GRADE 8 Core Knowledge Science®

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Unit 2

Sound Waves:

How can a sound make something move?

Student Procedure Guide

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Sound Waves:

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Core Knowledge Science

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Sound Waves

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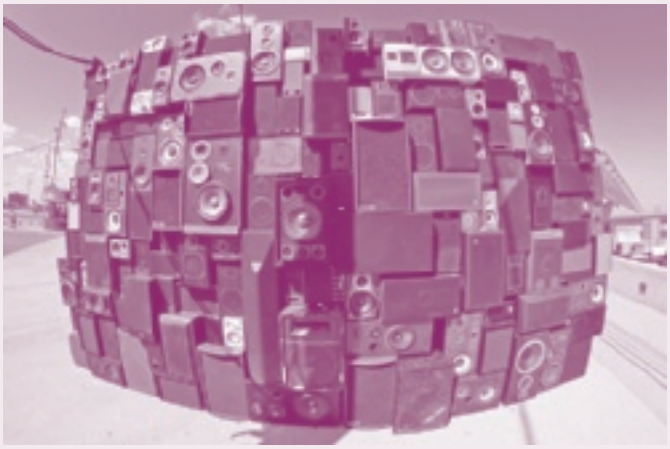


Lesson 1: How does a sound source make something like this happen?

What do you notice?

We are going to watch a video of a new phenomenon.

In your notebook

1. Make a T-chart in your science notebook using the following example.

Notice	Wonder

2. As you observe this new phenomenon, record your noticings and wonderings in the T-chart.

Sharing Observations

As you share with a partner, be sure to reference specific moments in the video so everyone understands what you are talking about.

Turn and talk

3. What did you observe in the video?
4. Why do you think those things happened?
5. What was puzzling to you? What questions do you have about what you observed?

With your class

6. Share your observations and your partner's observations with the class.

Making Observations of a Speaker

In your notebook

7. Make a T-chart in your science notebook using the following example.

Notice	Wonder

8. As you observe the speaker, record your noticings and wonderings in the T-chart. Think about the following questions:

- What is the speaker doing while it is making sounds?
- What do you see happening that might help us understand what's happening in the video of the truck and the window?

Initial Model: How does the speaker make the window move?

In your notebook

9. Develop an initial model to explain, "Why would a sound coming from one thing make another thing move?"

- Use pictures, symbols, and words in your model to help represent and further explain what you think is happening in each of the 3 locations on a zoomed-in scale.

Comparing Initial Models

Turn and talk

10. Share your model with a partner, looking for similarities and differences between your models.

- Have one member of your team keep track of the similarities and differences between your models. Be prepared to share these patterns with the whole group.

Consensus Model in a Scientists Circle

With your class

11. What do we all seem to agree on?

12. What do we disagree on?

13. What are some new ideas that we may want to consider?

Where have you seen something like this?

In your notebook

14. Add a "Related phenomena" section to your notebook.

15. Jot down other experiences you have had that relate to what we have observed so far. Use the following questions to guide your brainstorming:

- When or where have you seen before a time where an object making sounds caused something to move or shake, like the window in the video?
- When or where have you seen sounds being made before? What was making those sounds?
- When or where have you experienced a sound being received before? What objects have you seen receiving sounds besides the window in the video?
- Have you ever experienced a sound going over a distance, like in the video?

Sharing Related Phenomena

Once you have finished brainstorming, find the posters hung up around the room with the brainstorming questions written on them.

With your class

16. At each poster, write one of your responses on the poster under the question.

17. Be ready to discuss the following questions:

a. What phenomena did you see multiple times on these posters?

b. Which ones stood out to you the most?

c. Were there any you have never encountered before?

What questions do you have?

In your notebook

18. Add a "Questions" section to your notebook.

19. Jot down any questions you have had that relate to what we have observed so far.

- To help you brainstorm, you could look back at the T-charts you made in your notebook, your initial model, the class's consensus model, or your class's lists of related phenomena.

Driving Question Board

With your class

20. Review the questions you brainstormed at the end of last class. Use these question starters to create two revised questions to post to our Driving Question Board:

a. Why . . .?

b. How . . .?

c. How would it be different if . . .?

d. What if . . .?

e. What is the purpose of . . .?

f. What causes . . .?

21. Write each question on a sticky note or card. Write the question in dark marker and large enough for others to read.

22. Be prepared to post your questions to our Driving Question Board.

Ideas for Investigations

In your notebook

23. Make a new section in your notebook titled "Ideas for Future Investigations and Data We Need".

24. In this space, brainstorm investigations the class could do or sources of data the class might need to figure out the answers to the questions the class just put on the Driving Question Board.

With your class

25. What part of the consensus model does it make sense to explore first? Why?

26. What are we going to need to do to explore this part?

Lesson 2: What is happening when speakers and other music makers make sounds?

Navigation

We had a bunch of questions about what is happening at the sound source and ideas for how to investigate.

Turn and talk

1. How do you think sound sources like instruments and speakers make all those different sounds?
2. What would you expect to see if you looked closely at these sound sources while they are making sounds?

Prepare to observe instruments and the speaker.

In your notebook

3. Make a chart to record observations in your science notebook.

Data Source	Observations

4. For each new sound source, make a new row in your observation table to record your observations.

Observe instruments and the speaker at stations.

With your group

5. Work with your group to make observations at each station. Use the following prompts to guide your observations:
   - How does the object look and feel while it is being struck?
   - How does the object look and feel while it is making sounds?
   - How is what you notice similar to or different than what we saw a speaker do?
   - Can the sound source make different sounds? If so, how?
   - What patterns did you notice in how they make different sounds?

