Hyperloop

educator guide

WELCOME TO THE ENGINEERING HYPERLOOP Educator Guide!

In this Educator Guide, you'll find Grade Banded Learning Standards aligning to each of the activities. You will also find a QR Code linking you to COSI Connects, an online universe of science through videos, activities and so much more! COSI Connects also includes a section called Community Connects, a digital hub for online and in-person resources from museums, cultural institutions, and other nonprofits.

COSI Connects

For additional resources, including book recommendations, and video instructions for completing each of the activities inside your box be sure to check out **cosi.org/hyperloop-kitvideos.**

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

Table of Contents

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 **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.

Engineering Hyperloop

ACTIVITY 1: Become an Engineer

Learners will explore how friction works as they create their own friction board, test the friction between surfaces, and determine which surfaces have the most friction between them.

Ohio Learning Standards

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

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.

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.

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.

GRADES K–2

Extended Learning Questions:

1) Touch the contact paper, cardboard and sandpaper. Which is the smoothest? Which one feels rough? What would you use these for?
2) What happens when you pour all the stones into the bucket at once?
3) Pick something other than the block that you can tape or tie to the block and see how many stones it takes to move it. More or less? If you wanted something to hold up as many stones as possible, which is better, the block or something else?
4) Use the stones to practice addition and subtraction: place 7 stones in a pile. Place 3 stones in another pile. 7 + 3 = ___ ? Count all the stones to find out! Now what happens when you take away 2 stones?

Ohio Learning Standards:

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

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

Kindergarten Math K.OA.1 Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

First Grade Math 1.OA.1 Represent and solve problems involving addition and subtraction.

Second Grade Math 2.OA.1 Represent and solve problems involving addition and subtraction.

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.

Engineering Hyperloop

ACTIVITY 1: Become an Engineer

Learners will explore how friction works as they create their own friction board, test the friction between surfaces, and determine which surfaces have the most friction between them.

GRADES 3–5

Extended Learning Questions:

1) Use something other than the block that you can tape or tie to the block and see how many stones it takes to move. Does your object require more or less stones to move than the block? How did the weight and texture of the object you chose affect the result?
2) How did the movement of the block change when you increased the weight of the bucket? What direction does the bucket move? Why? What direction does the block move? Why?
3) Design a way to move the block that uses a push instead of a pull. First, draw out your design. Then, build it and test it out. Does it work? What causes the block to move?
4) Imagine you want to reduce the friction of one of your tracks. What would you coat the surface with? Why?

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.

Next Generation Science Standards:

3rd Grade Science 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

3rd-5th Grade Engineering 3-5-ETS1-3: 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.

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

Engineering Hyperloop

ACTIVITY 1: Become an Engineer

Learners will explore how friction works as they create their own friction board, test the friction between surfaces, and determine which surfaces have the most friction between them.

GRADES 6–8

Extended Learning Questions:

1) What would happen if you use a longer or shorter string? Would it change the number of stones required? Why or why not?
2) Tilt the back of the box up at a slight angle. Repeat the experiment. Now how many stones did it take to move the block? What if you reversed it and tilted the front of the box up at the same angle? What changes about the forces on the block when you tilt the track?
3) Attach different materials to the track to make a track that has more than one surface. Can you make a track that would start with the block moving quickly, and then cause it to stop?
4) Find the weight of one stone using a scale. Then, using math, estimate the weight of 23 stones. Check your work by counting and weighing 23 stones. How does your estimation compare to the actual weight? If your number was slightly different, why do you think that is?
5) Use a measuring utensil (like calipers) to find the approximate diameter of a stone. Use that diameter to calculate the radius, circumference, surface area, and area of the stone.

Ohio Learning Standards:

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

7th Grade Math 7.G.5: Solve real-life and mathematical problems involving angle measure, circles, area, surface area, and volume.

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

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.

Join us at our Community Learning Table: "Community Connects"

The Community Connects section of this digital hub brings together educational resources from museums, cultural institutions, and other nonprofits in your community to extend your learning

cosi.org/connects

COSI Center of Science and Industry

Engineering Hyperloop

ACTIVITY 2 : Learn from other Engineers

Learners will watch a Virgin Hyperloop Engineer explain how they can control the amount of friction on the Hyperloop. Then, learners will explore magnetic forces for themselves with ring magnets.

