LESSON 13:
ENGINEERING LIFTOFF



SUPPLIES

LESSON KIT #13
- Rubber Band (40)
- Mini paper clips (80)

PENCIL BOX
- Scissors
- Markers
- Pencils
- Hole punch
- Tape

MAIN BIN
- Mini paper cups (60)

HANDOUTS
- Rocket Parts Handout (10)

OBJECTIVES
- ☑ Learn how rocket engines create thrust and how thrust helps a rocket lift off.
- ☑ Build and launch a model rocket to observe tension, force, and lift off.

HOOK
2-3 min

Have you ever wondered how something as large as a rocket can lift off the ground and soar into the sky? A rocket can be taller than a building and weigh millions of pounds, yet it can lift off the launch pad and travel to space! Imagine standing near a rocket on launch day. You hear a giant roar. Fire and hot gases blast downward from the engines. The rocket begins to shake, and then—liftoff! The rocket rises into the sky. But how does it do that? Today, we are going to learn how modern rockets work, take a closer look at the most exciting part of a launch. Lift off!

INTRODUCTION
5 min

Modern rockets are carefully designed machines that carry people, spacecraft, satellites, and supplies into space. NASA, the National Aeronautics and Space Administration, builds and uses rockets, spacecraft, and robots, and trains astronauts for missions that help us learn more about the mysteries beyond our planet. But rockets are more than just powerful machines. They are the result of years of science, engineering, testing, and teamwork. Rockets must produce enough force, called thrust, to overcome Earth's gravity and lift off the ground. Once in space, they help astronauts and spacecraft travel to places such as the Moon and, someday, farther into the solar system. In this lesson, we will explore how rockets work, what makes them move, and how the same basic ideas of force and energy can be seen in a simple paper-cup rocket. By investigating these ideas, we can begin to understand how the science behind a small classroom demonstration connects to the incredible rockets used for space exploration.

LET'S LEARN ABOUT ROCKETS!

Rocketships carry astronauts, spacecraft, and supplies into space! But how do they lift off? Rockets use a powerful force called thrust, created when engines push hot gases downward, pushing the rocket upward. Think about letting go of a balloon: as air rushes out, the balloon moves in the opposite direction! A paper-cup rocket works similarly because stretched rubber bands store energy that pushes it upward when released. Real rockets use powerful engines to overcome Earth's gravity and explore space.

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DISCUSSION

25-30 min

Liftoff is the moment when a rocket leaves the launch pad and begins its journey upward.
So, how does a rocket get off the ground?

The answer is thrust.

A rocket engine burns propellants to create extremely hot, expanding gases. The gases are pushed downward and out of the rocket. The rocket is pushed in the opposite direction—upward.
Think about jumping. When you push your feet against the ground, your body moves upward. A rocket does something similar, except its engines push hot gases downward with an enormous amount of force.

For a rocket to lift off, its thrust must be greater than the force of Earth's gravity pulling the rocket downward.

Why doesn't the rocket just go straight up forever?

A rocket needs to travel upward first so it can gain enough speed to continue its journey into space. As the rocket climbs, its flight computers help guide it.

Rockets also use stages. When a part of the rocket has finished its job, it can separate so the spacecraft does not have to carry that extra weight. NASA's SLS uses different parts of the rocket at different points during its journey.

So, a rocket launch is not just one big blast. It is a carefully planned sequence:

Ignite → Create thrust → Liftoff → Climb →
Separate stages → Continue toward space



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ACTIVITY 25-30 min

1. Provide each student with three mini paper cups, two rubber bands, four mini paper clips, and a half-sheet rocket parts handout. Students will share scissors, markers, pencils, a hole punch, and tape.

