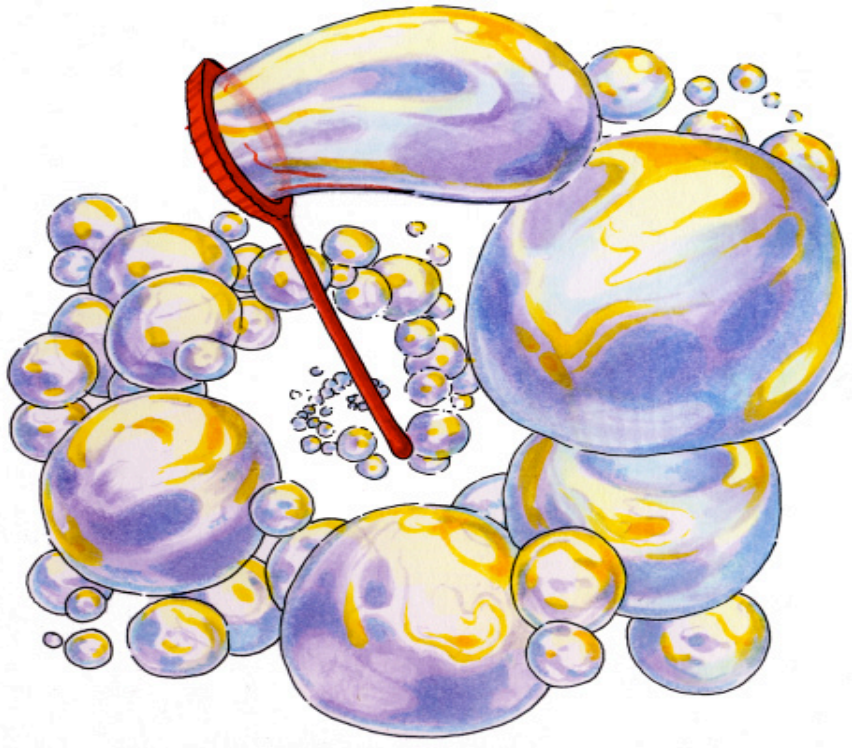
Engineering Adventures™

Bubble Bonanza: Engineering Bubble Wands

Materials Engineering for Kids in Out-of-School Time



Written by the Engineering is Elementary Team
Illustrated by Ross Sullivan-Wiley

Engineering is Elementary®
National Center for Technological Literacy®
Museum of Science, Boston

Engineering is Elementary
Museum of Science
1 Science Park
Boston, MA 02114

Written by the Engineering is Elementary Team

Project Director:
Christine Cunningham

Research and Evaluation:
Cathy Lachapelle
Jennifer Jocz
Jonathan Hertel
Chantez Neymoss
Preeya Phadnis
Stephen Sullivan

Multimedia:
Bharat Battu
Michelle Mizner
Jean Towns

Interns and Consultants:
Carolyn DeCristofano
Rachell Arteaga
Liz Jackson
Daniel Nass

Curriculum Development:
Owen Berliner
Martha Davis
Michelle DiIeso
Melissa Higgins
Katy Laguzza

Professional Development:
Valerie Costa
Erin Fitzgerald
Kristin Sargianis
Sharlene Yang
Emily Young

Outreach:
Jeffrey Odell

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Engineering is Elementary®

National Center for Technological Literacy®

Museum of Science, Boston

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Introduction

Activities

Note: Starred activities represent extensions to the core curriculum.

About Engineering is Elementary

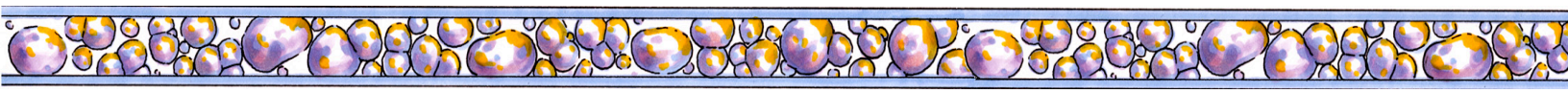
Engineering is Elementary® (EiE) fosters engineering and technological literacy among children. Most humans spend over 95% of their time interacting with technology. Pencils, chairs, water filters, toothbrushes, cell phones, and buildings are all technologies—solutions designed by engineers to fulfill human needs or wants. To understand the world we live in, it is vital that we foster engineering and technological literacy among all people, even young children! Fortunately, children are born engineers. They are fascinated with building, taking things apart, and how things work. Engineering is Elementary harnesses children's natural curiosity to promote the learning of engineering and technology concepts.

The EiE program has four primary goals:
Goal 1: Increase children's technological literacy.
Goal 2: Increase educators' abilities to teach engineering and technology to elementary students.
Goal 3: Increase the number of schools and out-of-school time programs in the U.S. that include engineering at the elementary level.
Goal 4: Conduct research and assessment to further the first three goals and contribute knowledge about engineering teaching and learning at the elementary level.

The first product developed by the EiE program was the Engineering is Elementary curriculum series. This curriculum, designed specifically for use in elementary school classrooms, is research-based, standards-driven, and classroom-tested. The EiE curriculum integrates engineering and technology concepts and skills with elementary science topics and promotes K-12 science, technology, engineering, and mathematics (STEM) learning. For more information about EiE, visit: eie.org.

In 2011, EiE began development of Engineering Adventures (EA), a curriculum specifically for use in out-of-school time settings. While many of the underlying principles of the EiE and EA curricula are the same, EA is designed to address the unique challenges and advantages of the OST setting. More information about EA can be found on the next page, or online at: engineeringadventures.org.

Engineering is Elementary is a part of The National Center for Technological Literacy (NCTL) at the Museum of Science, Boston. The NCTL aims to enhance knowledge of technology and inspire the next generation of engineers, inventors, and innovators. Unique in recognizing that a 21st century curriculum must include today's human-made world, the NCTL's goal is to introduce engineering as early as elementary school and continue it through high school, college, and beyond. For more information about the NCTL, visit: nctl.org.



About Engineering Adventures

The mission of Engineering Adventures is to create exciting out-of-school time activities and experiences that allow all learners to act as engineers and engage in the engineering design process. Our goal is to positively impact children's attitudes about their abilities to engineer by providing materials uniquely appropriate for the varied landscapes of out-of-school time settings.

The main ideas that guide the developers of EA are listed below.

We believe kids will best learn engineering when they:

- engage in activities that are fun, exciting, and connect to the world in which they live.
- choose their path through open-ended challenges that have multiple solutions.
- have the opportunity to succeed in engineering challenges.
- communicate and collaborate in innovative, active, problem solving.

Through EA units, kids will learn that:

- they can use the Engineering Design Process to help solve problems.
- engineers design technologies to help people and solve problems.
- they have talent and potential for designing and improving technologies.
- they, too, are engineers.

As kids work through their engineering design challenges, they will have the opportunity to build their problem solving, teamwork, communication, and creative thinking skills. Most importantly, this curriculum is designed to provide a fun learning opportunity for kids!

For more information on Engineering Adventures, please visit: engineeringadventures.org.

Organization of an Engineering Adventures Unit

Each Engineering Adventures unit introduces kids to an engineering problem that they are challenged to solve. In order to contextualize the problem, kids receive messages from Jacob and India, a globe-trotting brother and sister duo who write about an engineering problem that they have encountered during their travels. India and Jacob serve as models for the kids, as well as content experts, delivering pertinent information as kids proceed through the unit.

Engineering Adventures units are made up of a series of adventures, or activities, based on a common engineering theme. In Bubble Bonanza: Engineering Bubble Wands, kids are introduced to the field of materials engineering through the challenge of engineernig a wacky bubble wand.

The adventures build on each other. Try to encourage the same group of kids to participate throughout the unit. Kids usually won't be totally lost if they miss one activity, but it may be helpful for them to get a quick recap from you or a friend before starting the next adventure.

Most units include one or two optional activities, marked by lowercase letters (such as 1a, 1b, etc.). You may decide to skip them if you are pressed for time.

A minimum of two Preparatory Adventures should be completed before beginning your first Engineering Adventures unit. These adventures introduce kids to the concepts of technology and engineering. The Preparatory Adventures included in every EA unit are:

- Preparatory Adventure 1: What is Technology? Stepping Into Technology (introduces kids to the concept of technology)
- Preparatory Adventure 2: What is Engineering? Tower Power (introduces kids to engineering and the Engineering Design Process)

If you have already completed these adventures with your kids, or they are used to working on engineering activities, you may choose to skip these lessons. Alternately, you might substitute different Preparatory Adventures. Additional Preparatory Adventures can be found on the Engineering Adventures website (visit www.mos.org/eie/engineeringadventures/prep). These Adventures provide suggested modifications for introductions to technology and engineering (more/less physically active versions, arts and drama based versions, etc.).

What You Need to Know Before Teaching an EA Unit

Before you being teaching this unit, there are a couple of things you need to know. The first, and most important thing to know, is that engineering is not scary. In fact, engineering is fun! It's true! The EA team has heard this from many OST educators and kids. Engineering is really a way of problem solving—a way of thinking about the world—that is often very fun, creative, and interesting. Any time you need to solve a problem in order to reach a goal, you are engineering.

The second wonderful thing to know about engineering is that there are no right or wrong answers. There are often many great ways to solve the same problem. Not only is this a good engineering lesson for the kids in your program, it's a good life lesson.

Other Suggestions for Teaching the Unit

1. Consider Posting a Daily Agenda

Giving kids a sense of the day's adventure will help them to plan ahead. After participating in just a few Engineering Adventures sessions, kids will begin to get a feel for the flow of the activities. Particularly when beginning adventures that will continue on another day, it is good to let kids know in advance they will have plenty of time. That way they won't feel compelled to rush through things.

2. Help Facilitate Teamwork

Being able to work well in teams is an important skill for any engineer. Encourage kids to work with each other and to combine their ideas as they design.

Consider assigning or suggesting roles such as:

- Recorder
- Materials gatherer
- Presenter
- Tester

3. Invite Others to See the Showcase

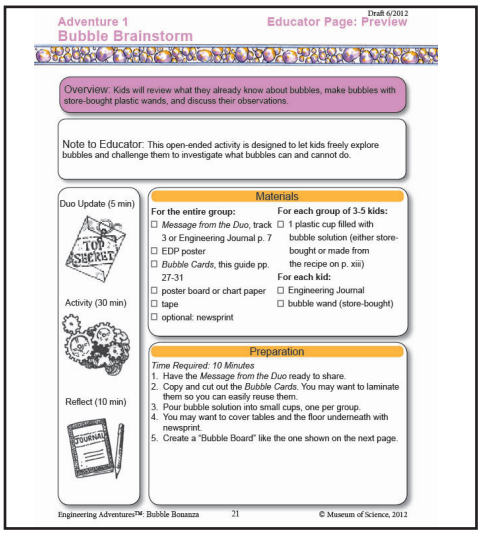
The showcase is a big deal! This is a chance for kids to highlight the engineering they've done and share their accomplishments with others. Consider inviting families, program staff, and other kids to come see the showcase.

4. Try it Out Yourself

It can be very helpful to try out the engineering challenge yourself—either beforehand or right alongside the kids in your program as they work through the adventures. Seeing you exploring and designing can be a strong motivator for the kids you work with, and can also help you understand the challenges kids might face.

Each Engineering Adventure Includes:

Preview Pages with an overview, relevant background information, materials and preparation needed for the adventure, and the Engineering Journal pages kids will use.


Draft 6/2012

Adventure 1
Bubble Brainstorm

Educator Page: Preview

Overview: Kids will review what they already know about bubbles, make bubbles with store-bought plastic wands, and discuss their observations.

Note to Educator: This open-ended activity is designed to let kids freely explore bubbles and challenge them to investigate what bubbles can and cannot do.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:
- ☐ *Message from the Duo*, track 3 or Engineering Journal p. 7
- ☐ EDP poster
- ☐ *Bubble Cards*, this guide pp. 27-31
- ☐ poster board or chart paper
- ☐ tape
- ☐ optional: newsprint

For each group of 3-5 kids:
- ☐ 1 plastic cup filled with bubble solution (either store-bought or made from the recipe on p. xiii)

For each kid:
- ☐ Engineering Journal
- ☐ bubble wand (store-bought)

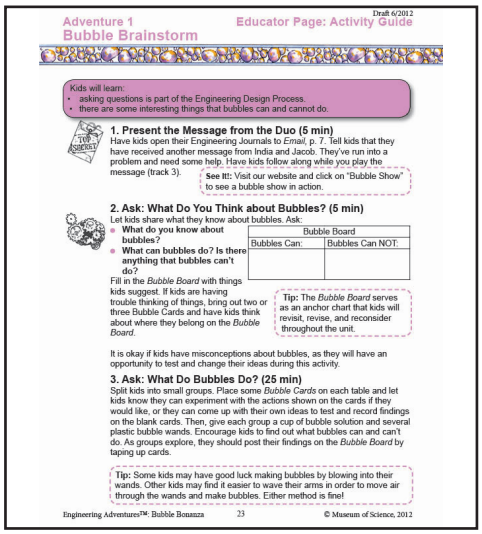
Preparation

Time Required: 10 Minutes

1. Have the *Message from the Duo* ready to share.
2. Copy and cut out the *Bubble Cards*. You may want to laminate them so you can easily reuse them.
3. Pour bubble solution into small cups, one per group.
4. You may want to cover tables and the floor underneath with newsprint.
5. Create a "Bubble Board" like the one shown on the next page.

Engineering Adventures™: Bubble Bonanza 21 © Museum of Science, 2012

An **Adventure Guide** with step-by-step instructions to guide you through the adventure, including discussion questions, extension ideas, and tips.


Draft 6/2012

Adventure 1
Bubble Brainstorm

Educator Page: Activity Guide

Kids will learn:
- asking questions is part of the Engineering Design Process.
- there are some interesting things that bubbles can and cannot do.

1. Present the Message from the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 7. Tell kids that they have received another message from India and Jacob. They've run into a problem and need some help. Have kids follow along while you play the message (track 3).

See It!: Visit our website and click on "Bubble Show" to see a bubble show in action.

2. Ask: What Do You Think about Bubbles? (5 min)

Let kids share what they know about bubbles. Ask:
- **What do you know about bubbles?**
- **What can bubbles do? Is there anything that bubbles can't do?**

Bubble Board	
Bubbles Can:	Bubbles Can NOT:

Fill in the *Bubble Board* with things kids suggest. If kids are having trouble thinking of things, bring out two or three Bubble Cards and have kids think about where they belong on the *Bubble Board*.

Tip: The *Bubble Board* serves as an anchor chart that kids will revisit, revise, and reconsider throughout the unit.

It is okay if kids have misconceptions about bubbles, as they will have an opportunity to test and change their ideas during this activity.

3. Ask: What Do Bubbles Do? (25 min)

Split kids into small groups. Place some *Bubble Cards* on each table and let kids know they can experiment with the actions shown on the cards if they would like, or they can come up with their own ideas to test and record findings on the blank cards. Then, give each group a cup of bubble solution and several plastic bubble wands. Encourage kids to find out what bubbles can and can't do. As groups explore, they should post their findings on the *Bubble Board* by taping up cards.

Tip: Some kids may have good luck making bubbles by blowing into their wands. Other kids may find it easier to wave their arms in order to move air through the wands and make bubbles. Either method is fine!

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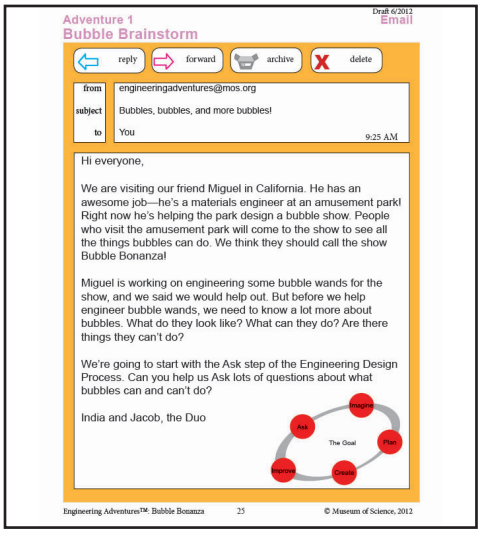
A **Message** from the Duo, India and Jacob. We recommend presenting the audio versions of the messages, but paper copies are included as emails in each adventure and in kids' journals.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Adventure 1
Bubble Brainstorm

Email

reply | forward | archive | delete

from: engineeringadventures@mos.org
subject: Bubbles, bubbles, and more bubbles!
to: You
9:25 AM

Hi everyone,

We are visiting our friend Miguel in California. He has an awesome job—he's a materials engineer at an amusement park! Right now he's helping the park design a bubble show. People who visit the amusement park will come to the show to see all the things bubbles can do. We think they should call the show Bubble Bonanza!

Miguel is working on engineering some bubble wands for the show, and we said we would help out. But before we help engineer bubble wands, we need to know a lot more about bubbles. What do they look like? What can they do? Are there things they can't do?

We're going to start with the Ask step of the Engineering Design Process. Can you help us Ask lots of questions about what bubbles can and can't do?

India and Jacob, the Duo

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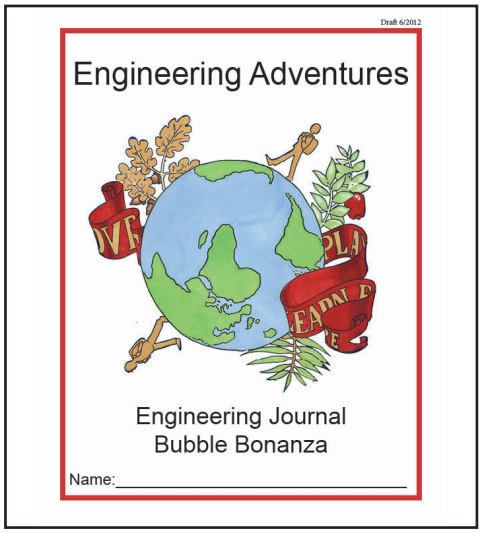
Engineering Journal pages that allow kids to record findings and reflect on their learning.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Engineering Adventures

Engineering Journal
Bubble Bonanza

Name:_____

The Sections of the Adventures

1. About the Messages from the Duo

Messages from India and Jacob, the Duo, are provided as a quick, exciting way to present the real-world context for the unit's engineering challenge. Providing a context helps kids to understand the challenge and be motivated to engage in finding solutions. If you have access to a CD or MP3 player, we strongly suggest using the audio recordings. If you do not have access to a CD or MP3 player, reading the emails aloud will convey the same information. Copies of each email are included in this guide, as well as the kids' Engineering Journals.

