Engineering

educator guide

WELCOME TO THE ENGINEERING Educator Guide!

Dear Educators, Parents, and Caregivers:

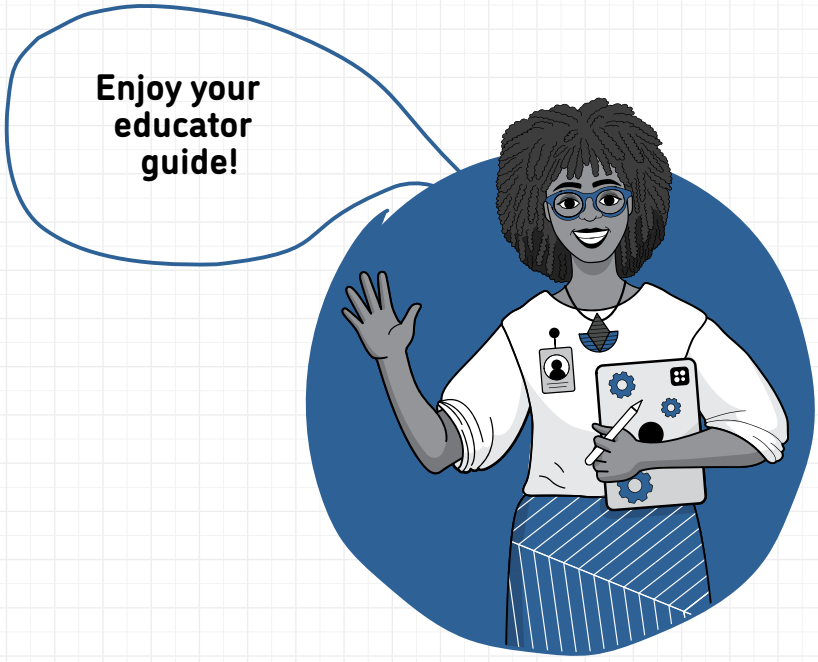
We know education is important now more than ever, and COSI stands ready to be your partner with this COSI Connects Kit. Together, we will engage, inspire, and transform our students and youth in science, technology, engineering, art, and math (STEAM) at school and at home. These activities correlate directly to Ohio's Learning Standards - the same key learning goals that schools, educators, parents and caregivers use.

COSI Connects

In this Educator Guide, you will find the Ohio Learning Standards and Next Generation Science Standards that correspond to each of the activities in this box. You will also find interactive questions that will promote critical thinking. If you want to dig deeper into science, additional experiences are available through our free Connects digital platform, www.cosi.org/connects.

For additional resources, including book recommendations, and video instructions for completing each of the activities inside your box be sure to check out www.cosi.org/connects/kits/engineering-kit-resources.php

For questions regarding the content inside this educator guide, please email sciencequestions@cosi.org.



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Facilitating STEAM Learning with Kits

Kits Overview

COSI Connects Kits contain carefully designed hands-on STEAM activities that support fun, engaging learning about a topic or theme. Each box comes with:

- **Supplies**: Materials for activities are in the box
- **Activity book:** This guide provides directions for setting up and completing activities, explains relevant STEAM content knowledge and skills, and offers discussion prompts to deepen the learning experience
- **Instructional videos:** Each kit has a QR code linking you to short videos demonstrating how to complete different steps of the activities. If you cannot scan the QR code, you can find the videos online at https://cosi.org/connects/kits/. Click on your kit, then click the "Parent/Educator Resources" tab.

Goals for Using Kits

At COSI, we know science is everywhere and for everyone. To reinforce this message, we've designed our kits to do so much more than just teach STEAM content knowledge. Every kit, regardless of the content or topic, also provides important non-content learning opportunities such as:

- Engaging with STEAM in fun, inspiring, and creative ways
- Making sense of scientific observations
- Seeing oneself as a capable, welcome, and valued STEAM community member
- Practicing a growth mindset by valuing effort and learning over ease and knowing
- Bonding with peers, family, and educators over shared experiences and excitement

Techniques for Facilitating COSI Connects Kits

Decades of research show that learning is rarely as straightforward as receiving information. This is especially true when the goal is to *understand* and *apply* information, not simply recognize and repeat it. Learning and understanding requires the student to make sense of the information for themselves: Have they heard anything like that before? Does it make sense? Does it support or contradict something they already know? Is it useful or interesting enough to warrant the effort to learn and remember it?

When helping your learners accomplish the goals of using a COSI Connects kit, you'll want to ask more questions than you answer (unless they're practical or logistical questions about the directions).

