FOSS® PHYSICS OF SOUND
TEACHER PREPARATION VIDEO TRANSCRIPT

<Larry Lowery Introduction to FOSS Program>
Lowery: Hello. Welcome to the Full Option Science System. This program was funded by the National Science Foundation. Its goal was to develop materials that would involve youngsters with both the processes and the content of science.

The program is developed with the Lawrence Hall of Science, with scientists, science educators and teachers working together as a team to develop the materials. The materials are tested in the hands of teachers and children in classrooms. It takes about two years to turn out a module.

Each module begins with firsthand experiences. This is done because it has been found that firsthand experiences are the best way for youngsters to learn about the concepts of science. As the module progresses, children are introduced to abstractions and reading materials. The sequence from firsthand experiences through reading materials is deliberate because it has been found that youngsters, when they have some experience before they read, learn and understand more from the reading. Authors of reading materials can then take youngsters to greater abstractions.

Trust the materials that you are getting acquainted with. They have been well-tested. We found that they work extremely well in the hands of all teachers and are effective for youngsters in learning about science.

<Larry Lowery Introduction to Physics of Sound>
The FOSS Physics of Sound module introduces students to the nature of sounds, how sounds are generated and how sounds travel. All animals send messages by sounds. They tell of their presence and they warn of dangers. Humans use sounds in many ways, especially to communicate.

Scientists study the components of sound in different aspects and study the source of sounds and how sounds are generated. They study how sounds travel and move through the air and through solid materials and through liquids. They also study the receivers of sound such as the human ear.

This module has four investigations. The investigations capitalize on students' ability to do one-to-one correspondences, to order and to group objects by commonalities in sound production. Working cooperatively students take turns making and replicating sounds. Students sort and organize objects by similarities in the sounds that they make. Students send sound coded messages to each other.

All activities require careful listening. All activities are almost limitless in the variety of ways by which objects can be explored.

<Sandra Rhodes Introduction to Module>

Narrator/Sandra Rhodes: Hi. I'm Sandy Rhodes. And I'm here to help you get started with the Physics of Sound kit. The Physics of Sound module consists of four investigations that students use to help them get started in learning about sound. Most of the equipment you need to teach this module comes in the kit. Everything you see on this table comes in these boxes. There's enough permanent equipment in the kit for a class of 32 students and enough consumable equipment for at least two classes.

You will need to check the inventory sheet in the Materials folio to see which materials are consumable and which are permanent. From the FOSS measurement kit you will need the basins. You will need to supply five identical glass soda bottles, some hangers, some pencils, thread, a nail, some tape -- both masking and transparent -- scratch paper, pliers, some tissues and some paper towels. These drop objects come in the kit. Some teachers like to add other objects which make interesting sounds such as wooden blocks, binder clips, small nails and bottle caps.

Before you begin teaching, you'll want to read through the entire Teacher's Guide. First you will find the Overview folio which points out the national standards addressed in this module as well as information about how to make best use of the Teacher Guide. It also includes valuable background information specially written for teachers who have not had extensive science training.

The suggested teaching schedule in the overview will be particularly helpful as you plan. Next you'll find the Materials folio. If you are the first teacher using a new kit, you'll want to turn to the section that describes first-time prep. If the kit has been used before, check the section called preparing your kit for your classroom. Both of these sections will give you helpful hints that will save you lots of prep time later.

The next four folios are the Investigation folios. These are the heart of the program. Each takes one or two weeks to complete. The first page provides overview information. The At A Glance chart summarizes the investigations and helps you plan for assessment and extension activities.

Next you'll find background information specific to this investigation. There is a section called Teaching Children About, which gives you some insight into research about how children think and learn. Then for each part of the investigation, you find a materials list, Getting Ready section and step-by-step instructions for how to proceed through the investigation.

At the end of the folio you'll find Interdisciplinary Extensions. You can do some of these extensions with the class or save them for students to use as projects at the end of the module. Next are the investigation duplication masters. Each master is labeled with a number so it will be easy to find when you need it.

Shortly before beginning this module, duplicate the Letter To Parents and send it home with the students. This letter tells parents about the module and suggests some activities that they can do at home with the children.

It's important to read the Assessment folio before you begin teaching. It describes a system for assessing students throughout the investigations and also gives you ideas for end-of-the-module

testing or portfolio assembly. The folio contains scoring guides for each of the assessments suggested.

Next are the assessment duplication masters. Here you'll find all of the masters for the assessment charts and end-of-the-module assessments. The Science Stories folio gives you background information, recommends when to read the stories and suggests follow-up activities. You may want to read the Science Stories during a reading period rather than science time, especially if you only teach science a few times a week.

In the Resource folio you will find lists of trade books, videos, computer software and other resources that you can use to enrich the program. The final tab is the FOSS website folio. On the website you'll find simulations for each module in the program. The students can contact scientists and FOSS students across the country. You'll need to check the website to see the many features available there, including resources for teachers. Now you're ready to begin.

<Investigation 1, Part 1>

Narrator: This activity begins with students exploring their ability to discriminate between sounds. For each activity you'll want to set up a materials station. Here is what you'll need for this part: From the kit you'll need the vision barriers, paper fasteners, drop chambers and the bags of drop objects. If you wish, you may add some other objects to the drop object bags such as wooden blocks, pennies, binder clips, nails, bottle tops and pencils. Make one copy of the Assessment Chart For Investigation 1.