2. Have students stack two mini paper cups together to create the main body of their rocket.

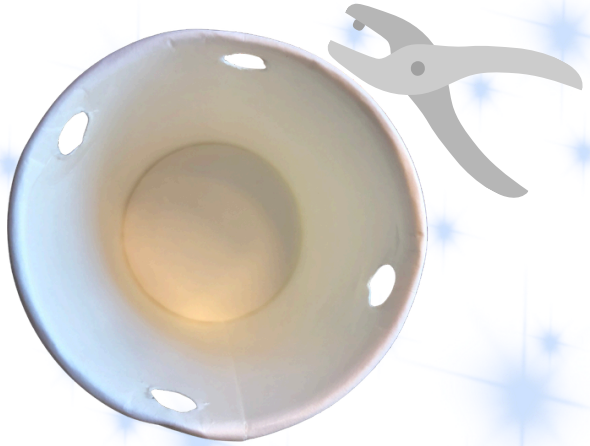
3. Instruct students to use the hole punch to make four evenly spaced holes just below the open rim of the cup.

4. Guide students to weave the two rubber bands through the holes, arranging them so they cross in the middle and create an X shape.

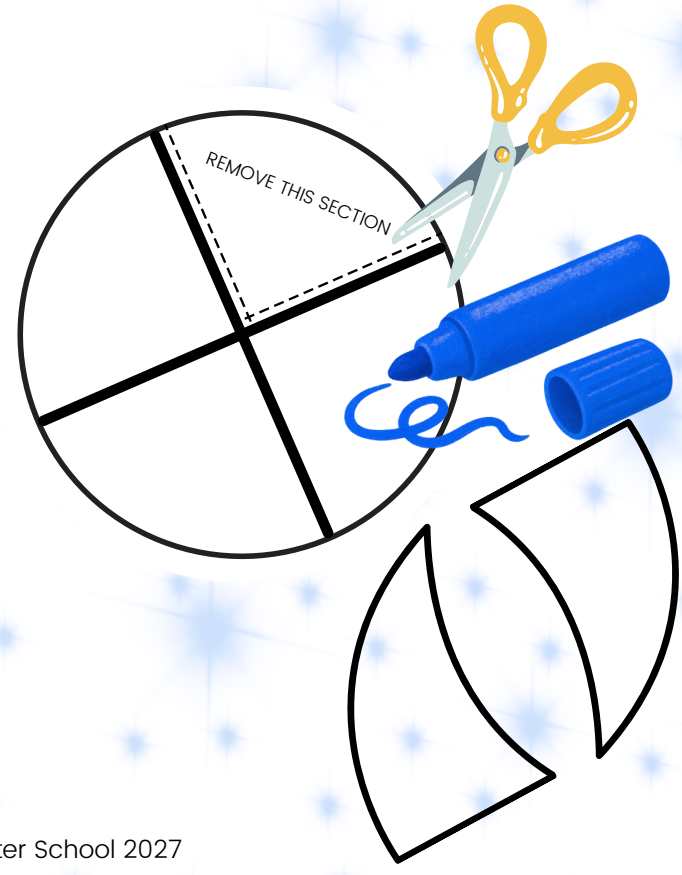
5. Use the mini paper clips to secure the rubber bands to the cup, making sure they lie flat against the sides of the cup.

6. Ask students to decorate their rocket body using markers. Encourage them to create a NASA-inspired rocket, invent their own rocket design, or use any colors and patterns they choose! Once students finish decorating, instruct them to carefully cut out the rocket parts from the half-sheet handout.

7. Have students carefully cut out the circle, which will become the rocket's cone, and the two fins. Instruct students to cut along the dotted lines to remove one triangular section from the circle, keeping the remaining three sections connected.







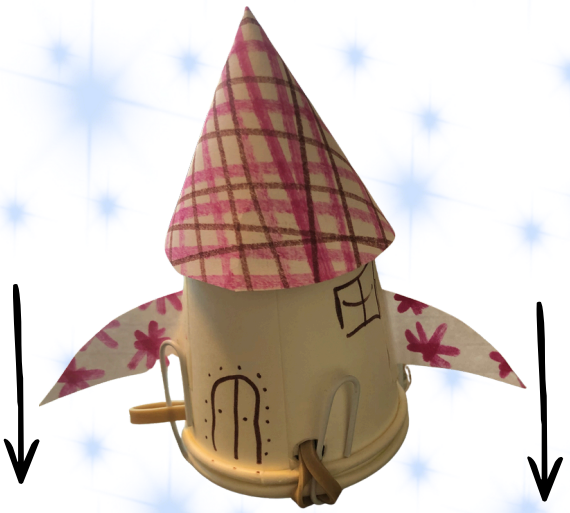
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ENGINEERING LIFTOFF

