Introduction

Welcome to Science F!

Throughout this program, your students will make plastic from corn, extract DNA, watch the effects of acid rain, look around corners, and so much more.

The 36 experiments in this program will introduce your students to Astronomy, Earth Systems, Physics, and Engineering Design. They are designed to teach your students to think like scientists and use real scientific skills and practices.

What do Students Need to Know?

In the past, science instruction focused on teaching students what we already knew about science. However, as technological growth and development exploded in recent years, we realized that simply teaching students what we know now isn't sufficient—it doesn't adequately prepare them for the future. The technology and scientific developments our students will use when they are adults haven't been invented yet. So how do we prepare them for what they will need to know when it is still unknown to us?

Instead of teaching facts and knowledge, our instructional focus needs to shift. In addition to exposure to familiar science topics, such as Physical Science, Life Science, and Earth and Space Science, today's students also need skills and scientific practices that will help them find out what they need to know on their own. They need to become innovators and developers, not just passive consumers of scientific knowledge. By the time your students are ready to further their education or to enter the workforce, they need to know how to investigate purposefully, build models, ask useful questions, and be able to report their findings so they can share what they learn with others. They should also be able to develop creative solutions to problems and build and test their designs to determine how well they work. Once tested, they should be able to improve their designs so they can develop an even better solution. The lessons required to arrive at this destination will need to be hands-on, interactive, and student-driven. They may be a little noisy, and hopefully not too messy, but certainly an adventure like no other.

Introduction

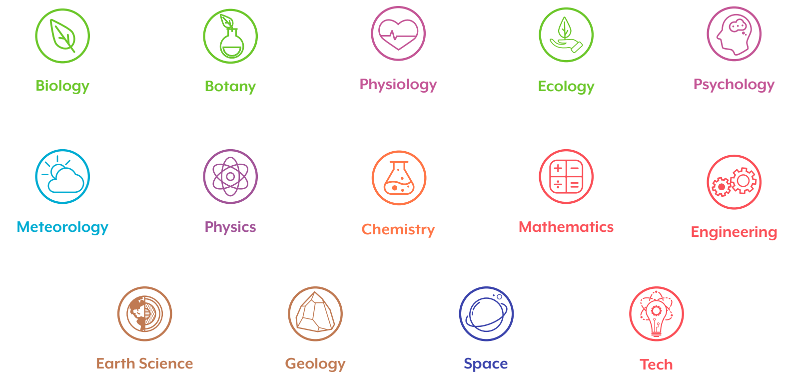
How This Program Works

Throughout this program, your students will use the Scientific Method to explore their world, not just memorize the steps. Your students will brainstorm solutions to problems, and have space to come up with ways to test them with you. Together, we will begin to prepare them to think for themselves, weigh the claims they encounter around them, and innovate on their own. We will also incorporate key Scientific and Engineering Practices to explore ideas that connect across all subjects, like cause and effect, patterns, structure and function, systems, stability and change, cycles, and more.

In addition to practicing the Scientific Method, you will also begin to teach the process of Engineering Design, in which students investigate a problem they can solve through design. Some lessons will present a challenge or problem which will require your students to design (and build!) a solution, and then they will test their solution's effectiveness in solving the problem. From there, they may also apply what they learned from their tests toward designing an improved solution.

BookShark's *Science F Experiments Book* will serve as your roadmap for this year's experiment instruction. We have chosen easy experiments that will fascinate your students and help them begin to develop key scientific skills through exploration. Before you start teaching, take a few minutes to familiarize yourself with this book and the structure of each experiment.

Each lesson begins with an overview of the **Key Concepts** that are intended to give you, the instructor, a big-picture view of the goals of the lesson. By the end of the experiment and discussion, your students should have a solid understanding of the lesson's Takeaways (which mirror the Key Concepts), so you know they have mastered the important information. And since each lesson is truly an exploration, your students will often delve into elements of several different scientific disciplines in a single day.