In your notebook

6. Discuss and record what you observe in your observation table.

Discuss observations.

With your class

7. What patterns did you notice?
8. What else could we do to figure out more about what is happening with these sound sources?

Observe slow-motion videos.

With your class

9. Observe slow-motion videos of instruments and speakers and share your observations.

In your notebook

10. For each sound source, make a new row in your observation table to record your observations.

Analyze our observation data.

In your notebook

11. In your notebook, use the observations you made in the observation table from the previous steps to respond to the following questions:
    a. What patterns or similarities did you notice in how the different objects you observed moved while they were making sounds?
    b. What patterns did you notice among the instruments and the speaker?

Discuss patterns.

With your class

12. What was similar about the motion of different instruments while they made sounds? What was different?
13. What types of shape changes did we see in objects when they were struck or plucked?
14. How did the shape of objects keep changing after we were done striking or plucking them?

Construct a consensus model.

With your class

15. Work together to construct a model of how an instrument moves when it makes sounds. Each box in the table, from left to right, will represent how the shape of a drum changes over time as it is making sounds.
16. Record the class consensus on your *How do instruments move when making sounds (vibrating)?* handout.

Apply our consensus model.

On your own

17. Individually, use our model to show what is happening with a different instrument that you observed during the lesson, like the guitar. Use the second page of the *How do instruments move when making sounds (vibrating)?* handout.

Compare models.

With a partner

18. 1 min: Use your model to explain what is happening when an instrument makes sounds.

19. 1 min: Give feedback. Here are prompts to consider as you give feedback:

a. I wonder about _____. I noticed you _____.

b. I appreciate how you _____.

c. It would be clearer if you added_____.

d. I see you're thinking about_____.

e. Do you think you should add_____?

20. Switch.

Scientists Circle: Add to our Progress Trackers.

With your class

21. Work together to summarize in words what we think is happening in all the sound sources when they make sounds.

Apply our model to other objects.

In your notebook

22. Do all objects vibrate when they make sounds (even ones that aren't musical instruments)?

23. Write this question in your notebook, then jot down your ideas.

24. Discuss your ideas with the class.

With your class

Lesson 3: Do all objects vibrate when they make sounds?

Navigation

Remember the patterns we found with musical instruments last time, and remember that we wanted to explore sounds from objects that are not designed to make sounds.

Turn and talk

1. Would you expect any object that makes sounds to move in the same way we saw the musical instruments and speaker move? Why or why not?
2. Be ready to share your thoughts with the whole group.

Investigation Planning

We will need to change the scale and "zoom in" on a solid object to see if it really does vibrate or not. Your teacher has some materials we can use to try this.

With your class

3. What question are we trying to answer? How can we use these materials to investigate this question?
4. How will we be changing the scale of the vibrations? Why?

Predicting Possible Outcomes

With a partner

5. Work with a partner to complete part 1 of your handout.
6. We will discuss our ideas as a class.

Collecting Data

With your class

7. As we carry out our investigation, record our data on part 2 of your handout.

Making Claim from Evidence

On your own

8. Complete part 3 of your handout. How do solid objects move when making sounds?
9. We will discuss our ideas next time we meet.

Building Understandings

With your group

10. Share your claim, evidence, and reasoning with at least three other people.
11. We will share ideas with the whole class.

Describing Patterns

Turn and talk

12. What differences did you notice in how the laser moved? What do you think caused those differences?

13. What else could we test with the laser-mirror apparatus to see more differences (and their possible causes)?

Making Predictions

Turn and talk

14. How do you think the laser dot will move when the speaker makes different sounds? What makes you think that?

15. We will share our predictions with the whole group.

Collecting Data

With your class

16. As we carry out our investigation, record our data on part 2 of your handout.

Making Claim from Evidence

On your own

17. Complete part 4 of your handout. How does changing the force affect the sound?

Building Understandings Discussion

Bring your handout and science notebooks to the Scientists Circle.

With your class

18. What claim can we make based on the evidence we found today? How does changing the force affect the sound?

19. What patterns did you see among your observations (from today and the last class)?

20. Do you agree or disagree with these claims? Why or why not?

Navigation

With your class

21. What do we mean by "more" vibration? Is there a way we could understand better how more force makes an object vibrate more?

Lesson 4: How do the vibrations of the sound source compare for louder versus softer sounds?

Progress Tracker: What have you figured out?

Use this Progress Tracker to record your learning throughout the unit.

In your notebook

1. Create a T-chart in your notebook under the heading "Progress Tracker".
2. Label the left side of your chart "Question" and the right side "What I figured out."
3. Write the lesson question in the left column: "How do solid objects move when they make sounds?"
4. On the right side, use words and/or drawings to record what you have learned.

Navigation

Turn and talk

5. What pattern did we notice in the vibrations last time when objects were making louder sounds?
6. Be ready to share your thoughts with the group and to discuss what we mean by "more" vibrations.

Recording Motion Detector Data

We will use a motion detector to change the scale of the vibrations of louder and softer sounds. First, we'll need to see how it works.

In your notebook

7. Sketch each of the graphs we made from walking away from and toward the motion detector.
   - Title each graph.
   - Label both axes on your graphs.
   - Describe in words next to each graph what it looks like.
8. Discuss with your class why you are seeing those patterns on your graphs.

Why should we use this stick?

We will use a long, thin stick to model our sound source. After discussing the following questions, write your own thoughts about them in your notebook.

In your notebook

9. How could this stick be a model for a guitar string or tuning fork?
10. How do you think it will move?
11. Why not just use the sound makers we have already looked at?
12. What differences in motion might we see when we model louder sounds versus softer sounds?