To assemble the drop chamber used in this part, you'll need to get the pieces of long tag board with holes in each end, bend them around so that they form a tube. And then you are going to use three paper fasteners and make an oval shape that will look like this with the fasteners holding it down. You'll get the piece of cardboard and insert the slots over the drop chamber. This will be a vision barrier. And you'll need to push it all the way down and center it so that it forms an oval.

Before you begin, prepare Word Bank and Content/Inquiry charts using large sheets of paper or a flip chart. Make a Project Folder for the class. During the investigations, as students have questions or ideas for projects, have them write them down and put them in the folder. At the end of the module, they can choose a project to work on for further investigation.

Teacher: This morning we're going to be studying the science of sound. And to begin I want you to close your eyes and listen.

Narrator: The session begins with the teacher dropping a coin.

Teacher: What do you think that sound was?

Student: A coin.

Teacher: Very good. How did you know it was a coin?

Student: Because a coin has a tingling sound. And I know it's a quarter because a quarter is

harder dropping than another coin. A penny or anything else would be like a light sound.

Teacher: Very good. Now, the sound that an object makes is one of its properties. And the way that it feels, the way that it looks and smells and tastes and sounds is also a property. We're going to be investigating what sounds objects make when they are dropped onto a table surface. And in order to do that you're going to be dropping objects in a drop chamber which you will be assembling.

Now, in order to assemble a drop chamber, you will need one of these papers and also a cardboard and three paper fasteners. And the getters will get this later. Now, to make your drop chamber, you will notice that there are three holes on this paper. And you match it up with the other three holes like this. And you will fasten it with your paper fasteners.

Narrator: The getters go to the materials station to pick up all of the materials they need for this part. The groups assemble their drop chambers.

Teacher: Now, your next challenge is to get familiar with the sounds that each of the objects in this bag will make as it is dropped in the chamber. Each team of two people will get a bag. And what you do is you dump out all of the stuff in your bag and you pick an object and drop it into the chamber and listen to it. And then lift your chamber, pick it up and put it back. Pick another. Do the same thing. Drop it in the chamber, listen to it and then pick it up.

I'm going to give you about three minutes to do this. Getters, please get two bags per group. Get two bags per group.

Student: We're just practicing for now.

Narrator: The students first drop their objects with their partners so that they all become familiar with how each object sounds.

Teacher: Now we're going to play a game called Drop Challenge. And what you're going to do is one team will select an object from their bag. And they will drop this object in the drop chamber being careful not to let the other team see what it is. So it's very important that you are all seated. Okay? You cannot stand up for this game. You drop it into the drop chamber. And then this team will think about the sound and figure out which it is, which one it is in their set. Can you try to figure out which one I dropped in there? Would you like to hear it again?

Narrator: The other team then tries to drop the same object in the drop chamber.

Teacher: Okay. Now look at your selection and see if you can match the sound. Okay. Try that one. Go ahead and drop it in the chamber.
Do you guys agree it's the same one?

Narrator: The group lifts the chamber up to see if they dropped the same thing.

Teacher: Oh, it's the same. Very good. Then you do it again. Now this time this group will select an object and you guys have to figure out which one it is.

Student: Yep.

Student: Our turn.

Student: We're trying to get the same sound.

Student: Yes.

Teacher: Okay. Same sound?

Student: Yes.

Teacher: Lift it up and see. Oh, you're right. How did you guys know? How did you guys know it was a spoon?

Student: Because it has that sound because it's plastic.

Teacher: It's plastic. Hmmm . . . how is that sound different from the coin?

Student: Because that has a sound kind of like glass and the coins still have that tingling.

Teacher: How many of you dropped this object in your drop chambers?

Narrator: The teacher leads a discussion about the properties of sound.

Teacher: Now tell me two sounds that you heard when you dropped this in your drop chambers. Charles?

Student: A little tick.

Teacher: Okay. Good.
Alena?

Student: Ruffling.

Teacher: Ruffling?

Student: Ruffling.

Narrator: The teacher leads a discussion about the sound each drop object made.

Teacher: Your ability to tell the sounds apart is called sound discrimination. What objects were easy to tell?

Student: The penny.

Teacher: The penny? And?

Student: And the silver that looks like a penny but a silver --

Teacher: The washer?

Student: Uh-huh.

Teacher: What other objects were easy to discriminate.
Vincent?

Student: The nail and this little silver thing right here that has a little hole in it.

Teacher: The washer?

Student: The little washer.

Teacher: Okay. Good. And think about some new words that you learned today. What are some new words that you can think of that you learned today?
Audrey?

Student: Sound discrimination.

Teacher: Good. Sound discrimination. What does sound discrimination mean?

Student: Something you can tell by its sound.

Teacher: Right. It's telling what the object is by the sound that it makes. And what are some other words?
Lalonie?

Student: Properties.

Teacher: Properties. Very good. And what does it mean, properties?

Student: It means to hear, look, taste and feel.

Teacher: Excellent. Good. What can you tell about the sound of some objects?

Narrator: The lesson ends with a Content/Inquiry chart.

Teacher: On this chart we're going to write what else we've learned. For example, what are the properties of some objects that have a loud sound, that make a loud sound?
Vincent?

Student: It's like when something is falling and it's heavy, it goes boom.

Teacher: Okay. So we can tell objects by their sound. Okay. Now, what are some properties of sound?
Christina?

Student: Some properties of sound are sounds like rattling, thud, tick, soft.

Teacher: Excellent. Sound has property.