Let's Get Started

To help you teach with confidence, we recommend you read through each experiment the night before. You may also use this time to gather the supplies you supply. While you will find some experiment supplies around your home, we have collected a number of materials for your convenience in our **Science Supplies Kit**, listed with a **K** in the Materials List. The data charts and templates, listed with a **P**, follow each experiment and are also included in the **Paper Packet**.

The **Appendix** of this book includes a complete list of the supplies you will need to provide yourself, a list of items in the Science Supplies Kit, and a list of charts and templates in the Paper Packet.

A few of the experiments require some early preparation, which we'll warn you about in a **Before You Begin** note at the start of the experiment. Be sure to check the next experiment for this note when you wrap up an experiment so you will be fully prepared to teach the next lesson when you intend to.

When you have gathered the supplies and are ready to teach, head to the experiment's **Introduction** and simply start reading to your students. Our provided instruction helps you pique your students' curiosity about each day's topic, and will challenge them to **Make a Prediction** about what they will experience in the experiment. The **Investigate** section offers step-by-step procedures that walk you through the experiment itself, and includes discussion information to help you explain what's happening along the way. Use the questions under **Draw Conclusions** to bring the concepts and observations together, and close with the thoughts under **Takeaway**.

As you have time, enjoy the information under **See the Bigger Picture** which illustrates how the scientific principles discussed in the lesson apply to the world at large. Also, be sure to check out the **Make Connections** section as you work to add more depth and extend conversation about the experiment's topic. We also include **Tips** to help you know what to expect and complete the investigations with as few bumps as possible. If your students still want more, try out the suggestions under **Go Further** for related activities that will help you extend the exploration.

Plan for your students to take an active role in setting up the experiment and completing the steps (with your help, of course). Give them room to be curious and ask questions. If we don't address something that comes up as you work by the end of the experiment, make a note to help them find the answer later. The more you can support their curiosity and inquisitiveness, the better you will teach them to think like a scientist. And don't forget—they can help you clean up, too!

You are Ready to Begin!

We can't wait for you to start this grand adventure with your students, helping them to explore their world while learning to think like scientists and design like engineers. Through this journey, you will prepare them to be an active part of a future that we can't even imagine today.

Experiments

1

Can You Improve a Catapult?

Key Concepts

The engineering design process is a process you can use to create new products and solve problems.

Materials

- 25 popsicle sticks K
- 2 wide craft sticks K
- 2 straight straws K
- 2 wooden skewers K
- 2 rubber bands K
- 2 condiment cups K
- glue gun with glue sticks
- scissors
- 5 mini-marshmallows or small pom-poms
- Can You Improve a Catapult? Test Chart P

K Indicates the item is in the Supply Kit.

P Indicates the item is in the Experiments Paper Packet.

Introduction

Look around! There are amazing inventions everywhere. Engineers and inventors are people just like you who have used their creativity and knowledge to solve problems. Engineers use a step-by-step process called the **engineering design process** to create new products and solve problems. You can use this same process to modify designs.

The engineering design process involves six basic steps:

1. **Ask** a real-live question that needs to be solved.
2. **Imagine** solutions to the problem.
3. **Plan** how you can make a prototype (a first model of your solution).
4. **Create** the prototype.
5. **Test** the prototype.
6. **Improve** the prototype by making changes to the design.

Now that you are familiar with the engineering design process, it is time to give it a try! In this activity, you will construct a catapult and use it to launch marshmallows. Then, you will research ways to modify the catapult's design and construct a new catapult based on your research. After comparing the catapults, you will determine which one was better at launching marshmallows.

Make a Prediction

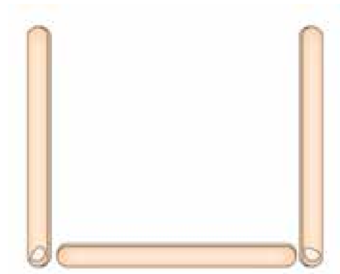
How can you use the engineering design process to improve the function of a catapult?

