Smithsonian Science for the Classroom

HOW CAN WE PREDICT
PATTERNS OF MOTION?

Grade 3 - Physical Science

TRAINER GUIDE

CURRICULUM PROFESSIONAL
DEVELOPMENT

Smithsonian
Science Education Center

The **Smithsonian Science Education Center** (SSEC) is an education organization within the Smithsonian Institution. The SSEC's mission is to transform K–12 *Education Through Science*™ in collaboration with communities across the globe. The SSEC promotes authentic, interactive, inquiry-based K–12 STEM teaching and learning; ensures diversity, equity, accessibility, and inclusion in K–12 STEM education; and advances STEM education for sustainable development. The SSEC achieves its goals by developing exemplary curriculum materials and digital resources; supporting the professional growth of K–12 teachers and school leaders; and conducting outreach programs through LASER (Leadership and Assistance for Science Education Reform) to help schools, school districts, state education agencies, and ministries of education throughout the world implement inquiry-based science education programs.

The **Smithsonian Institution** was created by an Act of Congress in 1846 "for the increase and diffusion of knowledge . . ." This independent federal establishment is the world's largest museum, education, and research complex and is responsible for public and scholarly activities, exhibitions, and research projects nationwide and overseas. Among the objectives of the Smithsonian is the application of its unique resources to enhance elementary and secondary education.

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How Can We Predict Patterns of Motion?

Grade 3—Physical Science

Trainer Guide

INTRODUCTION

In 2019, the US Department of Education awarded the Smithsonian Science Education Center an early-phase Education Innovation and Research (EIR) grant to support the development, implementation, and initial evaluation of evidence-based innovations to improve student achievement. The project, called Smithsonian Science for North and South Carolina Classrooms (PR# U411C190055), took place between October 2019 and September 2024 in third-, fourth-, and fifth-grade classrooms in North and South Carolina.

Between 2020 and 2023, participating teachers in implementation schools received curriculum professional development tied to two Smithsonian Science for the Classroom curriculum modules and content and pedagogy professional development tied to the content of each module to implement in their classrooms. The Center for Research in Educational Policy (CREP) at the University of Memphis evaluated the impact of these modules and professional development on student achievement using standardized assessments, classroom observations, and teacher focus groups.

This guide was developed as a support for trainers leading curriculum professional development for third grade teachers implementing the Smithsonian Science for the Classroom Physical Science module *How Can We Predict Patterns in Motion?*

RESOURCES

- Teacher Guide (TG)
- Student Activity Guide (SAG)
- Smithsonian Science Stories Literacy Series: *Motion and Magnets* (Reader)
- Carolina Science Online (CSO): Carolinascienceonline.com

HOW TO USE THIS TRAINER GUIDE

This guide shares important ideas and strategies for effectively introducing a Smithsonian Science for the Classroom (SSftC) module with educators, when used in conjunction with the corresponding Teacher Guide (TG). The Teacher Guide contains essential details needed to implement the module in the classroom, while this Trainer Guide outlines how to conduct professional development for that module; therefore, the two guides should be used in tandem.

The professional development plan for each section is outlined in a table at the start of each session. Within each section, there is another table. The first column shows the part of the lesson being addressed, and corresponding page numbers within the Teacher Guide, Student Activity Guide, and Reader. The second column provides the trainer with additional direction in concise bullet points.

ROOM SETUP

To set up a classroom for this workshop:

1. Move tables or desks so groups of three or four participants can work together.
2. Set module materials out on side tables where they can be easily accessed.
3. Locate the nearest restrooms and evacuation routes.

WORKSHOP OVERVIEW

This trainer guide provides direction on facilitating the curriculum sessions highlighted in the table below.

Day 1		Day 2	
10 a.m.	Welcome Session	**10 a.m.** Curriculum Session 3	Focus Questions 3–4 (Lessons 8–12)*
11 a.m. Curriculum Session 1	Introduction and Lesson 1	**12 p.m.**	Lunch
12 p.m.	Lunch	**12:45 p.m.** Curriculum Session 4	Focus Question 5 (Lessons 13–15)
12:45 p.m. Curriculum Session 2	Focus Questions 1-3 (Lessons 2–7)	**3 p.m.**	Closing Session
3:30 p.m.	Adjourn	**3:30 p.m.**	Adjourn

**Depending on the workshop design, this section may be led by participants if they have adequate time to prepare.*

Note: Italicized statements are intended to provide supporting information to facilitators.

SESSION 1:

Introduction and Lesson 1

In this session, the trainer leads lessons as a facilitator (wearing their "teacher hat") while teachers act as learners (wearing their "student hats").

Goal: The trainer facilitates the first lesson as an exemplar and introduces the concept storyline of the G3 Physical Science module. Participants experience Lesson 1 as learners and debrief the lesson as teachers.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Housekeeping and Introductions	10 minutes	
Lesson 1	30 minutes	
SSftC Features and CSO	15 minutes	
Concept Storyline	5 minutes	

	Key Points
Housekeeping and Introductions	**Introductions** Welcome participants to your session. Remind them that this professional learning workshop is meant to orient teachers to a new Smithsonian Science for the Classroom curriculum module. At times they will be asked to wear their "student hat" and experience lessons as their students will, and at others they'll reflect on the material wearing their "teacher hat." **Icebreaker Activity** Participants introduce themselves through an icebreaker activity. **Housekeeping** Preview the agenda. Verify the safety protocols in the classroom and locate the nearest restrooms, fire exit, tornado shelter.

	Key Points
	Establish the Tone for the Day Divide participants into small groups and ask them to think about what they want to achieve today. What norms do they think will encourage a positive learning environment? Introduce group norm ideas: • Be brave • Be present • Ask questions • Be respectful Have each small group discuss the suggested norms and add to the big group list of norms. Once everyone has added their ideas, ask if there are any changes, additions, or modifications that need to be made. When the discussion is finished, this will be the social contract the group abides by for the next two days.
	General Safety While the risk of injury is low, there should be clear safety guidelines and expectations when teaching this module. These guidelines will vary depending on the situation, but some useful examples can be found in the Stay Safe! contract included in the curriculum, chemistry lab rules, and general classroom safety expectations. Safety guidelines should be discussed before every lesson. Examples of safety guidelines: • Pull hair back • No tasting anything • Wear protective eyewear from start to finish • If something spills, report immediately to get help cleaning it up • Listen closely to instructions • No running in the classroom

Lesson 1: Playground Science

Objects in contact exert forces and cause motion.

30 minutes

Students explore model playground swings to gather evidence that applied forces affect the motion of objects. They work together to ask questions and identify data collection methods to further investigate this phenomenon.

Group discussion among participants is very important for these lessons. Strategies for supporting group discussions can be found in Appendix 1. Strategies for furthering discussion through guiding thought/questioning can be found in Appendix 2.

On CSO, navigate to Lesson 1 using the numbers at the top of the screen.

Resource/Page #	Lesson 1
Overview TG: p. 77	Objectives: • Use models of playground equipment to investigate how forces affect the motion of objects. • Ask questions about forces that could be answered using a model swing. • Identify evidence that could be collected to answer questions about forces. Lesson Background Information: • A force is a push or a pull that acts on an object. A force might cause an object to move, to change speed, to change direction, or to stop moving. Forces are described by their direction and strength. • In this lesson, participants complete a pre-assessment in which they record some initial ideas about forces and motion. They then manipulate a playground swing model to explore how forces affect a swing's motion. Participants find that a force—either a push or a pull—is needed for the equipment to start moving. They observe that the motion of the model depends on the strength and direction of the force. Groups discuss and share their observations. next page →

Resource/Page #	Lesson 1
	• In future lessons, groups will plan and carry out investigations independently. In preparation for those activities, Lesson 1 concludes with the participants asking questions about the motion of the swings and discussing what observations and data could be collected to help answer their questions. Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 78-79	Materials: • 1 roll of string • 1 ring stand • 1 support ring • 1 wing nut • 1 steel washer, 3.5 centimeters • Black pen or pencil • Red pen or pencil Printed Materials: • STEM Notebook • Lesson 1 Notebook Sheet A • Lesson 1 Notebook Sheet B • Lesson 1 Notebook Sheet C Digital Materials: • The Playground video file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Set up the ring stand.
Procedure: Getting Started TG: p. 79-80	***Getting Started*** • Open CSO and play The Playground video. • Use guiding questions to discuss observations on how the children and equipment moved. • Have participants complete Lesson 1 Notebook Sheets A and B as a pre-assessment, using black and red pencils or pens and their STEM Notebook to record their answers.

