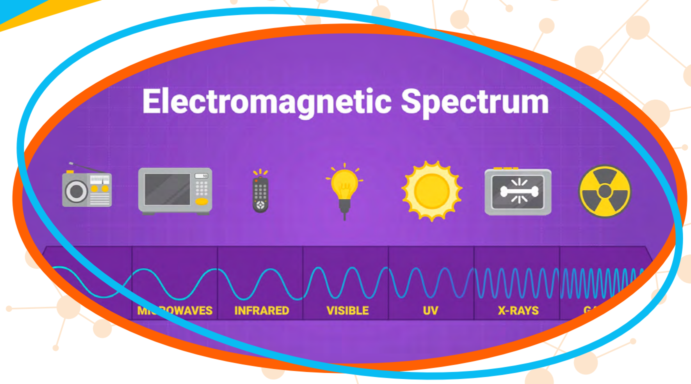
GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.



TEACHER GUIDE

ELECTROMAGNETIC SPECTRUM
GRADES 6-8

COMMON MISCONCEPTIONS

- **Waves transport or require matter.**
  Students may think that waves require a medium through which to travel or that waves transport matter over a distance. Students should understand that all waves transfer energy, not matter, and that electromagnetic waves can travel through empty space.

- **There are different “kinds” of electromagnetic radiation.**
  Students may consider radio waves, visible light, and X-ray and gamma radiation to be different phenomena rather than parts of a continuous spectrum. Related to this, students may consider all forms of “radiation” to be harmful. Students may also be confused by how lasers fit into the spectrum. Laser light can range from infrared to visible to ultraviolet.

- **Confusing relationships among wave properties**
  Students may confuse the relationships among amplitude, frequency, wavelength, and energy. Students should understand that frequency is directly proportional to energy and inversely proportional to wavelength. They should also understand that the amplitude of a wave of a given wavelength is proportional to that wave’s energy.

WAVE PROPERTIES

Waves result from vibrations in matter or fields. Waves transfer energy, but they do not transport matter over distances. A simple wave has a repeating pattern with a specific wavelength (spacing between wave peaks), frequency (waves passing a given point in 1 second), and amplitude (height of the wave). Waves of the same type can differ in amplitude and wavelength. For a wave of a certain wavelength and frequency, increasing amplitude is associated with increasing energy or intensity of the wave. The wavelength and frequency of a wave are inversely related to one another, so increasing wavelength decreases frequency. For a certain type of wave, higher frequencies are associated with greater energy.

ELECTROMAGNETIC RADIATION

Electromagnetic radiation (e.g., radio, microwaves, light) is a type of wave caused by changing electric and magnetic fields. Like all waves, electromagnetic radiation transfers energy. But unlike mechanical waves, electromagnetic waves can travel through empty space. Electromagnetic radiation occurs along a spectrum from low-energy, low-frequency, and long-wavelength radio waves to high-energy, high-frequency, and short-wavelength gamma rays. In between are microwaves, infrared waves, visible light, ultraviolet light, and X-rays.

TECHNOLOGIES / CAREERS RELATED TO ELECTROMAGNETIC SPECTRUMS

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. Electromagnetic waves can travel and be detected over long distances, and different parts of the spectrum interact with matter in different ways. This explains how different parts of the spectrum can be used for applications as diverse as encoding signals over WiFi networks and treating cancerous tumors.

TEACHER TIPS

- Encourage student questions from the microwave data table to motivate the wave exploration. The exploration is most authentic if it is generated by student questions.
- Facilitate student discourse among partners, in small groups, and with the whole class to support consensus-building. It is important for the class to take stock in competing ideas and then use evidence to figure out science ideas.
- Be sure to remind students of important lab safety considerations.

ABOUT THIS LESSON

This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.

They have requested we provide the following background with this lesson:

The Next Generation Science Standards (NGSS) are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.