2. Set the Stage

The Set the Stage part of each adventure provides important information and questions that will help prepare kids for the day's activity. The questions in this section often ask kids to share any prior knowledge they might have, or ask them to predict what they will find. By helping kids to share their initial thoughts on the challenge, you'll be getting them ready for experiencing and learning new things throughout the course of the adventure and building on what they already know

3. About the Adventures

Adventures are designed to get kids thinking and working together to solve the unit's engineering design challenge. As a provider, you play a leading role in guiding kids through these challenges. Keep an open mind and encourage kids to pursue their own ideas, even if you think they may not work.

4. About Reflection

Reflection is a key component of the Engineering Adventures curriculum, and it's important to leave a few minutes for reflection at the end of each adventure. Reflection time gives kids the chance to internalize new ideas, think about their own work, and remember what was learned. Each adventure includes a brief period at the end for kids to share what they did. The sharing and group questioning that is sometimes suggested during the Reflection section provide time for kids to learn from each other. This sharing of good ideas and making suggestions to help other groups can also help reduce competition and let kids support each others' designs. The reflection section also includes time for kids to record thoughts and ideas in their Engineering Journal.

Engineering Journals

Use the Engineering Journal as a duplication master to create journals for kids participating in the unit. Have an Engineering Journal ready for each kid as you begin working on this EA unit.

The purpose of the Engineering Journal is to provide a central location for kids to record their thoughts and ideas as they move through the unit. The Engineering Journal includes recording pages that will guide kids through the Engineering Design Process, pose questions kids can answer based on their experiences, and prompt kids to reflect on their leanring. After the group discusses the reflection questions at the end of each adventure, it is important to give kids 5-10 minutes to reflect individually in their journals. This time will allow kids to create a personalized record of their engineering learning.

The back page of each Engineering Journal is a passport page from the country or state where the unit takes place. Kids are encouraged to stamp the passport page when they finish a unit. A full passport that includes pages for all EA units can be found online at: www.mos.org/engineeringadventures/passport.

Scheduling the Adventures

This Engineering Adventures unit can be utilized in various out-of-school time settings. Each Adventure is formatted for a 45 minute session. Occasionally, an adventure may go longer than expected or the children may wish to continue an adventure on the following day. We recommend that you budget at least 7-10 hours in order to complete this unit. Consider the ideas below when determining the schedule for leading the unit.

Create a Weekly Schedule

Consider leading the Engineering Adventures unit once or twice a week on given days. Set up an Engineering Adventures club or group that meets to participate in the activities. This scheduling has worked particularly well in afterschool programs.

Pair Adventures Together to Fill Longer Blocks of Time

If you are leading the Engineering Adventures unit in a condensed period of time and can spend a few hours on the activities each day, consider pairing adventures together. This scheduling can work well in camp settings or during week-long school breaks. See the sample breakdown below for which activities go well together:

Day 1	Prep Adventure 1: What is Technology? Stepping Into Technology Prep Adventure 2: What is Engineering? Tower Power	2-3 hours
Day 2	Adventure 1: Bubble Brainstorm *Adventure 1a: Stop the Pop!	2-3 hours
Day 3	Adventure 2: Not Round Bubbles Adventure 3: Best of Bubbles	2-3 hours
Day 4	Adventure 4: Designing a Bubble Wand Adventure 5: Improving a Bubble Wand	2-3 hours
Day 5	Adventure 6: Design Showcase: Bubble Bonanza	1-1.5 hours

Unit Background:

Materials Engineering

Materials engineers are people who use their understanding of different materials (such as metals, plastics, or woods) to make things that solve problems. As part of their work, materials engineers must explore the properties of different materials to help them choose which material will work best to solve the problem.

In this unit, students experiment with many different materials that can be used to make bubble wands, such as metal wire, pipe cleaners, plastic twist ties, and paper. They consider which materials are best for making different kinds of bubbles, and which combination of materials they will use to create their own unique bubble wands.

Bubbles

Bubbles are a very thin layer of liquid (in the case of the bubbles in this unit, the liquid is bubble solution) surrounding a pocket of gas (in the case of this unit, the gas is air). If something punctures the surface of a bubble, the bubble will pop. Not all objects that come in contact with a bubble will puncture the surface, however. An object coated in liquid that has the same surface tension (the same attractive force between molecules) as a bubble can be inserted into a bubble without the bubble popping.

Most of us probably think of blowing bubbles just for fun, but bubbles can actually teach us a lot about math and science. Once fully formed, bubbles always take on a spherical shape. A sphere is the shape that allows for the liquid (the bubble solution) to have the smallest surface area possible. When bubble solution is stretched across a frame (a circular bubble wand or a more amorphous wire or string shape, for example) the bubble solution will also always take on the shape that allows for the smallest surface area possible.

As you and your kids are experimenting with bubbles, take note of the different shapes you see, particularly when bubbles come in contact with each other. Are there certain shapes, angles, or patterns that get repeated? Do the shapes or patterns you see remind you of anything you've seen before in nature?

Tips, Tricks, and Bubble Safety:

Bubble Wands

For some of the adventures in this unit, we note that either store bought wands or homemade wands can be used. The term store-bought wands refers to the ring-shaped bubble wands traditionally sold with bottles of bubble solution. Creating simple ring-shaped wands out of wire will also work to help complete the challenges in this unit.

Bubble Solution

Many people who have experience making bubble solutions have favorite “recipes” or special ingredients they like to add to standard recipes in order to increase the durability or longevity of bubbles. The recipe listed below is one that the Engineering Adventures team has had success with. If you would like to make a favorite recipe of your own, or if you would prefer to simply purchase bubble solution, feel free to do so.

The type of soap you use will matter. Use dish soap made to wash dishes by hand (not in a dishwasher). The brand of soap is important, too. The Engineering Adventures team has found that Dawn® or Palmolive® work well.

A good recipe to start with for a group of about 25 students is:
1 gallon of water
3 cups of dish soap
1 cup of glycerin

Glycerin can be purchased fairly easily and cheaply online, but in a pinch you might try substituting vinegar instead. As long as you store the bubble solution in a covered container, it should last for a long time!

Bubble Troubleshooting

Whether indoors or outdoors, any air currents can make it difficult to form bubbles without them popping. Try to be aware of the air currents in the space where you are working and consider shutting off air conditioning, heaters, or fans while you are working. Low humidity can also affect the durability and longevity of your bubbles. If you’re in a very dry climate, a humidifier can help.

Keeping Engineering Journals Dry

The Engineering Journals provide important learning support for every Adventure, but finding a dry spot in the room to work on them can be tricky! If possible, leave at least one table in the room that is soap-free and available to use for journaling.

Bubble Safety

Bubbles can be messy! While the adventures in this unit are designed to be fun, encourage kids to conduct themselves carefully and responsibly as they explore. Consider setting up a limited number of testing stations and confining the bubble solution to specific areas in order to minimize mess. It is best to cover surfaces near the testing area with newsprint or tableclothes that can easily be removed later on. Do not cover the floor with plastic tarps or table cloths, however, as the plastic can become slippery and dangerous when coated with bubble solution. If you are conducting challenges on tile floors, consider taping down newsprint to minimize slipperiness.

Dipping hands into soap or detergents may not be recommended for children with eczema, contact dermatitis, or very sensitive skin. If a child complains of itching or redness, have them remove and rinse their hands immediately.

Online Resources

For a list of online video resources about bubbles, visit:
www.mos.org/eie/engineeringadventures/bubblevideos.php

Materials List

Material	Quantity
Non-consumable Materials	
stuffed animal, small	1
bubble wands	24 (not included in pilot kit)
fans, small	2
hairbrushes	4
markers or pencils	8
pans or trays for bubble solution	4
rulers	8
scissors	8
tubes, plastic	10 (appx. 3/4” diameter, 8” length)
Consumable Materials	
balloons	20
bubble solution	3 gallons (pilot kit: ingredients included to make your own bubble solution, see p. xiii)
construction paper	1 pack
craft sticks	100
cups, paper	30
deli containers, plastic	24
index cards	800
newsprint (optional)	1 pad
paper	8 sheets
paper towel tubes	30
pipe cleaners	150
rubber bands	100
sandpaper	9 sheets
screen, cut into 4” x 4” squares	12
straws	80
string	1 roll
tape, cellophane	8 rolls
transparency sheets, plastic	20
twist ties, paper coated	200
wire, thin and flexible	8 spools

This materials list anticipates 24 kids, divided into 8 groups.

Vocabulary for Bubble Bonanza: Designing Bubble Makers

Bubble: A thin layer of liquid surrounding a pocket of air.

Bubble solution: A liquid substance (i.e. material) used to make bubbles.

Engineer: Someone who uses his or her creativity and knowledge of math and science to design things that solve problems.

Engineering Design Process: The steps that engineers use to design something to solve a problem.

Material: The substance (or "stuff") of which a thing is made.

Materials engineer: A person who uses his or her creativity and knowledge of science and math to solve problems related to what things are made of and create new materials with new properties.

Technology: Any thing, system, or process designed by humans to help solve a problem.

National Education Standards

		Prep Activity 1: What is Technology? Stepping Into Technology	Prep Activity 2: What is Engineering? Tower Power	Adventure 1: Bubble Brainstorm	Adventure 1a: Not Round Bubbles	Adventure 2: Stop the Pop	Adventure 3: Best of Bubbles	Adventure 4: Designing Bubble Makers	Adventure 5: Improving Bubble Makers	Adventure 6: Design Showcase: Bubble Bonanza
National Science Education Standards	Science as Inquiry			✓	✓	✓	✓	✓	✓	
	Physical Science			✓	✓	✓	✓	✓	✓	
	Life Science									
	Earth and Space Science									
	Science and Technology	✓	✓				✓	✓	✓	
	Science in Personal and Social Perspectives									
	History and Nature of Science									
ITEEA	The Nature of Technology	✓								
	Technology and Society									
	Design		✓	✓	✓	✓	✓	✓	✓	✓
	Abilities for a Technological World		✓				✓	✓	✓	
	The Designed World									

Dear Family, Date: _____

We are beginning an engineering unit called Bubble Bonanza: Designing Bubble Makers, which is part of the Engineering Adventures curriculum developed by the Museum of Science, Boston. Engineering Adventures is a curricular program that introduces children to the engineering design process and various fields of engineering. Throughout this unit, children will learn about materials engineering and work to solve a materials engineering design challenge. The premise for this unit is that children will design different types of bubble wands to help a fictional California amusement park develop a Bubble Bonanza show to entertain park visitors.

There are many reasons to introduce children to engineering:

- **Engineering projects reinforce topics children are learning in school.** Engaging students in hands-on, real-world engineering experiences can enliven math, science, and other content areas.
- **Engineering fosters problem-solving skills**, including problem formulation, creativity, planning, and testing of alternative solutions.
- **Children are fascinated with building and with taking things apart to see how they work.** By encouraging these explorations, we can keep these interests alive. Describing their activities as "engineering" when children are engaged in the natural design process can help them develop positive associations with engineering, and increase their desire to pursue such activities in the future.
- **Engineering and technological literacy are necessary for the 21st century.** As our society increasingly depends on engineering and technology, our citizens need to understand these fields.

Because engineering projects are hands-on, materials are often required. Several materials necessary to this unit are listed below. If you have any of these materials available, please consider donating them to us.

If you have expertise about materials engineering or California, or have any general questions or comments about the engineering and design unit we are about to begin, please let me know.

Sincerely,

If you have any of the following materials available and would like to donate them, I would greatly appreciate having them by the following date: _____ . Thank you!

_____ _____
_____ _____
_____ _____

Prep Adventure 1 Educator Page: Preview
What is Technology? Stepping Into Technology

Overview: Kids play a game that will ask them to decide whether or not an item is a technology.

Note to Educator: Many people think of technologies as only things that are electronic, or things that are "high-tech." Technology is really any object, system, or process designed by people to help solve a problem or meet a need.

Duo Update (5 min)

Activity (25 min)

Reflect (15 min)

Materials

For the whole group:

- ☐ *Message from the Duo*, track 1 or Engineering Journal, p. 1
- ☐ EDP Poster
- ☐ *Technology/Not a Technology List,* this guide, pp. 6-7, or *Technology Cards*, pp. 9-11
- ☐ large sheet of paper or other writing space
- ☐ tape

For each kid:

- ☐ Engineering Journal

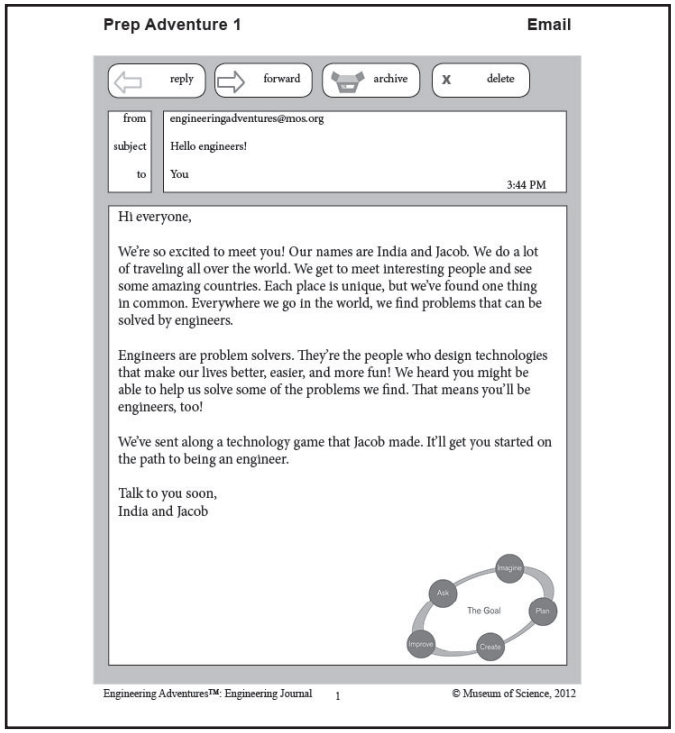
Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. For this activity, you can either read items off of the *Technology/not a Technology List*, or show items using the *Technology Cards*. If you would like to use the *Technology Cards*, cut them out and mix them together.
3. One a sheet or large paper, make a *What's What?* chart as shown on the next page.

Journal Pages for Prep Adventure 1

Message from the Duo, p. 1



Prep Adventure 1 Email

reply forward archive delete

from: engineeringadventures@mos.org
subject: Hello engineers!
to: You
3:44 PM

Hi everyone,

We're so excited to meet you! Our names are India and Jacob. We do a lot of traveling all over the world. We get to meet interesting people and see some amazing countries. Each place is unique, but we've found one thing in common. Everywhere we go in the world, we find problems that can be solved by engineers.

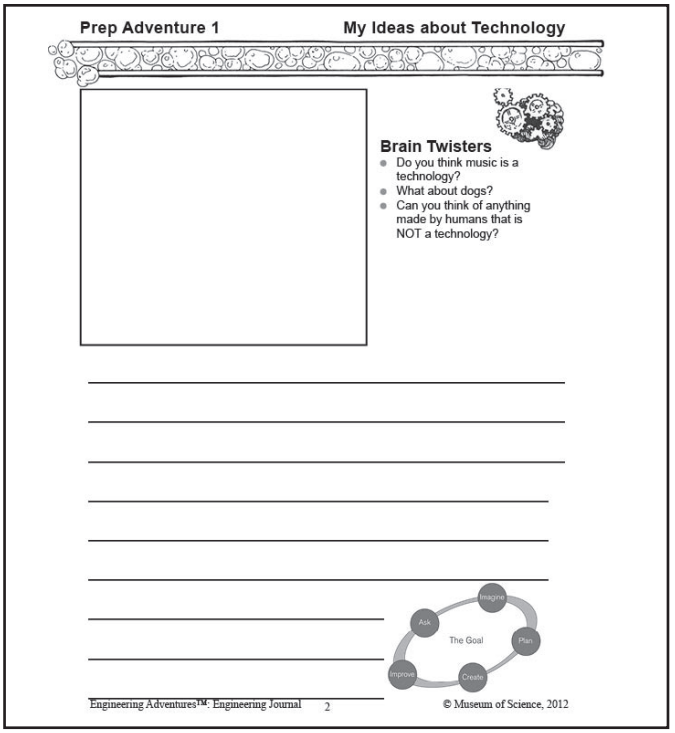
Engineers are problem solvers. They're the people who design technologies that make our lives better, easier, and more fun! We heard you might be able to help us solve some of the problems we find. That means you'll be engineers, too!

We've sent along a technology game that Jacob made. It'll get you started on the path to being an engineer.

Talk to you soon,
India and Jacob

Engineering Adventures™: Engineering Journal 1 © Museum of Science, 2012

My Ideas about Technology, p. 2



Prep Adventure 1 My Ideas about Technology

Brain Twisters

- Do you think music is a technology?
- What about dogs?
- Can you think of anything made by humans that is NOT a technology?

Engineering Adventures™: Engineering Journal 2 © Museum of Science, 2012

Chart for Prep Adventure 1

What's What?	
Technology	Not a Technology

What is Technology? Stepping Into Technology

Kids will learn:
- that technology is anything designed by people to help solve a problem or meet a need.
- engineers design technologies.

1. Present the Message From the Duo (5 min)

Tell kids that India and Jacob are a brother and sister who travel the world. They often find problems that can be solved with engineering and technology. They've sent a message with some information about a game they'd like you to play to learn more about technology (track 1). Have kids turn to p. 1 of their Engineering Journals to follow along.

2. Set the Stage (5 min)

To get kids thinking about technology, ask:

- **Jacob and India mentioned the word "technology". What do you think it means?**
- **Do you think a cell phone is a technology? How about dog food?**

Tell kids that they will find out the definition for themselves as they play a game.

3. Play Stepping Into Technology (20 min)

Split the kids into two groups. Groups should stand facing each other against opposite walls. Have each group choose a spokesperson who will give their group's answers. Hang the "What's What?" chart somewhere visible.