Predicting the Motion Graph of the Stick at Rest

In your notebook

13. Tape the graphs handout onto the left side of your notebook.

14. Use a pencil to sketch onto both graphs what you think it will look like when the stick is not moving.

Predicting and Testing Softer and Harder Pushes

As you work with your class to test the stick apparatus with the motion detector, record your results on the graphs in your notebook.

In your notebook

15. Use a different colored pen or pencil than you used for your "at rest" line.

16. Before the test, draw a dashed line where you think the data in the graph will be plotted and label it "prediction."

17. After the test, draw a solid line to show the stick's motion and label it "actual."

Recording Graphs of Speaker Motion

In your notebook

18. After you watch the simulation of the speaker's motion, sketch the speaker graphs on the right side of your notebook so you may compare them to the graphs of the motion of the stick.

What patterns do you see?

In your notebook

19. Look for similarities and differences within and among the four graphs in your notebook. Write complete sentences on or near your graphs starting with "I notice …" to describe what you see. Draw arrows pointing to important features of the graphs.

Describing Vertical Patterns on the Graphs

With your class

20. Discuss with your class the patterns you found within and among the four motion graphs from the stick and speaker. Add new ideas to your notebook as needed.

21. Measure the vertical distances (from the starting position to the highest or lowest point) on the graphs. Discuss what that evidence tells you about the vibrations of louder sounds versus softer sounds.

22. Define *amplitude* in your notebook, including a sketch.

23. Consider: What is the connection between amplitude and loudness?

Describing Horizontal Patterns on the Graphs

With your class

24. Measure the horizontal distances (from peak to peak or valley to valley) on the graphs. Discuss what that evidence tells you about the vibrations of louder sounds versus softer sounds.

25. Calculate how many waves would happen in double or even triple the time.

26. Define *frequency* in your notebook, including a sketch.

Answer our Lesson Question.

With your class

27. How does what we discovered from the graphs help us answer our original question, "How do the vibrations of the sound source compare for louder versus softer sounds?"

Progress Tracker: What have you figured out?

In your notebook

28. Draw a line underneath the work you did last class in your Progress Tracker. The column headings are still the same: "Question" and "What I figured out."

29. Write the lesson question on the left side: "How do the vibrations of the sound source compare for louder versus softer sounds?"

30. On the right side, use words and/or drawings to record what you've learned.

Evaluate the stick apparatus.

With your class

31. Consider and discuss: Why do you think the stick apparatus is a good model for a sound maker, or not? How is the stick apparatus like other sound makers, or not?

Navigation: What should we investigate next?

With your class

32. Discuss with your class how sounds can be different, other than loudness.

33. Explore instruments that make different sounds, such as a guitar, xylophone, and music box.

34. Propose how we could change the stick apparatus to investigate the vibrations of a sound maker that produces different notes.

Lesson 5: How do the vibrations from a sound source compare for higher-pitch versus lower-pitch sounds?

Navigation

Last time, we collected data from sticks that we pushed with different amounts of energy. Then we looked at several musical instruments.

Turn and talk

1. Discuss these questions:
   a. What patterns did we notice when looking at and playing the musical instruments at the end of Lesson 4?
   b. How does what we figured out about the musical instruments help us to determine our next investigation?
2. Be ready to share your thoughts with the whole group.

Graph data from sticks of different lengths.

We will predict what the motion graphs for a shorter stick and a longer stick will look like and gather data for each of these stick lengths. Then we will compare the stick data to graphs that show the motion a speaker makes for sounds with higher pitches and sounds with lower pitches.

In your notebook

3. Paste the Lesson 5 graphs on a clean, left-hand page of your notebook.
4. Predict what the motion graphs will look like for a shorter stick and a long stick.
5. Record data on your graphs for each of these conditions.
   a. Condition 1: long stick
   b. Condition 2: short stick
6. Write "Speaker vibration at different pitches" at the top of the right-hand page that faces your stick graphs.
   a. Make a box and label it "Low pitch."
   b. Make another box and label it "High pitch."
7. Record data about the motion a speaker makes for higher pitch sounds or lower pitch sounds in the corresponding box.

Analyze patterns from stick and speaker data.

We are now going to take some time to analyze the data we collected to look for patterns in the motion of the sticks.

With your group

8. Write "What I see" statements in your notebook. These statements describe patterns you see across the four graphs. Draw an arrow to an important feature, and then write one "What I see" comment for each pattern you notice. Remember to write directly on the graphs.
9. Calculate frequency and amplitude for each graph.

10. Write a "What it means" statement next to each of your "What I see" statements. These statements are your initial explanations of what you think is happening to cause the change in data.

Building Understandings Discussion about Frequency and Pitch

We are now going to take some time to analyze the data we collected to look for patterns in the motion of the sticks.

With your class

11. What do the patterns we noticed with the speaker and the stick mean for frequency and pitch?

12. What is the relationship among length, pitch, and frequency?

13. What role does amplitude play in frequency?

Apply ideas about frequency, pitch, and amplitude.

Use what we discovered from the graphs and the speaker simulation to help us answer our original question.

With your group

14. Discuss with your group how what we have figured out about frequency and amplitude could help us answer our question: "How might you explain how the speaker is making so many different sounds (loud, soft, high pitch, and low pitch)?"

Add to our Progress Tracker.

On your own

15. Draw a line under the work you added to your Progress Tracker last time. Then record your thoughts about today's work.

16. Write the lesson question in the left column: "How do the vibrations from a sound source compare for higher-pitch versus lower-pitch sounds?"

