Balls and Ramps Pacing Guide[1]

Use the information below to assist you in determining the amount of time needed to complete the entire unit. These recommendations assume the **average science class period is 45 to 60 minutes in length**. We recommend teaching science a minimum of three sessions per week in order to maintain consistency and keep students engaged. Many teachers accomplish this by rotating a science unit with a social studies unit, enabling you to teach more science sessions in one week and finish the unit in fewer weeks. We highly recommend that all teachers participate in the Expository Writing and Science Notebooks Program in order to further develop students' science understandings, as well as their scientific thinking and writing skills. To implement the science-writing curriculum requires, for most lessons, a separate 20 to 30 minutes for a science-writing mini-lesson and independent writing time. Time for these mini-lessons is not included in this pacing guide.

Lesson and Common Assessments (see corresponding pages in the Instructional Guide for lesson planning)	**Recommended Number of Periods**	**GLEs Addressed/Big Idea(s) of the Lesson**	**Considerations for Planning**	**Recommended Applications and Extensions**
Lesson 1: **Introducing Balls** Students look at and touch a variety of balls and describe their properties.	1	**GLE 1.1.1** Understand simple properties of common natural and manufactured materials and objects. **1.3.1** Know that a push or a pull is a force on an object. **1.3.2** Know that pushes or pulls can change the motion of common objects [balls]. **Big Idea**: Balls with different properties behave and move differently.	**Modification:** The engagement piece has been changed from the manual. Collect 7-8 balls that aren't in the kit, so that students can actually see and touch the balls as they talk about their properties.	Make the balls from this lesson available in a center for students to continue observing and noting properties.
Lesson 2: **Differences** Students compare the ping pong ball and the rubber ball.	1	**GLE 1.1.1** Understand simple properties of common natural and manufactured materials and objects. • *Identify and describe differences between common natural and manufactured materials using properties.* **Big Idea:** Balls with different properties behave and move differently.	• Use the tennis ball and the wooden ball to introduce the lesson. The students will use the ping pong ball and the rubber ball for the investigation. • **Tip:** Do not use the science notebook page in the manual. Have the students draw each ball in their science notebook and write its properties next to each drawing.	
Lesson 3: Comparing Balls (size, weight, bounce and roll) First Session: Students compare two balls that are quite different in size and weight. Second Session: Students look at the rest of the balls in the kit and complete the class *Properties Data Table*.	2	**GLE 1.1.1** Understand simple properties of common natural and manufactured materials and objects. • *Sort common materials using a simple property (e.g. texture, color, size, shape, weight].* **Big Idea:** Balls with different properties behave and move differently.	• Recommended balls for session 1 are the small rubber ball and the large polystyrene ball. • Construct a large class properties data table. • Help the students come up with a definition of a good roller. Chart the definition and refer back to it. • Do not include the Wiffle ball on the properties table. Save it for CBA A.	

[1] Pacing Guide for use with the *BALLS AND RAMPS* Teacher's Manual, Kendell/Hunt Publishing Company (1997)

CBA A: Identifying the Properties of Balls.	1	**GLE 1.1.1** Understand simple properties of common natural and manufactured materials and objects. • *Identify and describe a property of an object.*	Use a ball that students haven't formally observed as a class.	
Lesson 4: **Straws and Balls** Students use straws to see which balls are easier to start moving and which balls can knock over objects.	1	**GLE 1.1.2** Understand the position and motion of common objects. • *Know that things move in many different ways (i.e. back and forth, fast and slow, round and round, straight).* • *Describe that the way to change how something is moving is to give it a push or a pull.* **1.3.1** Know that a push or a pull is a force on an object, but that some forces can act without touching an object. • *Observe a push or a pull on an object is a force on that object.* **Big Idea:** The weight of a ball affects how easy it is to start a ball moving, to cause it to change directions, and to enable it to knock over an object.	• **Modification:** Have students focus on which ball is easiest to start moving and to change direction. Don't discuss which ball is hard to stop moving because the ping pong ball is hard to control and this can lead to misconceptions. • Students might find it easier to knock over the tubes if they can use the rulers to make a path. • <u>The lighter ball should be easier to start and to cause and change direction.</u> If the tubes are too light to get meaningful results (both balls can easily knock them down), then consider using something a bit heavier, such as student glue bottles. <u>The heavier ball should be able to knock it over, but not the lighter ball.</u>	Have students make a maze with blocks and try to blow different balls through it with straws. Have them discuss or write about which balls are easier to get through the maze, and which are more difficult. This will give students a chance to apply what they learned about the ping pong and rubber ball in the lesson to other balls.
Lesson 5: Bouncers This lesson is open exploration where students begin to form ideas about good and bad bouncers.	1+	**GLE 1.1.2** Understand the position and motion of common objects. • *Describe that the way to change how something is moving is to give it a push or a pull.* **Big Idea**: Balls with different properties behave and move differently. The different properties of the balls affect how they bounce and roll (e.g., weight, material, texture, shape).	• Students need plenty of time to explore the balls, so you might want to have two sessions. • Consider going to the gym or playcourt so students have lots of room to explore and bounce the balls. • Capitalize on student disagreement about which ball is the best bouncer because this will lead into the next lesson.	