Tip: If you would prefer that kids not compete, play the game as a whole group instead of two teams.

1. Read one item from the *Technology/Not a Technology List*, or hold up a *Technology Card*.
2. Give both groups 15 seconds to decide whether the item is a technology. The spokesperson from each group will give the group's answer.
3. Write the item or tape the card in the correct column on the "What's What?" chart.
4. If a group guesses right, the group can move forward ONE step. If a group guesses wrong, the group can not move.
5. The goal of the game is to be the first group to take 10 steps forward.

Tip: Kids will have the chance to discuss the chart later, so it is okay if they don't understand exactly why an item is a technology or not while they are playing the game.

Once finished, gather kids around the "What's What?" chart. Ask:

- **What do you think the technologies have in common?** *People designed them.*
- **What do you think the items that are NOT technologies have in common?** *They are natural. People did not design them.*

- **If you were writing a dictionary, how would you define technology?** *A technology is anything designed by people to help solve a problem or meet a need.*

4. Reflect (15 min)

Gather kids together. Ask the group:

- **What technologies do you see in this room?** *Examples include the wall, the floor, clothing, anything made by people, etc.*
- **Do you see anything in this room that is not a technology?** *Examples include plants, dirt, sunlight, air, etc.*
- **Who do you think designs these technologies?** *Engineers!*

Tip: Kids may debate about whether some things are technologies. Music, for example, is created by humans, but many people consider natural sounds, like bird songs, to be music as well. Tell kids that engineers debate about this all of the time! Encourage kids to explain their reasoning and come to a group decision.

Show kids the Engineering Design Process poster. Explain that when engineers are designing a technology, they use the steps of the Engineering Design Process to help them. Tell kids they'll learn much more about engineers and the Engineering Design Process as they do more of the activities in this unit.

Give kids time to record thoughts in their Engineering Journals on *My Ideas About Technology*, p. 2.

Extensions: Technology Tag

You will need a large open space to play this game. Label one edge of the space "Technology" and the opposite edge "NOT a Technology."

NOT a Technology | Open Space | Technology

1. Have kids stand in the center of the space.
2. Read an item out loud from the *Technology/Not a Technology List.*
3. Allow kids to run to and 'tag' the spot that they think correctly describes the item as Technology or NOT a Technology.
4. Announce if the item is a technology or not. Ask why it is a technology, then have kids come back to the middle of the space before reading the next item.

You can also seperate the kids into teams, and have them decide as a team if it is a technology or not and go to that space. Points can be awarded to the teams who choose correctly.

What is Technology? Stepping Into Technology

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	What is technology?
to	You 10:36 AM

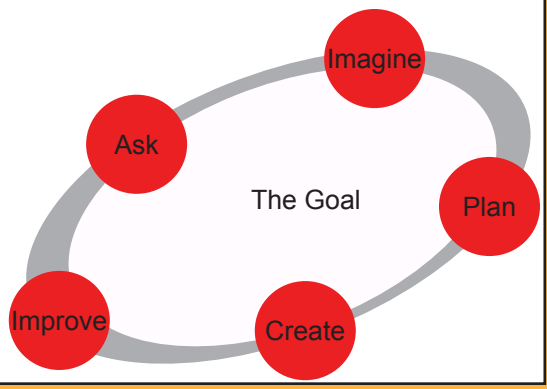
Hi everyone,

We're so excited to meet you! Our names are India and Jacob. We do a lot of traveling all over the world. We get to know interesting people and see some amazing countries. Each place is unique, but we've found one thing in common. Everywhere we go in the world, we find problems that can be solved by engineers.

Engineers are problem solvers. They're people who design technologies that make our lives better, easier, and more fun! Jacob and I design technologies to help solve problems all the time. We heard you might be able to help us engineer solutions to some of the problems we find. That means you'll be engineers, too!

During our travels we've seen some pretty amazing technologies made by engineers. We sent along a technology game that we made. You might be surprised at some of the technologies you'll discover. Understanding more about technologies will get you started on the path to being an engineer!

Talk to you soon,
India and Jacob



Technology

- computer
- television
- wind-up toy
- camera
- paintbrush and paint
- cup
- shoe
- radio
- hat
- soap
- digital clock
- dinner
- light bulb
- paper
- glasses
- cardboard box
- backpack
- cellphone
- dog food
- music
- airplane
- sponge
- pencil
- iPod
- ball
- stapler
- kite
- buildings
- coat
- piano

NOT A Technology

- a chicken foot
- turtle shell
- dried mud
- egg
- mountain
- waterfall
- cave
- cocoon
- toenail
- dirt
- pinecone
- tree
- grass
- ocean
- bird beak
- eyeball
- wind
- ant
- river
- volcano
- lightning
- tomato
- wild flower
- spider web
- hiccup
- fossil
- footprint
- wolf
- feather
- clamshell

"Bonus Point" Technologies

These technologies are things that are sometimes especially surprising to kids:

- buildings
- traffic intersections

Many technologies are objects, but technologies can also be processes or systems.

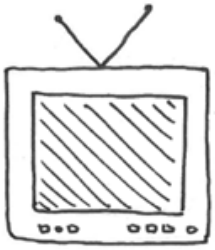
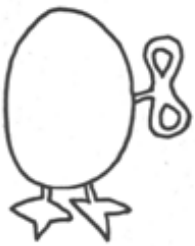
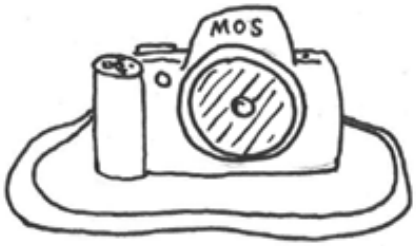
Processes are a series of actions or steps that lead to a goal. These technologies are processes:

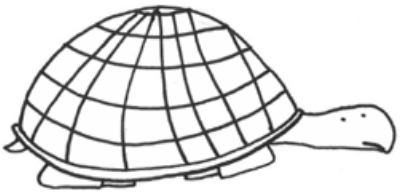
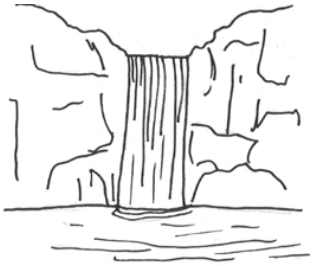
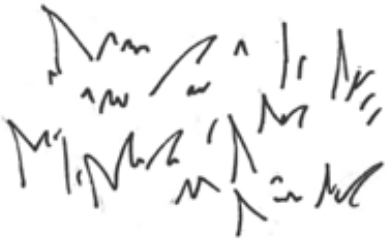
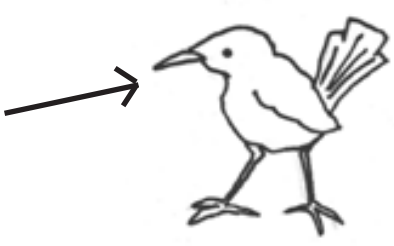
- the steps for making bread dough.
- the Engineering Design Process!

Systems are a group of parts that work together to meet a goal. These technologies are systems:

- an assembly line
- moving baggage through an airport
- the way lines are organized at an amusement park
- subway systems
- sewage systems

What is Technology? Stepping Into Technology

Computer 	Television 	Wind-Up Toy 
Camera 	Paintbrush and Paint 	Cup 
Shoe 	Music 	Paper 
Soap 	Buildings 	Dinner 
Glasses 	Dog Food 	Backpack 

Hiccup 	Turtle Shell 	Spider Web 
Egg 	Volcano 	Waterfall 
Cave 	Cocoon 	Lightning 
Footprint 	Wolf 	Tree 
Grass 	Fossil 	Bird Beak 

What is Engineering? Tower Power

Overview: Kids will design and build an index card tower that will support a stuffed animal.

Note to Educator: Engineering can be a scary word for those who are not familiar with it. Engineers are really just people who use science, math, and creativity to solve problems. Today kids will get the chance to be engineers as they design towers.

Duo Update (5 min)

Activity (30 min)

Reflect (15 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 2 or Engineering Journal, p. 3
- ☐ EDP Poster
- ☐ *Heightened Emotions*, this guide, p. 19
- ☐ timer or clock
- ☐ 1 small stuffed animal

For each group of 3-5 kids:

- ☐ 1 pack of index cards (about 100 cards)
- ☐ 1 ruler
- ☐ 1 pair of scissors
- ☐ At least 1 foot of cellophane tape

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Cut one foot-long piece of cellophane tape for each group. If you think this activity might be difficult for your kids, you may want to give them more tape.
3. Make samples of the cards found on *Building with Cards,* Engineering Journal p. 4.

Journal Pages for Prep Adventure 2

Message from the Duo, p. 3

Prep Adventure 2 **Email**

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Designing a Tower
to	You
	12:09 PM

Hi everyone,

You did a great job figuring out what's technology and what's not. India and I have met lots of engineers all over the world who work to design some of the technologies you discovered. Now that you're well on your way to becoming engineers, we thought we would send you an engineering challenge that we had a lot of fun solving!

The problem is that there are some animals living in a swamp along with lots of hungry alligators. The animals need to be at least one foot above the alligators to be out of their reach. India and I thought we could build a sturdy tower that the animals could jump on as they're moving through the swamp. Do you think you can try engineering a tower for us?

We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. There's a picture of it below. Those are the steps that engineers use when they're trying to solve a problem.

India and Jacob

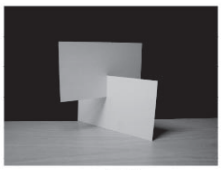
Building with Cards, p. 4

Prep Adventure 2 **Building with Cards**

Here are three ways to build with index cards.

Roll it!

Fold it!



Cut it!

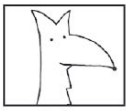
Will any of these ideas help your group build a tower? What other ideas do you have?
Talk with your group to figure it out!

Heightened Emotions, p. 5

Prep Adventure 2 **Heightened Emotions**

Fearless
8 inches and up

Confident
6-8 inches



Calm
4-6 inches

Nervous
2-4 inches

Terrified
0-2 inches

PANIC!

Recording Page, p. 6

Prep Adventure 2 **Recording Page**

Draw Your Tower

Use the space below to draw a picture of your tower. Then answer the question below.

What parts of your tower design would you change if you could do it again?

What is Engineering? Tower Power

Kids will learn:
- the Engineering Design Process is a tool they can use to help solve problems.

1. Present the Message From the Duo (5 min)

Have kids turn to Engineering Journal p. 3 and tell them India and Jacob have a mini-engineering challenge to get everyone ready for bigger challenges to come. They've sent a message with more details (track 2).

To check for understanding ask:

- **What do India and Jacob need us to engineer?** *A tower to save animals from being eaten by the alligators.*

2. Set the Stage (5 min)

Tell kids that today they are going be engineers and use the Engineering Design Process to solve a problem. Give each group a few index cards. Tell them these are the materials they'll have available for building their towers (they'll also get some tape, scissors, and a ruler). Ask:

- **Can you think of any ways you could use these cards to engineer a tower?**

After kids share their ideas, show groups the index card samples you prepared, or have them look at *Building with Cards*. Ask:

- **Do you think any of these examples might inspire your design?**

Split kids into engineering groups of 2 to 4. Show the kids the stuffed animal and remind them the animal lives in a dangerous area with hungry alligators. To be safe, the animal needs to be at least 10 inches above the alligators on a sturdy tower.

1. The challenge is to build a tower that can hold a stuffed animal 10 inches in the air for at least ten seconds.
2. Each group will have 20 minutes to engineer a solution.
3. The only materials that can be used in the tower are index cards and tape. Each team will get a pack of index cards, one foot of tape, and a pair of scissors. The scissors are a tool only and cannot be used in the tower.
4. The kids are allowed to hold the stuffed animal briefly, but can't test it on their tower until the tower showcase portion of the activity.

Tip: You can choose to offer unlimited tape, or you can challenge groups by limiting the tape to one or two feet.

3. Let the Engineering Begin (20 min)

Show groups the Engineering Design Process poster. Ask:

- **Which step do you think will be most helpful as you engineer your tower?**

Give each engineering group a pair of scissors, a pack of index cards, one

ruler, and one foot of tape. Tell kids they have 20 minutes to build. As groups work, circulate around the room. Ask:

- **What type of structure are you creating?**
- **Why do you think that will work well?**
- **Are you using any steps of the Engineering Design Process? Which steps?**

4. Tower Showcase (5 min)

Have each group present their tower. Ask each group:

- **Can you tell us about your design?**
- **How tall is your tower?**
- **Which steps of the Engineering Design Process did your group use?**

Use *Heightened Emotions* or a ruler to measure the tower. Give one kid the stuffed animal and have him or her place it on top of the tower. Count to ten and observe what happens. Ask:

- **What would you change if you could design the tower again?**

5. Reflect (10 min)

Show kids the Engineering Design Process Poster. Read each step and the example of what might be done during that step. Remind kids that when engineers are solving a problem, they use the Engineering Design Process. Ask:

- **Did your group use any of these steps? Which ones?** *Yes! We used Ask when we asked you what we were supposed to do; we used Imagine when we thought of solutions with our group; we used Plan when we decided what design to build; we used Create and Improve when we built and fixed the tower. Congratulate kids on using the same steps that engineers use!*
- **Why do you think engineers use these steps to help them design technologies?** *It helps them solve problems while working with a team. It helps them keep track of their ideas and what works and what doesn't work.*

Give kids time to use the *Recording Page*, p. 6, to make a drawing of the tower they made and write about how they might improve their design if they had the chance.

Extension: Improve Your Tower Design! (30 min)

Allow students time to make improvements to their tower design and test again. Ask:

- **What parts of your design are you changing?**
- **What step of the Engineering Design Process are you using?** *Improve and Create.*
- **Why do you think engineers use the Improve step?**

Prep Adventure 2

Email

What is Engineering? Tower Power

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Designing a Tower
to	You 11:11 AM

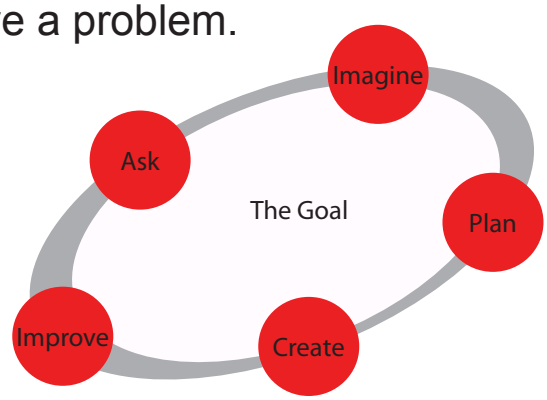
Hi everyone,

You did a great job figuring out what's technology and what's not. India and I have met lots of engineers all over the world who work to design some of the technologies you discovered. Now that you're well on your way to becoming engineers, we thought we would send you an engineering challenge that we had a lot of fun solving!

The problem is that there are some animals living in a swamp along with lots of hungry alligators. The animals need to be at least 10 inches above the alligators to be out of their reach. India and I thought we could build a sturdy tower that the animals could jump on as they're moving through the swamp. Do you think you can try engineering a tower for us?

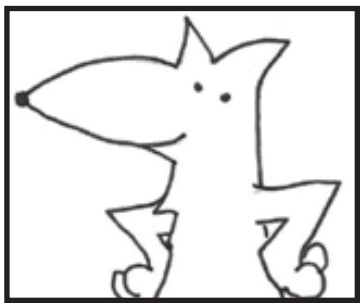
We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. There's a picture of it below. Those are the steps that engineers use when they're trying to solve a problem.

Good luck!
India and Jacob

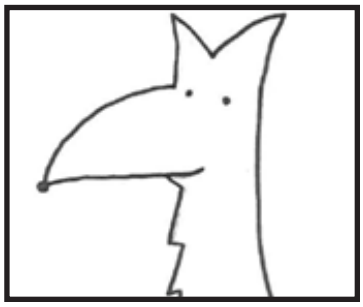


Fearless
8 inches and up

Confident
6-8 inches



Calm
4-6 inches



Nervous
2-4 inches

Terrified
0-2 inches

PANIC!

Adventure 1
Bubble Brainstorm

Educator Page: Preview

Overview: Kids will review what they already know about bubbles, make bubbles with store-bought plastic wands, and discuss their observations.

Note to Educator: This open-ended activity is designed to let kids freely explore bubbles and challenge them to investigate what bubbles can and cannot do.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 3 or Engineering Journal p. 7
- ☐ EDP poster
- ☐ *Bubble Cards*, this guide pp. 27-31
- ☐ poster board or chart paper
- ☐ tape
- ☐ optional: newsprint

For each group of 3-5 kids:

- ☐ 1 plastic cup filled with bubble solution (either store-bought or made from the recipe on p. xiii)

For each kid:

- ☐ Engineering Journal
- ☐ bubble wand (store-bought)

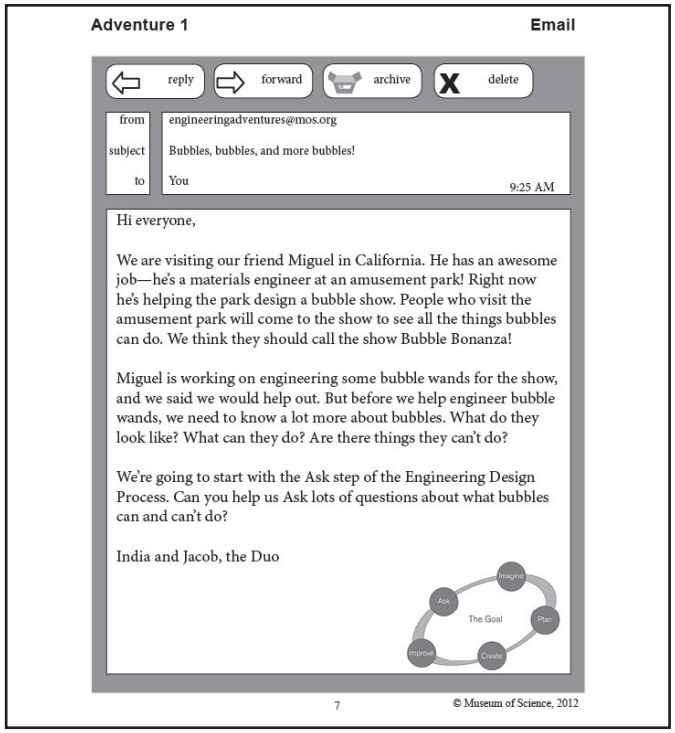
Preparation

Time Required: 10 Minutes

1. Have the *Message from the Duo* ready to share.
2. Copy and cut out the *Bubble Cards*. You may want to laminate them so you can easily reuse them.
3. Pour bubble solution into small cups, one per group.
4. You may want to cover tables and the floor underneath with newsprint.
5. Create a "Bubble Board" like the one shown on the next page.

