Using Waves to Track Objects in Orbit

Companion lesson to X-STEM All Access episode "Bringing Space Into Focus"

Grade/ Grade Band: High School	**Topic:** Physics/Physical Science

Brief Lesson Description: Students will communicate how reflecting telescopes use waves to track objects.

Performance Expectation(s):

HS-PS4-5: Communicate technical information about how some technological devices use the properties of wave behavior and wave interactions to transmit information and energy.

Specific Learning Outcomes:

- Students can access background knowledge of space debris using a KWL chart
- Students can use multimedia to determine the key structures/functions of a telescope
- Students can explain how a telescope works using the terms refraction, reflector, magnification, and resolution.
- Students can use technical information to determine how the Space Surveillance Telescope works.
- Students will communicate technical information using text and graphics.

Narrative / Background Information

Prior Student Knowledge:

Students should have an understanding of the properties of wave behavior including reflection and refraction.

Science & Engineering Practices:

Obtaining, Evaluating and Communicating Information

Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system in multiple formats inducing orally, graphically, textually, and mathematically.) (HS-PS4-5)

Disciplinary Core Ideas:

PS4.A: Wave Properties

- Information can be digitized (e.g. a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-5)

PS4.B: Electromagnetic Radiation

- Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)

PS4.C: Information Technologies and Instrumentation

- 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)

Crosscutting Concepts:

Cause and Effect

- Systems can be designed to cause a desired effect. (HS-PS4-5)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-PS4-5)

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in a cycle known as research and development (R&D). (HS-PS4-5)

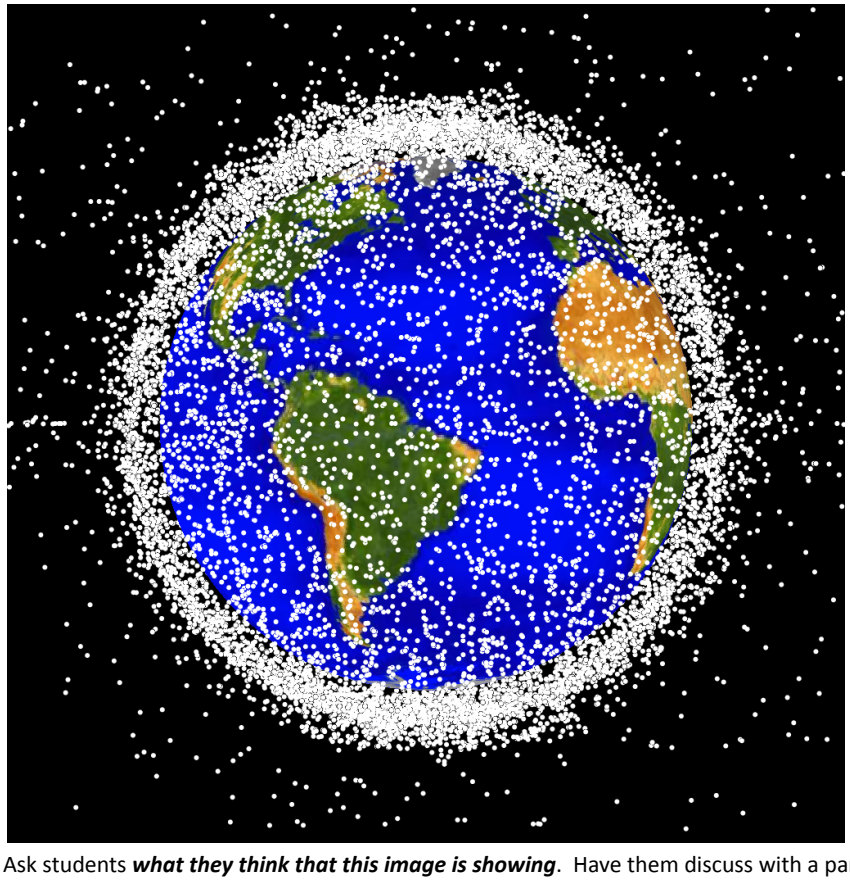
Possible Preconceptions/Misconceptions:

- Magnification is more important than the aperture of a telescope.
- A bigger telescope will always result in being able to see further and in more detail.
- Images viewed through a telescope will look like those found on the internet.
- Atmospheric effects of light distortion may not be considered.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Start the lesson by showing the following NASA Image:



Ask students ***what they think that this image is showing***. Have them discuss with a partner and then as a class. After sharing their predictions, explain that this image shows the space debris that is currently orbiting Earth.

