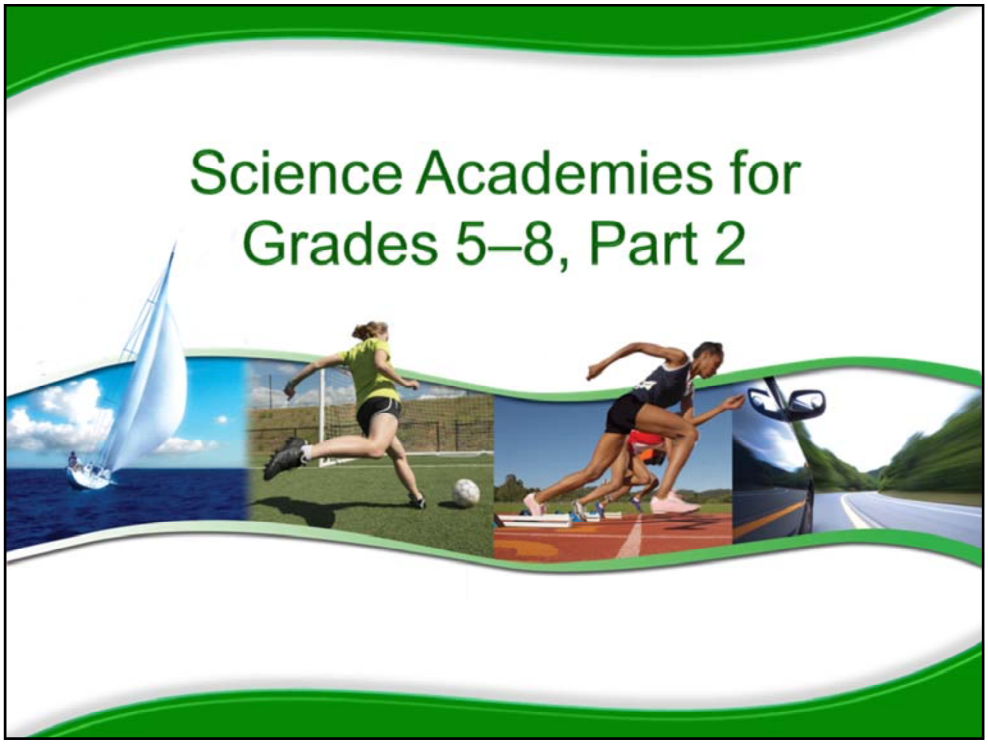


Directions for Presenter: italics
Information for Trainer to Convey: bold

Read through the presenter notes, and fill in all blank lines with page numbers from the participant notes.

Place one table card (letters A–J) in the center of each table.

Make sure all the tables have table boxes, markers, and paper. Place chart paper around the room for easy access.

Post one sheet of chart paper close to the door and write "Parking Lot" on it for participants to post questions and comments.

Welcome and meet participants; facilitate grouping.

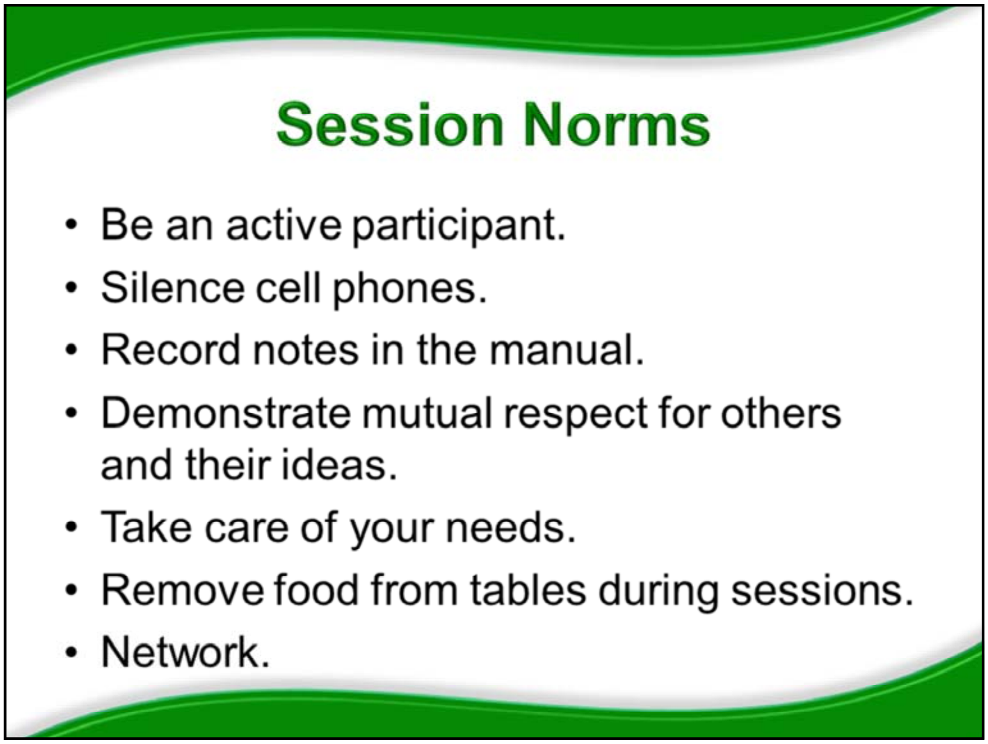
Hi! My name is __________. Welcome to the Science Academies for Grades 5–8, Part 2, training. Open your guide to the first page and write your name, district, and any other identifier you think is necessary in case your guide is misplaced.

You will find paper and markers on the table. Take a moment and make a name tent for yourself. Please number off at your table starting with 1 and going no higher than 6.

<u>Materials</u>
table boxes
table cards (A–J)
markers
paper

Read the slide.

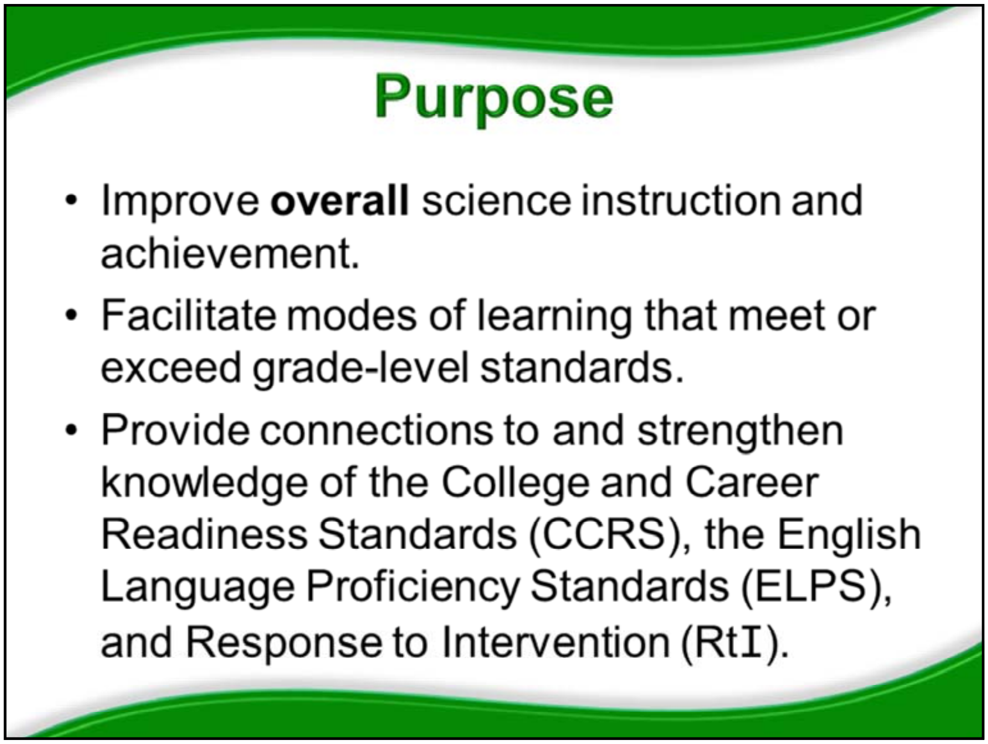
Allow participants time to complete the task.



Read and discuss the session norms listed on the slide.

Answer questions or concerns.

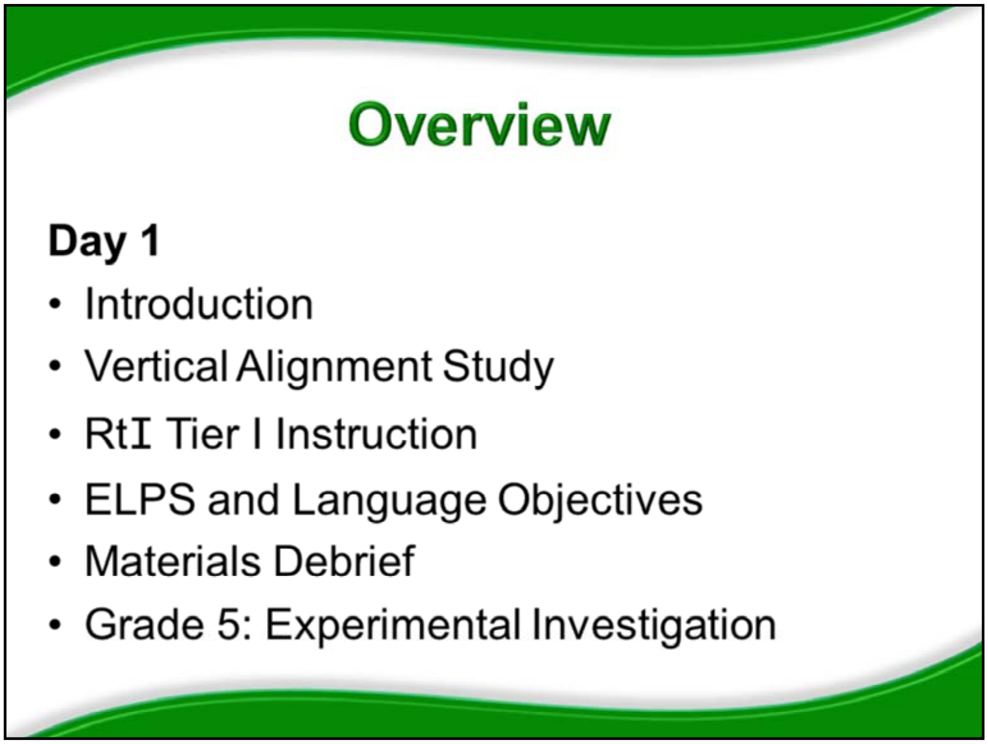
Identify locations of restrooms and exits.



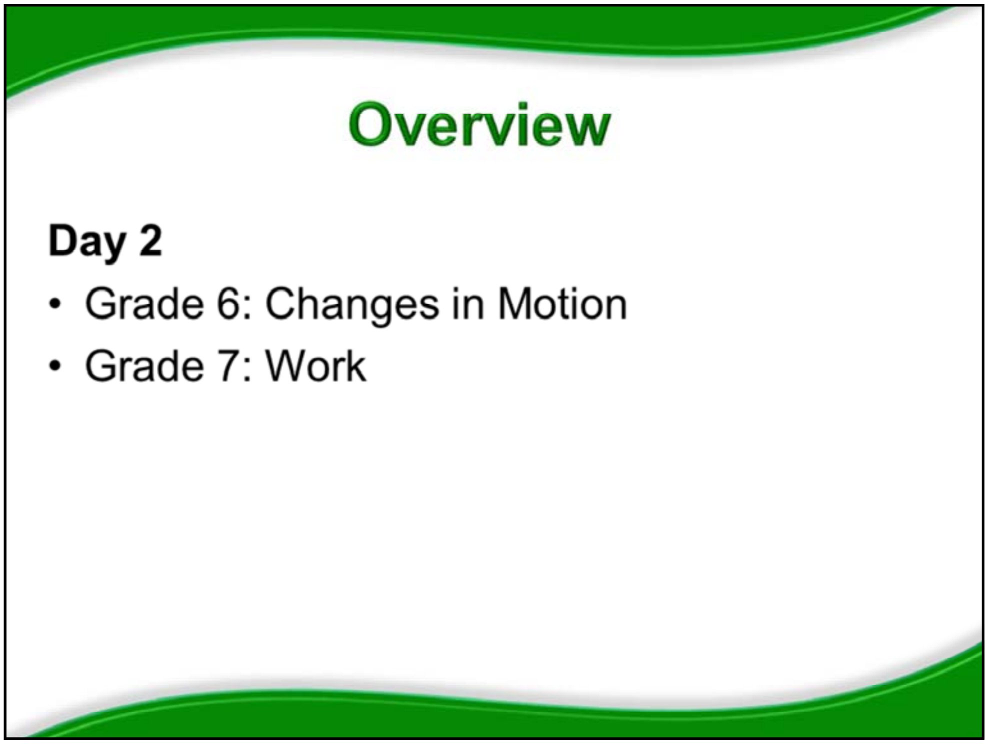
Our purpose for the next 3 days is to—

Read the slide.

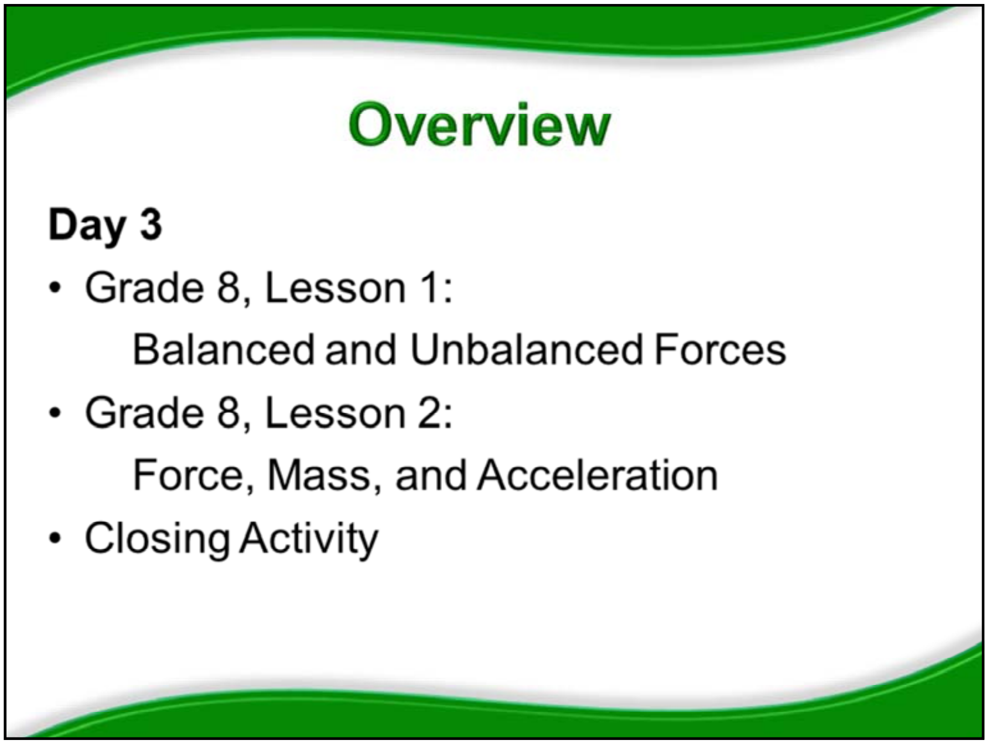
Note: Teachers who attended Part One have basic knowledge of CCRS, ELPS, and RtI. Additional information is located in the Support Frameworks section of the participant guide.



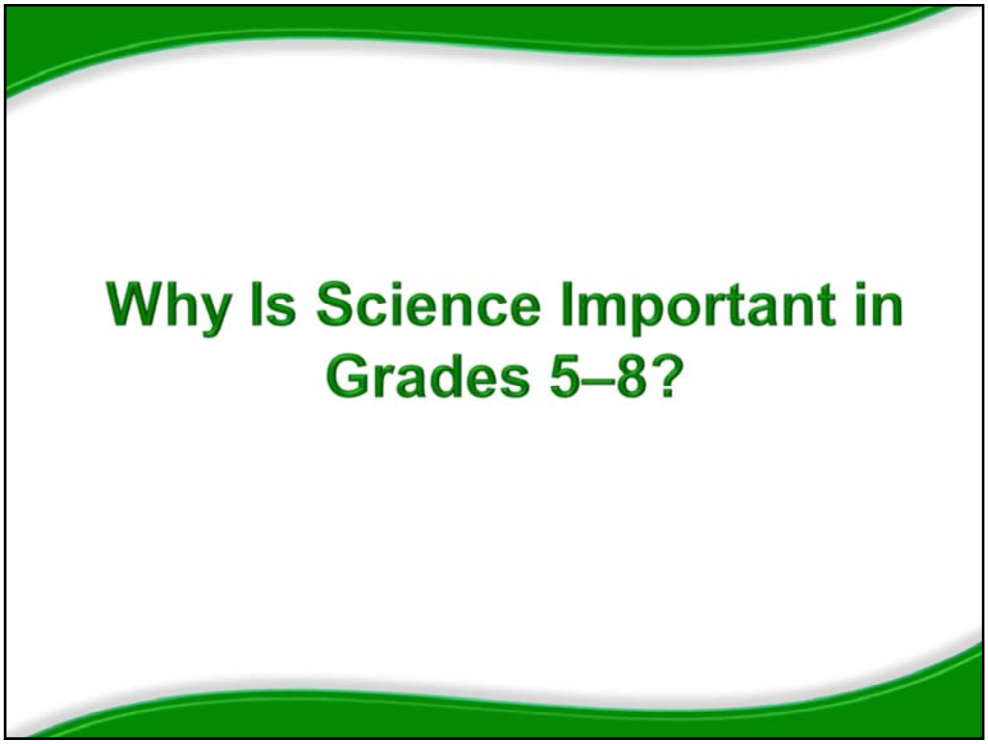
Read the slide.



Read the slide.



Read the slide.

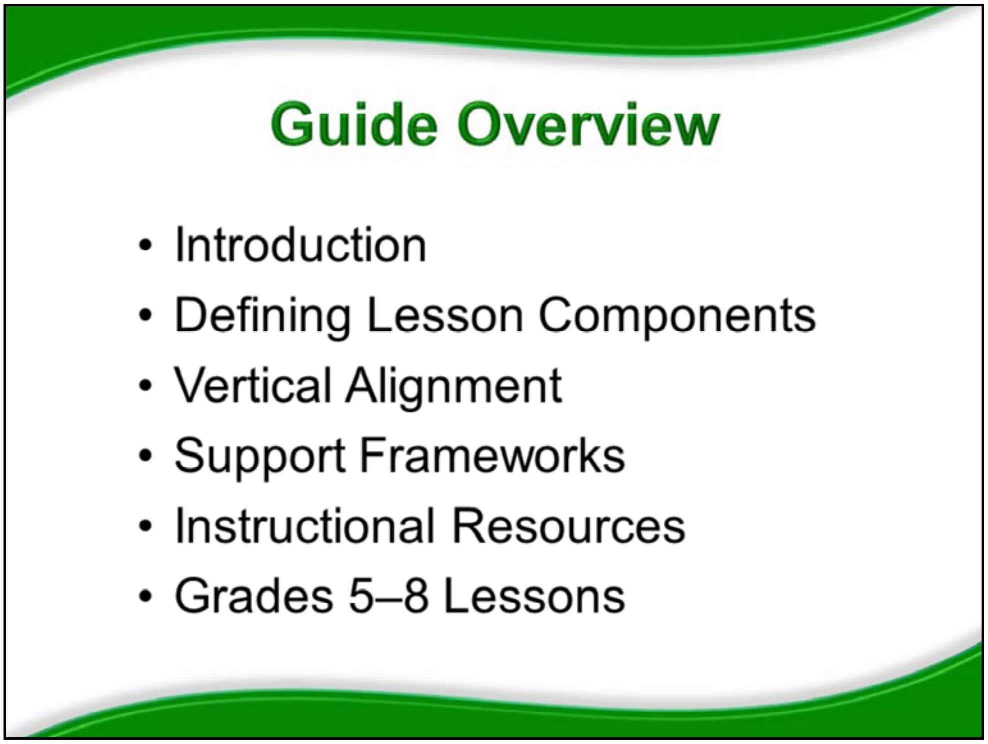


Read the slide.

Work together as a table group to create a list of the three top reasons why teaching science in grades 5–8 is important. Write your list of reasons on chart paper, and post your list on the wall.

Instruct groups to post their lists around the room, and allow time for groups to do a gallery walk. Answers may include that middle school science is the bridge between elementary and high school science. It builds on the foundation laid by elementary teachers and deepens content knowledge to support higher level learning in high school and beyond. Depending on the paths students pursue after middle school, they may not experience certain sciences such as earth science again. This makes middle school science extremely important. Teachers also have the opportunity to build upon the natural curiosity students exude in elementary school science.

<u>Materials</u>
chart paper
markers



Open your guide, and find the table of contents and the overview, which is located before the first tab.

The table of contents details what is included in the guide.

The overview provides a brief agenda for the Science Academies for Grades 5–8, Part 2.

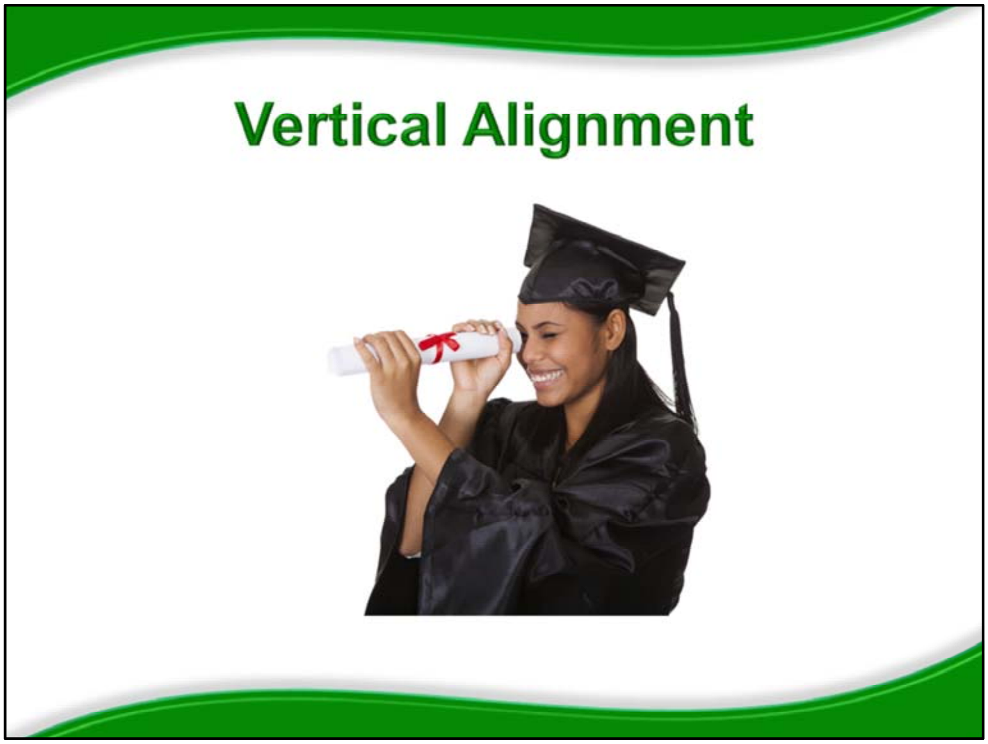
Turn to page 5, and review the different lesson components.

Take a moment to identify each tab and familiarize yourself with the guide.

Allow participants time to flip through their guides.

<u>Materials</u>
participant guides

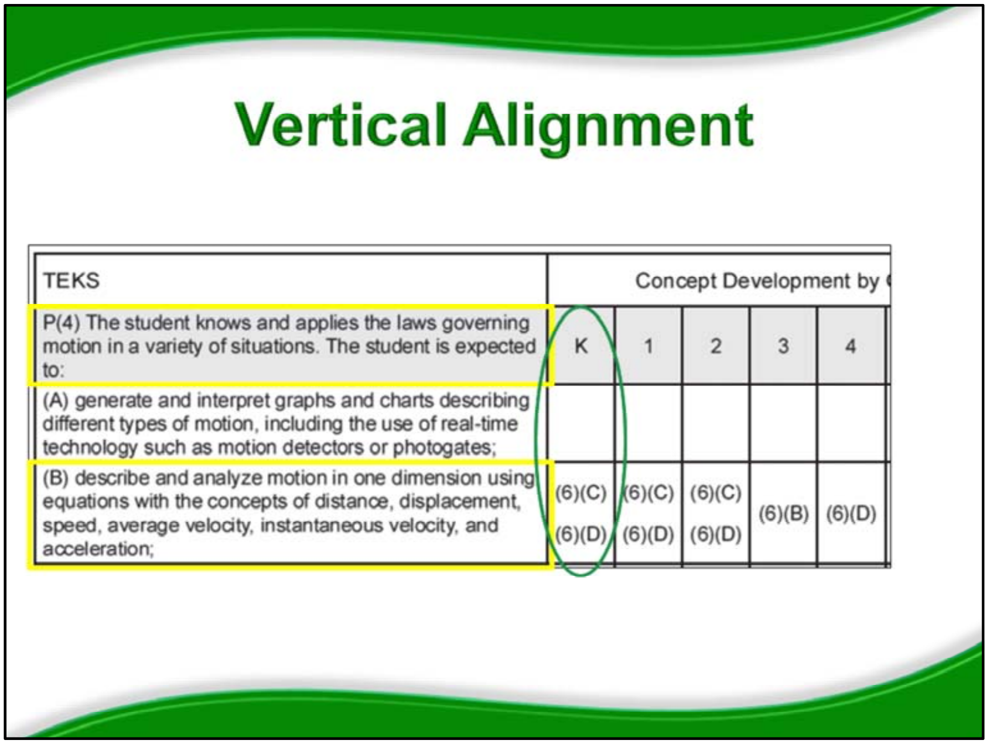
When we consider the instructional pathway from students' first days of kindergarten to their first days of college or on the job, they are exposed to thousands of learning experiences. Each step in the journey is as important as the last. Grades 5–8 builds on the foundation set by K–4 by increasing students' content knowledge and preparing them for high school and future careers and/or college.



Locate the Vertical Alignment tab in your guide. The Physics Vertical Alignment Table is the first set of pages behind that tab. The K–8 Science Concepts TEKS pages follow the Physics Vertical Alignment Table. You will need both sets of pages to complete the activity.

<u>Materials</u>

highlighters



Locate P(4) on the first page of the Physics Vertical Alignment Table.
The “P” stands for physics and the “4” denotes the fourth section of TEKS.

Click.

Find the header “Concept Development by Grade Level TEKS” and the K–8 TEKS in the boxes below it. These K–8 TEKS align to the physics TEKS.

Let’s look at one together.

Locate P(4)(B) on the Physics Vertical Alignment Table.

Click.

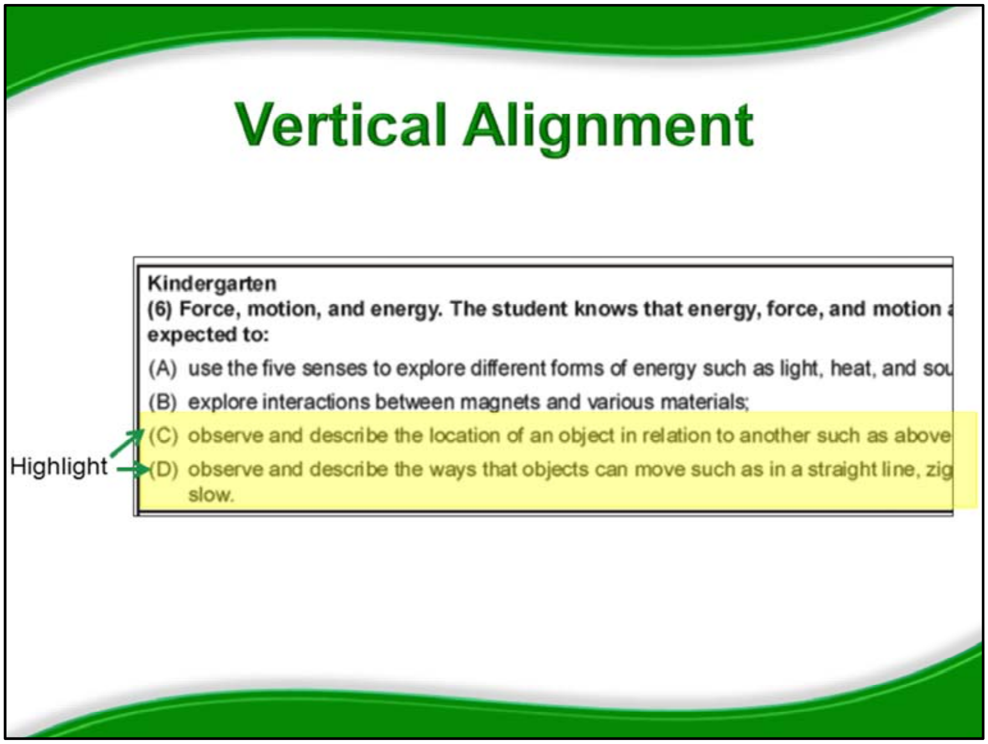
Which kindergarten TEKS align to P(4)(B)?

Click.

K(6)(C) and K(6)(D) align to P(4)(B).

What does that alignment mean?

Kindergarten teachers begin laying the foundation for physics.



Use a highlighter to highlight K(6)(C) and K(6)(D) on the K–8 Science Concepts TEKS page.

Click.

When looking at the TEKS in the Physics Vertical Alignment Table, focus only on the TEKS printed in black because they align to the Force, Motion, and Energy strand, which is the focus of this training. The TEKS printed in gray align to physics, but not with that content strand.

Follow the same procedure to highlight the remaining science concepts TEKS in grades K–8 that align to physics.

Allow participants time to complete the task.

What can you conclude from the highlighted TEKS?

Ask for participant responses. Answers should include that many of the K–8 TEKS support high school physics.

How do the K–8 and high school physics TEKS support the College and Career Readiness Standards (CCRS)?

Ask for participant responses. Answers should include that the TEKS support skills students will need as they enter college or begin careers.

Circle or star the following grades K–4 TEKS on pages ___ (K–8 Science Concepts TEKS).