Journal Pages for Adventure 1

Message from the Duo, p. 7


Adventure 1 Email

reply forward archive delete

from engineeringadventures@mos.org

subject Bubbles, bubbles, and more bubbles!

to You 9:25 AM

Hi everyone,

We are visiting our friend Miguel in California. He has an awesome job—he's a materials engineer at an amusement park! Right now he's helping the park design a bubble show. People who visit the amusement park will come to the show to see all the things bubbles can do. We think they should call the show Bubble Bonanza!

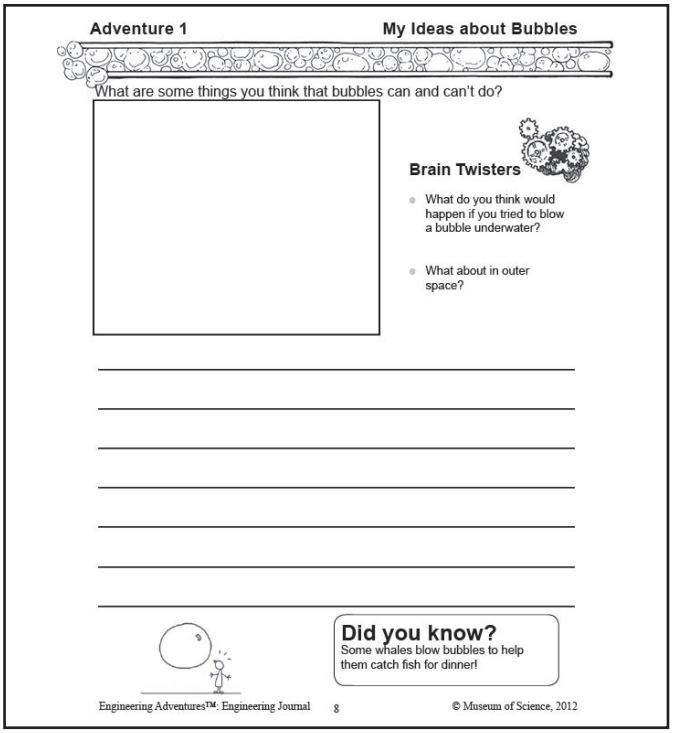
Miguel is working on engineering some bubble wands for the show, and we said we would help out. But before we help engineer bubble wands, we need to know a lot more about bubbles. What do they look like? What can they do? Are there things they can't do?

We're going to start with the Ask step of the Engineering Design Process. Can you help us Ask lots of questions about what bubbles can and can't do?

India and Jacob, the Duo

7 © Museum of Science, 2012

My Ideas about Bubbles, p. 8


Adventure 1 My Ideas about Bubbles

What are some things you think that bubbles can and can't do?

Brain Twisters

- What do you think would happen if you tried to blow a bubble underwater?
- What about in outer space?

Did you know?
Some whales blow bubbles to help them catch fish for dinner!

Engineering Adventures™: Engineering Journal 8 © Museum of Science, 2012

Chart for Adventure 1

Bubble Board	
Bubbles Can:	Bubbles Can NOT:

Adventure 1
Bubble Brainstorm

Educator Page: Activity Guide

Kids will learn:
- asking questions is part of the Engineering Design Process.
- there are some interesting things that bubbles can and cannot do.

1. Present the Message from the Duo (5 min)

Have kids open their Engineering Journals to *Email,* p. 7. Tell kids that they have received another message from India and Jacob. They've run into a problem and need some help. Have kids follow along while you play the message (track 3).

See It!: Visit our website and click on "Bubble Show" to see a bubble show in action.

2. Ask: What Do You Think about Bubbles? (5 min)

Let kids share what they know about bubbles. Ask:

- **What do you know about bubbles?**
- **What can bubbles do? Is there anything that bubbles can't do?**

Bubble Board	
Bubbles Can:	Bubbles Can NOT:

Fill in the *Bubble Board* with things kids suggest. If kids are having trouble thinking of things, bring out two or three Bubble Cards and have kids think about where they belong on the *Bubble Board*.

Tip: The *Bubble Board* serves as an anchor chart that kids will revisit, revise, and reconsider throughout the unit.

It is okay if kids have misconceptions about bubbles, as they will have an opportunity to test and change their ideas during this activity.

3. Ask: What Do Bubbles Do? (25 min)

Split kids into small groups. Place some *Bubble Cards* on each table and let kids know they can experiment with the actions shown on the cards if they would like, or they can come up with their own ideas to test and record findings on the blank cards. Then, give each group a cup of bubble solution and several plastic bubble wands. Encourage kids to find out what bubbles can and can't do. As groups explore, they should post their findings on the *Bubble Board* by taping up cards.

Tip: Some kids may have good luck making bubbles by blowing into their wands. Other kids may find it easier to wave their arms in order to move air through the wands and make bubbles. Either method is fine!

4. Reflect (10 min)

Come together as a group and look at the *Bubble Board*. Ask:

- **Did you discover anything new about bubbles today?**

Show kids the Engineering Design Process poster. Remind kids how they used the Engineering Design Process when they made towers out of index cards. Ask:

- **What steps of the Engineering Design Process did we use today?**
  Accept all responses, but guide kids to focus on the Ask step. Remind them that they asked lots of questions about what bubbles can and cannot do.

Give kids time to record thoughts on *My Ideas About Bubbles*, p. 8. The prompt on the page reads:

- **What are some things you think that bubbles can and can't do?**

Tip: If you can, keep the *Bubble Board* for use in later activities.

Adventure 1
Bubble Brainstorm

Email

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Bubbles, bubbles, and more bubbles!
to	You

9:25 AM

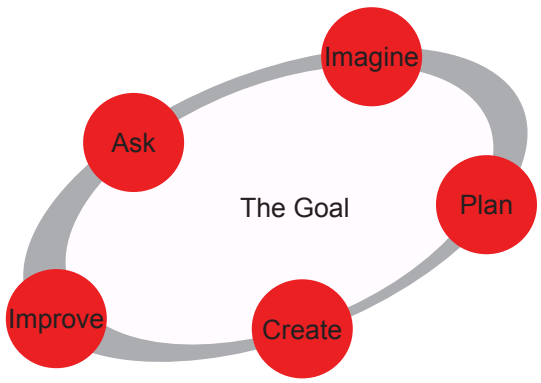
Hi everyone,

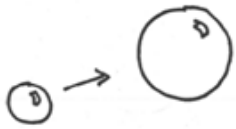
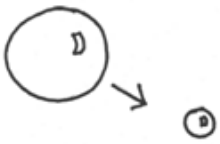
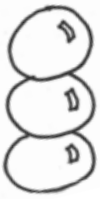
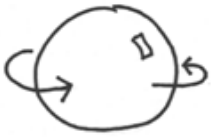
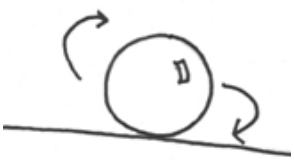
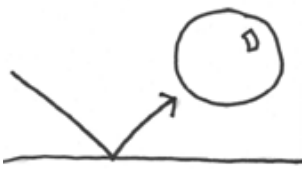
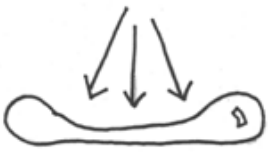
We are visiting our friend Miguel in California. He has an awesome job—he's a materials engineer at an amusement park! Right now he's helping the park design a bubble show. People who visit the amusement park will come to the show to see all the things bubbles can do. We think they should call the show Bubble Bonanza!

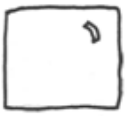
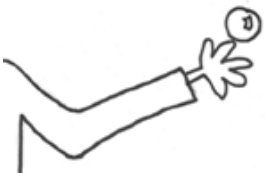
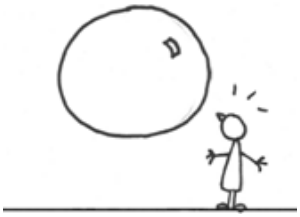
Miguel is working on engineering some bubble wands for the show, and we said we would help out. But before we help engineer bubble wands, we need to know a lot more about bubbles. What do they look like? What can they do? Are there things they can't do?

We're going to start with the Ask step of the Engineering Design Process. Can you help us Ask lots of questions about what bubbles can and can't do?

India and Jacob, the Duo



Float 	Stretch 	Grow 
Shrink 	Stack 	Split 
Crack 	Explode 	Bend 
Spin 	Drip 	Reflect 
Roll 	Bounce 	Flatten 

Balance 	Disappear 	Move Quickly 
Move Slowly 	Stand Still 	Look Like a Square 
Fall 	Pop 	Fold 
Stick to the Wall 	Stick to Clothes 	Stick to Skin 
Be Smaller than a Penny 	Be Bigger than a Person 	Make Sound 

Adventure 1a (optional) Stop the Pop

Educator Page: Preview

Overview: Kids will explore ways to stop bubbles from popping when landing on surfaces with different textures.

Note to Educator: Often, when a bubble touches something, the thin layer of solution is broken and the bubble pops. But sometimes, a bubble will land on a surface and remain intact. If a surface is coated in soapy water, bubbles can rest on the surface without popping.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 4 or Engineering Journal p. 9
- ☐ EDP poster
- ☐ *Challenge of the Day,* this guide p. 39
- ☐ a table that can get wet
- ☐ hairbrush
- ☐ piece of sandpaper
- ☐ optional: newsprint

For each group of 3-5 kids:

- ☐ one plastic cup of bubble solution
- ☐ hairbrush (groups can share)
- ☐ piece of sandpaper

For each kid:

- ☐ Engineering Journal
- ☐ bubble wand (store-bought)

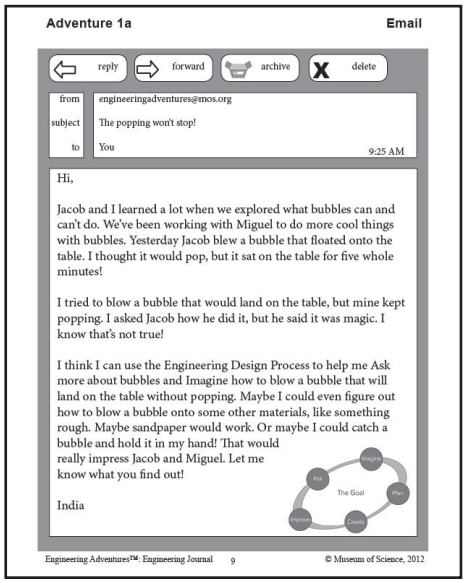
Preparation

Time Required: 15 minutes

1. Have the *Message from the Duo* ready to share.
2. Make a *Pop Chart* as shown on the next page.
3. Pour bubble solution into plastic cups, one for each group.
4. You may want to cover tables and floors with newsprint. Leave one table uncovered so that kids can try landing bubbles on it.
5. Post the *Challenge of the Day* sheet.
6. Place a piece of sandpaper and a hairbrush aside to keep them dry. You can bring out these dry items out later in the lesson for comparison purposes.
7. Optional: Test out some of the activities described on the *Challenge Cards* yourself before you try them with kids.

Journal Pages for Adventure 1a

Message from the Duo, p. 9



Adventure 1a — Email

reply | forward | archive | delete

from: engineeringadventures@mos.org
subject: The popping won't stop!
to: You
9:25 AM

Hi,

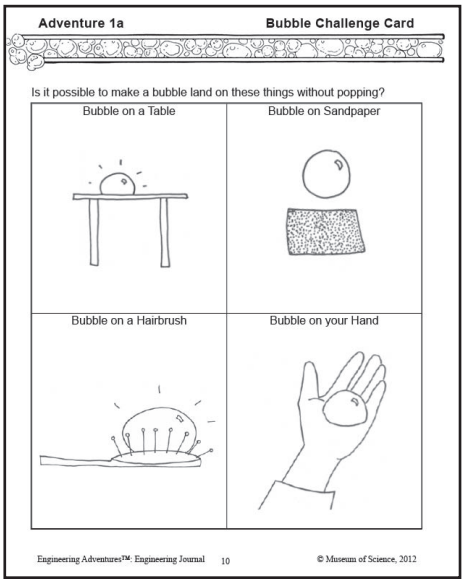
Jacob and I learned a lot when we explored what bubbles can and can't do. We've been working with Miguel to do more cool things with bubbles. Yesterday Jacob blew a bubble that floated onto the table. I thought it would pop, but it sat on the table for five whole minutes!

I tried to blow a bubble that would land on the table, but mine kept popping. I asked Jacob how he did it, but he said it was magic. I know that's not true!

I think I can use the Engineering Design Process to help me Ask more about bubbles and Imagine how to blow a bubble that will land on the table without popping. Maybe I could even figure out how to blow a bubble onto some other materials, like something rough. Maybe sandpaper would work. Or maybe I could catch a bubble and hold it in my hand! That would really impress Jacob and Miguel. Let me know what you find out!

India

Challenge Card, p. 10

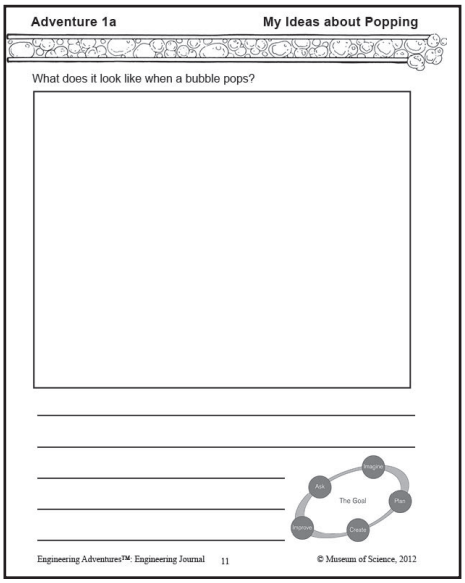


Adventure 1a — Bubble Challenge Card

Is it possible to make a bubble land on these things without popping?

Bubble on a Table	Bubble on Sandpaper
Bubble on a Hairbrush	Bubble on your Hand

My Ideas About Popping, p. 11



Adventure 1a — My Ideas about Popping

What does it look like when a bubble pops?

Chart for Adventure 1a

Can you make the bubble land without popping?		
	Yes	No
Table		
Sandpaper		
Hairbrush		
Your Hand		

Adventure 1a (optional) Stop the Pop

Kids will learn:
- bubbles tend to pop when they land on dry surfaces.
- bubbles will stay intact when they land on surfaces that are wet and soapy.

1. Present the Message from the Duo (5 min)

Tell kids to open their Engineering Journals to *Email,* p. 9 to see what India has to ask them about bubbles (track 4). To check for understanding, ask:

- **What is India asking us to do?** *Figure out if bubbles can land on things without popping.*
- **Which steps of the Engineering Design Process did she say might help us?** *Ask and Imagine.*

2. Ask: What Do We Know about How Bubbles Pop? (5 min)

Guide students to think about bubbles they have experimented with. Ask:

- **What happens to bubbles when they bump into other objects?** *Some kids may say that they can land on objects, but most will say the bubbles usually break.*

Explain to kids that today they will try to make bubbles land on different textures without popping. Ask:

- **Do you think bubbles can land on rough textures, like sandpaper? How about smooth textures, like tabletops?**

Point out the *Challenge of the Day* sheet and encourage kids to refer to it as they work.

3. Ask: Can We Stop the Pop? (25 min)

Split kids into small groups, and tell them they are going to try to make a bubble land on different surfaces without popping. Give each group a piece of sandpaper, a hairbrush, and a cup of bubble solution. Allow kids to try some of the challenges on p. 10 of their Engineering Journals. If groups have explored for a bit and no one has successfully made a bubble land on the surfaces, encourage kids to make the surfaces soapy before trying to land bubbles on them.

As kids explore, have them record their results on the *Pop Chart*. You will discuss results together after everyone has finished testing.

Tip: Have kids blow their bubbles into the air first, then land them on various surfaces. When kids blow bubbles directly onto the surfaces, the soap tends to dribble and spill, coating the surface with soap solution very quickly.

As kids work, ask:

- **How would you describe the texture of the things you are working with?**
- **Do you think this texture affects the bubbles?**

4. Reflect (10 min)

First, review the *Pop Chart*. Ask:

- **Was anyone able to make bubbles land on different things without the bubbles popping? Did the texture matter?** *If something is covered with bubble solution, the bubble probably won't pop. It is harder to cover a rough or pointy texture with bubble solution than it is to cover a smooth texture with it.*

Refer back to the *Challenge of the Day*. Ask:

- **How can you make a bubble land without popping?** *By making the thing it lands on soapy!*
- **How would you tell India to hold a bubble?** *Dip your hand in bubble solution first.*

Show kids the Engineering Design Process poster. Ask:

- **Which steps of the Engineeering Design Process did you use today?** *Accept all responses, but guide kids to focus on how they used the Ask and Imagine steps. Remind them that they imagined what would happen to bubbles when they landed on rough surfaces and answered questions about how to prevent the bubble from popping.*

Give kids time to record thoughts on *My Ideas About Popping*, p. 11. The prompt on this page reads:

- **What does it look like when a bubble pops?**

See It!: Have you ever wondered what exactly happens when a bubble pops? See it in slow motion: http://www.mos.org/eie/engineeringadventures/bubblevideos and click on "Bubble Pop"

Adventure 1a (optional)
Stop the Pop

Email

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	The popping won't stop!
to	You

9:25 AM

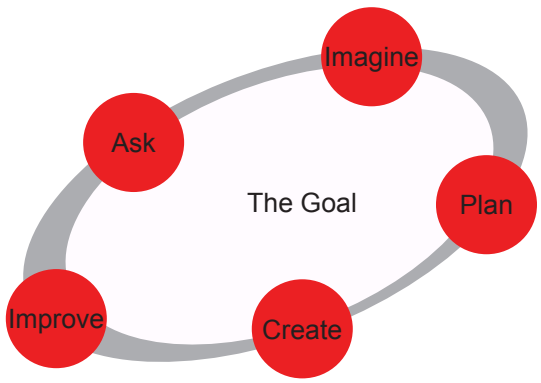
Hi,

Jacob and I learned a lot when we explored what bubbles can and can't do. We've been working with Miguel to do more cool things with bubbles. Yesterday Jacob blew a bubble that floated onto the table. I thought it would pop, but it sat on the table for five whole minutes!