Why? For a few reasons:

1) If learners have a question in mind before doing an activity, or before doing a step of the activity, they'll be primed to notice information that is useful for sense-making or question-asking.
2) This technique helps you model the process of science for your learners. Instead of assuming what they do or don't know and thus what you need to tell them, you are being curious, collecting data (their knowledge and ideas) and interpreting those data to decide how to most effectively help them.
3) This invites critical thinking: you can follow most questions with things like, "Why do you think that?" or "What did you observe during your activity that makes you think that?"
4) It shows your learners that you are interested in their experiences, and that you find them valuable and interesting to know.
5) If something isn't working, it can help you troubleshoot the issue: Did they skip a step? Use a different material? Was the reaction really fast or really subtle and they missed it?

Make sure you ask your questions with curiosity and openness: you are asking the question because you want to learn your learners' answers, not because you will try to change their minds (even if you do want to!). This will help them feel more comfortable sharing, which will deepen and sustain their conversations and learning.

Technique	Examples of Effective Questions
Model the scientific method before, during & after Model the scientific method before, during & after Scientists work together to collect information (evidence) they can use to answer questions about how things work, why things happen, or even if/when things *will* happen! They collect this evidence by learning from their peers, making observations, and conducting experiments. Additionally, scientists are never "done" learning: experiments often leave scientists with more questions than answers, which is exciting!	· What questions could we answer by doing this activity? · What information could we collect to answer that question? What changes or results could we look for? · What do you think will happen? Why? · What information or knowledge did you use to come up with your answer? · What new questions do you have? What about those questions is interesting to you? How would you collect evidence to answer your questions?
Focus on ideas rather than terminology If a learner is having a hard time with a particular word or phrase (pronouncing, understanding – anything!), help them find other words to use instead. It's more important for learners to learn by making sense of ideas and practicing skills than it is for them to use terminology correctly.	· What are other words that mean the same thing? · How would you explain it to a younger sibling? · Can you act out the word, or draw the word? · Is there a similar word that means something different, and that's making this feel confusing? · How can you remember the information/skill even if you forget the specific word(s)?

Help learners see themselves as scientists by challenging negative misconceptions Importantly, "science" is a *process*, not a product - science is not simply a collection of information or facts. Science is a process of asking questions, making observations to collect information, and thinking carefully to make sense of the information. The goal of science is not to "prove" that a certain idea is "right," or to get "the correct result" from doing an experiment. If an experiment produces an outcome that suggests a scientist's idea was wrong, that's great because there is something new to be learned! A "good" scientist is not somebody who is already very smart, works all by themselves without any help, and never makes mistakes. A "good" scientist is curious, collaborative, and learns from their mistakes.	· What does the word "science" mean to you? · Do you think science is interesting? Fun? Exciting? Scary? Boring? Why? · How do we use science to learn about things? · How does science help us understand things? · How do you use science to understand things? · What does the word "scientist" mean to you? · What does a scientist do? · What makes somebody a "good scientist" or "good at science"? · Do you think you can be a scientist? · How are you like a scientist every day? · What attributes make you a good scientist? · Why do you think it's more important for a scientist to learn from mistakes than to never make mistakes? · Have you ever made a mistake that helped you learn something really useful?
Invite sense-making and peer discussion It's great for learners to have questions because that means they're curious, and they have the opportunity to learn something new! Ask your learners to share what kit activity information and experiences they're curious or confused about and want to understand better. Ask other learners in your group to share how they figured something out. This is especially helpful when you have learners who want to work more quickly than others: capitalize on their energy and help them engage more deeply!	· Was any part of the kit activity surprising, strange, or even counterintuitive to what you expected? · Why do you think that was surprising/strange/counterintuitive – what made you think that something else would happen? · Did any part of the kit activity not make sense? · Did you see or try anything in the kit activity that helped something make sense? · Do you have any other information or experiences from before the kit activity that helped something make sense?
Explore real-world connections Learners are more likely to value the effort required to learn or complete a task if they believe the results will provide something useful and relevant. Personal connections can also help learners see themselves as capable STEAM community members and practitioners.	· Is this something you've ever wondered about? · Would a friend or family member find this interesting? · How could you use something you learned from this activity in your own life? · How could you use something you learned from this activity to help someone else?
Reflect on progress and experiences At the end of each activity, or even after a step within an activity, ask your learners questions that help them see things like: · They learned a new fact or skill · They had a fun/cool/interesting experience · They overcame an obstacle and achieved success · They are scientists and they're doing science · They changed their mind with new information · They turned a "mistake" into a learning opportunity · They wondered new and interesting questions	· What is the most interesting thing you learned? · Was anything confusing at first, but now you understand it better? · Was anything frustrating at first, but it helped you learn something? · Why was it confusing at first? How did you get to understand it better? · What is something you learned that you want to tell a friend or family member? · What is something you learned that you want to use in your everyday life?

Kit Accessibility Tips

This is an additional resource to support the success of learners. Below are tips and tools from COSI's accessibility experts that can be used when adapting for learners.

Fine Motor Adaptations

- Get creative! When completing a movement required activity, think of different ways to accomplish it, like moving an object by attaching it to a wheelchair.
- If an object is too small to handle, swap for similar but larger objects, like switching a bouncy ball for a basketball. You can also attach the smaller object to a larger one to make it easier to hold.
- Use hand over hand to support students when completing fine motor tasks.
- For the writing portions, provide notepaper to give extra space for writing.

