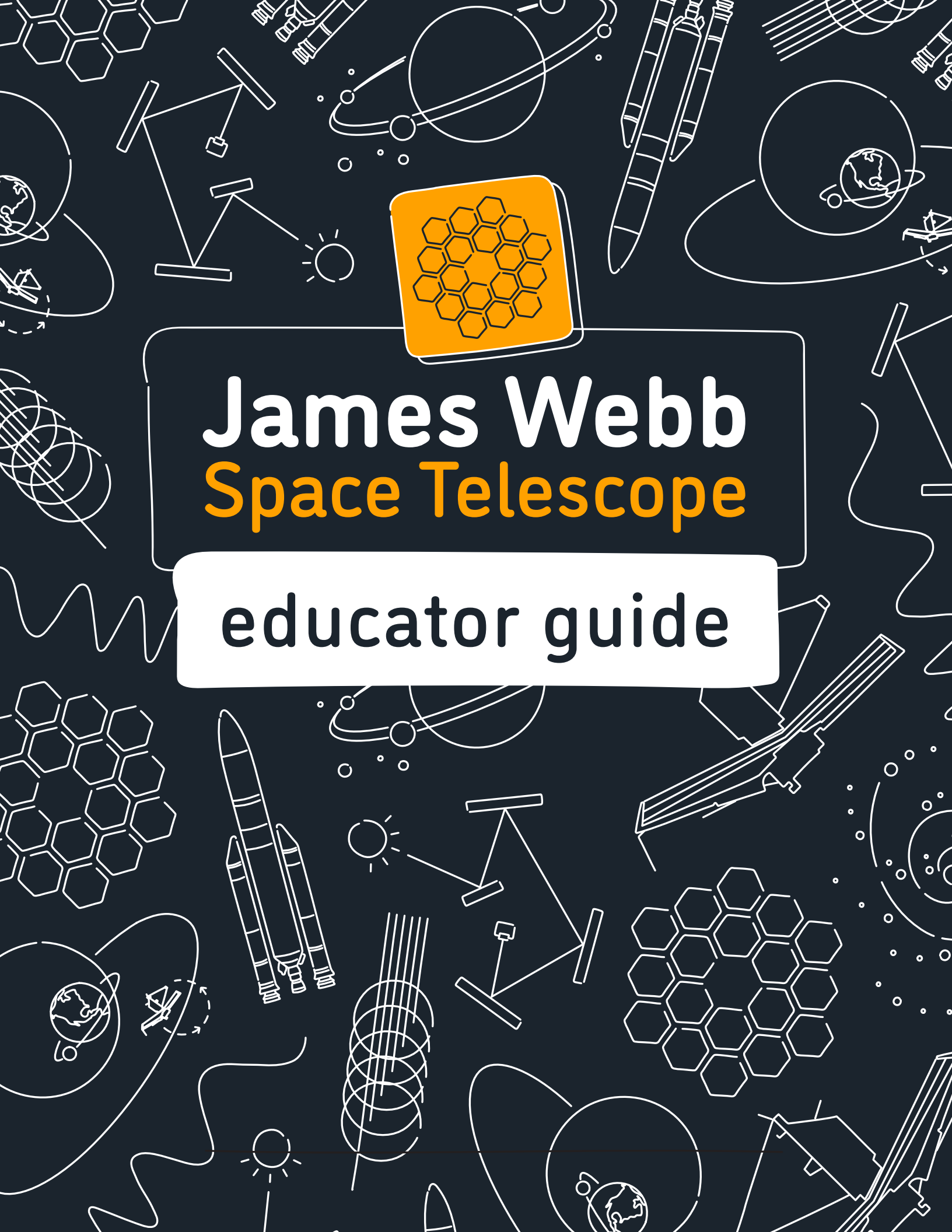

James Webb Space Telescope

educator guide

WELCOME TO THE JAMES WEBB SPACE TELESCOPE
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/jameswebbkitvideos** and **cosi.org/connects/kits/james-webb-kit-resources.php**.

