



## Sound Pacing Guide<sup>1</sup>

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 45-60 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 Notebook Program in order to more fully develop students’ science understandings, as well as their scientific thinking and writing skills. To implement the science-writing curriculum requires 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 lesson in Instructional Guide for lesson planning)	Recommended Number of Periods	Big Idea(s) of Lesson	Considerations for Planning	Recommended Applications and Extensions
<p><b>Lesson 1: Thinking about Sound.</b> Teacher activates students’ prior knowledge and records on class charts. Students investigate tuning forks and the sounds produced by the tuning forks.</p>	2	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <b>Big Idea:</b> Sounds are produced by vibrating objects.</p>	<ul style="list-style-type: none"> <li>Explain to students what tuning forks are and their purpose. The “Tips on Using a Tuning Fork” section, on page 16 of the teacher’s manual, is useful if you are not familiar with using a tuning fork.</li> </ul>	<ul style="list-style-type: none"> <li>Take students on a “sound walk” indoors or outdoors. This activity is described on page 18 in the teacher’s manual under the science extension.</li> <li>In order to help students be more conscious of sounds around them, make a tape of everyday sounds and see if students can guess the appropriate object making the sound.</li> </ul>
<p><b>Lesson 2: How Sound Travels.</b> Students explore how the sounds produced by tuning forks travel through different materials: wood, metal, string.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <b>Big Ideas:</b> Sounds are produced by vibrating objects. Sound travels differently through various objects.</p>	<ul style="list-style-type: none"> <li>You will want to prepare pieces of string and foil that are about a meter long before you begin the lesson. Each pair or group will need a wooden meter stick. These are not included in the kit.</li> </ul>	<ul style="list-style-type: none"> <li>Invite students to explore how sound travels in other objects in the classroom. One student holds the stem of a vibrating tuning fork near one end of the object while another student listens for sound at the other end of the object.</li> </ul>
<p><b>Lesson 3: Making Sounds with Nails.</b> Students explore the sounds made by vibrating nails of different sizes.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <b>GLE 2.2.3</b> Understand why similar investigations may not produce similar results. <i>Describe reasons why two similar investigations can produce different results.</i> <b>Big Ideas:</b> Sounds are produced by vibrating objects. Objects of different sizes can be used to produce sounds of different pitches.</p>	<ul style="list-style-type: none"> <li>After students have conducted investigation and you have discussed the results, discuss whether or not this was a fair test and the variables that could have affected the results.</li> </ul>	<ul style="list-style-type: none"> <li>Note Extensions 1 and 2 on page 30 in the teacher’s manual.</li> </ul>

<sup>1</sup> Pacing Guide for use with the *SOUND* Teacher’s Manual, National Academy of Science (1997)