Resource/Page #	Lesson 1
Procedure: Activity TG: p. 81-83	***Activity*** • Facilitate a discussion on safety rules. • Divide the participants into groups of four and have one participant from each group retrieve materials. • Groups should investigate how to start and stop the model swing (Lesson 1 Notebook Sheet C, questions 1 and 2). • Begin a discussion about scientific questions and planning investigations. • Have participants think about what other questions they could answer using the model, and record their answers on question 3.
Procedure: Bringing It All Together TG: p. 83-85	***Bringing It All Together*** • Ask groups to share their observations about the model swing. • Introduce the concepts of cause and effect, forces, and how forces affect the motion of objects. • Explain the definition of "force" as a push or pull on an object. Ask participants what forces are present as they pertain to the ring stand.
Assessment, Enrichment & Extension TG: p. 85-88	Briefly review, as time allows: • Assessment Rubrics: Pre-Assessment • Extension: Playground Diary (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Smithsonian Science for the Classroom Features and Carolina Science Online

15 minutes

Key Points	
TG	Hand out TGs. Briefly review the physical items that accompany a module: • Teacher Guide (1) • Student Activity Guide (8) • Smithsonian Science Stories (16) • Materials (for 32 students)
CSO	CSO is the virtual platform that hosts the Teacher Guide, digital copies of the student readers, digital readers in Spanish, and other digital resources for the module. **Set Up a Carolina Science Online Account** Before training, you should receive an email directing you to create your teacher login on CSO (www.carolinascienceonline.com). On the main page, hover over the "Teacher login" button. "Create a Teacher Account" will appear as an option. Enter the required information. Make sure you choose a password you can remember. Return to the main page and log in. At the top of the page, click "redeem code." Enter the code that was emailed to you. The account is now ready to use. On the main page, all the titles available to you will be in bright colors. Click on the module you need. The module will open in the "Module Overview" tab. The "Home" button in the top left of the screen will take you back to the main screen with all of the available titles. "Bookmarks" will open your bookmarks folder. You can bookmark any of the digital resources on CSO by clicking on the star underneath the resource. "Assignments" shows all assignments you have created using CSO digital resources. You can add a digital resource to assignments by clicking "add to assignment" on any CSO digital resource.

	Key Points
TG and CSO TG: p. 1-17	Navigate to the "Curriculum Overview" section in the TG, which is also found under the "Module Overview" tab in CSO. This section provides an introduction to the curriculum and the research-based methods integrated into Smithsonian Science for the Classroom.
TG: p. 20-21	**Concepts and Practices Storyline** Modules are broken down into areas that revolve around a single focus question. The focus questions build a storyline that provides a coherent experience that builds toward solving a problem. The storylines are carefully integrated with the 5E model and each lesson is identified as to where it fits in the model. This module has four focus questions, with the final focus question being the Science Challenge.
TG: p. 22-24	**Prerequisite Concepts and Practices** The listed items are the skills and knowledge students will lean on to incorporate new skills and content learning. Each set of concepts and practices identifies where the prerequisites should have been taught.
TG: p. 24-27	**Module Background Information** This section provides background information for the teacher. It covers content that is not directly discussed in the module but may prove useful in understanding where content or practices are headed. It also provides information that is a fundamental building block for content and practices used in the module.
TG: p. 28-31	**Common Misconceptions** Students may express misconceptions throughout the lesson. This section provides a list of common misconceptions identified in research for both content and practices, an explanation of the misconception, and a possible example of how it may come up. The number after the misconception refers to which reference the misconception is described in. next page →

	Key Points
	Throughout the module, misconception callouts will be highlighted using the Good Thinking! bubble. Good Thinking! is a YouTube video series created by the Smithsonian Science Education Center focused on misconceptions and learning. **Materials Management and Safety** This section provides information on materials that will be provided with the module kit, needed but not supplied materials, safety concerns, and a safety contract for students. Under the "Materials Lists" section you will need to click on the hyperlink to download the materials lists. These lists show you everything that will be included in the module kit and items teachers will need to supply. The lists also show how much of each material is needed and in which lesson. In the "Safety" section, there are callouts for specific concerns for this module and a link to a Stay Safe! contract. The contract lists expectations for students to keep themselves and others safe during science investigations. It has lines for both students and guardians to sign.
TG: p. 31-36	
TG: p. 40-41	Navigate to the "NGSS Alignment and Planner" tab in CSO. **Module Alignment to NGSS** These modules are aligned to the Next Generation Science Standards, which teachers can use as an additional tool to identify student objectives and goals for learning. next page →

	Key Points
TG: p. 42-71	**Lesson Planners** The lesson planners highlight everything that will happen in a lesson, such as: • Focus Question • Step of 5E model • Number of class periods needed • Vocabulary that will be introduced • Student objectives • Misconceptions: more information can be found in the "Module Overview" tab or TG p. 28-31 • Disciplinary core ideas: content focus • Science and engineering practices • Crosscutting concepts: ideas that are multidisciplinary • ELA and math connections: numbers reference the Common Core Standards • Extensions: additional lessons that are not necessary to move forward in the module
TG: p. 74-75	In the TG, review the callout icons itemized in the Guide to Module Investigations: • NGSS • Common Core • Misconceptions • Digital Resource • ELL Strategy • Teacher Tips and Tech Tips • Guiding Questions • Safety Notes • Class Period Break
Readers and CSO	All the written materials (Readers, Student Activity Guides, Notebook Sheets) are available digitally on CSO. Navigate to the student readers under the "Digital Resources" tab in CSO. There are multiple versions. The on-grade reader cover has a matchstick with the round end pointing up. The below-grade reader cover has a matchstick with the round end pointing down. The Spanish reader is only available on grade. next page →

Key Points	
	The on-grade reader exists in two forms on CSO. One is an interactive book and the other is an e-book. The other readers are only available in the e-book format. Both formats have tools for students. In the interactive book, students can highlight and make notes using the tools in the toolbar. In the e-book format, students can use the text-to-talk feature by highlighting the text and selecting the speaking icon.
Support and CSO	Finally, Carolina Science Online provides a number of supports to teachers, including: • Teacher Resource videos: These videos provide an overview of the focus questions and show any lessons with a potentially tricky setup. They're available under the "Digital Resources" tab. • Tutorial videos: For help with using CSO's features, choose "Support" from the vertical toolbar on the left side of the homepage. • Get Ready! Professional Learning: These short videos offer information on-demand and teacher tips about the program. They can be found at https://www.smithsonianstc.com/ssftc-get-ready-campaign-172N7-44857Z.html

Concept Storyline

Grade 3 Physical Science: *How Can We Predict Patterns of Motion*?

5 minutes

Concept Storyline	
TG and CSO TG: p. 20–21	**Concepts and Practices Storyline** Return to the "Concepts and Practices Storyline" tab and walk through the module's structure. This module has five focus questions, with the final focus question being the Science Challenge. Explain each focus question with its objectives, as below: next page →

	Concept Storyline
	FQ#1: How do forces applied by touch affect an object's motion? (Lessons 1-3) *In the first focus question, students manipulate model swings and balls and see that contact forces can start and stop motion. They practice forming scientific questions and carry out investigations to explain what happens when balanced and unbalanced forces act on objects at rest.* FQ#2: How can we observe and measure repeating patterns of motion? (Lessons 4-6) *In the second focus question, students obtain information about bicycles and clock pendulums and describe the repeating patterns of motion that these, and other objects, exhibit.* FQ#3: What kinds of forces can act at a distance? (Lessons 7-9) *In focus question three, students observe examples of noncontact forces causing objects to move and investigate these cause-and-effect relationships. They participate in a static electricity-fueled race and investigate at what distance different magnets are able to attract objects.* FQ#4: How can magnets be used to solve problems? (Lessons 10-12) *Focus question four is all about application. Students obtain information from text about uses of magnets in transportation and communication. They identify problems and how criteria and constraints are important factors when designing solutions. Groups then use magnets to design, build, and test a solution to a trash-sorting problem.* FQ#5: How can magnets affect the pattern of motion of a pendulum? (Lessons 13-15) *In the final focus question, students engage in a two-part summative assessment. In the written assessment, students recap their understanding of forces, with a focus on magnetic forces, and apply their science knowledge to an engineering problem. Students then face a Science Challenge, where they must investigate how magnets affect the motion of a steel pendulum. They work in groups to ask a scientific question, plan and carry out an investigation, and use their data to predict the pattern of motion of a model swing that interacts with magnets. Individual students then write a claim to formally answer their research question.*

	Concept Storyline

Assessment	There are four types of assessment throughout the module.
	• Pre-Assessment (Lesson 1)
	• Formative Assessment (Lessons 2-12)
	• Summative Assessment (Lessons 13-15)
	    • Written Summative Assessment
	    • Performance Summative Assessment
	• Self-Assessment (SAG): Stop & Check

SESSION 2:

Lessons 2–7

The trainer introduces Lessons 2-3 (Focus Question 1), Lessons 4-6 (Focus Question 2), and Lesson 7 (Focus Question 3).