ACTIVITY 25-30 min



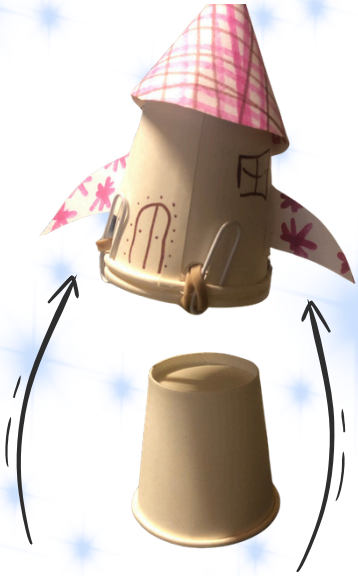
8. Next, have students gently bring the two open edges of the circle together to close the gap and form a cone shape. Use tape to secure the edges of the cone together. Position the cone on top of the rocket body and secure it with tape. Have students attach one fin to each side of the rocket body using tape. Finally, allow students to add any finishing touches and decorations to their rockets.



9. Finally, prepare for liftoff! Place the third mini paper cup on the floor or another safe launching surface. Guide students to slowly position their rocket over the third cup. As they push the rocket downward, ask them to observe the tension created by the stretched, crisscrossed rubber bands.

10. Have students gently push the rocket down over the third cup, stretching the rubber bands.

11. Before launching, make sure everyone is standing safely away from the launch area.



12. Count down as a class and on 0, have students gently release their rockets and watch them lift off! Ask students what they noticed about the rubber bands before and after the rocket launched. Encourage them to think about how the stored energy in the stretched rubber bands helped push their rocket upward.

After the launch, ask students:

- What happened when you pushed the rocket downward?
- What happened when you released it?
- Where did the energy for the launch come from?
- How was the rubber-band launch similar to a real rocket launch?
- How was it different from a real rocket?
- What do you think would happen if the rubber bands were stretched more?
- Why does a real rocket need so much thrust to leave Earth

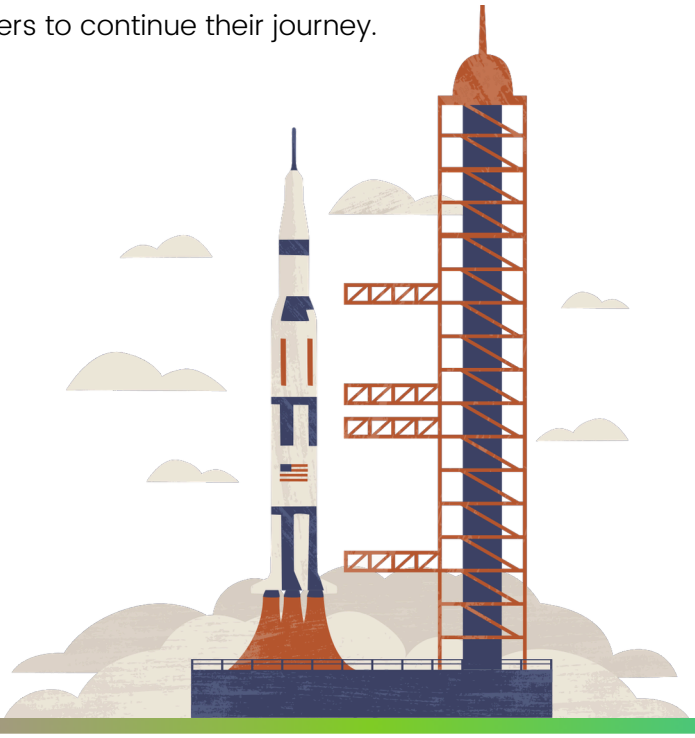
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CONCLUSION 25-30 min

Discuss as a class:

A paper-cup rocket is much smaller and simpler than NASA's rocket ships but both demonstration show an important idea: a force can cause an object to move. The rubber bands stored energy when they were stretched. When you released the rocket, that stored energy helped push the rocket upward. A real rocket works differently. Its engines and boosters create thrust by pushing hot gases downward and out of the rocket. When the thrust is strong enough to overcome the pull of Earth's gravity, the rocket can lift off Rockets don't simply "fly" into space. They create enormous amounts of thrust to push themselves away from Earth and then use carefully planned stages, engines, and computers to continue their journey.