<p><b>Lesson 4: Making Sounds with Rulers.</b> Students investigate length of a vibrating object as a specific variable that affects pitch.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i>  <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations following all safety rules.  <b>Big Ideas:</b> Sounds are produced by vibrating objects. Changing the length of an object affects the nature of the vibrations and the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>This lesson is designed to be open exploration.</li> </ul>	<ul style="list-style-type: none"> <li>Language Arts integration: Read, “The Elephant’s Rumble” in the teacher’s manual on pgs. 38-39 with students and discuss.</li> </ul>
<p><b>Lesson 5: Exploring Pitch.</b> Students continue their investigation of length of objects and the changes in the pitch of the sound produced.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i>  <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i>  <b>Big Ideas:</b> Sounds are produced by vibrating objects. Changing the length of an object affects the nature of the vibrations and the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>You will use meter sticks or yardsticks in this lesson and these do not come in the kit.</li> </ul>	<ul style="list-style-type: none"> <li>The music extension at the end of lesson 5 is easy to do and very engaging. It is in the teacher’s manual on pg. 46.</li> </ul>
<p><b>Lesson 6: Vibrations We Can’t See.</b> Students experiment with sound produced by a vibrating column of air in a slide whistle. Students make a scientific illustration of a slide whistle and discuss the slide whistle as a system.</p>	1.5-2	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i>  <b>GLE 1.1.4</b> Understand that energy comes in many forms. <i>Identify or describe the forms of energy present in a system (i.e., heat energy, sound energy, light energy, electrical energy, food energy, energy of motion (kinetic), chemical energy.</i>  <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other.  <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations following all safety rules. <i>Identify and use simple equipment to gather data.</i>  <b>GLE 2.1.3</b> Understand how to construct a reasonable explanation using evidence.  <b>Big Ideas:</b> Sounds are produced by vibrating objects and vibrating air columns. Changing the length of an object affects the nature of the vibrations and the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>Follow the instructional guide instead of the teacher’s manual for this lesson since it has been modified to address the GLEs about systems.</li> <li>Assemble a slide whistle before the lesson begins.</li> <li>If there is not already tape on the dowels, you will want to apply the tape to the end of the rods.</li> <li>Cut graph paper for each student so it fits on half a notebook page.</li> <li>Read the safety tip on page 41 in the teacher’s manual.</li> </ul>	<ul style="list-style-type: none"> <li>Language Arts integration: Read, “Wind Instruments around the World” on pages 54 and 55 in teacher’s manual. If you have students from other countries they may also want to share specific instruments they have played.</li> </ul>
<p><b>Lesson 7: Designing a Reed Instrument.</b> Students design and demonstrate a wind instrument that uses a vibrating reed.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i>  <b>Big Ideas:</b> Sounds are produced by vibrating objects and vibrating air columns. Changing the length of an object affects the nature of the vibrations and the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>This lesson can be used as an embedded assessment.</li> <li>Practice making the instrument beforehand to see if you can generate sound.</li> </ul>	<ul style="list-style-type: none"> <li>Music Connection: Students create their own reed instruments to demonstrate their understanding of the relationship between length of vibrating air and pitch.</li> </ul>

<p><b>Lesson 8: Making a Model Eardrum.</b> Students make a model eardrum and observe how sounds make it vibrate; they connect earlier investigations on how sound travels. Students draw a diagram of an ear model and discuss the ear as a system.</p>	1	<p><b>GLE 1.2.1:</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify the parts of a system and how the parts go together. Describe the function of a part of a system (e.g., the ear is a system).</i></p> <p><b>GLE 2.1.4:</b> Understand how to use simple models to represent objects, events, systems, and processes. <i>Create simple model of a common object (e.g. physical model).</i></p> <p><b>GLE 3.2.2:</b> Understand that people have invented tools or everyday life and for scientific investigations. <i>Describe tools invented to advance scientific investigations (e.g. hearing aids).</i></p> <p><b>Big Ideas:</b> The human ear has a membrane that vibrates when sound reaches it. The ear and the brain translate these vibrations into the sensation of sound.</p>	<ul style="list-style-type: none"> <li>• Make sure that students know that models are used by scientists to learn about something that can't be observed directly.</li> <li>• The key to this lesson is to use loose tea (instead of salt, sand, sugar or loose paper).</li> <li>• Also integral to the success of this lesson is handling the noisemaker in a certain way. See page 16 in instructional guide.</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Read and discuss, "Protecting Our Hearing" on pgs. 73-74 in the teacher's manual.</li> <li>• Have students record all their questions concerning the eardrum or hearing and invite your school Hearing and Speech Therapist to come in as a guest speaker to answer their questions.</li> </ul>
<p><b>Lesson 9: Making Sounds with Strings.</b> Students engage in an in-depth exploration of the variables that affect the pitch of sound produced by a vibrating string.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i></p> <p><b>Big Idea:</b> Changing the length, tension, or thickness of an object affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>• The pointed end of a compass or a pushpin can be used to puncture holes in the cups. The holes should be made by the teacher before the lesson begins.</li> <li>• This is an exploratory lesson and sets the stage for more focused lessons with string to come.</li> </ul>	<ul style="list-style-type: none"> <li>• After exploring independently, students enjoy working with each other, attaching their cups together.</li> </ul>
<p><b>Lesson 10: Changing Pitch by Changing Tension.</b> Students experiment with the production of a sound from tightened strings.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i></p> <p><b>Big Idea:</b> Changing the length, tension, or thickness of an object affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>• Make sure you have assembled a 1-string harp to show the class before you begin the lesson.</li> </ul>	<ul style="list-style-type: none"> <li>• It is engaging for students to work in pairs or teams to develop tunes to play for the class on their pegboard harps.</li> </ul>
<p><b>Lesson 11: Tuning a Stringed Instrument.</b> Students build a pegboard harp with several strings and experiment with ways to change the pitch of the sounds produced. Students plan and conduct a fair test.</p>	2	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i></p> <p><b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations following all safety rules.</p> <p><b>Big Idea:</b> Changing the length, tension, or thickness of a string affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>• This is a modified 2-part lesson which includes planning a controlled investigation.</li> <li>• Assemble a 4-stringed pegboard harp beforehand.</li> <li>• The concept of <i>fair test</i> is discussed in the teacher Background information on p. 95 of the teacher's manual.</li> </ul>	<ul style="list-style-type: none"> <li>• As in Lesson10, it is engaging for students to work in pairs or teams to develop tunes to play for the class.</li> </ul>