1

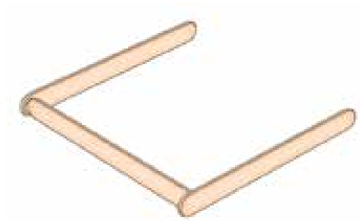
Investigate

Your challenge is to construct a catapult that can launch a marshmallow 3 feet.

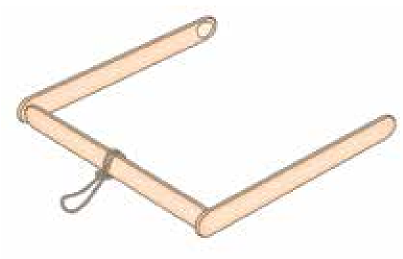
1. Lay two popsicle sticks on the table and stand them up along their long edge.



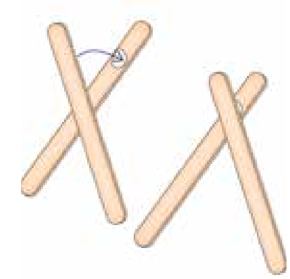
2. Use hot glue to connect the two pieces together with a 3rd popsicle stick.



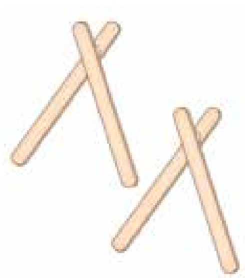
3. Tie the rubber band to the popsicle stick that connects the two upright sticks. Allow the loop to extend backward. The rubber band should be pulled tight against the popsicle stick.



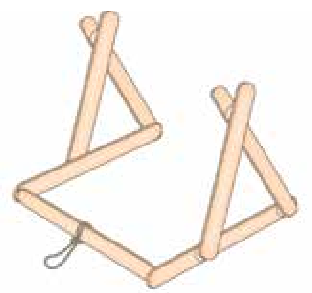
4. Glue 2 popsicle sticks in a “X” shape with the center of the X closer to one side than the other.



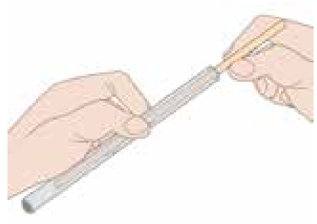
5. Repeat Step 4 with two more popsicle sticks.



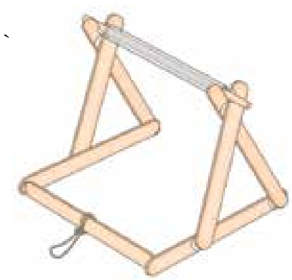
6. Attach the “X” supports onto the frame you built earlier, as shown below.



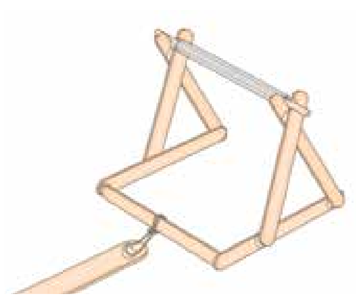
7. Cut a piece of straw to slide over the wooden dowel rod (or skewer).



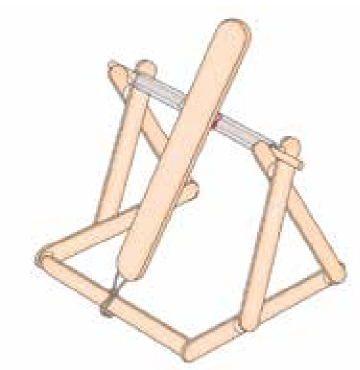
8. Attach the skewer across the top of the side braces.



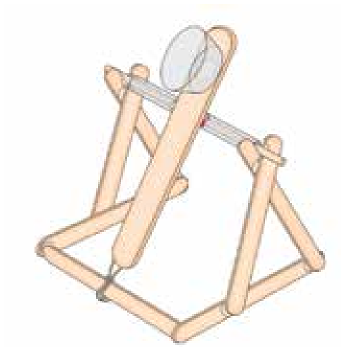
9. Glue the rubber band to the end of a wide craft stick.