I tried to blow a bubble that would land on the table, but mine kept popping. I asked Jacob how he did it, but he said it was magic. I know that's not true!

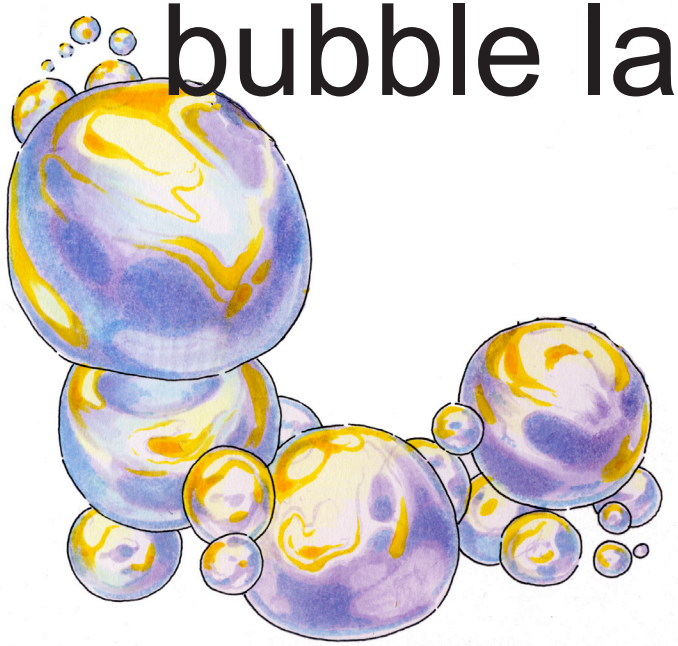
I think I can use the Engineering Design Process to help me Ask more about bubbles and Imagine how to blow a bubble that will land on the table without popping. Maybe I could even figure out how to blow a bubble onto some other materials, like something rough. Maybe sandpaper would work? Or maybe I could catch a bubble and hold it in my hand!
That would really impress Jacob and Miguel. Let me know what you find out!

India



Challenge of the Day:

How can you make a bubble land without popping?



Overview: Kids will build wands of different shapes, observe the bubbles they create, and discuss how wand shape affects (or does not affect) bubble shape.

Note to Educator: Bubbles are made when a thin layer of soap film surrounds a pocket of air. The soap film pulls itself into a shape that has the smallest possible surface area, and this shape is always a sphere. This means that a bubble made from a wand of any shape will become a sphere once it is released from the wand.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 5 or Engineering Journal p. 12
- ☐ EDP poster
- ☐ *Challenge of the Day*, this guide p. 47
- ☐ bubble solution
- ☐ optional: newsprint

For each group of 3-5 kids:

- ☐ plastic cup filled with bubble solution
- ☐ scissors
- ☐ spool of thin, flexible wire (floral wire)
- ☐ 10 paper twist ties

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Prepare one cup of bubble solution for each group.
3. Post the *Challenge of the Day*.
4. You may want to cover tables and floors with newsprint.

Journal Pages for Adventure 2

Message from the Duo, p. 12

Adventure 2 **Email**

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Not-round Bubbles?
to	You

9:25 AM

Hi everyone,

India and I are having a blast playing with bubbles! We can make them stick together, catch them with our hands, and even make them land on a hairbrush. We did all this using the round plastic bubble wand that comes with store-bought bubble solution. But Miguel's job is to engineer wands for the show that do even more cool things than the round store-bought wands. We need to help him engineer even better wacky wands.

Miguel tells us that materials engineers test and explore properties of materials before they use the materials to create things. We found two materials we think would be good for making wands: wire and twist ties. You'll have to let us know which material you like best.

Let's start by making wacky-shaped wands! We can use the Engineering Design Process to Ask some good questions. What kind of bubble can you make by using a square wand? What about a triangle? Can you Imagine other shapes to try?

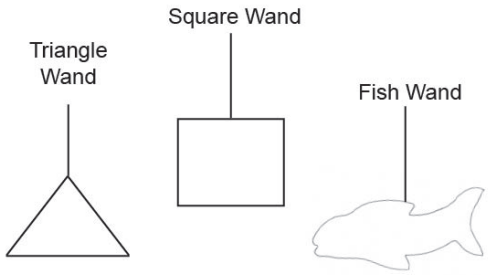
Jacob

Wacky Wands, p. 13

Adventure 2 **Wacky Wands**

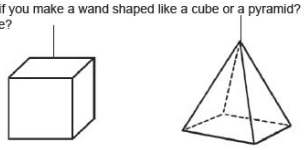
Wacky Wands

Bend wire along the lines below so that the wire makes the same shape.



Can you make a not-round bubble with these wands?

What will happen if you make a wand shaped like a cube or a pyramid? Can you make a not-round bubble?



Recording Page, p. 14

Adventure 2 **Recording Page**

Directions: *Keep track of your experiments! Draw the bubble wands you use and the shapes of the bubbles they create.*

Wand #1

☐ the bubble I made was round
☐ the bubble I made was not round

Wand #2

☐ the bubble I made was round
☐ the bubble I made was not round

Wand #3

☐ the bubble I made was round
☐ the bubble I made was not round

Wand #4

☐ the bubble I made was round
☐ the bubble I made was not round

My Ideas About Bubble Shape, p. 15

Adventure 2 **My Ideas about Bubble Shape**

Is it possible for a bubble wand to make a not round bubble?

For the Record

Bubbles are always round.

☐ I agree.
☐ I disagree.
☐ I'm waiting for more information.
☐ _____

Did you know?
All sorts of people play with bubbles! Even mathematicians use bubbles to help them solve math problems.

Kids will learn:
- bubbles can be made with differently shaped wands.
- once a bubble is made, it forms a sphere—a perfectly round symmetrical shape.

1. Present the Message from the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 12 to read what Jacob has to ask about bubbles and the shapes they make (track 5).

2. Set the Stage (5 min)

Explain to kids that today they will get the chance to make and experiment with bubble wands of any shape to see how the shape of the wand affects the shape of the bubble. Ask:

- **Think about bubbles you have observed. What shapes were the bubbles?** *Bubbles are round, circles, spheres, etc. Some kids may suggest other shapes, which is fine for now.*
- **Do you think you can create a bubble that is not round?**
- **Do you think the shape of the wand matters?**

Point out the *Challenge of the Day* and encourage kids to refer back to it as they're working.

3. Ask: What Shape Bubbles Can We Make? (25 min)

Show kids the wire and twist ties they'll have available for making their wands. Split kids into small groups. Give each group a cup of bubble solution and allow them to explore. Encourage kids to create differently shaped wands and use them to make bubbles. The three designs on *Wacky Wands,* p. 13, can help kids who need more direction.

Ask:

- **What shape is the bubble solution when it is in the wand?** *It takes on the shape of the wand.*
- **What shape is it after you release the bubble from the wand?** *Round, a sphere.*
- **Do you think one wand material works better than the other?** *Some kids might not like that the paper twist ties get soggy, but others may like that the paper lets them soak up more solution.*

Tip: Kids may ask you if bubble solution still attached to a wand "counts" as a bubble. Tell kids that bubble solution does not become a bubble until it is released from the wand.

Have kids use the *Recording Page,* p. 14, to keep track of the wand shapes they used and what the bubbles looked like.

Tip: If kids finish early, challenge them to make wands that are shaped like animals, cartoon characters, or other crazy shapes!

4. Reflect (10 min)

Have kids gather in a group, holding the wands they created. Refer back to the *Challenge of the Day*. Ask:

- **Was anyone able to make a wand that made bubbles that were not round? What shape was the bubble you made?** *Most kids will say that all of the bubbles were round, but a few kids will probably say they made bubbles of other shapes.*

If anyone says "yes", have them show how they made not-round bubbles with their wand. Kids will observe that when bubbles are blown, they are basically round, without flat edges or corners. Sometimes, bubbles that are very large can come out elongated and wobbly, but if they last long enough, they will eventually become spheres.

Tip: Kids may notice that a bubble is not round when it is pressed up against another object or still attached to the wand. For instance, bubbles on flat surfaces are dome-shaped, and bubbles half blown from a wand can be tube-shaped. When released into the air, however, all bubbles form spheres.

Have kids think about the wand materials they tested. Ask:

- **Did anyone find a favorite wand material? Why did you like it?**

Show kids the Engineering Design Process poster. Ask:

- **How did we use the Engineering Design Process today?** *Accept all responses, but guide kids to focus on the Imagine and Create steps.*
- **What did you Create?** *We created bubble wands from wire and twist ties.*

Give kids time to record thoughts using *My Ideas About Bubble Shape*, p.15. The prompt on this page reads:

- **Is it possible for a bubble wand to make a not round bubble?**

Extensions

Ring Around A Bubble

You will need a large open space to conduct this activity.

1. Have all the kids in the class hold hands.
2. While holding hands, have them step backwards as far apart from each other as they can, and point out the shape they have made is a circle.
3. Explain that they represent the soap film on the outside of a bubble and the space in the middle represents the air inside the bubble.
4. Have the kids demonstrate what happens when the bubble pops!

Adventure 2
Not-Round Bubbles

Email

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Not-round Bubbles?
to	You

9:25 AM

Hi everyone,

India and I are having a blast playing with bubbles! We can make them stick together, catch them with our hands, and even make them land on a hairbrush. We did all this using the round plastic bubble wand that comes with store-bought bubble solution. But Miguel's job is to engineer wands for the show that do even more cool things than the round store-bought wands. We need to help him engineer even better wacky wands.

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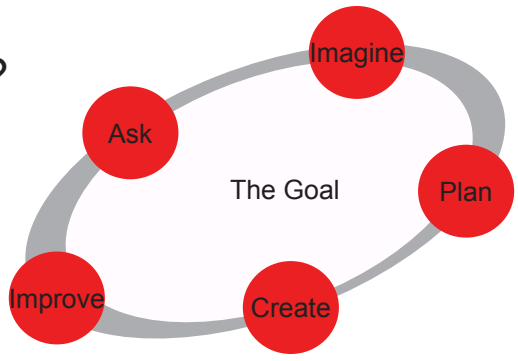
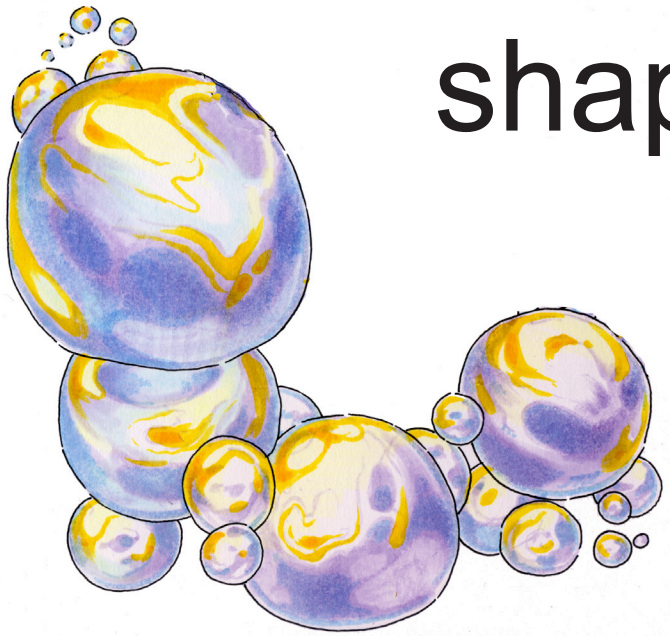


Jacob

Challenge of the Day:

Can you find out how the shape of a bubble wand affects the shape of bubbles?



Adventure 3
Best of Bubbles

Educator Page: Preview

Overview: Kids test, record, and compare how well certain types of bubble tricks can be done with wands of different materials.

Note to Educator: Some objects are better than others at making certain kinds of bubbles. For example, an object like a paper towel tube can absorb lots of bubble solution and make really big bubbles. Because screen has many small holes, it can create lots of bubbles at once, but it does not hold a lot of solution so it can't make really big bubbles.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 6 or Engineering Journal p. 16
- ☐ EDP poster
- ☐ *Bubble Tricks,* this guide pp. 55-69
- ☐ roll of string
- ☐ 4 pans of bubble solution
- ☐ 4 spools wire
- ☐ 8 blank sheets of paper
- ☐ 8 markers or pencils
- ☐ 8 pairs of scissors
- ☐ 8 pieces of screen
- ☐ 10 paper towel tubes
- ☐ 20 straws
- ☐ 30 rubber bands
- ☐ 50 paper twist ties
- ☐ 50 pipe cleaners
- ☐ optional: newsprint

For each kid:

- ☐ Engineering Journal

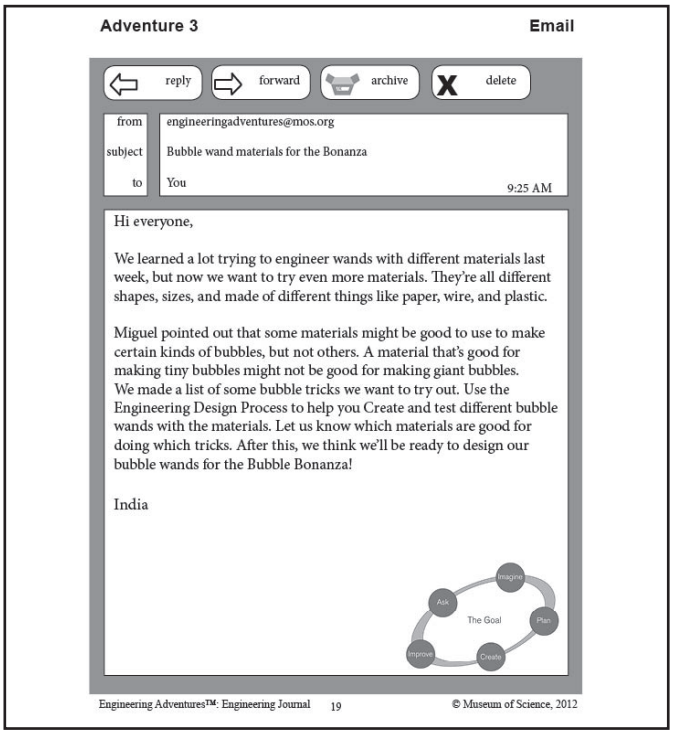
Preparation

Time required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Copy and post the eight *Bubble Trick* pages, each with a blank sheet of paper taped below it for recording. If you're short on time or space, you might want to post only half of the *Bubble Tricks*.
3. Lay out the materials that kids can use in their explorations.
4. Set up a testing station with four pans of bubble solution where groups can test their bubble wands. You may want to cover this table and the floor underneath with newsprint.

Journal Pages for Adventure 3

Message from the Duo, p. 16



Adventure 3 Email

reply forward archive delete

from: engineeringadventures@mos.org
subject: Bubble wand materials for the Bonanza
to: You
9:25 AM

Hi everyone,

We learned a lot trying to engineer wands with different materials last week, but now we want to try even more materials. They're all different shapes, sizes, and made of different things like paper, wire, and plastic.

Miguel pointed out that some materials might be good to use to make certain kinds of bubbles, but not others. A material that's good for making tiny bubbles might not be good for making giant bubbles. We made a list of some bubble tricks we want to try out. Use the Engineering Design Process to help you Create and test different bubble wands with the materials. Let us know which materials are good for doing which tricks. After this, we think we'll be ready to design our bubble wands for the Bubble Bonanza!

India

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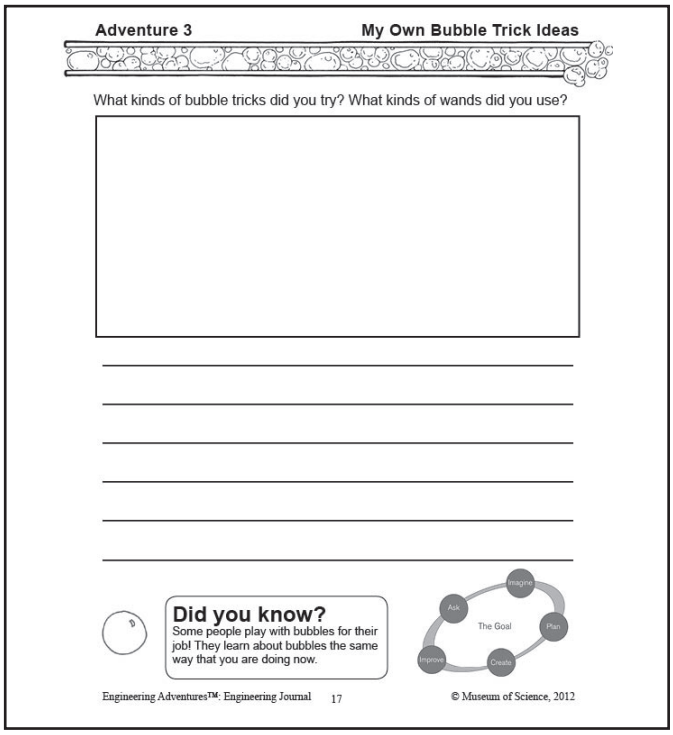
My Own Bubble Trick Ideas, p. 17



Adventure 3 My Own Bubble Trick Ideas

What kinds of bubble tricks did you try? What kinds of wands did you use?

Did you know?
Some people play with bubbles for their job! They learn about bubbles the same way that you are doing now.

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Kids will learn:
- bubble wands can be made from many different materials.
- the material used to make the wand will affect the kind of bubbles they make.

1. Present the Message From the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 16 to read what India has to ask about making bubble wands out of different materials (track 6).

