Lesson 13: Is communication technology that uses radiation safe?

Previous Lesson *We developed different ways to send messages with EM waves using a simulation. We developed a model for this system and compared it to digital communication systems. We gathered information from multiple sources in various formats. We integrated this information to summarize how our wireless electronic devices use EM waves to reliably communicate different types of information.*

This Lesson

Putting Pieces Together

1.5 days

We return to the Driving Question Board to take stock of where we have been and what questions we have answered. We work through an assessment task in which we evaluate two social media posts about 5G radiation, and we use our model for EM radiation to argue from evidence about whether this technology is safe.

Next Lesson *There is no next lesson.*

BUILDING TOWARD NGSS

HS-PS2-5, HS-PS4-1, HS-PS4-2, HS-PS4-3, HS-PS4-4, HS-PS4-5, HS-ESS2-4

What students will do

13.A Integrate information from various resources to answer Driving Question Board questions about cause-and-effect relationships and structure and function in the EM spectrum and related technologies. (SEP: 8.2; CCC: 2.2, 6.1; DCI: PS4.A.1, PS4.B.1, PS4.B.2, PS4.C.1)

Transfer Task PE: HS-PS4-4. Evaluate the validity and reliability of claims in published materials about the effects that various frequencies of electromagnetic radiation have when absorbed by matter. (SEP: 7.3, 8.4; CCC: 2.2; DCI: PS4.B.2)

What students will figure out

- We have answered many of our questions about EM radiation.

- 5G technology is most likely not dangerous because it is not a form of ionizing radiation, but long-term exposure could lead to potential health consequences.

Lesson 13 • Learning Plan Snapshot

Part	Duration		Summary	Slide	Materials
1	20 min		**RETURN TO THE DRIVING QUESTION BOARD** Use crosscutting concepts to review our progress over the course of this unit. Return to the Driving Question Board to determine which questions we have answered. Reflect on experiences during the unit.	A-D	sticky dots (green, yellow, and red), Takeaways poster, Driving Question Board, markers
					End of day 1
2	45 min		**COMPLETE THE FINAL ASSESSMENT** Complete a final assessment evaluating competing arguments about the safety of 5G technology.	E	*Evaluating 5G Safety Transfer Task*, *#1 Social Media Post*, *#2 Social Media Post*
					End of day 2

Lesson 13 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • sticky dots (green • yellow • and red) • *Evaluating 5G Safety Transfer Task* • *#1 Social Media Post* • *#2 Social Media Post*		• Takeaways poster • Driving Question Board • markers

Materials preparation (20 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Three-hole punch all the images and handouts so they can be added to students' notebooks.

Make sure the Driving Question Board is visible to everyone in the classroom.

Title a piece of chart paper "Takeaways".

Lesson 13 • Where We Are Going and NOT Going

Where We Are Going

This is the last lesson of the unit. It is designed to give students the opportunity to reflect on their learning over the past several weeks and demonstrate their competence with an assessment. The disciplinary core ideas (DCIs) that students return to in this lesson to answer Driving Question Board questions and complete the assessment include:

- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)
- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

In the assessment, students identify potential health effects of long-term exposure to 5G technologies. They examine two social media posts providing different pieces of evidence arguing for and against claims of safety risks associated with 5G.

Students encounter a definition for *5G* in the assessment. **Do not** post any words or ask students to add them to their Personal Glossaries until after the class has developed a shared understanding of their meaning.

Where We Are NOT Going

Though students read two social media posts about 5G technology, they are limited to using data provided in those posts to evaluate the arguments. We intentionally avoid diving deeper into understanding 5G technologies and how they work in order to limit understanding to where 5G radiation is found along the EM spectrum.

LEARNING PLAN for LESSON 13

1 · RETURN TO THE DRIVING QUESTION BOARD

20 min

MATERIALS: science notebook, sticky dots (green, yellow, and red), Takeaways poster, Driving Question Board, markers

Review our progress. Present **slide A**. Ask students to turn and talk about the prompts:
How did our investigations over the course of this unit help us figure out...

- *...how the properties of different materials and the structures of different components can affect the way a technology functions?*
- *...macroscopic cause-and-effect relationships by examining smaller-scale mechanisms within the system?*

Elicit 2-3 ideas quickly. Accept all responses.

Frame the activity. Present **slide B**. Say, *We've figured out so much! I bet we can answer many of our questions on the Driving Question Board.* ✱

Use sticky dots to mark patterns in questions answered. Have students gather in a Scientists Circle around the DQB. Focus the discussion on identifying questions that (1) we agree we can answer, (2) we have at least a partial answer to, and (3) we cannot answer at all. Choose one color of sticky dots to mark each category (or use the suggestion on **slide B**). Distribute a set of sticky dots to each student. Allow them to come up to the DQB and add their dots to the existing questions. ✱

ALTERNATE ACTIVITY

If you have time, have students choose one question from the DQB with sticky dots for category 1 or 2 to answer individually in their notebook and then share their answer during the discussion.