Lesson 6: Comparing Bounciness I Students set up a fair test to determine if the rubber ball or the ping pong ball is the better bouncer. They create a back-to-back line plot to analyze the class data.	1-2	**GLE 1.1.1** Understand simple properties of common natural and manufactured materials and objects. **2.1.2** Understand how to plan and conduct a simple investigation. • *Make predictions of the results of an investigation.* • *Plan and conduct an observational investigation that collects information about properties.* • *Collect data using simple equipment and tools that extend the senses.* **2.1.3** Understand how to construct a reasonable explanation using evidence. • *Categorize and order observational data from multiple trials.* • *Explain an event using observations as evidence (e.g., shape, texture, size, weight, motion).* **2.1.5** Understand how to record and report an investigation. • *Report investigations using drawings and simple sentences.* • *Report the process used and the results of the investigation (e.g., verbal, visual, mathematical).* **2.2.1** Understand that all scientific observations are reported accurately even when the observations contradict expectations. **2.2.3** Understand that similar investigations may not produce similar results. • *Observe procedures for similar investigations; explain that they produced different results.* **Big Idea:** The different properties of the balls affect how they **bounce** and roll (e.g., weight, material, texture, shape).	• All pairs need to be able to test both balls (the manual suggests half the pairs test one ball, and half test the second ball). Having all the pairs test both balls will give you more data and increase students' confidence in the results. • **Do not** use the science notebook page from the manual. **Do not** make a bar graph as shown on p. 98 in the manual. Make a back-to-back line plot instead. • It may or may not be obvious which ball is the better bouncer, depending on the class data. One ball's number of bounces may only be slightly higher. It is important for students to think about whether or not they can answer the focus question and to explain their reasoning. It is possible that the conclusion may be that the two balls bounce about the same. Or students may decide that they need to continue testing because there is not enough data, or because they were not careful about doing a fair test.	Students may decide that a good bouncer bounces high. Have them create a fair test to investigate which ball is the best bouncer in terms of height.
Lesson 7: **Comparing Bounciness II** Using the fair test procedure the students created in the previous lesson, they test the rest of the balls. They use a class data graph to compare the balls. Students then come up with a definition of a good bouncer.	1-2	**GLE** same as for lesson 6 **Big Idea**: The different properties of the balls affect how they **bounce** and roll (e.g., weight, material, texture, shape).	• Students apply what they have learned about a fair test to other balls, so this lesson can be used as a **formative assessment**. • Do not use the science notebook page in the manual. Have students record on a T-Chart in their science notebooks as they did in lesson 6. • A bar graph, as suggested in the manual, isn't an appropriate graph for this data. Instead of coloring in the bar, place a dot or sticker in each column next to the middle number of bounces for each ball. • Have students come up with a definition of a good bouncer. Chart the definition and refer back to it.	

Assessment B: Designing a Fair Test	1	**GLE 2.1.2** Understand how to plan and conduct simple investigations following all safety rules.		
Lesson 8: Making Clay Balls Students use clay to make balls and explore whether they can roll and bounce.	1	**GLE 1.1.1** Understand properties of common natural and manufactured materials and objects. **1.1.2** Understand the position and motion of common objects. **Big Idea:** The different properties of balls affect how they **bounce** and **roll** (e.g., weight, material, texture, shape).	**Tip:** Having students make balls using only clay helps them focus on the properties of roundness and smoothness.	The home-school worksheet in the manual could be sent home following this lesson.
Lesson 9: **Making More Balls (Embedded Assessment)** Session 1: Students use a variety of materials to make balls. Session 2: Using what students have learned in the previous session, students try to make balls that are good bouncers and/or rollers.	2	**GLE 1.1.1** Understand properties of common natural and manufactured materials and objects. **1.1.2** Understand the position and motion of common objects. **Big Idea:** The different properties of balls affect how they **bounce** and **roll** (e.g., weight, material, texture, shape).	• Collect a variety of materials that students might want to use to make their balls. Make sure you have plenty of rubber bands. • Allow as many students as you have time for to share their balls and explain why they made them the way they did.	Place the ball making materials and the cut in half balls in a center so that students can keep exploring their ideas about making good bouncers and rollers.
Lesson 10: **Balls, Ramps, and Roadways** Students spend two sessions on open exploration. They informally test their ideas about how balls move on ramps and roadways. At the end of the second session, students turn their ideas into questions, which lead into the investigations in the following lessons.	2	**GLE 1.3.1** Know that a push or a pull is a force on an object but some forces can act without touching an object. **1.3.2** Know that pushes or pulls can change the motion of common objects. • *Observe that objects fall toward the ground because of the pull of Earth's gravity.* **Big Idea:** A ramp system affects how balls move. In order to start a ball moving a ball must be given a push or a pull (e.g. gravity pulls a ball down a hill). A ball will roll faster on a steeper incline (ramp) than a less steep incline. A fast moving ball will be able to push an object further than a slower moving ball.	• Chart what students are thinking and learning as they observe even if their ideas aren't accurate. • Help students turn their ideas into testable questions. *Does…*is a good way to begin the questions.	• You might want to allow students to design an investigation to find answers to their questions or allow students to do this independently at a learning center. (Some of the questions may be similar to the focus questions of the next few lessons.) • Consider using Session III in the Teacher's Manual as a center activity.

