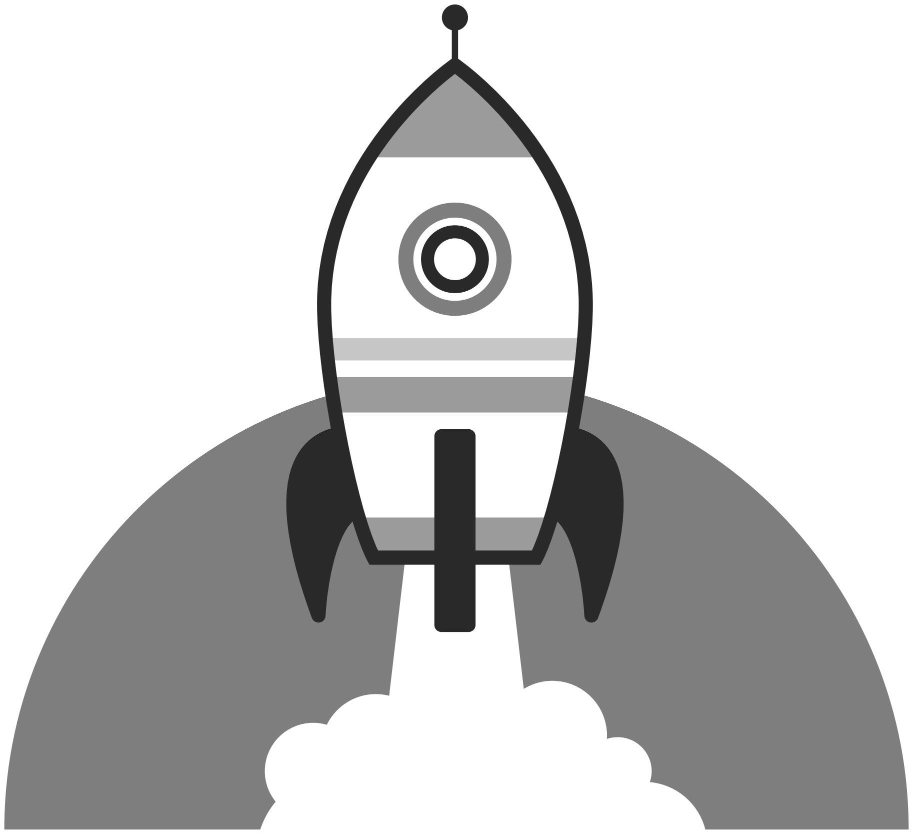
4 - H NATIONAL YOUTH SCIENCE DAY



4 - H NATIONAL YOUTH SCIENCE DAY

ROCKETS TO THE RESCUE

YOUTH GUIDE

4-H PLEDGE

HEAD	HEART	HANDS	HEALTH

I PLEDGE MY **HEAD** TO CLEARER THINKING,

MY **HEART** TO GREATER LOYALTY,

MY **HANDS** TO LARGER SERVICE, AND

MY **HEALTH** TO BETTER LIVING,

FOR MY CLUB, MY COMMUNITY, MY COUNTRY,

AND MY WORLD.

INTRODUCTION

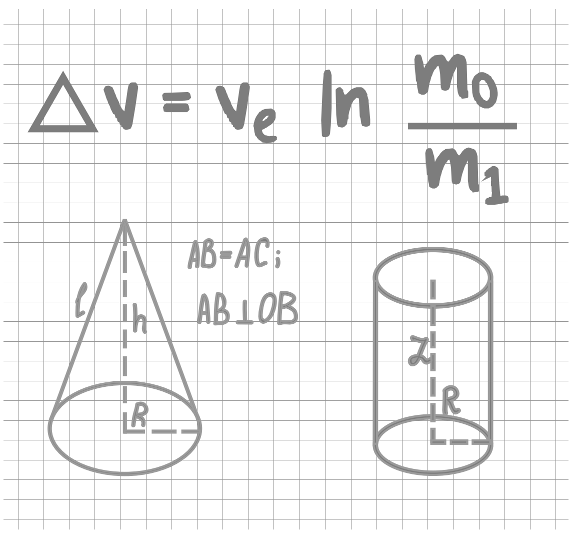
In October 2014, millions of young people across the nation—like you—will become scientists for the day during the seventh annual ***4-H National Youth Science Day*** (**NYSD**).