<p><b>Lesson 12: How do Different Strings Sound?</b> Students explore and describe sounds produced by vibrating strings of different thickness; compare and contrast ways to change pitch. Students plan and conduct a fair test.</p>	1-2	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i> <b>Big Idea:</b> Changing the length, tension, or thickness of a string affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>This lesson has also been modified so you are able to guide students in planning and conducting another fair test.</li> <li>Assemble a 4-stringed harp with strings of different thickness beforehand.</li> </ul>	<ul style="list-style-type: none"> <li>As in Lesson 10 and 11, it is very engaging for students to work in pairs or teams to develop tunes to play for the class.</li> </ul>
<p><b>Lessons 13: Making Louder Sounds with Strings.</b> Students focus on factors affecting volume of sound produced. Students discuss the instrument as a system.</p>	1	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i> <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify the parts of a system and how the parts go together (e.g., stringed instrument).</i> <b>Big Idea:</b> Changing the length, tension, or thickness affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>This lesson has been modified to construct the understanding of a system with interrelated parts that must work together in order for the system to function properly.</li> </ul>	<ul style="list-style-type: none"> <li>Bring in visuals of other instruments with strings of different thickness and instruments with a bridge to help solidify conceptual understanding.</li> </ul>
<p><b>Lesson 14: Making Sounds with Air and Strings: The Human Vocal Cords.</b> Students investigate the sound producing "instrument" in our bodies--the vocal cords--and make connections and applications to earlier observations.</p>	1	<p><b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify the parts of a system and how the parts go together. Describe the function of a part of a system.</i> <b>GLE 2.1.4</b> Understand how to use simple models to represent objects, events, systems, and processes. <i>List similarities and differences between a model and what the model represents.</i> <b>Big Idea:</b> Sound is produced by the human vocal cords as air moves through the tightened cords.</p>	<ul style="list-style-type: none"> <li>It is helpful to read the Background information on pgs 105-106 in the teacher's manual.</li> </ul>	<ul style="list-style-type: none"> <li>Language Arts integrations: Read, "Making Sounds with Our Vocal Cords" on page 110-111 in the teacher's manual with students.</li> <li>Have students record all their questions concerning speech, the throat, vocal cords, etc. and consider inviting your school Hearing and Speech Pathologist to come in as a guest speaker to answer their questions.</li> </ul>
<p><b>Lesson 15/16: What Have We Learned about Sound? Sharing What We Have Learned.</b> Students apply conceptual understanding of sound by designing and constructing a musical instrument. Students discuss instruments as a system.</p>	3	<p><b>GLE 1.1.3</b> Understand the behavior of sound in terms of vibrations and pitch. <i>Explain that when an object vibrates the object may produce a sound that people can hear.</i> <i>Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound.</i> <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify the parts of a system and how the parts go together (e.g., stringed instrument).</i> <b>Big Ideas:</b> Sounds are produced by vibrating objects and vibrating air columns. Changing the length, tension, or thickness affects the frequency of the vibrations and therefore the pitch of the sound produced.</p>	<ul style="list-style-type: none"> <li>This lesson was developed as a performance-based, summative assessment. If you feel that having students create their own instruments is not an option for your class, use the information on pages 119-121 of the teacher's manual to create an assessment.</li> </ul>	<ul style="list-style-type: none"> <li>Students can perform and present to other classrooms. Some classrooms invite parents/ community to a Sound night where they present their instruments.</li> </ul>