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.

James Webb Space Telescope

ACTIVITY 1 : Build a Rocket

Build and launch a rocket to send the James Webb Space Telescope to space!

Ohio Learning Standards

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

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.

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

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.

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) Can you use the rubber band to make a sound? What happens when you stretch it and pluck it with your finger? What do you hear? What do you see?
2) Launch a rocket. Then, use words to describe how it moves.
3) Draw a picture of a rocket launch. Explain your picture to someone else.

Ohio Learning Standards:

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

Kindergarten Art K.1CO: Connect ideas, stories, and personal experiences to works of art.

Next Generation Science Standards:

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

James Webb Space Telescope

ACTIVITY 1: Build a Rocket

Build and launch a rocket to send the James Webb Space Telescope to space!

GRADES 3–5

Extended Learning Questions:

1) Try launching your rocket from different angles. (Straight forward horizontally is 0 degrees, straight up into the air is 90 degrees. Halfway between is 45 degrees.) Predict how it might move, then test it out. Does the angle change how the rocket moves after launch? How?
2) Look up a rocket launch that happened in the past. Find at least two reliable sources that tell about the rocket launch. Now, imagine that you were an engineer or astronaut involved in that rocket launch. Write a short story about the launch.

Ohio Learning Standards:

Fourth 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.

Third – Fifth Grade ELA W.3-5.3: Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Third – Fifth Grade ELA W.3-5.7 Conduct short research projects that build knowledge about a topic

Next Generation Science Standards:

3-PS-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) When does your rocket have potential energy? When does it have kinetic energy?
2) Launch a rocket into the air three times. Each time, use a stopwatch to measure how long the rocket is in the air. Write down the time for each trial. Add up the three times and divide the sum by 3 to find the average amount of time the rocket was in the air. Optional: If in a class, have students compare their times by graphing them. What type of graph works best for this?
3) Develop an experiment to determine the relationship between the angle at which you launch the rocket and how far it travels horizontally.
4) Try adding a payload (weight) to your rocket. How would you design an experiment to test the effect of the payload on the path of the rocket?

Ohio Learning Standards:

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

Sixth Grade Math 6.EE.9 Represent and analyze quantitative relationships between dependent and independent variables.

Next Generation Science Standards:

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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COSI Center of Science and Industry

James Webb Space Telescope

ACTIVITY 2 : Build a Rocket

Webb can see better from its home in space than it would on Earth. Learn about the Earth's atmosphere and find out why the Webb was sent to space.

Ohio Learning Standards

2nd Grade Science 2.ESS.1: The atmosphere is primarily made up of air.

2nd Grade Science 2.ESS.2: Water is present in the atmosphere.

Next Generation Science Standards

5-ESS2-1: Develop a model using an example to describe ways in which the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen.

GRADES K–2

Extended Learning Questions:

1) Get some bowls. How quickly can you sort the water beads by color? How many are in each color bowl? Other than by color, how else can you sort them? Optional: sort them using forceps.
2) Use your water beads to practice addition and subtraction: Place 5 water beads in a pile. Place 4 water beads in another pile. 5 + 4 = ___ ? Count all the beads to find out! Now what happens when you take away 2 water beads?
3) Use a funnel to pour water beads into a balloon. Add a little bit of water (a tablespoon or two). Tie the balloon. Squish it around. How does it feel?

Ohio Learning Standards:

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

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

Kindergarten Math K.MD.3: Classify objects and count the number of objects in each category.

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:

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

James Webb Space Telescope

ACTIVITY 2 : Build a Rocket

Webb can see better from its home in space than it would on Earth. Learn about the Earth's atmosphere and find out why the Webb was sent to space.