K(6)(A) and K(6)(B)

1(6)(A) and 1(6)(B)

2(6)(A) and 2(6)(B)

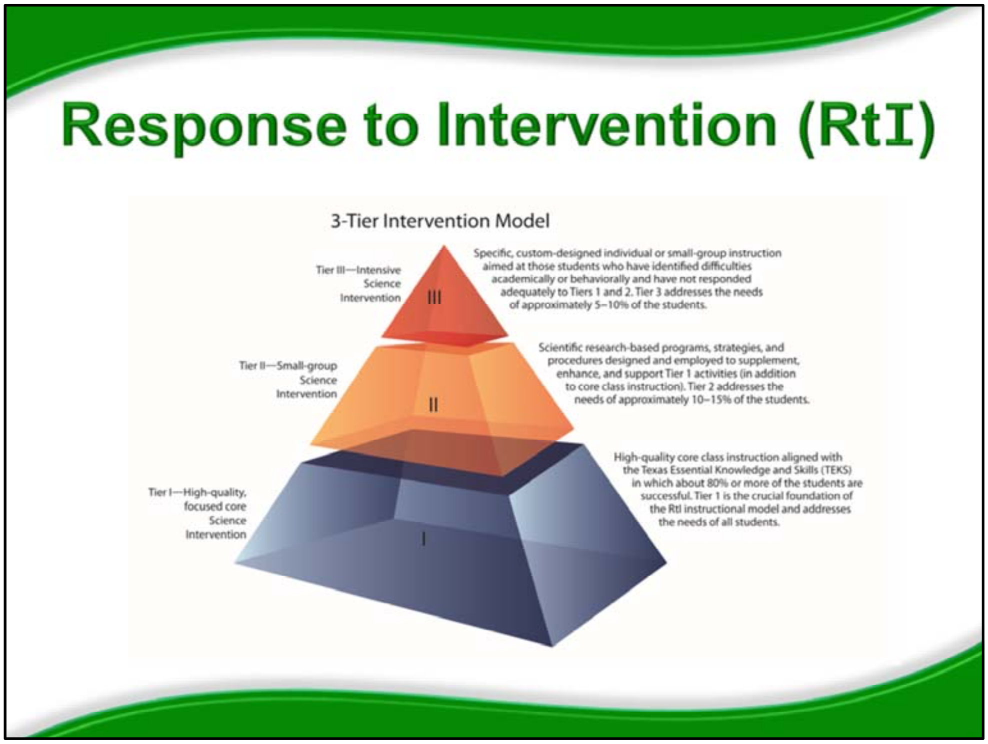
3(6)(A), 3(6)(B), and 3(6)(C)

4(6)(A), 4(6)(B), 4(6)(C), and 4(6)(D)

The lessons in the Science Academies for Grades K–4, Part 1, addressed these TEKS.

At the end of each lesson, we will revisit these pages to circle or star the TEKS that the grades 5–8 lessons address. This will help you see exactly how we are supporting high school physics.

Take a moment to study this image. What could it represent in a student's education?
Ask for participant responses. A bridge could represent a student's educational path. The individual planks could symbolize each year of education. The two people in front appear to be older and could possibly represent teachers leading the way. The planks in the bridge are all present because teachers must prepare and plan ahead of time to make sure learning is most effective. The hand rails help keep students focused and on the path. The support pillars along the bridge could represent learning supports to aid in student success.



In Science Academies for Grades 5–8, Part 1, we learned about Response to Intervention (RtI). Share with your group what you know or remember about RtI. Locate the *Support Frameworks* section of your guide to find information about RtI. Be prepared to share and explain RtI with the whole group.

Allow 3–5 minutes for participants to discuss RtI and read pages ___.

Select one craft stick and roll the die.

I selected a craft stick with the letter ___ (*read the letter from the selected craft stick)* **and rolled a ___** *(read the number from the die)***.**

Now, number ___ *(repeat the number rolled)* **at table___** *(repeat the letter from the selected craft stick)* **please share what you know about RtI.**

Repeat until 2–3 participants have shared.

Allow 5–7 minutes for participants to complete this activity.

Participants should report that RtI is a multitiered approach to intervention. Their responses should include core RtI features/attributes listed on page ____ in the guide.

RtI asks, "What can we do to support each student's performance and help promote success?"

Click to the next slide to answer this question.

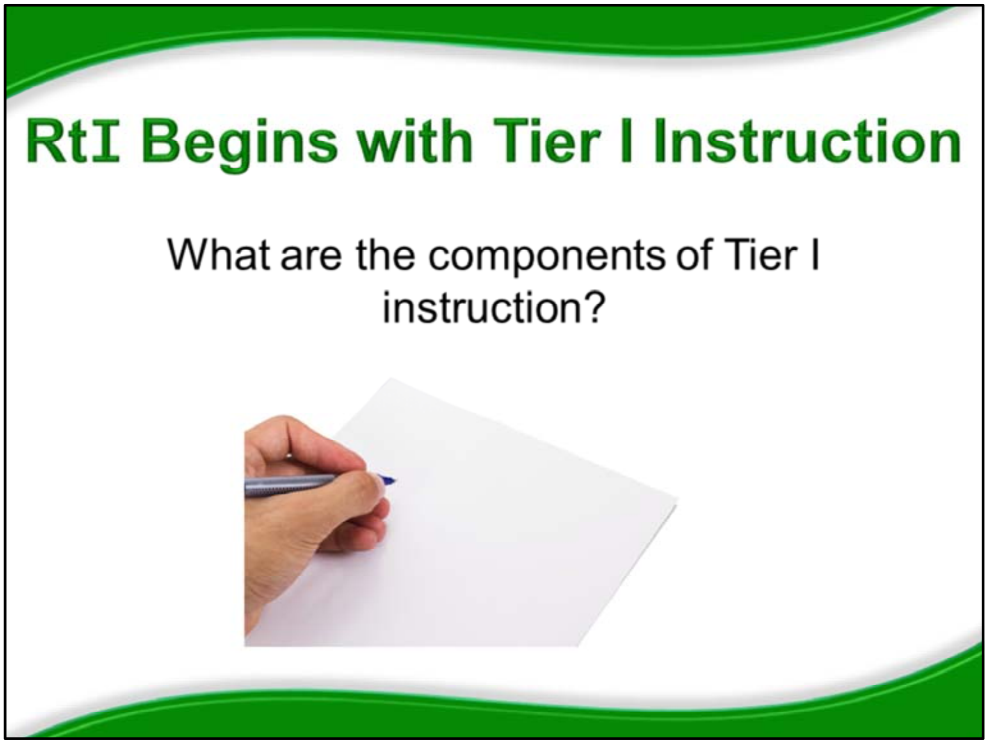
<u>Materials</u>

table cards (A–J)

labeled craft sticks (A–J) in a cup

1 die

timer (optional)



RtI begins with Tier I instruction.

At this time, please close your guides. On a piece of paper, list and describe the components of Tier I instruction using a pencil or pen with black ink. Do not write your name on the paper.

Allow 1–2 minutes for participants to complete the task.

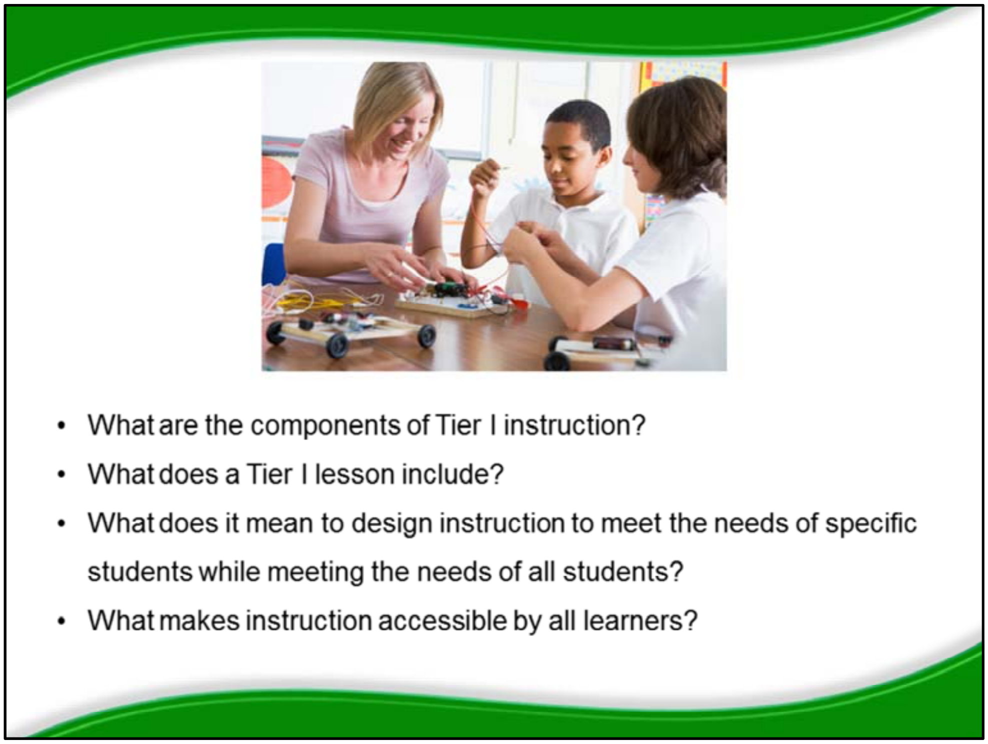
Crunch your paper into a ball.

Click.

When I say *go*, you will stand up, make eye contact with another person, and toss the paper balls from person to person around the room. When I say *stop*, pick up or hold one paper ball. Return to your home table.

Allow 1–2 minutes for participants to toss their paper balls from person to person and then return to their home tables.

<u>Materials</u>
- timer (optional)
- white paper
- writing utensils



In your group, open the paper ball you caught and share what is written. As a group, use the response on the paper balls caught and your own understanding to create a description of Tier I instruction. Record your group's response on chart paper. You may use the questions on the screen to guide your discussion. Post your completed response when time is up.

Assign a place in the room for groups to post their responses.

Allow 7–10 minutes for groups to share, discuss, and post their responses.

Use the checklist on page ___ in the guide to evaluate your description.
Participants should reference the Tier I Instruction Checklist in the guide to evaluate their understanding of Tier I instruction. Facilitate this process as you walk around the room and check for understanding.

Allow 5 minutes for groups to check their work.

Does your description include 8–10 of the items on the checklist? 5–7? 4–6? 1–3?

How does the tossing the paper ball strategy engage all students?
This strategy helps students feel safe expressing their ideas and answers because it is anonymous. Those students who do not normally contribute to class discussions have

the opportunity to use their voices through writing as opposed to speaking. During the debrief, a student can objectively discuss the answer on his or her paper because it is not as personal since another student wrote it.

Materials
chart paper
markers
white paper
writing utensils

Without Tier I instruction, some students may feel the way you feel when your shoes don't fit quite right. They may be too small or rub on the heel.

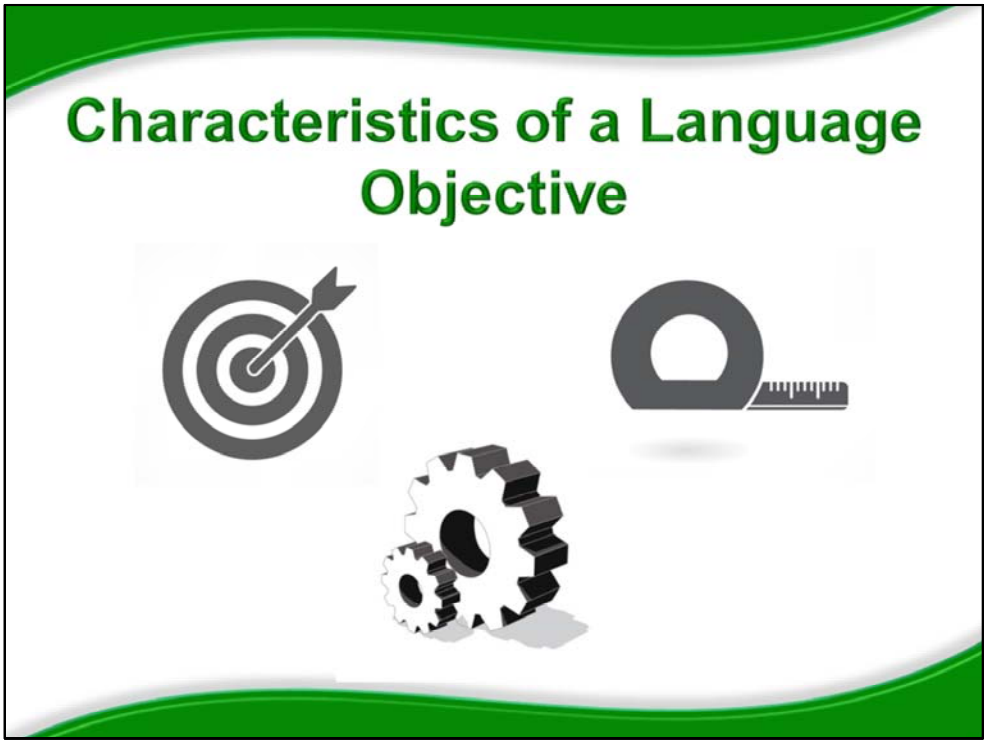
Click.

One-size-fits-all instruction can leave students feeling like their shoes are too big and on the wrong feet.

Click.

Quality Tier I instruction lays the foundation for future learning by meeting the needs of all students and building on their strengths and interests.

Within the lessons, you will see some sections denoted as either a Tier I Support or a Differentiation Strategy. Tier I Support sections aid in the facilitation of an activity such as grouping options or the addition of a whole-group strategy. Differentiation Strategy sections describe ways to accommodate students working on different cognitive levels within the same topic or activity. Both of these sections are designed to help you meet the needs of all your students.



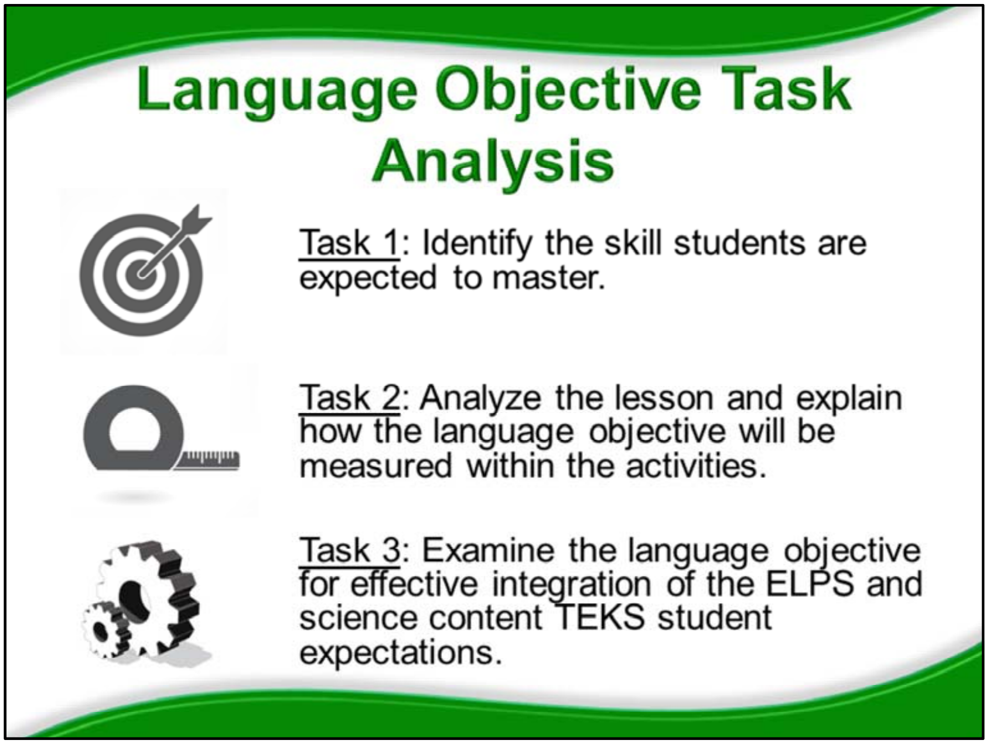
Each of these images represents a characteristic of a language objective. Which language objective characteristic do you think each image symbolizes? Explain the connection between the symbol and the characteristic you identified.

Possible participant responses—

<u>*Target*</u>*: The language objective is targeted toward a specific skill a student is to master.*

<u>*Measurement*</u>*: The language objective provides an opportunity to accurately measure a student's skill development and content knowledge.*

<u>*Gears*</u>*: The language objective is integrated with both the ELPS and content student expectation that is supported by the instructional design.*



Let’s take a moment to examine the language objectives in the lessons. As a table, select one of the lessons to accomplish the following three tasks.

Click.

Task 1: Identify the skill students are expected to master.

Participants may ask about the appropriate number of language objectives for a lesson. It is important that participants understand that a lesson should have one language objective even though students may be writing, speaking, listening, and reading all within one lesson. Tracking the progress of many students can be overwhelming, so limiting the mastery skill to one is key for success.

Click.

Task 2: Analyze the lesson and explain how the language objective will be measured within the activities.

Writing an effective language objective includes using verbs that can be measured. For example, a language objective that states "I can write about force using the words *magnetism*, *friction*, and *gravity*." can be measured.

Click.

Task 3: Examine the language objective for effective integration of the ELPS and science content TEKS student expectations.

The ELPS student expectation should support the science content TEKS student expectation. For example, students will be speaking, reading, writing, and/or listening as they learn science content.

Allow groups 5–7 minutes to complete the language objective analysis.

Use the craft sticks labeled with group letters to randomly select groups to share their findings regarding the language objectives in the lessons.

<u>Materials</u>

craft sticks

As we move through the lessons, consider what these experiences mean to the students in our schools and classrooms. How do effective language objectives help them? How do we most effectively track their progress?

Distribute one Linguistic Instructional Alignment Guide (LIAG) to each participant.

As you look through the LIAG, let's note the following features:

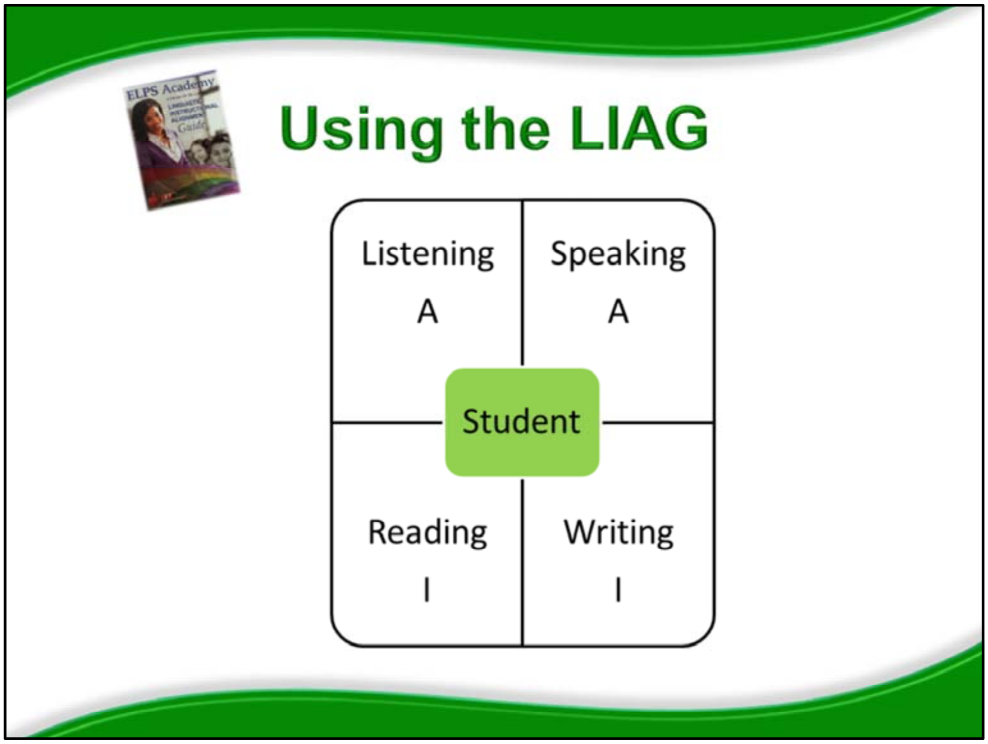
1. **The first page provides performance-based activity ideas for each domain (listening, speaking, reading, and writing).**
2. **The LIAG is divided into four domains: listening, speaking, reading, and writing. The listening and speaking domains are for grades K–12. Reading and writing each include grades K–1 and grades 2–12 sections. Why are the reading and writing domains broken into two sections each?** *In grades K–1, students are learning to read and write whereas in grades 2–12, students are reading and writing to learn.*
3. **On the left margin of each left domain page are proficiency level descriptors for beginning, intermediate, advanced, and advanced high.**
4. **On the center margin of the left page are the ELPS Expectations.**
5. **On the center margin of the right page are correlating CCRS and then sample activities for each domain.**

6. **On the right margin of the right page are suggested teacher behaviors for each proficiency level.**

7. **The last page that folds out is a student tracking chart for each domain and proficiency level. The tracking chart can be reused if dry-erase or overhead projector markers are used.**

<u>Materials</u>

Linguistic Instructional Alignment Guide

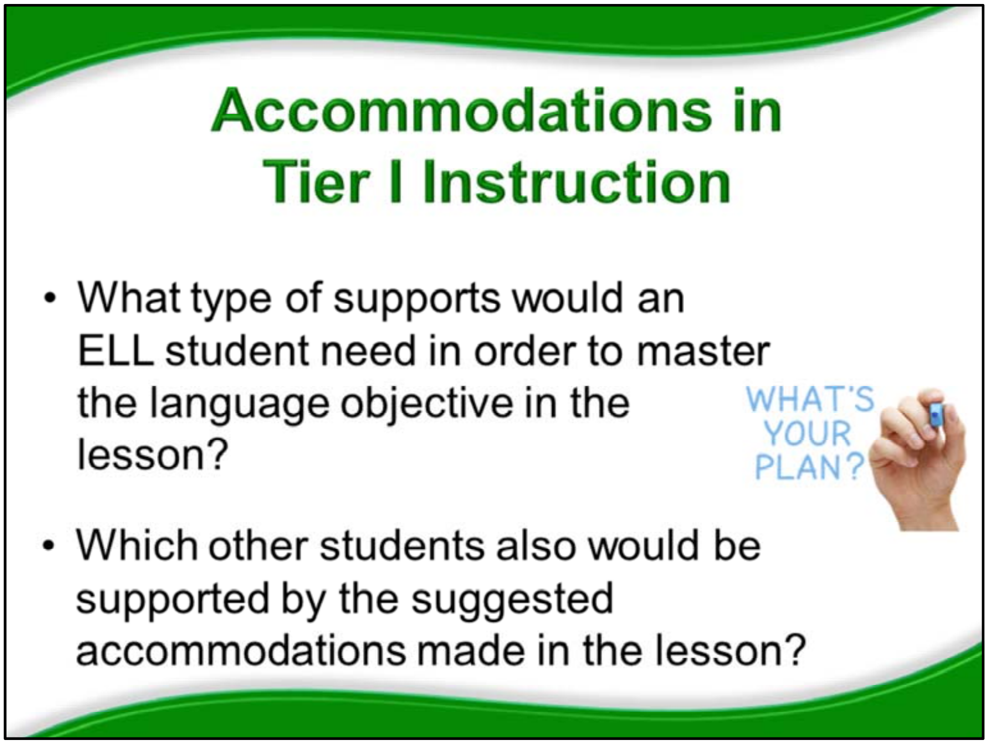


Think about an English language learner (ELL) at your school or in your classroom. How would you rate him or her in the four domains? Would the ratings all be the same across the four domains or could they be different?

Ask a few participants to share their thoughts.

Click.

Depending on the student, he or she may have differing proficiency levels in each of the four domains.



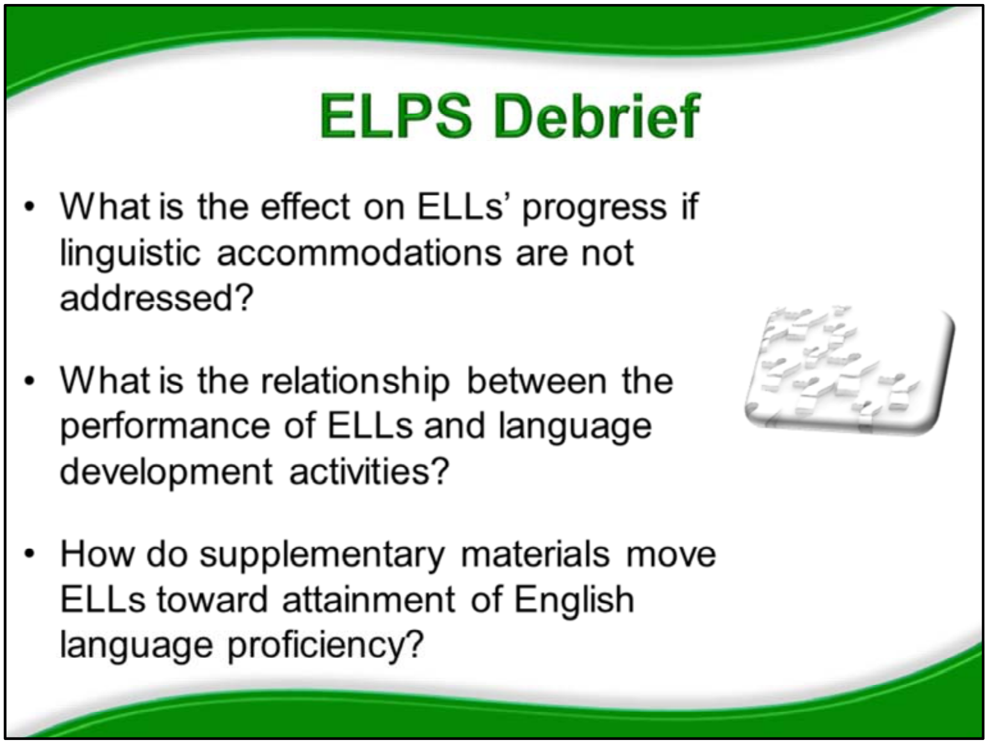
Now that you have considered the proficiency levels of ELL students, let's see what that means in regard to the language objective in the lesson you were just analyzing. Review the language objective, select an instructional strategy in one of the lesson sections, and design/create an accommodation to support an ELL student.

Click.

What type of supports would an ELL student need in order to master the language objective in the lesson?
Allow participants time to share their ideas with the whole group.

Click.

Which other students also would be supported by the suggested accommodations made in the lesson?
Strategies used for language acquisition can be effective for all students.



What is the effect on ELLs' progress if linguistic accommodations are not addressed?

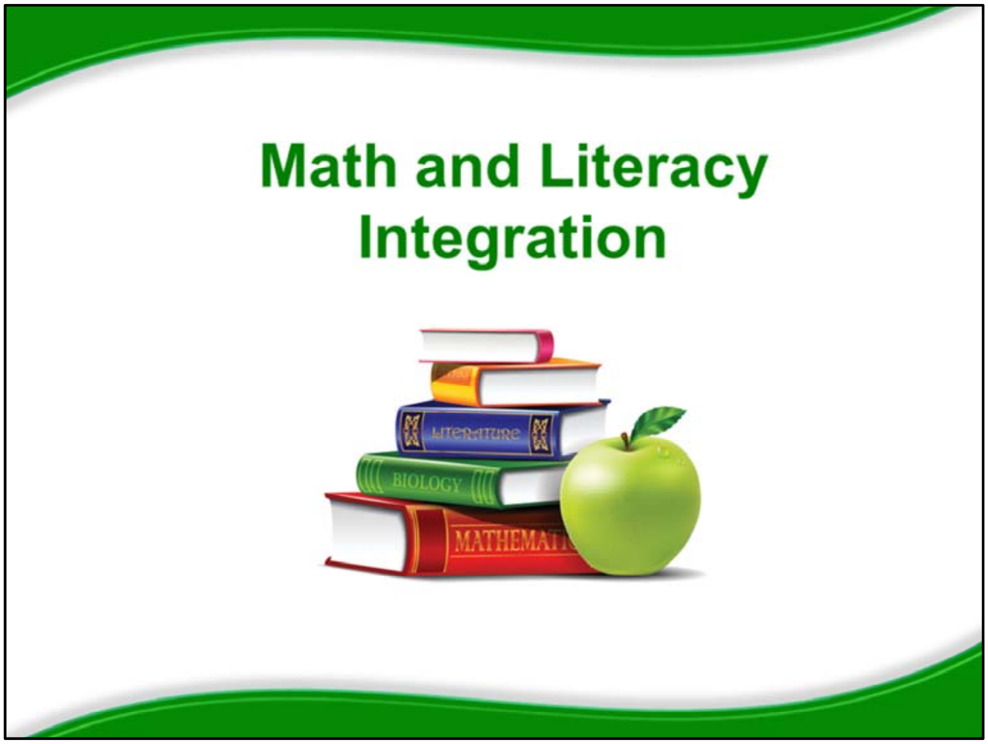
Progress is not made or is inconsistent without linguistic accommodations in language development.

What is the relationship between the performance of ELLs and language development activities?

Language development activities should be focused and scaffolded. Student performance should improve over time.

How do supplementary materials move ELLs toward attainment of English language proficiency?

Supplementary materials help differentiate and support the learning experience.



We can support math and reading through science. It is important to collaborate and communicate with teachers from other content areas to best help students transfer knowledge from one subject to another. You will see math and literacy strategies throughout the lessons that will add to your repertoire and knowledge base.

Each lesson is accompanied by an expository text that is written in a magazine-style format that incorporates its own literacy strategy. The literacy strategies can be applied to other grade levels and content areas.

Math content and strategies are embedded into the science concepts. Extensive collaboration between math and science specialists occurred to make the math content seamless. The goal is for science teachers to use the same strategies and terminology as a math teacher. This helps students speak a common language in both classes and transfer their knowledge and skills to new situations.

