ATHENAS
Apparel and Textiles Higher Education
Nurturing Advancement of Sustainability

Climate Change and the Textile & Apparel Industry Module

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Demonstrating the Wavelength, Frequency and Energy of Light Activity

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This active learning demonstration is written out in some detail here as a basic guideline. Many versions are possible.

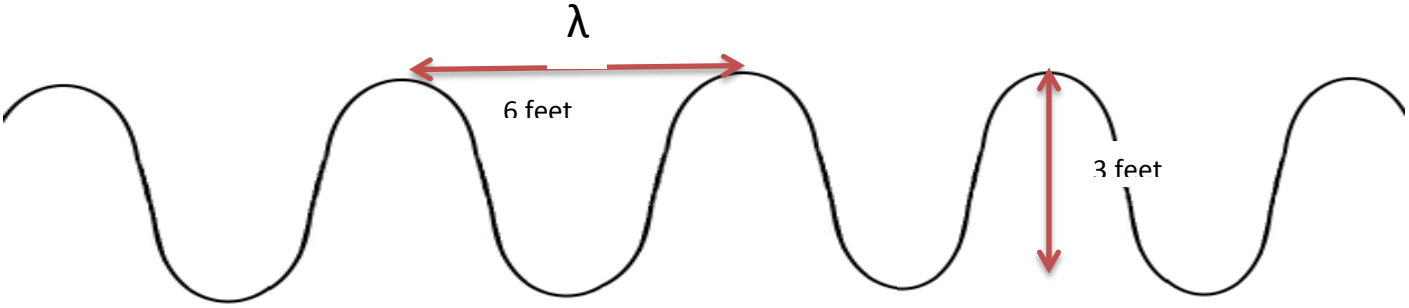
Time: 10-15 minutes.

Requirements:

a. Either a long chalkboard (20 feet or more) or a long piece of paper of the same length – as from a roll of paper – taped to an uninterrupted wall.
b. A red, green and a purple piece of chalk (for a board) or magic markers of the same colors (for paper).
c. Three willing volunteers

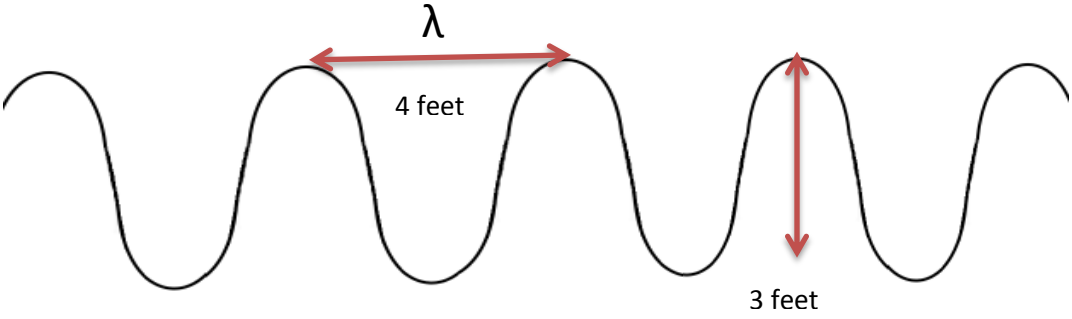
Procedure: (Text in quotes is what the instructor will say. "He" stands for he or she.)

1. "All light is made of waves."
2. Draw large wave on the board with RED marker or chalk, a height of about 3 feet and a length of about 6 feet as shown.

