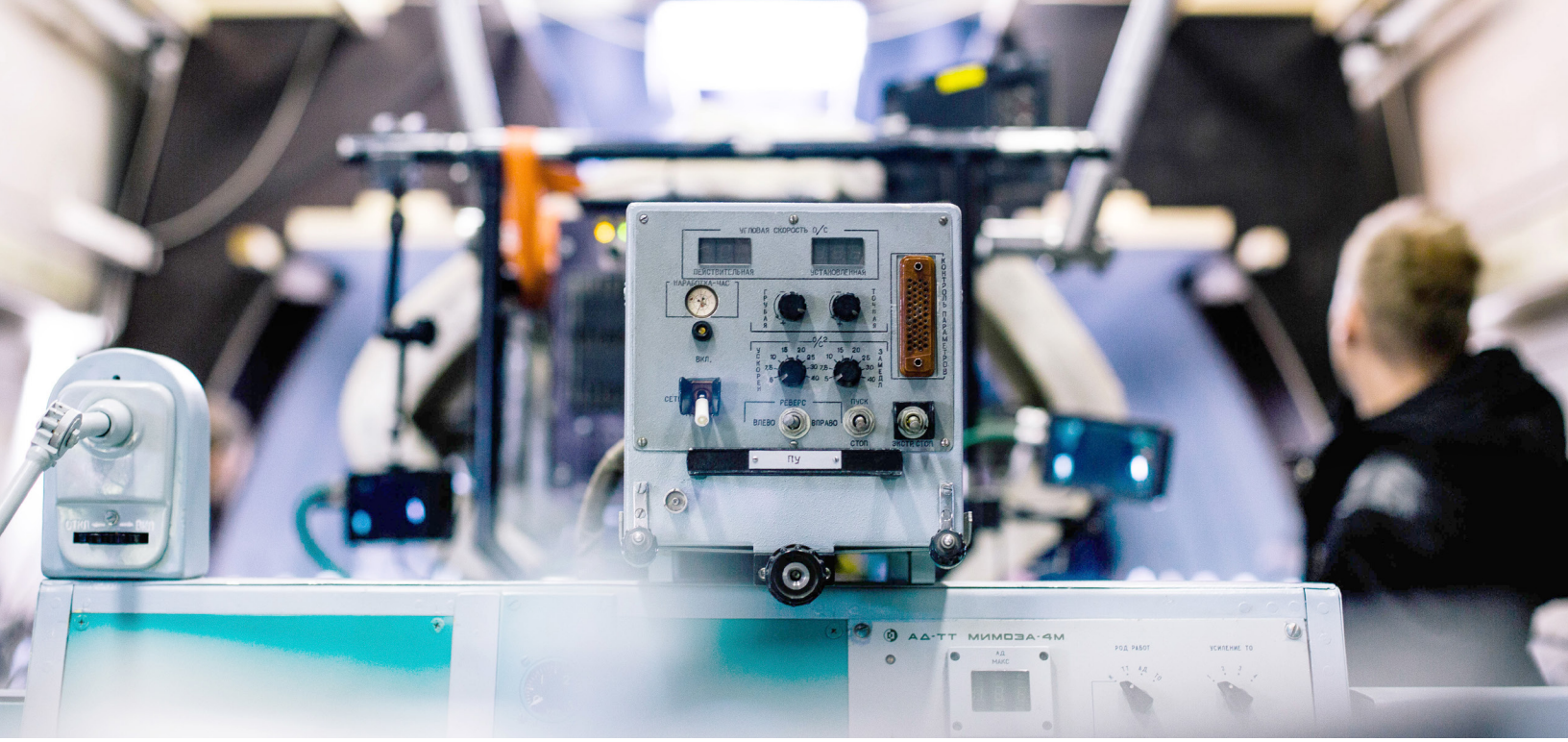
Show the **"Upside Down and Inside Out"** music video (3 minutes and 21 seconds).

Once the video ends, ask your students how they think the video was made. After they've shared a few ideas, show the **"How we did it"** video (5 minutes 39 seconds). This will show students how the video was made and will introduce the concept of microgravity.

DISCUSSION

Explain the effect of gravity and the state of microgravity.