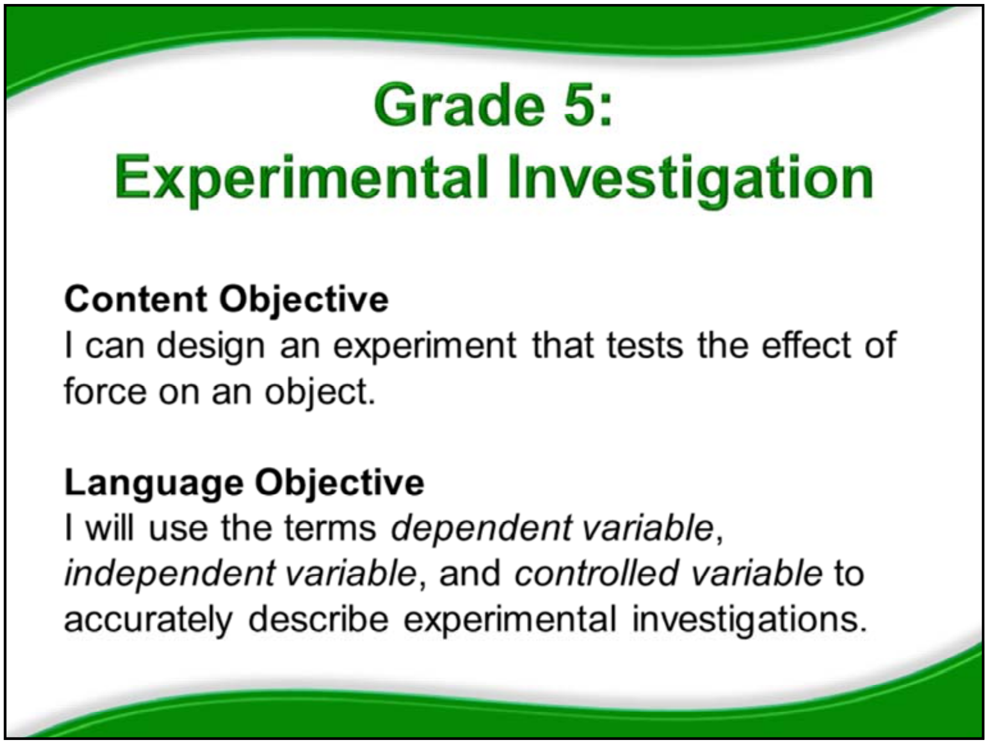
Dismiss participants for lunch.

Remind participants of the importance of starting the afternoon session on time.

The materials can be found in the margins of the guide for each lesson. The materials are separated by E in the 5E lessons. When looking at quantity, please note whether the materials are needed for the teacher only, for each student, or for student groups. Most of the materials can be purchased at multipurpose or hobby stores. Some items may need to be ordered from science suppliers or vendors if you do not have them on your campuses or in your districts. I can supply you with an order form and a master materials list should you need either or both.

Over the next couple of days, pay attention to how materials are bagged, labeled, distributed, and collected. Effective management of materials is key to safety and success in science.

Please ask questions about where to find materials or how to manage them as we work through the workshop.



Grade 5: Experimental Investigation

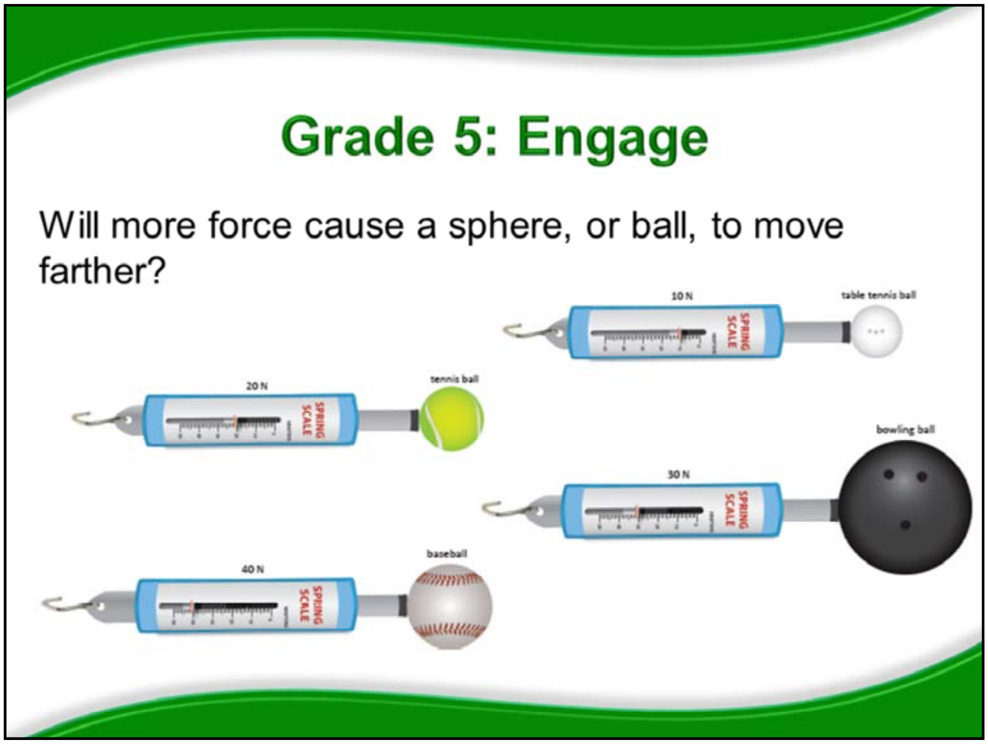
We are beginning with the grade 5 lesson.

Please take a moment to read the content and language objectives for this lesson.

The grade 5 lesson follows the 5E model and includes math and literacy strategies, Tier I support, and differentiation.

This lesson should take approximately 90 minutes to complete in this training. The time allotment is as follows:

Engage	*5 minutes*
Explore	*25 minutes*
Explain	*20 minutes*
Elaborate	*30 minutes*
Evaluate	*10 minutes*



This lesson uses the 5E model. The first *E* is Engage.

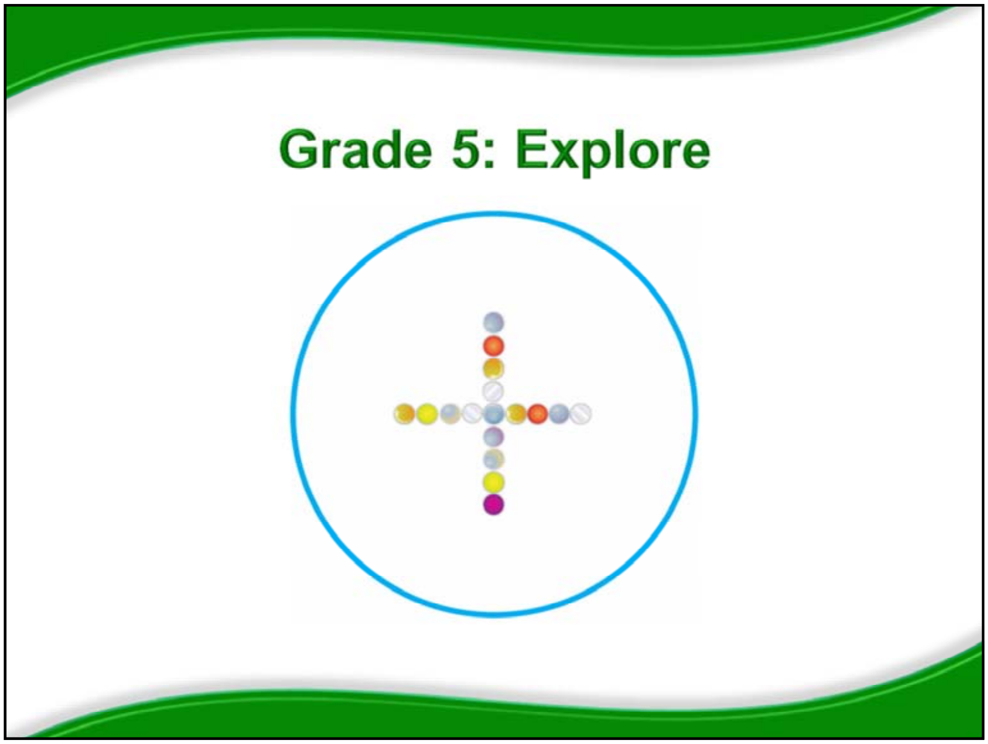
Ask participants to find a partner sitting near them.

Turn to *RM 1* in the grade 5 lesson on page _____. Discuss with your partner what the question is asking.

Allow participants 1 minute to discuss. Use the craft sticks and die to randomly call on a few participants to share their thoughts. Participants should respond that the question is asking whether increased force moves an object a greater distance.

What is being tested?
A pushing force is being tested.

Is the experiment properly set up to answer the question? Why or why not?
The experiment has too many variables. To properly answer the question and to test force, students should only use one kind of sphere, or ball. They would need to launch the ball with each of the four different spring scales to see if the scale with the strongest force moved the ball the greatest distance. More than one trial should be conducted with each spring scale to collect reliable data and observations.



The second *E* is Explore.

Ask participants to turn to page _____ in the guide. Bring their attention to the Content Builder and allow them a few minutes to read it.

What is the goal of a Content Builder?
The goal of a Content Builder is to build a teacher's content knowledge. The information in a Content Builder is not necessarily meant to be used with students. If a student asks a question that is difficult to answer, teachers can refer to the information in the Content Builder to answer the student's question.

What is this Content Builder about?
This Content Builder is about independent (manipulated), dependent (responding), and controlled (constant) variables. These terms are introduced in fifth grade.

Ask participants to form groups of three and to send one group member to retrieve materials for the Explore activity. If participants are using circles made from string, prepare those ahead of time.

Turn to RM 2 on pages _____ and read the directions for the marbles game. Take 3–5 minutes to set up the game and practice launching the marbles. You will have 15 minutes to play the game. Get started!

Following game play, debrief the activity using the facilitation questions.

What was the goal of the game? *The goal of the game was to move the marbles out of the circle.*

What did you do to move the marbles out of the circle? *We moved around the perimeter of the circle to get the best angle and then used the force of the large marble to knock the smaller marbles out of the circle.*

Were forces involved with playing this game? If so, which forces and how? *Yes, force was involved with this game. The pushing force of the large marble moved the smaller marbles.*

How could the game be played differently? *We could have started with more or fewer marbles in the circle. We could have placed the marbles in a different pattern or just scattered them in the circle. We could have increased or decreased the size of the circle. We could have rolled the large marble. We could have used marbles of different sizes.*

Turn to page ____ and locate the Differentiation Strategy section. This section offers ways to differentiate within the same activity for the different cognitive and ability levels of students in your classroom.

If we think about the marbles game as an experiment, what questions could we be trying to answer? What might we be trying to find out? *Answers will vary but may include what is the best way to get the marbles out of the circle, does staying in one position on the circle's perimeter make it more difficult to remove the marbles from the circle, and does rolling the large marble or launching it work better.*

What things stayed the same in the experiment? *The things that stayed the same in the experiment were the size of the circle, the number of marbles that started in the circle, and the size of the marbles.*

What things changed in the experiment? *The things that changed in the experiment were our positions as we moved around the perimeter of the circle, how much force we used to launch the large marble, and the distance between the marbles as the marbles moved throughout the game.*

How would you explain how to conduct the experiment to someone else? *Groups should list the steps of how they would do the experiment; they may deviate from the way they played the game.*

What materials would you need to conduct the experiment? *Students should list a certain amount of marbles, marbles of two sizes, something to create a circle, a meter stick, and possibly tape.*

What observations and measurements could you make? *We could observe the direction the marbles roll and measure the distance they travel.*

How would you record your observations and measurements? *Observations and measurements can be recorded in written paragraph form and in a table.*

What would you use to draw a conclusion? *We could write a conclusion based on our observations and measurements.*

The third *E* is Explain.

Turn to RM 3 on pages _____. Look through the reading passage noting the title, any subtitles, and all graphics.

Ask a volunteer to read aloud pages 1–4 to the whole group. Allow time to read.

Instruct participants to fill in the graphic organizers on RM 4 (pages ___________) as they finish reading RM 3 pages 5–8 in pairs. Allow participants 10 minutes to complete this task.

What is an experimental investigation?
An experimental investigation involves a fair test with one independent variable.

What are the parts of an experimental investigation?
An experimental investigation includes asking a question; making a hypothesis; identifying variables; writing directions or a procedure detailing how to do an experiment; listing materials necessary to conducting the experiment; observing, recording, and measuring data; and interpreting data to come to a conclusion.

How might scientists think of questions to ask?
Scientists observe the world around them and are sometimes curious about how events happen. They design experiments that model a problem or an event in an effort to figure out how or why they occur.

What are the different kinds of variables in an experiment? *The different kinds of variables in an experiment include controlled, independent, and dependent variables.*

What is a controlled variable? *A controlled variable identifies those factors that stay the same and do not change in an experiment.*

What is an independent variable? *An independent variable is changed by the scientist in order to study the relationship between it and the dependent variable. For example, different types of magnets may have stronger or weaker magnetic fields. One magnet may attract a paper clip from a greater distance than another. In this case, the various magnets would be the independent variable. Independent variables are also called manipulated variables.*

What is a dependent variable? *A dependent variable depends on the independent variable. In the above example, the distance from which a paper clip is attracted to different magnets is the dependent variable. The distance depends on the strength of the magnet. A dependent variable is also called a responding variable.*

In what ways can scientists observe and collect data?
Scientists can make observations and collect data by writing, drawing pictures, measuring, and creating data tables and graphs.

How can scientists help ensure the data they collect are reliable?
Conducting multiple trials helps ensure the collection of reliable data. In the event that one trial has different data than another, it could be ruled out if enough data exist to refute it.

What do scientists do with their observations and data?
Scientists interpret their data in order to support or deny their hypotheses.

How will the note-taking guides help students?
The note-taking guides help students chunk the reading and extract the important parts. This makes the reading less overwhelming and allows students time to process what they are reading.

The fourth *E* is Elaborate.

Note the Advanced Preparation section on page _____. Make sure you have plenty of materials on hand for participants to use as they design their experiments. Copy RMs 6 and 7 two-sided such that a scenario is on one side of the card and the corresponding materials list is on the opposite side. It may be necessary to print two sets of cards to accommodate a group size of 30.

Instruct participants to form groups of three while you distribute RM 5 to each participant. Distribute a scenario/materials card to each group.

Locate and read the Differentiation Strategy on page _____.

Allow participants time to read.

I've given you a card with a scenario on one side and a materials list on the other. You may choose whether you focus on the scenario, the materials list, or both to design an experiment that involves force. With students, you may have cards with just materials lists or scenarios printed on them. Some groups will be able to design an experiment involving force only using a materials list. Other groups may need a scenario to design an experiment while some groups may need both a materials list and a scenario.

Use the checklist on RM 5 as you design an experiment. You will have 20–25 minutes to complete the task.

Debrief the activity using the facilitation questions.

How did your group think of an experiment to design? *Answers will vary.*

How did force affect your experiment? *Answers will vary.*

What were the independent, dependent, and controlled variables in your experiment? *Answers will vary.*

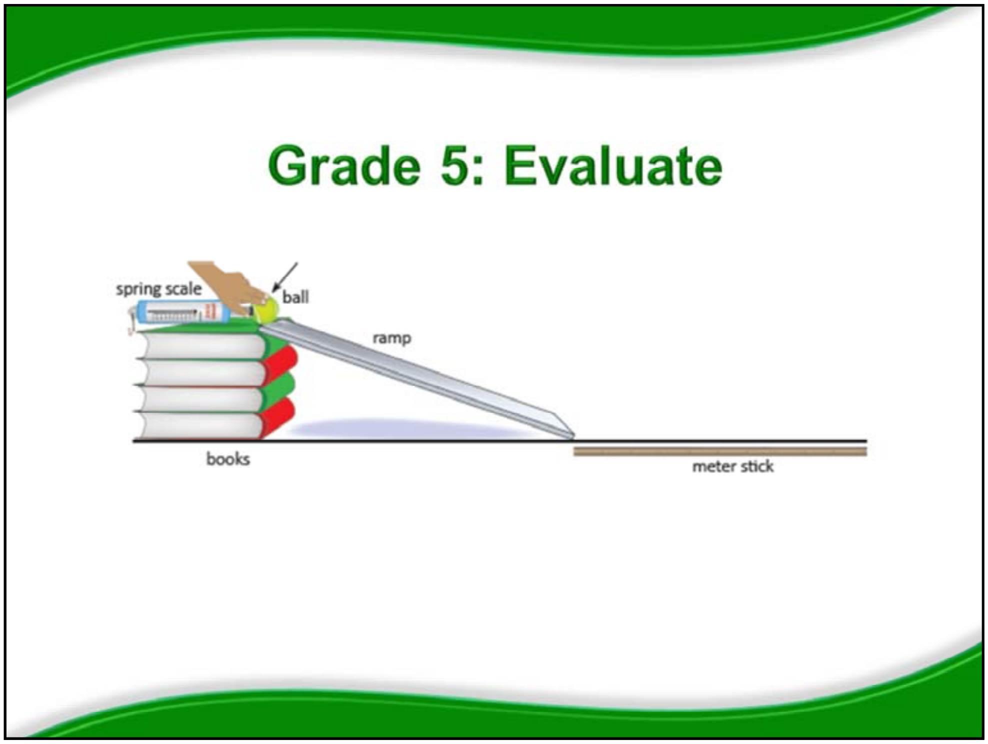
What was the relationship between the variables in your experiment? *Answers will vary.*

Did your results support your hypothesis? *Answers will vary.*

What parts of your experiment were designed well? *Answers will vary.*

Were there parts of your experiment that you would change or redesign? If so, what parts and why? *Answers will vary.*

Turn to pages _____ in the guide. Possible experiment procedures are provided in the event you need them.



The fifth *E* is Evaluate.

Take a moment to read the assessment on RM 8.

What did the students do correctly?

- *The students included all the parts of an experimental investigation (question, hypothesis, materials, procedure, data, results, and conclusion) in their design.*
- *The students performed multiple trials to collect more reliable data.*
- *The controlled variables stayed the same, including the tennis ball, ramp, meter stick, and books.*
- *The students recorded their measurements in tables using centimeters as their only unit of measurement.*

What could the students have done better?

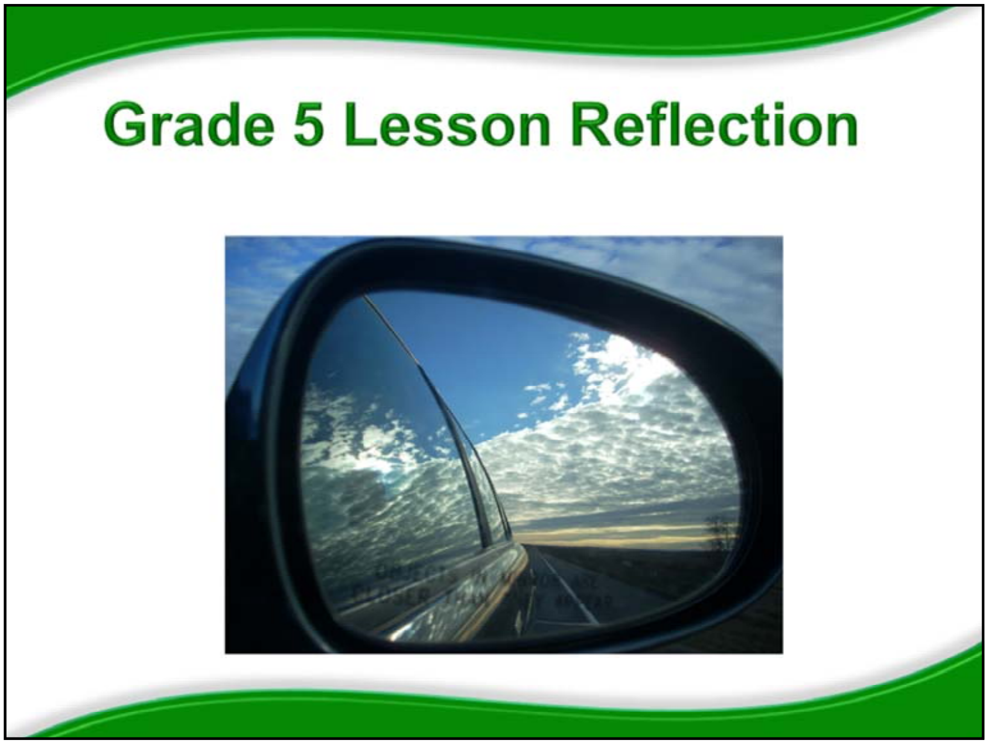
- *The students should have limited their independent variables to one. They should have chosen to test how far the ball would roll either by releasing or by launching on one type of flooring.*
- *Students performed Part A using two books under the ramp and Part B using four books under the ramp. They should have used either two or four books for both parts.*

Based on the experiment, is the students' hypothesis supported by their data?

- *On a superficial level, it appears the data support the students' hypothesis. Under close inspection, the data do NOT support the hypothesis because the students conducted Part A using two books under the ramp and Part B using four books under the ramp.*

Did the students design the experiment to find an accurate answer to their question? Why or why not?

- *To find an accurate answer to their question, the students would need to redo Parts A and B using the same number of books under the ramp.*
- *Students could also simplify their experiment by having one independent, or manipulated, variable: type of flooring or releasing, instead of launching the ball.*



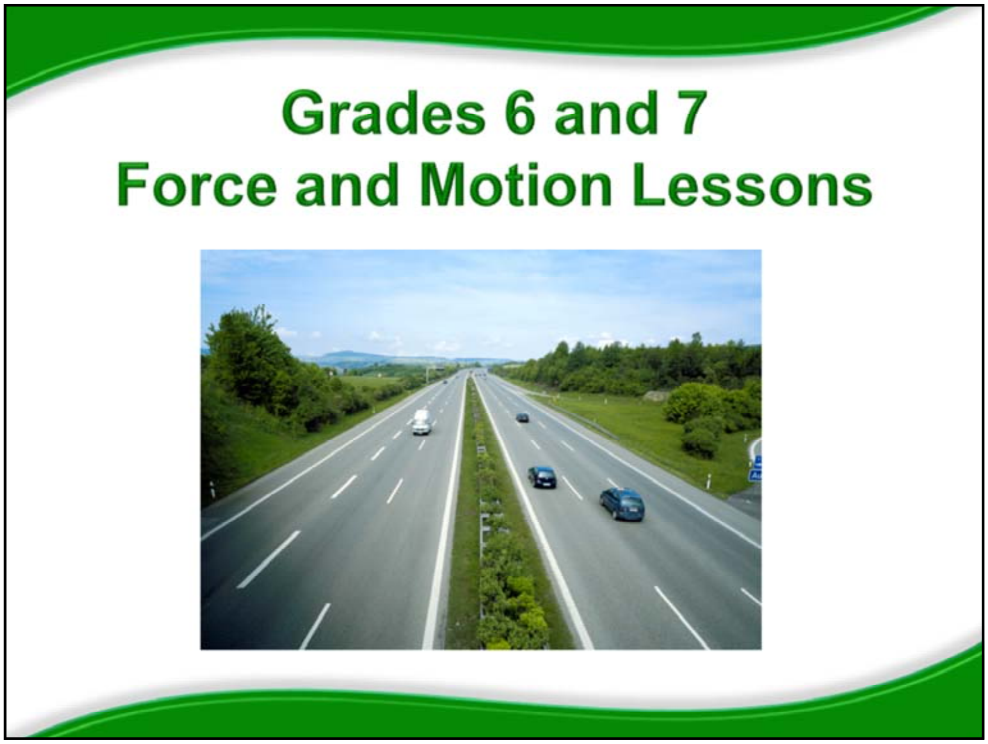
Take a moment to reflect on the grade 5 lesson. Consider how literacy and math strategies were embedded into this lesson.

Locate page _____ in the Instructional Resources section and record how those things were embedded.

Allow 5 minutes for participants to record their responses.

How does this lesson build on grade 4 and also support higher grade levels?
TEKS 4(6)(D) introduces students to designing an experiment on a basic level. Students learn the parts of an experiment and fill in the blanks on a prewritten report in the grade 4 lesson of the Science Academies for Grades K–4, Part 1. This grade 5 lesson takes an inquiry-based approach, where students design their own experiment that models an event. Inquiry and observation are vital parts of high-level science.

Please refer back to the K–8 Science TEKS pages _____ in the Vertical Alignment section, and circle the TEKS this lesson addressed.

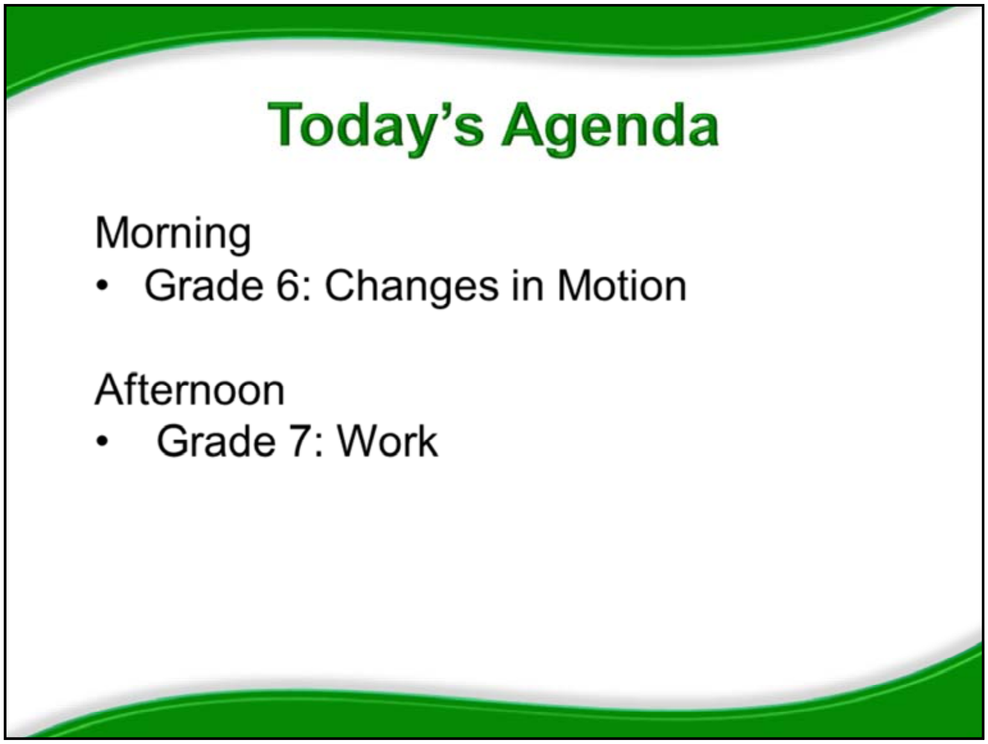


Tomorrow we will begin with the grade 6 lesson and conclude the day with the grade 7 lesson.

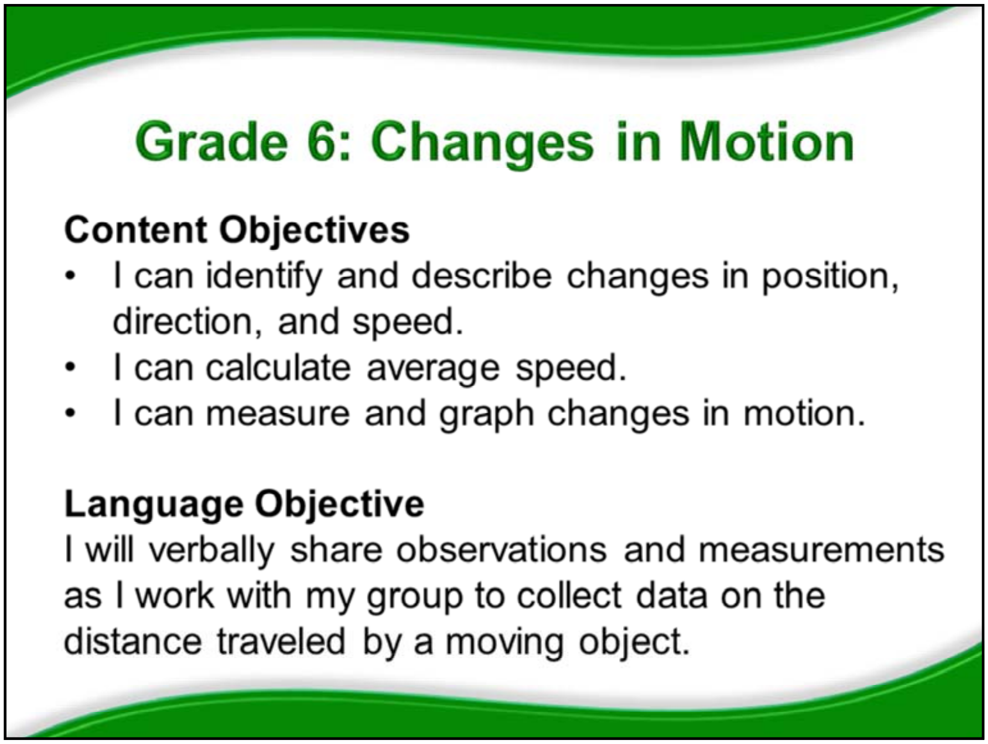
Please leave your tables neat and organized for tomorrow. Have a great afternoon! See you in the morning.

Welcome back to the Science Academies for Grades 5–8, Part 2!

Please greet the members at your table and introduce yourself to any new group members.



We will begin with the grade 6 lesson and work our way through the grade 7 lesson. As you're working, note how ELPS, RtI, CCRS, and math and literacy strategies are embedded.



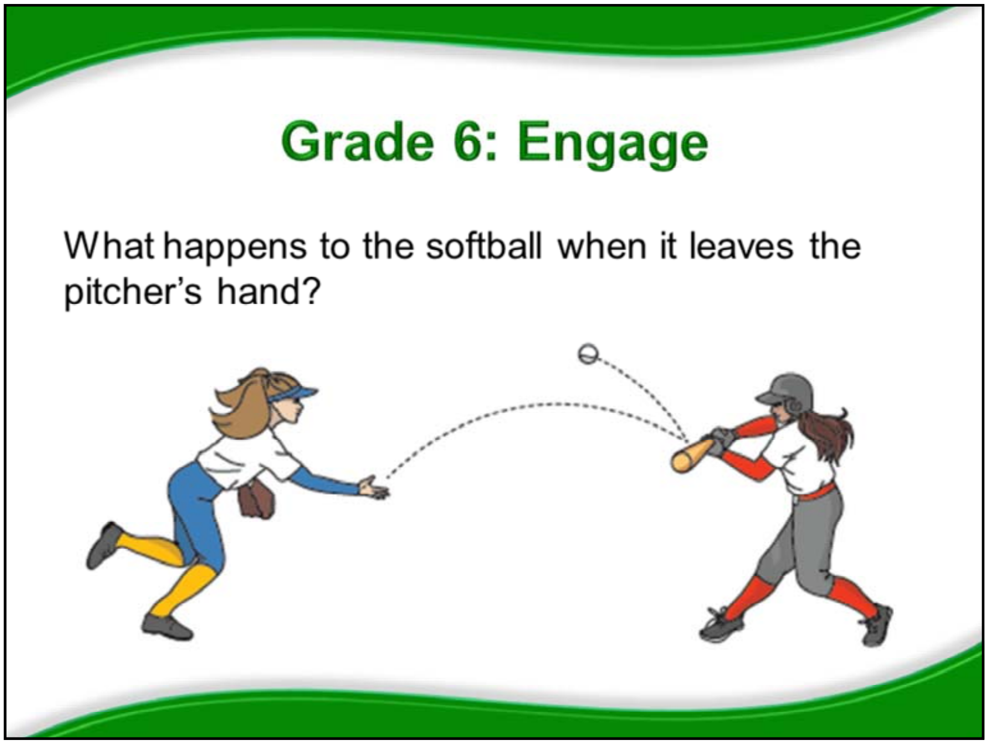
Grade 6: Changes in Motion

Please take a moment to read the content and language objectives for this lesson.