GRADES 3–5

Extended Learning Questions:

1) What state of matter do you think water beads are? Did the state of matter change when they were filled with water? Explain.
2) Sort the water beads by color. What sort of graph could you make to show how many of each color you have? Create that graph.
3) Use a scale to measure the weight of one water bead. Write that down. Predict: how much will 10 water beads weigh? Once you've made your prediction, count 10 water beads and find the weight. Was your prediction correct? Why or why not? Try again with 100 water beads.

Ohio Learning Standards:

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

Third Grade Math 3.MD.4: Represent and interpret data.

Third Grade Math 3.MD.1: Solve problems involving money, measurement, and estimation of intervals of time, liquid volumes, and masses of objects.

Next Generation Science Standards:

Fifth Grade 5.PS1.2: Matter and its interactions. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

James Webb Space Telescope

ACTIVITY 2 : Build a Rocket

Webb can see better from its home in space than it would on Earth. Learn about the Earth's atmosphere and find out why the Webb was sent to space.

GRADES 6–8

Extended Learning Questions:

1) Sometimes, water beads are different sizes. Your job is to sort the water beads by size. Use a measuring utensil (like calipers) to find the approximate diameter of each one and then organize them into piles based on size. How many piles did you make? Graph your results. Compare your graph to someone else's.
2) What percentage of your water beads are clear? What percentage of them are blue?
3) Measure the diameter of one water bead. Calculate the volume of that water bead. How can you calculate the circumference? What about the surface area?
4) Use calipers to measure the diameter of 6 differently sized water beads. Measure the weight of each of those same 6 water beads. Graph the diameter vs weight on a line graph. What can you say about the relationship between diameter and weight? Does this result make sense? Why or why not?
5) What are water beads made of? If you aren't sure, do some research online to find out. What other products are made of this type of material?

Ohio Learning Standards:

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

Seventh Grade Math 7.SP.2: Broaden understanding of statistical problem solving.

Eighth Grade Math 8.EE.5: Understand the connections between proportional relationships, lines, and linear equations.

Next Generation Science Standards:

Middle School MS.PS.1: Matter and its interactions. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

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COSI Center of Science and Industry

James Webb Space Telescope

ACTIVITY 3 : Unfolding the Universe

The Webb unfolds before it can take pictures. Make a model desktop James Webb Space Telescope.

Ohio Learning Standards

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

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.

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

Next Generation Science Standards

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.

GRADES K–2

Extended Learning Questions:

1) In this activity, there are hexagon stickers. A hexagon has 6 sides. How many sides does a triangle have? What about a square?
2) Go on a shape hunt in your classroom. How many different shapes can you find? Are there any hexagons?
3) What do you think makes stickers sticky? Is there anything that stickers don't stick to? Get a few different kinds of stickers. Are some stickier than others? How could you test it?

Ohio Learning Standards:

Kindergarten Math K.G.1:
Identify and describe shapes

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.

James Webb Space Telescope

ACTIVITY 3 : Unfolding the Universe

The Webb unfolds before it can take pictures. Make a model desktop James Webb Space Telescope.

GRADES 3–5

Extended Learning Questions:

1) The Webb has a mirror that is about 6.5 meters (21 feet) in diameter. How big is that? Go outside to an open space. Bring a meterstick or measuring tape and chalk or small flags for markers. Use these tools to mark a distance of 6.5 meters. Optional: Use a 3.25 meter-long piece of string to map out a circle with diameter 6.5 meters. How does this size compare to the size of a car?
2) Imagine you are an engineer building a new space telescope. What would you build? Write at least three features of your new space telescope. Now, imagine your budget is limited (you don't have enough money for all the features). You must remove two of those three features. What would you remove and why?

Ohio Learning Standards:

Third – Fifth Grade Technology 3-5.DT.2.a. Critique needs and opportunities for designing solutions.

Fourth Grade Math 4.MD.1: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

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.

James Webb Space Telescope

ACTIVITY 3 : Unfolding the Universe

The Webb unfolds before it can take pictures. Make a model desktop James Webb Space Telescope.

