STEAM Subject: Engineering
Lab: Blast Off! – Build Your Own Rocket

Grades: 2nd-8th

Learning Objective
Students will be able to:

- describe how a rocket works and identify its parts.
- build a model of a rocket

ENGAGE:
Ask your students the following questions:

- What is the job of the scientists and engineers at the National Aeronautics and Space Administration (NASA)? *Space exploration, scientific discovery, and aeronautics research.*
- What is the name of the type of engineer who designs and builds rockets and planes? *Aerospace engineer.*
- How long does it take for a rocket to reach space? *It takes approximately 8 ½ minutes for the rocket to get to orbit.*

EXPLORE:
Rocket Model 1 Activity

Materials needed per student:

- A small diameter straw
- A larger diameter straw or a nerf dart
- A small empty water bottle
- A sticker, tape, putty, or clay
- Knife or drill (Parental supervision needed)

Directions:

1. Grab an empty water bottle and make a hole in the bottle cap the size of the small diameter straw. SAFETY NOTE: Parental supervision needed. A knife or drill is suggested to make the hole.
2. Cut the small diameter straw down to about 3 inches in length.
3. Insert this straw into the hole made in the water bottle lid.

All pictures in this first activity are courtesy of EIS Engineering Instructor Maria Morgan.

4. To make the rocket, cut down the larger straw to the desired size
    a. Students can try different sizes for their rocket and see the difference in flight length/height.
5. On one side of the larger straw, close the hole by using the sticker, tape, clay, or putty. Make sure that the hole is fully closed off to any outside air. This will allow the rocket to launch farther. The last three steps are shown below.
6. Place the rocket/larger straw on top of the smaller straw in the bottle. The rocket is now ready for launch!
7. Find an open space where you can let your rocket fly. Once you are ready, give the water bottle one big squeeze and watch your rocket soar! Make sure your squeeze is hard and fast – this helps the rocket launch more efficiently. **Refer to video here for how to launch your rocket.**

Change it up: Try changing your model and observe how that affects how your rocket flies. For example, you can change the size of the water bottle, the length of the straw for the rocket, using a sticker/tape versus using clay/putty, and how hard and fast you squeeze the bottle. Ask yourself why these changes are happening!

Challenge: Set up different targets to see if you can launch your rocket to hit each target.

Paper Rocket Model 2 Activity

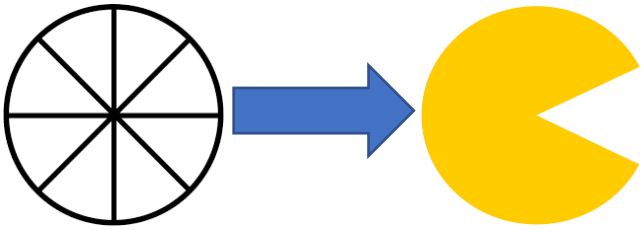
Materials needed per student:

- One piece of printer paper
- Pencil/Pen
- A plastic cup - other cups work fine as well
- Scissors
- Tape
- Color pencils - optional but recommended!
- Plastic straw - bendy straws work best
- Ruler or straightedge - a piece of cardboard or a school ID card works fine.

Directions:

1. Cut a 5-by-5-inch paper square using a ruler or straightedge. If you want to decorate your rocket with the color pencils, do so now!
2. Set the square to the side and trace the bottom of the cup with a pencil on the remaining paper. Cut that circular piece of paper out with your scissors.

3. Take your square and roll it onto your pencil or pen- wrap it around as tight as possible, enough room so the pencil or pen can slip out. Then, tape the paper tube together - this will serve as the base for your rocket.
4. Take the circle you cut out and divide it into 8 equal pieces with your ruler/straightedge. Shade one of those pieces in, and then cut that piece out with your scissors - it's like cutting a slice of pizza. Your circle should now look like Pac-Man.



5. Wrap the Pac-Man into a cone using your fingers. Spin the paper with your fingers until you get the cone shape and tape it together.

6. Tape down the cone and the base of your rocket. You can add wings to your rocket by cutting small triangular pieces of the excess paper and taping them to the side.
7. Grab a straw, place your rocket on one end, blow into the straw, and see how far your rocket flies into the sky! See image below.