NYSD is the premiere national rallying event for 4-H Science year-round programming. It brings together thousands of youth, volunteers and educators from the nation's 109 land-grant colleges and universities to simultaneously complete the National Science Experiment.

The 2014 National Science Experiment, *Rockets to the Rescue*, provides the opportunity to explore firsthand how aerospace engineering can be used to solve real world challenges—such as food distribution in emergency situations—to make a positive impact in our world.

This IS Rocket Science.

Professional aerospace engineers frequently encounter design challenges when developing, manufacturing and testing aircraft and aerospace products. They are given goals, requirements and constraints, and they must use their creativity and imagination to best solve the problem.



When disasters strike, logistics can be a key challenge for emergency responders trying to deliver food aid and supplies to the people who need it most. Severe storms can flood roads, take out bridges, ports and runways, and make even normal transportation options practically impossible.

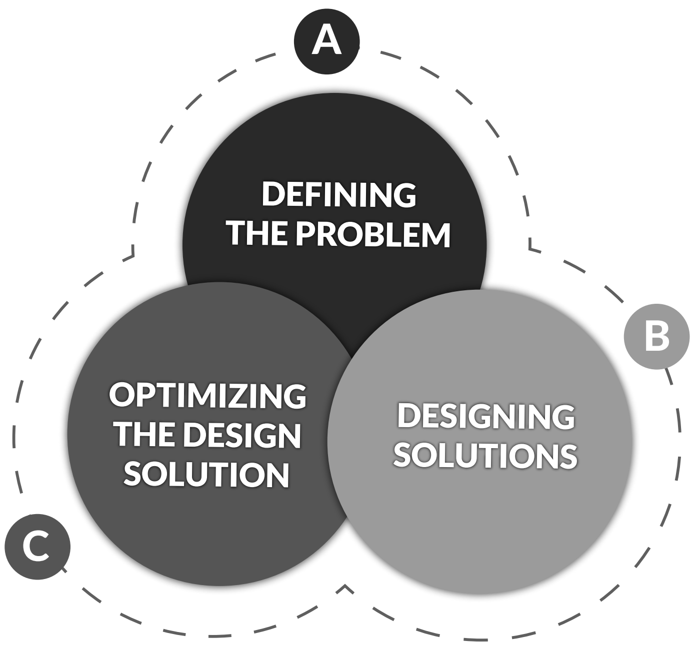
As an aspiring aerospace engineer, your challenge is to come up with an aerospace design idea for solving this problem. This is the premise for the 2014 National Youth Science Day Experiment.

Think Like an Engineer

Engineers design and build all types of structures, systems and products that solve problems and make a difference in how we live, learn, work and play. Aerospace engineers specialize in designing aircraft, spacecraft, satellites, missiles and other high-altitude vehicles. They also test prototypes to make sure that they function according to design.

At the heart of their work are **engineering design practices**, a collection of processes that engineering teams use to guide them as they explore possibilities and solve problems.

Core Engineering Design Process



A **Defining engineering problems** involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits.

B **Designing solutions to engineering problems** begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

C **Optimizing the design solution** involves a process in which solutions are systematically tested and refined, and the final design is improved by trading off less important features for those that are more important.

As part of the engineering design process, engineers may repeat these steps over and over again, refining and changing their designs until they get it just right. As part of the **2014 National Science Experiment**, you will use these practices to carry out your challenge.

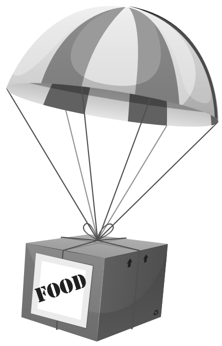
THE SCIENCE EXPERIMENT

Rockets to the Rescue provides the opportunity to let your imagination take flight and explore how aerospace engineering can address real world problems, such as delivering food and supplies in emergency situations.

Using the lessons you've learned in science, math and physics, you will design and develop an aerodynamic Food Transportation Device (FTD) that can deliver a **payload** to a desired target using different trajectories.