Next, ask students to complete the first two columns of a KWL Chart for the topic Space Debris. (This may be done digitally or by making a copy for each student to fill out). After a few minutes, have students share ***what they know and wonder about space debris.*** Then, explain to students that we will be learning about how the United States Space Force is tracking the Space Debris found around Earth. Show the X-STEM All Access Episode "Bringing Space into Focus." As students watch the video, they should add information that they learn to the "L" portion of their chart. After the video, discuss as a class ***what they learned about space debris from Sgt Shields***.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Explain to students that today our goal is to explain how a reflecting telescope uses light to track objects in space and communicate that technical information to others.

To start exploring this idea, students explore the "Scope it Out" game sponsored by NASA. The goal of this game is for students to learn about key parts of a reflecting telescope and their functions. As they complete levels 0-3, students should complete the "Scope it Out Worksheet". (Level 4 is not needed for the remainder of the lesson).

After playing the game, discuss the following prompts as a class:

1. ***What parts do reflective telescopes have in common?***
2. ***Would you expect the reflecting telescopes that the U.S. Space Force uses to scan for debris to have the same parts? Why or why not?***
3. ***How does light travel through the parts of a reflecting telescope? Would you expect a similar pattern in the U.S. Space Force telescopes? Why or why not?***

EXPLAIN: Concepts Explained and Vocabulary Defined:
Explain to students that now that we have explored the parts of a telescope, it is time to learn how light properties help scientists to see objects beyond Earth.

Have students watch the video "Crash Course Astronomy #6: Telescopes".
As students watch the video, they should take two column notes with the following key topics:
How Telescopes Work
Refraction
Magnification
Resolution
Reflectors
What kind of telescope should you buy
Technology and the Light Spectrum

Following the video, students can complete the Kahoot to review the information. (Need to know how to use Kahoot? Watch this tutorial!)

ELABORATE: Applications and Extensions:
Explain to students that the newest telescope that is used to detect space debris is the Space Surveillance Telescope (SST). Tell students that their task is to create an explanation of how the SST Works using their knowledge of light, how telescopes work, and the technical information provided below*:

What it Does
How it Works
Article
*Students may do additional research on their own as needed

Their explanation can be written in words and/or use images. The explanation should include:

- Key structures/functions of the telescope
- How light is collected and travels through the telescope
- What type of sensor is used to gather data
- Uses of the telescope
- Citations for all information used

EVALUATE:
Formative Monitoring (Questioning / Discussion): A variety of formative prompts are found in ***bold italics*** throughout the lesson. Data from the Kahoot in the Explain portion of the lesson may also be utilized.

Summative Assessment (Quiz / Project / Report): After completing their initial explanation of the SST, students will create a presentation to share with their classmates using presentation software. Students will present their explanation to other students in the class. Presentations can be assessed using the **Science Presentation Rubric.**

Elaborate Further / Reflect: Enrichment:
Students can build a working telescope using one of the following lesson plans and then develop an explanation of how their telescope works:
Refracting Telescope from NASA
Reflecting Telescope from Space Scoop

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency Addressed: Self-Awareness

In the X-STEM Episode, Sgt Shields discussed the importance of taking care of our mental health and the support that he received from his superiors when he felt stuck in his career path. In this lesson, students will consider their own thoughts about mental health services and then learn about and discuss the stigma of taking care of mental health issues.

1. Start the lesson by providing students an opportunity to individually respond to the following prompt: "Would you ever seek help for your mental health? Why or why not?"
2. Explain to students that there is often a stigma when people talk about going to get help for mental health. Ask students what the word stigma means. If they are unsure, provide the following definition:
   Stigma:a mark of disgrace associated with a particular circumstance, quality, or person.
3. Show the Video "There is no shame in taking care of your mental health." by Sangu Delle

4. Following the video, discuss the following as a class:
    - Why do you think there is a stigma with discussing and seeking help for mental health?
    - How might this stigma affect those suffering with mental health issues?
    - How can we, as a community, help to remove the stigma of seeking help for mental health?
    - Who in your life/school can you go to for help?

INTERDISCIPLINARY CONNECTIONS/IDEAS

Mathematics: Students can consider the mathematical relationships related to telescope technology using NASA's Space Math

- **English Language Arts:** Students can compare and contrast technical explanations of how telescopes work from a variety of resources including text, multimedia, infographics, etc.. For each of the sources, they should identify what text/graphic features are most helpful and why. They can then create a guide for science communicators about attributes of effective science communication.

Social Studies: Space debris is a global problem attributed to many different nations. Students can evaluate data and debate whose responsibility it is to track and or remediate the space debris tracked by the U.S. Space Force.

Materials Required for This Lesson/Activity	
Quantity	**Description**
1 per student	KWL Chart (Digital or Photocopy)
1 per student	"Scope it Out" Worksheet
1 per student	Device with internet access for video, Kahoot, and research purposes

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