Blind and Low Vision Adaptations

- Use puffy paint on the activity book images to create additional tactile images.
- Use manipulatives (objects) for students to touch when explaining how something works to help students process what is happening.
- Use the camera on a phone or tablet to magnify the words and images in the activity book.

Deaf Adaptations

- Utilize COSI's demonstration videos with closed captioning when completing an activity.
- Visually demonstrate the activity steps.

Cognitive Adaptations

- Break the activity into smaller steps to make processing easier.
- For harder to understand concepts use manipulatives (objects) to explain or relate to a practical process.
- Model the steps for the child to follow and complete at the same time.
- Ask leading questions to help students problem solve. For example: "How could you change the shape of the wings to make it fly better?"

Speech Adaptations

- Have students present in alternate ways, like with drawings or by demonstrating what they did.

Standards Alignment and Extension Questions

The following pages will include Ohio Learning Standards and Next Generation Science Standards that are aligned with each activity in the kit. In addition to these standards, you will find extension questions to scale up or scale down the content of each activity according to your students' abilities or grade level. These extension questions are arranged in grade level bands of Kindergarten – Second Grade, Third – Fifth Grade, and Sixth – Eighth Grade. Each set of these questions are also aligned with both Ohio Learning Standards and Next Generation Science Standards.

Throughout the kit activities, your students will find opportunities to write down their scientific findings and connect to digital learning resources through COSI Connects. This will allow them to fulfill the Ohio English Language Arts, Technology, and Digital Literacy Learning standards listed below.

Kindergarten – 2nd Grade

- K-2.ICT.3.b.: Use visuals found in digital learning tools and resources to clarify and add to knowledge.
- W.K.2: Use a combination of drawing, dictating, and writing to compose informative/ explanatory texts that name what is being written about and supply some information about the topic.
- W.1.8: With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.2.8: Recall information from experiences or gather information from provided sources to answer a question.
- K-2.ST.2.a.: Communicate and collaborate using several digital methods.

Third Grade – Fifth Grade

- 3-5.ICT.1.a.: With guidance, identify and use digital learning tools or resources to support planning, implementing and reflecting upon a defined task.
- W.3-5.10: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- 3-5.ICT.4.d.: Produce and publish information appropriate for a target audience using digital learning tools and resources.

Sixth Grade – Eighth Grade

- 6-8.ICT.4.b.: Select and use a variety of media formats to communicate information to a target audience.

COSI connects learning lunchbox

Engineering

ACTIVITY 1: Aerospace Engineer

Aerospace engineers design and build components and systems for air and space. This includes planes, rockets, and satellites to name just a few! Today, as an engineer, your challenge is to design, build, and test the best glider.

Ohio Learning Standards

K – 2nd Grade Technology K-2.DT.2.d.: Demonstrate that there are many possible solutions to a design problem.

2nd Grade Science 2.PS.1: Forces change the motion of an object.

2nd Grade Mathematics 2.MD.1: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

3rd Grade Mathematics 3.MD.4: Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.

3rd – 5th Grade 3-5.ICT.3.c.: Organize observations and data collected during student explorations to determine if patterns are present.

3rd – 5th Grade 3-5.DT.2.b.: Plan and implement a design process: identify a problem, think about ways to solve the problem, develop possible solutions, test and evaluate solution(s), present a possible solution, and redesign to improve the solution.

8th Grade Science 8.PS.1: Objects can experience a force due to an external field such as magnetic, electrostatic or gravitational fields.

8th Grade Science 8.PS.2: Forces can act to change the motion of objects

Next Generation Science Standards

Kindergarten Science K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

3rd Grade Science 3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

GRADES K–2

Extended Learning Questions:

1) What weather would be best to fly a glider in? What would be the worst? Why?
2) Try throwing your gliders outside every day for a week. Do they fly differently on different days? Did the weather change how they fly?
3) Throw the same glider three times. Does it always land in the same spot? Why or why not?
4) You measured your glider circles in inches. Use a different ruler to measure the lengths in centimeters.
5) Do you think a longer glider or shorter glider would work better? Replace the straw to build one longer glider and one shorter glider. Measure the length of each glider. Then, test the gliders. Which flies the best?

Ohio Learning Standards:

Kindergarten Science K.ESS.1: Weather changes are long-term and short-term.

2nd Grade Mathematics 2.MD.2: Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.

2nd Grade Mathematics 2.MD.9: Generate measurement data by measuring lengths of several objects to the nearest whole unit or by making repeated measurements of the same object. Show the measurements by creating a line plot, where the horizontal scale is marked off in whole number units.

Next Generation Science Standards:

Kindergarten Science K-ESS2-1: Use and share observations of local weather conditions to describe patterns over time.