ROCKETS TO THE RESCUE

Food Delivery Takes Flight



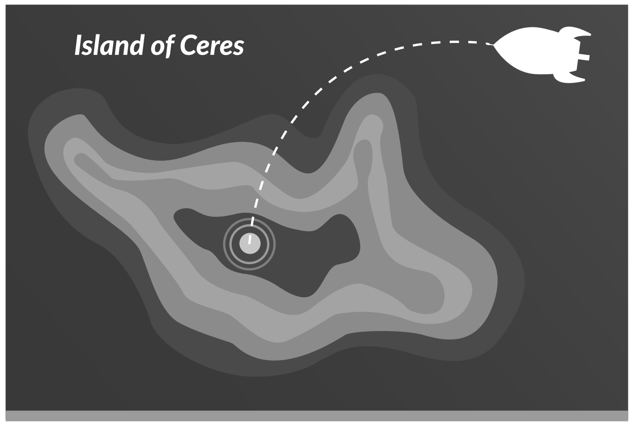
In emergency situations, such as a natural disaster, logistics can be an incredible challenge. Speed is the name of the game. *What is the quickest and most efficient way to gather and deliver vital resources and supplies—such as food—to the people who need it most? Can we use rocket science to help people in the affected communities survive and recover?*

Imagine being stranded on a remote island without food, water, shelter or medical supplies for a week. This was a real situation for thousands of Filipinos in November 2013. In that month, Typhoon Haiyan, estimated to be one of the worst storms ever recorded, struck the Philippines. It killed thousands of people and destroyed entire towns and cities on six of the major islands, displacing millions of people.

Could aerospace engineering principles be used to help in an emergency situation? Let's find out.

3-2-1 Lift Off! | ***4-H aerospace engineers to the rescue!***

THE CHALLENGE



A severe storm just hit several islands in the Pacific Ocean, resulting in damage of historic proportions. Bridges are gone. Harbors are destroyed. Roads have disappeared. Communications systems have been uprooted. Entire towns have been wiped out as a result of storm surges and tsunamis.

The inhabitants of a small island named **Ceres** have been completely cut off from all food deliveries. After nearly a week, they are close to starvation. Ships are on the way but will not arrive for several more days. Airplanes cannot land because the runways are destroyed. Helicopters are not a viable solution.

As a team of aspiring aerospace engineers, you have been asked to use a rocket propulsion system to launch and deliver a payload of food to this island. The food needs to arrive intact and still fresh, so that the people of Ceres can survive long enough until normal transportation options have been restored.

The situation is urgent. You and your team do not have much time.

Are you up for the task? | ***Let's Go!***

On the Job: It Takes Teamwork

Individuals don't build rockets. Teams do. Aeronautic engineering requires dozens of teams working in highly supervised coordination. No aerospace engineer works alone, so strong teamwork skills are an essential part of the job. When working in a team, it is important to be considerate and respectful of each member's thoughts and ideas and judge them based on their own merits.

THE EXPERIMENT

Time required: 90 minutes

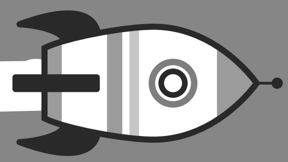
YOUR CHALLENGE

Design, build and test a propulsion system and prototype Food Transportation Device (FTD) that can accurately deliver its food payload to a specific target.

MATERIALS

To build the FTD, each team will need:

- 1 FTD Construction Kit *(enclosed in a large plastic bag)*
  - » 2 sheets of 8 ½ X 11 cardstock
  - » 3 sheets of paper
  - » 10 rubber bands
  - » 1 plastic grocery bag
  - » 3 feet of string
  - » 4 cotton balls
  - » 1 rubber cork
  - » 4 straws
  - » 2 pipe cleaners
  - » 1 sheet of gift tissue paper
  - » 12" section of ½" PVC pipe for rolling tube *(Use one of the 3 sections provided for the launcher. Teams will need to share.)*
- 4 raisins
- Packing tape
- Scissors



FOR THE LAUNCH YOU WILL NEED:

- 1 rocket launcher kit *(This is built in Step #3.)*
- Safety goggles
- Hula hoops, rope or chalk to create and mark different targets
- Measuring tape
- Duct tape

Step 1: Identify the problem.