The grade 6 lesson follows the 5E model and includes math and literacy strategies, Tier I support, and differentiation.

This lesson should take approximately 165 minutes to complete in this training. The time allotment is as follows:

Engage	*5 minutes*
Explore	*60 minutes*
Explain	*60 minutes*
Elaborate	*30 minutes*
Evaluate	*10 minutes*



The first *E* is Engage.

Instruct participants to silently read and consider an answer to the question on the screen. After 1 minute, ask participants to share their answers with a partner. After 2 minutes, ask a few participant pairs to share their answers with the whole class.

What happens when to the softball after it leaves the pitcher's hand?

The softball moves forward and then gets hit by the batter.

What changes when the softball is hit by the batter?

The softball's direction, position, and speed change when it is hit by the batter.

Why do the softball's direction, position, and speed change?

The force of the bat changes the softball's direction, position, and speed.

The second *E* is Explore. For this lesson, there will be four parts in Explore. Part One of the Explore focuses on observing and collecting distance and time measurements.

Instruct participants to form groups of three.

Turn to pages 1 and 2 of RM 2. Read the directions on how to conduct the investigation. Decide which group members will serve as the Timer, Position Marker, and Recorder. Turn to page 3 of RM 2. You will receive a copy of this page on which you can record your measurements. Send one group member to pick up materials. You may get started after retrieving materials.

Provide to each participant a copy of page 3 of RM 2 on which to record measurements. Allow groups 20 minutes to complete the investigation.

What did you observe in the investigation?

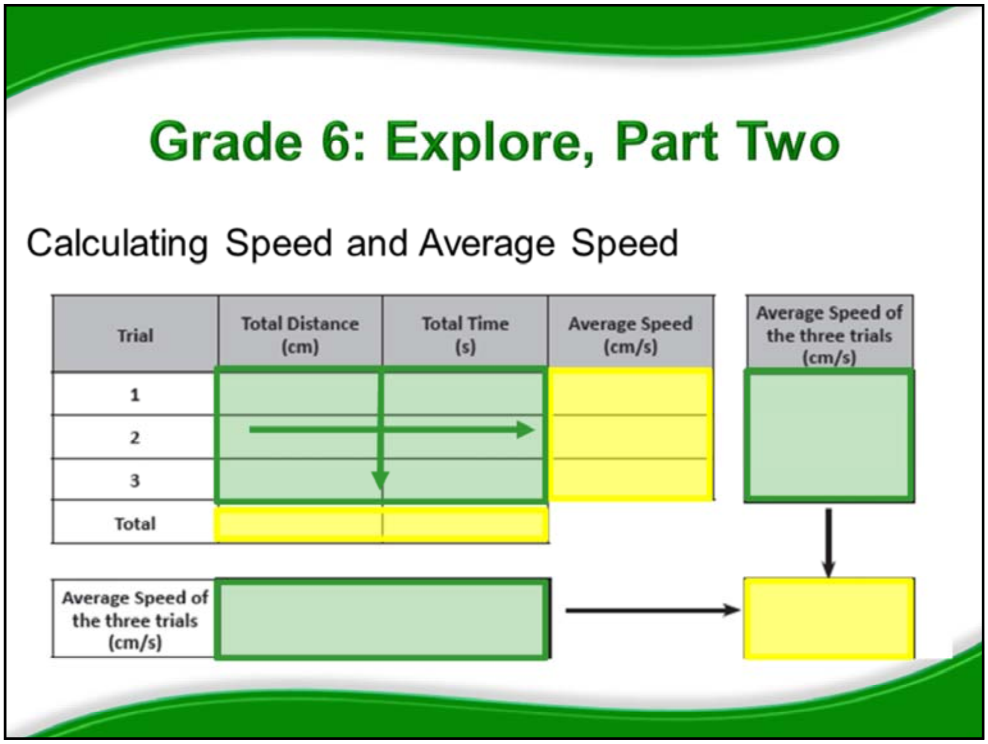
Participants may have observed the toy traveling in a straight line, slowing down, and eventually stopping. The toy may have traveled a shorter distance between each subsequent time interval.

What units of measurement did you use?

We used centimeters for distance and seconds for time.

Why did you repeat the investigation?

We repeated the investigation to collect reliable data. The more trials are conducted, the more likely the data is reliable.



Part Two of the Explore focuses on calculating average speed.

Distribute a copy of page 4 of RM 2 to each participant.

Record the total distance and time measurements from each trial in the table.

Allow participants time to complete the task. Click.

Calculate and record the average speed for each of your trials by dividing the distance by time. Round to the nearest tenth. Students have the option to use a calculator to do these calculations but should be able to do the math without a calculator.

Allow participants time to complete the task. Click.

Calculate and record the average speed of the three trials by adding the three speeds from Trials 1–3 and dividing them by 3. Round the average speed to the nearest tenth.

Click.

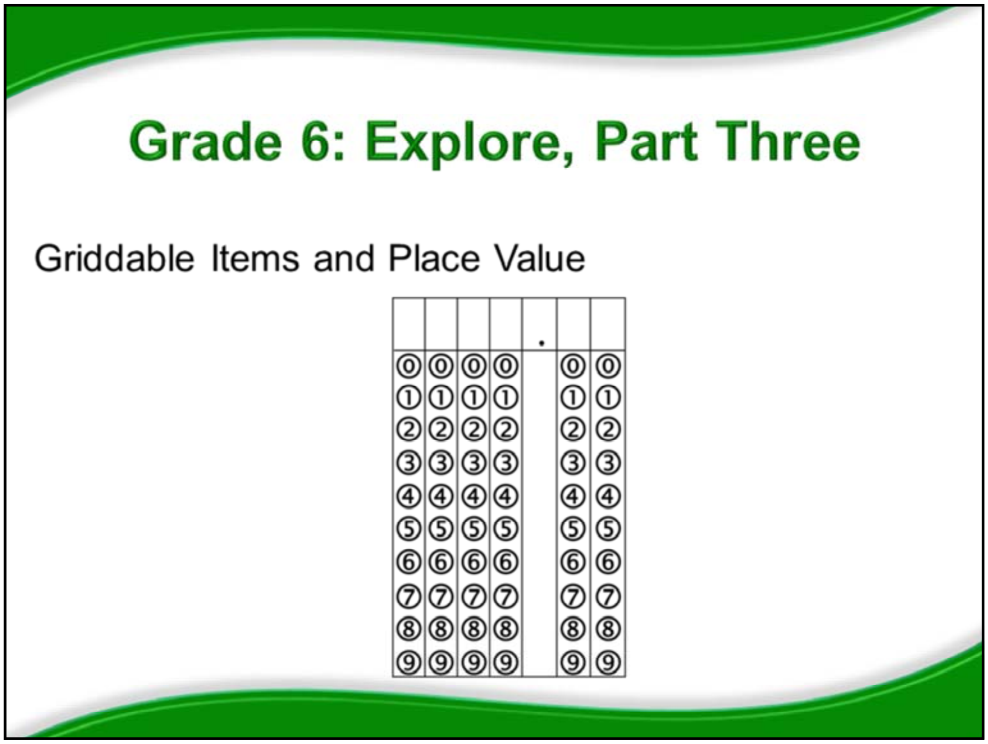
Add the time measurements from the three trials and record the total time in the table. Then, add the distance measurements from the three trials and record the total distance in the table.

Click.

Calculate and record the average speed by dividing the total distance by the total time. Round the average speed to the nearest tenth.

Click.

The average speeds for both methods of calculation should match. If they do, transfer the overall average speed to the box in the lower right corner of the table. If the average speed calculations do not match, check your mathematical processes and note whether rounding could be the cause.



Part Three of the Explore focuses on entering answers into griddable items.

Turn to page 5 of RM 2. Our students struggle with how to correctly enter numbers into griddable items. This part of the Explore is designed to help emphasize decimal placement and place value. Students will use the speeds from Trials 1–3 and the average speed calculated on page 4 to enter into the griddable items.

Is it always necessary to have a number in the tenths place?

No, it is not necessary to have numbers in the tenths place if the answer results in a whole number. Students have the option to fill in a zero in the tenths place.

If there is not a number in the tenths place, what do you do?

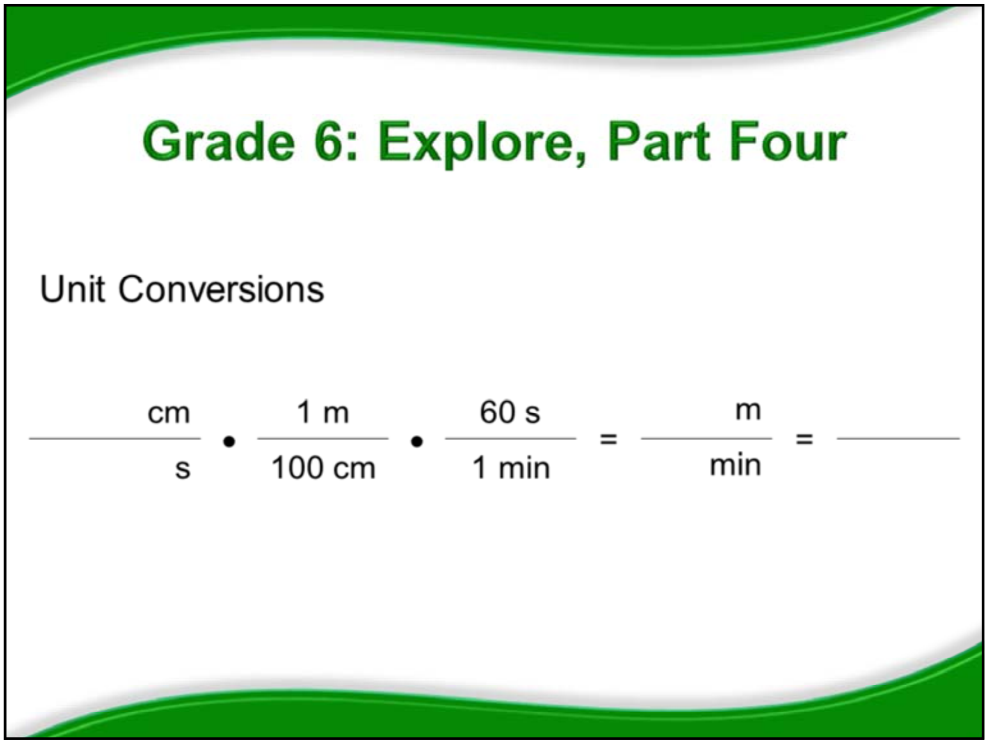
If there is not a number in the tenths place, leave the box blank (or empty) or write a zero in the box and fill in the appropriate bubble.

What is a whole number?

A whole number is a number without fractional parts and does not have numbers after the decimal.

How do you write a whole number in the griddable item?

A whole number belongs on the immediate left of the decimal.



Part Four of the Explore focuses on converting speed from one unit of measurement to another.

Distribute a copy of pages 6 and 7 to each participant. Work through the top of page 6 with the group emphasizing the importance of multiplying by a ratio of 1 to convert units of measurement. Students have the option to use a calculator to do the conversions but should be able to do the math without a calculator.

Allow participants 15 minutes to work through problems a–d.

What does it mean to convert units of measurement?

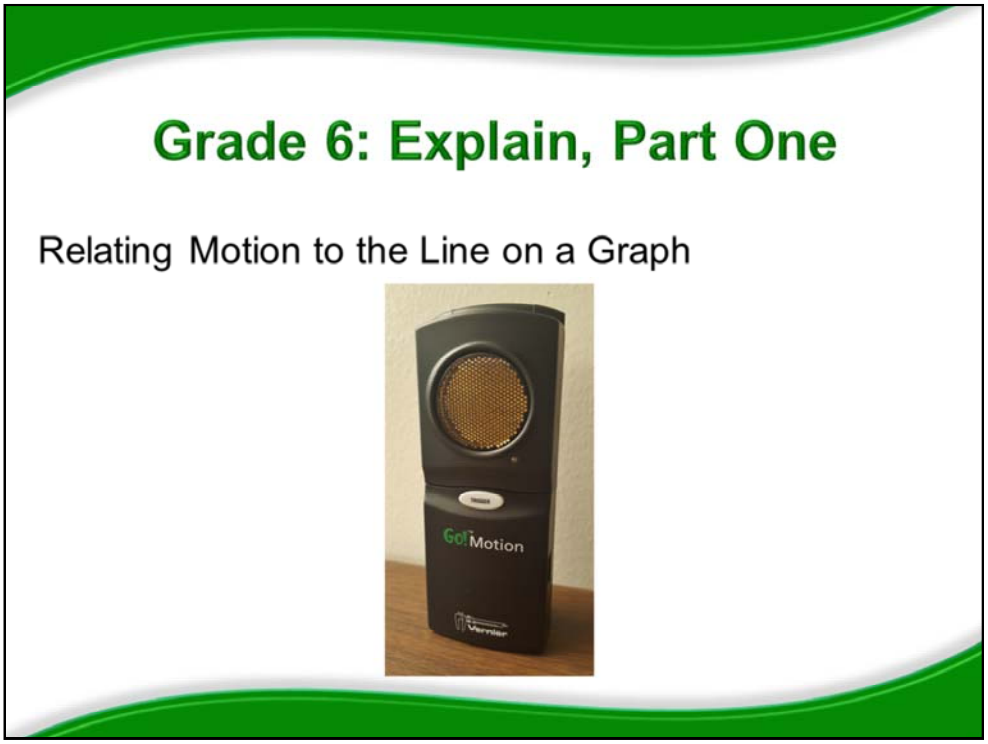
Converting units of measurement means to change from one unit of measurement to another.

How do we convert units of measurement?

We can convert units of measurement by multiplying by a ratio of 1.

What was different or changed about the process of converting units of measurement in problems a–d?

We multiplied by a ratio of 1 once for problems a and b, twice in c, and three times in d.



The third *E* is Explain. For this lesson, there will be three parts in Explain. Part One of the Explain focuses on the relationship of actual motion to a line representing motion on a line graph.

Turn to pages _____ and read the Teacher Note and Advance Preparation sections.

Allow participants time to complete the task.

Form groups of five. One group will work with a motion sensor and a laptop and the remaining groups will each work with a motion sensor and a graphing calculator. Turn to RM 3 on pages _____. The first page of RM 3 contains directions for the laptop and a motion sensor. The last four pages contain directions for a motion sensor and a graphing calculator. If you cannot find a blank wall, you can use a sheet of foam board as a substitute. Take turns matching the graph. You will have 25 minutes to complete the task.

Allow participants time to complete the task.

What is the relationship modeled by the line in the graphs you attempted to match?

The graphs showed the relationship between distance and time.

Were you able to match the line on the graph?

Answers will vary and may include that participants had to change their position by moving closer to and farther from the wall to match the line on the graph.

How did you make the line decrease and increase?

We moved closer to the wall to make the line decrease and farther from the wall to make the line increase.

What happened when you moved faster or slower?

The line became steeper when we moved faster and become flatter when we moved slower.

What did you do to create a horizontal line on the graph?

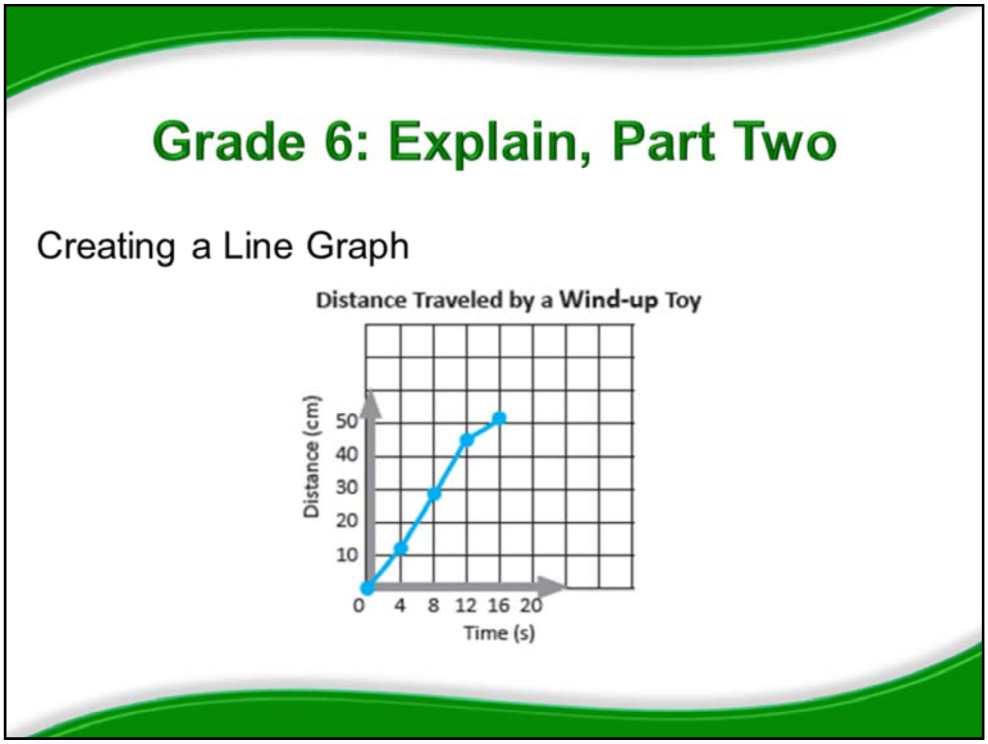
To create a horizontal line on the graph, I remained in one place or did not move.

What changed over time as you moved?

My position, direction, and speed changed over time as I moved.

What do line graphs mean?

Answers will vary, but should include that the lines represent changes in distance over time and are not just data points from a table.



Part Two of the Explain focuses on teaching students how to create a distance-time graph.

Use RM 4 to work through how to make a line graph with participants. Then, instruct participants to graph their data from Explore. Allow participants 10 minutes to complete the task. Debrief using the facilitation questions.

What is the name of the (0,0) point on a graph?

The (0,0) point on a graph is called the origin.

Which variable belongs on the *x*-axis?

The independent, or manipulated, variable belongs on the x*-axis.*

Which variable belongs on the *y*-axis?

The dependent, or responding, variable belongs on the y*-axis.*

What must you always remember to include as part of your axis labels?

We must always include our units of measurement on our axis labels.

How do you determine the scale on each axis?

To determine the scale on each axis, we could divide the highest number in each data column by the number of available squares on the graph paper. Then we would need to decide if it was best to count by 1, 2, 3, or something else.

How do you figure out where to plot the data points?

To plot the data points, we have to count across the x-*axis and then up the* y-*axis.*

What does the line tell you about motion?

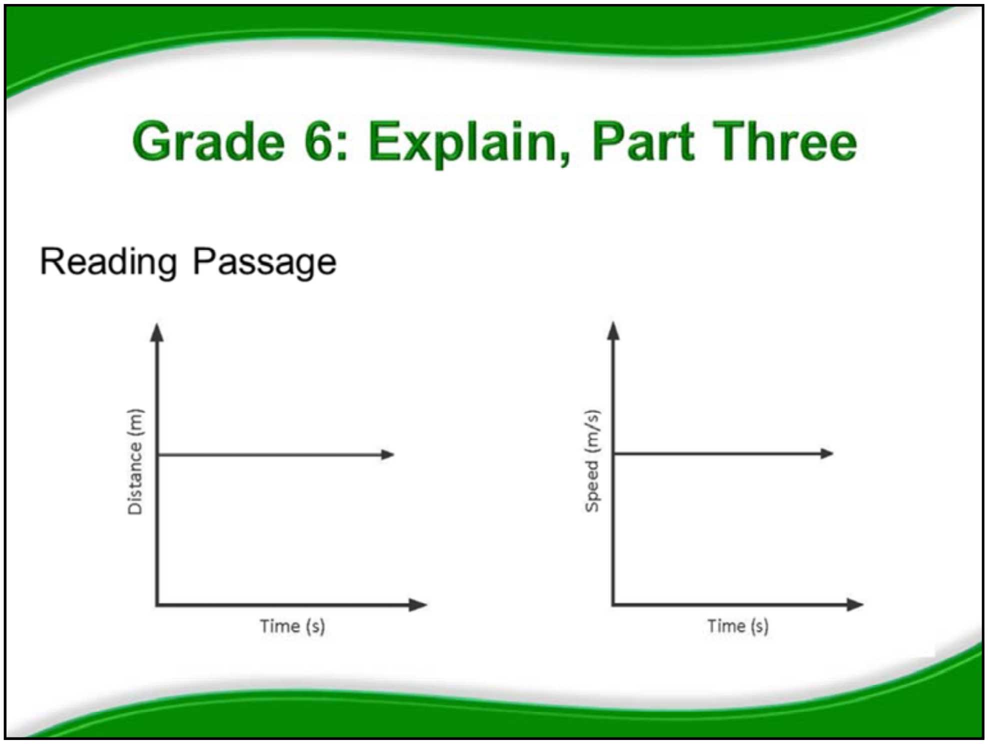
A steeper line means an object is moving faster and a flatter line means an object is moving slower.

What is the overall pattern of movement shown by the line on your graph? How do you know?

Initially, the wind-up toy was moving quickly; then it slowed down and eventually stopped. The line on the graph started steeper, began to flatten, and then became horizontal, or flat.

What changed over time as the wind-up toy moved?

The wind-up toy's position and speed changed. Its direction may have changed if it did not move in a straight path.



Part Three of the Explain focuses on interpreting distance-time and speed-time graphs.

Instruct participants to turn to RM 5: Speed Reading and RM 6: What Do You Know? on pages _____. Project the RM to facilitate whole-class reading and discussion. Ask for volunteers to read aloud RM 5. Discuss and check for understanding as you read.

After reading RM 5, participants can work together to complete RM 6.

What kind of visuals were in the reading passage?

The reading passage visuals included pictures, graphs, and ratios that multiply by one.

Do you feel like you understand how to interpret graphs more effectively?

Answers will vary but should include that they understand that the line on a graph represents changes in distance or speed over time as opposed to plotted data points.

What kind of information can you extract from a graph?

From reading a graph, we can see how far and how fast an object is traveling. We can make assumptions about why an object's motion is changing based on our prior knowledge. We can use the information on a graph to calculate speed in intervals as well as average speed.

Advance Preparation

For a group of 30 participants, print the following:

- *4 copies of Set A problems (RM 7 pages 1 and 2) on pink cardstock*
- *4 copies of Set B problems (RM 7 page 3) on yellow cardstock*
- *4 copies of Set C problems (RM 7 pages 4, 5, and 6) on green cardstock*

Cut the problems apart and group them as follows:

- *A1, B2, C3*
- *A2, B3, C1*
- *A3, B1, C2*

- *A1, B3, C2*
- *A2, B1, C3*
- *A3, B2, C1*

Locate nine areas around the classroom to display the different problems. After students finish working through the problems, they will post them in the designated areas. The *class will do a gallery walk to see how different groups solved the same problems.*

The fourth *E* is Elaborate. Turn to page _____ and read the Teacher Note and Differentiation Strategy.

Allow participants time to complete the task.

What's the difference between Sets A–C?

Set A problems ask students to calculate speed and then convert it to other units of measurement. Set B problems ask students to interpret the motion represented by the line on a speed-time graph. Set C problems ask students to calculate speed and average speed and enter their answers in the provided griddable items.

What's the difference between levels 1–3?

Level 1 contains the simplest problems. Level 2 increases in difficulty, with Level 3 being the most difficult.

Instruct participants to form groups of 3.

For the purposes of this training, each group will receive a three problems, one problem each from sets A–C and from levels 1–3. This will help you see the variation in content and ability levels. In a classroom setting, you may choose to give groups problems from sets A–C but all level 1 if that is the group's ability or knowledge level. The number of problems you give each group in a classroom will also vary.

Distribute a set of problems to each group. Inform participants that they are to post their completed work in the nine designated areas. Allow groups 15 minutes to work through and to post their problems.

We are going to do a gallery walk. You will compare how groups worked the problems. Begin as a group at one of the problems you worked so you have some familiarity with it. Get started.

Allow groups 10–15 minutes to do the gallery walk.

Did all the groups solve the problems the same way?

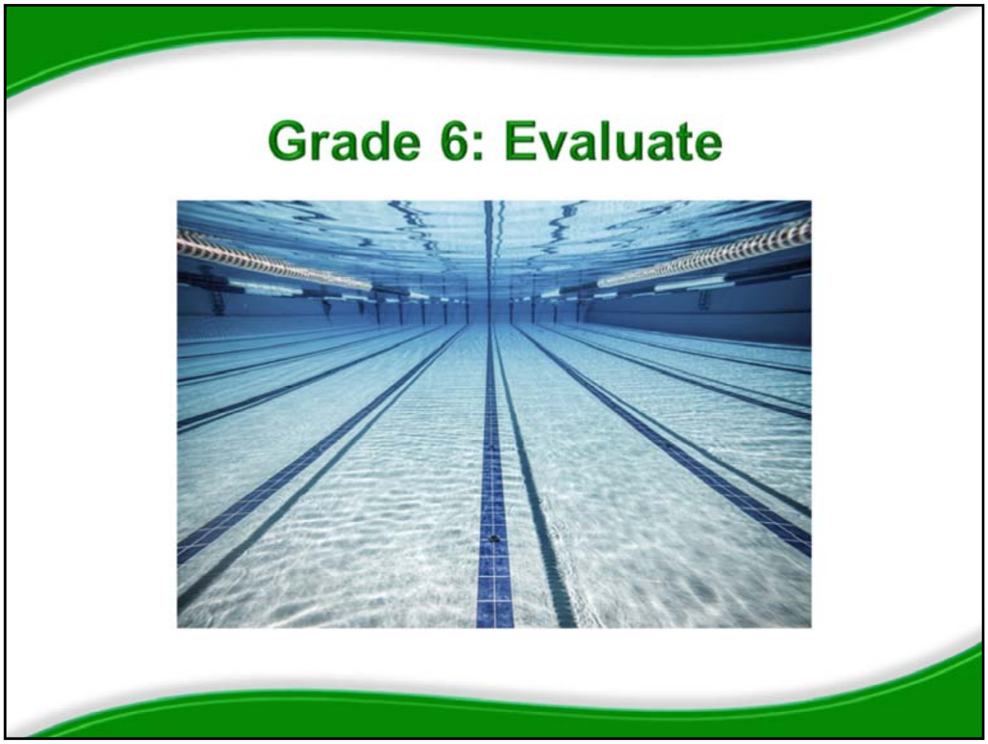
Answers will vary and may include that some groups solved the problems the same way while others did not.

What are the two ways to calculate average speed?

Average speed can be calculated by determining the average of the speeds from individual trials or by dividing the total distance by the total time from more than one trial.

What is the difference between a horizontal line on a distance-time graph and a horizontal line on a speed-time graph?

A horizontal line on a distance-time graph indicates no movement. A horizontal line on a speed-time graph indicates a constant speed that is neither increasing nor decreasing.



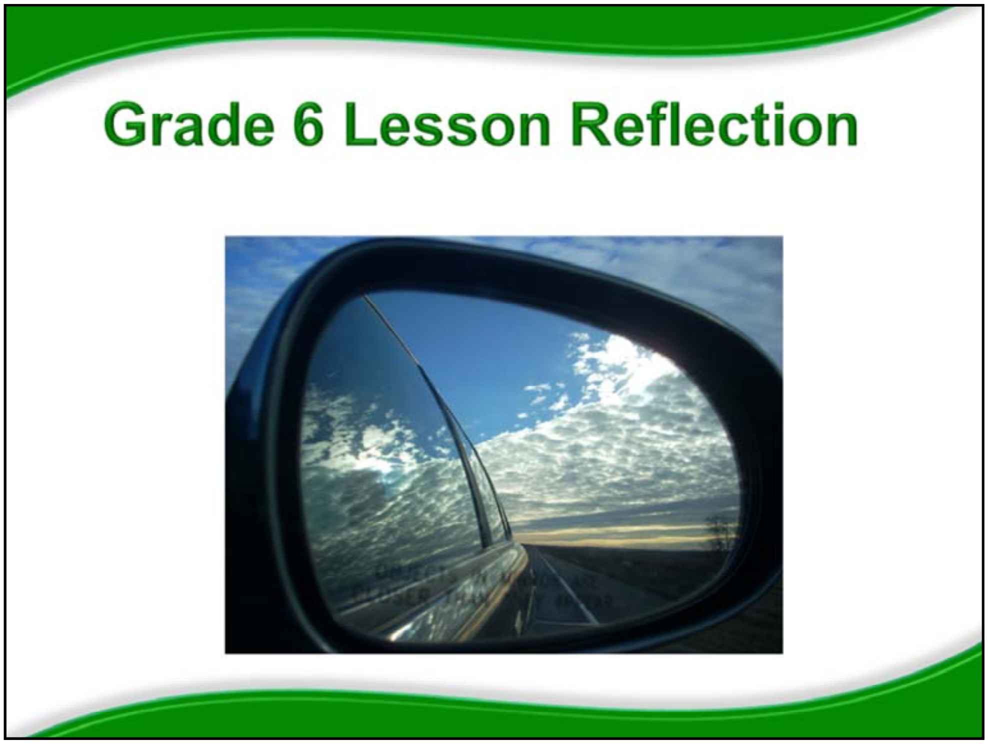
This lesson uses the 5E Model. The fifth *E* is Evaluate.

Take a moment to read the assessment on RM 8.

Look at the first question. The data is represented differently than in Elaborate. Why?
Seeing data displayed differently helps students apply what they know regardless of the situation or representation.

Look at the second question. Why is it included on the assessment?
This question tests students to see if they have mastered place value when entering their answers on griddable items.

Look at the third question. What must students understand to correctly answer this question?
Students must understand how motion is represented by a line graph. Horizontal lines represent a constant speed, decreasing lines represent decreasing speed, and increasing lines represent increasing speed.