Goal: The trainer facilitates Lessons 2-7, with participants experiencing the lessons as learners and debriefing each focus question as teachers.

At various points in the training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Group Roles	5 minutes	Make sure Group Roles poster is visible
Lesson 2	25 minutes	Tape together Activity Sheets A and B (unless printed on 11-x-17 paper), gather one-fifth of a tub of craft dough
Lesson 3	20 minutes	
Short break	10 minutes	
Lesson 4	15 minutes	
Lesson 5	30 minutes	Locate the ring stand and support ring from Lesson 1, maintain the setup of the support ring, remove the swing (washer and string)
Short break	10 minutes	
Lesson 6	15 minutes	Hand out Readers
Lesson 7	25 minutes	Mirror the trainer's demonstrations, gather a wool cloth for the demo and an aluminum can and a wool cloth for each group, mark the start and finish lines of the aluminum can races about 1 meter apart

Many of the lessons use group roles to assign specific jobs. For strategies on using group roles effectively, please see Appendix 3.

Group Roles

5 minutes

Starting in Lesson 2, students will be assigned group roles. The assignments and a possible rotation system can be found in Appendix 3. Group roles are a common tool to build teamwork skills such as turn taking, communication, and responsibility for individual and group needs. Additionally, having a specific role can increase student involvement and confidence by ensuring they know what is expected of them in a given situation. You can learn more about collaborative groups and group roles in the Zero Barriers in STEM Education Accessibility and Inclusion Workbook found at https://ssec.si.edu/zero-barriers.

Lesson 2: Play Ball!
Unbalanced forces will affect an object's motion.

25 minutes

Students carry out investigations into how forces affect the motion of balls. They use models to diagram the cause-and-effect relationships between forces and motion.

On CSO, navigate to Lesson 2 using the numbers at the top of the screen.

Resource/Page #	Lesson 2
Overview TG: p. 89	Objectives: • Carry out investigations to answer the question, "How do forces affect the motion of balls?" • Use models (force diagrams) to describe how forces affect an object's motion. Lesson Background Information: • When more than one force acts on an object, those forces can either balance each other out or be unbalanced. Balanced forces do not cause a change in an object's motion. Unbalanced forces cause a change in the motion of an object. • In this lesson, participants extend their exploration of how forces affect the motion of objects. Participants are introduced to force diagrams, a model they will use throughout the module to describe the forces acting on objects and any resulting motion. They then work in small groups to explore how changes in force direction are necessary to move a ping-pong ball through a maze. • While participants are not expected to make quantitative measures of force strength or speed of motion, they will use the terms "start" and "stop" to describe changes in speed and use models to document relative force strength. The terms "balanced forces" and "unbalanced forces" are introduced following the participants' explorations. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 2
Materials & Preparation TG: p. 90-91	Materials: • Inflatable ball, 41 centimeters • Craft dough • Ping-pong ball • Wood craft sticks • Tape • Red pencils • Black pencils • SAG Printed Materials: • STEM Notebook • Lesson 2 Activity Sheet A • Lesson 2 Activity Sheet B • Lesson 2 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Assemble the maze templates using Lesson 2 Activity Sheets A and B.
Procedure: Getting Started TG: p. 91-93	***Getting Started*** • Have two participants roll a ball back and forth and ask them to share their observations. • Demonstrate to participants how to draw force diagrams. • Have participants draw force diagrams in their STEM Notebook.

Resource/Page #	Lesson 2
Procedure: Activity TG: p. 93-95 SAG: p. 1-3	***Activity*** • Divide participants into groups and assign group roles. • Have participants follow steps 1-4 in the SAG to maneuver the ball through the maze by applying forces with the stick. • Ensure participants are clear on the instructions for steps 5-6 in the SAG and have them complete a force diagram based on step 5 on their Lesson 2 Notebook Sheet.
Procedure: Bringing It All Together TG: p. 95-97	***Bringing It All Together*** • Ask groups to share their discoveries using evidence from their STEM Notebook. • Guide discussions to help participants recognize that forces are applied on the ball when it is stopped. • Have participants share ideas with their shoulder partner about how forces could be applied to the ball without the ball moving. • Have participants share suggestions and volunteers try the suggestions until they are successful in creating balanced forces. • Draw and discuss a representative force diagram. Explain the ideas of balanced and unbalanced forces. Ask what would happen if one person applied a greater force than the other.
Assessment, Enrichment & Extension TG: p. 98-100	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Let's Skate (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 3: Tug-of-War

Unbalanced forces will cause a change in an object's motion. Balanced forces will not.

20 minutes

Students ask questions. Groups carry out investigations to answer questions about what happens when balanced and unbalanced contact forces are applied to an object. They identify patterns in their data to form an explanation of the effects of the forces.

On CSO, navigate to Lesson 3 using the numbers at the top of the screen.

Resource/Page #	Lesson 3
Overview TG: p. 101	Objectives: • Carry out an investigation to answer a question about what happens when balanced and unbalanced forces are applied to an object. • Identify patterns in data to make a claim that balanced forces cause no change in an object's motion, while unbalanced forces cause an object at rest to move. Lesson Background Information: • In almost all cases, more than one force is acting on an object. Sometimes multiple forces act on an object in the same direction; other times, the forces act in different directions. • In this lesson, participants use tug-of-war as the inspiration for an exploration of unbalanced and balanced forces. Using a common question, groups plan and carry out investigations about the effects of forces acting on a block of wood. • Scaffolding is provided to guide participants in designing fair tests and collecting useful data. As participants conduct their investigations, they record their data so they can look for patterns in the data from all groups. • Participants will make a claim that answers the group question. The group will find that for an object at rest, unbalanced forces cause motion and balanced forces don't cause motion. Class Periods: 2 (1 class period = about 35 minutes)

Resource/Page #	Lesson 3
Materials & Preparation TG: p. 102-103	Materials: • Wood blocks with hooks • Rubber bands • Metric ruler • 11-x-17 paper • Tug-of-War card Printed Materials: • STEM Notebook • Lesson 3 Activity Sheet A • Lesson 3 Activity Sheet B • Lesson 3 Notebook Sheet A • Lesson 3 Notebook Sheet B Digital Materials: • Tug-of-War video • Tug-of-War card file • Tug-of-War board file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 103	***Getting Started*** • Review and discuss how forces applied to objects affect the motion of the object. • Have participants observe ways that forces are applied to an object in the Tug-of-War video and then share out.
Procedure: Activity TG: p. 104-107	***Activity*** • Project the Tug-of-War card and tell participants that each group will develop their own investigation plan to explore how balanced and unbalanced forces affect an object at rest. • Demonstrate a test using balanced forces and discuss how they will complete their data tables. • Divide participants into groups and assign group roles. • Have each group create their Tug-of-War board. next page →

Resource/Page #	Lesson 3
	• Have participants complete Lesson 3 Activity Sheet A, recording three trials of their first pair of forces on Lesson 3 Notebook Sheet A. • Discuss fair tests and how participants will change just one variable and run three more trials to compare. • Have groups complete Lesson 3 Activity Sheet B. • Have participants independently reflect on balanced and unbalanced forces using Lesson 3 Notebook Sheet B.
Procedure: Bringing It All Together TG: p. 108–109	***Bringing It All Together*** • Review how forces applied by touch affect an object's motion. • Have participants share patterns they observed about balanced and unbalanced forces and record their responses in a T chart (Figure 3.5 in the TG), and then draw force diagrams for both. • Have a group discussion about claims and evidence. Then have participants answer the investigation question (What happens when balanced or unbalanced forces are applied to an object at rest?) in their STEM Notebooks.
Assessment, Enrichment & Extension TG: p. 110–112	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Playground Poster (Art)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 4: Around and Around, Back and Forth

Natural and designed objects exhibit repeating patterns of motion.

15 minutes

Students obtain information from a reading, videos, and personal experience and combine them to identify patterns of repeated motion in various kinds of phenomena. They analyze the different types of patterns of motion to form categories of how objects move.

On CSO, navigate to Lesson 4 using the numbers at the top of the screen.