17. On the right side, use words and/or drawings to record what you have learned.

Exit Ticket: Analyze frequency graphs.

On your own

18. Your ticket out the door is to complete the *Analyzing Graphs of Sound Source Vibrations*.

19. You will receive feedback during our next lesson.

20. You will hand this in, so make sure to write your name at the top!

Lesson 6: How can any object make so many different sounds?

Navigation

Last time, we collected data from the motion of sticks with different lengths. Look back at your Progress Tracker from the last lesson.

Turn and talk

1. How do the vibrations from a sound source compare for higher-pitch versus lower-pitch sounds?
2. Be ready to share your thoughts with the whole group.

Revisiting Frequency Graphs (Exit Ticket from Lesson 5)

With a partner

3. Compare your thinking about the exit ticket from the last lesson:
   a. Where did you agree? Disagree?
   b. What questions do you have?

Connecting Graphical Representations to the Sounds Made

With a partner

4. Work with your partner to answer your assigned set of questions. Be sure both you and your partner are prepared to share.

With another pair:

With your group

5. Explain your claims, evidence, and reasoning to another team. Be sure you and your partner each share. Do you agree with the ideas of the other team? What questions do you have for them?

Revisiting and Revising Our Consensus Model

With your class

6. Gather in a Scientists Circle with your science notebook.
7. Work together to revise our consensus model to reflect what we have figured out about what the sound source (including the truck speaker) is doing when it makes different sounds.
8. Add to our Progress Tracker as a whole class.

Revisit Our DQB (Driving Question Board)

Let's revisit our DQB and see which questions we have made progress with.

With your class

9. Use a symbol to note the progress made on each question:

a. We did not answer this question or any parts of it yet: **O**

b. Our class answered *some parts* of this question, or I think I could answer *some parts* of this question: ✓

c. Our class answered this question, or using the ideas we have developed I could now answer this question: ✓+

Individual Assessment

On your own

10. Watch the video of the harp playing different sounds and then independently complete the assessment.

Lesson 7: What is actually moving from the sound source to the window?

Returning to Our Consensus Model

We have figured out a lot about one part of our model but we still have questions that we need to answer to fully explain what's happening in the truck-window video.

With your class

1. Discuss the following questions:
   a. What ideas did we have about the question, "What is actually moving from the sound source to the window?"
   b. What questions do we have on our DQB that are related to this question?

Revisiting Our Initial Models

Turn and talk

2. Compare initial models with a partner and discuss the following questions:
   a. What ideas did you have on your initial model about what is traveling between the speaker and window to make the window move?
   b. What ideas did your partner have on their initial model?

Planning an Investigation

In your notebook

3. Paste the Investigation Plan table you receive from your teacher into your notebook.
4. Record the following question in the space under box 1 in the table:
   - Is air moving all the way from the sound source to our ears or the window when sounds are produced?

Brainstorming Investigation Ideas

In your notebook

5. Add the investigation idea that we come up with to the space under box 2 in the Investigation Plan table in your notebook.

Possible Outcomes for Our Investigation

With your class

6. Discuss the following questions:

a. What are the possible outcomes of our investigation?

b. What would each of these outcomes tell us?

In your notebook

7. Add the possible outcomes we identify as a class and what they could tell us to the spaces under boxes 3 and 4 in the Investigation Plan table in your notebook.

Results of Our Investigation

With your class

8. Discuss the following questions:

a. What did we observe in our investigation?

b. What claim can we make based on our results?

In your notebook

9. As we conduct our investigation, jot down your observations in the space under box 5 in the Investigation Plan table in your notebook.

Improving Our Investigation

Turn and talk

10. How could we make sure air is really being blocked and that no air is getting in or out?

Results of Our Investigation

In your notebook

11. Jot down in your notebook your thoughts about the following questions:

a. How did the mass of the container and the sound source change before and after sounds left the container?

b. What claim can we make now about whether air is traveling from the sound source to our ears?

Analyzing Claims from Our Initial Models

On your own

12. Look back at your initial model. On a sticky note, summarize in words what claim you originally made about what is traveling between the speaker and the window.

13. Use sticky notes to write feedback on your partner's model following our *Peer Feedback Guidelines*. Use the following questions to guide your feedback:

a. What claim or claims does your partner's model make about what is traveling between the speaker and the window?

b. Do you think that this claim is supported by the evidence we have collected so far in our investigations?

c. If not, what changes do you think your partner could make to their claim about what is traveling between the speaker and the window?

d. What specific evidence can you connect to your partner's claim to support your feedback?

Exit Ticket

On your own

14. List at least 2 important pieces of feedback that you received from your partner. What could you add or change on your model to address these pieces of feedback?

15. After collecting new evidence in our investigations and getting feedback from your partner, do you still support the claim you made in your initial model? If not, what new claim would you make about what is traveling between the speaker and the window?

16. What did you see in the evidence we collected today that makes you think your claim from Q2 is correct? How does that evidence support the claim you chose?

Lesson 8: Do we need air to hear sound?

Revisiting a Question from Last Class

Last class, we figured out that air is not moving all the way from the sound source to our ears.

Turn and talk

1. Discuss the following questions:
   a. If the air from near the sound source is not moving all the way to our ears or the window, then what is moving?
   b. Is the air inside the container even needed for sound to travel to our ears?

Investigating Two Different Claims about This Question

With your class

2. Discuss the following questions:
   a. Do we have any evidence from our investigations so far to support either of these arguments for what sound needs to travel?
   b. How could we tell if the air inside the container is needed for us to hear the sound?