Discuss the questions we can now answer. Present **slide C**. Discuss the questions on the slide as a class. Record students' answers on the Takeaways poster. Revisiting the DQB at the end of the unit helps students see the progress we have made toward answering questions that were important to us at the onset of the unit.

ASSESSMENT OPPORTUNITY

What to look for/listen for:

- Students should incorporate evidence from prior investigations and build on each other's ideas. (SEP: 8.2)
- Listen for ideas framed by structure and function and cause and effect. (CCC: 2.2, 6.1)
- Listen for students to incorporate ideas about EM radiation and related technologies from

✱ ATTENDING TO EQUITY

Revisiting the DQB is important for students to feel that their questions are valued and recognized. Though not all questions will have been addressed (it's more likely that 50-75 percent will be at least partially answered), this helps students see the hard work that they have done to answer many of their own questions.

✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

Remind students here that their work throughout this unit has been a reflection of the Nature of Science: Scientists work to answer their questions about natural phenomena, such as the way microwave ovens work. These questions motivate the use of various methods, such as investigations, simulations, and discussions, to gather and evaluate data that could help them make sense of phenomena. In this unit, student questions have motivated a set of explorations to build and refine models

throughout the unit to accurately answer their DQB questions. (DCI: PS4.A.1, PS4.B.1, PS4.B.2, PS4.C.1)

What to do: If students disagree about an answer, ask questions for clarification or more information, such as: *Can you tell me more? In what investigation did we figure out that piece of information? Can anyone point to evidence to support ___'s answer?*

Building toward: 13.A Integrate information from various resources to answer Driving Question Board questions about cause-and-effect relationships and energy flows in the EM spectrum. (SEP: 8.2; CCC: 2.2, 6.1; DCI: PS4.A.1, PS4.B.1, PS4.B.2, PS4.C.1)

Celebrate the class's accomplishments. Say, *I can't believe how far we have come since we first ran the microwave oven on day 1. We should be very proud of what we have accomplished.*

Reflect upon our experiences during the unit. Present **slide D**. Tell students to find a blank piece of paper in their notebook, label it "Reflection," and record their answers to the questions on the slide:

- *What was most challenging in this unit?*
- *What was most rewarding in this unit?*

ALTERNATE ACTIVITY

If you have time, you could also structure this reflection as a "blizzard." For a blizzard, students record their reflections anonymously on a piece of loose paper, crumple it up, and throw it up in the air. One by one, students then pick up a ball of paper and read aloud what is written on it, until everybody's reflections have been shared.

Ask each student to share part of their reflection with the class. Taking time to reflect upon the process allows students to think metacognitively about what works well for them as learners.

that could answer our questions about electromagnetic waves.

End of day 1

2 · COMPLETE THE FINAL ASSESSMENT

45 min

MATERIALS: *Evaluating 5G Safety Transfer Task*, *#1 Social Media Post*, *#2 Social Media Post*, science notebook

Administer the assessment. Present **slide E**. Say, *This is our final individual assessment for the unit. We've figured out how a microwave oven works through examining the relevant electric fields, forces, and energy flows. To wrap up the unit, you will apply your understanding of everything we've figured out to a new situation, and respond to some people posting on social media who might not have a complete understanding of the science.*

Have students return to their seats. Distribute a copy of *Evaluating 5G Safety Transfer Task*, *#1 Social Media Post*, and *#2 Social Media Post* to each student

Read the first paragraph of the assessment aloud:
You have probably heard the phrase "5G" thrown around a lot lately. It's in cell phone commercials and on the news. Many people are calling it a game-changer for wireless technology. A 5G network should be able to offer significantly faster data transmission speeds than 3G or 4G, and can accommodate much more traffic. This is possible, in part, because 5G networks use a portion of the electromagnetic (EM) radiation spectrum to transmit digital information that isn't currently being used by other wireless communication devices. Companies are racing to increase their 5G coverage nationwide. To support this transition, some companies are building as many as 1 5G tower per block!

Elicit reactions and clarifying questions, and then have students begin the assessment. This task will take the remainder of the class period. Have students turn in their completed assessment to you before they leave so you can give them written feedback.

ASSESSMENT OPPORTUNITY

What to look for/listen for: Use *Evaluating 5G Safety* for scoring guidance.

What to do: If students struggle to identify relationships between the EM spectrum and 5G technology, encourage them to revisit the *Creating Digital Images* reading, their science notebook Lesson 10 arguments, and/or the *Static Field Visualization* handout.

Transfer Task PE: HS-PS4-4. Evaluate the validity and reliability of claims in published materials about the effects that different frequencies of electromagnetic radiation have when absorbed by matter. (SEP: 7.3, 8.4; CCC: 2.2; DCI: PS4.B.2)

Additional Lesson 13 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA	CCSS.ELA-LITERACY.SL.11-12.1.D: Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task. When students complete the final assessment, they need to identify the claims presented by two social media posts and discuss what parts of each post they agree and disagree with, taking into account the types of evidence used to support the post.