2. Set the Stage (5 min)

Tell kids that today they will continue engineering and will investigate how some new materials can be used to make bubble wands. Show them (or hand out samples of) the pipe cleaners, paper towel tubes, straws, string, rubber bands, and screen. They will also have the same wire and twist ties they experimented with before. Ask:

- **Are any of these things similar to materials we've already used? How?** *The pipe cleaner is like the wire and twist ties, except it is fuzzy instead of smooth.*
- **Are they different? How?** *Some are made of plastic, cardboard, and cotton. Some are already shaped in circles, so we don't have to bend them.*

Point out the *Bubble Tricks* posted around the room. Ask:

- **Do you think all the materials will work well for all the challenges? Why?**

3. Ask: What Materials Work Best? (25 min)

Split kids into small groups and explain that they should pick one of the tricks posted on the wall and use any of the materials to try to accomplish it. As they work, remind them to ask themselves:

- **What would be the best material to use for this trick? Why?**

Encourage groups to test as many different materials and try as many different tricks as they can. When someone succeeds at performing a specific trick, they should the go to where that trick is posted and use the blank sheet of paper to record how they did it and which materials they used. At the end of the activity, they will share their findings with the group.

Tip: You may want to make a "testing station" so that the bubble solution stays in one area.

Tip: If kids are having trouble using the cardboard tube, explain that they can dip one end of the tube in the bubble solution, then blow into the other end of the tube.

4. Reflect (10 min)

Gather kids together and have them put all materials down on the tables. Review the posted notes about each trick. Ask:

- **Is there anything that surprises you here?** *Accept all responses, but guide kids to think about the predictions they made about materials and how good those materials actually were at performing tricks.*

Review each of the eight tricks by asking questions like:

- **Which material was best at making lots of tiny bubbles?** *Kids may suggest screen or materials they can bend into small circles.*
- **Which material was best at making big bubbles?** *Kids may suggest materials that soak up a lot of solution, or materials they can bend into big circles.*
- **Are there any materials you did not like? Why?** *Kids may not like that some of the paper materials get soggy in the solution.*

Show kids the Engineering Design Process poster. Ask:

- **What step of the Engineering Design Process helped you most today?**

Give kids time to record thoughts using *My Own Bubble Trick Ideas*, p. 17. The prompt on this page reads:

- **What kinds of bubble tricks did you try? What kinds of wands did you use?**

See It!: For science background on bubbles and glimpses of a bubble artist and scientist at work, visit: http://www.mos.org/eie/engineeringadventures/bubblevideos and click on “Bubble Scientist.”

Extensions

Around the Room

Have the kids look around the area they are in. Have them make a list of anything they see that they could make bubble wands with.

Adventure 3
Best of Bubbles

Email

reply | forward | archive | delete

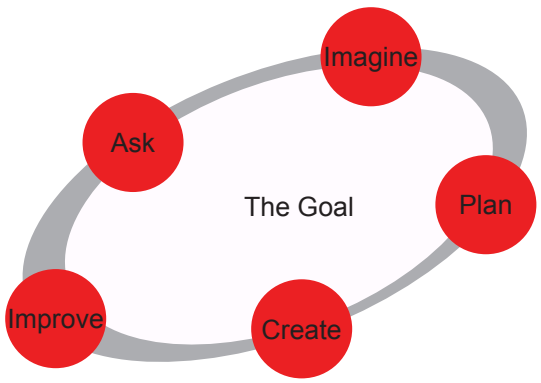
from	engineeringadventures@mos.org
subject	Bubble wand materials for the Bonanza
to	You
	9:25 AM

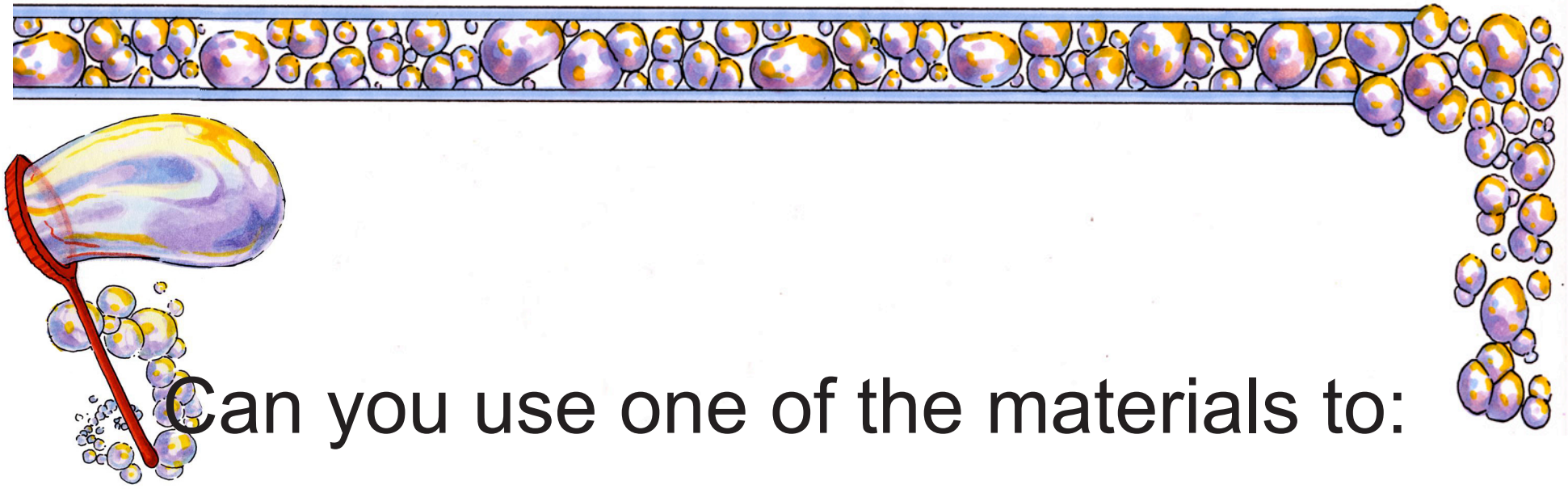
Hi everyone,

We learned a lot trying to engineer wands with different materials last week, but now we want to try even more materials. They're all different shapes, sizes, and made of different things like paper, wire, and plastic.

Miguel pointed out that some materials might be good to use to make certain kinds of bubbles, but not others. A material that's good for making tiny bubbles might not be good for making giant bubbles. We made a list of some bubble tricks we want to try out. Use the Engineering Design Process to help you Create and test different bubble wands with the materials. Let us know which materials are good for doing which tricks. After this, we think we'll be ready to design our bubble wands for the Bubble Bonanza!

India



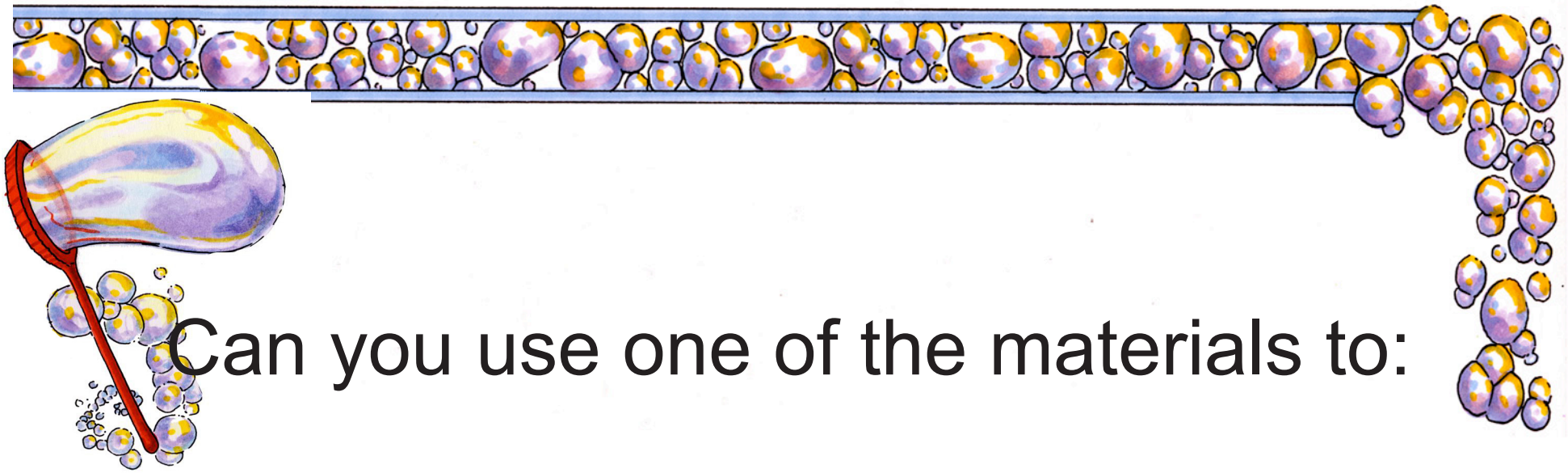


Can you use one of the materials to:

Make bubbles as big as your head!

How did you do it?

(write below)

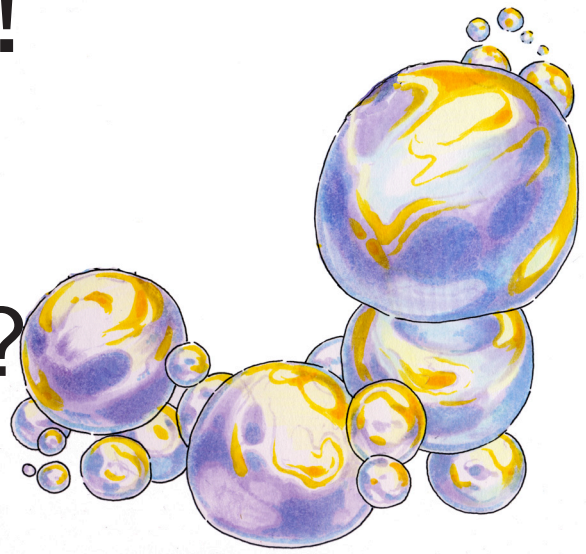


Can you use one of the materials to:

Make at least ten bubbles with just one blow!

How did you do it?

(write below)



Can you use one of the materials to:

Make just one teeny, tiny bubble!

How did you do it?

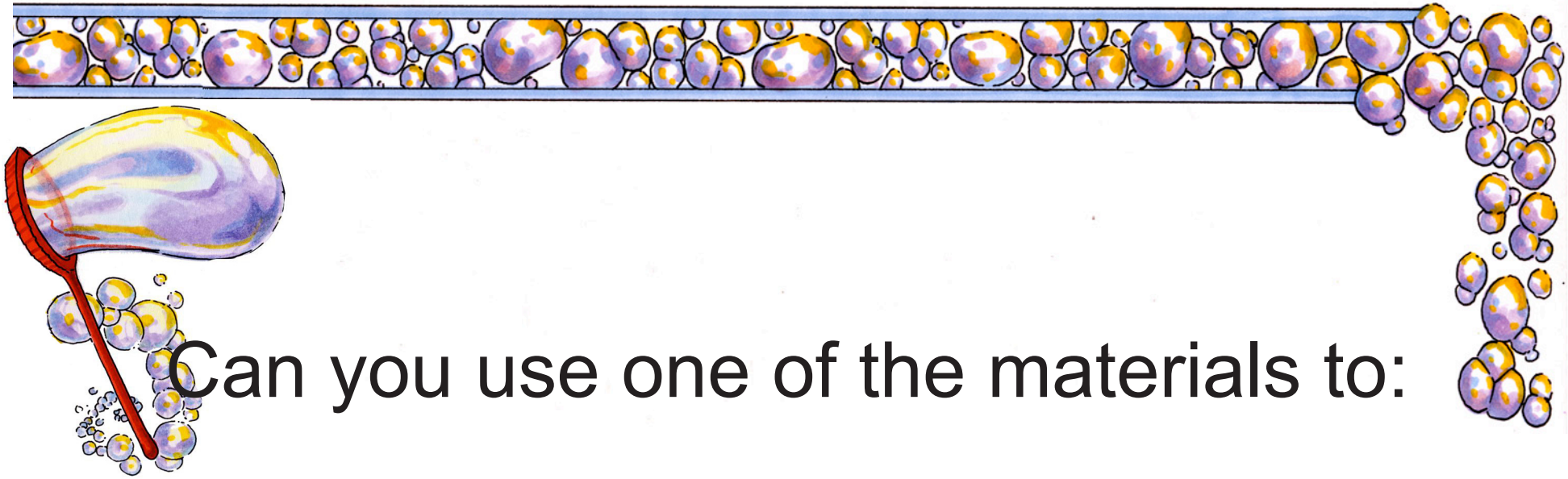
(write below)

Can you use one of the materials to:

Make double bubbles!

How did you do it?

(write below)

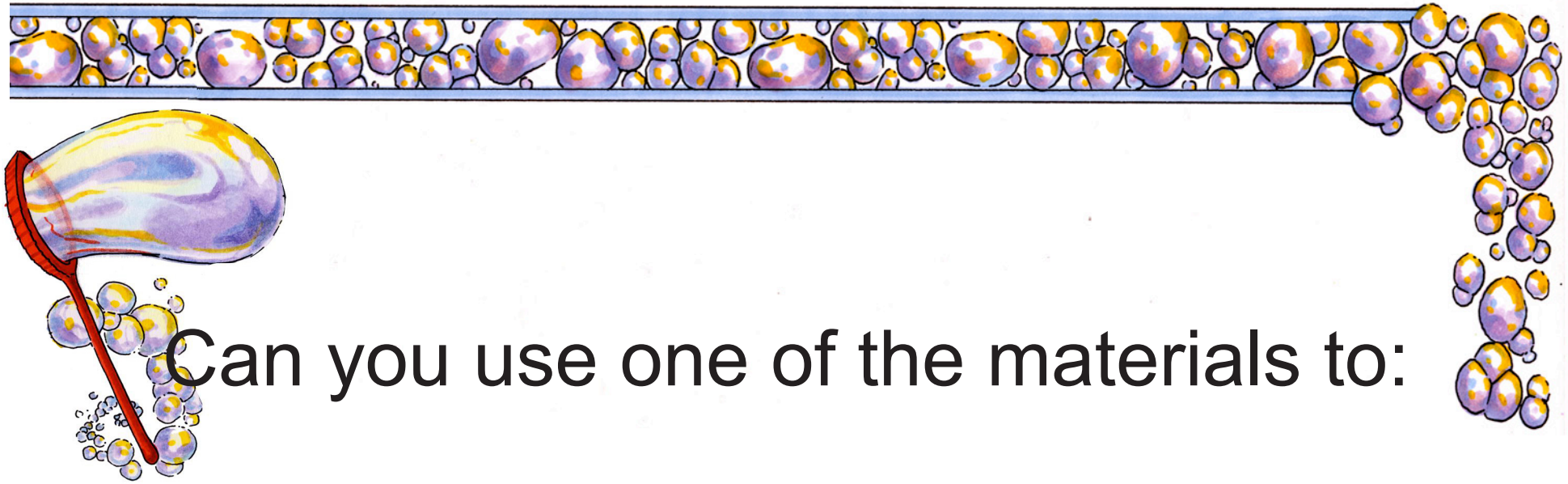


Can you use one of the materials to:

Catch bubbles without popping them!

How did you do it?

(write below)

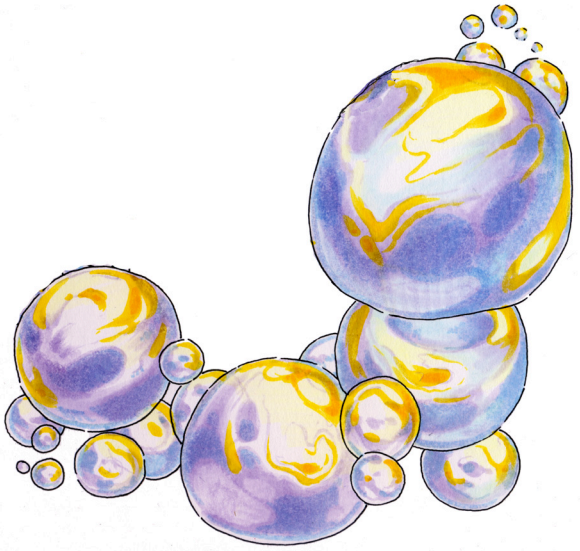


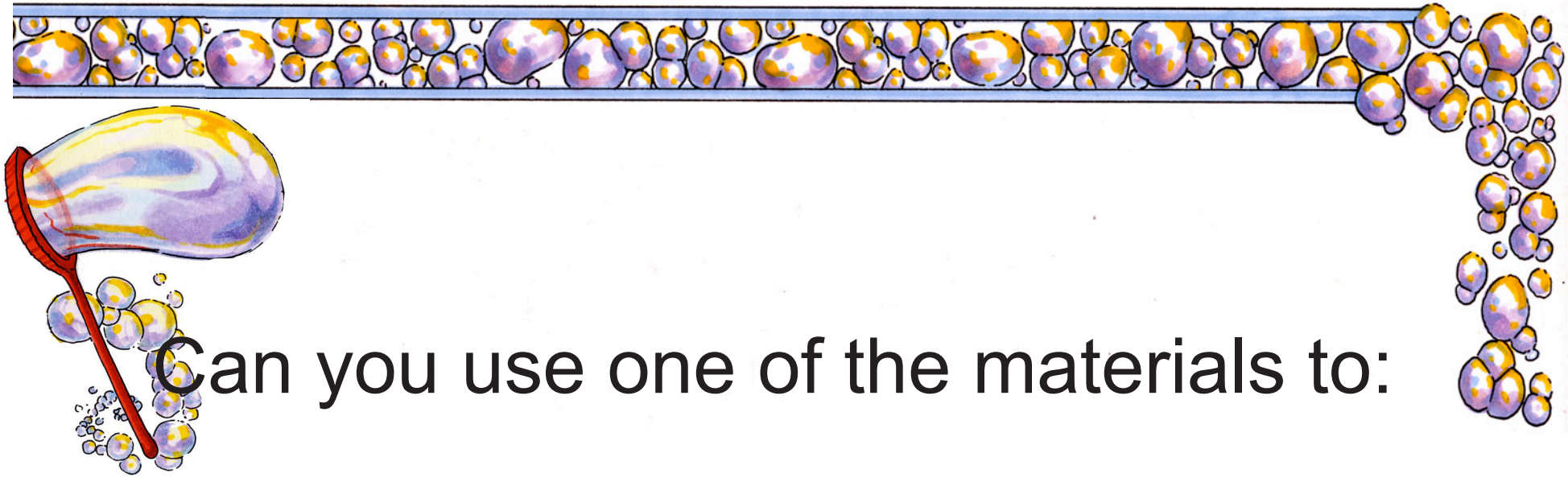
Can you use one of the materials to:

Spin bubbles around!