Planning an Investigation

In your notebook

3. Write the following question at the top of the next clean page in your notebook:
   a. "Can we hear sounds coming from a container with no air inside?"

Setting Up Our Investigation

In your notebook

4. Under the question you wrote in your notebook, make a T-chart to record your answers to the following questions:
   a. What are the possible outcomes of our investigation?
   b. What would each outcome tell us about the question we are investigating?

Results of Our Investigation

In your notebook

5. As we conduct our investigation, record in your notebook what you observe as well as what claim you can make about this question:
   a. "Can we hear sounds coming from a container with no air inside?"

With your class

6. Discuss the following questions:
   a. What did we observe in our investigation?
   b. What does our new evidence tell us about our claims for what sound needs to travel?

Planning Our Second Investigation

In your notebook

7. Write the following question at the top of the next clean page in your notebook:

a. "Will sound still travel through something other than air?"

Setting Up Our Investigation

In your notebook

8. Under the question you wrote in your notebook, make a T-chart to record your answers to the following questions:

a. What are the possible outcomes of our investigation?

b. What would each outcome tell us about the question we are investigating?

Results of Our Investigation

In your notebook

9. As we conduct our investigation, record in your notebook what you observe as well as what claim you can make about this question:

a. "Will sound still travel through something other than air?"

With your class

10. Discuss the following questions:

a. What claim can we make from the evidence we gathered through our last investigation?

b. What can we say about the two arguments about what sound needs to travel?

Consensus Discussion

With your class

11. Discuss the following questions:

a. What evidence did we collect today about whether sound needs air to travel?

b. What does this evidence tell us about our two arguments about whether sound needs air to travel?

In your notebook

12. During our discussion, record the key findings of your class in the Progress Tracker in your notebook.

Brainstorming Future Investigations

Turn and talk

13. Discuss the following questions:

a. If we were to draw a model of how sound travels through matter, what would we need to include in that model?

b. What do we need to figure out about each of these parts of the model so that we can represent how energy is transferred when sound travels through matter?

Lesson 9: How can we model sound traveling through a solid, liquid, or gas?

Navigation

With your class

1. Discuss the questions (looking back at your Progress Trackers):
   a. What were the big ideas about sound that we figured out last lesson?
   b. What questions did these ideas raise for us?

Model matter in different mediums.

In our last lesson, we did an investigation where we made a sound underwater inside of a tank and then heard the sound through the air, a gas, after it traveled through the liquid water and solid glass.

With a partner

2. Get *Sound and States of Matter* from your teacher.
3. With a partner, develop a model to represent the different states of matter that the sound traveled through after it was made.

Share models for different states of matter.

Several partners will stand up and describe their models to the class. During sharing, look for areas of agreement and disagreement with other groups' models.

With your class

4. What do we mean when we say "matter"?
5. What did we see that was *similar* for the different states of matter in all of our models?
6. What did we see that was *different* for the different states of matter in our models?
7. Why are we talking about the matter of solids, liquids, and gases?
8. What do our models not show that might help us figure out how the sound is traveling through the medium?

Simulate particle movement (with our bodies).

Volunteers line up in the front (with a bit of space between them) to represent particles. The teacher holds a piece of cardboard to represent the sound source, which will move back and forth. The students who are representing particles nearest the sound source prepare to slowly simulate what would happen to them as the sound source vibrates. The teacher with the cardboard sign holds it with one hand on the top and one hand on the bottom of the cardboard and moves it back and forth (like a door opening and closing). What would the cardboard do when it touches a particle of the medium? The student who is the first particle hit by the sound source keeps moving until coming up against another "particle." The new particle that is hit starts moving toward the next particle. This process repeats every time a particle hits another particle.

With your class

9. What did you notice about what happened with the particles as they got bumped?

10. What could we call it when the particles are passing a movement along by pushing or hitting one another?

11. How was energy transferred as the sound traveled?

12. How might we simulate a smaller-amplitude vibration? What effect would that have?

13. Why was it a little tricky for us to simulate the vibrations at the sound source using people?

Particle Movement Discussion

Discuss how the simulation helps you understand the interactions between particles in different states of matter and how we can use these ideas to explain why we could not hear anything when the air was removed.

With a partner

14. What state of matter do you think we were simulating? What is your evidence?

15. Would we see similar interactions between particles if we simulated sound traveling through a solid or a gas? How would those compare?

16. How does this model help us understand why, in an investigation in Lesson 8, we could not hear any sound when we sucked the air out of a system?

Model matter around a sound source.

Develop a model to show the state of matter (liquid or gas) that would be next to the small spots (shown as rectangles in the diagrams on page 36) on the surface of either object producing sound (drum or tuning fork). Then show what you predict would happen to the matter in each medium if the spot on the sound source in question started making sound and vibrating.

On your own

17. Work individually to develop this model on *Modeling the Matter around the Sound Source*.

Share models of matter around a sound source.

With your group

18. Share your model with your small group.

19. Be prepared to share with the class the interesting pieces from your peers' models that helped you think about how sound moves across the matter.

20. Share out:

a. What ideas about what happens to the particles when a sound source starts vibrating did you see or hear?

Navigation

Scientists often build computer simulations to help investigate and visualize outcomes in systems that have parts (or particles) in them that are too small to see. Computer simulations are programmed to have the objects and interactions that the user wants or needs. Think about what you would want to see included in such a computer simulation that would help you understand more how sound travels across a medium.

With a partner

21. What sort of things would you want to be able to adjust in that simulation about the motion of the sound source?

22. What sort of particle interactions in the medium would need to be included in the simulation?

23. How might running a computer simulation that includes all the things you listed above help us better visualize and understand what exactly is traveling across a medium when a sound is produced from a sound source?