10. After the glue hardens, hold the wide craft stick by the opposite end and find the location where it rests on the straw without putting tension on the rubber band. Mark that location on the bottom of that craft stick. Add hot glue to the mark on the craft stick and glue the wide craft stick to the straw.



11. Glue the condiment cup to top of the wide craft stick.



1

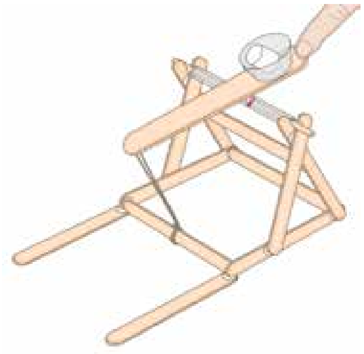
Make Connections

When you think of catapults, you probably think of contraptions used to launch rocks into castles during wars in the Middle Ages. Catapults were actually used long before castles appeared in history. Many different cultures used some variation of catapults over many centuries. It is believed that catapults were first used in China in the 3rd and 4th Century BCE. The first catapults were similar to a long crossbow, but with a swinging arm. Catapults are complex machines that store energy then quickly release it to fire a projectile. In this case, the stored elastic energy was converted to mechanical energy when you pulled back the large craft stick and then released it.

12. Add two more popsicle sticks to the front of the catapult to stabilize it for the launch.

13. Add two more popsicle sticks horizontally to the back of the catapult to add support to the structure.

14. Test your catapult by putting a marshmallow in the cup, pulling the arm down, and letting go quickly.



15. Launch 3 marshmallows. Record your observations on the **Test Chart** located after this experiment on the **Engineering a Catapult Worksheet**.

16. Complete questions 1 through 5 on the **Engineering a Catapult Test Data** worksheet to plan improvements and build a better second catapult.

Draw Conclusions

- Were you successful in improving the design of your catapult? If so, in what ways did you improve upon the first design? If not, how was the first design better?
- Why do you think the catapult machine was abandoned as a military weapon?
- Can you think of a way a catapult could be used to solve a problem you face every day, or how it can be used to make something easier in your life?
- Can you think of a new use for a catapult? Explain.

Takeaway

Engineers use the engineering design process to come up with new ideas for buildings, computers, water purification systems, toys, and so much more. They approach the process just like you did in this activity. By first identifying the problem, then finding possible solutions, developing a prototype, and testing the prototype. Engineers work in teams. Working in teams is a valuable way to approach a problem. Each team member has different ideas that they can contribute to brainstorming sessions.

Go Further

With an adult's permission, research other weapons used in history, such as slings and slingers which were the precursors to a slingshot. Make a list of ways the machine could be modified to help society today, in a positive way. Use the engineering design process to make a prototype of your idea and share your idea with others.

See the Bigger Picture

If you love to solve problems and think of new ways of doing things, maybe you should consider a career as an engineer. An engineer is a person who designs and builds structures, machines, or new products. Engineers like to find out how and why things work the way they do. The field of engineering has several different branches, such as chemical engineering, civil engineering, mechanical engineering, and electrical engineering. Engineers work with other professionals to help design and build new things.

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Can You Improve a Catapult? Test Chart

Test Chart:

	Distance
Launch 1	
Launch 2	
Launch 3	

1. What is the longest distance the machine launched a marshmallow? ________________

2. Were you successful in launching the marshmallow 3 feet? ________________

3. Using the Internet or other sources, research different ways to construct a catapult. List your findings below:

4. Think of some ways you can improve your machine. List the improvements below:

5. Choose the best idea for improving upon your catapult. Make a list of materials you need, then draw a diagram on the other side of this page of your best idea:

   Materials:

1 Can You Improve a Catapult? Test Chart

Diagram