Narrator: The most important thing for students to take away from this part is that objects can be identified by the sounds they make and that sounds have properties that we can identify. There are several readings in the FOSS Science Stories about sound. Be sure to check the Science Stories folio to be able to plan the best time to have your students read the stories.

<Investigation 1, Part 2>
Narrator: In Part 2 students develop a code and send messages to each other. Here is what you'll need for this part: The eight drop chambers you made for Part 1 and the drop objects. You will need to supply scratch paper.

You will need to duplicate Student Sheet No. 2 called Sorting Mat, Student Sheet No. 3 called Response Sheet - Dropping In, which you can use for assessment. Have the Assessment Chart For Investigation 1 available so you can make notes as you work with students. Consult the Assessment folio for details.

This session begins with the teacher asking the students about how certain sounds give information. A fire alarm, a school bell. The students' challenge is to develop a sound code. Students develop their drop code by giving a letter to each of the six selected objects.

Student: Nail.

Student: Nail?

Student: Nail.

Narrator: These students are using the six letters in the word stream for the code. Students send one-word messages to each other.

Student: Next letter, please.

Student: Next letter, please.
Okay. Done.

Teacher: Did you hear -- any other letters? That's all? Okay. What was the word?

Student: Seat.

Teacher: Is that correct?

Student: Yes.

Teacher: Very good. Excellent. Now it's your turn.

Narrator: Students should understand that sounds can be used to give information, warn people and to communicate by code. Before ending this session, introduce the Project Folder to the students. Explain that when they have questions and ideas, they can write them down and put them in the folder. They will then choose a project to investigate further later on.

<Investigation 1, Part 3>

Narrator: In Part 3 students will observe vibrations as a sound source and identify sound receivers. Here is what you'll need for this part: From the kit blocks of wood, tuning forks, ping pong balls, tone generator, the AC adapter, door fiddle, pieces of string which you'll need to cut into 40 centimeter lengths -- you'll need eight of those -- beans, cups and eight plastic bags. You'll need to supply eight wire hangers, some transparent tape, thread which you'll cut into 30 centimeter lengths, a nail, some pliers, scissors, four cups with water and some paper towels. You'll need to duplicate Student Sheet No. 4 called The Tuning Fork, Student Sheet No. 5 called The Long Gong and have the Assessment Chart For Investigation 1 available.

There are four different setups for this investigation: The door fiddle, which is done with the whole class; the tone generator, which is also done with the whole class; the long gong, which is done in four separate stations; and the tuning fork, which is also done at four separate stations. I'll now go over each one of the setups.

Here is how to set up a door fiddle. Find a door with a knob. A door with a handle will also work. Pass the cord around the door. The important part is to pull the cord tight. Wrap the end of the cord tightly around the door knob. Here is a good way to get tension on the cord. Tie it off using a slip knot so you can undo it easily. Slide the piece of wood flat under the strings and stand it up. The fiddle is now tuned and ready.

The tone generator can work off a nine-volt battery or you can attach a transformer and run it off an outlet. Plug the speaker into the recessed hole and hook the wire into that. Turn it on and you're ready to start. Turn the volume all the way up to high and slowly turn the pitch. And you can feel with your fingers the vibrations. During the activity you will try this with some beans placed on top of the speaker. And you'll be able to see the vibrations when it's on high.

If you're the first person to use this kit, you'll need to assemble the materials for the two mini activities in this part. To make the long gong, you'll first need to untwist a wire hanger. You'll want to bend the ends down so that they are not sharp. You are going to twist it into an arch shape so it looks like this. Take one of the plastic cups and a large nail and twist to punch a hole in it like that.

Then you're going to take one of the pieces of string you've cut, thread it through the bottom of the cup and tie a knot in it so it stays in and tie it to the bottom of the hanger. And you have completed your long gong. You're now going to stick it in the bag that you have labeled "Long Gong." You'll make eight of these long gongs.

Place a tuning fork and a block of wood in each of four plastic bags that you have labeled "Tuning Fork." Take the 30 centimeter threads that you've cut and tape them to the ping pong balls. Fill four cups about three-quarters full of water and place a stack of paper towels with them. These materials will be placed at the materials station to be picked up after the students have had some free exploration with the tuning forks.

Practice using the tuning fork before you begin the lesson so that you'll be better able to assist the students. Here is how you use the tuning fork: Hold the fork firmly by the stem so it's on its side. Strike the wood block crisply with the tip of one of the tines. Place the fork near your ear and listen. An alternative method is to hit the tuning fork on the sole of your shoe.

Begin this session by explaining to the students that they will be exploring the sounds made by two objects. Show the class how to use the tuning fork and the long gong safely.

Teacher: Let me show you how to use the tuning fork. You hold it by the stem. This is called the stem. And you hit it on this wooden block. Okay. Just like that. And then you will also be exploring the sound that this thing makes. And it's called a long gong. And you put the cup to your ear like this and just listen. And you'll have to figure out --

Narrator: Set the ground rules for using the equipment.

Teacher: And you have to be careful that this part does not touch anything so you have to kind of lean back maybe. Make sure it doesn't touch anything.

Narrator: Establish a signal for the students to change stations.

Student: It's this making noise. It's not the wood.

Student: It makes a funny sound.

Student: Can you hear it?

Student: Ouch.

Narrator: Introduce the tone generator with the beans so students can see evidence of vibrations.

Teacher: Listen carefully and watch.

Narrator: The teacher plays the door fiddle and asks the class what they observed.

Teacher: What do you hear and what do you see?
Vincent, what did you hear?