Lesson 10: What exactly is traveling across the medium?

Progress Tracker: What have you figured out?

In your notebook

1. Create a T-chart in your notebook under the heading "Progress Tracker."
2. Label the left side of your chart "Question" and the right side "What I figured out."
3. Write the lesson question in the left column: "What exactly is traveling across the medium?"
4. On the right side, use words and/or drawings to record what you have learned.

Navigation: Initial Ideas Discussion

Now, we will read a few questions from the DQB that we are wondering about. What did we want to see in our computer simulation to help us better understand how sound travels across a medium?

With your class

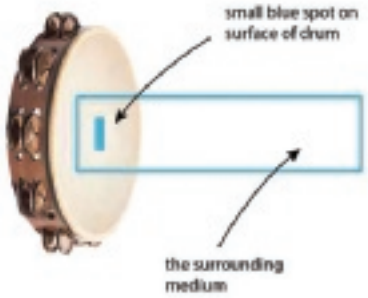
Discuss as a class:

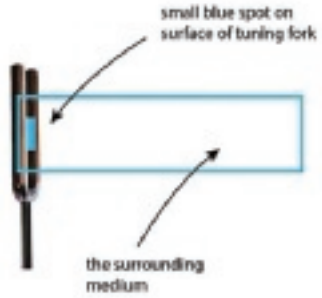
5. What things related to the motion of the sound source would you want to be able to adjust in that simulation?
6. What sort of particle interactions in the medium would need to be included in the simulation?
7. How might running a computer simulation that includes all the things you listed above help us better visualize and understand what exactly is traveling across the medium when a sound is produced from a sound source?
8. What questions did these ideas raise for us?

Map representations from the visualizing sound in a medium simulation.

We have a computer simulation available to use, but we need to make sure we understand what the simulation represents and that it does what we want it to do.

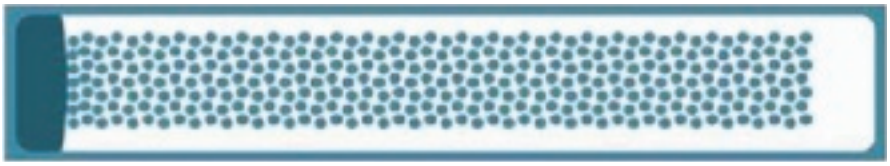
With your class





9. We can imagine a tiny piece of any object that is vibrating and the space immediately around it.

10. When we use the simulation, the blue rectangle on the left in the simulation will move back and forth, just as a tiny piece of any vibrating object would move back and forth.



11. What is different about this second representation of the medium around the sound source?

Map representations onto the analogy map.

With your group

12. Your teacher will give you *Visualizing Sound Analogy Map*. Tape this handout into your science notebook.

13. Work with your group and complete the analogy map. The first row is done for you.

Make predictions about the visualizing sound simulation.

Before you start using the *Visualizing Sound in a Medium* simulation, make some predictions in your science notebook.

In your notebook

14. Your teacher will distribute *Visualizing Sound in a Medium Investigations*. Complete Part 1: Predict.

Investigation 1: What is happening at a spot in space in the medium?

With your group

15. Follow the instructions on *Visualizing Sound in a Medium Investigations*.

16. Complete Part 2: Investigation 1: What is happening at a spot in space in the medium?

Investigation 2: How will the patterns you see moving across the medium change?

With your group

17. Follow the instructions on *Visualizing Sound in a Medium Investigations*.

18. Complete Part 3: Investigation 2: How will the patterns you see moving across the medium change?

19. Be ready to share your ideas with the class.

Navigation: What are we seeing in our simulation?

With your class

Discuss as a class:

20. What variable did your group change first?

21. What patterns did your group see?

Making Sense of Our Sound Simulation Observations

With your class

22. Your teacher will refer you to the observation page.

23. Tape this handout in your notebook and join together in a Scientists Circle to make sense of our findings.

Adding to Our Progress Trackers

Add the conclusions your class has made about the lesson question to your Progress Tracker.

In your notebook

24. Write the lesson question in the left column: "What exactly is traveling across the medium?"

25. On the right side, write our source(s) of evidence.

26. On the bottom, use words and/or drawings to record what consensus the class reached after this lesson.

Home Learning

Use the ideas in this lesson to explain how music produced from the speaker in the truck caused the window in a building across the parking lot to move.

Home Learning

27. Make a sketch of what is happening and be sure to include the following in your model:

a. vibrations of the sound source
b. collisions between particles
c. energy transfer
d. changes that happen in the particle density across the medium

Lesson 11: How does sound make matter around us move?

What have we been up to?

With your class

1. Flip through your science notebook to recall some of the phenomena we've investigated so far.
2. Discuss with your class: What did those phenomena help us figure out?

A New Phenomenon: Bouncing Salt

Watch the salt on the plastic-wrapped bowl as your teacher strikes the drum.

With your class

3. Discuss with your class what you notice happening.
   - Does the outcome change if you change how hard you hit the drum?
   - Do you think this phenomenon is similar to the truck speaker making the window move? Why or why not?

Can we explain this in general?

How are sounds caused, and how can they make anything move?

With your class

4. Discuss these questions with your class:
   - Why would it be helpful to have a model that answers this broader question?
   - Why might we need to consider more than just the truck speakers moving the window as we begin to answer this bigger question?
   - Do we have other experiences we can connect to if we need multiple examples to help us explain something?