K-2-ETS1-3 Engineering Design: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

COSIconnects learning lunchbox

Engineering

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GRADES 3–5

Extended Learning Questions:

1) When you threw the glider, you gave it energy. Where did your energy come from?
2) Measure the distance each glider you tested went in feet. Can you convert that to inches? If you are working in a group, plot all distances on a graph to show how far each glider flew .
3) Add a small weight to your glider. Does it fly differently? How? What's the heaviest thing it could carry?
4) If you throw the same glider several times, does it always land in the same spot? What changes could you make to make your glider more accurate?
5) Try throwing your glider from different angles. Which one works best?

Ohio Learning Standards:

3rd Grade Mathematics 3.MD.4: Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by creating a line plotG, where the horizontal scale is marked off in appropriate units-whole numbers, halves, or quarters.

4th Grade Science 4.PS.2: Energy can be transferred from one location to another or can be transformed from one form to another.

5th Grade Science 5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.

5th Grade Mathematics 5.MD.1: Know relative sizes of these U.S. customary measurement units in solving multi-step, real-world problems.

4th Grade Mathematics 4.MD.5: Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.

Next Generation Science Standards:

4th Grade Science 4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

5th Grade Science 5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.

COSIconnects learning lunchbox

Engineering

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GRADES 6–8

Extended Learning Questions:

1) When does your glider have potential energy? When does it have kinetic energy? How do you know?
2) When your glider is in the air, there are four forces on it: lift (pushing up), gravity (pulling down), thrust (pushing forward), and drag (pulling backward). What would happen if there was less drag on your glider? How might you reduce drag? (Engineers call something with less drag "more aerodynamic")
3) Drag force is caused by the air – planes are flying against the air and the air pushes back into the plane. The higher up you go, the less dense the air is (less air molecules). What do you think that does to the drag on a plane? How do you think pilots decide how high to fly their planes?
4) Imagine you want to build the most lightweight glider possible. What would you do? Would this cause other limitations with your glider?

Ohio Learning Standards:

6th Grade Science 6.PS.3: There are two categories of energy: kinetic and potential.

6th-8th Grade 6-8.DT.1.e: Describe how trade-offs involve a choice of one quality over another.

7th Grade Science 7.ESS.3: The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere.

Next Generation Science Standards:

MS-PS2-2 Motion and Stability: Forces and Interactions

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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COSI Center of Science and Industry

COSIconnects learning lunchbox

Engineering ACTIVITY 2: Chemical Engineer and Materials Engineer

Some engineers don't build structures at all. Chemical engineers develop and design processes for manufacturing chemicals. They could be working with things like food, medicine, fuel or plastics to name a few. And materials engineers work with materials like metals, plastics, or ceramics; or they make new materials! You will be both a chemical engineer and a materials engineer as you design the perfect bubble solution and the perfect wand to go with it!

Ohio Learning Standards

3rd – 5th Grade Technology 3-5.DT.2.b.: Plan and implement a design process: identify a problem, think about ways to solve the problem, develop possible solutions, test and evaluate solution(s), present a possible solution, and redesign to improve the solution.

3rd – 5th Grade Technology 3-5.DT.3.a.: Design a product with multiple components and describe how the components interact to form a system.

3rd – 5th Grade Technology 3-5.DT.3.b.:

Explore and document connections between technology and other fields of study.

3rd – 5th Grade Technology 3-5.DT.3.c.:

Identify a product and describe how people from different disciplines combined their skills in the design and production of the product.

GRADES K–2

Extended Learning Questions:

1) Look at the glycerin and the water. How are they similar? How are they different?
2) Make three wands with three different shapes. What shapes did you choose?
3) Try different wands with the best recipe you found. Does one wand work best?
4) What is your favorite shape of wand? Could someone else like a different shape better?

Ohio Learning Standards:

Kindergarten Science K.PS.1: Objects and materials can be sorted and described by their properties.

1st Grade Mathematics 1.G.2: Compose two-dimensional shapes or three-dimensional shapes to create a composite shape, and compose new shapes from the composite shape.

Kindergarten-2nd Grade Technology K-2.DT.2.d: Demonstrate that there are many possible solutions to a design problem.

Kindergarten-2nd Grade Technology K-2.DT.1.c: Explain that systems have parts or components that work together to accomplish a goal.

Next Generation Science Standards:

K-2-ETS1-3 Engineering Design: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

2nd Grade Science 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2nd Grade Science 2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

COSI connects learning lunchbox

Engineering

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GRADES 3–5

Extended Learning Questions:

1) What do you consider the "best" bubbles? Does "best" mean biggest, fastest, most bubbles in a row? Does it mean the bubble that lasts longest before popping? Discuss.
2) What other materials could you use to make a wand besides the pipe cleaner? Optional: design a new wand, gather the supplies, and test it out!
3) Try blowing softly to create a bubble. Then, blow more forcefully to create a bubble. How does the force of your blowing change the type and speed of the bubbles created?
4) Work in groups of 4. Pick one bubble recipe and test how the amount of water affects the recipe. First, choose 4 different amounts of water to try (try ½ cup, 1 cup, 1 ½ cups, and 2 cups, for example). Make the bubble recipe 4 times, only changing the amount of water. Try blowing bubbles and write down your results. Which amount of water works best? Why do you think that is?