Student: I heard like a bass sound when it goes boom, boom, boom.

Teacher: Oh, I see. And what -- did anyone see anything? What did you see? When I did that experiment, what did you see?
Everett?

Student: I seen it wiggle. It was like . . .

Teacher: Everett, what wiggled?

Student: The rope.

Narrator: After the teacher introduces the term vibration and distributes the student sheets, the students return to the instruments to look for evidence of vibrations.

Student: Ouch.

Student: Do you feel it?

Student: Whoa.

Narrator: The important thing for the students to learn is that sounds come from something that is vibrating. A sound source makes sound. And strong vibrations make a sound louder.

This brings us to the end of Investigation No. 1. Be sure to select several of the interdisciplinary activities for your students to do and have them do the math problem of the week before moving on.

<Investigation 2, Part 1>

Narrator: In this part of the investigation, students are introduced to pitch and explore pitch using tongue depressors and their voices. Here is what you'll need for this part: From the kit you'll need the door fiddle, the tone generator with a few beans, the AC adapter or a nine-volt battery and plenty of tongue depressors. You'll want to have extra tongue depressors in case some break.

Students will use the tongue depressor to explore length and vibrations. The best way for small hands to work with the continuing depressor is to hold one end of the depressor against the table with the palm of the hand and strike the other end with a finger. Make a copy of the Assessment Chart For Investigation 2, which you should keep with you so you can make notes about how your students are working.

Begin this investigation by having students recall their observations about the door fiddle, the tone generator, the long gongs and the tuning forks.

Class: Uhhhh . . .

Teacher: What are you feeling here?

Class: My voice.

Teacher: What is it doing? What's the word we talked about?

Class: Vibrating.

Narrator: The students describe what they feel when they put their fingers on their throats and make different sounds.

Teacher: This was the source. And your ears are the receiver. What we're going to study today

then is pitch. I wrote it on the board. Pitch is how high or how low a sound is. Okay? Let me demonstrate. I'll use this. Okay. I'll turn it up so you can be sure to hear it. Is this high or low? What do you think?

Class: Low.

Teacher: Okay. Now, listen. What do you think about that?

Class: High.

Teacher: High. Okay.

Narrator: The teacher uses the tone generator to produce high and low pitches.

Teacher: So stand up, push your chairs in. Stand up near -- behind your chair. If the pitch you hear is high, you're going to go up high. Think high. If the pitch is low, you're going to go down. Okay?

Class: Okay.

Teacher: Are you ready? I'm going to start it in the middle, okay, so don't do anything. And then I'm going to move it. And you do what you think you hear.
What pitch you think you hear, high or low? All right. Now I was using this. This was a tone generator, if you remember that from the other day. And I was able to change the pitch. I was the one who made it high or made it low. You're going to get a chance to change the pitch on something.

Narrator: After the teacher demonstrates how to hold the tongue depressors, the students use them to create different pitches.

Teacher: You need to try it different places. See if you can change the way it moves, change the way it sounds.
Okay. Sit down and I'll bring you a new one.

Someone tell me, how did you make a high pitch and how did you make a low pitch?
Barbara?

Student: If you stuck it out -- if you stuck it out a little, it would be a high pitch. But then if you stuck it out a lot, it would be a low pitch.

Teacher: Okay. Now, let's talk about vibration. What did you notice about the vibrations?
Skyler?

Student: There was a lot more vibration when you had it out.

Teacher: When you had it extended beyond -- way beyond the desk, you noticed that there was a lot more vibration?

Student: Yeah.

Teacher: All right. Now, let me move it in and you watch the vibration. See if it changes.

Student: When you had it on -- the vibration on the stick -- when you had it on the table and at first when you had it like this, when you put it out more, it was going more faster. But when you stuck it in, it didn't go.

Teacher: So Lamika pointed out that if this was extended way beyond the desk, she could see it shaking. But when it was just extended a little, she could not see it vibrating. Okay? Let me explain to you what's happening.

If it's extended way out over the desk, it looks like it's vibrating more than when it's not extended. But what's really happening is when it's extended just a little over the edge of the desk, it's vibrating so quickly that our eye cannot see the vibrations. So it looks like it's not vibrating at all. In fact, it's vibrating more when it's shorter. All right. Let's look at something else.

Narrator: The teacher uses the door fiddle to demonstrate changes in pitch.

Teacher: We've seen this before. This is called a door fiddle. But you have to really be listening because the sound isn't really that loud. So you have to be watching and listening. All right. Now watch and listen.

There's low pitch and there's high pitch. Listen for that when I do this. Okay.
Adrian?

Student: It's like the stick when we do it on our desk. The top part of the rope vibrated more but our eye cannot see it. It's vibrating faster so our eye can't see it. And the bottom one is vibrating slower and we can see it better.

Teacher: Great. Exactly.

Narrator: Show the students the tone generator again. They should see that as the pitch gets higher, the beans do go faster.

Narrator: In this part, students should have learned that a high pitch is made by fast vibrations. A low pitch is made by slower vibrations. Be sure to check the folio for the Foss Science Stories so your students can do the reading during this investigation.

<Investigation 2, Part 2>

Narrator: In this part, students use four different instruments to see how length affects pitch. Here is what you'll need for this part: From the kit the door fiddle, the large plastic bags, two kalimba bases with the flexible metal strips, two foam pads with the metal tubes, six popsicle sticks, four mallets, two half meter sticks, two binder clips, two pieces of fishing line and two cups. You will need to provide a meter or yard stick and five identical glass soda bottles with tops and a carrier. Duplicate student sheets 6, 7, 8 and 9. Also have Assessment Chart 2 available.