GRADES 6–8

Extended Learning Questions:

1) The Webb has a mirror that is about 6.5 meters (21 feet) in diameter. How big is that? Go outside to an open space. Bring a meterstick or measuring tape and chalk or small flags for markers. Use these tools to mark a distance of 6.5 meters. Use a 3.25 meter-long piece of string to map out a circle with diameter 6.5 meters. How could you measure the size of the circumference? How could you calculate the size of the circumference? Which is easier?
2) In this activity, you built a model of the James Webb Space Telescope. Look online to find images of other space telescopes or spacecraft. Choose one to design a model of. Start with images to make your model. How big will it be? What materials will you use? Once you have a plan, build your model.
3) Find an equation to calculate the area of a hexagon. Measure and calculate the area of one of the hexagon stickers. How does this compare to the size of one of the actual mirrors?
4) Imagine you are an engineer building a new space telescope. First, pretend you have an unlimited budget. What would you build? List at least three features of your new space telescope. Now, imagine your budget is limited and you must remove two of those three features. What would you remove and why? Now, have everyone share their ideas. Discuss the pros and cons of each.
5) How much do you think it cost to build the James Webb Space Telescope? How does the government decide what money goes to what project?

Ohio Learning Standards:

Seventh Grade Math 7.G.4. Work with circles.

Sixth through Eighth 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.

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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James Webb Space Telescope

ACTIVITY 4 : Far Out Photography

The Webb takes beautiful photos of space. Use your artistic skills to create a model nebula.

Ohio Learning Standards

5th Grade Fine Arts: Visual Art 5.3PR: Communicate an interdisciplinary concept using the elements of art and principles of design.

7th Grade Science 7.PS.1: Elements can be organized by properties.

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

Next Generation Science Standards

5-PS1-3: Make observations and measurements to identify materials based on their properties.

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements.

GRADES K–2

Extended Learning Questions:

1) After the class finishes making their nebulae, have everyone write their name on their own model. Then, put all of the models on a table together. How are they similar? How are they different? Can we sort them into groups by color? What are some other ways we could sort them?
2) As a group, make three nebula jars. In the first jar, use only yellow water and blue water to dip your cotton balls. In the second jar, use only yellow water and red water. In the third jar, use only red water and blue water. Predict: what colors will you see in the final nebula model? Then try it out!
3) Find a picture of a nebula online, or use one of the pictures in the book. Use watercolor paint to paint a picture of it. Before it dries, drop salt onto the wet paint to make stars!

Ohio Learning Standards:

First Grade Visual Arts 1.2CR: Explore materials to devise imagery and symbols.

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.

James Webb Space Telescope

ACTIVITY 4 : Far Out Photography

The Webb takes beautiful photos of space. Use your artistic skills to create a model nebula.

GRADES 3–5

Extended Learning Questions:

1) Look up pictures of nebulae online. Find one that you like. Use watercolor paint to paint a picture of it. Experiment with adding different substances to the watercolor painting: white crayon before you paint, lemon juice while the paint is wet, and both coarse and fine salt while the paint is still wet. Observe the effects of each addition and write down what happens. Why do you think these effects happen? What might your observations tell you about the properties of crayons, lemon juice, and salt?
2) If you could hear a nebula instead of seeing it, what do you think it would sound like? Scientists have asked the same question. go to the website **https://science.nasa.gov/mission/hubble/multimedia/sonifications/#hds-sidebar-nav-10** to hear what sounds the scientists gave to nebulae and other things in space. Find a nebula, and click the play button to listen to the sonification. Is the sound what you expected? Explain.
3) Estimate how many stars you can see in the picture of the nebula on page 15 of the Activity Guide.
4) What is the closest star to Earth? How are we impacted every day by that star? Why does it look brighter than the rest of the stars?

Ohio Learning Standards:

Third Grade Art 3.2CR: Investigate artistic challenges using various materials and tools.

Fifth Grade Art 5.3CR: Select and use the elements of art and principles of design to investigate interdisciplinary concepts.