Ohio Learning Standards

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

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

3rd Grade Science 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3rd Grade Science 3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

GRADES K–2

Extended Learning Questions:

1) How does the motion of the magnets change when you flip the top magnet during pencil experiment?
2) Try putting paper or cloth between the magnets. Do they still stick together?
3) Find something else in the room that the magnets stick to. Why do you think they stick?
4) How far apart are the magnets when they levitate?

Ohio Learning Standards:

Kindergarten Mathematics K.MD.1: Identify, describe, and compare measurable attributes.

1st Grade Mathematics 1.MD.2: Measure lengths indirectly and by iterating length units.

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

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.

GRADES 3–5

Extended Learning Questions:

1) What happens when you apply force by pushing down the top magnet on the pencil? What causes it to spring up when you let go?
2) Attach something to the top magnet to push it closer to the bottom magnet. Does the space between the magnets close completely? Why or why not?
3) Find other things that are magnetic. What are similarities you notice among these magnetic things?
4) Attach one magnet to something small. How can you use the other magnet to push or pull the object?

Ohio Learning Standards:

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

5th Grade Science 1.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.

Next Generation Science Standards:

3rd Grade Science 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Engineering Hyperloop

ACTIVITY 2: Learn from other Engineers

Learners will watch a Virgin Hyperloop Engineer explain how they can control the amount of friction on the Hyperloop. Then, learners will explore magnetic forces for themselves with ring magnets.

GRADES 6–8

Extended Learning Questions:

1) Try the following two ways to get the magnets to move: (1) Hold the magnets together on the pencil when they are repelling each other, then let them go. (2) Drop the top one from the highest point on the pencil. Run a few tests and observe the results. Which launches the top magnet higher: (1) or (2)? Why do you think that is?
2) When do the magnets have potential energy? When do they have kinetic energy? How do you know?
3) Move a metal wire around the magnets. Do you feel any push or pull? Where? How can this tell you where the magnetic field is? Where the magnetic field is the strongest?
4) What tools or machines do we use that have magnets in them? Use digital tools to learn more. Write a list of at least 5 items and compare lists with your classmates.

Ohio Learning Standards:

6th-8th Grade Technology 6-8. ICT.2.a: Use advanced search techniques to locate needed information using digital learning tools and resources.

7th Grade Science 7.PS.4: Energy can be transferred through a variety of ways.

Next Generation Science Standards:

Middle School Science MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Join us at our Community Learning Table: "Community Connects"

The Community Connects section of this digital hub brings together educational resources from museums, cultural institutions, and other nonprofits in your community to extend your learning

cosi.org/connects

COSI Center of Science and Industry

Engineering Hyperloop

ACTIVITY 3 : Make a Plan

Learners will explore magnetic fields extending from their ring magnets as well as Earth's magnetic field. They will use a compass to determine which way is North and design a map.

Ohio Learning Standards

1st Grade Social Studies 4: Maps can be used to locate and identify places.

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

2nd Grade Social Studies 5: Maps and their symbols, including cardinal directions, can be interpreted to answer questions about location of places.

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.

4th Grade Social Studies 9: A map scale and cardinal and intermediate directions can be used to describe the relative location of physical and human characteristics of Ohio and the United States.

7th Grade Mathematics 7.G.1.a.: Compute actual lengths and areas from a scale drawing and reproduce a scale drawing at a different scale.

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

3rd Grade Science 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3rd Grade Science 3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

Middle School Science MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

GRADES K–2

Extended Learning Questions:

1) Work in groups to draw a map of a room somewhere in your school. Then, have a classmate identify the location based on the map.
2) Looking at your map, describe how to get from one station to another. How did you use directions? How did you describe things on your map along the way?
3) Besides a compass, what sorts of tools do people use to find their way around? If you could invent a new tool to help people get around, what would it be?
4) How can you measure the distance between two places on your map?
5) Have one person cover up their eyes and tell them in words how to get from one spot to another in the room. Don't forget to tell them how many steps to go and when to turn!

Ohio Learning Standards:

2nd Grade Mathematics 2.MD.1: Measure and estimate lengths in standard units.

Next Generation Science Standards:

Kindergarten Engineering K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Engineering Hyperloop

ACTIVITY 3 : Make a Plan

Learners will explore magnetic fields extending from their ring magnets as well as Earth's magnetic field. They will use a compass to determine which way is North and design a map.