You will need to assemble two sets of materials for each mini activity. Here is what you'll need to make: For each kalimba loosen the wing nuts. Slide the five steel bars under the dowel so they are all different lengths and tighten the wing nuts so the bars sit securely. The lengths should not be placed in order of size. Play the kalimba with your thumbs or a popsicle stick. Place a kalimba and four popsicle sticks inside of a plastic bag and label it "Kalimba."

Here is how to make the waterphones. For each set fill the five soda bottles with varying amounts of water. The bottle with the least amount of water should contain at least a full inch of water. Tap under the water line in each bottle to determine if they produce pitches that are recognizably different. Either place the bottles in a six-pack carrying case. Add a mallet to the case and label it "Waterphone" or place the sets in large plastic bags and label them.

To make the xylophone, place the five different lengths of aluminum tubes on the foam square. Tap them with a mallet and you can hear the different sounds. To prepare this set, place the five different lengths of aluminum tubes, the foam square and the mallet in a bag labeled "Xylophone." You'll need to make two of these.

To make a string beam, you'll first need to cut a piece of fishing line 125 centimeters long and tie a knot in one end. Find the slit cut into the 50 centimeter end of the half meter stick and slit the line into it. Pull the knot up against the stick making sure that the knot is on the inch side of the stick.

Poke two small holes in a paper cup near the base. Run the line through the cup. Run the line the length of the stick, around the end and up the back of the slit. Thread the line back through the slit. Pull the line very tight. Put the binder clip over the end of the stick to hold the line.

The cup slides along the string bean and will change the pitch of the sound. Break a popsicle stick in half. Then slide the popsicle stick under the zero end of the stick to provide more tension. Make two of these and put each in a bag that you have labeled.

During this session, each group has the opportunity to work with each instrument. At the teacher's signal, the groups switch instruments. The teacher shows the equipment briefly, removing one set at a time from the bags but doesn't actually demonstrate the activities for the students.

Teacher: You get to make your own little xylophone. This piece of foam and then these are the metal parts. And all you need to do is lay them on the foam just like that. These are bottles that have different amounts of water in them. Now, you don't take off the top. I don't want to see any tops off the bottles. And you're going to strike the bottles. And the important thing to remember about this is that you strike below the water line. Don't strike up here. Strike down here.

Narrator: The students have a short time to explore each of the instruments.

Student: Let's make it like this. Okay.

Teacher: Now that you've had a chance to listen to the pitch of these different things,

instruments mainly, what you're going to do is you're going to do it again. But this time, you're going to try to make order out of the pitches. You're going to listen to them from say lowest to highest. Okay?

Narrator: The teacher visits all the groups and asks the students to identify the high and low pitches on the instrument they are working with.

Student: Which one?

Student: That.

Student: Which is higher?

Narrator: After the students have had an opportunity to explore pitch using the instruments in their own way, they now use the student sheets to focus their observations.

Student: Which one is higher and lower?

Student: This one is higher and this one is lower.

Student: Which one is higher or lower?

Student: This one is higher.

Student: The first one was higher.

Student: No, lower.

Student: The first one was lower. And the second one was higher.

Student: Is that right?

Student: Which one is higher?

Student: This one is higher. This one is lower.

Narrator: Students should complete the activity sheets with their groups and be ready to share their observations. They should also complete the response sheets which can be used for assessment.

The most important things that students learn in this part is that long length makes a low pitch and a short length makes a high pitch and a long string vibrates slowly. A short string vibrates quickly. Encourage students to continue to add ideas and questions to the Project Folder.

<Investigation 2, Part 3>

Narrator: In this part, students will use two different instruments to investigate how tension affects pitch. Here is what you'll need for this part: To construct eight mini gutbuckets you'll need eight strings that are cut to 50 centimeters each, 16 paper clips, eight plastic cups and you'll

need to provide a nail for punching holes in the bottoms of the cups.

To construct four FOSS-Uleles, you'll need four plastic cups, four paper clips and four strings cut to 250 centimeters. You'll need to provide four pencils. You'll need to duplicate the student sheets called Response Sheet - Good Vibrations, The Mini Gutbucket and the FOSS-Ulele and have the Assessment Chart For Investigation 2 available.

You'll need to prepare eight mini gutbuckets. For each one take a plastic cup and punch a hole in the center of the bottom. Thread one end of the 50 centimeter string through it. Tie a knot in one end with a paper clip to keep the string from coming back out. At the other end tie another paper clip. This paper clip will be used to wind around the chair to keep it from becoming loose and providing tension. You'll be putting two mini gutbuckets in each of four bags labeled "Mini Gutbucket."

To construct each of the FOSS-Uleles, tie a paper clip to one end of a 250 centimeter string and a pencil to the other one. Tie it securely in the center of the pencil. If you would like to use tape to hold it in position, you may do so. You'll see the FOSS-Ulele being used later on in the video. Place the pencil with the string and the cup in each of four plastic bags labeled "FOSS-Ulele."

Begin this session by posing some questions to the students: What is tension? How does tension affect pitch? Then introduce the two instruments the students will be using. In a guided discussion, the students learn that tension means how tight or loose something is. The teacher tells them that they will investigate two different instruments to find out how tension affects pitch.

The teacher introduces the instruments. The students explore the two instruments. After several minutes, the groups switch and continue to explore freely.