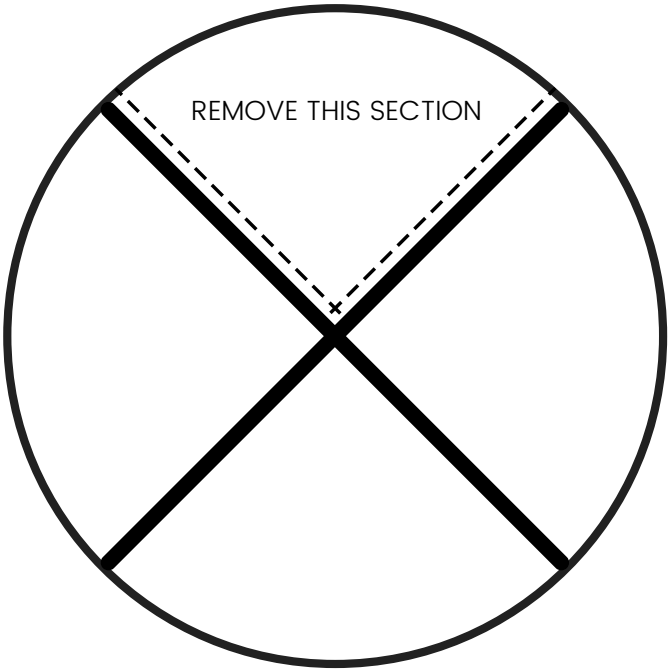
Exit Ticket

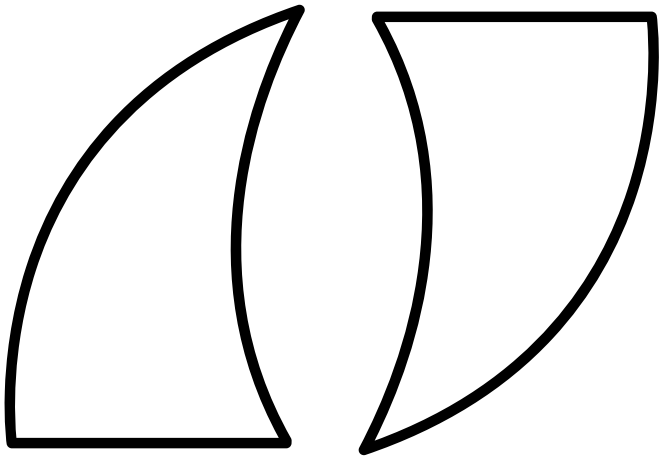
Ask each student one of the following questions as they walk out the door.

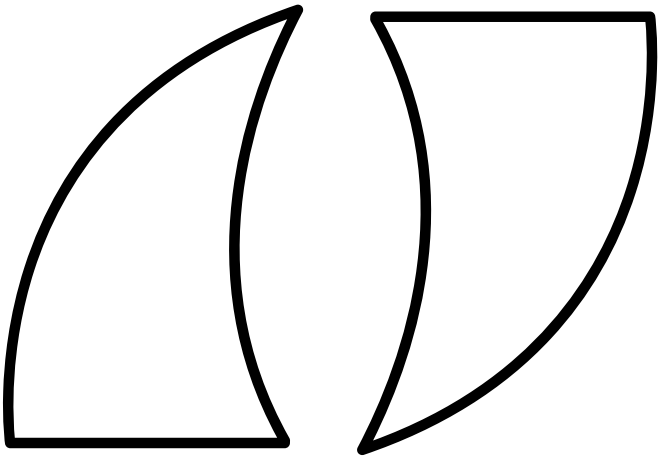
- What is the name of the force that helps a rocket lift off the ground?
  - Thrust
- How does a rocket engine create thrust?
  - It pushes hot gases downward and out of the rocket, pushing the rocket upward.
- Why must a rocket's thrust be greater than Earth's gravity to lift off?
  - So the rocket can overcome gravity and move upward.
- How is a paper-cup rocket similar to a real rocket?
  - Both use stored energy or force to make an object move upward.

