

Class/Grade Level: 12th Grade Physics

Topic: Light As Wave

State Standard:

New Generation Science Standards:

HS-PS4-1

Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-5

Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

Common Core State Standards:

Reading:

RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (*HS-PS4-1*)

Writing:

WHST.9-12.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (*HS-PS4-5*)

Mathematics:

MP.2

Reason abstractly and quantitatively. (*HS-PS4-1*)

MP.4

Model with mathematics. (*HS-PS4-1*)

HSA-SSE.A.1

Interpret expressions that represent a quantity in terms of its context. (*HS-PS4-1*)

- HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. *(HS-PS4-1)*
- HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-PS4-1)*

Materials List :

LCD Projector
Powerpoint Presentation
Equipment/Manipulative
Clear, single filament light source
Double slit diffraction grating
Filters (red and blue)
Model of a picket fence
Polarizing sunglasses
Polarization filters (1 pair per group)
Small cord or rope
Vernier lab probe with light sensor (optional)

Duration: 180 minutes (2 days)

Objectives:

At the end of the lesson, students will be able to:

- Explore light's wave properties through the use of diffraction gratings and polarization filters.
- Evaluate different technologies that use the wave properties of light.

Standards:

This lesson is designed to introduce the wave properties of light.. The lesson will explain the difference between wavelength, amplitude and frequency.

Key Concepts:

Wavelength, Frequency, Amplitude, Interference

Anticipatory Set or Set Introduction

- **Build Vocabulary: Vocabulary Knowledge Rating Chart**
Have students construct a chart with four columns labeled Term, Can Define It or Use It, Heard It or Seen It, and Don't Know. Have them place the terms wavelength, amplitude, frequency, interference and then rate their term knowledge in the other columns
- **Build Reading Literacy: Outline**
Have students use the headings from the unit of the textbook to create an outline.
- **Use Visuals:**
 1. Have students compare the frequency and wavelength using the visuals. And have them discuss the mathematical relationship of these two concepts.
 2. Have students compare and contrast transverse and longitudinal waves

Teaching Input:

Macromedia Flash Presentation of Wave Properties of Light

Teaching: Checking for Understanding:

Teacher will incorporate native beliefs and myths about light. Teacher will invite Elders from the community to discuss the traditional perspective about light. Students will be asked to share their ideas about the traditional beliefs and myths. Teacher will divide the class in groups and ask each group to perform the lab activity. Teacher will explain each procedure of the experiment, safety precautions and remind students about the lab rules. Teacher will facilitate the partner and small group discussions. Teacher will check to see how students are progressing on the experiment and see how much more time they need.

Detailed Activity:

1. The teacher will break the class up into groups and provide each group with two thin sheets of polarizing filter. Help them with the first direction: Have the students identify the two pieces of plastic and ask them to hold a piece of polarizing filter up to the window and rotate it 90 degrees.

Questioning Strategies: “What do you see?”

2. Have the students overlap the filters and rotate only one filter through 360 degrees.

Questioning Strategies: “What do you see now?”

3. The teacher will ask each group to record their observations in their activity sheets and have them compare hypotheses. (Students share ideas.)
4. Have one student hold a piece of the “picket fence” and feed a rope or string through two pickets. With a student holding each end of the rope, ask one student create a transverse wave.

Questioning Strategies: “How many directions can you move your arm to generate waves that will fit through the slits?”

5. The teacher will ask each group to feed the rope through a second section of fence aligned the same way.

Questioning Strategies: “Can you make a wave pattern travel through both fences?” “What if one of the picket fences is rotated 90°? Will the wave still be able to travel through both fences?”

6. From their observations, students will formulate a convincing argument that light acts like a transverse wave on their activity sheet.

Questioning Strategies: “So how do polarizing sunglasses work?”

7. The teacher will ask students to do an activity using LabQuest with a light sensor. The polarizing filters can be rotated through 360° as the sensor gathers data on light intensity. The data can be downloaded to a graphing program to show a graph illustrating alternating maximum and minimum light intensity values plotted by degree. Students can incorporate multimedia by holding the filters up to a window and taking digital photographs at several degrees around the circle. The images can then be linked to the appropriate degrees on the light intensity curve. When someone clicks on the curve, a corresponding picture will appear.
8. Extend students’ understanding by discussing a dark line spectrum:

Questioning Strategies: “If light can travel as a wave, think back to our ripple tank lab. What happened to water waves when they traveled through

two small openings? We saw alternating dark and light bands that resulted from constructive and destructive interference.” Make the room very dark. Plug in a clear, straight filament lamp and observe the lamp through double diffraction slits of a diffraction grating. Students should be able to observe alternating bands of light and dark, providing further support for light traveling as a wave.

9. Next cover half of the bulb with a blue filter and half with a red filter.
Questioning Strategies: “What do you observe when you look at the light through a double diffraction slit?”

Help students by explaining that the blue light has a higher frequency and therefore a shorter wavelength than the red light.”

10. Teacher will provide an example of another sort of electromagnetic wave. And explain and locate these waves in the electromagnetic spectrum. Have students observe the transparency of the various wavelengths.

Questioning Strategies: “If you have ever been speeding and were pulled over by a police car, you may have experienced radar first hand. How does it work

11. Ask students to complete their lab journals by writing a marketing pitch for polarized sunglasses.

Closure:

Teacher will assign students to summarize, analyze and reflect on what they have learned in the activities and lesson.