Take a moment to reflect on the grade 6 lesson. Consider how literacy and math strategies were embedded into this lesson.

Locate page _____ in the Instructional Resources section and record how those things were embedded.

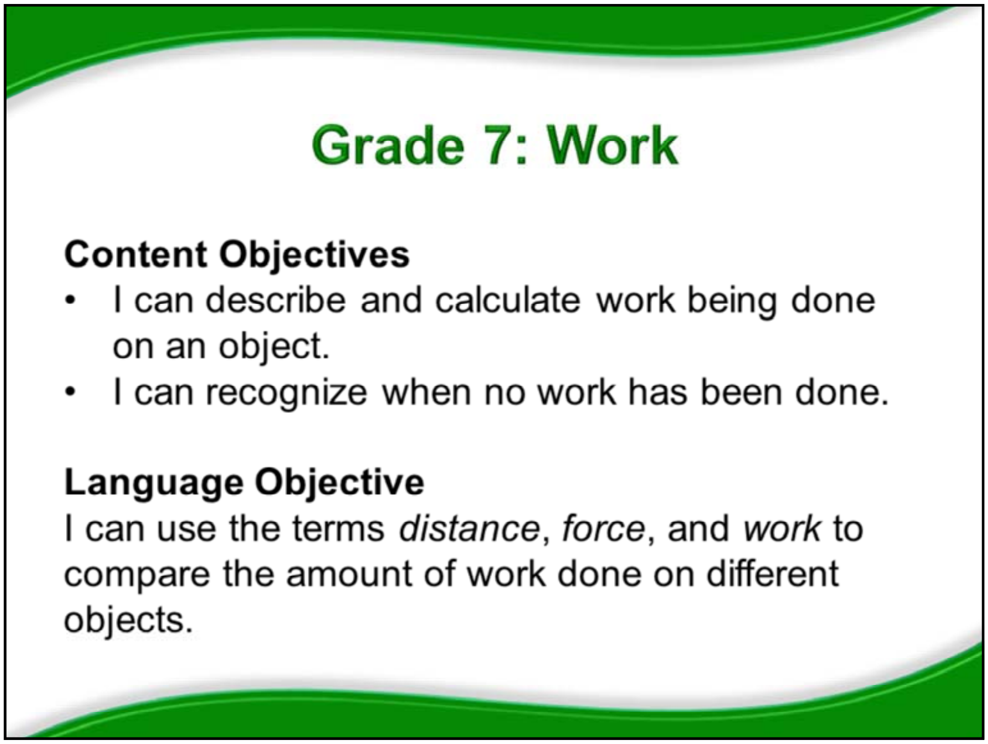
Allow 5 minutes for participants to record their responses.

How does this lesson support higher grade levels?
Math skills including measurement, unit conversion, calculation of speed and average speed, interpreting line graphs, and rounding support math and science. The concepts of speed and average speed directly support grade 8 science.

Please refer back to the K–8 Science TEKS, pages _____ , in the Vertical Alignment section, and circle the TEKS this lesson addressed.

Dismiss participants for lunch.

Remind participants of the importance of starting the afternoon session on time.



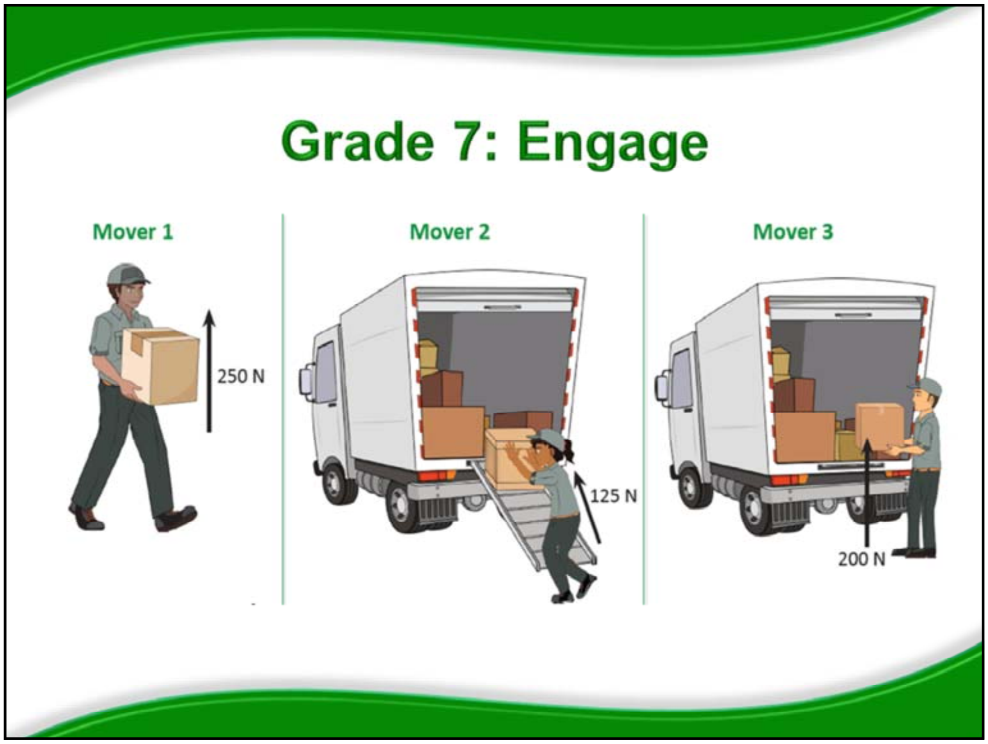
Grade 7: Work

Please take a moment to read the content and language objectives for this lesson.

The grade 7 lesson follows the 5E model and includes math and literacy strategies, Tier I support, and differentiation.

This lesson should take approximately 130 minutes to complete in this training. The time allotment is as follows:

Engage	*15 minutes*
Explore	*15 minutes*
Explain	*50 minutes*
Elaborate	*40 minutes*
Evaluate	*10 minutes*



The first *E* is Engage.

Refer participants to RM 1 on page ____, and distribute blank half-sheets of paper.

Study the three situations and think about who is doing the most work. Consider how students might approach the activity based on their ideas about work. We will not write on RM 1 at this time. On your blank half-sheet of paper, record which mover you think does the most work and explain your thinking. Do not write your name on your paper.

Allow 2–3 minutes for participants to record their ideas, When they are finished, instruct participants to crumple their half-sheets of paper and pass or toss the paper balls around the room for 20–30 seconds. When time is up, participants should each pick up a paper that lands near them and read the response.

Participants with a response that describes Mover 1 will form a group in one area of the room. Mover 2 responses will meet in a second area of the room, and Mover 3 responses will meet in a third area of the room. Once participants are in one of the three designated areas, allow 2–3 minutes for participants to discuss reasons why people chose a particular mover.

Use the facilitation questions to elicit ideas about doing work. Do not address the correct answer at this time.

What do you think it means to do work?

Accept all answers with justification. Students will learn about the concept of work during the Explore and Explain activities.

What are some reasons students think Mover 1 does the most work?

Answers will vary.

What are some reasons students think Mover 2 does the most work?

Answers will vary.

What are some reasons students think Mover 3 does the most work?

Answers will vary

During this lesson, we will learn more about work as a science concept. We will revisit the Engage scenarios later in the lesson.

The second *E* is Explore.

Distribute a push-pull spring scale, a load object, and a meter stick or measuring tape to each group.

Model or ask a volunteer to model the proper method to calibrate and use the spring scale.

In science, the term *load* can be used to describe an object that is being moved. What is our load object?

The load object is the object participants will move using the spring scale. The type of object used is determined by the presenter.

During Explore, you will measure and describe the amount of force applied to the load object and the distance the object moves. Turn to RM 2 on page ___. Follow the instructions on RM 2 to complete the investigation. You will have 15 minutes to complete the activity.

Use the facilitation questions and sample answer key on pages _____ to debrief the activity.

During Task 1, in what direction was the force acting on the load?

The direction of the force was up.

During Task 1, in what direction was the load moving?

The load was moving up.

During Task 2, in what direction was the force acting on the load?

Answers will vary. The direction of the force will usually be represented with an arrow to the right or an arrow to the left.

During Task 2, in what direction was the load moving?

Answers will vary. The direction the load moves should be in the same direction as the pulling force.

During Task 3, in what direction was the force acting on the load?

Answers will vary. The direction of the force will usually be represented with an arrow to the right or an arrow to the left.

During Task 3, in what direction was the load moving?

Answers will vary. The direction the load moves should be the same direction as the pushing force.

During Task 4, in what direction was the force acting on the load?

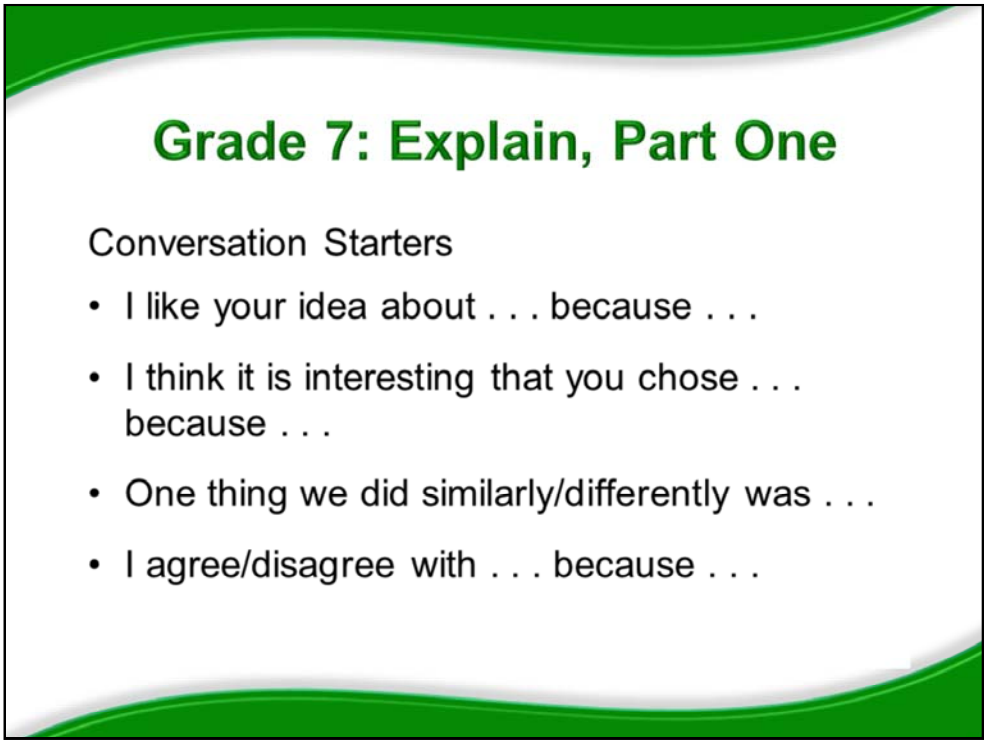
The direction of the force is up.

During Task 4, in what direction was the load moving?

The load was moving forward or the direction the student walked; the direction the load moves is not in the direction of the force used to hold the load up.

Compare the amount of force used for each task. Was the same amount of force applied in each task? Why or why not?

More force is used to lift the load. The amount of force used to pull or push the load should be approximately the same. Less force is needed to pull or push the load because the table is also applying a force to the object.



The third *E* is Explain. There are two parts in this Explain. Part One of the Explain focuses on developing the idea of work as a science concept.

Turn to RM 4 on page ___. You will read about work as a science concept. After you have completed the reading, you will create an IDEA vocabulary card for the term *work* as it is used in science.

In this context, IDEA stands for illustrate, describe, elaborate, and associate. Instructions for the IDEA vocabulary card and a blank template are provided on RM 4. An IDEA vocabulary card for the term *force* has been provided as an example.

Turn to RM 3 on page ___. You will have 15 minutes to read RM 3 and complete an IDEA vocabulary card for the term *work*.

After participants have completed their IDEA vocabulary cards, instruct participants to stand up at their tables.

Click.

You will move around the room and find a partner who was not sitting at your table. You will have two minutes to exchange IDEA vocabulary cards and discuss how your cards are similar and different. You may find these sentence starters helpful to support a productive conversation. Please find a partner at this time.

At two minutes, give participants a signal to wrap up conversations. **Thank your partner and then find a new partner.** *Instruct participants to repeat the activity with a second partner.* **Thank your partner and then return to your seat.**

Ask volunteers to share either their's or a partner's vocabulary card. Use the facilitation questions to lead a whole group discussion.

What are some different ways we use the word *work* outside of science class?

Answers will vary but may include a job or career, making an effort, doing labor, a creation or work of art, or to succeed or function properly.

What does it mean to do work in science?

Work is done on an object when a force is applied to the object and the object moves in the direction of the applied force.

Is work done every time a force is applied to an object?

No; work is done only if the object moves in the direction of an applied force. If the object doesn't move, no work is done.

The delivery man did work on the box when he lifted it, but he did not do work on the box while he was carrying it. Why not?

Work is only done on an object when a force is applied to the object and the object moves in the direction of the applied force. He applies an upward force on the box, but the box isn't moving up while he carries it. It is moving forward.

How can we calculate work?

Work equals force times distance ($W = Fd$).

What is the SI unit for work?

Joules (J)

How are work and energy related?

Energy is the ability to do work. When work is done on an object, energy is transferred from one object to another.

Before we move on to Part Two, take a moment to review the Tier I Supports on page ___. *Allow 1–2 minutes for participants to read.*

Grade 7: Explain, Part Two

Task	Description	Force (N)	Direction of Force	Distance (m)	Direction of Motion	Work (J)
example	Use the spring scale to pull the load 0.5 m across the floor or table.	2.0 N	→	0.5 m	→	$W = Fd$ $W = 2N \cdot 0.5m$ $W = \underline{1\ J}$

During Part Two of Explain, we will calculate work using the formula *W = Fd*.

Refer to the table on RM 2 on page ____ that was completed during the Explore activity. Add a column on the right side of the table like the table shown on the screen. You will use this space to calculate work done on the load during each task.

We will practice with the example task. Two Newtons of force to the right was applied when pulling the object. The object moved 0.5 meters to the right. To calculate work done on the object, we need to multiply the force in Newtons times the distance in meters.

Click.

We can calculate that one Joule of work was done on the object when it was pulled to the right.

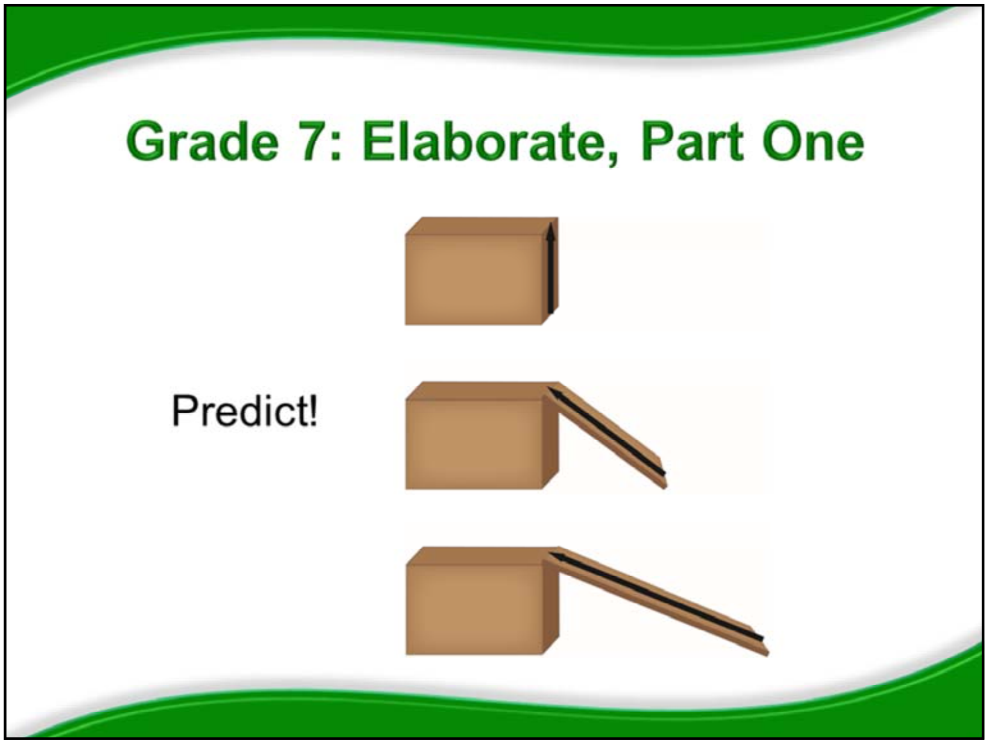
You have 10 minutes to calculate the work done during the four Explore tasks.

When participants have completed all four calculations, ask four volunteers to come to the front of the room to share how they determined the amount of work done during each task. They may use chart paper and markers to show their work. If appropriate technology tools for teachers to share their work are available, this is an opportune time for technology integration.

Refer to the facilitation questions and sample answer key on page ____ to discuss the work done during each task.

How much work was done in Task 1? Task 2? Task 3? *Answers will vary based on measurements.*

How much work was done in Task 4? *No work was done in Task 4. The load does not move in the direction of the applied force.*



The fourth *E* is Elaborate. There are two parts in this Elaborate. During Part One, we will investigate work done with and without a ramp.

Distribute a push-pull spring scale, meter stick or ruler, load object, empty box or crate, and ramps that are two different lengths to each group.

Turn to RM 5 on page ____. During Elaborate, you will calculate and compare the amount of work done to the load as it is moved to the top of a box using three different methods. You will lift the load straight up and then using two different ramps. *Model the three tasks.*

Make a prediction. Is more work done when you lift an object straight up; push or pull the object up a short, steep inclined plane; or push or pull the object up a long, gradual inclined plane? Record your ideas on RM 5. *Allow 2–3 minutes for participants to discuss and record their ideas.*

You will have 15 minutes to complete the three tasks on RM 5 and answer the four analysis questions.

Use the facilitation questions and sample answer key on pages ______ to debrief the activity.

How did your results compare with your prediction?

Answers will vary.

Compare the amount of work done in the three tasks.

The least work is done on the load when lifting it straight up during Task 1, but more force was used. More work is done on the object when using the inclined planes in Tasks 2 and 3. Approximately the same amount of work is done with both inclined planes.

How does Task 2 compare with Task 3?

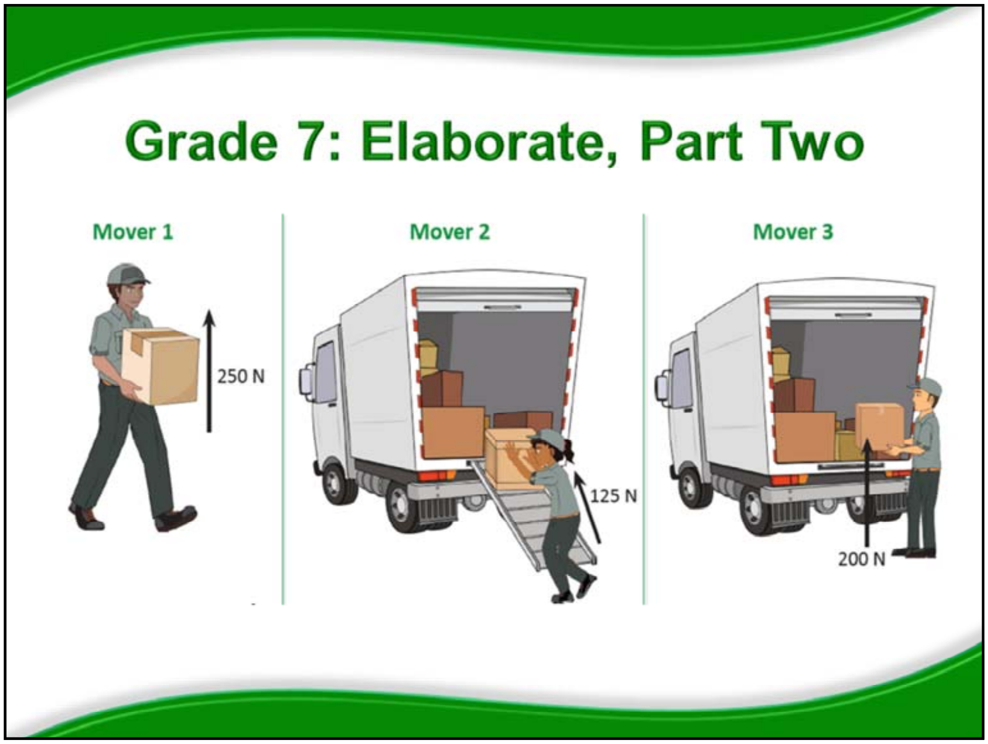
Approximately the same amount of work is done in Task 2 and Task 3. More force is applied to the load in Task 2, but it is applied over a shorter distance. Less force is applied to the load in Task 3, but it is applied over a greater distance.

How does the use of an inclined plane affect the amount of force and distance?

The inclined plane allows you to use less force over a longer distance.

During each task, the load is moved from the table to the top of the box. One might expect the same amount of work to be done in each task, but we found less work was done in Task 1, lifting the load straight up. What are some possible reasons less work is done in Task 1 and more work is done in Tasks 2 and 3?

Possible reasons more work is done when using inclined planes include friction between the load and the surface of the inclined planes and variation in rounding measurements and calculations.



Part Two of the Elaborate focuses on applying new ideas about work to the scenarios discussed during the Engage activity.

Return to RM 1 on page ____. Calculate the amount of work done by each mover and determine who did the most work. You may use the space at the bottom of RM 1 to show your work and write your explanation.

You have 5 minutes to complete RM 1.

After participants have finished recording their responses, ask participants with a response that describes Mover 1 to form a group in one area of the room. Mover 2 responses will meet in a second area of the room, and Mover 3 responses will meet in a third area of the room. Participants should find that Mover 2 did the most work. If all participants selected Mover 2, use the facilitation questions to debrief the activity.

If any participants select Mover 1 or Mover 3, ask volunteers to explain their thinking. After each group explains their thinking, invite participants to move to a different group if their ideas about work changed.

Who did the most work on the box? How do you know?

Mover 2 did the most work on the box. Mover 1 did not do work on the box. Mover 2 applied less force than Mover 3 but over a greater distance.

How much work does Mover 2 do on the box?

Force = 125 N up the ramp   distance = 4 m up the ramp

W = Fd

W = 125 N • 4 m

W = <u>500 J</u>

How much work does Mover 3 do on the box?

Force = 200 N straight up   distance = 2 m straight up

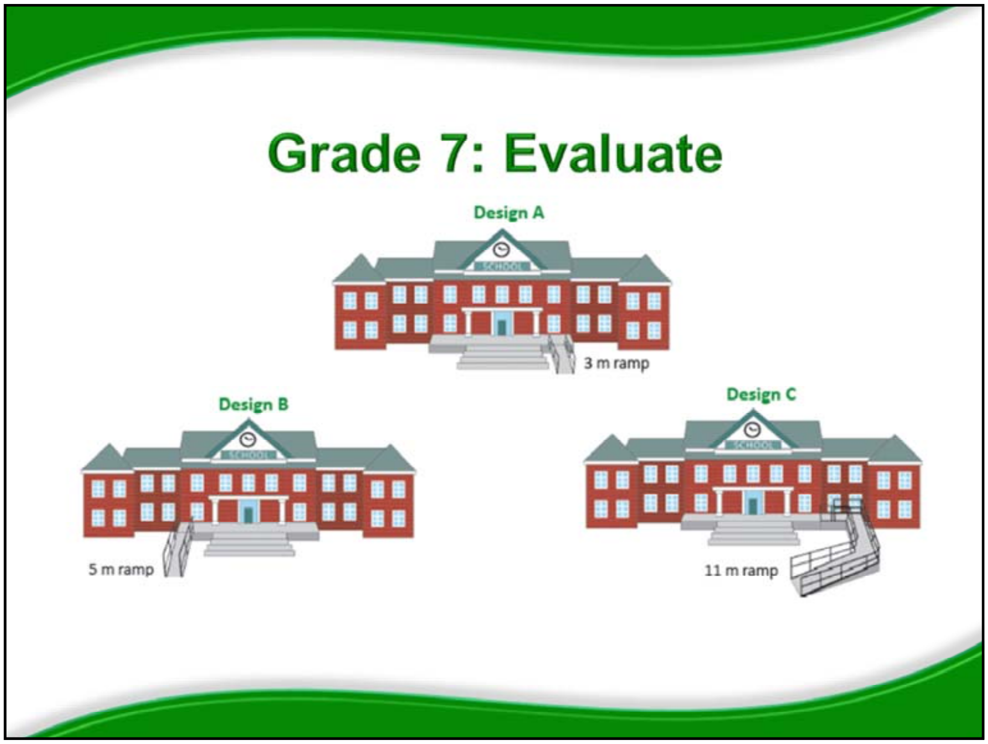
W = Fd

W = 200 N • 2 m

W = <u>400 J</u>

How much work does Mover 1 do on the box?

Mover 1 doesn't do any work on the box while the box is carried. The force applied to the box is upward, but the box is not moving up. The box is moving toward the truck. If Mover 1 lifted the box before carrying it to the truck, work was done on the box when it was lifted. Once the box is carried and moves horizontally, work is no longer done on the box.



This lesson uses the 5E Model. The fifth *E* is Evaluate.

Read through the Evaluate assessment as written in RM 6 on page ____.

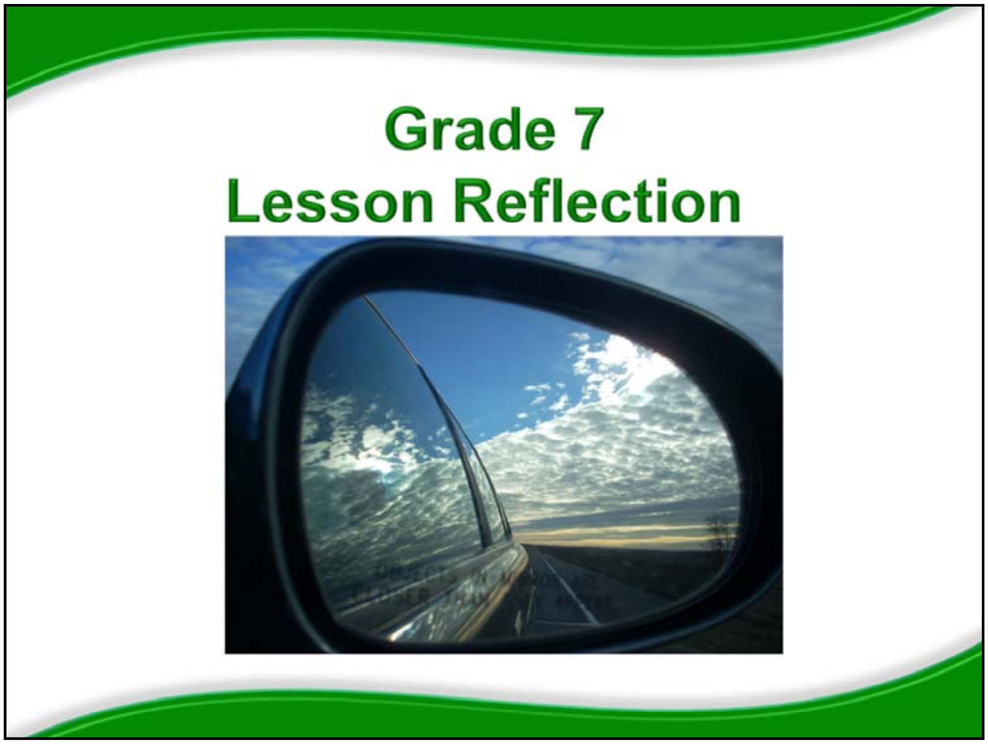
Allow 5–7 minutes for participants to review the assessment items. Refer participants to the answer key on page ___. Address any questions about the Evaluate assessment.

Look at the first two questions. What must students understand to correctly answer these questions?

Students must understand how to calculate work and that work is only done on an object if it moves in the direction of the applied force.

Look at the third question. What must students understand to correctly answer this question?

Students must understand that an inclined plane allows you to use less force, but the force must be applied over a longer distance.



Take a moment to reflect on the grade 7 lesson. Consider how literacy and math strategies were embedded into this lesson.

Locate page _____ in the Instructional Resources section, and record how those things were embedded.

Allow 5 minutes for participants to record their responses.

How does this lesson build on previous grade levels and also support higher grade levels?
TEKS 3(6)(B) introduces students to the concept of work. Students learn how position and motion are changed by pushing and pulling objects. TEKS 6(8)(E) introduces students to inclined planes and pulleys. Students investigate how inclined planes and pulleys can be used to change the amount of force needed to move an object. This grade 7 lesson helps students develop a deeper understanding of work as a science concept by measuring force and distance and calculating work. Students also learn the direction of motion must be in the same direction as the force for work to be done on an object.

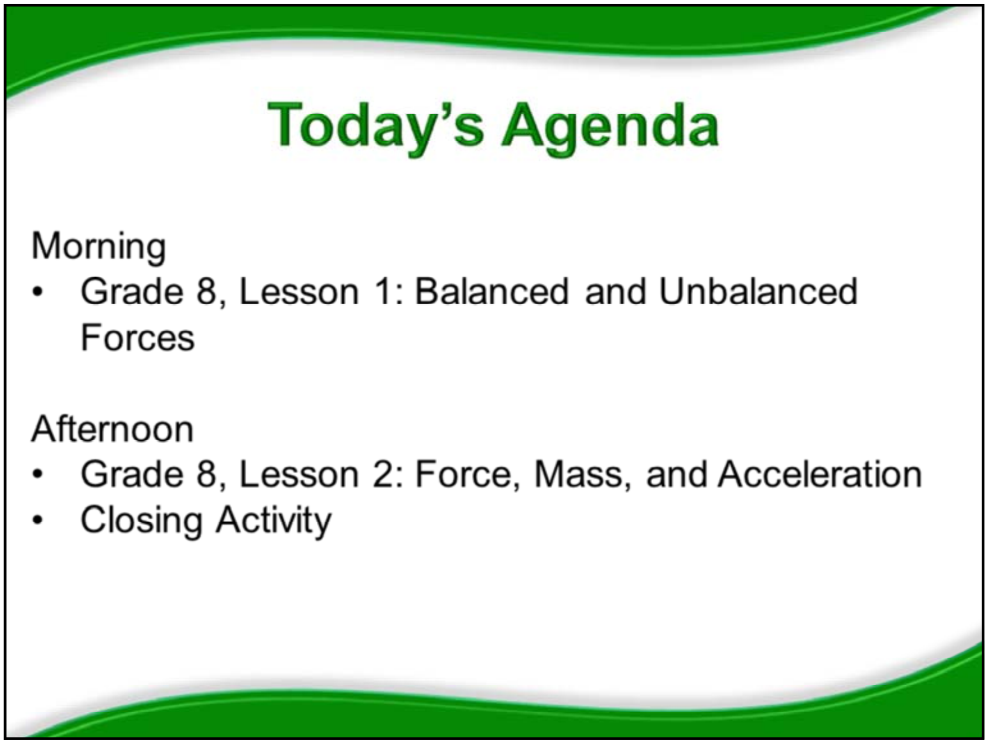
Please refer back to the K–8 Science TEKS pages _____ in the Vertical Alignment section, and circle the TEKS this lesson addressed.