Your team has been tasked with designing, building and testing a propulsion system and prototype Food Transportation Device (FTD) that can accurately deliver food to the island.

Take a few moments to reflect upon what you already know about rockets.

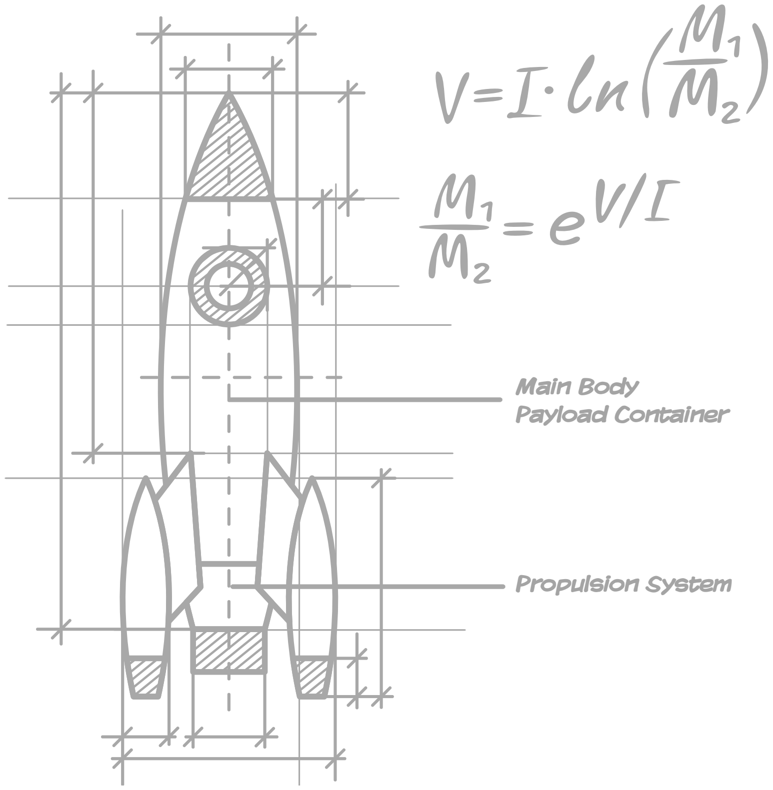
Step 2: Form teams and secure materials.

Working with your team members, you will use the materials you have been provided to design, construct and test your FTD. You may choose to determine roles for each team member, such as chief engineer, materials specialist, builder, recorder, reporter, etc. The FTD is comprised of two parts: a propulsion system and a payload container.

- A **propulsion system** is a machine that produces thrust to push an object forward. In this activity, we refer to the base of the FTD as the *propulsion system*, but it is actually the stomp launcher and this base working together that propels the FTD into the air.
- The **payload container** is the part of your rocket that will carry the food (four raisins) that will be transported to the island.

TALK ABOUT IT

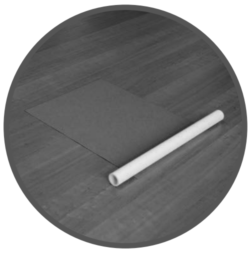
- What shapes in nature are the most resistant to outside pressures?
- What shapes are the most sleek and aerodynamic?
- How will you create space for your payload?
- How will the role of **gravity** affect your design?
- How might you lessen the impact of a hard landing?
- What **angle** is going to be best for your **trajectory**?



Step 3: Build a launcher.

Before you begin to build your FTD, you must work with the other teams of engineers in the room to construct a launcher that will be shared by everyone. Use the materials and instructions provided by the facilitator.

Step 4: Build a propulsion system.



A | Place the PVC rolling tube at the narrow end of the one sheet of cardstock.

B | Roll the entire sheet of paper tightly around the rolling tube.

C | The paper tube should be relatively tight, but not too tight. If it is too loose or too tight, it will not work well as a propulsion system.

D | Seal the edges of the cardstock paper with packing tape. Be careful not to tape it to the PVC rolling tube.

E | Carefully slide the cardboard tube off the PVC rolling tube. This is now your propulsion system.