How did you do it?

(write below)



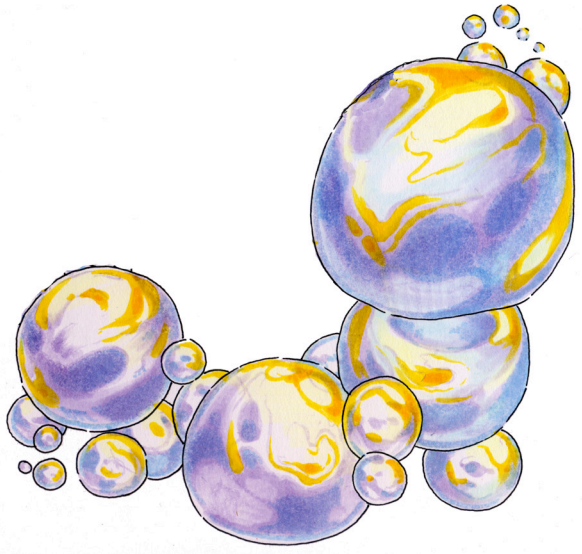


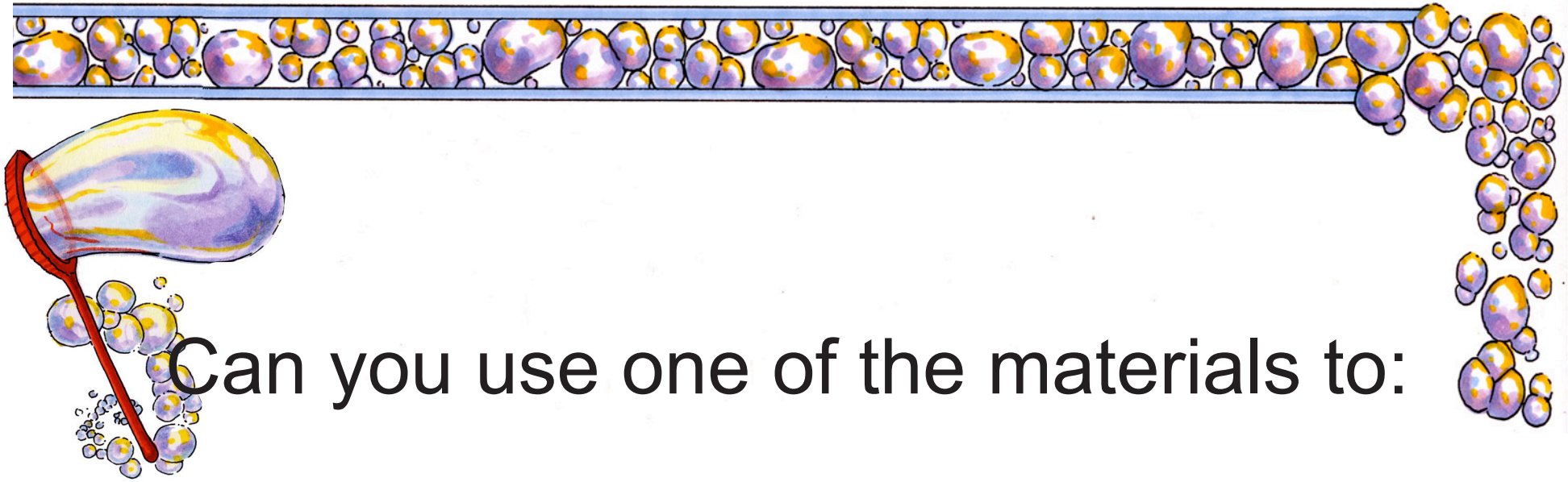
Can you use one of the materials to:

Pop every bubble that it touches!

How did you do it?

(write below)





Can you use one of the materials to:

Make bubbles bounce!

How did you do it?

(write below)

Adventure 4
Designing Bubble Wands

Educator Page: Preview

Overview: Groups decide what type of wand they will engineer. They plan two designs, using at least three different materials in each, and begin to create their wands.

Note to Educator: Kids have explored several different types of bubble wands during the unit, and have used a variety of different materials to make bubbles. In this activity, encourage kids to apply what they have learned to engineer a bubble wand that uses materials in new ways and combines materials.
Be sure to save the wacky wands kids create for use in Adventures 5 and 6!

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 7 or Engineering Journal p. 18
- ☐ EDP poster
- ☐ *Challenge of the Day,* this guide p. 77
- ☐ roll of string
- ☐ spool of wire
- ☐ 4 pans of bubble solution
- ☐ 8 pieces of screen
- ☐ 10 balloons
- ☐ 10 paper towel tubes
- ☐ 10 plastic tubes
- ☐ 10 transparency sheets
- ☐ 15 paper cups
- ☐ 30 straws
- ☐ 30 twist ties
- ☐ 35 rubber bands
- ☐ 50 craft sticks
- ☐ 50 pipe cleaners
- ☐ 50 sheets construction paper
- ☐ optional: newsprint
- ☐ optional: plastic mesh berry baskets

For each group of 3-5 kids:

- ☐ scissors

For each kid:

- ☐ Engineering Journal

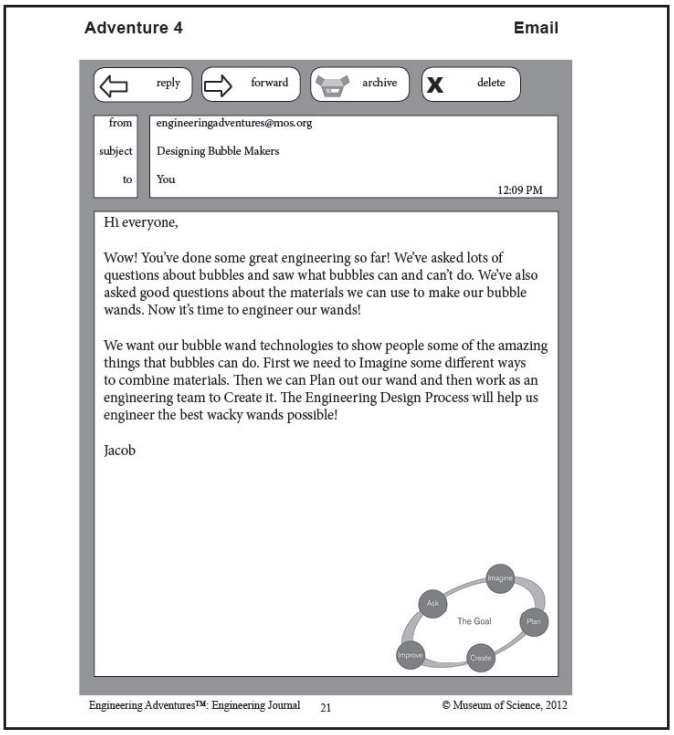
Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Set up a Materials Store with all of the materials and supplies kids will have available for engineering their bubble wands.
3. Set up a testing station with four pans of bubble solution in a central location where groups can test their bubble wands. You may want to cover the workspace with newsprint.
4. Post the *Challenge of the Day.*

Journal Pages for Adventure 4

Message from the Duo, p. 18



Adventure 4 **Email**

reply | forward | archive | delete

from: engineeringadventures@mos.org
subject: Designing Bubble Makers
to: You
12:09 PM

Hi everyone,

Wow! You've done some great engineering so far! We've asked lots of questions about bubbles and saw what bubbles can and can't do. We've also asked good questions about the materials we can use to make our bubble wands. Now it's time to engineer our wands!

We want our bubble wand technologies to show people some of the amazing things that bubbles can do. First we need to Imagine some different ways to combine materials. Then we can Plan out our wand and then work as an engineering team to Create it. The Engineering Design Process will help us engineer the best wacky wands possible!

Jacob

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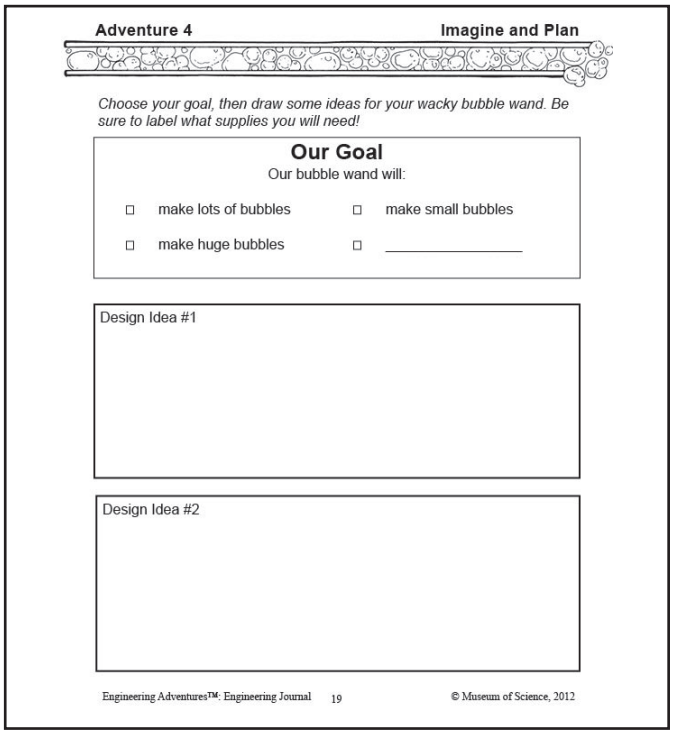
Imagine and Plan, p. 19



Adventure 4 **Imagine and Plan**

Choose your goal, then draw some ideas for your wacky bubble wand. Be sure to label what supplies you will need!

Our Goal

Our bubble wand will:

- ☐ make lots of bubbles
- ☐ make small bubbles
- ☐ make huge bubbles
- ☐ _____

Design Idea #1

Design Idea #2

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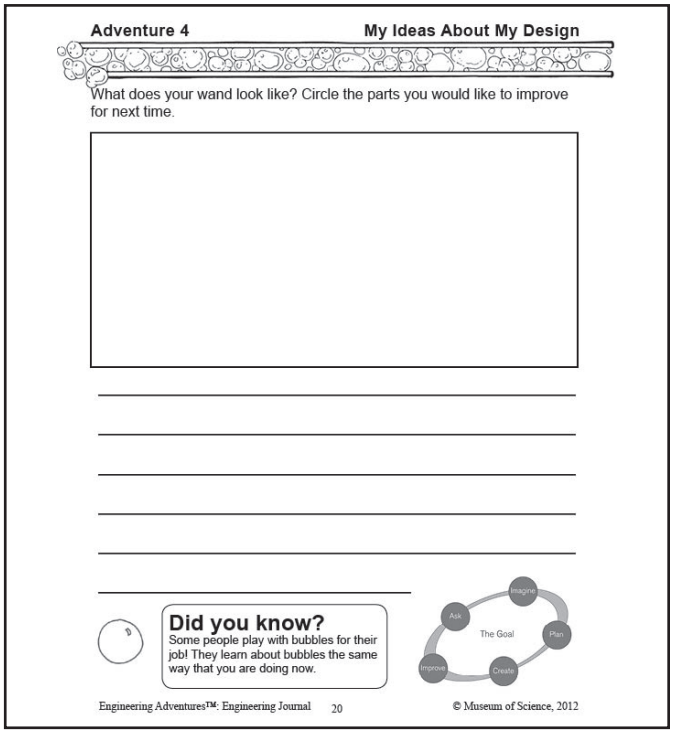
My Ideas About My Design, p. 20



Adventure 4 **My Ideas About My Design**

What does your wand look like? Circle the parts you would like to improve for next time.

Did you know?
Some people play with bubbles for their job! They learn about bubbles the same way that you are doing now.

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Adventure 4 Educator Page: Activity Guide
Designing Bubble Wands

Kids will learn:
- following the steps of the Engineering Design Process will help them Imagine, Plan, and Create bubble wands for the Bubble Bonanza.

1. Present the Message From the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 18 to read what India has to ask about making bubble wands out of different materials (track 7). To check for understanding, ask:

- **What technology do India and Jacob want us to engineer?** *Bubble wands.*
- **What process did Jacob say would help us?** *The Engineering Design Process.*

Show students the Engineering Design Process poster and let them know you will have it posted so they can look at it as they are designing.

See It!: To see a real bubble festival, visit our website and click on "Bubble Festival."

2. Ask: What is the Goal? (5 min)

Tell kids that today they will get the chance to use all that they have learned about wand materials to design a wacky bubble wand that can be used in the Bubble Bonanza. Explain that their design MUST include at least three of the bubble wand materials on the table. Show kids the new materials that have been added to the Materials Store—craft sticks, paper cups, construction paper, plastic tubes, transparency sheets, and berry baskets. Ask:

- **How are these materials similar to other things you've tested?**
- **What is your goal for your bubble wand?**

Tell kids they can choose their goal for their bubble wand. Possible goals include engineering a wand that makes lots of bubbles, big bubbles, small bubbles, etc. Point out the *Challenge of the Day* and encourage kids to refer back to it as they work.

3. Plan a Wacky Bubble Wand (10 min)

Have each group use *Imagine and Plan*, p. 19, to choose a goal for their bubble wand and sketch out two ideas they have. Explain that drawing the plans for their wands is an important step that engineers use to make sure they don't waste time and materials figuring out what they want to do. Once teams have picked one idea they want to create, they can get supplies from the Materials Store.

Tip: You can set up the testing station before this adventure starts, but encourage kids to Plan and Create (build) for at least 10 minutes before they start testing.

4. Create! (20 min)

Give kids plenty of time to Create and test their wand designs. As they are building, ask questions like:

- **How will your wand meet your goal?**
- **Why did you choose those materials?**

When kids bring their wands to the bubble solution pans for testing, ask questions like:

- **What parts of your wand are working well?**
- **What parts of your wand are not working well?**
- **How could you improve your wand?**

Use the Engineering Design Process Poster to guide conversations and encourage students to use the names for the steps of the Engineering Design Process to describe what they are doing.

Tip: Be sure to keep the bubble wands for Adventures 5 and 6!

5. Reflect (10 min)

Gather kids together and have them put all materials down on the tables. Assure them that they will have more time to work on their designs during the next adventure. Have groups share their work so far. Ask:

- **What materials are working the best for your designs? Why do you think so?**

Show kids the Engineering Design Process poster. Ask:

- **How did we use the Engineering Design Process today?**
- **What did we Create?**
- **How did we Plan?**
- **Did anyone Imagine or Improve today? How?**

Give kids time to record thoughts using *My Ideas About My Design,* p. 20. The prompt on this page reads:

- **What does your wand look like? Circle the parts you would like to improve for next time.**

Adventure 4

Designing Bubble Wands

Email

reply | forward | archive | delete

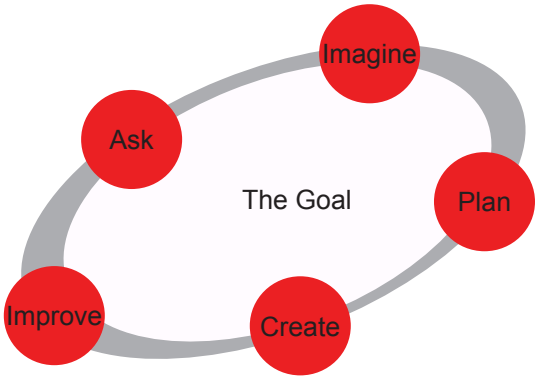
from	engineeringadventures@mos.org
subject	Designing Bubble Makers
to	You
	12:09 PM

Hi everyone,

Wow! You've done some great engineering so far! We've asked lots of questions about bubbles and saw what bubbles can and can't do. We've also asked good questions about the materials we can use to make our bubble wands. Now it's time to engineer our wands!

We want our bubble wand technologies to show people some of the amazing things that bubbles can do. First we need to Imagine some different ways to combine materials. Then we can Plan out our wand and then work as an engineering team to Create it. The Engineering Design Process will help us engineer the best wacky wands possible!

Jacob



Challenge of the Day:

Can you put THREE different materials together to engineer a wacky wand for our Bubble Bonanza?

Adventure 5
Improving Bubble Wands

Educator Page: Preview

Overview: Kids focus on the Improve step of the Engineering Design Process. They continue working on their wands, testing and Improving their designs.

Note to Educator: The goal of this lesson is for kids to improve upon their original wand designs. Kids are also given small fans that they can use to automatically blow bubbles through their wands.

Be sure to keep the improved bubble wands for Adventure 6!

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 8 or Engineering Journal p. 21
- ☐ EDP poster
- ☐ *Challenge of the Day,* this guide p. 85
- ☐ roll of string
- ☐ spool of wire
- ☐ 2 small fans
- ☐ 4 pans of bubble solution
- ☐ 8 pieces of screen
- ☐ 10 balloons
- ☐ 10 paper towel tubes
- ☐ 10 plastic tubes
- ☐ 10 transparency sheets
- ☐ 15 paper cups
- ☐ 30 straws
- ☐ 30 twist ties
- ☐ 35 rubber bands
- ☐ 50 craft sticks
- ☐ 50 pipe cleaners
- ☐ 50 sheets construction paper
- ☐ optional: newsprint
- ☐ optional: mesh berry baskets

For each group of 3-5 kids:

- ☐ scissors

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Set up a testing station with four pans of bubble solution in a central location where groups can test their bubble wands. You may want to cover the workspace with newsprint.
3. Post the *Challenge of the Day.*

Journal Pages for Adventure 5

Message from the Duo, p. 21

Adventure 5 **Email**

reply | forward | archive | delete

from: engineeringadventures@mos.org
subject: The Best of the Best Bubble Wands
to: You
12:09 PM

Hi everyone,

Jacob and I are so impressed with the wacky wands you engineered. They are great technologies! We know you're using the Engineering Design Process to make these wands the best they can be.

Share your ideas with each other and try to Improve your wacky wands even more! We sent you one more special supply to make your wands even more exciting to watch during the Bubble Bonanza. Jacob and I can't wait to see your final designs.