Drafting a Gotta-Have-It Checklist

Your teacher will give you a blank Gotta-Have-It Checklist to tape into your notebook. Consider what big ideas will help us explain how a sound is caused and how it can make something else move.

With a partner

5. Work with a partner to list the "must haves" of a model that answers this question on the left side of the checklist. Leave the right columns empty for now.

Create a model of the bouncing salt phenomenon.

How did hitting the drum cause it to make a sound and how did that sound cause the salt to move?

With your group

6. Work with your group to create a model that answers this question.

7. Use the ideas on your Gotta-Have-It Checklist and check them off in the "used" column as you go. If you do not use an idea, check the "did not use" column instead.

Gallery Walk to Give Helpful Feedback

During the gallery walk, think of specific changes or additions each group could make to improve their model.

With your class

8. Write comments or questions on sticky notes such as the ones listed below:

- The part where you said / showed _____ is not very clear to me. You could help me understand your thinking better by _____.
- Your model said / showed _____. I disagree because _____. I think you should change _____.
- I notice that your model seems to be missing _____. It would be more complete if you added _____.
- You showed / explained _____ really well. Please share that with the whole class during discussion.

Responding to Feedback

We use peer feedback to improve our work, making it more clear, more accurate, and better supported by evidence.

With your group

9. With your group, read your feedback carefully. Ask someone else to help you understand it, if needed.

10. Decide if you agree or disagree with the feedback and talk with your group about why you agree or disagree.

11. Revise your work to address the feedback.

Consensus Discussion

With your class

12. Review and discuss one group's model of the bouncing salt as you write a final Gotta-Have-It Checklist with your class. Discuss the following questions:

- What do we need to show first at the sound source? Why does that piece have to be at the beginning?
- Does it matter how much force we apply to the sound source?
- How does the force affect the sound source? Can we see that in our example model?
- During our last discussion, we also mentioned the frequency of the vibrations. Why do we not see frequency in this model?
- Looking at the model again, what happens around the sound source when it is vibrating?
- What do we need to see on the model to show how the sound moves across the space between the drum and bowl? How can we show that energy is moving there?
- How does the sound detector move?
- Why does the salt stop bouncing?

Create a revised model of the truck speaker and window phenomenon.

Our big question is: How is sound (music from the truck speaker) caused and how can it make something else (a window near the parking lot) move?

On your own

13. Work independently on *Revised Model* to create a revised version of your initial model that answers our question about the truck speaker and window phenomenon.

14. Use your Gotta-Have-It Checklist to be sure you have included all the pieces that we agreed are most important.

Lesson 12: What goes on in people's ears so they can detect certain sounds?

Where have we been, and where are we going next?

Look back at our consensus model. Then discuss these questions with your class.

With your class

1. Of the three parts of our model (sound source, medium, and detector), where do you think we have made the most progress?
2. What questions do we still have on our DQB?

Making Predictions

Discuss the following questions with your class. Your teacher may also ask you to draw your predictions on *Model Inside an Ear*.

With your class

3. Look at our consensus model again. What do you think happens when these kinds of particle compression waves hit human ears?
4. What do you think is going on inside people's ears that allows them to hear different sounds?

Possible Investigations

Talk about these questions with a partner and then be ready to share your thoughts with the group.

Turn and talk

5. If we want to investigate how human ears work, how could we do that?
6. What evidence do we need to find to support some of our ideas?

Watch and discuss the ear exam video.

Your teacher will show you a video of ear examination. After you watch the video, discuss these questions with your class.

With your class

7. What did you notice during this video?
8. What structures in the ear remind you of anything we have already investigated?
9. Where or how could we get more information about how human ears work?

Reading: Information from the Experts

Your teacher will give you *Lesson 12 Activity Sheet* and a reading about an interview with two experts, *Information from the Experts*.

On your own

10. Read the interview, watch the linked videos, and look at the animations on the linked websites.

11. Record your thinking on the *Lesson 12 Activity Sheet*.

Annotate the ear diagram.

With your class

12. Work with your class to use what you learned in the reading and videos to explain how the ear works by annotating the diagram on the *Lesson 12 Activity Sheet*.

Where do we need to explore next?

With your class

13. What new questions do we have about these ideas of frequency and amplitude in regard to our hearing?

Reading about Animal Hearing

Home Learning

14. Your teacher may assign *Reading: Hearing in Elephants, Dogs, and Humans* as home learning.

15. You may choose to use the Online Tone Generator (http://onlinetonegenerator. com/) to investigate how well you and your family can hear different pitches.

Lesson 13: What transfers more energy, waves of bigger amplitude or waves of greater frequency?

Connecting to Our Question from Last Time

Last class, we agreed that louder sounds and higher-pitched sounds can damage people's ears.

With your class

1. Discuss the following questions:

a. Why might louder sounds do more damage than quieter sounds? Why would they transfer more energy?

b. Why might high-pitched sounds do more damage than low-pitched sounds? Why would they transfer more energy?

Our Lesson Question

In your notebook

2. Write the following question at the top of the next clean page in your notebook:

a. "What transfers more energy, waves of bigger amplitude or waves of greater frequency?"

Setting Up Our Investigation

Turn and talk

3. Discuss the following questions:

a. What would we need in order to figure out what transfers more energy, waves of bigger amplitude or waves of greater frequency?

b. What would we need to include in our investigation?

Analogy Map

In your notebook

4. Paste the analogy map into your notebook.

5. As we go through the setup for our investigation, fill out your analogy map. In each row, record an element of our investigation setup in the row for what it represents from the real world and our reasoning for how the element represents this real-world concept.