Student: It goes higher when it's tighter.

Teacher: Okay. And when it's looser, the pitch is what?

Student: Lower.

Teacher: Lower. Okay. Did you try that?

Student: Uh-huh. No.

Teacher: Why don't you try it. She'll hold it tight or you can hold it tight. You don't need to listen -- you listen here. So hold tight on it. Okay. Now pull tighter on it. When is the pitch higher?

Student: The pitch is higher --

Teacher: When it's tighter or looser?

Student: When it's tight. And when you go like that --

Teacher: The pitch is what?

Student: Lower.

Teacher: Yeah. Good.

Narrator: After the students have had an opportunity to work with both instruments and record their observations, you can distribute the response sheet called Good Vibrations. This can be used as an assessment. By the end of this activity students should understand that changing the tension on a sound source makes a different pitch.

This brings us to the end of Investigation 2. Be sure to select several of the interdisciplinary activities for your students and have them do the math problem of the week before you move on.

<Investigation 3, Part 1>

Narrator: In this investigation, students compare how sound travels through air and through water. Here is what you'll need for this part: From the kit you'll need a megaphone, paper fasteners and the tone generator.

This is for the activity on amplification. And for all of these you'll need bags to store the materials in. You'll need tuning forks with wood, listening tubes and rubber bands. These are for the investigations on sound through air.

For sound through water you'll need stethoscopes, rubbing alcohol and cotton balls. Also for the sound through water investigation from the measurement kit you'll need four basins which you'll partially fill with water and you'll need to provide paper towels.

Duplicate Student Sheet No. 15 called Response Sheet - How Sound Travels. This can be used for assessment. Also make one copy of the Assessment Chart For Investigation 3. Begin this session by referring to a specific sound source that the students can identify such as a school bell.

Teacher: When the bell rings outside, how do you think the sound gets from the bell to our ears? Do you think that the sound comes through the walls or do you think it comes through the air? What do you think?
Skyler?

Student: It goes through the air.

Teacher: If the room were filled with water, what do you think would happen? Do you think that sound can travel through water?

Student: No.

Teacher: Manuel?

Student: No.

Teacher: Well, today we're going to find out how sound travels through different materials. And

I'm going to show you some of the things that you're going to use.

Narrator: The teacher introduces the mini activity.

Teacher: You put it up to your ear like this. Another thing you're going to be using is a stethoscope.

Student: Wow.

Teacher: It looks like this. This part goes into your ear --

Student: And the other part --

Teacher: And this part is -- this is what they use to listen to the body usually. You're going to clap your fingers. This is how you clap two fingers together. So you'll be clapping two fingers.

Narrator: Students need to clean the ear pieces on the stethoscopes with alcohol each time they are used by someone new.

Student: Try it again.

Student: It sounds like a teapot.

Teacher: Now what you want is your recorder needs to read this here where it says "Describe what is the same and different." And together you talk about it and then your recorder will write down what you've observed.

Student: "Describe your observations. How was the finger tapping different when you listened to it through the water?"

Student: It was louder. In the water it was louder.

Student: To me it felt like it was like really loud because when you moved your fingers --

Student: It made bubbles.

Student: The movement -- the echo was going through and you could hear it through your ears.

Student: It was real loud.

Narrator: After discussing the group observations of sound traveling through air and water, introduce a new challenge. With the tone generator at a low volume challenge the students to make the sound louder without turning up the volume.

Teacher: What would be some ways that you could hear this better? Is there something you could do so that you could hear this better?
Adrian?

Student: You get -- if you get a paper and fold it in half and listen through your ear.

Teacher: Where would you put the paper?

Narrator: The students might suggest doing something at the sound receiver like making big ears or do something at the sound source like listening through a listening tube. Bring out the megaphone and let them investigate.

Teacher: This is called a megaphone.

Student: Wow.

Teacher: And what I can do with this is I can put this up to my ear. And the sound comes in here. And it makes it louder to my ear. I can also put the megaphone and use it this way where I talk through the megaphone. How does this work? How do you think the megaphone works to make the sound louder?
Barbara?

Student: It can go from very -- it can bounce off and go up to your ear.

Teacher: So where is it bouncing off?

Student: It's bouncing off the paper.

Teacher: Bouncing off the paper out here? Inside?

Student: No, inside of it.

Teacher: Inside the paper. The sound is bouncing off and coming into my ear. Good. Feel your ear. It works like the megaphone. And this is called the outer ear. And when sound is coming through the air, it goes -- it can go around in here. And then it will go to the inner ear, which you can't see. And that's how the message gets to your brain. But this outer ear works the same way that the megaphone works. It helps bring that sound right into your inner ear.
Skyler?

Student: How fast does sound go into your ear?

Teacher: How fast does sound go into your ear? That's a really good question. Why don't we put that in the Project Folder. Okay.

Narrator: The important thing for students to remember at the conclusion of this activity is that sound travels through air. Sound travels through water better than it travels through air. And sound that is directed travels better through air. Be sure to read the Science Stories folio so you can plan the best time to have your students read the selections.

<Investigation 3, Part 2>
Narrator: In this part, students explore how well sound travels through solids. Here is what you'll need for this part: From the kit 16 plastic cups, some paper clips, eight dowels, eight

strings cut into two meter lengths and some large plastic bags. You will need to provide a small nail for punching holes in the cup, some facial tissue and four rolls of transparent tape.