India

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Improving Bubble Wands, p. 22

Adventure 5 **Improving Bubble Wands**

What does your final wand look like? What materials did you choose?

Did you know?
Some scientists think our universe is part of a giant bubble.

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Adventure 5 Educator Page: Activity Guide
Improving Bubble Wands

Kids will learn:
- they can use the Improve step of the Engineering Design Process to make their technologies even better.

1. Present the Message From the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 21 to read what India has to ask about using the Improve step of the Engineering Design Process (track 8).

2. Ask: How Can We Improve Our Designs? (5 min)

Show kids the new material that Jacob and India sent: small fans. Tell kids that the fans will be near the testing station so groups can try them out after Improving their designs. Have kids share some of their experiences from last time. Ask:

Tip: If you don't have small fans available, you could substitute a larger fan or a hair dryer.

- **Which materials are working well in your bubble wand designs?**
- **Are there any materials that are not working well?**
- **What parts of your design do you want to Improve so that you can meet your goal?**

Some groups may have had difficulty with materials getting soggy. Guide kids to make suggestions for one another based on what is working well in their own designs. Have kids look back at *My Ideas About My Design*, p. 20, where they sketched out their bubble wand design in the previous Adventure. Have kids circle things they would like to improve and encourage them to draw a new plan.

3. Let the Improving Begin! (25 min)

Point out the *Challenge of the Day* and encourage kids to refer back to it as they Improve their first designs. As they are working, ask questions like:

- **Which three materials are you using?**
- **What parts of your wand are working/not working well?**
- **How are you Improving your wand so that you can meet your goal?**

As teams work, use the Engineering Design Process poster to guide conversations and encourage students to use the names for the steps of the Engineering Design Process to describe what they are doing.

4. Reflect (10 min)

Gather kids together and have them put all materials down on the tables. Show kids the Engineering Design Process poster. Ask:

- **How did you engineer today? Did anyone use the Improve step while engineering your wands?**

- **What are some problems you are having? How are you working with your team to solve these problems?**

In a dry area of the room, have kids use *Improving Bubble Wands,* p. 22 to draw their final bubble wand design and label the materials they used.

A possible writing prompt includes:

- **Write a letter to India and Jacob about your final design. Draw a picture of your wacky wand and write down which materials you used to make it.**

Tip: The Duo can be reached by email at EngineeringAdventures@mos.org

Adventure 5
Improving Bubble Wands

Email

reply | forward | archive | delete

from: engineeringadventures@mos.org

subject: The Best of the Best Bubble Wands

to: You

12:09 PM

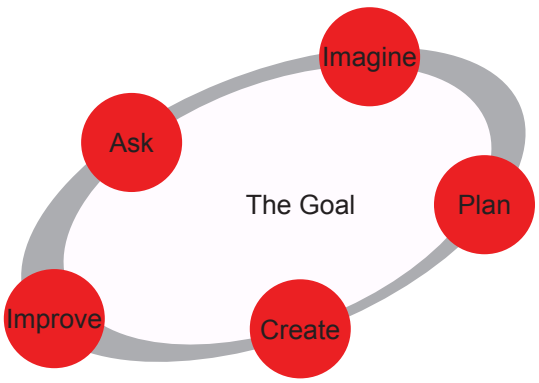
Hi everyone,

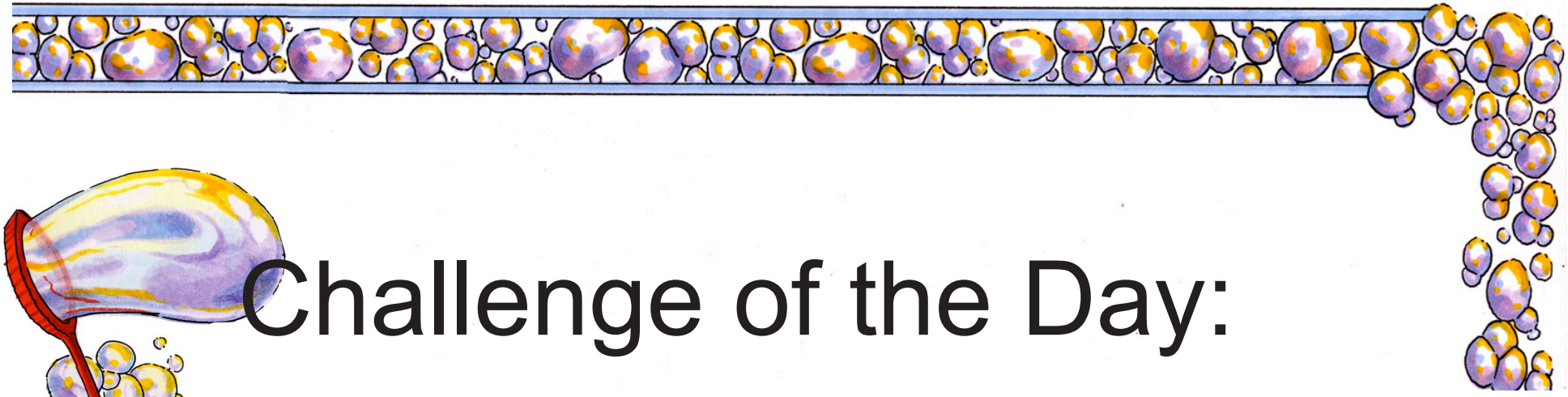
Jacob and I are so impressed with the wacky wands you engineered. They are great technologies! We know you're using the Engineering Design Process to make these wands the best they can be.

Share your ideas with each other and try to Improve your wacky wands even more! If your goal is to make big bubbles, can you Improve your wand so the bubbles it makes are giant? If your goal is to make lots of bubbles, can you Improve your wand so it makes fifty or even one hundred bubbles?

To help you out, we sent you one more special supply to make your wands even more exciting to watch during the Bubble Bonanza. Jacob and I can't wait to see your final designs.

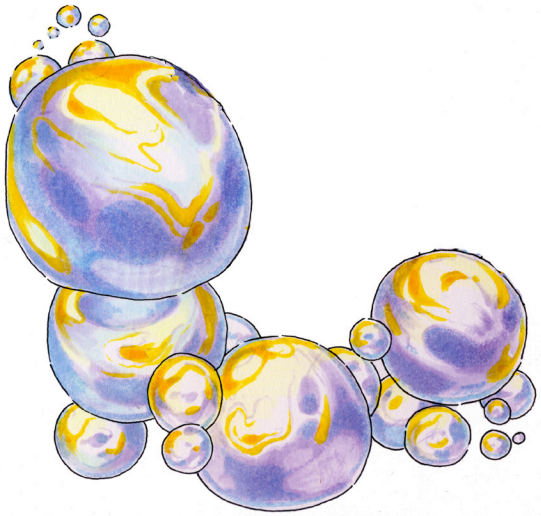
India

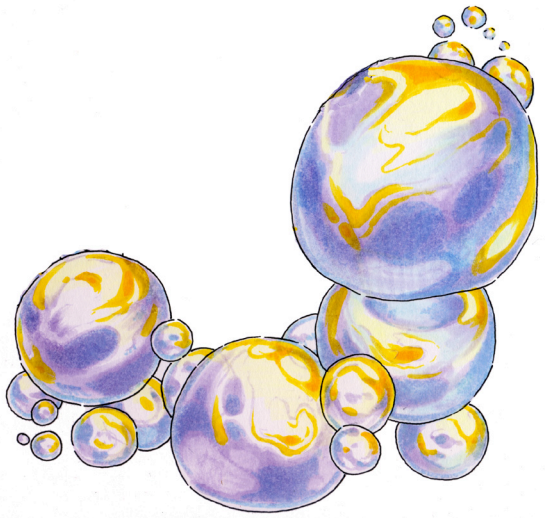




Challenge of the Day:

Can you Improve your bubble wand so it meets your goal?





Adventure 6 Educator Page: Preview

Design Showcase: Bubble Bonanza

Overview: During this activity, kids show their wacky wands and their knowledge of the Engineering Design Process in a Bubble Bonanza show.

Note to Educator: The Bubble Bonanza provides the chance for all groups to share the wands they engineered. You should choose a presentation format that is best for your kids. You could set it up like a fair, with each group standing at their own station and explaining their bubble wands. Or, you could actually create a show set to music where each group has an allotted time to be on stage and show the wands they engineered.

Duo Update (5 min)

Activity (30 min)

Reflect (10 min)

Materials

For the entire group:

- ☐ *Message from the Duo*, track 9 or Engineering Journal p. 23
- ☐ EDP poster
- ☐ *Challenge of the Day,* this guide p. 93
- ☐ markers
- ☐ paper
- ☐ 2 hand-held fans
- ☐ 4 pans of bubble solution
- ☐ optional: newsprint

For each group of 3-5 kids:

- ☐ final wacky wand designs from Adventure 5

For each kid:

- ☐ Engineering Journal

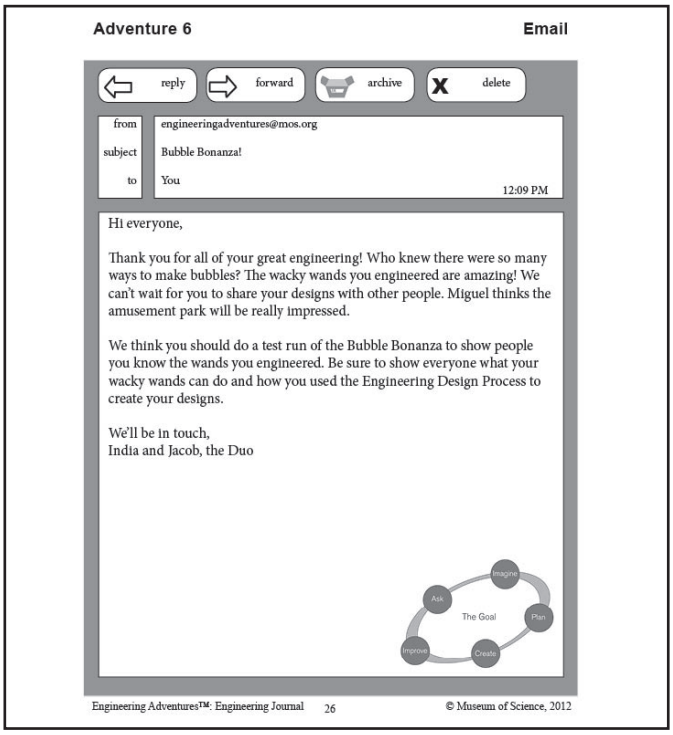
Preparation

Time Required: 5 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Challenge of the Day.*
3. Decide how you will format the Bubble Bonanza.
4. Prepare one pan of bubble solution for each group.
5. You may want to cover tables and the floor with newsprint.
6. If possible, arrange to record or photograph this activity!

Journal Pages for Adventure 6

Message from the Duo, p. 23



Adventure 6 **Email**

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Bubble Bonanza!
to	You

12:09 PM

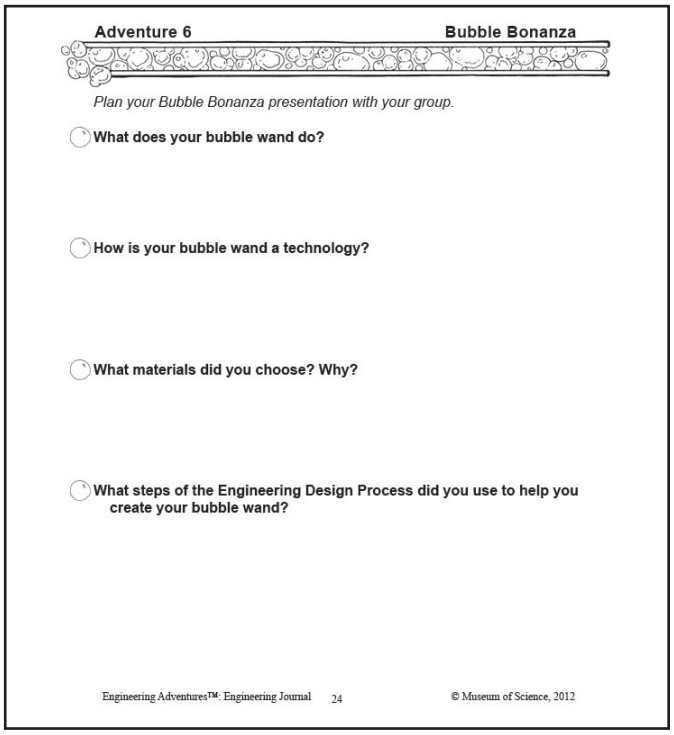
Hi everyone,

Thank you for all of your great engineering! Who knew there were so many ways to make bubbles? The wacky wands you engineered are amazing! We can't wait for you to share your designs with other people. Miguel thinks the amusement park will be really impressed.

We think you should do a test run of the Bubble Bonanza to show people you know the wands you engineered. Be sure to show everyone what your wacky wands can do and how you used the Engineering Design Process to create your designs.

We'll be in touch,
India and Jacob, the Duo

Bubble Bonanza, p. 24



Adventure 6 **Bubble Bonanza**

Plan your Bubble Bonanza presentation with your group.

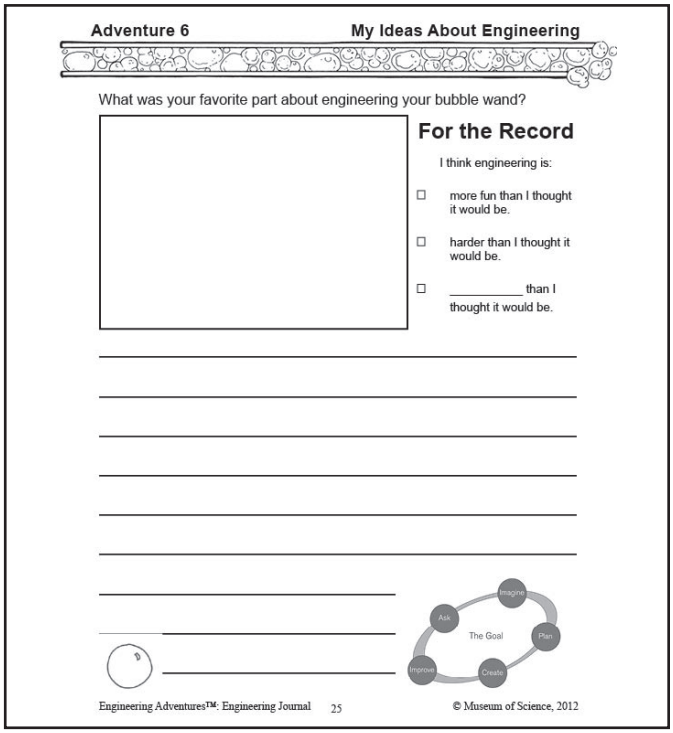
What does your bubble wand do?

How is your bubble wand a technology?

What materials did you choose? Why?

What steps of the Engineering Design Process did you use to help you create your bubble wand?

My Ideas About Engineering, p. 25



Adventure 6 **My Ideas About Engineering**

What was your favorite part about engineering your bubble wand?

For the Record

I think engineering is:

- ☐ more fun than I thought it would be.
- ☐ harder than I thought it would be.
- ☐ _____ than I thought it would be.

Design Showcase: Bubble Bonanza

Kids will learn:
- to describe how they used the steps of the Engineering Design Process to help them Ask, Imagine, Plan, Create, and Improve their wand design.

1. Present the Message From the Duo (5 min)

Have kids open their Engineering Journals to *Email*, p. 23 to read what India and Jacob want them to do today (track 9). Post the *Challenge of the Day.* To check for understanding, ask:

- **What do India and Jacob want us to do?** *They want us to show others our wacky wands and tell them how we used the Engineering Design Process to create them.*

2. Plan the Bonanza (10 min)

Tell kids about the format for the Bubble Bonanza that you decided on (a fair, a show, etc.). Groups can create spoken presentations, visual displays, or anything that you think your group will enjoy. Have kids fill out *Bubble Bonanza,* p. 24, to help them prepare for their presentation. Circulate and help kids write down or think about their responses to the questions:

- **How does your wand meet your goal?**
- **How is your wand a technology?**
- **What materials did you choose? Why?**
- **What steps of the Engineering Design Process did you use to help you create your wand?**

Tip: If you are having visitors come to the final presentation, you may want to have extra wand materials available so that groups can lead them through some designs of their own.

3. Share (20 min)

Allow each group to share their wands with everyone. Have each child talk about their design, or ask them to respond to each question on *Bubble Bonanza*, p. 24. Record the presentations or take pictures!

4. Reflect (10 min)

Have groups make their final entry in their Engineering Journals, on *My Ideas About Engineering*, p. 25. Possible prompts include:

- **What was your favorite part about engineering your bubble wand?**
- **Why do you think engineers use the Engineering Design Process?**

Adventure 6
Design Showcase: Bubble Bonanza

Email

reply | forward | archive | x delete

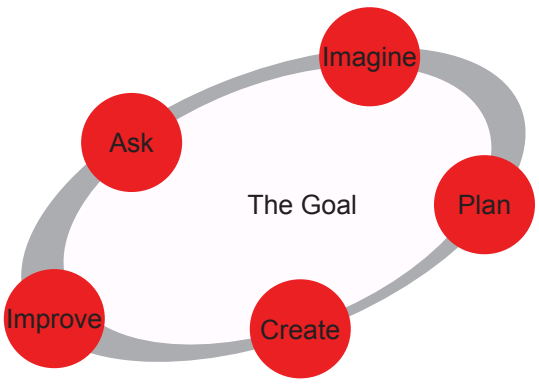
from	engineeringadventures@mos.org
subject	Bubble Bonanza!
to	You
	12:09 PM

Hi everyone,

Thank you for all of your great engineering! Who knew there were so many ways to make bubbles? The wacky wands you engineered are amazing! We can't wait for you to share your designs with other people. Miguel thinks the amusement park will be really impressed.

We think you should do a test run of the Bubble Bonanza to show people the wand technologies that you engineered. Be sure to tell people your goal and show everyone what your wacky wands can do. Don't forget to tell people how you used the Engineering Design Process to create your designs!

We'll be in touch,
India and Jacob, the Duo



Challenge of the Day:

Can you share how you used the Engineering Design Process to engineer your bubble wand?