F | Place a rubber cork into one end of the paper tube and secure with packing tape. Leave the other end open. This is the part that will go over a tube on the launcher.

G | Place the propulsion system back on the PVC rolling tube. Try sliding it back and forth on the tube to ensure that the propulsion system hasn't changed diameter or is too tight. If so, you will need to start over.

Step 5: Test launch your propulsion system.

Now you have a chance to test your propulsion system on the launcher to ensure the integrity of your design and estimate the correct angle and trajectory you will need to successfully launch your FTD.

Use instructions in Appendix A to test the propulsion system *without* a payload. Take turns launching your propulsion system using a variety of angles for the launch tube and measuring the distance of each to get an idea of the capacity of the launcher.

Draw what you see and record your distances. When launching the propulsion system, what seems to work well? What doesn't work well? These will be useful notes to reflect upon when designing, building and testing your FTD.

Step 6: Build your FTD.

The next step is to design a FTD prototype using only the materials that have been provided in your plastic bag. As designers, it is important to think carefully about your concept.

Your FTD will need to be:

- Capable of carrying a specified payload of food items – in this case, four raisins.
- Aerodynamically shaped (not a ball) with recognizable sections and a forward/up orientation.
- Durable enough to survive the impact of landing. The payload must not be damaged.
- Inexpensive and easy to replicate by others.

Use this area to **create sketches and designs of your proposed FTD**.

After you've built your FTD, give your team a name. You should also give your FTD a name and write it on your propulsion system.

This will be important for tracking your results later.

TEAM NAME:

FTD NAME:

Step 7: Launch your FTD.

You will now have the opportunity to test and launch your FTD.

Your goal is to land in the defined target area—a bull's-eye is 5 points, the second level is 3 points and the outside circle is 1 point. No points are awarded for failing to get within one of the 3 rings of the target area.

The first launch will be an opportunity to test your FTD on the launcher to ensure the integrity of your design as well as estimate the correct angle and trajectory you will need to successfully launch your FTD. You will then have the opportunity to make adjustments and launch your FTD again. Repeat this process as needed, until you achieve a design that works.

Step 8: Record your data.

Record your data using the chart below. Only alter one variable at a time!

Team Name: **FTD Name:**
Location of Launch (indoors/outdoors) **Wind Conditions (if outdoors):**
Team Members:

Trial #	Angle of Launch Tube *(in degrees)*	Position of FTD on Launch Tube *(all the way, half-way down, ¼)*	Person Stomping on Bottle	FTD Design and/or Adjustments Since Previous Launch/Trial	Points Scored *(0, 1, 3, or 5)* and Observations
1					
2					
3					
4					
5					
6					
7					
8					

SAFETY FIRST!

Always wear safety goggles when launching your FTD.

Step 9: Reflect, discuss, and redesign (then repeat steps #7-9).

As you are completing your trials, keep track of what is working and what isn't working:

What Works *(Ex. fresh bottle)*	**What Doesn't Work** *(Ex. fatigued bottle)*

Incorporate what you learn from each new launch.

Take a few minutes to review and share what you have observed.

TALK ABOUT IT

- Which FTD landed closest to the target?
- Which designs worked well? What designs didn't work?
- What did you learn when testing your FTD?
- What did you learn about the angle and trajectory you used?
- What changes did you make in your design after observing other launches?
- What might you have tried earlier in the design and build process to improve your success rate?
- What were some of the tradeoffs you considered when developing your design?

Step 10: Apply what you learned.
Think about your original challenge: to design a solution capable of bringing food to the people of Ceres. How can what you've learned from this activity be applied to real world situations?