Ohio Learning Standards:

3rd-5th Grade Technology 3-5. DT.1.b: Give examples of how requirements for a product can limit the design possibilities for that product.

3rd-5th Grade Technology 3-5.DT.4.b: Examine a familiar product or process and suggest improvements to its design.

5th Grade Science 5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.

3rd Grade Mathematics 3.MD.2: Measure and estimate liquid volumes and masses of objects using standard units of grams, kilograms, and liters. Add, subtract, multiply, or divide whole numbers to solve one-step word problems involving masses or volumes that are given in the same units.

Next Generation Science Standards:

3-PS2-1 Motion and Stability: Forces and Interactions Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-5-ETS1-3 Engineering Design Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

COSIconnects learning lunchbox

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GRADES 6–8

Extended Learning Questions:

1) Look at the chemical structure of a glycerin molecule ($C_3H_8O_3$) and a water molecule (H_2O) on the activity book page 5. Compare the two molecules. Which is bigger? What similarities and differences do you notice?
2) Imagine you need to design an automatic bubble maker that doesn't need a person to blow the bubbles. What would you use to build it? Draw a diagram of your design. Optional: gather the supplies and build it! Does it work?
3) Look at the bubble recipe you chose. What is the ratio of glycerin (if used) to water? What is the ratio of dishwashing liquid (if used) to water?
4) How might a different bubble recipe change the type of wand needed? How might a different type of wand change the bubble recipe needed?

Ohio Learning Standards:

6th Grade Science 6.PS.1: Matter is made up of small particles called atoms.

6th Grade Mathematics 6.RP.2: Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship.

6th-8th Grade Technology 6-8. DT.3.e: Deconstruct a system into its component parts and describe how they interrelate.

6th-8th Grade Technology 6-8. DT.1.f: Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.

Next Generation Science Standards:

Middle School Science MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

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Engineering

ACTIVITY 3 : Structural Engineer

Structural engineers create careful drawings and evaluations for buildings. They make calculations to ensure a building will be safe. Test your design skills and build structures out of paper!

Ohio Learning Standards

K – 2nd Grade Technology K-2.DT.2.d.: Demonstrate that there are many possible solutions to a design problem.

2nd Grade Mathematics 2.G.1: Recognize and identify triangles, quadrilaterals, pentagons, and hexagons based on the number of sides or vertices. Recognize and identify cubes, rectangular prisms, cones, and cylinders.

3rd – 5th Grade Technology 3- 5.DT.1.a.: Demonstrate how applying human knowledge using tools and machines extends human capabilities to meet our needs and wants.

3rd – 5th Grade Technology 3-5.DT.3.b.: Explore and document connections between technology and other fields of study.

Next Generation Science Standards

2-PS1-3 Matter and Its Interactions: Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

GRADES K–2

Extended Learning Questions:

1) Look around the room. What shapes do you see? Do any of those shapes hold things up?
2) Go for a walk outside. What shapes do you see in structures? Look for shapes in houses, buildings, playgrounds, fences, or other structures.
3) Build a structure out of your triangles and rectangles. Now, think about how you would decorate your building. Optional: gather supplies and decorate it!
4) Why do we build different structures? Can you think of something we build to...
   - Live in?
   - Cross over obstacles?
   - Be protected from the weather?
   - Be together with other people?
5) What other reasons do we build structures?

Ohio Learning Standards:

Kindergarten-2nd Grade Technology K-2.DT.2.a: Observe and describe details of an object's design.

Kindergarten-2nd Grade Technology K-2.DT.2.e: Communicate design plans and solutions using drawings and descriptive language.

Kindergarten-2nd Grade Technology K-2.DT.4.a: Identify and discuss the use of aesthetics in everyday objects.

Kindergarten-2nd Grade Technology K-2.DT.4.b: Identify and discuss functional aspects of everyday objects.

Kindergarten-2nd Grade Technology K-2.DT.1.b: Describe technology as something someone made to meet a want or need.

Next Generation Science Standards:

2-PS1-1 Matter and Its Interactions
Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

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Engineering

ACTIVITY 3 : Structural Engineer

Structural engineers create careful drawings and evaluations for buildings. They make calculations to ensure a building will be safe. Test your design skills and build structures out of paper!