Fifth Grade Science 5.ESS.2: The sun is one of many stars that exist in the universe.

Next Generation Science Standards:

5-ESS1-1 Earth's Place in the Universe: Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.

5-PS1-3 Matter and Its Interactions: Make observations and measurements to identify materials based on their properties.

James Webb Space Telescope

ACTIVITY 4 : Far Out Photography

The Webb takes beautiful photos of space. Use your artistic skills to create a model nebula.

GRADES 6–8

Extended Learning Questions:

1) Look up pictures of nebulae online. Choose three of them. Observe the colors in these nebulae. Look up what each color represents – which chemical elements are present in each one? Then, use watercolor paint to paint a picture of one of the nebulae. Add some fine and coarse salt before the paint dries to make stars. When it dries, label at least three of the elements found in that nebula.
2) How might blind and visually impaired communities enjoy the beauty of a nebula? Look at a picture of a nebula. If a nebula was a song, what song do you think it would be? Why? Now, go to the website **https://science.nasa.gov/mission/hubble/multimedia/sonifications/#hds-sidebar-nav-10**. This website assigns pitch and volume to every part of an image. Find a nebula, and click the play button to listen to the sonification. Does the sound surprise you? Does it match the song you thought of? What other ideas can you think of as ways for visually impaired people to experience images from space? Share your ideas with others and compare the pros and cons of each idea.
3) Choose any one nebula. Find a picture of that nebula and read about it. Where is it located? How big is it? What elements are found in it? How did we first learn about it? What are scientists learning from the nebula?
4) Choose any one nebula. Find how big it is in light-years. Convert this number from light-years to kilometers. Now convert the number of kilometers to miles. How many Earths could fit along this distance?

Ohio Learning Standards:

Sixth Grade Visual Arts 6.1CR: Reference multiple sources for visual expression.

Sixth – Eighth Grade Technology 6-8.ICT.1.b.: Select and use digital learning tools or resources to support planning, implementing and reflecting upon a defined task.

Sixth – Eighth 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.

Seventh Grade Math 7.EE.3: Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Next Generation Science Standards:

MS-ESS1-3 Earth's Place in the Universe: Analyze and interpret data to determine scale properties of objects in the solar system.

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COSI Center of Science and Industry

James Webb Space Telescope

ACTIVITY 5 : Clues to the Universe

Learning from Webb photos, discover an exoplanet and determine if it could support life.

Ohio Learning Standards

2nd Grade Science 2.ESS.2: Water is present in the atmosphere.

5th Grade Science 5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.

5th Grade Science 5.ESS.2: The sun is one of many stars that exist in the universe.

7th Grade Science 7.PS.1: Elements can be organized by properties.

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

Next Generation Science Standards

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

5-PS1-3: Make observations and measurements to identify materials based on their properties.

GRADES K–2

Extended Learning Questions:

1) What do you think an alien might look like? Use your imagination to think about what an alien might look like. Then, draw a picture of an alien.
2) Look at the braille alphabet card. Why does it use bumps instead of letters? How would you write your name in braille?
3) Think of one animal that lives in a very cold place on Earth. How does that animal stay warm? Some planets are further from the sun (our star), and so they are much colder. If an alien lived on a colder planet, what might it use to stay warm?
4) Imagine you are a pen pal with an alien. What would you want to ask them? Write a letter to your alien pen pal.

Ohio Learning Standards:

K.LS.1: Living things have specific characteristics and traits.

K.LS.2: Living things have physical traits and behaviors, which influence their survival.

First Grade Science 1.LS.1: Living things have basic needs, which are met by obtaining materials from the physical environment.

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

Next Generation Science Standards:

K-LS1-1 From Molecules to Organisms: Structures and Processes: Use observations to describe patterns of what plants and animals (including humans) need to survive.