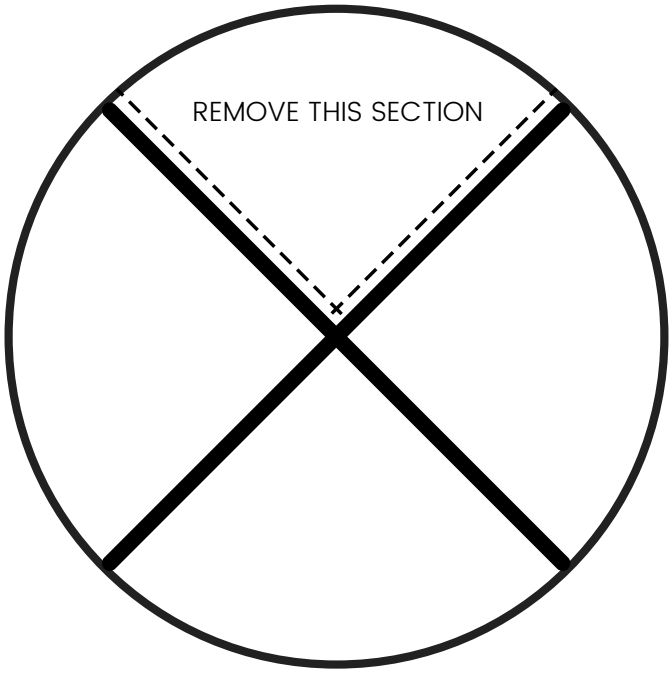
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ROCKET PARTS HANDOUT









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ENGINEERING LIFTOFF: STUDENT DIRECTIONS

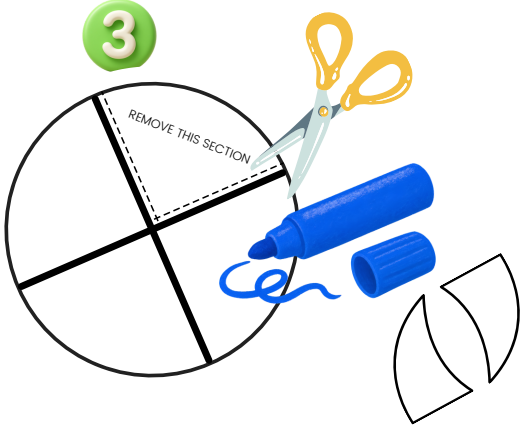
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ENGINEERING LIFTOFF: STUDENT DIRECTIONS

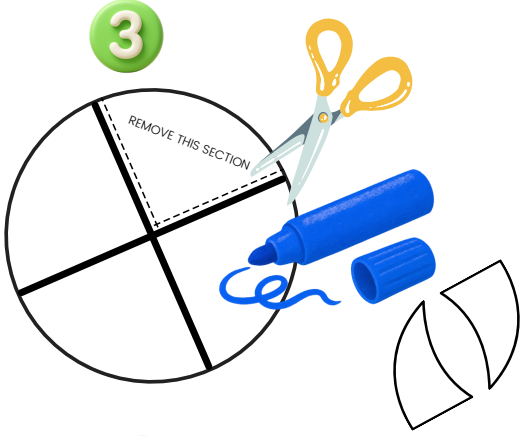
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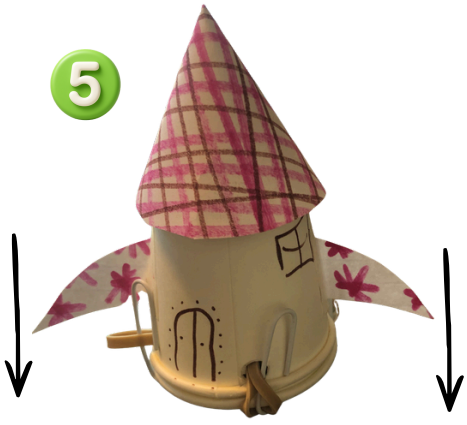
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