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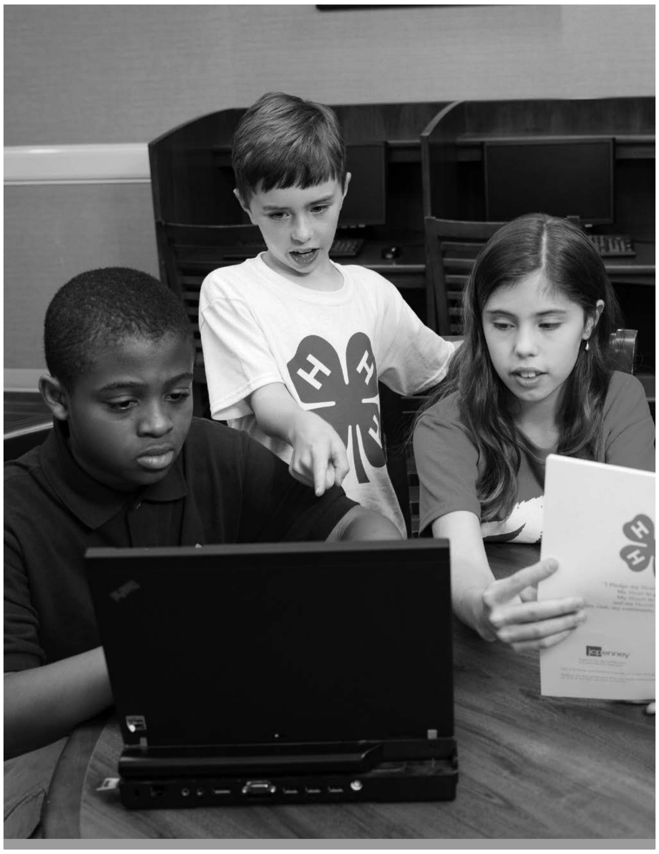


THINK ABOUT IT

- In thinking about world food distribution problems, what can you suggest that might help quickly get food to people in need?
- Are there better ways to quickly deliver food to isolated populations?
- Given the facts that devastating storms are just as likely to occur again, how might countries better prepare for such catastrophes?
- What other long-term and sustainable ideas can you come up with for feeding hungry people?

READY FOR MORE?

Now that you have completed Activity 1, continue your engineering exploration with two additional activities, available for download at **www.4-H.org/NYSDregister**.

Activity 2: Incoming! Fragile Fruity Payload

Activity 3: Really Fast Food to the Rescue ($E=mc^2$)

TAKE IT FURTHER

Don't forget to register at **www.4-H.org/NYSDregister** to access supplemental *Rockets to the Rescue* activities, register your local event and much more.

ADDITIONAL ACTIVITIES RELATED TO THIS EXPERIMENT

- **High-Pressure Foam Rocket**
  http://makezine.com/projects/high-pressure-foam-rocket

- **How to Make Match Rockets**
  http://makezine.com/2012/07/02/how-to-make-match-rockets

- **How High Did it Go? By Robert L. Cannon. Estes Educator.com**
  Elementary Mathematics of Model Rocket Flight
  http://www.estesrockets.com/rockets

- **How Fast Did it Go? By Robert L. Cannon. Estes Educator.com**
  http://www.estesrockets.com/rockets/

- **Soda Straw Rockets**
  http://www.jpl.nasa.gov/education/images/pdf/sodastrawrocket.pdf

APPENDIX A – HOW TO LAUNCH YOUR FTD

3-2-1 LIFT OFF!

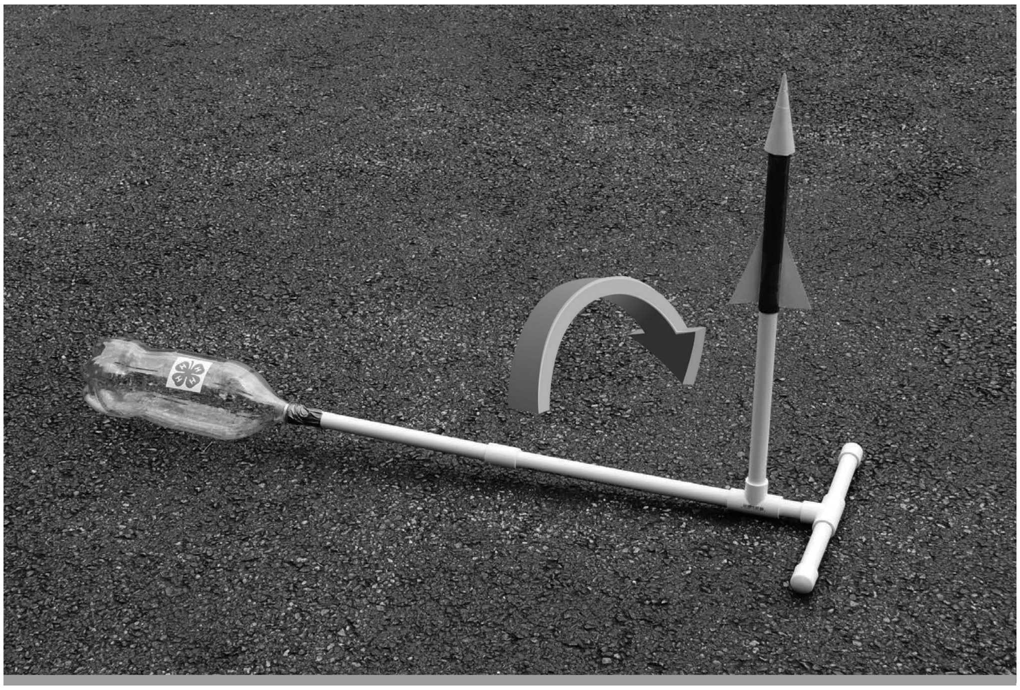
Prior to launch, construct the Soda Bottle Launcher using the instructions and materials provided by your facilitator.