To assemble the materials for sounds through solid wood, place two dowels, some facial tissue and some transparent tape in a plastic bag labeled "Wood." You'll need to make four of these bags.

You will need to duplicate Student Sheet No. 16 called Sounds Through Solids: Wood, Student Sheet No. 17 called Sounds Through Solids: String, and have Assessment Chart For Investigation 3 available.

To assemble the materials for Sounds Through Solids: String, you'll need to take both plastic cups and poke a hole in the bottom of each one. Thread the string through. Tie a knot around a paper clip to keep the string from coming back out. You'll make eight sets. You'll need to put two sets in each of four bags labeled "String."

Begin this part by discussing examples of sound traveling through air and water. Ask students: Can sound travel through solids?

Teacher: Those of you who did the stethoscope under water, what was the difference when you listened to the finger clapping when the stethoscope was out of the water compared to when the stethoscope was in the water?
Skyler?

Student: It was louder when it was in the water.

Teacher: The finger clapping sounded louder when you had the stethoscope under the water?

Student: Uh-huh.

Teacher: Okay. What we're going to do today is we're going to investigate sound and observe sound through solids. Like . . . do you remember what a solid is? It's not water. That's a liquid. It's not air. Air is a gas. We're going to do it through solids.

And let me just show you a couple of things that you'll need to know when you start your observations. So you're going to be using a dowel, which is a solid piece of wood. And you're going to cover it. The reason you're going to cover it with this tissue is to protect your ear and so that also you don't get anything onto the dowel. So you can either hold the tissue on here and you're just going to have it right at your ear not shoving it in there. And there's also some tape. If you would like to put a piece of scotch tape around it, you can do that too to hold it on.

For your second investigation you're going to be using two cups and the string. Anybody have an idea what this is called?
Shakiro?

Student: It's called a phone. One person talks to the other one. And the other one talks through the other phone.

Teacher: Let me tell you a couple things about this so you'll know how to do it. You'll get a chance to try it, hopefully everybody. When you're doing this, don't touch the string and don't touch the bottom. Be sure that you're just holding this part. Let me just demonstrate.
Tiara, could you stand up for a second? You hold that end. Now back up. You're going to want to have it -- you're not going to want to pull it so tight that this pops out. But you're going to want to have it tight.

Narrator: Students read the directions on the student sheet before getting the materials.

Teacher: Stand apart and talk softly to your partner without using the phone. Now talk softly into the cup of the string telephone. Be sure the string is pulled tight.

Narrator: Students will find that tension on the telephone string will affect how the sound travels through the string.

Teacher: If you have the sticks, take off the tissue. Just put it in your desk for now. Put your sticks and tape back in the bags. Those of you with the phones, put those back in the bags. And we're going to switch.

Student: Can you hear this?

Student: Can you hear this?

Student: Can you hear this?

Student: I am, too.

Student: You are?

Student: Yes, I am.

Narrator: Students discover many interesting ways to investigate sound traveling through solids.

Student: It hears weird.

Teacher: Yeah. Do it around the corner. Maybe you're not going to hear.

Student: Would you like to have hamburgers with me?

Teacher: Can you hear her?

Student: No.

Teacher: No, she can't hear you.
Let's talk about what you have observed. And let's start with the wood. Now you all did everything. So you all have some observations about everything. But using the sticks, what did you observe?
Skyler?

Student: It was louder on the floor than in the -- on the window.

Student: When you put the stick up to the window and tap on the window, you hear the air outside and you tapping on the window.

Student: We put the sticks and we put our head on the table and it was a little bit loud.

Narrator: The most important thing that students learn is that sound must have a medium to travel through such as water, air or a solid. And that sound traveling through air seems softer than sound traveling through water or solids.

This brings us to the end of Investigation 3. Be sure to select from the interdisciplinary activities at the end of the folio and have your students complete the math problem of the week before moving on.

<Investigation 4, Part 1>

Narrator: In this investigation, students are challenged to apply what they have learned about vibration, pitch and how sound travels. Here is what you will need: From the kit you will need six listening tubes and three megaphones. These will be assembled with the paper fasteners. You'll also need three wood blocks, eight dowels, 16 plastic cups, some string, the tone generator, the stethoscopes, rubbing alcohol and cotton balls.

In addition, you'll need the sets of sound devices that you used in previous investigations, the long gongs, the kalimba, the xylophone, the string telephone, the mini gutbucket, the string beam, the FOSS-Ulele, the tuning fork and the waterphones. From the measurement kit you'll need two basins. You'll need to provide facial tissue, a nail, a pair of scissors and some paper towels. Optional equipment is a garden hose. Duplicate Student Sheets 18 through 25. Make one copy of the Assessment Chart For Investigation 4.

Begin this session by presenting the quiet challenge to the students and work together as a class to come up with solutions. The students come up with many creative suggestions for reducing the sound coming from the tone generator without using the volume knob.

Teacher: And I need for you to help me design a way so that the least amount of sound will reach your ears. The problem is, I can't turn the volume down. Think of a way. Audrey?

Student: Cover your ears.

Teacher: Okay. Cover your ears is one solution. Excellent, Audrey. Another solution? Lalonie?

Student: You could cover the generator.

Teacher: Cover the generator. Good. Cover the sound source. Another solution? Alena?

Student: Cover your ears and the generator.

Teacher: Okay. Cover both. Okay. Is there another solution?
Charles?

Student: Back up as far as you can so you can't hear it.

Teacher: Okay. Put some distance between you and the sound source.

Student: Yeah.