Gravity is a force that attracts everything in the universe to everything else. Gravity holds the moon in orbit around the Earth. But if there is gravity in space why does it appear that astronauts in orbit are weightless? Think about other times that people feel weightless. Skydivers might experience weightlessness between the time they jump out of a plane and the time their parachute opens (except for the air rushing past them, slowing them down). Riding an elevator from the top of a skyscraper down to the ground, you might feel weightless as the elevator starts moving. In both these cases, instead of fighting gravity, you're letting gravity accelerate you downward. A spaceship in orbit, and the astronauts inside, are still being pulled toward the earth by gravity, but the force of gravity is just enough to keep it in orbit. Similarly, passengers on an airplane falling freely under the force of gravity will feel weightless. This is called micro-gravity.



DISCUSSION CONTINUED

In the video Upside Down and Inside Out, the band is experiencing this same phenomenon as their plane flies through the air. These sequences of microgravity occur when the plane is descending and the rate at which the plane falls is the same as the rate at which the objects inside are falling. This causes the band and the objects to float through the space of the plane.

For many, hanging out at the pool is a great way to pass the time on hot summer afternoons. But did you know that spending time in a pool is one way that astronauts get ready to spend an extended period of time living and working on the International Space Station? For astronauts, spending time in NASA's Neutral Buoyancy Lab (which is basically a really big swimming pool) is the best way to simulate microgravity without ever leaving the Earth's atmosphere. Why is this? When something is neutrally buoyant, there are two forces in action on it—the force of gravity which pulls the object down and the buoyant force which pushes the object up. When something or someone is neutrally buoyant, it neither floats to the top nor sinks to the bottom. When an astronaut is suited up in a special space suit and dives into the Neutral Buoyancy Lab (NBL) pool, they feel the sensation of being weightless.

So what is zero gravity?

It's important to recognize that gravity is still present even if you don't feel it. Nothing can shield an object against gravitational forces so the only way to truly have zero gravity would be to find a place where the gravitational pulls of objects in different directions cancelled one another. That's not what we see in orbit or in the video. The weightlessness we see is not due to an absence of gravity but rather to falling freely with gravity.

DISCUSSION CONTINUED

Describe briefly a few different ways that gravity affects the human body.

The human body is designed to support itself under the constant, compressive force of gravity. Like an egg, which demonstrates great strength when stood on its tip, bones have tremendous strength along their length. The human vascular system is also designed to work against the force of gravity in certain places. Our muscles have grown strong by keeping us upright all day, standing us up after we've sat down, lifting our body weight, etc.

If a bodybuilder suddenly stops all exercise, they will return to the size of an ordinary person over time. Imagine instead of a bodybuilder ceasing to exercise, it was a group of astronauts experiencing microgravity in outer space for an extended period of time. They no longer need to stand up or walk, and their bones don't need to support their body weight against gravity. Their hearts can pump blood freely, fighting no observable gravitational forces along the way. These body parts and systems will gradually become weaker, as there is no longer a reason for them to maintain their previous levels of strength.

This is dangerous when the astronauts return to earth because their bodies may have grown unaccustomed to working against the forces of gravity. For this reason, astronauts on the space station have specially designed exercise equipment and regular workout routines to prevent their bodies from weakening too much.

DISCUSSION CONTINUED

Have students brainstorm more ways that gravity affects the body.

Give students two or three minutes to individually think about more ways that gravity could affect the body. Then, split them into groups of two or three to share their ideas with their peers. Each group should add their ideas to a class list, which can be created on a whiteboard, smart board, Poll Everywhere, Slido, shared Google doc, etc. The teacher can then choose a few items off the list and go into more detail about how changes in gravity bring about these effects.

DISCUSSION QUESTIONS

Can you think of some places in space where the gravitational attraction of different bodies might cancel out because they are pulling in different directions? What happens if you move slightly from such a location?

In orbit, gravity is needed to keep the spacecraft moving in a curved path. On earth, we need forces to keep us moving in a curved path too. Think about riding in a car and turning a corner. Can you feel the car pushing on you to keep you moving with the car? Which way is it pushing? (This can be tricky.)

Related to the previous question, imagine that you have a helium filled balloon in the car with you. These balloons float because of buoyancy. Which way will it tilt as you go around a corner?

Given how gravity affects the body, how might people and animals be different if they lived on planets with more gravitational attraction? Less?

ASSESSMENT

Evaluation of Learning Objectives: By writing either on a piece of paper or in an email or a Google doc, have students describe 1) the differences between microgravity and zero gravity and 2) something new they learned in the lesson. The brainstorming activity will serve as evidence that students can list ways that gravity affects the body.

Closure: Ask a few students to share what they wrote on their exit ticket about what they learned throughout the course of the lesson. You could also take a couple minutes to explain how these concepts fit into past/upcoming units or how students will see them in action in an upcoming lab experiment.