Resource/Page #	Lesson 4
Overview TG: p. 113	Objectives: • Obtain and combine information from an informational text and videos to identify and describe patterns of motion in various kinds of phenomena. • Categorize patterns of motion according to how objects move. Lesson Background Information: • Many situations involve repeating patterns of motion. For example, objects that spin have a pattern of circular motion, while objects that swing like a pendulum have a pattern of back-and-forth motion. An understanding of these patterns can be used to predict future motion. • In this lesson, participants listen to an informational text, "Round and Round," read aloud to learn about the patterns of motion in a bicycle. They then watch videos of various objects that exhibit repeating patterns of motion. Participants make observations to identify the patterns of motion in each video and share their observations with the class. • Pairs of participants then work together to identify other patterns of motion they have observed in real life. Participants organize these patterns of motion according to similarities in how the objects move. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 4
Materials & Preparation TG: p. 114	Materials: • Chart paper • Reader Printed Materials: • Lesson 4 Notebook Sheet Digital Materials: • Patterns of Motion video *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*

Procedure: Getting Started
TG: p. 114-115
Reader: p. 9-14
	Getting Started
	• The Reader *Motion and Magnets* has multiple versions. They all have the same readings but in multiple forms:
	  • On-Grade Readers: 16 physical copies shipped with your supplies, with Lexile scores for third grade
	  • CSO Readers: All CSO readers can be assigned to students using the CSO system
	    1. Spanish reader: on-grade reader in Spanish has notes and text-to-speech
	    2. Student reader: Digital copy of on-grade reader with note-taking and text-to-speech
	    3. Below-grade reader: the same information but simpler sentence structure, to decrease the Lexile score by about 100 points
	    4. Smithsonian Science Stories: *Motion and Magnets* Student Reader: e-book version of the on-grade reader with annotation toolbar
	• Read aloud reading 2, "Round and Round" from the Reader.
	
	next page →

Resource/Page #	Lesson 4
	Reading Summary The reading describes the parts of a bicycle that work together and how unbalanced forces start a bicycle moving, resulting in repeating patterns of motion. When you pedal it causes the chain to move, which moves a sprocket and propels the bike forward. • Have participants share what they learned from the reading and identify evidence about repeating patterns of motion.
Procedure: Activity TG: p. 115-117	***Activity*** • Show the Patterns of Motion video and have participants record on Notebook Sheet 4 how each object moves. • Have participants share their tables with a shoulder partner and then brainstorm other repeating patterns of motion they have observed.
Procedure: Bringing It All Together TG: p. 117	***Bringing It All Together*** • Have participants share their observations and record their responses in a T chart on chart paper—one column for back-and-forth motion and the other for circular motion.
Assessment, Enrichment & Extension TG: p. 118-119	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Patterns of Motion in Everyday Life (Leisure Activity) and Who Was Isaac Newton? (History)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 5: Pendulum Swings

Observations of patterns of motion can be used to predict future motion.

30 minutes

Groups plan and carry out investigations and identify patterns in their data to answer their questions.

On CSO, navigate to Lesson 5 using the numbers at the top of the screen.

Resource/Page #	Lesson 5
Overview TG: p. 121	Objectives: • Ask questions about what affects the motion of a pendulum. • Plan and carry out an investigation to answer a question about what affects the motion of a pendulum. • Analyze patterns in data to predict future pendulum motion. Lesson Background Information: • A pendulum is a weight that hangs from a string or light rod that is attached to a fixed point. A pendulum swings freely back and forth, making it useful for observing patterns of back-and-forth motion. The time it takes for a pendulum to finish one complete cycle of back-and-forth motion is called a "period." • The length of the pendulum affects the pendulum period; other factors such as pendulum mass do not. While their investigation will focus on pendulum length, students at this level do not need to know this. • In this lesson, an introductory discussion provides scaffolding as participants form scientific questions that could be tested with a pendulum. Participants will then use simple pendulum designs, similar to their model swings, to build their experience in planning and carrying out investigations. Class Periods: 2 (1 class period = about 35 minutes)

<table>
<tr><th>Resource/Page #</th><th>Lesson 5</th></tr>
<tr><td>Materials & Preparation
TG: p. 122-123</td><td>Materials:
Roll of string
Steel washers, 3.5 centimeters
Ring stands and support rings
Scissors
Meter stick
Printed Materials:
Lesson 5 Notebook Sheet A
Lesson 5 Notebook Sheet B
Lesson 5 Notebook Sheet C
Pendulum Release Guide
Digital Materials:
Pushing a Swing video
The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.

To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should:
Assemble pendulums (13, 22, and 35 centimeters).</td></tr>
<tr><td>Procedure: Getting Started
TG: p. 124</td><td>Getting Started
Show the Pushing a Swing video.
Discuss the pattern of motion of the tire swing. Compare and contrast the model swing from Lesson 1 to the tire swing to introduce the word "pendulum."</td></tr>
<tr><td>Procedure: Activity
TG: p. 124-129</td><td>Activity
Facilitate a discussion to help participants construct testable questions about simple pendulum motion. Compile suggestions about things that could be changed, possible impacts of the change, and data that could be collected in a chart.
Have participants independently create a testable question.
next page →</td></tr>
</table>

Resource/Page #	Lesson 5
	• Have participants complete questions 2-4 on Lesson 5 Notebook Sheet A and then have them peer review their ideas with their shoulder partner. • Discuss as a group if the ideas would lead to a fair test. • Divide participants into groups and assign group roles. Have groups collect materials. • Give groups time to discuss their initial ideas before asking guiding questions to support their investigative plan development. • Have groups draw a diagram on Lesson 5 Notebook Sheet B to help plan their investigation, before reviewing their plan. • Groups should carry out their investigation, collect data on Lesson 5 Notebook Sheet C, then discuss their results and individually answer the investigation question.
Procedure: Bringing It All Together TG: p. 130	***Bringing It All Together*** • Have participants share out the patterns they observed in their data and then use the patterns to make predictions.
Assessment, Enrichment & Extension TG: p. 131-132	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Pendulum Bar Graph (Math)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 6: Tick Tock

Humans can take advantage of naturally repeating patterns of motion.

15 minutes

Students read a brief history of pendulum clocks and obtain information from the reading to explain the relationship between a pendulum's length and its period. Students analyze patterns in data to predict the motion of a seconds pendulum.

On CSO, navigate to Lesson 6 using the numbers at the top of the screen.

Resource/Page #	Lesson 6
Overview TG: p. 133	Objectives: • Obtain information from an informational text to analyze the repeating motion of a pendulum. • Use mathematical patterns in data to predict the motion of a pendulum. Lesson Background Information: • Pendulums display a regular pattern of motion. The period of a pendulum is determined by its length. Longer pendulums have a longer period. • Pendulum motion has been used to control clocks since the 17th century. Pendulum clocks use a seconds pendulum, which has a two-second period. • In this lesson, participants read an informational text about the devices that people use to keep time, with an emphasis on clocks with pendulums. The reading includes information about the relationship between the length of a pendulum and its period. • Participants compare the periods of different length pendulums. They use information from the reading and patterns in a partially completed data table to predict the motion of a seconds pendulum. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	**Lesson 6**
Materials & Preparation TG: p. 134	Materials: • Reader Printed Materials: • Lesson 6 Notebook Sheet Digital Materials: • Pendulum Clock video *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 134-135	***Getting Started*** • Ask participants to draw or visualize a pendulum clock and ask how the pendulum might help the clock keep time. • Show the Pendulum Clock video.
Procedure: Activity TG: p. 135-136 Reader: p. 15-20	***Activity*** • Read reading 3, "Tick Tock," from the Reader. **Reading Summary** The reading describes different ways we tell time. A sundial uses shadows to show the time of day but has no seconds or minutes, and can only be used when it's light out. Clocks with cogs spin because a weight pulls the cog down, and then another part that looks like a claw stops it. This repeats and the motion keeps time. However up until the 1500s, clocks would be an hour off by the end of each day. A pendulum can be used to keep time because all pendulums of the same length have the same period, which is the amount of time a pendulum takes to swing back and forth. The back-and-forth swinging moves the claw part of the clock and is more accurate. However, it requires a clock-maker to know each pendulum's period and make a different size cog to work with each size pendulum. The seconds pendulum lets the main cog move every second, which provides an accurate way to measure time and led to many scientific discoveries. New clocks use a quartz crystal. The crystal vibrates, which is also a pattern of motion, and controls the motion of the other clock parts. next page →

Resource/Page #	Lesson 6
	• Discuss the reading to help participants think about what they read. • Participants should reread "Tick Tock" and identify the relationship between pendulum length and period, then use the partially completed table on the Lesson 6 Notebook Sheet to predict pendulum motion.
Procedure: Bringing It All Together TG: p. 136-138	***Bringing It All Together*** • Facilitate a discussion about pendulum clocks and the reading to support understanding. • As a group, discuss the chart on the Notebook Sheet and the patterns identified.
Assessment, Enrichment & Extension TG: p. 138-140	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: A World Without Time (Writing) and Keeping the Beat (Music)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 7: Supercharged Science

Static electricity is a force that can act between objects that are not in contact with each other.

25 minutes

After observing a static electricity demonstration, students carry out an investigation to see how they can cause an object to move without touching it. They use models to diagram the effect of static electric forces that are applied from a distance.

On CSO, navigate to Lesson 7 using the numbers at the top of the screen.