Step 1: Place the launcher in an open space.

If the ground is soft, consider putting a solid object, such as a piece of plywood, under the bottle to create a solid surface.

Step 2: Tilt the launch tube in the direction you want the FTD to go.

The launch tube can be aimed at different angles by tilting to one side or another.



Step 3: Slide the rocket down the launch tube.

Step 4: Prepare for take off.

Make sure the landing zone is clear of people and that any participants involved in launching the rocket are wearing eye protection.

Step 5: Countdown to zero.

Stomp or jump on the bottle, using the sticker on the bottle as a target. This will force most of the air inside the bottle through the tubes and will launch the rocket.

Step 6: Re-inflate the bottle.

Separate the bottle from the launcher by pulling it from the connector. Wrap your hand around the pipe end to make a loose fist and blow through the opening into the pipe. Lips should not touch the tube. Use your other hand to help flex the bottle back into its original shape. Reconnect the bottle to the launcher. It is ready to go again.

GLOSSARY

Acceleration - The rate that velocity changes with time. Acceleration has magnitude and direction.

Angle - The figure formed by two lines diverging from a common point. In this experiment, youth will use a protractor to estimate the angle of launch, which will influence trajectory.

Ceres - The Roman goddess of agriculture and the name of an island in the Pacific Ocean.

Drag - The resisting force of an object moving through the air. The force you feel when you put your hand out of the window of a moving car is drag.

Engineering - The application of scientific and mathematical principles to practical ends such as the design, manufacture and operation of efficient and economical structures, machines, processes and systems.

Gravity - The attraction of an object to the mass of the earth.

Kinetic energy - The energy of an object in motion.

Momentum - The product of mass and velocity of a moving object. The momentum is a significant factor in the flight of the FTD.

Objective – A measurable characteristic to be achieved by the system, such as the FTD.

Payload - The cargo carried by a craft for a particular mission.

Potential Energy - Stored energy, such as the air that is compressed in the FTD launcher.

Prototype - An experimental model or example on which a final design is based.

Trajectory - The path an object takes when moving through the air. The trajectory is a function of velocity, momentum and drag.

Velocity - Adds the direction of motion to the speed. For this FTD, the velocity can be given as its speed going away from the launcher at the angle from the ground.

NOTES

College of Agriculture and Life Sciences
Arizona
Cooperative Extension
4-H Youth Development

National 4-H Council

USDA United States Department of Agriculture
National Institute of Food and Agriculture

Lockheed Martin

HughesNet

John Deere

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4-H, the nation's largest youth development and empowerment organization, cultivates confident kids who tackle the issues that matter most in their communities right now. In the United States, 4-H programs empower six million young people through the 109 land-grant universities and Cooperative Extension in more than 3,000 local offices serving every county and parish in the country. Outside the United States, independent, country-led 4-H organizations empower one million young people in more than 50 countries. National 4-H Council is the private sector, non-profit partner of the Cooperative Extension System and 4-H National Headquarters located at the National Institute of Food and Agriculture (NIFA) within the United States Department of Agriculture (USDA).