Lesson 11: Exploring Different Ramps Students explore how the steepness of a ramp affects the speed of a ball. Then, they create a fair test to investigate how the speed of a ball affects how far a ball moves an object. They create a back-to-back line plot to analyze their data.	1+	**GLE 2.1.1** Understand how to ask a question about objects, organisms, and the environment. **2.1.2** Understand how to plan and conduct simple investigations following all safety rules. **2.1.3** Understand how to conduct a reasonable explanation using evidence. • *Categorize and order observational data from multiple trials.* **2.1.5** Understand how to record and report investigations, results, and explanations. **2.2.1** Understand that all scientific observations are reported accurately even when the observations contradict expectations. **2.2.3** Understand that similar investigations may not produce similar results. **Big Idea:** A ramp system affects how balls move. A ball will roll faster on a steeper incline (ramp) than a less steep incline. A fast moving ball will be able to push an object further than a slower moving ball.	• Don't make the class chart shown on p. 157 in the Teachers' Manual or attempt to measure how far the balls go. • Small milk cartons work well for blocks. Plastic cups could also be used if they are upside down. Try both to determine which works best on the floor surface in your classroom. • Two rulers can be taped to guide the ball so it hits the carton/cup squarely. • Do not use the science notebook page in the manual. Students should make two t-charts in their science notebooks. • Construct a back-to-back line plot in order to compare the class data.	• The home-school worksheet following page 164 could be sent home following this lesson. • Consider making the materials available as a center activity for students to continue exploring.
Assessment C: Understanding Ramps of Different Heights	1	**GLE 2.1.3** Understand how to construct a reasonable explanation using evidence. Evidence of learning: • *Explain and event or phenomena using observations as evidence.*	Have a one-block and a two-block ramp set up in the room in case students need to be able to make another observation before answering the question. But, **do not** allow students to retest. They should use their data, or the class data on the line plot, to answer the questions on the CBA.	
Lesson 12: Ramps and Different Weight Balls Students create a fair test to see if balls of different weights roll down a ramp at different speeds or the same speed.	1+	**GLE** same as for lesson 11 **Big Idea:** Balls of different mass (weight) and size will roll down the ramp at the same speed if all other variables are controlled.	• **Follow the Instructional Guide for this lesson. Do not use the Teacher's Manual.** • **Do not use the word "race"** as this causes students to expect one ball to be the winner and makes it more difficult to be objective. • Have students practice before they begin recording to increase the accuracy of their results. • Under perfect conditions, the two balls would reach the bottom of the ramp at the same time. Given differences in texture of the ramps and balls, that may not happen in the classroom; however, it will be close.	

Lesson 13: Ramps and Different-Size Balls Students use the same fair test plan as in lesson 12, but this time they investigate whether **different sizes** roll down the ramp at different speeds or the same speed.	2	**GLE** same as for lesson 11 **Big Idea:** Balls of different mass (weight) and size will roll down the ramp at the same speed if all other variables are controlled.	This lesson is exactly the same format as the previous lesson, except the students are testing balls of **different sizes**. **Follow the Instructional Guide for this lesson. Do not use the Teacher's Manual.**	
Lesson 14: Building a Complex System Students work in groups of 2-3 to plan and construct a ramp system that causes the ball to move in a certain way.	1 long session	**GLE 1.2.1** Understand that things are made of parts that go together. • *Identify the parts of objects, organisms, and materials. [ramp system]* • *Describe how the parts of objects, organisms, and materials go together.* • *Construct simple devices to do common tasks using common materials and explain how the parts depend on each other. [ramp system]* **Big Idea:** A ramp system affects how balls move. Different ramp systems cause balls to move in different ways. If one part of the system is removed, the entire system will not function the same way.	Students should draw their plan **before** they are given any materials. This will help you informally assess students as they are working. You might allow students to revise their plans once, since as they work, they will probably want to improve them.	Allow students to continue working with the materials as a center activity. This will give students a chance to improve upon their plans by incorporating ideas from other students' systems.
Assessment D: Identifying the Parts of a System	1	**GLE 1.2.1** Understand that things are made of parts that go together. Evidence of learning: • *Identify the parts of objects, organisms, and materials.* • *Describe how the parts of objects, organisms, and materials go together.* • *Construct simple devices to do common tasks using common materials and explain how the parts depend on each other.*		