Connecting Our Investigation to Our Lesson Question

Turn and talk

6. Discuss the following questions:

a. How will you use this setup to change the amplitude of the vibrations?

b. How will you use this setup to change the frequency (number per time period) of the vibrations?

Conducting the Energy Transfer for Amplitude and Frequency Investigation

Safety Precautions

7. When working in your group of 3-4 students:

a. Everyone should wear goggles the entire time you are at your stations.

b. You will need one person to make sure the base of the ruler stays in place and to hold it in place if it is slipping, another person to make sure the first marble is lined up against the ruler as it is pulled back, and a third person to pull the ruler back. If you have a fourth person, they can record data for your group on your group's data sheet.

Recording Our Class's Data

In your notebook

8. As the class reports the data collected by each group, add these data to your class data tables. While we are recording our class's data, be sure to look out for patterns you notice in our data as well as any outliers that fall outside these patterns.

Finding Patterns in Our Class Data

With your class

9. Discuss the following questions:

a. How could we use all our groups' data to find a typical value for each column in our tables?

b. Are there any values that look like they are extreme outliers?

c. How do we think we should deal with these outliers so that we use everyone's data but make sure our class data is as accurate as possible?

d. Is there a way we could make patterns in our data tables easier to see more visibly?

Analyzing Our Class's Data

In your notebook

10. Stop and jot your answers to the following questions:

a. What patterns did you notice in how changing the amplitude of the vibration changed the amount of energy transferred?

b. What patterns did you notice in how changing the frequency of the vibration changed the amount of energy transferred?

c. Using the tables and graphs of our data, which do you think transferred more energy: waves of bigger amplitude or waves of greater frequency? How did you arrive at your claim?

Adding to Our Progress Trackers

With your class

11. During our discussion, record our class's key findings in your Progress Tracker in your notebook.

Lesson 14: How can we explain our anchoring phenomenon, and which of our questions can we now answer?

Revisiting Our DQB

With a partner

1. You will receive from your teacher a handout showing your class's DQB questions. Tape it into your science notebook. With a partner, discuss which questions on our DQB you think we have answered.

   a. Mark the questions on your handout with these symbols:

   - We did not answer this question or any parts of it yet: O
   - Our class answered some parts of this question, or I think I could answer some parts of this question: ✓
   - Our class answered this question, or using the ideas we have developed, I could now answer this question: ✓+

What questions have we made progress on?

On your own

2. Take your handout (in your notebook) and 10 sticky dots over to the DQB.
3. Place your sticky dots on the sticky notes that match questions that you think we have made progress on.
4. Once you have placed your 10 dots, step back to form the Scientists Circle.
5. As you are waiting for others to place their sticky dots
   - be prepared to share out your evidence for what the answers to the questions might be and
   - notice and wonder about which questions have the most sticky dots.

Revisiting Our Driving Question Board

With your class

6. In your Scientists Circle, look for patterns in the sticky dots. Work together to answer the following questions:
   - Which questions have we made the most progress on?
   - What have we figured out?

Demonstrate understanding on an assessment task.

On your own

7. Use what you have figured out to demonstrate your learning on an end-of-unit assessment.

Quick Write: Reflect on our experiences.

In your notebook

8. Answer the following questions in your science notebook:

- What was most challenging in this unit?
- What was most rewarding?
- Think about how you engage in sensemaking discussions with classmates. How would you want to engage in those experiences the next time around?
- What would you do the same?
- What would you do differently?

9. Be prepared to share your thoughts with your class.

Instrument and Speaker Stations

For each station

1. Record the name of the object at each station in the left column of your observation table.
2. Carefully pluck or strike the instrument or play the speaker at each station so as to make sounds.
3. Record in the right column your observations about how the speaker or instrument looks and feels while being played or struck as well as while it is making sounds.

Use the following prompts to guide your observations:

- How does the object look and feel while it is being struck?
- How does the object look and feel while it is making sounds?
- How is what you notice similar to or different than what we saw a speaker do?
- Can the object make different sounds? If so, how?
- What patterns did you notice in how they make different sounds?

Peer Feedback Guidelines

Giving Feedback to Peers

This tool was inspired by the Sticky Note Feedback resource originally developed by Ambitious Science Teaching at: https://ambitiousscienceteaching.org/sticky-note-student-feedback/

Feedback needs to be specific and actionable.

That means it needs to be related to science ideas and provide your own suggestions for improvement. Productive examples:

- "Your model shows that the sound source changes position when it is hit. I think you should add detail about how the sound source moves back and forth after it is hit."
- "You said that the drum moves when it makes sound, but the table doesn't move when it makes sound. We disagree and suggest reviewing the observation data from the laser investigation."

Nonproductive examples of feedback that do not help other students improve are:

- "I like your drawing."
- "Your poster is really pretty."
- "I agree with everything you said."

How to Give Feedback

Your feedback should give ideas for specific changes or additions the person or group can make. Use the sentence starters below if you need help writing feedback.

- The poster said _____. We disagree because _____. We think you should change _____.
- I like how you _____. It would be more complete if you added _____.
- We agree that _____. We think you should add more evidence from the _____ investigation.
- We agree/disagree with your claim that _____. However, we do not think the _____ (evidence) you used matches your claim.

Receiving Feedback from Peers

The purpose of feedback is to get ideas from your peers about things you might improve or change to make your work more clear, more accurate, or better supported by evidence you have collected. It can also help you to communicate your ideas more effectively to others.

When you receive feedback, you should take these steps:

- Read it carefully. Ask someone else to help you understand it, if necessary.
- Decide if you agree or disagree with the feedback and say why you agree or disagree.
- Revise your work to address the feedback.

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