GRADES 3–5

Extended Learning Questions:

1) What is the maximum weight your structure can support? Make a prediction, then test it out. If you are placing objects on top, be sure you know or measure their weights.
2) Look at the pictures of structures inside your activity guide (or online). What structure do you like the best? Why? What do people use that structure for?
3) Look at pictures of famous structures. Use your triangle blocks and paper rectangles to build a model of that famous building or structure. See if other people can guess which one you modeled.
4) Work in groups. Imagine you must design and build a bridge out of your triangles and rectangles. The bridge must be at least three inches high and at least seven inches across. You are limited to only using the triangles and rectangles in your box. Make a design and test it out, rebuilding if needed.
5) If the triangle blocks were made of a different material, like cardboard or plastic, how do you think that would affect the final product?

Ohio Learning Standards:

3rd-5th Grade Technology 3-5. DT.2.b: Plan and implement a design process: identify a problem, think about ways to solve the problem, develop possible solutions, test and evaluate solution(s), present a possible solution, and redesign to improve the solution.

3rd-5th Grade Technology 3-5. DT.4.a: Use criteria developed with guidance to evaluate a new or improved product for its functional, aesthetic and creative elements.

3rd-5th Grade Technology 3-5.DT.2.a: Critique needs and opportunities for designing solutions.

3rd-5th Grade Technology 3-5. DT.1.b: Give examples of how requirements for a product can limit the design possibilities for that product.

Next Generation Science Standards:

3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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Structural engineers create careful drawings and evaluations for buildings. They make calculations to ensure a building will be safe. Test your design skills and build structures out of paper!

GRADES 6–8

Extended Learning Questions:

1) Read in your activity guide or from an online resource how architect Shigeru Ban builds things to help people. Imagine you are an architect. What might you build to help people? Write a paragraph about it.
2) If the triangles were made of a different material, like cardboard or plastic how would that affect the final product? What would be the best material for the environment? Which would be the best for stability of structures you build?
3) Look online to find a picture of famous structures in the country of your choice. Use your triangle blocks and paper rectangles to build a model of that famous building or structure. You may also use other supplies to add to your structure and make it more realistic. Create a sign to place next to your structure. On the sign, include a picture of the structure and a paragraph about the structure. (Where is it? Who designed it? What is it used for?) Have a gallery walk to view other peoples' structures.
4) Work in groups. You must design and a bridge bridge out of your triangles and rectangles. The bridge must be at least five inches high and at least ten inches across. You are limited to only using the triangles and rectangles in your boxes. Make a design and test it out, rebuilding if needed. Share your results with others. What didn't work well? What did work well?

Ohio Learning Standards:

6th-8th Grade Technology 6-8. DT.2.a: Apply a complete design process to solve an identified individual or community problem: research, develop, test, evaluate and present several possible solutions, and redesign to improve the solution.

6th-8th Grade Technology 6-8.DT.2.d: Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems.

6th-8th Grade Technology 6-8.DT.4.c: Apply the design principle "form follows function" to develop a product.

Next Generation Science Standards:

MS-ETS1-2 Engineering Design: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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Engineering

ACTIVITY 4 : Marine Engineer

Some engineers design submarines and dive suits! Challenge yourself to create a submarine model that can keep neutral buoyancy for five seconds!

Ohio Learning Standards

K – 2nd Grade Technology K-2.DT.2.b.: Demonstrate the ability to follow a simple design process: identify a problem, think about ways to solve the problem, develop possible solutions, and share and evaluate solutions with others.

K – 2nd Grade Technology K-2.DT.2.e.: Communicate design plans and solutions using drawings and descriptive language.

K –2nd Grade Technology K-2.DT.3.b.: Work as a team to identify possible problems to solve and their potential technological solutions.

3rd – 5th Grade Technology 3-5.DT.2.b.: Plan and implement a design process: identify a problem, think about ways to solve the problem, develop possible solutions, test and evaluate solution(s), present a possible solution, and redesign to improve the solution.

6th – 8th Grade Technology 6-8.DT.2.a.: Apply a complete design process to solve an identified individual or community problem: research, develop, test, evaluate and present several possible solutions, and redesign to improve the solution.

Next Generation Science Standards

3-5-ETS1-1 Engineering Design: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Engineering Design: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

GRADES K–2

Extended Learning Questions:

1) Gather a bowl of water and five different objects that can get wet. You might try a rubber band, a small piece of paper, or an eraser. For each object, predict whether it will sink or float in the water. After you've made a prediction, drop it in to see what happens!
2) How many different objects did you put into your submarine?
3) What do you think made a submarine sink? What do you think made it float?
4) What do you think people use submarines for?
5) Imagine you are going for a trip in a submarine. What will you bring with you? What animals do you think you'll see? Is there something you really hope you'll get to see underwater?

Ohio Learning Standards:

Kindergarten Science K.PS.1: Objects and materials can be sorted and described by their properties.

Kindergarten Math K.CC.6: Orally identify (without using inequality symbols) whether the number of objects in one group is greater/more than, less/fewer than, or the same as the number of objects in another group, not to exceed 10 objects in each group.

Kindergarten Math K.M.D.1: Identify and describe measurable attributes (length, weight, and height) of a single object using vocabulary terms such as long/short, heavy/light, or tall/short.