Tomorrow we will work through the grade 8 lessons.

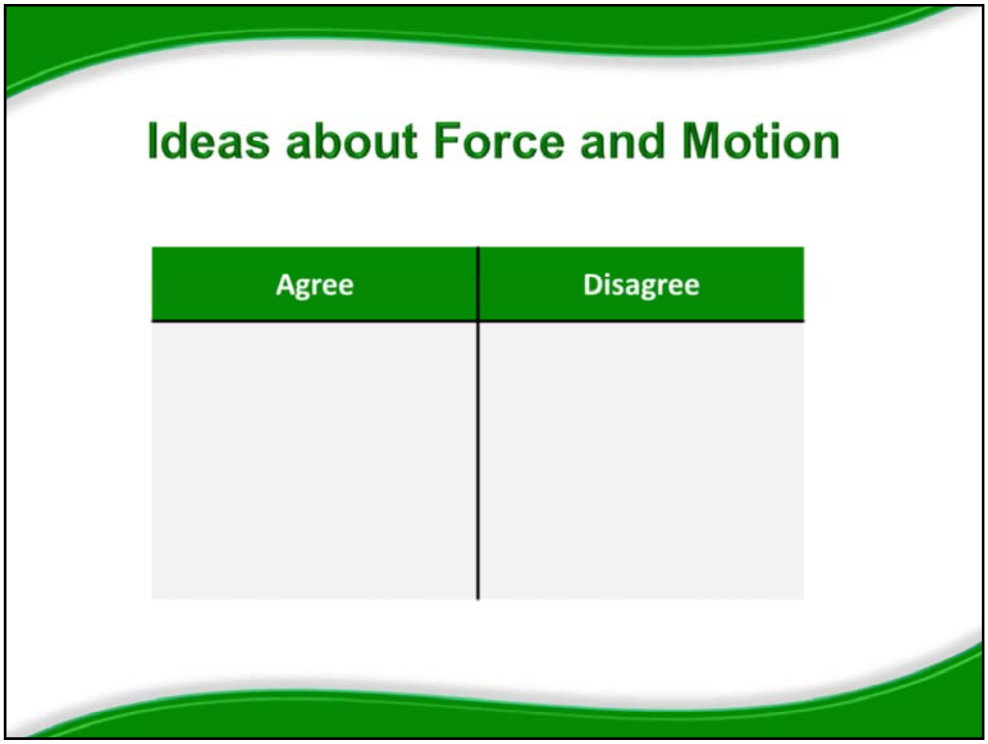
Please leave your tables neat and organized for tomorrow. Have a great afternoon! See you in the morning.

Welcome back to the Science Academies for Grades 5–8, Part 2!

Please greet those at your table, and introduce yourself to any new group members.



We will experience two grade 8 Force and Motion lessons today. Following the completion of all five lessons, we'll share closing thoughts and comments.



Advance Preparation
Print the Prelesson Sort on cardstock for each group. Laminate and cut into cards. Place one side of adhesive Velcro® to the back of each card. Place the cards in a bag for storage. For each group, prepare a folder with a strip of Velcro® down the inside of each side of the folder. The Velcro® strip will be used to hold the sort cards in place.

Distribute a set of Prelesson Sort cards and a prepared folder to each group.

We will use this sort before and after each lesson today to capture our ideas about force and motion and to see if any of our ideas change based on our learning experiences. Velcro® has been placed on the back of each card so the cards will stay in place within the folder.

Find the “Agree” and “Disagree” cards. Place the “Agree” card at the top of the left side of the folder and the “Disagree” card at the top of the right side of the folder. Read and discuss the statements about force and motion. Place each card under “Agree” or “Disagree” based on your discussion.

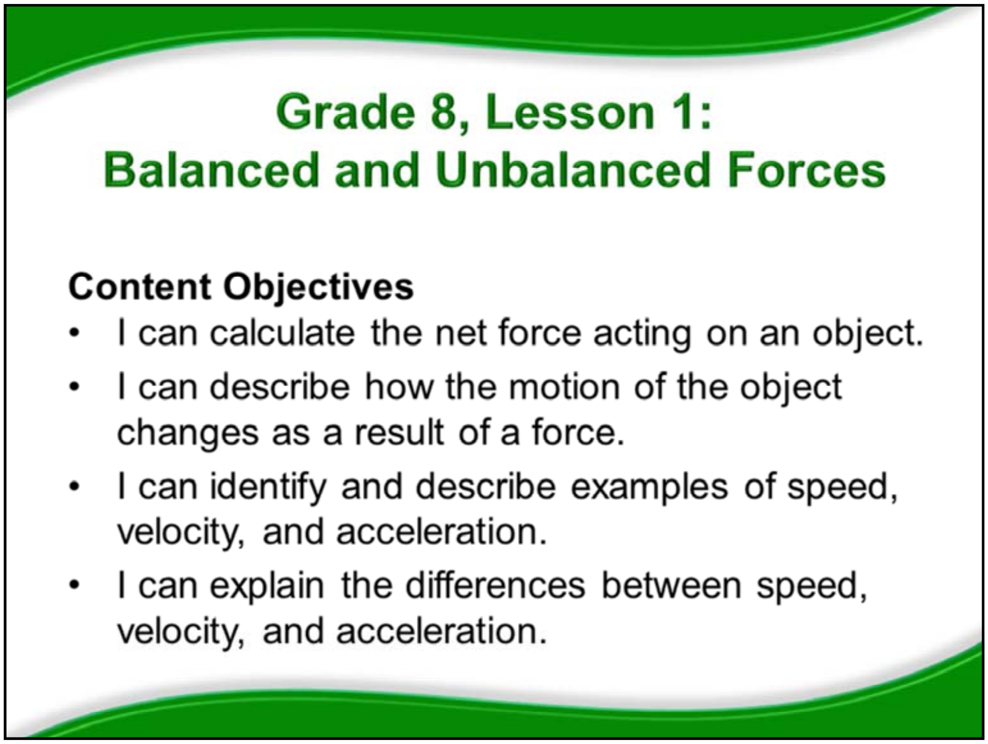
You have 10 minutes to complete the sort.

After all groups have placed their cards in the folder, conduct a gallery walk to provide participants with an opportunity to observe how other groups sorted the statements.

Participants may find that groups did not sort all of the cards the same way. Do not discuss which ideas are correct at this time.

Did every group sort their cards the same way? *Allow volunteers to share.*

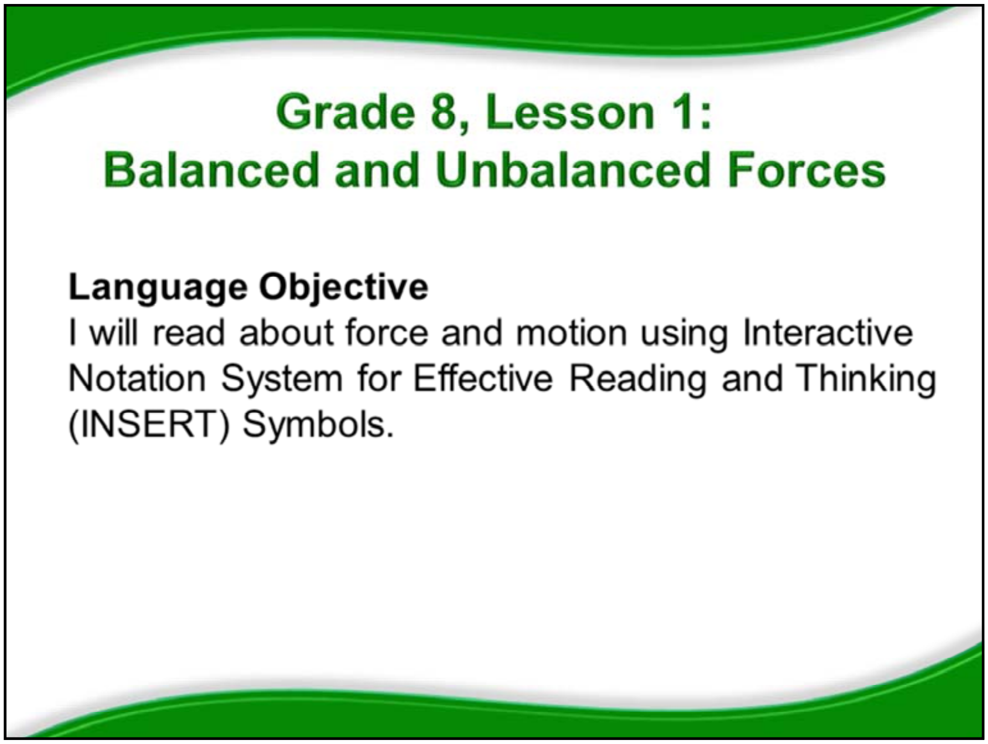
Misconceptions about force and motion are very common amongst students as well as adults. Common but incorrect ideas can be very difficult to change. It is important to provide learning experiences that require students to challenge incorrect ideas. Please leave your cards as they were sorted in the folder. We will revisit this activity after Lesson 1 and again after Lesson 2.



Grade 8, Lesson 1: Balanced and Unbalanced Forces

Please take a moment to read the content objectives for this lesson.

Click to view the language objective on the next slide.



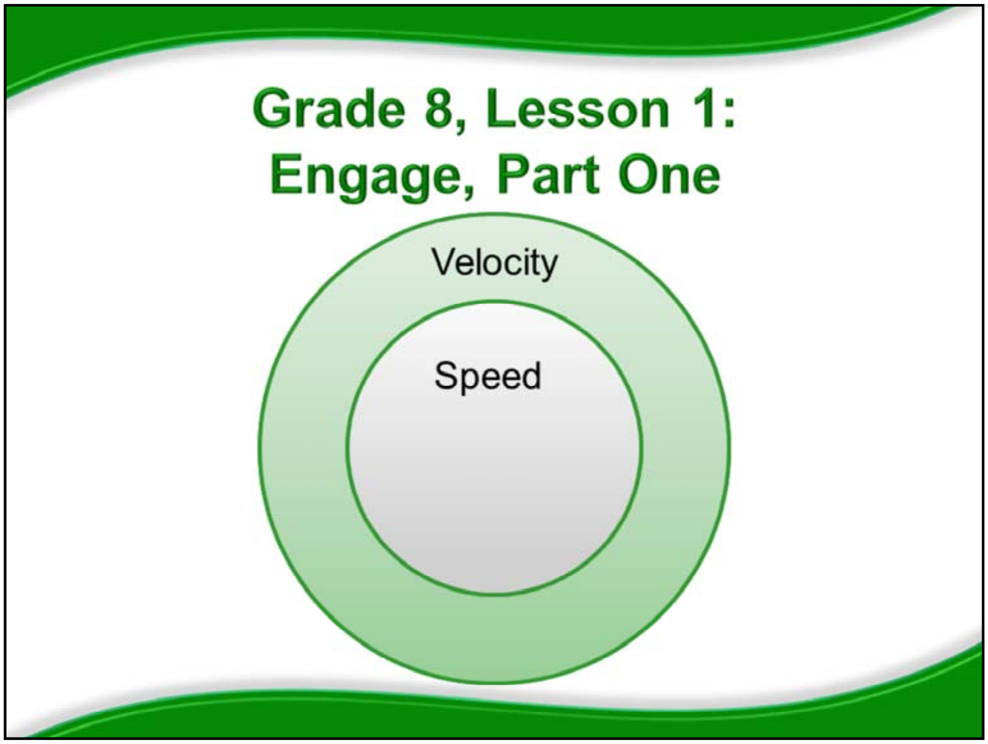
Grade 8, Lesson 1: Balanced and Unbalanced Forces

Please take a moment to read the language objective for this lesson.

This grade 8 lesson follows the 5E model and includes math and literacy strategies, Tier I support, and differentiation.

This lesson should take approximately 150 minutes to complete in this training. The time allotment is as follows:

Engage	*20 minutes*
Explore	*20 minutes*
Explain	*50 minutes*
Elaborate	*50 minutes*
Evaluate	*10 minutes*



The first *E* is Engage. Part One of Engage focuses on comparing speed and velocity.

Distribute one set of RM 1 cards and two pieces of yarn or string to each group of three.

Use the two pieces of yarn or string to create a graphic organizer on your table similar to the image shown on the screen. Find the cards labeled "Speed" and "Velocity." Label the outer circle "Velocity" and the inner circle "Speed." Read and discuss the remaining cards to determine where each card should be placed. If the card describes velocity only, place it within the outer circle. If the card can be used to describe both speed and velocity, place it within the inner circle.

You have 5 minutes to complete this activity.

Use the facilitation questions and answer key on page ___ to debrief the activity.

Why is the speed circle inside the velocity circle?

Speed is a component of velocity.

What are the two components of velocity?

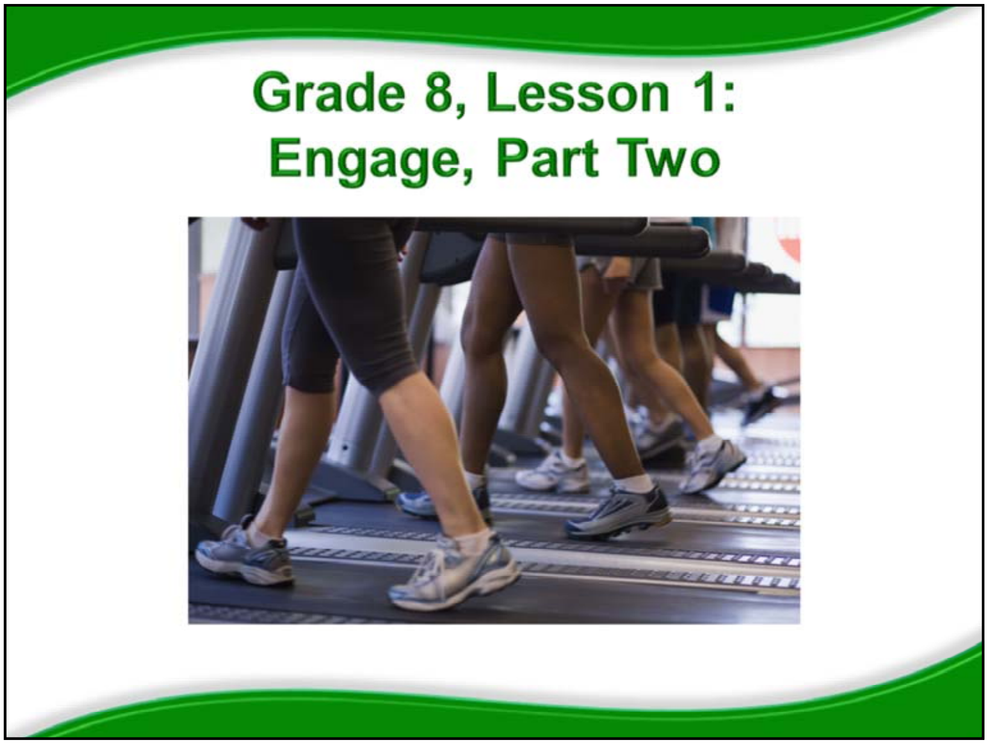
Velocity has a speed (magnitude) and a direction.

How are speed and velocity similar?

Both can be used to describe how fast an object is moving. The same units of measurement are used for speed and velocity. Answers will vary.

How are speed and velocity different?

Speed is used to describe the distance traveled in a period of time. Velocity is used to describe how the position of an object changes in a period of time. The direction of motion is important for velocity but is not a factor for speed.



If students struggle to differentiate between speed and velocity in Engage Part One, it may indicate that students do not understand the difference between distance and displacement. Part Two of Engage is an optional activity that uses movement to help students better understand distance and displacement.

Please stand up and push in your chairs. Find an area where you have enough room to take five or six steps forward without running into an object or person. *If space is limited, ask a few volunteers to stand around the room and demonstrate the activity for the whole group.*

We will be moving at a steady rate of one step per second. Let's practice taking a few steps at this rate. When I say "go," you may start. Remember to take small steps and to watch for obstacles around you. *Using a clock or timer, clap or snap each second to provide a beat that participants can follow. After 4 or 5 beats, say "go" to indicate participants should begin walking one step per second. For 5–6 seconds, continue providing a beat while participants are moving. After participants are comfortable moving at this rate, ask them to return to their starting positions.*

This time we will move five steps forward at a steady rate of one step per second. I will start the beat, and when I say "go," you may start. I will tell you when to stop.

Using a clock or timer, clap or snap each second to provide a beat participants can follow. After 4 or 5 beats, say "go" to indicate participants should begin walking one step per second. Continue providing a beat as participants are moving. Say "stop" after five steps.

What was the total distance, in steps, you just traveled?

The total distance traveled is five steps.

What is your displacement in steps?

Everyone traveled five steps forward. Displacement is five steps forward compared to starting positions.

Return to your starting positions. This time we will move three steps forward and two steps backward. Let's practice the movement first. *Allow participants to practice moving for 30 seconds. When participants are comfortable with the movement, continue with the activity.*

I will start the beat, and when I say "go," you may start. I will tell you when to stop. *Using a clock or timer, clap or snap each second to provide a beat participants can follow. After 4 or 5 beats, say "go" to indicate participants should begin walking one step per second. Continue providing a beat as participants are moving. Say "stop" after five steps (three steps forward and two steps backward).*

What was the total distance, in steps, you just traveled?

The total distance traveled is five steps.

What is your displacement in steps?

Displacement is one step forward compared to starting positions.

Use the facilitation questions to debrief the activity.

Based on the activity, how would you define distance?

Distance describes how far something moves.

Based on the activity, how would you define displacement?

Displacement describes how the position of an object changes compared to where it started.

How are distance and displacement different?

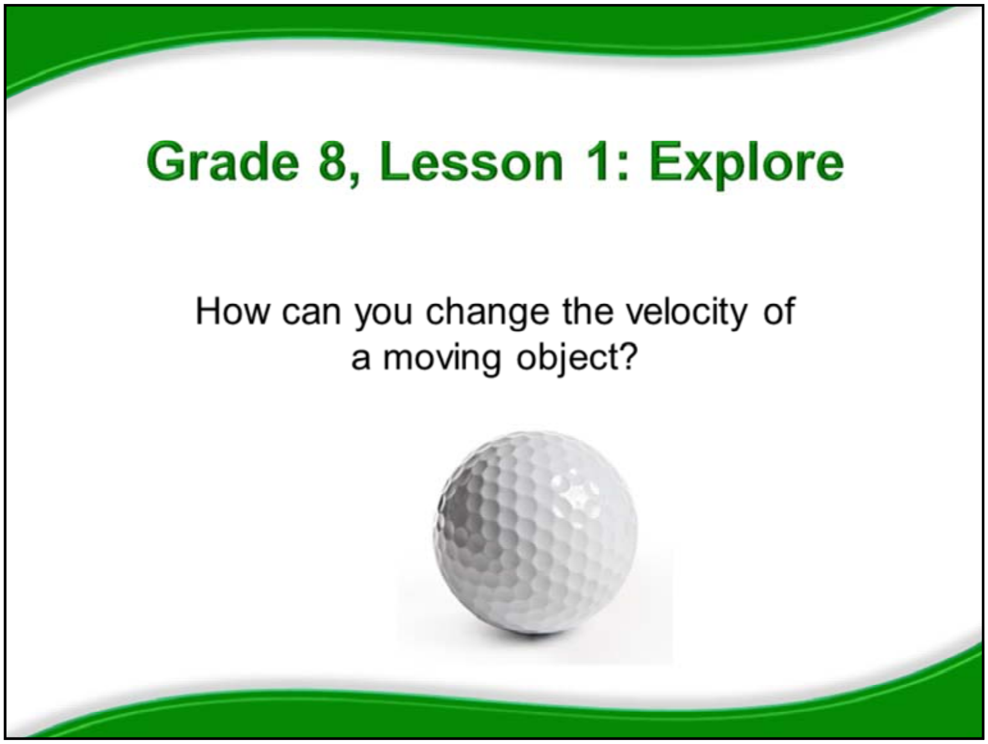
The direction of movement is important for displacement.

How are distance and displacement related to speed and velocity?

Speed is used to describe the distance traveled in a period of time. Velocity is used to describe how the position of an object, or displacement, changes in a period of time.

How does the image on this slide relate to distance and displacement?

Allow participants to discuss for 1–2 minutes. Ask volunteers to share their ideas. A treadmill usually shows the distance the person travels in miles or kilometers. The longer the person walks or runs, the farther they travel. A person using a treadmill is walking in place, so their displacement is always zero.



The second *E* is Explore.

Distribute safety glasses to each participant and a small ball (e.g., golf ball, tennis ball, table tennis ball, etc.) and additional materials such as an extra ball, rulers, and blocks to each group. Alcohol pads can be used to clean safety glasses as needed.

Turn to RM 2 on page ____. During Explore, you will investigate how to change the velocity of a moving object. During each investigation you will slowly start the ball rolling across the floor or table and then use the available materials to change the velocity of the ball. During Investigation A, you will find a way to make the speed of the ball increase. During Investigation B, you will find a way to make the speed of the ball decrease. During Investigation C, you will find a way to change the direction of the ball. *Explain which materials participants may use and which areas of the room may or may not be used. Remind participants to roll the ball slowly and to use materials safely.*

You will have 15 minutes to complete the Explore investigations.

Use the facilitation questions to debrief the Explore investigations.

How did you increase the speed of the ball?

Answers will vary. Possible answers include hitting the ball with another object or rolling the ball down a ramp to make it speed up.

How did you decrease the speed of the ball?

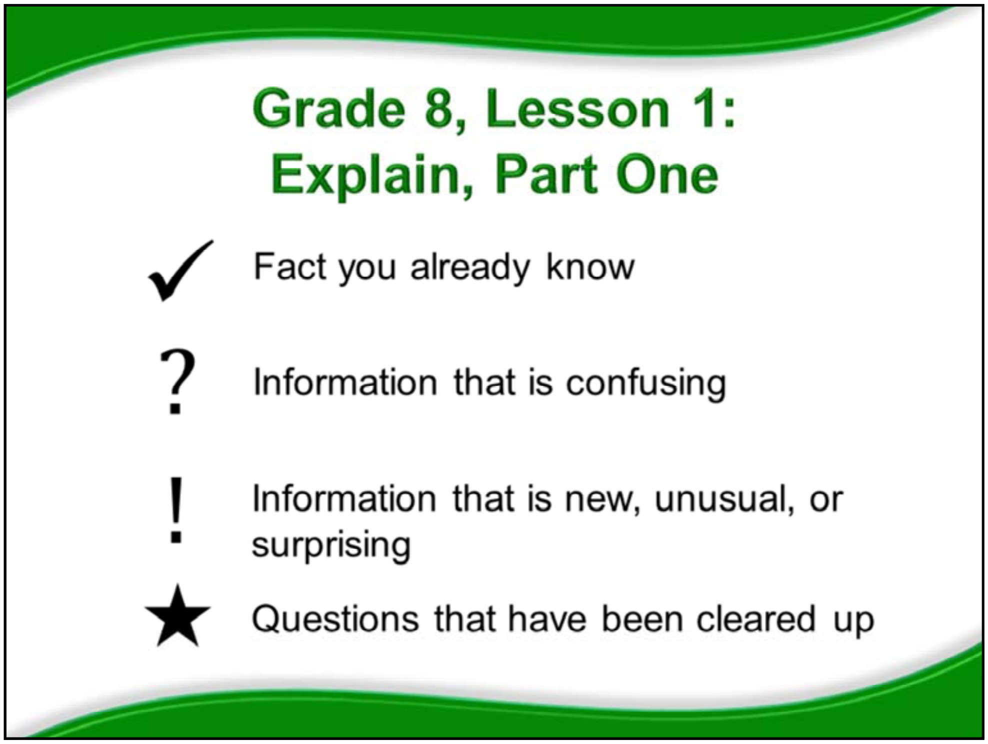
Answers will vary. Possible answers include rolling the ball into a stationary object, hitting the ball with a force in the direction opposite of motion, or rolling the ball up a ramp.

How did you change the direction of the moving ball?

Answers will vary. Possible answers include hitting the ball, rolling the ball into another object at an angle, or rolling the ball along a curved surface.

Based on the investigations, what must happen to change the velocity of an object?

A force must be applied to an object to change its speed or direction.



The third *E* is Explain. Part One of Explain reinforces the idea that a net force results in a change in velocity.

Distribute an INSERT symbol bookmark to each participant. Distribute sticky notes to each group.

During Explain Part One, we will use the INSERT symbol reading strategy. In this context, INSERT stands for Interactive Notation System for Effective Reading and Thinking. A coding system is used during reading to identify concepts and facts that are already known, ideas that are confusing, and concepts that are new or surprising.

Turn to RM 3 on page ___. As you read, write a checkmark next to any facts you already know. Write a question mark next to information that is confusing. Write an explanation mark next to information that is new, unusual, or surprising. Make your marks at the beginning of the statement or in the margin next to the statement. You should not mark every sentence. Focus on big ideas and important concepts and terms. If you would like more structure for this activity, you may use the *INSERT Symbols Chart* on the second page of RM 4 to record your ideas. *Refer participants to RM 4 on page ____.*

If questions in one part of the reading are cleared up in another part of the reading, you can go back and mark a star next to the original question mark. You might not clear up all questions on your own. We will have opportunities to clear up remaining question marks after reading. Are there any questions before we begin? *Address any questions about the activity.*

You will have 10 minutes to read and code the text independently.

After participants complete the reading, they will share and discuss their INSERT marks with a partner. **Find a partner with whom you have not worked. You will have approximately five minutes to share and discuss your INSERT marks. Be sure to take time to discuss statements with a question mark that you found confusing. If your partner helps you clear up the idea during your discussion, mark a star next to the question mark. If you still have a question after discussing the idea with your partner, write the page number, statement, and question on a sticky note and post it in the "Parking Lot."**

Collect any sticky notes with questions about the reading. Use the facilitation questions to debrief Explain Part One. Be sure to address questions posted on sticky notes.

In science, what do we call changes in velocity?

Changes in velocity are called acceleration.

What are the three types of acceleration?

The three types of acceleration are speeding up, slowing down, and changing direction.

What causes acceleration?

Forces cause acceleration.

What is net force?

The net force is the total of all the forces acting on an object.

How do we calculate net force?

We calculate net force by adding forces acting in the same direction and subtracting forces acting in opposite directions.

What are balanced forces?

All the forces acting on an object cancel out. The net force is zero.

How do balanced forces affect the motion of an object?

Balanced forces result in no change in motion. The object may be motionless or may be moving with constant speed and direction.

What are unbalanced forces?

The forces do not cancel out. There is a net force in a particular direction.

How do unbalanced forces affect the motion of an object?

Unbalanced forces cause a change in motion—speeding up, slowing down, or changing direction.

Do you still have questions about the reading that we have not answered?

Answers will vary. Refer to sticky note feedback, and address ideas and statements that participants find confusing.

Look at Example 4 in the reading. What is the net force acting on the block?

The net force is 5 N to the right.

How do the forces change the motion of the block in Example 4?

The block moves to the right. The speed of the object will increase as long as the net force is acting on the block.

Look at Example 5 in the reading. What is the net force acting on the block?

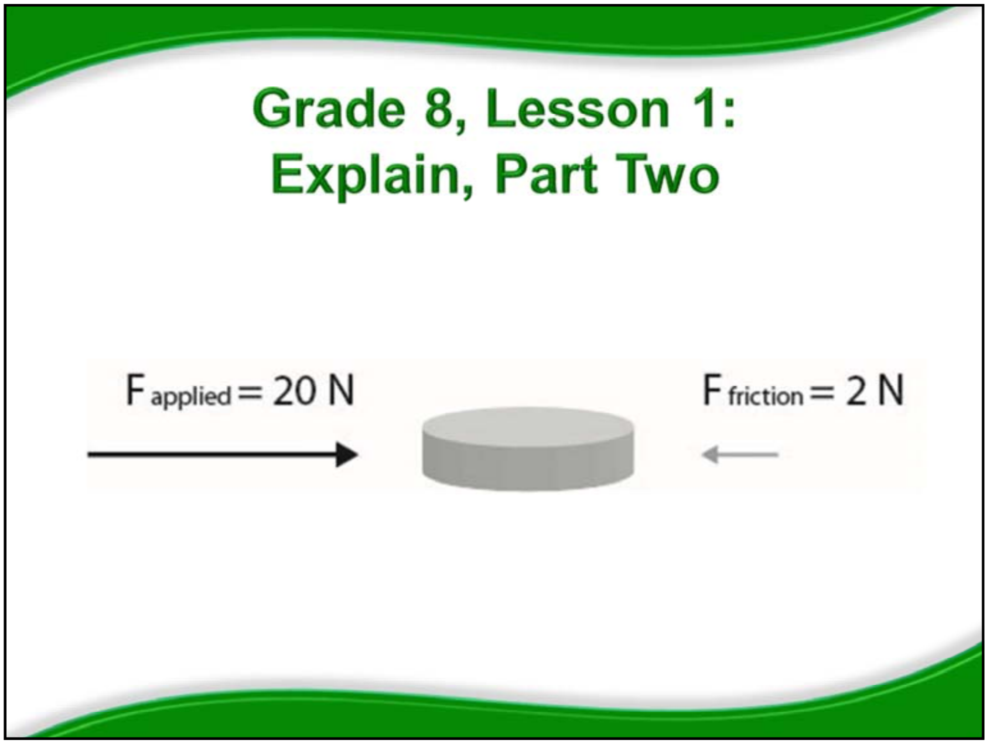
The net force is 2 N to the right.

How do the forces change the motion of the block in Example 5?

The block moves to the right. The speed of the object will increase as long as the net force is acting on the block.

How does the motion of the block in Example 4 compare with the motion of the block in Example 5? Why?

The block in Example 4 will speed up faster than the block in Example 5 because there is a larger net force in Example 4.