Resource/Page #	Lesson 7
Overview TG: p. 141	Objectives: • Carry out an investigation to explain how an object can cause another object to move without contact. • Use models to describe how noncontact forces affect an object's motion. Lesson Background Information: • Static electricity is the buildup of electric charges on an object. It can be produced by rubbing two objects together. Rubbing a balloon with a piece of wool transfers charged particles from the wool to the balloon. The balloon can then apply a force on other charged objects. • In this lesson, participants conduct investigations to discover that electric forces can act at a distance. Participants use wool and two balloons to see if the charge on one balloon will cause the other balloon to move. When one balloon is rubbed with wool and brought close to another balloon, the balloons attract because of their charges. When both balloons are rubbed with wool and brought close together, the balloons repel because they are both negatively charged. • Teams of participants are then challenged to use these forces to move a can in a race. Participants discover that a charged balloon can move a can by attracting it. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 7
Materials & Preparation TG: p. 142-143	Materials: • Latex balloons • Wool cloth • Salt • Pepper • Paper plate • Masking tape • Meter stick • Empty aluminum cans Printed Materials: • Lesson 7 Notebook Sheet A • Lesson 7 Notebook Sheet B Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Mirror the trainer's demonstrations. • Gather a wool cloth for the demo and an aluminum can and a wool cloth for each group. • Mark the start and finish lines of the aluminum can races about 1 meter apart.
Procedure: Getting Started TG: p. 143-144	***Getting Started*** • Demonstrate static electricity using a charged balloon and salt and pepper. • Have participants share their observations and ideas about what they observed.
Procedure: Activity TG: p. 144-147	***Activity*** • Demonstrate that uncharged balloons remain at rest when close to each other. Then ask participants to think about what would make them move. next page →

Resource/Page #	Lesson 7
	• Divide participants into groups. Have one participant from each group pick up two balloons and a wool cloth. Groups should experiment with the balloons and determine ways to get their balloons to attract or repel each other, recording their observations on Lesson 7 Notebook Sheet A. • Facilitate a discussion of their findings and explain that they have been working with static electricity. • Explain that static electricity is a type of force. Have participants draw force diagrams of the two simulations they have seen in this lesson on Lesson 7 Notebook Sheet B. • Have groups use what they have learned about static electricity to move an aluminum can in a race.
Procedure: Bringing It All Together TG: p. 147	***Bringing It All Together*** • Use guiding questions to facilitate a discussion about the static electricity race and participants' observations.
Assessment, Enrichment & Extension TG: p. 148-150	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Charge It Up! (Literacy and History) and Science Poems (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

SESSION 3:

Lessons 8–12

The trainer introduces lessons 8-12 (Focus Questions 3 and 4).

Goal: The trainer facilitates Lessons 8-12, with participants experiencing the lessons as learners and debriefing each focus question as teachers.

At various points in the training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Lesson 8	20 minutes	Assemble bags of testing materials, hand out Readers and SAGs
Lesson 9	25 minutes	Set up stations and magnetic force strength testers
Short break	10 minutes	
Lesson 10	15 minutes	
Lesson 11	25 minutes	Collect a container of "trash," a ring stand, and chart paper, gather sticky notes
Lesson 12	25 minutes	Chart paper

Lesson 8: Stuck on You

Magnetic forces can act between objects that are not in contact with each other.

20 minutes

Students carry out an investigation and analyze patterns in their data to see what materials are attracted by a magnet and observe that a magnetic force can attract an object without touching it. They use models to diagram the effect of these forces that are applied from a distance.

On CSO, navigate to Lesson 8 using the numbers at the top of the screen.

Resource/Page #	Lesson 8
Overview TG: p. 151	Objectives: • Carry out an investigation to answer the question, "What materials are attracted to a magnet?" • Identify patterns in data to help answer the question, "What materials are attracted to a magnet?" Lesson Background Information: • A magnet is a material or object that exerts a magnetic force. Magnets attract certain metals, including iron, but not all metals. US coins are made with mixtures of metals that are not attracted to magnets. • In this lesson, participants test a number of common items to find out which materials are attracted to magnets. They record their observations and use them to identify patterns among the materials that magnets do and do not attract. • Participants read a brief piece on lodestones, and use it to support their observations about which materials are attracted to magnets. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 8
Materials & Preparation TG: p. 152	Materials: • Roll of aluminum foil • Roll of string • Metric ruler • Scissors • Plastic bags, 20-x-28 centimeters • Paper clips • Steel washers, 1.5 centimeters • Nails • Wood craft sticks • Plastic spoons • US coins • Rubber bands • Small bar magnet • Reader • SAG Printed Materials: • Lesson 8 Notebook Sheet A • Lesson 8 Notebook Sheet B Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Assemble bags of testing materials.
Procedure: Getting Started TG: p. 153	***Getting Started*** • Facilitate a discussion about how an object's motion can change without something touching the object. Make sure magnetic force is discussed.

<table>
<tr><th>Resource/Page #</th><th>Lesson 8</th></tr>
<tr><td>Procedure: Activity
TG: p. 153-156
SAG: 4-6</td><td>Activity
Divide participants into groups and assign group roles. Have groups collect materials.
Have participants predict whether objects will be attracted to a magnet and record their predictions (steps 1-4 in the SAG).
Have participants test how magnets affect each object in their bag of materials (steps 6-10 in the SAG) and record the results on Lesson 8 Notebook Sheet A.
Using their results, have groups complete the questions on Lesson 8 Notebook Sheet B.</td></tr>
<tr><td>Procedure: Bringing It All Together
TG: p. 157-158
Reader: p. 27-30</td><td>Bringing It All Together
Have participants share patterns they observed while using the magnet and explain that magnets are attracted to iron.
Read reading 5, "Surprising Stones," from the Reader.
Reading Summary
The reading describes a naturally occurring magnetic material called lodestone. Sailors discovered that it always lines itself up in a north-south direction, and the magnetic compass was created.
Discuss the reading to ensure understanding.
Show participants a compass and demonstrate that it always points north.</td></tr>
<tr><td>Assessment, Enrichment & Extension
TG: p. 158-161</td><td>Briefly review, as time allows:
Assessment Rubrics: Formative Assessment
Extension: Magnet Painting (Art)</td></tr>
<tr><td>Reflection</td><td>After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss:
What student learning can you expect from this lesson?
Any potential challenges you might have in this lesson?
Any potential difficulties or misconceptions that students may struggle with in this lesson?
What strategies or supports can be applied?</td></tr>
</table>

Lesson 9: Magnet vs. Magnet

Magnets attract objects with similar properties, and the strength of the force they apply depends on the distance to an object. They interact with each other in specific ways, based on their relative orientation.

25 minutes

Students carry out investigations into how magnets interact with other magnets. They analyze their data, looking for patterns to provide evidence that all magnets attract the same types of materials and that the magnetic force lessens as distance is increased.

On CSO, navigate to Lesson 9 using the numbers at the top of the screen.

Resource/Page #	Lesson 9
Overview TG: p. 163	Objectives: • Carry out investigations into how magnets interact with steel objects and with other magnets. • Analyze data to explain that magnetic force varies with distance and type of magnet. • Ask questions about the effects of forces that act at a distance. Lesson Background Information: • When magnets attract objects, the strength of the magnetic force depends on the distance between the magnet and the object—the closer the magnet, the stronger the force. • A magnet has two poles, and the magnetic force is strongest at the poles. When two magnets are brought together, like poles repel and unlike poles attract. • An electromagnet is a device made by passing an electric current through a wire wrapped around an iron or steel object. Electromagnets attract the same kinds of objects as other magnets, but the magnetic force of an electromagnet can be turned on and off. next page →

Resource/Page #	Lesson 9
	• In this lesson, participants carry out tests to further investigate characteristics of magnets and how magnets interact with other magnets. They will move through stations performing six tests using different types of magnets. They will use their test results to draw conclusions about how magnets interact with each other and about the strength of magnets at a distance. Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 164-166	Materials: • D battery • Metal D battery holder • Roll of 24-gauge wire • Nail • Masking tape • Roll of string • Paper clips • Metric ruler • Small bar magnets • Large bar magnets • Horseshoe magnets • Ring magnets • Cow magnets • Metric rulers • Compasses • Magnetic force strength testers • SAG • Chart paper Printed Materials: • Lesson 9 Notebook Sheet A • Lesson 9 Notebook Sheet B • Lesson 9 Notebook Sheet C Digital Materials: • Crazy Compass video • Magnetic Force Strength Test file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 9
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Set up the magnetic force strength testers at each station. • Set up the magnet stations (Small Bar magnet, Large Bar magnet, Horseshoe magnet, Ring magnet, Cow magnet, and Electromagnet) with a ruler, compass, SAG, and two of the same type of magnets.
Procedure: Getting Started TG: p. 167	***Getting Started*** • Show participants the Crazy Compass video and discuss the difference between the compass in the video and the compass they saw in Lesson 8.
Procedure: Activity TG: p. 167-173 SAG: p. 7-11	***Activity*** • Divide participants into groups and assign group roles. • Introduce the six different magnet stations and where they are in the room. • Demonstrate the magnetic force test and discuss what the test can tell you. • Have groups test the strength of the magnets at their stations and record the data on Lesson 9 Notebook Sheet A. Repeat for at least two other stations. • Have groups investigate how magnets interact with other magnets and compasses, document the results on Lesson 9 Notebook Sheet B, and verbally summarize all their observations from the lesson so far. • As a class, discuss how the magnets they tested are alike and different. • Facilitate a discussion to summarize their understanding of magnetic forces, using the vocabulary "attract," "repel," "cause," and "effect." next page →