1st Grade Science 1.LS.2: Living things survive only in environments that meet their needs.

Kindergarten Technology K-2. DT.1.d: Give examples of how resources such as tools and materials are things that help people get a job done.

Next Generation Science Standards:

2nd Grade Science 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2nd Grade Science 2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Kindergarten Science K-ESS3-1: Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

2nd Grade Science 2-LS4-1: Make observations of plants and animals to compare the diversity of life in different habitats.

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Engineering

ACTIVITY 4 : Marine Engineer

Some engineers design submarines and dive suits! Challenge yourself to create a submarine model that can keep neutral buoyancy for five seconds!

GRADES 3–5

Extended Learning Questions:

1) One of your constraints was that everything you use must be either inside or attached to the submarine body. If you didn't have this constraint, would you build your submarine differently? How? Optional: test it out!
2) Did your materials and design plan work the first time, or did you have to change it after testing? If you changed it, what was the most important change you made to the design?
3) Imagine you were going to drop your submarine into honey instead of water. How would your results be different? Why?
4) How do people use submarines? What can a submarine do that a diver can't do?
5) Imagine you are going in a submarine to the bottom of the Mariana Trench. Look online to learn what sorts of organisms you might encounter on your trip. Pick one organism and write a paragraph about it. Share with others what you learned.

Ohio Learning Standards:

3rd Grade Science 3.PS.1: All objects and substances in the natural world are composed of matter.

5th Grade Science 5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.

3rd-5th Grade Technology 3-5. DT.1.b: Give examples of how requirements for a product can limit the design possibilities for that product.

3rd-5th Grade Technology 3-5.DT.1.a: Demonstrate how applying human knowledge using tools and machines extends human capabilities to meet our needs and wants.

3rd-5th Grade Technology 3-5. DT.1.c: Describe a process as a series of actions and how it is used to produce a result.

3rd-5th Grade Technology 3-5.DT.2.c: Generate, develop and communicate design ideas and decisions using appropriate terms and graphical representations.

Next Generation Science Standards:

3rd Grade Science 3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

COSIconnects learning lunchbox

Engineering

ACTIVITY 4 : Marine Engineer

Some engineers design submarines and dive suits! Challenge yourself to create a submarine model that can keep neutral buoyancy for five seconds!

GRADES 6–8

Extended Learning Questions:

1) Try to make a submarine neutrally buoyant using the least amount of materials possible. Why might engineers sometimes need to limit the number of materials they use?
2) After getting your submarine to be neutrally buoyant, try dropping it into the water from a height. Then try holding it still in the top inch of water before letting it go. What differences do you notice? What does this tell you about the forces acting on your submarine?
3) Imagine you are going in a submarine to the bottom of the Mariana Trench. Look online to learn what sorts of organisms you might encounter on your trip. Write a one-page paper describing some of the things you might encounter on your trip. What are you most excited to see? What are you least excited to see? Why?

Ohio Learning Standards:

6th-8th Grade Technology 6-8. DT.2.c: Explain how innovation is the process of modifying an existing system or system element(s) to improve it.

6th-8th Grade Technology 6-8.DT.3.b: Explain ways that invention and innovation within one field can transfer into other fields of technology.

6th-8th Grade Technology 6-8. DT.1.f: Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.

6th-8th Grade Technology 6-8. DT.3.d: Give examples of how changes in one part of a system can impact other parts of that system.

8th Grade Science 8.PS.2: Forces can act to change the motion of objects.

Next Generation Science Standards:

Middle School Science MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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Engineering

ACTIVITY 5 : Automotive Engineer

Electrical engineers design, build, test, and fix devices that include automobiles. In this activity, design, build, and test your own miniature car!

Ohio Learning Standards

K-2nd Grade Technology K-2.DT.2.d: Demonstrate that there are many possible solutions to a design problem.

1st Grade Science 1.PS.2: Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

2nd Grade Science: 2.PS.1: Forces change the motion of an object.

3rd Grade Science: 3.ESS.3: Some of Earth's resources are limited.

6th Grade Science 6.PS.3: There are two categories of energy: kinetic and potential.

Next Generation Science Standards

Kindergarten Science K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

4th Grade Science 4-ESS3-1: Earth and Human Activity

Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

GRADES K–2

Extended Learning Questions:

1) What does the car sound like when you let it go? Why doesn't it sound the same when it's not moving?
2) How do cars make our lives easier?
3) What happens if you give your car a push as you let it go? Does it go farther or faster?
4) Try making your car go down a ramp. Then, make it go up a ramp. What do you notice?
5) List as many vehicles as you can (you may think about cars, trucks, boats, planes, etc.) Why are some vehicles big and some small? Why do some vehicles have different shapes? What does the shape of a vehicle tell you about it?

Ohio Learning Standards:

Kindergarten Science K.PS.2: Some objects and materials can be made to vibrate to produce sound.