The third *E* is Explain. Part Two of Explain focuses on calculating net force.

Refer participants to RM 5 on page ____.

We learned that net forces cause changes in motion. If there is a net force, the motion of the object is changing in some way—speeding up, slowing down, or changing direction. During Explain Part Two, you will calculate the net force acting on various objects and describe the resulting change in motion. You may work independently or with a partner. You may also use materials from the Explore investigations to model the forces in each scenario described in RM 5.

You have 10 minutes to complete RM 5.

After participants have completed RM 5, assign a different scenario from RM 5 to each group. **Each group has been assigned a scenario from RM 5. You will have 1–2 minutes to present your problem to the whole group. You may choose to use materials from Explore and chart paper to present your group explanation.** *Allow 1–2 minutes for each group to present their problem to the whole group. Refer to the answer key on pages ________ as needed.*

The fourth *E* is Elaborate.

Distribute two fan carts and materials to connect the carts to each group.

Turn to RM 6 on page ___. During Elaborate we will use a "system" of fan carts to explore balanced and unbalanced forces. The two fan carts will be connected together and will move as one large object, or cart system. Please use the fan carts on the floor, and work together to ensure the carts do not run into people or hit obstacles such as tables or walls.

Demonstrate an appropriate method to connect the fan carts together. The two carts must be attached so that the carts remain aligned during motion. Model the proper use of the fan carts.

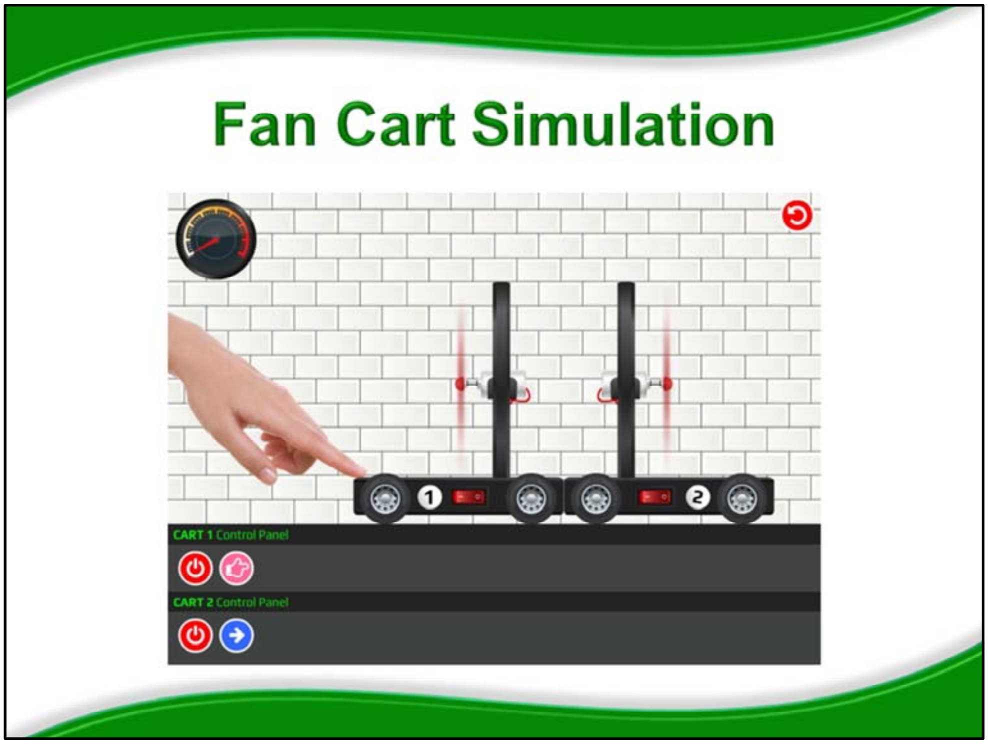
There are six parts in Elaborate. In Parts 1, 2, and 3, the carts will be connected with the fans facing the same direction as shown in the image on the screen. During Part 1, only one fan will be turned on. During Part 2, both fans will be turned on. During Part 3, the cart system will start with only one fan on and the second fan will be turned on after the cart system is in motion.

Click.

In Parts 4, 5, and 6, the carts will be connected with the fans facing the opposite directions as show in the image on the screen. During Part 4, both fans are turned on while the cart is at rest. During Part 5, both fans are turned on and an outside force is applied to the cart system to put the cart system in motion. During Part 6, the cart system will start with only one fan on, and the second fan will be turned on after the cart system is in motion.

You will have 25 minutes to complete the activity.

Use the facilitation questions and supporting images on pages ________ as the answer key and to debrief the activity.

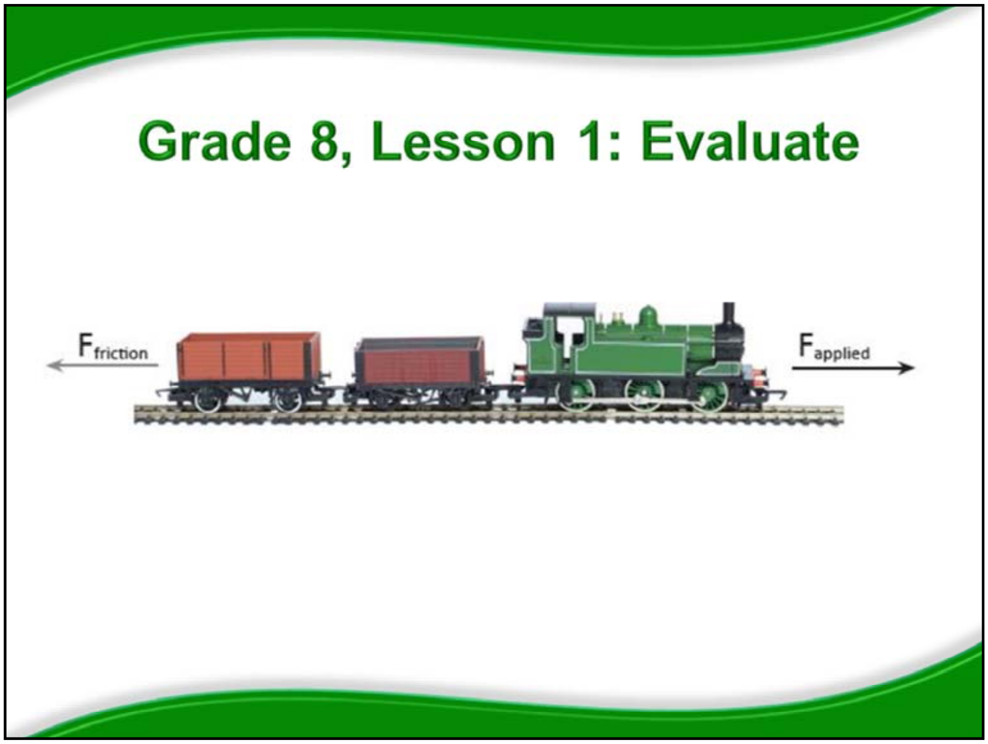


Please take a moment to read through the Teacher Note on pages ________. *Allow 2–3 minutes for participants to read.*

If alternate materials for the Elaborate are available for demonstration purposes, allow participants an opportunity to view the materials. For example, there are a few different types of fan carts that are commercially available. Different materials may be used to connect multiple carts depending on the style of the cart. If teachers are not able to purchase fan carts, handheld, battery-operated fans can be used with Halls carriage carts or other science carts to make a fan cart.

A fan cart simulation was developed for this training and is available on the Texas Gateway. The simulation can be used as an alternate resource for classroom teachers. For example, students can explore the simulation after completing the hands-on investigation to clarify and reinforce ideas about balanced and unbalanced forces. Let's take a few minutes to explore the online simulation.

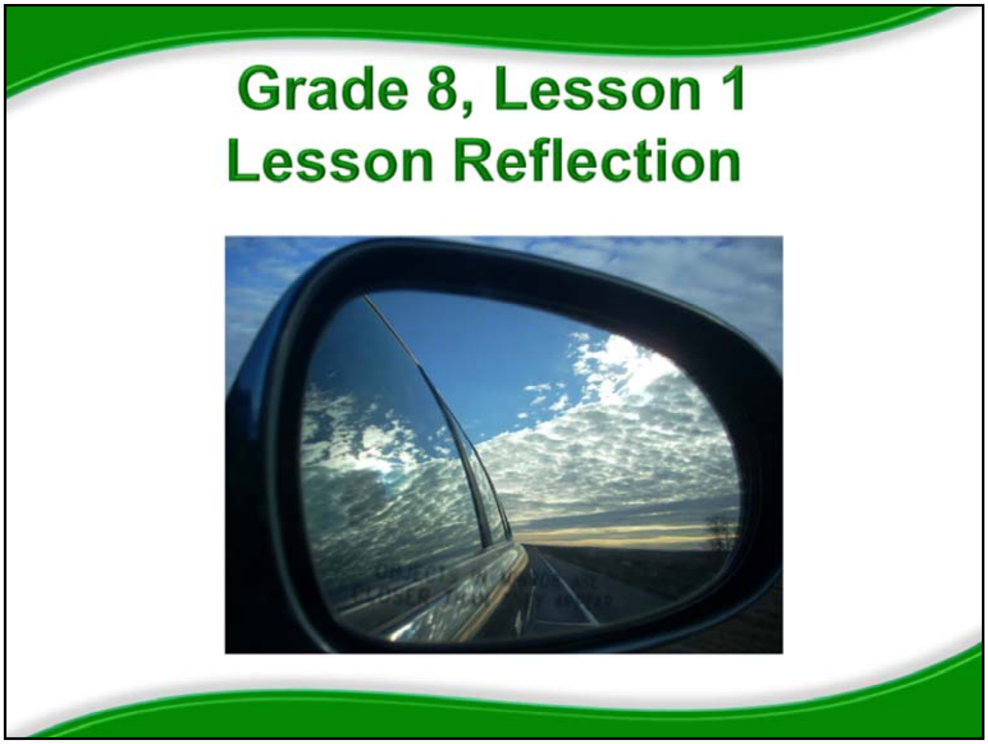
Click the image to go to the online simulation. Demonstrate how it can be used to complete the Elaborate activity. If participants have access to technology, provide 5–10 minutes for participants to explore the simulation on their own.



The fifth *E* is Evaluate.

Read through the Evaluate assessment as written in RM 7 on page ____.

Allow 5–7 minutes for participants to review the assessment items. Refer participants to the answer key on page ___. Address any questions about the Evaluate assessment.



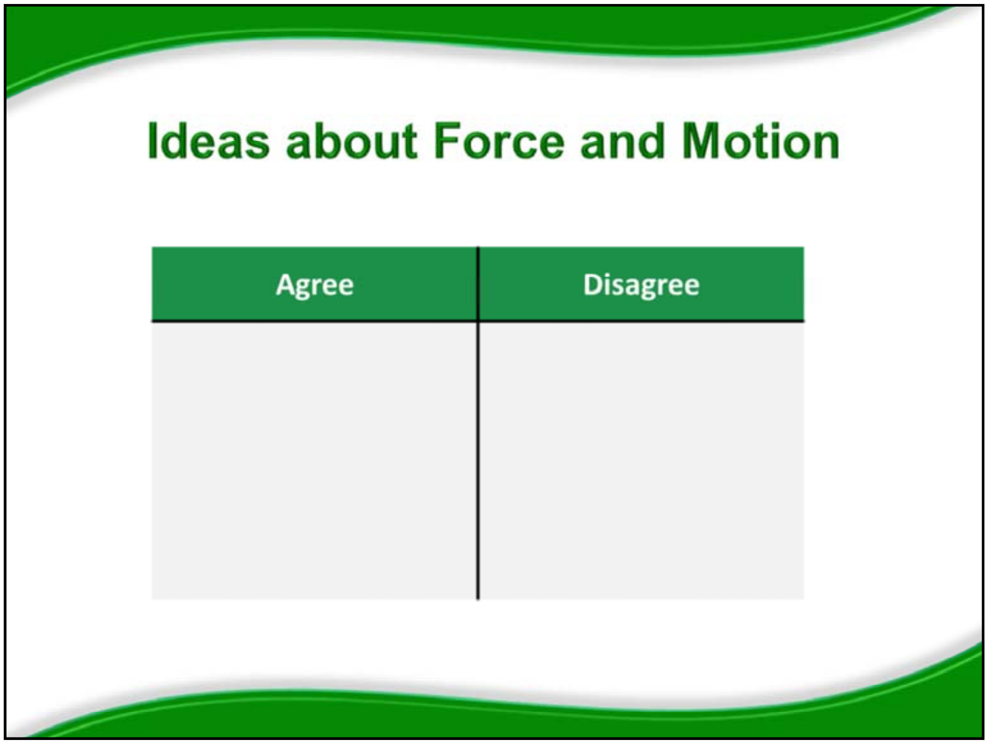
Take a moment to reflect on grade 8 lesson 1. Consider how literacy and math strategies were embedded into this lesson.

Locate page _____ in the Instructional Resources section, and record how those things were embedded.

Allow 5 minutes for participants to record their responses.

How does this lesson build on previous grade levels and also support higher grade levels?
The concept of force is studied throughout elementary science. Students study pushing and pulling in grades 1–3 and are introduced to the term force *in grade 4. Students design experiments to test the effect of force in grades 4 (TEKS 4(6)(D)) and 5 (TEKS 5(6)(D)). TEKS 6(8)(B) introduces students to the concept of unbalanced forces. Students learn unbalanced forces cause changes in the position, direction, and speed of an object. TEKS 6(8)(C) focuses on calculating speed, and TEKS 6(8)(D) focuses on graphically representing changes in motion. Students use distance and time measurements to calculate speed and to create and analyze distance-time graphs. This grade 8 lesson helps students differentiate between speed and velocity and helps students develop the idea that unbalanced, net forces result in a change in velocity, or an acceleration.*

Please refer back to the K–8 Science TEKS pages _____ in the Vertical Alignment section, and circle the TEKS this lesson addressed.



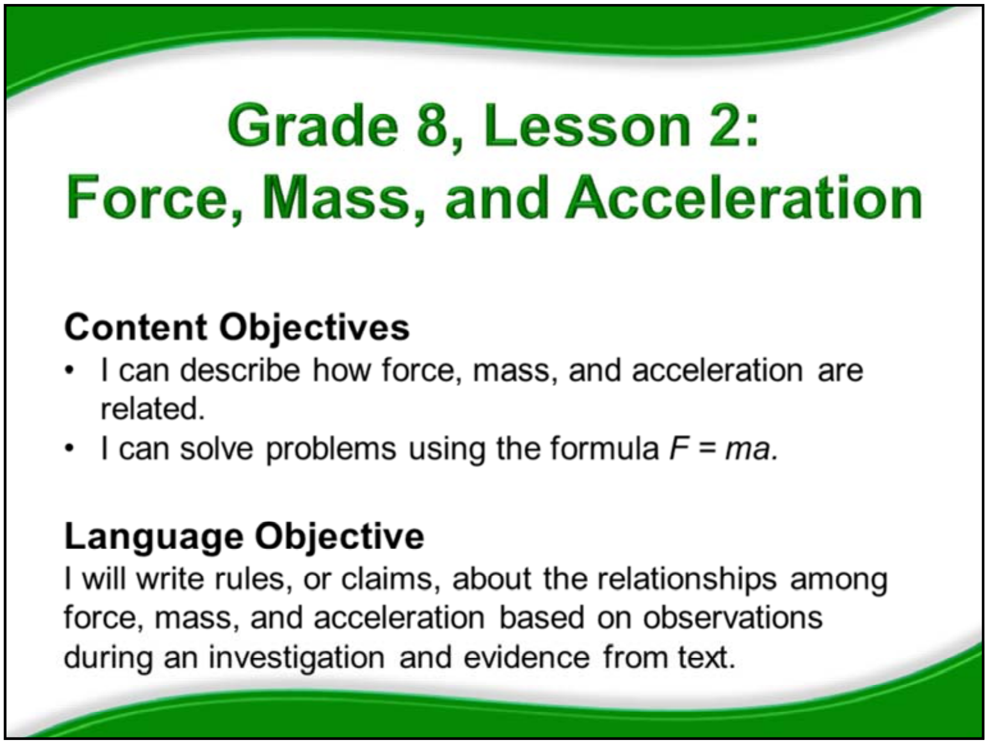
Review and discuss the statements in your Ideas about Force and Motion sort. You may rearrange the cards if any of your ideas about force and motion have changed.

Allow 3–5 minutes for groups to review the sort. Do not discuss the correct answers at this time.

Please leave your cards as they were sorted in the folder. We will revisit this sort again at the end of the day.

Dismiss participants for lunch.

Remind participants of the importance of starting the afternoon session on time.



Grade 8, Lesson 2: Force, Mass, and Acceleration

Please take a moment to read the content and language objectives for this lesson.

This grade 8 lesson follows the 5E model and includes math and literacy strategies, Tier I support, and differentiation.

This lesson should take approximately 140 minutes to complete in this training. The time allotment is as follows:

Engage	*25 minutes*
Explore	*25 minutes*
Explain	*60 minutes*
Elaborate	*20 minutes*
Evaluate	*10 minutes*

The first *E* is Engage. There are two parts to this activity. In Part One of the Engage, we will identify examples and non-examples of acceleration.

Distribute RM 1 cards and masking tape or chart paper to each group.

Use the materials provided to create an Example/Non-Example T-chart on your table. Read and discuss each card to determine whether it will be placed in the example column or the non-example column. You will have 10 minutes to complete the activity. You may begin.

After groups have completed the sort, debrief the activity using the facilitation questions.

In science, what do we call changes in velocity?

Changes in velocity are called accelerations.

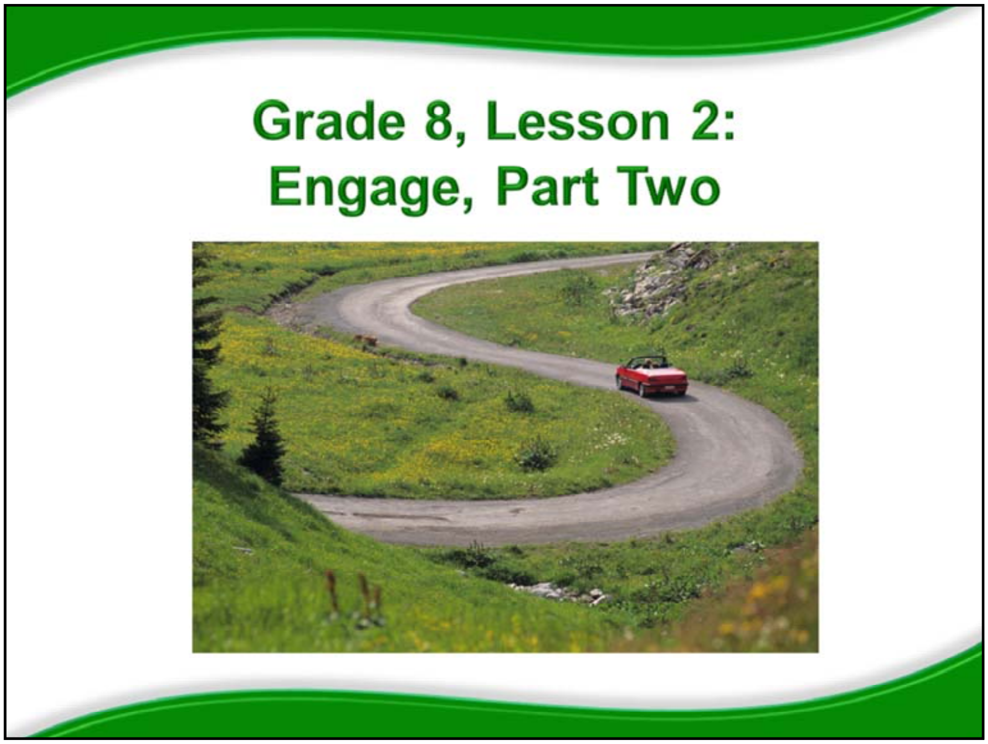
What are the three types of acceleration?

The three types of acceleration are speeding up, slowing down, and changing direction.

What causes an acceleration?

Forces cause accelerations.

Review the placement of each card. RM 1 on page ___ can be used as an answer key. The left column includes examples of accelerations. The right column includes non-examples of accelerations.



Part Two of the Engage focuses on the difference between large accelerations and small accelerations.

Does a large acceleration always result in an object moving very fast? *No. A large acceleration does not always result in an object going very fast. A large acceleration means that the velocity of an object is changing very quickly. The object is quickly speeding up, slowing down, or changing direction.*

Can anyone give an example of a large acceleration you have experienced?

Responses will vary but should describe an object or person quickly speeding up, slowing down, or changing direction.

How is a small acceleration different than a large acceleration?

A small acceleration means that the velocity of the object is changing slowly. The object gradually speeds up, slows down, or changes direction.

Can anyone give an example of a small acceleration you have experienced?

Responses will vary but should describe an object or person gradually speeding up, slowing down, or changing direction.

Can you feel the difference between a large acceleration and a small acceleration?

Yes

How does speeding up very quickly in a car feel compared with speeding up gradually?

It feels like you are being pressed back into the seat when a car takes off quickly. The feeling is not as noticeable when you speed up slowly.

How does slowing down very quickly in a car feel compared with slowing down gradually?

It feels like you are being pushed or thrown forward when a car slows down quickly. The feeling is not as noticeable when you slow down slowly.

How does turning very quickly in a car feel compared with turning gradually?

It feels like you are being pushed or thrown to the side of the car when a car turns quickly. The feeling is not as noticeable when you turn slowly.

Look at the cards in the example column of your T-Chart. As a group, sort the examples of acceleration into large accelerations and small accelerations. You have 5 minutes to complete this sort.

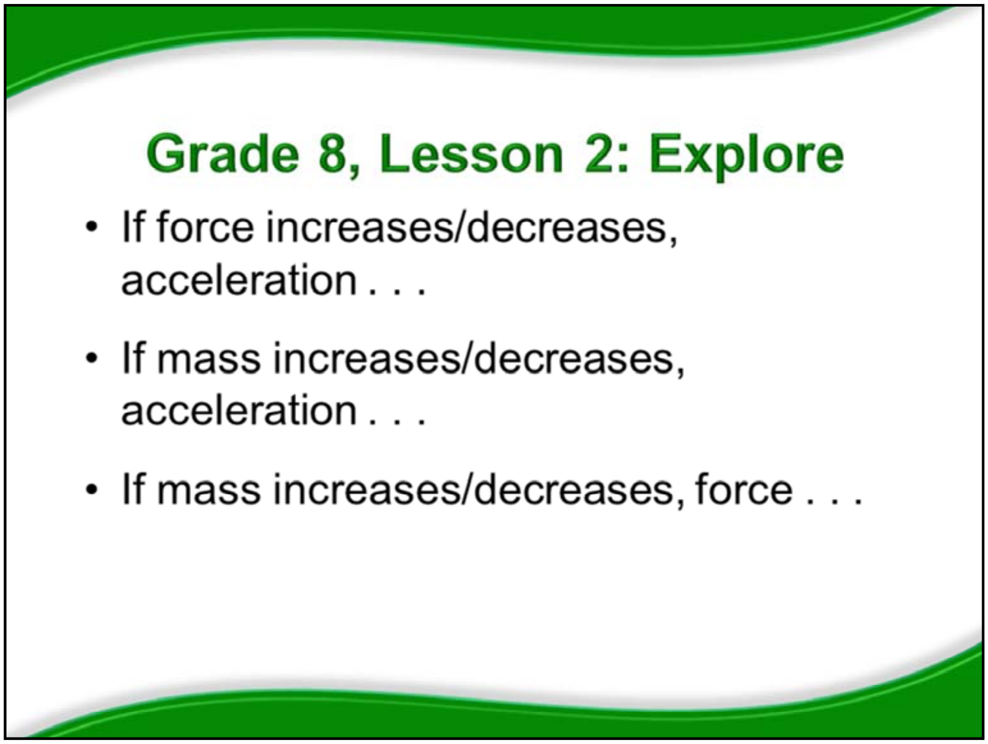
After groups have sorted the examples, use the facilitation questions to debrief the activity. Groups may interpret examples differently based on their own experiences. Accept reasonable responses with appropriate justification.

Which cards describe examples of large accelerations?

Answers will vary. Accept responses that include cards that describe an object speeding up, slowing down, or turning quickly. An airplane slowing down quickly and a rollercoaster car going down a hill may be interpreted as large accelerations.

Which cards describe examples of small accelerations?

Answers will vary. Accept responses that include cards that describe an object speeding up, slowing down, or turning slowly. A soccer ball rolling to a stop in the grass may be interpreted as a small acceleration.



The second *E* is Explore. During Explore, you will conduct three experimental investigations to learn about the relationships between force, mass, and acceleration.

In an experimental investigation, what is the independent variable?

The independent variable is the variable that is changed, or manipulated, by the investigator. There is only one independent variable in an experimental investigation.

In an experimental investigation, what is the dependent variable?

The dependent variable is the responding variable. The dependent variable changes as a result of the independent variable. There is only one dependent variable in an experimental investigation.

In an experimental investigation, what are controlled variables?

Controlled variables are any variables that remain constant during an investigation. There can be more than one controlled variable in an investigation.

Distribute RM 3 to each participant. Distribute investigation materials to each group or set up each investigation as a station. If using stations, explain how groups will move around the room.

Turn to RM 2 on pages ___. You will follow the instructions on RM 2 to complete the three investigations. During Investigation 1, you will change force and observe how this affects the acceleration of the cart. *Model the appropriate method to use a push–pull spring scale to launch the cart or toy car. Refer participants to the Teacher Note on page ___.*

Click.

During Investigation 2, you will change mass and observe how this affects the acceleration of the cart.

Click.

During investigation 3, you will change the mass and observe how this affects force. For each investigation, you will write a rule to describe the relationship you observed.

Click.

When writing your rules, you may use the sentence stems in the Tier I Support section on page ____.

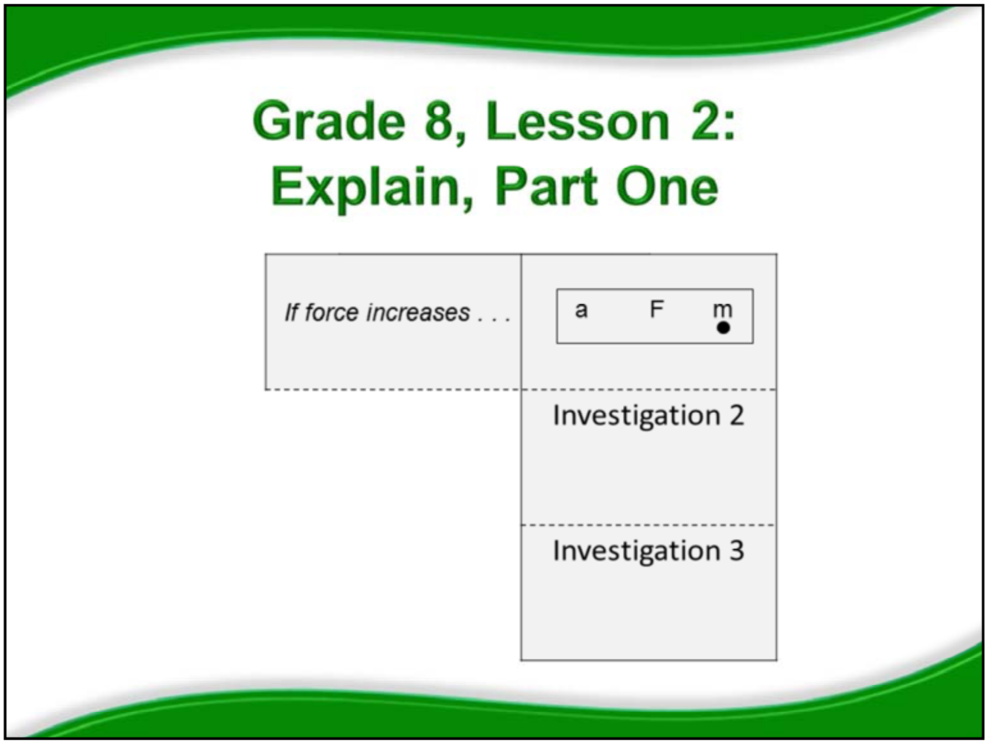
It is important to note that we will be making qualitative observations rather than quantitative observations. By grade 8, students are accustomed to taking measurements during science investigations. For this reason, many students and teachers will feel the need to measure the distance the car travels when observing acceleration. Is distance traveled an accurate measurement of acceleration?
No. Acceleration describes how quickly speed or direction changes. Distance and time measurements could be used to calculate average speed, but not acceleration. There are other factors that may affect the distance the cart travels, so distance does not really indicate the acceleration of the cart.

How can we observe acceleration? What should we look for when comparing trials?
Participants should observe and compare how quickly the cart "takes off" when different amounts of force or mass are used. Groups may want to conduct multiple trials before writing their rules.

Are there any questions before we begin?

You will have 20 minutes to complete the three investigations. You can get started!

The Explore investigations will be debriefed during Explain, Part One.



The third *E* is Explain. There are three parts in this Explain. We will debrief the Explore investigations during Part One of the Explain.

Distribute one piece of paper or cardstock, a set of three aFm strips from RM 4, and three brass fasteners to each participant.

Fold the blank cardstock in half to form a booklet, and cut the front page of the booklet to form three tabs as shown in the diagram. Label Investigation 1, Investigation 2, and Investigation 3 at the top of the three tabs. You will record information from each investigation inside each of the tabs. Cut the aFm strips apart. We will use these in the booklet.

Click.

Refer to Investigation 1 on your student page from Explore. Record the investigation question on the tab for Investigation 1.

Click.

What did you observe in Investigation 1? What was your generalization, or rule?

Answers will vary. Participants should have observed as force increased, acceleration of the cart increased.

What were the independent and dependent variables in Investigation 1?

The independent variable was force, and the dependent variable was acceleration.

What was held constant in Investigation 1?

Mass was held constant.

Look at one of the aFm strips. What do you think the *a*, the *F*, and the *m* represent?

acceleration, force, and mass

We will use one of the brass fasteners to attach the aFm strip inside the top section of the booklet. Because mass was held constant in Investigation 1, position the brass fastener below the *m*.