GRADES 3–5

Extended Learning Questions:

1) Write down directions to get from one landmark on your map to another. Hand a friend your map. Tell them where to start. Read them your directions. Did they end up where you wanted them to? Why or why not?
2) Choose one landmark on the map. Using the map scale, what is the distance from Station 1 to that landmark?
3) Find some maps online for local or national parks. What features are in those parks? What symbols do they use to represent the features on a map? If you were making the map, would you change any of the symbols to look like something else?
4) Push one magnet from one station to the next with the other magnet. How many pushes did it take?
5) Use one magnet to carry something from Station A to Station B? How much weight can it carry? Use a scale to record your test results.

Ohio Learning Standards:

3rd Grade Social Studies 4: Physical and political maps have distinctive characteristics and purposes. Places can be located on a map by using the title, key, alphanumeric grid and cardinal directions.

3rd Grade Mathematics 3.MD.2: Measure and estimate liquid volumes and masses of objects using standard units of grams, kilograms, and liters.

3rd-5th Grade Technology 3-5.ICT.2.b: Use appropriate search techniques to locate needed information using digital learning tools and resources.

Next Generation Science Standards:

4th Grade Science 4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.

Engineering Hyperloop

ACTIVITY 3 : Make a Plan

Learners will explore magnetic fields extending from their ring magnets as well as Earth's magnetic field. They will use a compass to determine which way is North and design a map.

GRADES 6–8

Extended Learning Questions:

1) Double the size of your map by computing lengths and areas from the original map?
2) Look up three famous cities. How far apart are they from each other? Write these distances down. How many times farther apart are the farthest two from the closest two?
3) Push one magnet from one station to the next with the other magnet. What was the total distance travelled in miles? Use the scale at the bottom of the map.
4) Push one magnet toward the other. Can you make the other magnet flip rather than slide? Why might that happen?
5) Use one magnet to carry something from Station A to Station B by pushing it with the other magnet. Does the extra mass change the distance each push from the other magnet causes? Why or why not?

Ohio Learning Standards:

6th Grade Mathematics 6.RP.1: Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

7th Grade Mathematics 7.G.1.a.: Compute actual lengths and areas from a scale drawing and reproduce a scale drawing at a different scale.

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.

Join us at our Community Learning Table: "Community Connects"

The Community Connects section of this digital hub brings together educational resources from museums, cultural institutions, and other nonprofits in your community to extend your learning

cosi.org/connects

cosi Center of Science and Industry

Engineering Hyperloop

ACTIVITY 4 : Build, Test, and Improve

Learners will design, build, test, and improve a track that will get a marble from point A to point B!

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.d.: Demonstrate that there are many possible solutions to a design problem.

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

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.

Next Generation Science Standards

Kindergarten-2nd Grade Engineering K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

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

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.

3rd-5th Grade Engineering 3-5-ETS1-2: 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.

3rd-5th Grade Engineering 3-5-ETS1-3: 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.

GRADES K–2

Extended Learning Questions:

1) Show someone your design drawing. Describe it to them in words.
2) Test a few different tracks as a class: one cardboard tube, one cardboard tube with felt in it, and one cardboard tube with oil on it. Which one do you think the marble will roll fastest along? Test them out. Did anything surprise you?
3) What happens if your marble runs into something in the track? How does its motion change?
4) Have a classroom marble race! Each person gets one paper towel tube. Try to get your marble from one side of the room to the other: (1) Roll it as far as you can! (2) Use your tube as a hockey stick to hit it across the room. (3) Get in lines of 3 or 4. See if you can get the marble from one end of the line to the other by running it through everyone's marble tube.

Ohio Learning Standards:

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

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.

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.

Engineering Hyperloop

ACTIVITY 4 : Build, Test, and Improve

Learners will design, build, test, and improve a track that will get a marble from point A to point B!

GRADES 3–5

Extended Learning Questions:

1) Would your track work the same if your marble was twice as big? What if it was twice as heavy? Why or why not?
2) Move your Headquarters location marker four paces away from your COSI location marker. How will you change your design to work successfully with a longer distance?
3) Think about the three tracks from Activity 1: contact paper, sandpaper, and cardboard. Which would be the best to coat this track with? Why?
4) How does the angle of the starting tube affect how fast the marble goes?
5) Look at your track. When does the marble have the most kinetic energy? How do you know?

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.

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.

Next Generation Science Standards:

3rd-5th Grade Engineering 3-5-ETS1-3: 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.

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

Engineering Hyperloop

ACTIVITY 4 : Build, Test, and Improve

Learners will design, build, test, and improve a track that will get a marble from point A to point B!