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

James Webb Space Telescope

ACTIVITY 5 : Clues to the Universe

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GRADES 3–5

Extended Learning Questions:

1) Use the braille alphabet card to write a word or short sentence in braille (use a pen or punches to mark the dots). Pass it to a partner to have them decode it.
2) Write a secret message! Advanced preparation: create a liquid indicator by boiling red cabbage and reserving the purple juice. Set aside. Have students use a paintbrush or cotton swab dipped in vinegar to write a message on a white sheet of paper. Allow the paper to dry. Exchange secret messages. Talk about the chemical reaction that took place on the paper!
3) Different adaptations allow plants and animals to survive in Earth's environment. Look up one of the other planets in our solar system to learn about its environment. What sorts of adaptations might a plant or animal need to live on that planet?

Ohio Learning Standards:

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

Third Grade Science 3.LS.3: Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.

Fourth Grade Science 4.LS.1: Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.

Next Generation Science Standards:

3-LS3-2 Heredity: Inheritance and Variation of Traits Use evidence to support the explanation that traits can be influenced by the environment.

3-LS4-3 Biological Evolution: Unity and Diversity Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

James Webb Space Telescope

ACTIVITY 5 : Clues to the Universe

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GRADES 6–8

Extended Learning Questions:

1) Develop your own secret code. Write a message, then create a decoder for someone to figure out what was written in the message. Once you've created it, exchange secret codes with a partner. Can you crack their code?
2) Get into groups. Imagine you are designing a museum exhibit about exoplanets. First, think about what would be in the exhibit. What do you think would be most interesting to people visiting the museum? Would there be something hands-on that people could do? Now, think about how you would make sure the exhibit can be enjoyed by all visitors. How can visitors who are hearing-impaired enjoy the exhibit? What about visually impaired learners?
3) Work with a partner. Visit the Webb Telescope page at **https://webbtelescope.org/**. Click "Menu" in the upper right, then click "Images" on the dropdown. Use the filter across the top to search an image: Under "Topic," select "Exoplanets." Under "Type," select "Spectra." Press "Apply." Now, choose one of the spectra to look at. Look at the image, and scroll down to read "About this Image." Look up any words you don't know, or ask a teacher for help. What is this a spectrum for? What elements are shown? Talk about what you've learned with a partner.

Ohio Learning Standards:

Sixth through Eighth Grade 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.

Sixth through Eighth Grade 6-8.DT.4.b. Analyze environments or products that are examples of the application of the principles of universal or inclusive design.

Sixth through Eighth Grade 6-8.ICT.3.a. Analyze and integrate textual, visual and quantitative information (e.g., images, diagrams, maps, graphs, infographics, videos, animations, interactives) from multiple digital learning tools and resources.

Next Generation Science Standards:

MS-ETS1-1 Engineering Design: 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.

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Glossary:

Electromagnetic Spectrum– A chart that shows all the different kinds of light given off by objects in the universe.

Exoplanet– A planet that orbits a star outside of our solar system.

False-color image– A picture that was colored by scientists. They add color because the information in the picture is normally invisible to humans.

Hexagon– A six-sided polygon.

James Webb Space Telescope (JWST)– A telescope launched in 2021 that orbits in space and looks at different wavelengths of light coming from galaxies far away from us.

Light Pollution– Excessive outdoor light. It can interfere with wildlife and with our ability to see stars and other celestial objects.

Micrometer- A measurement that is one thousand times larger than a nanometer. It is one millionth of a meter.

Nanometer– A small measurement that is one billionth of a meter. There are a billion nanometers in one meter.

Nebula– An area in space with clouds of gas and dust. Nebulae are where new stars are born.

Primary Mirror– The mirror on the JWST that collects light from the universe.

Secondary Mirror – The circular mirror on the JWST where light is reflected onto from the primary mirror.

Spectroscopist– A scientist who uses light to study things.

Sunshield– A part of the JWST that protects the telescope from the sun's light.

Telescope- A tool that helps us see things that are far away.

Wavelength– The distance between two hills in a wave.

Visible Light- Light we can see with our eyes.