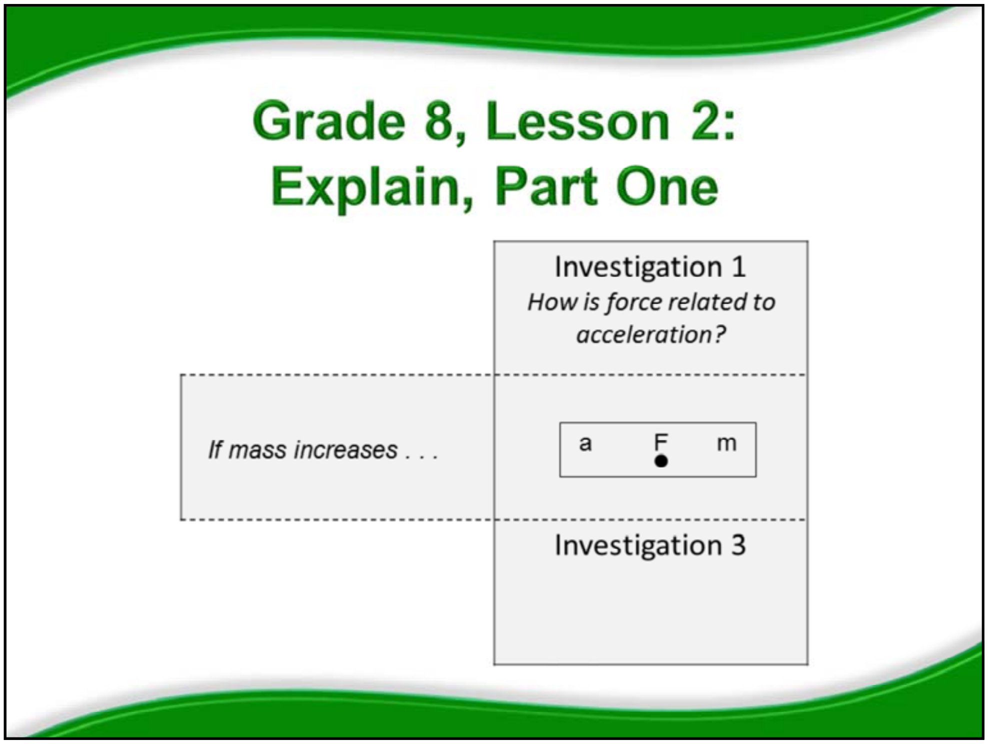
Click.

After participants have attached the strip correctly, instruct them to move the free end of the paper strip up and down. Model the movement for the group. **If the mass is constant, what happens to acceleration as force increases?** *As you ask the question, raise the free end of the strip, and the* a *and the* F *will both move up.* **Does this model support your rule about force and acceleration?** *The model should support participants' rules about force and acceleration.*

If the mass is constant, what happens to acceleration as force decreases? *As you ask the question, lower the free end of the strip, and the a and the F will both move down.* **Does this model support your rule about force and acceleration?** *The model should support participants' rules about force and acceleration.*

Record your rule about force and acceleration inside the Investigation 1 tab.

Click.



Refer to Investigation 2 on your student page from Explore. Record the investigation question on the tab for Investigation 2.

Click.

What did you observe in Investigation 2? What was your generalization, or rule?

Answers will vary. Participants should have observed as mass increased, acceleration of the cart decreased.

What were the independent and dependent variables in Investigation 2?

The independent variable was mass, and the dependent variable was acceleration.

What was held constant in Investigation 2?

Force was held constant.

Because force was held constant in Investigation 2, position the brass fastener below the *F*.

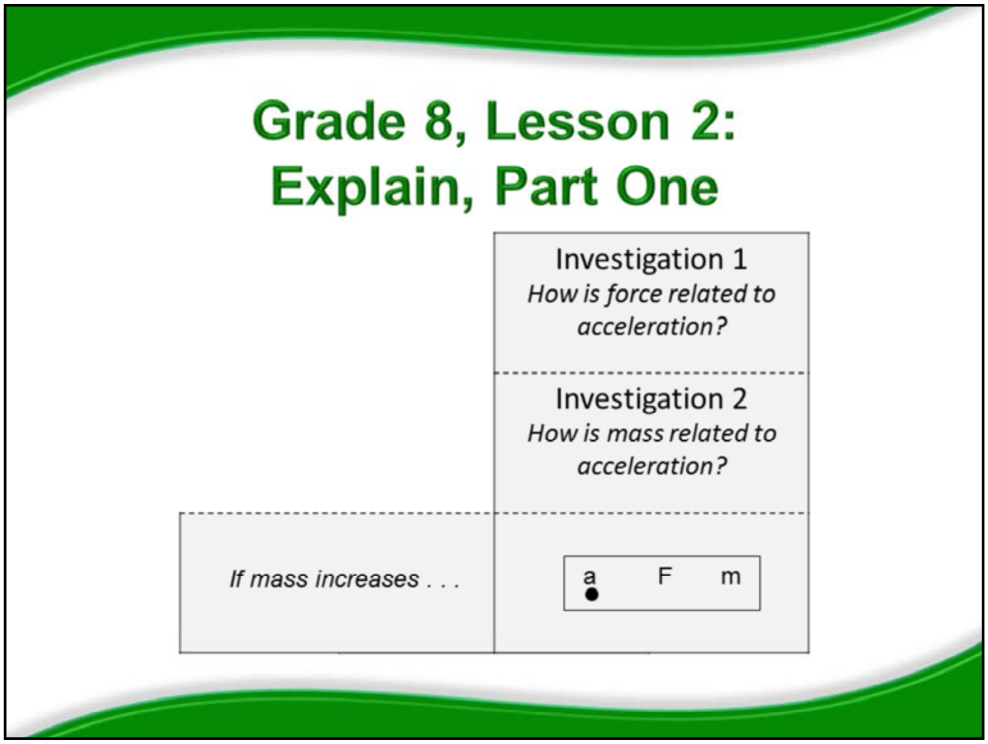
Click.

After participants have attached the strip correctly, instruct them to move a free end of the paper strip up and down. Model the movement for the group. **If force is constant, what happens to acceleration as mass increases?** *As you ask the question, raise the end of the strip labeled* m*, and the* a *will move down.* **Does this model support your rule about mass and acceleration?** *The model should support participants' rules about mass and acceleration.*

If the force is constant, what happens to acceleration as mass decreases? *As you ask the question, lower the end of the strip labeled* m*, and the* a *will move up.* **Does this model support your rule about mass and acceleration?** *The model should support participants' rules about mass and acceleration.*

Record your rule about mass and acceleration inside the Investigation 2 tab.

Click.



Refer to Investigation 3 on your student page from Explore. Record the investigation question on the tab for Investigation 3.

Click.

What did you observe in Investigation 3? What was your rule?

Answers will vary. Participants should have observed as mass increased, force increased.

What were the independent and dependent variables in Investigation 3?

The independent variable was mass, and the dependent variable was force.

What was held constant in Investigation 3?

Acceleration was constant.

Because acceleration was held constant in Investigation 3, position the brass fastener below the *a*.

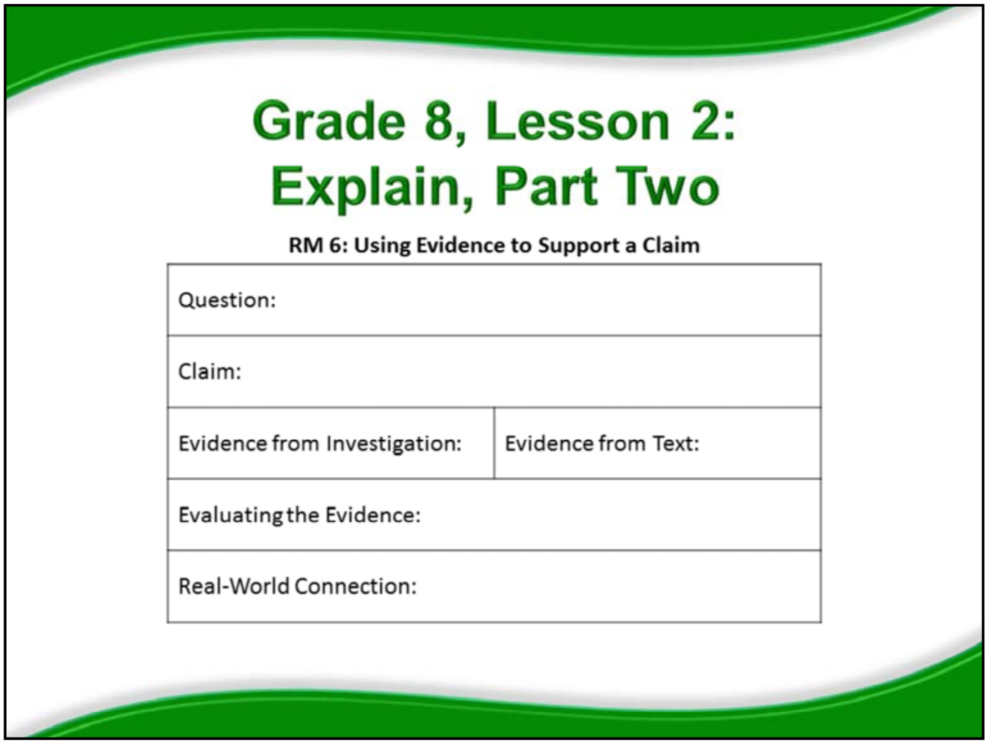
Click.

After participants have attached the strip correctly, instruct them to move the free end of the paper strip up and down. **If acceleration is constant, what happens to force as mass increases?** *As you ask the question, raise the end of the strip labeled* m*, and the* F *will move up.* **Does this model support your rule about mass and force?** *The model should support participants' rules about mass and force.*

If the acceleration is constant, what happens to force as mass decreases? *As you ask the question, lower the end of the strip labeled* m*, and the* F *will move down.* **Does this model support your rule about mass and force?** *The model should support participants' rules about mass and force.*

Record your rule about mass and force inside the Investigation 3 tab.

Click.



During Part Two of Explain, we will use evidence from the reading passage and Explore activity to support our claims about force, mass, and acceleration.

Turn to RM 5 on page ___. We will only read pages 1 and 2 and the box at the top of page 3 at this time. Stop when you reach the section titled "Calculating Force, Mass, and Acceleration." You may read independently or with a partner, and you may choose to use a reading strategy, such as highlighting important information, as you read. You have 7 minutes to complete the first part of the reading.

Distribute chart paper, chart markers, and sticky notes to each group.

Click.

Turn to RM 6 on page ___. In science, a claim is a possible answer to a question that is being investigated. We must use evidence to support a claim. Your group will create a claims and evidence chart like the one shown on RM 6 on chart paper.

Assign one investigation question from the Explore to each group. **As a group, complete the chart for your assigned investigation question. You will have 10 minutes to complete your chart.** *Indicate where groups should post their charts when completed.*

We will conduct a gallery walk to observe charts created by your peers. Work with a partner or a group or three. Use sticky notes to leave feedback or questions on your peers' charts. A list of sentence starters is provided on RM 7 on page ____.

You have 5 minutes to complete the gallery walk . Please return to your chart when you have completed your gallery walk , and review the feedback and questions provided by your peers.

Allow 5 minutes to conduct the gallery walk *and an additional 2–3 minutes for groups to review feedback and questions posted on their charts.*

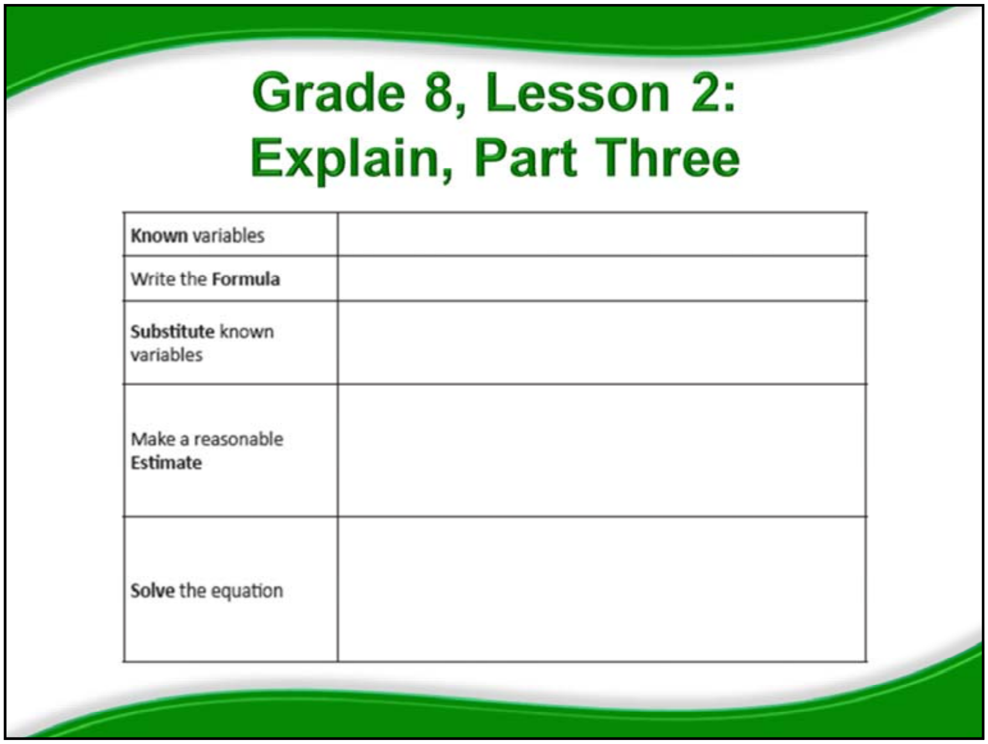
Use the facilitation questions to reflect on the activity as a whole group.

Did the gallery walk clarify or extend your understanding? Why?

Answers will vary.

Did any of the feedback from your peers clarify or extend your understanding? Why?

Answers will vary.



Distribute two or three calculators to each group. **Part Three of Explain focuses on the mathematical relationship between force, mass, and acceleration.**

Turn to the third page of RM 5 on page ___ in your book. Read the section titled "Calculating Force, Mass, and Acceleration" on pages 3 and 4 of RM 5. You may read independently or with a partner, and you may choose to use a reading strategy, such as highlighting important information, as you read. Be sure to complete Example 3 at the end of the reading passage. Calculators have been provided if you would like to check your calculations.

You have 10 minutes to complete the reading and example problem.

Use the facilitation questions to debrief the reading passage.

Which of Newton's laws of motion describes the relationships between force, mass, and acceleration?

Newton's second law of motion relates force, mass, and acceleration.

What formula is used to describe the relationships between force, mass, and acceleration?

Force equals mass times acceleration, or F = ma*.*

What is the SI unit for force?

Force is measured in Newtons (N).

What is the SI unit for mass?

Mass is measured in kilograms (kg).

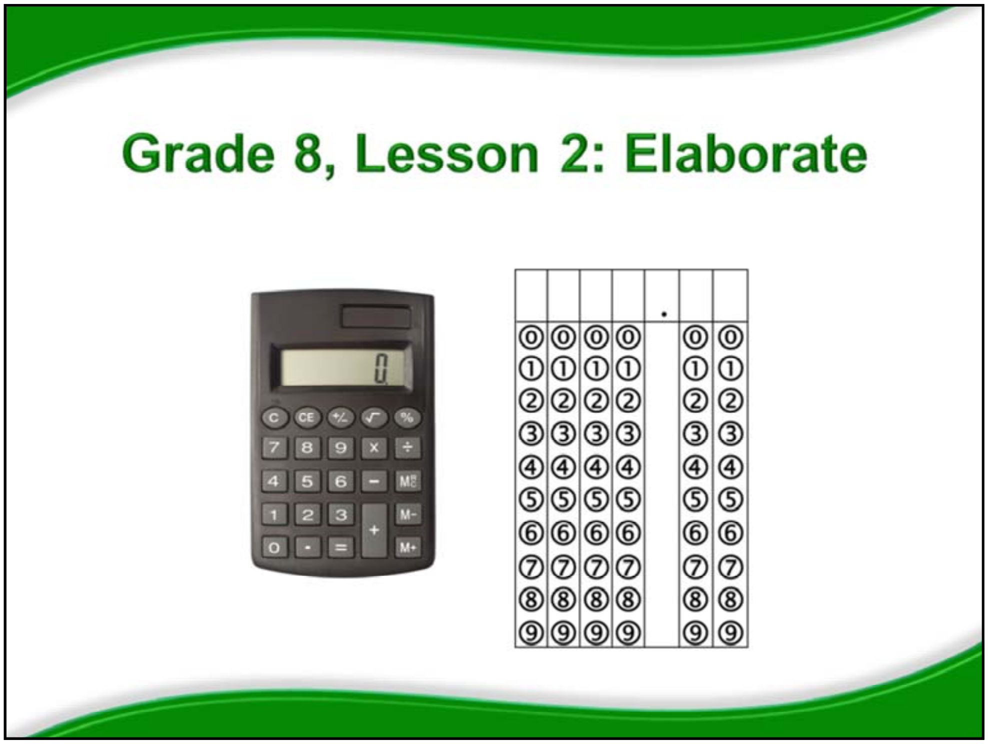
What is the SI unit for acceleration?

Acceleration is measured in meters per second squared (m/s^2).

When using the problem-solving chart, what should you do if your solution is not reasonable (close to your estimate)?

If the solution to the problem is not reasonable, there may have been a calculation error or a procedural error. Check calculations for errors. If there are no multiplication or division errors, try a different process to solve the problem.

Refer to the answer key on page ___ to review Example 3.



The fourth *E* is Elaborate.

Please read the Content Builder on page ___. *Allow 1–2 minutes for participants to read.*

By the time students reach eighth grade, they should be able to solve for any of the variable in *F = ma* using substitution. It is important to work with math teachers on your campus to ensure students use the same approach to problem-solving in math and science.

Turn to RM 8 on page ___. Use the problem-solving chart for each calculation. Record and bubble your answer if a grid is provided.

You may work independently or with a partner. You may refer to the example problems from RM 5 as you work. Calculators have been provided if you would like to check your work for calculation errors.

You have 15 minutes to complete RM 8.

If time allows, instruct participants to find a partner or form a group of three with people who are not in their table group. Allow 5 minutes for partners or groups to discuss and compare their problem-solving charts and calculations.

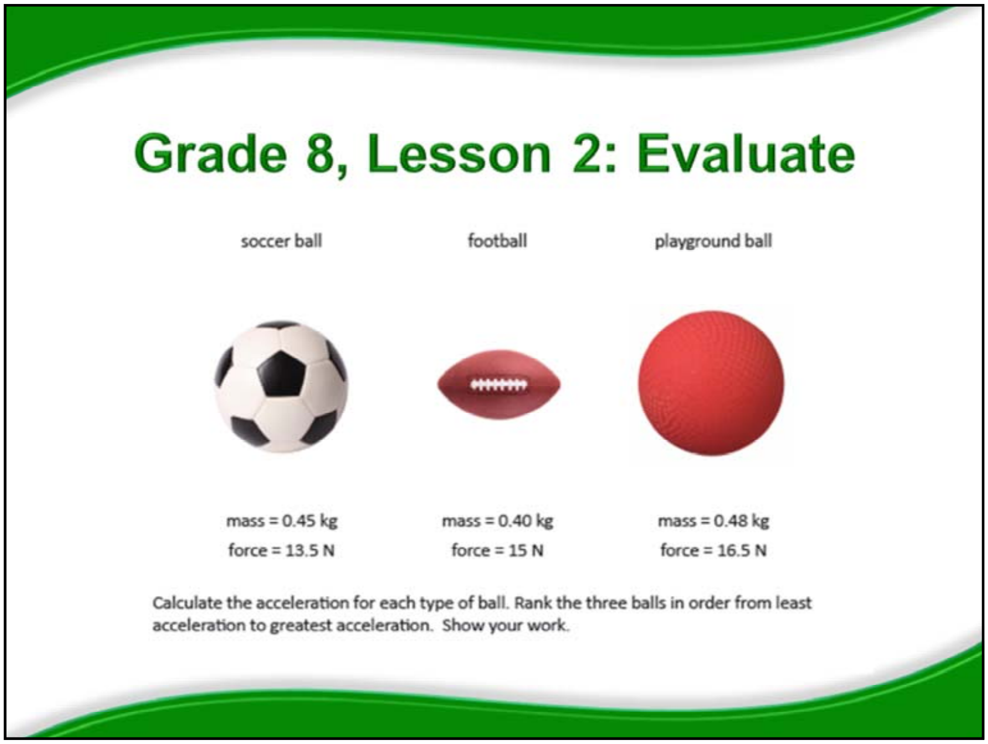
Refer participants to the answer key on pages ______ . Use the answer key and facilitation questions to debrief the activity.

How does the problem-solving chart support student success?

The problem-solving chart provides a set of steps students can follow as well as a chart to organize student work. The chart also helps students make a connection between processes skills used in math class with processes and skills used in science class.

What is the benefit of comparing problem-solving charts?

Answers will vary. Students have an opportunity to check their work. Students may benefit from seeing what strategies other students used to make their reasonable estimate.



The fifth *E* is Evaluate.

Turn to RM 10 on page ___. The blank problem-solving charts on RM 10 can be used with the Evaluate assessment. RM 10 can also be used as a Tier I Support with other lessons that require students to solve calculations.

Read through the Evaluate assessment as written in RM 9 on page ____.

Allow 5–7 minutes for participants to review the assessment items. Refer participants to the answer key on page ___. Address any questions about the Evaluate assessment.

Grade 8, Lesson 2
Lesson Reflection

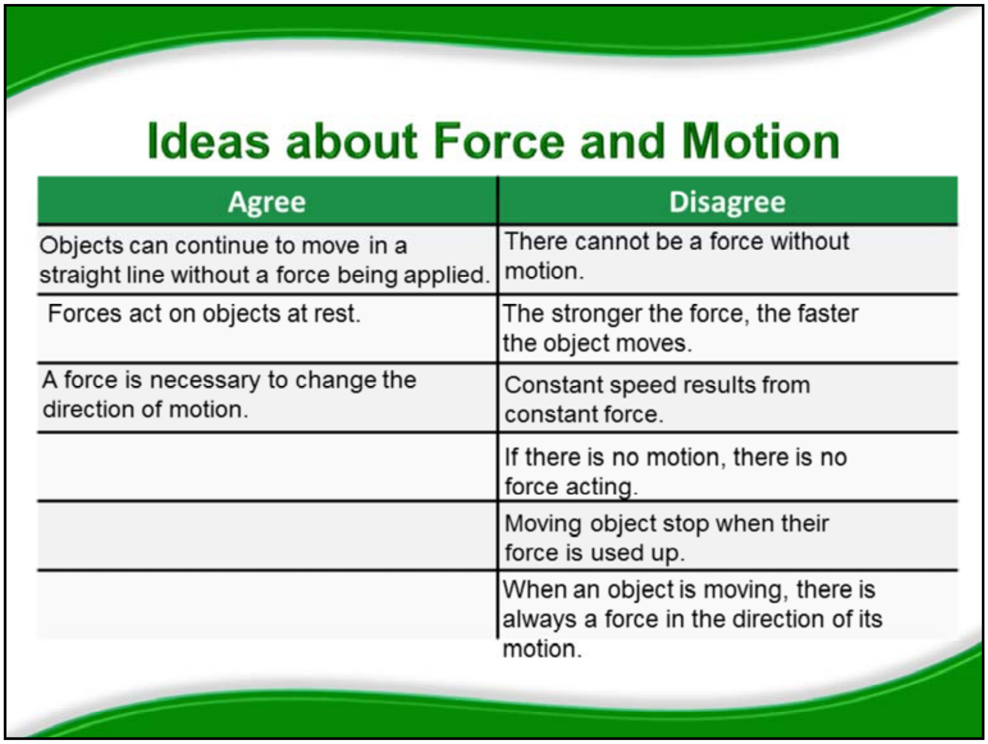
Take a moment to reflect on grade 8 lesson 2. Consider how literacy and math strategies were embedded into this lesson.

Locate page _____ in the Instructional Resources section, and record how those things were embedded.

Allow 5 minutes for participants to record their responses.

How does this lesson build on previous grade levels and also support higher grade levels?
The concept of force is studied throughout elementary science. Students study pushing and pulling in grades 1–3 and are introduced to the term force *in grade 4. Students design experiments to test the effect of force in grades 4 (TEKS 4(6)(D)) and 5 (TEKS 5(6)(D)). TEKS 6(8)(B) introduces students to concept of unbalanced forces. Students learn unbalanced forces cause changes in the position, direction, and speed of an object. TEKS 6(8)(C) focuses on calculating speed, and TEKS 6(8)(D) focuses on graphically representing changes in motion. Students use distance and time measurements to calculate speed and to create and analyze distance-time graphs. This grade 8 lesson helps students reinforce the idea that unbalanced, net forces result in a change in velocity, or an acceleration. Students learn the relationships between force, mass, and acceleration and are able to use the formula,* F = ma, *to solve problems.*

Please refer back to the K–8 Science TEKS pages _____ in the Vertical Alignment section, and circle the TEKS this lesson addressed.



Review and discuss the statements in your Ideas about Force and Motion sort. You may rearrange the cards if any of your ideas about force and motion have changed.

Allow 3–5 minutes for groups to review the sort.

Did any of your ideas about force and motion change? *Allow volunteers to share how their ideas changed.*

We will review the correct Agree and Disagree statements.

Read each statement and then click to reveal the answer. Explanations are provided if participants question the placement of a statement.

There cannot be a force without motion. *Click.* **Disagree.** *Forces can and do act on objects that are not moving.*

The stronger the force, the faster the object moves. *Click.* **Disagree***. Stronger force results in greater acceleration. Greater acceleration may result in an object speeding up faster, but it can also mean and object is slowing down faster or changing direction faster.*

Objects can continue to move in a straight line without a force being applied. *Click.* **Agree**. *A force is needed to make an object start moving, but once the object is in motion its inertia keeps it moving. The object will continue moving at the same speed and in the same direction until an unbalanced (net) force is applied to the object. Because outside forces, including friction and gravity, affect the motion of objects on Earth, objects usually slow down and stop if no additional force is applied to keep the object in motion.*

Constant speed results from constant force. *Click*. **Disagree**. *If speed is constant (in a straight line), the forces acting on the object are balanced. A constant force will result in a change in motion, such as speeding up, slowing down, or changing direction.*

Forces act on objects at rest. *Click.* **Agree**. *Forces can and do act on objects at rest.*

If there is no motion, then there is no force acting. *Click.* **Disagree**. *Forces can and do act on objects that are not moving.*

Moving objects stop when their force is used up. *Click.* **Disagree**. *A force is an interaction between two objects. Force cannot be stored and "used up." Moving objects stop because an unbalanced force (usually friction) caused the object to slow down and stop.*

A force is necessary to change the direction of motion. *Click.* **Agree**. *An unbalanced (net) force is needed to change the direction or speed of an object.*

When an object is moving, there is always a force in the direction of its motion. *Click.* **Disagree**. *An unbalanced force is required to make an object start moving. Once the object is in motion, it may continue moving without a force applied the in the direction of its motion. The inertia of the object keeps it in motion.*

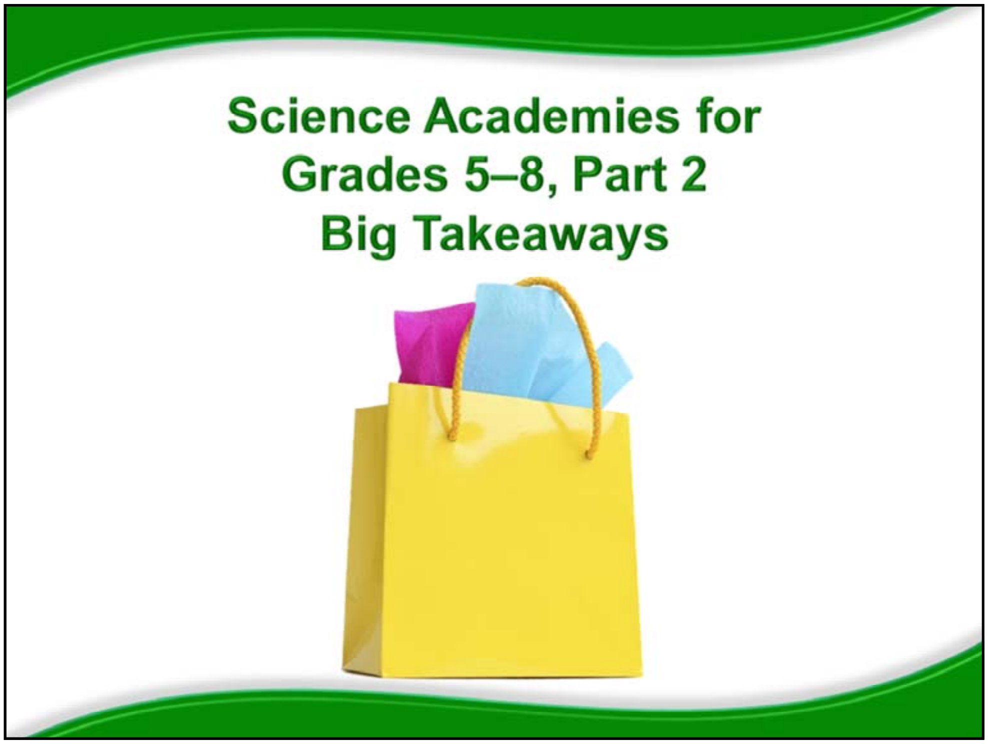
These statements include the most common misconceptions about force and motion. It is not uncommon to find that, as adult learners, we still have misconceptions about force and motion. We must be aware of our own misconceptions so that we can continue to work to change our own incorrect ideas.

Force and Motion Debrief

Grade	TEKS	Lesson Titles
8	8(6)(A)	Force, Mass, and Acceleration
8	8(6)(A), (B)	Balanced and Unbalanced Forces
7	7(7)(A)	Work
6	6(8)(B), (C), (D)	Changes in Motion
5	5(6)(D)	Experimental Investigation

Take a moment to reflect on the Force and Motion strand of the TEKS and the lessons we have explored over the past 3 days. How do these lessons support the physics curriculum? What are students learning through these experiences that will help them be successful in high school physics?

Allow 3 minutes for participants to share their responses.



Designate places to display posters.

Think about the last 3 days of instruction with your group. We have learned science content, math and literacy strategies, how to differentiate an activity, and how to add Tier I Supports to our lessons. Over the next few minutes, summarize what you will take away from this workshop and implement in your classrooms. Write your summary on chart paper, and post it in the designated area.

Allow participants time to do a gallery walk.

This activity should last no longer than 10–15 minutes.

Thank you for your participation and for doing your part to nurture our future scientists.

Please remind participants to organize their tables.