GRADES 6–8

Extended Learning Questions:

1) How do you and your family travel from place to place? What would it be like for your family to have faster and more reliable transportation? How would it impact your community?
2) Build a track as a team of three. Assign roles: a record keeper, a builder, and a planner. Before you get started, determine what each person is responsible for doing. After you build your track, discuss. How was working as a team different than working on your own?
3) Put the Station B at a higher location than Station A. What can you do to get the marble to go uphill to Station B?
4) Use two marbles. Set up a track with the second marble stationary on the track. Can you set it up in a way that your second marble reaches Station B after the first marble collides with it? (Hint: think about when a stationary object has the most gravitational potential energy)

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.3.a.: Collaborate to solve a problem as an interdisciplinary team modeling different roles and functions.

6th – 8th Grade Technology 6-8.DT.3.c.: Evaluate the effectiveness of the group's collaboration during the engineering design process and the contribution of the varying roles.

Next Generation Science Standards:

Middle School Engineering MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Join us at our Community Learning Table: "Community Connects"

The Community Connects section of this digital hub brings together educational resources from museums, cultural institutions, and other nonprofits in your community to extend your learning

cosi.org/connects

COSI Center of Science and Industry

Engineering Hyperloop

ACTIVITY 5 : Create your Model Hyperloop Set

Learners will mold a model Hyperloop pod from clay and build a Hyperloop tube for it. They will explore how to reduce the friction to make their pod slide more quickly through the tube.

Ohio Learning Standards

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

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.

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.

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.

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.

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.

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.

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

GRADES K–2

Extended Learning Questions:

1) What happens if you send the pod through the track when it's straight up and down? What about when the track is at a tilted angle?
2) How do your decorations make your pod stand out?
3) Work together in a group to make a long track. How long of a track can you make in 10 minutes? How many sheets of paper did you use? Can your pod move through the track?
4) Attach a small toy to your pod. Does it still fit in the track? Can it move through without the toy falling off? Why or why not?
5) What shape did you make your pod? How does it compare to the shapes of other peoples' pods? Which shape seems to move through the tube best? Why?

Ohio Learning Standards:

Kindergarten Math K.G.5: Model shapes in the world by building shapes from components, e.g., sticks and clay balls, and drawing shapes.

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

3rd Grade Fine Arts 3.2PE: Demonstrate expressive and purposeful use of materials and tools.

Next Generation Science Standards:

Kindergarten-2nd Grade Engineering K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

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

Engineering Hyperloop

ACTIVITY 5 : Create your Model Hyperloop Set

Learners will mold a model Hyperloop pod from clay and build a Hyperloop tube for it. They will explore how to reduce the friction to make their pod slide more quickly through the tube.

GRADES 3–5

Extended Learning Questions:

1) What kind of jobs do you think it takes to design and produce the Hyperloop?
2) What would happen if the pod was half its size traveling through the track? What if it was double in size?
3) Try your pod on the track from Activity 4. Does it still work as well?
4) What would happen if your pod weighed twice as much? Why?

Ohio Learning Standards:

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.

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.

Next Generation Science Standards:

3rd Grade Science 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

GRADES 6–8

Extended Learning Questions:

1) What types of forces can you use to move the pod through the track? What forces slow it down? How does it move differently from the marble?
2) Imagine your pod needs to slow down and stop as it approaches the station. How might you design a track that slows it down as it approaches the station?
3) What is the minimum circumference of the track you could use based on your pod size?
4) How would your tunnel work if it could have the air removed from it, like a vacuum? Why?

Ohio Learning Standards:

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

7th Grade Mathematics 7.G.4: Work with circles.

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

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.

Middle School Engineering MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Join us at our Community Learning Table: "Community Connects"

The Community Connects section of this digital hub brings together educational resources from museums, cultural institutions, and other nonprofits in your community to extend your learning

cosi.org/connects

COSI Center of Science and Industry

Glossary :

Air Resistance– the friction between the air and anything moving in it.

Compass– a tool that uses a magnet to point North to help people figure out direction.

Constraints- rules or limits that need to be followed when making a new product.

Distance– the amount of space between two points.

Force– a push or a pull.

Friction– a force when two objects move (or try to move) against each other.

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

Legend– a list that shows what symbols on a map or graph represent.

Levitate- when an object floats or rises in the air without being held up by an actual object.

Magnetic Field– every magnet has an invisible magnetic field around it. Magnetic objects inside that magnetic field will experience a push or a pull.

Magnetic Force– the push or pull on any magnetic object in a magnetic field.

Water Resistance– friction between water and anything moving in it.