INNOVATION AT PLAY

TEACHER ACTIVITY

POWER OF GRAVITY

Yes, gravity keeps us from floating off into space. But how else does it affect our lives and the decisions we make?

Grab a teammate and work your way through the following steps as you uncover some new discoveries about this important force.

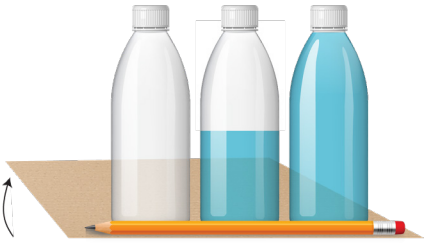
STEP 1: CONNECT

Gravity is the force that draws objects on Earth towards its center. In what circumstances has gravity proven useful for you? In what circumstances may it be better if it didn't exist?

STEP 2: INVESTIGATE

You may think you know all there is to know about gravity by now, but we bet this isn't true. Try out this investigation to learn more!

You'll need: three small plastic bottles, water, a piece of thick cardboard (at least 12 inches long), a pencil, and tape.



Begin by filling one bottle completely with water, filling one bottle halfway with water, and leaving the third bottle empty. Replace the caps on each one and then place the bottles standing up side by side.

Grab the cardboard and pencil. Tape the pencil onto the long edge of the cardboard so it creates a lip, as seen in the image here.

Place the water bottles on the cardboard alongside the pencil.

Slowly lift the end of the cardboard opposite the pencil until one or more of the bottles fall. Be sure to observe which bottle(s) fall first!

STEP 3: DISCUSS

Which bottle(s) toppled over first? Why?

You likely saw that the empty and full bottles fell first. This happened because of each object's center of gravity.

An object's center of gravity is the point where its weight is even on all sides. The center of gravity of the empty bottle and full bottle was directly in the middle of the bottle. The center of gravity of the half-full bottle could be found in the middle of the liquid inside it. This lower center of gravity made it more stable.

How might this concept influence the design decisions of vehicles, buildings, and more?

STEP 4: MATERIALS

Let's keep learning about gravity with another challenge. To prepare, gather the following materials:

- A helium balloon
- Ribbon or string
- Paperclip
- Index cards

STEP 5: THE CHALLENGE

Your challenge is to make a helium balloon *hover* between the floor and the ceiling. In other words: the balloon shouldn't go all the way up to the ceiling, but it also shouldn't be on the floor!

Begin by tying a ribbon or string around the bottom of the helium balloon if there is not one already.

Next, attach a paperclip to the ribbon. Does the balloon move up or down at all?

Now attach one of the index cards to the paperclip. What happens? Add and/or remove small pieces of the index card(s) until the balloon is hovering midair between the floor and the ceiling.

Once it is balanced, consider:

- It didn't take a lot to pull this balloon partway down. If the balloon was heavier, how would this challenge be affected?
- Newton's Law of Gravitation states that:

  F = force of gravity

  G = gravitational constant

  m_1 = mass of object 1

  m_2 = mass of object 2

  r = distance between centers of the masses

$$F = G \frac{m_1 m_2}{r^2}$$

Based on this equation, how is the force of gravity affected by mass?

Every wonder how many balloons it would take to counteract gravitational pull and make an object float?

Use a scale to measure the mass of the paperclip and index cards that made the balloon hover.

Now calculate… If *one* balloon could make something of this mass hover, how many balloons would be needed to lift the following?

Banana: 118 grams

Phone: 175 grams

Bicycle: 12 kg

Car: 1000 kg

STEP 6: SHARE

Now that you've investigated, considered, and maybe even learned a few new things about gravity, create a quick video that shared the top three facts about gravity that you believe "everyone" should know. Use the hashtags #InnovationAtPlay and #Gravity to help spread the word!

NGSS STANDARDS

- HS-PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] *[Assessment Boundary: Assessment is limited to systems with two objects.]*

COMMON CORE ELA STANDARDS

- CCSS.ELA-LITERACY.CCRA.SL.4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.