1st Grade Science 1.PS.2: Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

2nd Grade Science: 2.PS.1: Forces change the motion of an object.

Kindergarten-2nd Grade Technology K-2.DT.4.b: Identify and discuss functional aspects of everyday objects.

Kindergarten-2nd Grade Technology: K-2.DT.1.b: Describe technology as something someone made to meet a want or need.

Next Generation Science Standards:

1st Grade Science 1-PS4-1: Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Kindergarten Science K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

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Engineering

ACTIVITY 5 : Automotive Engineer

Electrical engineers design, build, test, and fix devices that include automobiles. In this activity, design, build, and test your own miniature car!

GRADES 3–5

Extended Learning Questions:

1) Try adding some weight to your car (you can use other materials from your kit). How much weight can your car carry? Does the car go as far with weight on it as it does without weight? Why or why not?
2) Try your car on three different surfaces. Twist the rubber band the same number of times for each trial. Measure how far it goes on each trial. On which surface does the car go the farthest? Why do you think that is?
3) Your car is powered by a rubber band. What powers other vehicles, like cars, planes, trains, and boats? Are there different ways to power vehicles? Do some research to learn about what effect these different power sources have on the environment.
4) Make a ramp. Starting at the top, send your car down the ramp three times, twisting the rubber band the same number of times for each trial. Measure the distance the car went in each trial. Then, starting at the bottom, run three trials with the car going up the ramp. Twist the rubber band the same number of times as you did on the way down. Record your data in a table or graph. What do you notice?
5) Can you decorate your car without affecting its speed or distance? Discuss. Optional: decorate your car and try it out!

Ohio Learning Standards:

3rd Grade Science 3.PS.3: Heat, electrical energy, light, sound, and magnetic energy are forms of energy.

3rd Grade Science 3.ESS.2: Earth's resources can be used for energy.

5th Grade Science 5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.

4th Grade Math 4.MD.5: Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.

3rd-5th Grade Technology 3-5.DT.2.a: Critique needs and opportunities for designing solutions.

3rd-5th Grade Technology 3-5. DT.4.a: Use criteria developed with guidance to evaluate a new or improved product for its functional, aesthetic and creative elements.

Next Generation Science Standards:

4th Grade Science 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

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Engineering

ACTIVITY 5 : Automotive Engineer

Electrical engineers design, build, test, and fix devices that include automobiles. In this activity, design, build, and test your own miniature car!

GRADES 6–8

Extended Learning Questions:

1) How would you change the shape of the car to make it more aerodynamic? How do you think engineers change the shape of real cars to make them more aerodynamic? Find cars from different decades, what differences do you notice?
2) Use a scale to measure the weight of your car. Write the weight down. Wind your rubber band and watch your car go. Measure the distance it travels before stopping. Write down the weight, the number of turns of the rubber band, and the distance it traveled. Then, design an experiment to determine the effect of the weight on how far the car moves.
3) Drive your car three times across a flat surface. Make sure you wind the rubber band the same number of times each trial. Measure the distance traveled each time and write those measurements down. Add the three numbers together and divide by three to find the average distance traveled. Don't forget to include units.
4) What forces are acting on the car as it goes forward? (Hint: you should list at least 4 forces). How are these forces similar to and different from the forces on the glider? (See Page 5 of the Activity book.)
5) Work in groups. Find three different surfaces to test the rubber band cars on. Your research question is: what surface allows the car to travel farthest? Start with a hypothesis (educated guess). Then, design an experiment to find the answer. Make sure you control other variables, such as which car you're using and how many times you turn the rubber band). Once you have your results, look at the surfaces and guess which one has the most friction. How do you think friction affects the motion of the wheels?

Ohio Learning Standards:

6th-8th Grade Technology 6-8.DT.4.c: Apply the design principle "form follows function" to develop a product.

6th Grade Science 6.PS.4: An object's motion can be described by its speed and the direction in which it is moving.

8th Grade Science 8.PS.2: Forces can act to change the motion of objects.

6th-8th Grade Technology 6-8. DT.1.e: Describe how trade-offs involve a choice of one quality over another.

6th-8th Grade Technology 6-8. DT.2.c: Explain how innovation is the process of modifying an existing system or system element(s) to improve it.

Next Generation Science Standards:

Middle School Science MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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Glossary:

Buoyancy – The upward force that a fluid exerts on anything submerged in it.

Aerodynamic – Having a shape that reduces drag from the air.

Architect – Someone who designs buildings and other spaces for people to use and enjoy.

Viscous – A fluid that is thick, sticky, and slow-moving.

Thrust – A force that pushes an object forward.

Lift – A force that pushes an object up.

Drag – A force that pushes against an object's movement.

Gravity – On Earth, the force that pulls everything toward the center of the Earth.

Variable – Something that can change in an experiment.

Mass – The amount of matter in an object.

Volume – The amount of space taken up by an object.