EXPLAIN:

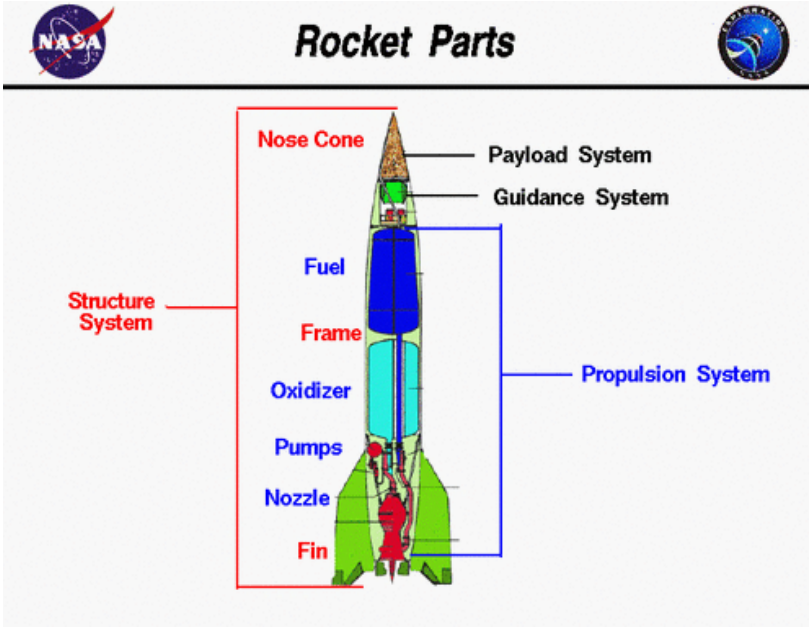
What is a rocket?

- A cylindrical **projectile** that can be propelled to a great height or distance by the **combustion** of its contents, used typically as a firework or signal, and used for scientific purposes as an engine to carry payloads including satellites and missiles.

How does a rocket fly?

- When the rocket is turned on, the fuel is ejected at extremely high **velocity** in the opposite direction that the rocket needs to go. If the rocket needs to fly upwards, the fuel is ejected downwards, and vice versa.
- This has to do with **Newton's Third Law**, which says that every action has an equal and opposite reaction. If an amount of **force** is applied on an object in one direction, that object in return will exert the same amount of force in the opposite direction.
- A rocket needs a huge amount of fuel to overcome Earth's gravity and be able to go into space. It needs to reach a speed of about 28000 km/h to be fast enough to enter **orbit**. That is extremely fast!

What are the four main parts of a rocket?



1. Structure system: this is the outer skeleton that includes all the parts that make up the frame of the rocket – the nose cone, frame, fins, and more. The material that the rocket is made from must be lightweight, but also strong.
2. Payload system: this is the most important part of the rocket. It carries the satellite, telescope, missile, etc. to the required destination safely.
3. Guidance system: this holds sensors, computers, radars, and communication equipment. Its main roles are to provide stability and control the rocket during maneuvers.
4. Propulsion system: this contains all the parts that make up the rocket engine – the tank pumps, **propellants** (fuel and oxidizer), rocket nozzles and more. Its purpose is to produce **thrust**. This is where the combustion happens.

REVIEW STEAM VOCABULARY:

- **Projectile:** an object that is launched or thrown, usually in the air, by a force.
- **Velocity:** a measure of how fast something moves in one direction.
- **Newton's Third Law:** every action has an equal and opposite reaction.
- **Force:** any action applied to an object which would cause the object to move, change the way it is currently moving, or change its shape.
- **Orbit:** the curved path in space that is followed by a planet, satellite, spaceship, etc. going around a planet, moon, or star. It is usually an elliptical path.
- **Thrust:** the force produced by an engine that pushes in one direction.
- **Combustion:** a chemical reaction between substances that is usually accompanied by the creation of heat and light in the form of a flame.

- **Propellant:** any gas, liquid, or solid when expanded can be used to impart motion to another substance or object. The two propellants in rockets are the fuel and the oxidizer.
- Students are encourage to read more information about rockets at https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-rocket-58.html

ELABORATE

- Watch the following videos:
  - "How Does a Rocket Fly?": https://youtu.be/9g0FehS0H1E
  - "How Rockets Work": https://youtu.be/jI-HeXhsUIg
  - "Making History: NASA and SpaceX Launch Astronauts to Space! (#LaunchAmerica Success May 30, 2020)": https://youtu.be/pMsvr55cTZ0
- Visit the NASA Kids Club to learn more about space and play some fun space games: https://www.nasa.gov/kidsclub/index.html
- Read the Questions & Answers session with a NASA Mission Team: https://www.nasa.gov/mission_pages/shuttle/shuttlemissions/sts121/launch/qa-leinbach.html

EVALUATE

- Research different rocket launches that have taken place, ones that have succeeded, and others that have failed. What do engineers and rocket scientists say about why the launches failed?
- Design new rockets using different materials and test which reaches the highest distance and longest time aloft in the air.