Resource/Page #	Lesson 9
	• Have participants draw a force diagram for the magnet test described on Lesson 9 Notebook Sheet C. • Have participants ask a question about forces that act at a distance. The question must involve cause and effect and must be testable.
Procedure: Bringing It All Together TG: p. 174-175	***Bringing It All Together*** • Facilitate a class discussion about magnetic forces and compare the electromagnet to the other magnets used. • Introduce the term "magnetic poles" and have participants draw force diagrams on the board or chart paper. • Discuss how the magnet and compass interacted and remind participants of the "Surprising Stones" reading from Lesson 8.
Assessment, Enrichment & Extension TG: p. 176-178	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Our Magnetic Planet (Reading)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 10: Making Magnets Work for You

The predictable forces of magnets can be used to design solutions to meet specified criteria and constraints.

15 minutes

Students obtain information from a reading on how the attractive and repulsive effects of magnets have been used to solve problems. As an introduction to criteria and constraints, they identify how these were defined for the problems in the reading.

On CSO, navigate to Lesson 10 using the numbers at the top of the screen.

Resource/Page #	Lesson 10
Overview TG: p. 179	Objectives: • Obtain information from a text on how electromagnets and magnets can work as part of a system to solve a problem. • Define problems that have been solved by using electromagnets and magnets as part of a system. Lesson Background Information: • Participants will consider a real-world problem and engineer a solution to the problem. First, participants learn about some aspects of engineering design: that solutions to problems are usually designed to meet certain criteria and constraints, and that solutions are often systems made up of multiple components. • They obtain information from a reading about three objects—the telephone, compass, and maglev train. All these systems use magnets to solve specific problems. Participants identify the problem each object solved and the criteria and constraints associated with the solution. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 10
Materials & Preparation TG: p. 180	Materials: • Chart paper • Markers • Reader Printed Materials: • Lesson 10 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 181	***Getting Started*** • Ask participants to brainstorm ideas with their shoulder partner about problems that could be solved using magnets. • Introduce the criteria and constraints table (Figure 10.2 in the TG) that will help organize the criteria and constraints for each device in the reading.
Procedure: Activity TG: p. 181-184 Reader: p. 37-48	***Activity*** • Read the section "Finding Your Way with Magnets" from reading 7, "Saying Hello with Magnets," in the Reader. • Have participants discuss criteria and constraints with their shoulder partner. **Reading Summary** The reading describes different ways magnets have helped solve problems. A compass that uses a lodestone is heavy, so engineers created a lighter vision by striking a small iron needle with a lodestone to make it a magnet. Maglev trains use electromagnets and permanent magnets to move. The electromagnets on the track repel the permanent magnets on the train, propelling it forward. These trains are faster, smoother, and are less likely to break down because they do not have wheels; they levitate off the track. next page →

Resource/Page #	Lesson 10
	A telephone transmits sound by having puffs of air from your voice turn on an electromagnet, which is repelled by a permanent magnet nearby. Then an electromagnet moves a thin disk back and forth to create sound at the receiving end. • Discuss the reading to help participants understand and add criteria and constraints to the table. • Assign participants to either read the section, "A Better Way to Travel" or "Sending Your Voice Far Away" in reading 7, "Saying Hello with Magnets" of the Reader. Have them use the Lesson 10 Notebook Sheet to identify the problem, criteria, constraints, and solution in the reading.
Procedure: Bringing It All Together TG: p. 185	***Bringing It All Together*** • Have participants share the criteria and constraints they identified from the two readings. • Add to the class table and discuss how well the systems solved the problems.
Assessment, Enrichment & Extension TG: p. 186-188	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Comparing Magnets (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 11: Trash Matters

Solutions to real-world problems are designed to meet specified criteria and constraints.

25 minutes

Students design a solution to a problem that can be solved using magnets, specifying criteria for success and design constraints. They design a solution model.

On CSO, navigate to Lesson 11 using the numbers at the top of the screen.

Resource/Page #	Lesson 11
Overview TG: p. 189	Objectives: • Define a problem that can be solved with a system that includes a magnet. • Design solutions to a problem that can be solved with a system that includes a magnet. Lesson Background Information: • Steel is used in a wide variety of products, including cars, appliances, buildings, and aircraft carriers. In the classroom, the rings of three-ring binders and the spiral wire of notebooks likely contain steel. • Steel is the most recycled material on the planet. Steel materials that end up in the trash are sorted out of the waste stream using magnets. Landfills often use large electromagnets on cranes to pick up and move these materials to another location. • In this lesson, participants work in teams to design a magnetic trash-sorting tool. The tool will be a model of a device that could be used to separate steel from classroom trash. Participants are provided with a set of specific criteria for success and design constraints. Groups will design their model in this lesson and build and test it in the following lesson. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 11
Materials & Preparation TG: p. 190-192	Materials: • SAG • Roll of string • Roll of aluminum foil • Petri dishes with lids • Wood marbles • Plastic beads • Steel washers, 1.5 centimeters • Mini washers • Ring stands • Set of magnets/electromagnet materials • Rubber bands • Wood craft sticks • Tape • Scissors • Sticky notes • Chart paper Printed Materials: • Lesson 11 Notebook Sheet A • Lesson 11 Notebook Sheet B • Lesson 11 Activity Sheet Digital Materials: • Junkyard Magnet video *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should: • Collect a container of "trash," a ring stand, and chart paper. • Gather sticky notes.
Procedure: Getting Started TG: p. 192-193	***Getting Started*** • Present the trash sorting problem to the class. • Show the contents of the demonstration trash can to participants as they record each item on Lesson 11 Notebook Sheet A. next page →

Resource/Page #	Lesson 11
	• Discuss what categories the trash could be sorted into. • Show the Junkyard Magnet video. Discuss participants' observations of the device and the problem it is trying to solve.
Procedure: Activity TG: p. 193-195 SAG: p. 12-15	***Activity*** • Divide participants into groups and assign group roles. Have groups collect materials, including the Lesson 11 Activity Sheet and a SAG. • Have participants read in the SAG about steel recycling and correlate the objects in their "trash" with the items in the demonstration trash can. • Have groups read the criteria and constraints of the problem and set up their sorting facility. • Have participants sketch design ideas on Lesson 11 Notebook Sheet B, share their ideas, and then finalize a design for the group. • Have participants create a claim about why their design will be successful.
Procedure: Bringing It All Together TG: p. 195	***Bringing It All Together*** • Facilitate a gallery walk where participants will review and provide feedback on other groups' designs.
Assessment, Enrichment & Extension TG: p. 196-199	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Recycling Posters (Art and Community)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 12: Putting Trash in Its Place

The predictable forces of magnets can be used to design solutions to meet specified criteria and constraints.

25 minutes

Students build a model of their device that solves a real-world problem. They test the model to determine whether the design meets the criteria of the problem.

On CSO, navigate to Lesson 12 using the numbers at the top of the screen.

Resource/Page #	Lesson 12
Overview TG: p. 201	Objectives: • Develop and use a model of a trash-sorting device that includes a magnet as part of a system. • Test model trash-sorting devices and compare solutions to identify a successful design. Lesson Background Information: • As engineers design solutions, they typically work in groups to brainstorm ideas, as groups did in Lesson 11. Engineers then select what they think will be the best approach, build a prototype, run tests using the prototype, evaluate the test results, and redesign as needed. They may build, test, and compare multiple designs before deciding which one best solves the problem. • In this lesson, participants work in teams to build their model trash-sorting devices. Each group evaluates the success of their model by counting how many steel objects were moved and how many other objects were moved to the recycling container. They consider which parts of their design were successful and identify failure points. • The class then compares all designs, looking for common successful features, and discusses how magnetic forces were used in the designs. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 12
Materials & Preparation TG: p. 202	Materials: • SAG • Roll of string • Roll of aluminum foil • Petri dishes with lids • Wood marbles • Plastic beads • Steel washers, 1.5 centimeters • Mini washers • Ring stands • Set of magnets/electromagnet materials • Rubber bands • Wood craft sticks • Tape • Scissors Printed Materials: • Lesson 12 Notebook Sheet A • Lesson 12 Notebook Sheet B Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 203	***Getting Started*** • Have participants to return to their groups from Lesson 11, with the same group roles. • Have the Materials Manager retrieve all necessary materials. • Groups should review the problem criteria and constraints, and then revise their group design based on the peer review comments.
Procedure: Activity TG: p. 203-204 SAG: p. 16-17	***Activity*** • Have groups collect materials for their model trash sorter and a SAG. • Groups should build and test their models and record the results on Lesson 12 Notebook Sheets A and B. • Have groups evaluate the strengths and weaknesses of their design.

