Wavelength and Frequency
3D Printed Wave Form Demos

Purpose/Overview: This activity uses a 3D printed wave stencil and a short video to introduce the concept of a waveform as a way of describing electromagnetic radiation. It should be done before introducing wavelength and frequency.

Standards Addressed:

HS-PS4-1 **Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** Link to Standard

HS-PS4-3 **Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model and that for some situations one model is more useful than the other.** Link to Standard

***Note: For this standard, stress that electromagnetic radiation is modeled as a wave when it TRAVElS through space. When EM radiation interacts with matter it is modeled as a particle.*

Cross Cutting Concept: Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. **(This is copied from the linked standard HS-PS4-3)**

Focus Questions:

1. If electromagnetic waves are invisible, why do you think we describe them as waves?
2. Which features of a wave does our 3D printed model explain well?
3. What would we need to change about the model to better demonstrate waves in motion?

Materials:

1. A 3D printed stencil model of a waveform - https://www.thingiverse.com/thing:2458874
2. Access to Dr. Nic Bonne's Wave Introduction - https://youtu.be/CaX6HisjVt0

In advance:

1. 3D print the waveform stencil from Thingiverse. Print enough for one for each group.

Procedures:

1. Pass out the 3D wave stencils.
2. Ask groups to generate a list of things they know about the shapes on the form. Just a few minutes is sufficient.
3. Students should be able to identify the stencil as illustrating a wave. After sharing some of the vocabularies they associate with this shape, ask them to share what types of waves they have encountered. Make a list.
4. Watch the video, "Dr. Nic Bonne's Wave Introduction."
    a. Did Dr. Bonne use any words to describe waves that you do not have on your list? What are they? Can you describe them using your stencil?
5. Give the groups five minutes to come up with another non-visual model that can be used to demonstrate waves and the associated vocabulary.

Accessibility Considerations:

1. Although this activity is designed to bridge the visibility gap between common waveform diagrams for students who are not familiar with them, this does not need to be identified as an activity for BVI individuals. Using an atypical modality to demonstrate a concept requires students to think more deeply about the meaning of the vocabulary they are encountering.

Extensions/Modifications:

1. You can have groups describe the model they propose or, if you have additional time, ask them to create their model as a homework assignment.

Credits: **Innovators Developing Accessible Tools for Astronomy (IDATA)**, officially known as *Research Supporting Multisensory Engagement by Blind, Visually Impaired,* and *Sighted Students to Advance Integrated Learning of Astronomy and Computer Science,* and the resulting curricular resources, Afterglow Access software, and project research were made possible with support from the U.S. National Science Foundation's STEM+C program (Award 1640131). IDATA institutional collaborators include AUI, GLAS Education, Linder Research & Development Inc., Logos Consulting Group, TERC, University of Nevada – Las Vegas,

University of North Carolina at Chapel Hill, and Universidad Diego Portales. Individual consultants on the project include Kathy Gustavson and Alexandra Dean Grossi. IDATA Teacher collaborators in the U.S. include Amanda Allen, Jacqueline Barge, Holly Bensel, Neal Boys, Tim Fahlberg, Kristin Grender, David Lockett, Matthew McCutcheon, Caroline Odden, Michael Prokosch, Kara Rowbotham, Rick Sanchez, and Barbara Stachelski. IDATA Student collaborators in the U.S. include Evan Blad, Naleah Boys, Ellen Butler, Jayden Dimas, Riley Kappell, Joseph Murphy, Logan Ruby, Alex Scerba, Charlize Sentosa, Meg Sorensen, Remy Streichenberger, Trevor Warren, and others. IDATA Undergraduate Mentors include Tia Bertz, Katya Gozman, Chris Mathews, Kendall Mehling, Andrea Salazar, Ben Shafer, Alex Traub, and Sophia Vlahakis. Special thanks to the IDATA external advisors including Nic Bonne, Al Harper, Sue Ann Heatherly, Russ Laher, Luisa Rebull, Ed Summers, and Kathryn Williamson.