Teacher: Okay. One more. Let's try to think of just one more.
Vincent?

Student: Leaving the room.

Teacher: Okay. Leaving the room. Okay. Let's try out some of the solutions. Let's try the first one. Cover the sound receiver. Now we're going to try to cover up our --

Class: Ears.

Teacher: Ears. Let me turn it on. How did that work? Did that work?

Class: No.

Teacher: Was the sound loud or did it get softer?

Class: Softer.

Teacher: So it worked a little bit. Let's try the second solution. Cover the sound source. I'll turn it. And I'll cover it up with this basin. Is the sound loud or did it get softer?

Class: Softer.

Teacher: Okay. Good. Now, let's try both covering up both the receiver and the source. Let's turn it on again. Remember, you're going to cover your --

Class: Ears.

Teacher: Okay.

Student: It worked.

Teacher: How was that?

Student: It was not loud because that covered a little bit of that and we covered our ears and it covered all of it.

Teacher: Okay. Very good, Paul.
Now, think about what the sound had to go through to reach your ears.
Alena?

Student: It had to go through the basin.

Teacher: Very good. And then?

Student: The air.

Teacher: And then?

Student: Our ears.

Teacher: And then through your ears. That's right. In your ear.

Narrator: The teacher asks which is the best solution. And the students say that covering both the source and the receiver made the tone generator the quietest.

Teacher: Alena?

Student: Cover both.

Teacher: Very good. Now, you're going to be working with some challenges of your own. I'm going to pass out some paper. And each one has a different challenge that I want you to try and solve. Now, before I give those out, I want to remind you of the steps that we took in order to solve our problem. What was the first thing we did? When I told you there was a problem about the sound, what was the first thing we did?
Alena?

Student: We thought about our solutions.

Teacher: Very good. And you worked together to come up with different solutions. And we listed them on the board. And then what was the next thing we did? What was the next thing we did?
Christina?

Student: We tried all three of them.

Teacher: Very good. We tried three solutions. And then the last thing we did was?

Student: Asked Alena which one she thought was the best one.

Teacher: That's right. Excellent, Charles. We thought about and decided which was the best solution. Now I'm going to give you your challenges. Getters --

Narrator: The students will now break into eight groups. And each group will have its own sound challenge to solve in the same manner.

Student: "The kalimba challenge. Design a way to hear the sound of a kalimba as far away as possible. Hints: The sound of a kalimba can travel through the air."

Student: "Describe your best solution."

Student: Wait. The wood is the tube.

Student: The wood is the tube.

Student: The wood is the tube.

Teacher: Remember, one person is going to speak into this and three people have to be able to hear that person. So how can you do that? Remember, you can use any instrument there. You can use the megaphone. You can use the sound tube. You can use string. You can use tape. You can use cups.

Student: You can make more strings.

Student: Huh-uh. But you only said this. But he says you can make more string.

Student: More strings and more cups.

Student: I think it's like this. Cross the rope again right here.

Narrator: The teacher provides encouragement and support as the students work on their challenges.

Teacher: Just one? Remember all three of you have to hear the sound source.

Student: I know. That's why I'm only making three, one to go this way and these two.

Teacher: Okay. But this is going to be the sound source. So this is the sound source. This is the sound receiver, right? Now, you want two more people to be able to hear the sound source. So what are we going to do?

Student: We connect one here and one that way and one on the side.

Teacher: Oh, I see. So you're going to connect two strings and make two more receivers?

Student: Yeah. And see if it can go that way and that way.

Teacher: Oh, that's interesting. Okay.

Student: Louder.

Student: Now can you hear?

Student: We can hear through the piece of wood.

Student: Put this here. See if it makes a louder sound.

Student: Can you hear it?

Narrator: Each group will take turns reading their challenge and showing their best solution.

Teacher: How can three people listen to this?

Student: Three? Well, since this is loud, you can probably make sure a person is behind you.

Teacher: You think it will make it louder so all three people can hear?

Student: You have to talk a little louder and back up a little farther string here.

Teacher: All right. But not very tight. All right.

Student: Can you hear me?

Student: Yeah.

Teacher: Did that work?

Student: Yeah.

Narrator: Be sure to check the Science Stories folio to plan time for student reading.

<Investigation 4, Part 2>

Narrator: The last part of this module allows students to choose their own investigation. The projects allow them to investigate their own interests and gives you insight as to how well they understand sound.

This is the time to bring out the Project Ideas folder. As much as possible you want students to use their own ideas and investigate the questions that they have come up with during the module. If you don't have enough ideas in the Project Folder for everyone to investigate, you can use the project idea sheet to help students think about more investigations.

The project plan sheet should be completed by each student or team of students doing a project. This sheet helps you control materials and keep tabs on what the students are doing. You will need to decide whether or not you will be able to supply any additional equipment the students ask for. You will also want to make sure that the projects the students propose are realistic and will be of some benefit to the class.

FOSS suggests students give three-minute presentations following the guidelines on the Presentation Guidelines sheets. They can also make a poster to help them explain their investigation to the class. You should plan about two weeks for the students to complete their projects. They can work on them at school or they can plan to work on some of it at home.

The Assessment folio has suggestions for scoring the students' work on the projects. Also in that folio you will find information and masters for two kinds of summative assessment: An end-of-module test given in a variety of formats and suggestions for assembling portfolios.

This is the end of the Physics of Sound module. Keep in mind there are details in the Teacher's Guide that we weren't able to show you in the video. I hope your students enjoy this module as much as ours did.