Resource/Page #	Lesson 12
Procedure: Bringing It All Together TG: p. 204-205	***Bringing It All Together*** • Groups should share their design strengths and weaknesses and identify what common features led to successful or unsuccessful models. • Review how magnetic forces were used in the models.
Assessment, Enrichment & Extension TG: p. 205-208	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Investigating Electromagnets (Math)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

SESSION 4:

Lessons 13–15

The trainer introduces Focus Question 5 (Lessons 13-15).

Goal: The trainer facilitates Lessons 13-15, with participants experiencing the lessons as learners and debriefing each focus question as teachers.

At various points in the training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Lesson 13	30 minutes	Measure and cut string, set up pendulums
Lesson 14	30 minutes	
Lesson 15	30 minutes	
Wrap Up	15 minutes	

Lesson 13: The Dynamic Duo Swing Ride Part 1

Magnetic forces acting between objects that are not in contact with each other can be used to influence patterns of motion in predictable ways.

30 minutes

Students ask questions about how magnets affect the pattern of motion of a steel pendulum.

On CSO, navigate to Lesson 13 using the numbers at the top of the screen.

Resource/Page #	Lesson 13
Overview TG: p. 209	Objectives: • Ask questions about how magnets affect the pattern of motion of a steel pendulum. Lesson Background Information: • Participants are ready to begin their Science Challenge. A hypothetical company called Outdoor Playtime wants to design a new playground swing called the Dynamic Duo. It will incorporate magnets into an existing tire swing design. The company needs information on how magnets affect the motion of a swing. • Participants must use what they have learned about forces and motion to plan an investigation to determine how magnets affect the motion of a steel pendulum. Groups will use small pendulums as models of swings. • In this lesson, participants complete a written formative assessment. They will then use what they know about pendulums and magnets to ask a question about how these two things will interact. Using the information from Outdoor Playtime, groups will then form a testable question that they will investigate in the remaining lessons of the module. Class Periods: 1 (1 class period = about 35 minutes)

<table>
<tr><th>Resource/Page #</th><th>Lesson 13</th></tr>
<tr><td>Materials & Preparation
TG: p. 210</td><td>Materials:
• 60-centimeter pendulum on a ring stand
• Bar magnets
• Stopwatch
• Measuring tape
Printed Materials:
• Lesson 13 Notebook Sheet A
• Lesson 13 Notebook Sheet B
• Lesson 13 Notebook Sheet C
Digital Materials:
• Dynamic Duo Swing Investigation file
The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.

To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, the group should:
• Make sure the pendulum is set up as it was in Lesson 5, with a 60-centimeter string.</td></tr>
<tr><td>Procedure: Getting Started
TG: p. 211</td><td>Getting Started
• Ask participants to reflect on what they have learned about forces that will help them complete the Science Challenge.
• Have participants complete the written assessment on Lesson 13 Notebook Sheet A.</td></tr>
<tr><td>Procedure: Activity
TG: p. 211-212</td><td>Activity
• Ask participants to write down questions on Lesson 13 Notebook Sheet B that they could test about how magnets can affect motion.
• Read the description in the TG about how they can make Outdoor Playtime’s new swing more fun.
• Divide participants into groups and assign group roles.

next page →</td></tr>
</table>

Resource/Page #	Lesson 13
	• Demonstrate the basic swing design and materials that can be used, then give groups time to read the Dynamic Duo Swing Investigation file. • Have groups reflect on their earlier pendulum investigation and discuss whether collecting data in the same way would be helpful. • Have groups share their ideas to form a group question.
Procedure: Bringing It All Together TG: p. 212-213	***Bringing It All Together*** • Discuss the concept of fair tests and how they will be used in this investigation. • Have groups develop their plan and record on Lesson 13 Notebook Sheet C how their investigation will be a fair test.
Assessment, Enrichment & Extension TG: p. 214-219	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment • Extension: The Best Swing Ever (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 14: The Dynamic Duo Swing Ride Part 2

Magnetic forces acting between objects that are not in contact with each other can be used to influence patterns of motion in predictable ways.

30 minutes

Students plan an investigation to answer a question about how magnets affect the pattern of motion of a steel pendulum.

On CSO, navigate to Lesson 14 using the numbers at the top of the screen.

Resource/Page #	Lesson 14
Overview TG: p. 221	Objectives: • Plan an investigation to answer a question about how magnets affect the pattern of motion of a steel pendulum. • Communicate a data collection plan that will explain cause-and-effect relationships between magnets and a steel pendulum. Lesson Background Information: • Outdoor Playtime wants to design a new playground swing called the Dynamic Duo. It will incorporate magnets into an existing tire swing design. In this lesson, groups work together to plan an investigation that will answer their question from Lesson 13. • Groups will use information they prepared in Lesson 13 to help ensure that their investigation uses fair tests. They will peer review one other group's plan and incorporate suggestions from that group into their final investigation plan. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 14
Materials & Preparation TG: p. 222-223	Materials: • 60-centimeter pendulum on a ring stand • Bar magnets • Stopwatch • Measuring tape • Metric ruler • Pendulum Release Guide • Chart paper • Tape Printed Materials: • Lesson 14 Activity Sheet A • Lesson 14 Activity Sheet B Digital Materials: • Dynamic Duo Swing Investigation file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 223	***Getting Started*** • Have participants join the same groups and take on the same group roles as in Lesson 13. • Show participants the Dynamic Duo Swing Investigation file and remind them of the fair test they will be planning. • Explain that they will not be provided with a data table, but they may want to use the table from Lesson 5 as a template.
Procedure: Activity TG: p. 223-225	***Activity*** • Have groups collect materials to use in planning their investigation. • On chart paper each group should write their testable question and tape to their chart the appropriate Activity Sheet. Note that each group is investigating just one swing design—either Lesson 14 Activity Sheet A or Activity Sheet B based on what they chose in Lesson 13. next page →

Resource/Page #	Lesson 14
	• Ask groups to create a list of steps for their investigation that use fair tests. Review them before groups write them on their chart paper and a blank data table based on their investigation plan. • Have each participant read and provide feedback on one other group's procedure. • Allow time for groups to review the feedback and revise their plan, if necessary.
Procedure: Bringing It All Together TG: p. 225	***Bringing It All Together*** • Facilitate a discussion about how data from an investigation can be used to make predictions. • Answer any final questions about the plans the groups will carry out in the next lesson.
Assessment, Enrichment & Extension TG: p. 226-228	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment • Extension: A Day on the Playground (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 15: The Dynamic Duo Swing Ride Part 3

Humans can take advantage of naturally repeating patterns of motion.

30 minutes

Students carry out an investigation to answer a question about how magnets affect the pattern of motion of a pendulum. They use their data to predict the future motion of their swing and write a claim that answers their question.

On CSO, navigate to Lesson 15 using the numbers at the top of the screen.

Resource/Page #	Lesson 15
Overview TG: p. 229	Objectives: • Carry out an investigation to answer a question about how magnets affect the pattern of motion of a steel pendulum. • Analyze data to predict the pattern of motion of a steel pendulum that interacts with magnets. • Make a claim, based on evidence, that answers a question about how magnets affect the pattern of motion of a steel pendulum. Lesson Background Information: • In this lesson, groups carry out their investigations according to the plans they developed in Lesson 14. • Participants work together in their groups to analyze the data from their investigation. They then use their observations and measurements to make a prediction about the future motion of their pendulum. • Groups prepare a claim for Outdoor Playtime about how the company should make a better swing. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 15
Materials & Preparation TG: p. 230	Materials: • 60-centimeter pendulum on a ring stand • Bar magnets • Stopwatch • Measuring tape • Metric ruler • Pendulum Release Guide • Chart from Lesson 14 Printed Materials: • Lesson 15 Notebook Sheet A • Lesson 15 Notebook Sheet B Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.*
Procedure: Getting Started TG: p. 230	***Getting Started*** • Explain that in this lesson groups will conduct their investigations, analyze the data, and write a claim about how magnets affect the motion of a steel swing.
Procedure: Activity TG: p. 231-234	***Activity*** • Have participants join the same groups as in Lessons 13 and 14. Assign group roles. • Have groups collect the materials they will need for their investigation and the charts they made in Lesson 14. • Have groups set up and carry out their investigations. They will write their data on their charts. • Have each participant analyze their data and then make a claim about how magnets affect a steel pendulum. • Have participants use Lesson 15 Notebook Sheets A and B to answer their group's question about their claim.
Procedure: Bringing It All Together TG: p. 234-235	***Bringing It All Together*** • Have groups share their data, observations, and patterns from their investigation.

Resource/Page #	Lesson 15
Assessment, Enrichment & Extension TG: p. 235-238	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment • Extension: Letter to Outdoor Playtime
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Wrap Up

Take a few minutes to check in with the group before dismissing.

15 minutes

	Key Points
Q&A	Invite participants to ask any final questions about materials, implementation, strategies, or anything else on their mind.
Continuing Support	If you are willing, provide your contact information for questions and concerns that the participants may have in the future.

APPENDIX 1: GROUP DISCUSSION

The goal of group discussions is to provide an opportunity for shared learning by asking multiple people to propose connections between their individual experience and the new content of focus.

The facilitator has three primary jobs during group discussions:

1. Support individuals sharing.
   It may be unnerving for individuals to share their thoughts in a group. When facilitating group discussions, use the following techniques to boost individuals' confidence and likelihood of sharing their thoughts:
   - Pay attention to speakers.
   - Smile and nod at appropriate moments to nonverbally communicate that you are engaged.
   - Provide anonymous sharing opportunities using chart paper or sticky notes.
2. Manage group participation.
   It is important to have active and balanced participation from the group to gain as many perspectives as possible. While it is important to hear from everyone, not every person needs to comment on every question. Here are some techniques to help you manage participation of individuals during a group discussion:
   - Use small groups with a designated sharer/speaker.
     - Assigning roles: Change roles for each lesson.
   - When no one wants to speak up:
     - Use the silence. Generally someone will speak up within 15 seconds.
     - Make eye contact with someone you would like to hear from.
   - How to stop a monopolizing speaker:
     - Do not make eye contact with them.
     - Redirect comments and questions from monopolizers to others.
3. Support group thinking.
   - Record individual member suggestions or points in a central location.
   - Ask guiding questions to have the group highlight connections.
   - Summarize.

If you would like to see group discussions in practice, please visit:
TERC Inquiry Project videos: https://inquiryproject.terc.edu/prof_dev/library.cfm.html

APPENDIX 2: QUESTIONING/GUIDING THOUGHT

Questioning is a useful tool with many applications. For this application we will focus on questioning as a way to discover what people are thinking, encourage further thought, and develop group understanding.

The best questions to use are open-ended questions, which do not have a set answer and often require a sentence or more to answer. Questions like:

- What do you know about . . . ?
- Does anyone have anything to add?
- Why do you agree/disagree?

Generally the first level will be eliciting new ideas by asking questions about what people already know or can observe during the lesson:

- What did you observe?
- Has anyone ever encountered . . . ?
- What are some ways to introduce students to . . . ?

The second level is encouraging further thought by asking people to reflect on what has been said, to identify connections to the current topic:

- What do you mean by . . . ?
- Can you tell me more about . . . ?
- What is the evidence for/against . . . ?

The final level we will look at is creating a group understanding by coming to consensus on what has been discussed:

- What idea do you think best connects what everyone is saying?
- Can someone summarize for me?
- Based on what the group is saying, how would this affect . . . ?

Further suggestions for questioning:

- Give thinking time of three to five seconds after posing a question.
- Avoid saying “correct/incorrect.” Instead, let the group validate or clarify what someone is saying.
- Avoid the habit of only collecting one “correct” response and moving on. Always have at least two people answer a question, even if their answers are similar.
- Questioning can also be used to help keep time by letting people know how much longer the discussion can go on.
- Validate everyone’s input by thanking them for speaking up.

APPENDIX 3: GROUP ROLES

Each person in a group having a role can provide many positive outcomes. Some benefits of using group roles include:

- Increases participant motivation by having a unique role
- Models positive classroom behaviors
- Decreases the amount of time spent waiting for a group to decide or discuss who will do what
- If a job is assigned, it pushes participants to participate in different ways

Here are some ideas for how to begin using group roles:

- Change roles regularly to maintain interest.
- Try to give everyone a chance at each role.
- Have a system in place for assigning roles. Possible systems include:
  - Colored dots and frames—Give each person in the group a colored dot. Place a matching color frame around their role for the day. Change the frame placement as needed.
  - Numbers—Assign each member of the group a number (1-4). Place a sticky note with the corresponding number on their role for the day.
  - Badges—Give each person in the group a badge or card with their role for the day listed.
  - Desk tents—Give each person in a group a desk tent with their role for the day.

More information about group roles can be found at: https://ctl.wustl.edu/resources/using-roles-in-group-work

The chart here shows which roles are used in each lesson. The roles and rotation are based on having four members in each group. The numbers in each column suggest how to rotate roles.

	Lesson #									
Group Role	**2**	**3**	**5**	**8**	**9**	**11**	**12**	**13**	**14**	**15**
Recorder										
Artist						1	3	2	4	
Builder	1	2	3			4	1	3	1	2
Tester	2	3	4	1	2					4
Materials Manager	3		1	2	4	3	2	4	3	1
Speaker		4	2							
Gardener/ Zookeeper										
Questioner	4			3	1					
Organizer		1		4	3	2	4	1	2	3
Messenger										

For these trainings, use the roles listed in each lesson, as described on the Group Roles poster.

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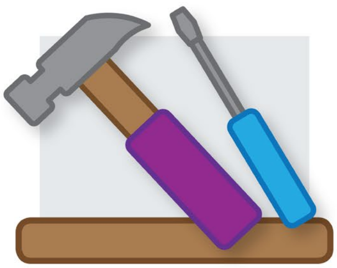
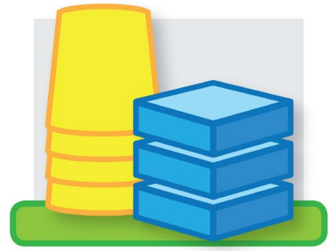
Scientists and Engineers in Our Classroom: Group Roles

Artist
Draws any sketches, diagrams, or graphs.



Builder
Takes the lead in putting together materials.

Gardener/Zookeeper
Makes sure live organisms are cared for and treated with respect.



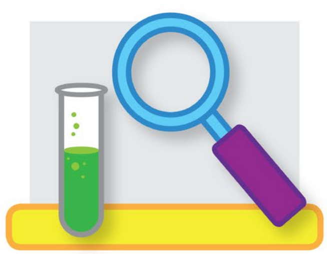
Materials Manager
Collects, cleans up, and puts away materials neatly.

Messenger
Asks questions of the teacher for the group.

Organizer
Makes sure group members work together and complete work on time.

Recorder
Writes down data, observations, and explanations.

Speaker
Shares the group's final work or ideas with the whole class.



Tester
Takes the lead in carrying out investigations and testing designs.

Questioner
Asks questions of group members to make sure all points of view are considered.

APPENDIX 4: MANAGING DIFFERING OPINIONS

At some point, it is highly likely that participants will have different opinions and thoughts. Working through these differences and coming to a point of mutual understanding is important to keep the group moving forward. This is also at the core of inquiry science and changing education practices.

Hearing different opinions and thoughts shows there is not always one "right" answer and there are multiple ways to interpret evidence. Often we are trying to come to consensus, which may require each participant to compromise or focus on where they agree and come back to the other areas.

To have meaningful conversations around different interpretations and ideas, it is important to build a culture of discussion and argumentation. At the beginning of the training, set group norms for how to interact when people do not agree, such as:

- Disagree with an idea, not the person.
- Use respectful language.
- Use phrases like "I disagree about . . ." or "I agree on . . ."
- Listen quietly to other people.
- Ask questions politely.
- Speak loudly and clearly.
- Always use evidence.

As with any other discussion, everyone needs to have the opportunity to be heard. Make sure you are allowing a variety of people to speak and that people are not cutting each other off.

Not every discussion of different opinions can come to a complete end every time. One way to table a discussion in order to move on is to take advantage of a parking lot or other idea repository. The chart on the next page lists a few ideas about when the parking lot should be used instead of having the discussion continue. Note: Every circumstance is different. These are suggested criteria, not hard rules.

Parking Lot	Keep Going
Requires input from people outside of training	Is specific to the current topic
Will be covered more in future lessons or sessions	Will likely be wrapped up in the session
Not related to the current topic	Multiple participants are highly engaged
Discussion becomes combative	Group has good evidence to come to consensus
Only one participant is speaking	

Sometimes the difference of opinions and ideas stems from a misconception. The Teacher Guide has a list of content and practice-based misconceptions that may come up in each module. Additionally, it is important to ask participants about what sources they are using, why they believe this information, or other questions to get at the root of their misconception while avoiding an accusatory or negative tone of voice. You can also use their peers' input to help clarify. If you must correct misconceptions to support learning later in the module, try using a supportive phrase such as, "Many people think that is true but the evidence so far supports . . ."

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