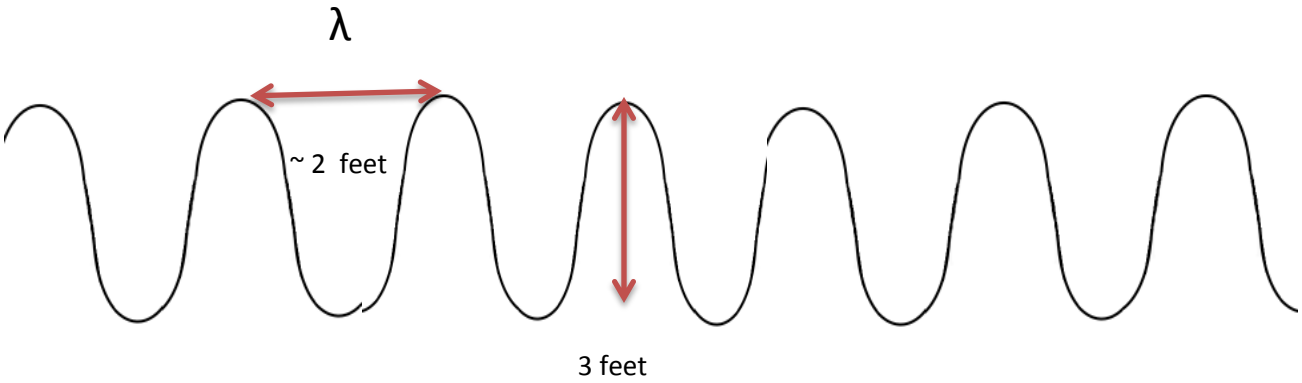


3. "Waves are measured in wavelengths, from the top of one wave to the top of the next."
4. Draw a straight line from the top of one peak to the top of the next peak as shown in the drawing.
5. "We symbolize a wavelength with the Green letter lambda."
6. Add the letter lambda λ on top of the straight line.

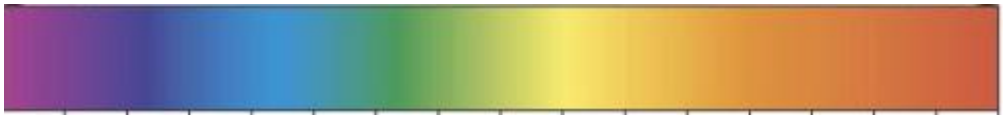
7. "Lambda is usually measured in nanometers – one billionth of a meter. Very small."
8. "Now I need a volunteer." Choose a very tall volunteer from the audience. Have him come to the board, go all the way to the left, and place his head near the board at the same height as the drawing. Then have him go the length of the entire drawing with his head staying at the level of the drawing. In other words, he will be bobbing up and down as the wave goes up and down behind him. When he gets to the far (right) end, have him stand and wait.
9. "The wave we have shown is a large wave, but they come in many, many different sizes. For visible light, the light we can see, different wavelengths have different colors. Let's look at another color – that is a shorter wavelength of light."
10. Draw another wave with a yellow or green marker, with a shorter wavelength but the same 3 foot height on top of the original wave. Keeping the height the same is important so students don't get wavelength and intensity (the wave height) mixed up. See figure below. [Sorry, can't figure out a way to illustrate this on top of the first.)



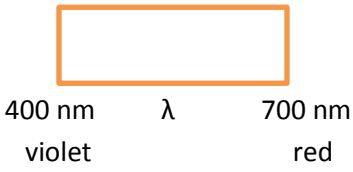
11. Draw another lambda with the green chalk to emphasize the new wavelength on top of the other two. Choose a shorter volunteer (about normal height) to illustrate the shorter wavelength by having him bob up and down in accordance with his wavelength. He should stand at the right end when he is finished as well.
12. Repeat 10 and 11 with yet a shorter wave drawn on top of the first and second. Use violet chalk. This volunteer should be very short and often is a woman. Draw another lambda. This figure is shown below.



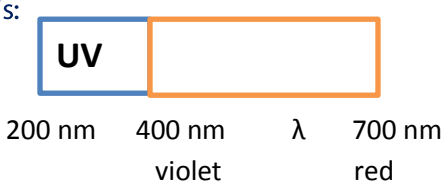
13. "All waves of light travel at the same speed. This speed is called???…(wait for an answer from the class)…the speed of light! To illustrate this we will have all 3 of the different people move down the board (right to left) at the same speed but using their own wavelengths."
    Students should move shoulder to shoulder from right to left but bobbing up and down at different times. Make sure they do it. Some students chicken out. Make them do it back again if they don't do a good job the first time.
14. Thank the volunteers and have them return to their seats.
15. "Different wavelengths of light have different energies. Which of the three students used the most energy?(answer, the shortest) So…the shorter the wavelength, the higher the energy!"
16. "As we said before, light in the visible range, the range that we can see with our eyes, is measured in nanometers. In fact, we can only see from 400 to 700 nm. This is called **visible light.** At 400 nm wavelength, the light is violet. At the 700 nm end, the light is red. Between are all the colors of the rainbow. Remember ROYGBIV? "
17. Then ask, "What color of the light we can see has the least energy? (answer : red) The most?" (Answer: indigo) "WHY?" (Answer: the shorter wavelength is indigo and the shorter the wavelength the more energy.
18. Show the rainbow of light on PowerPoint Slide.



19. Draw a rectangle about 1 foot long with 400nm at the left end and 700 nm written at the right end and lambda in the middle, like this.



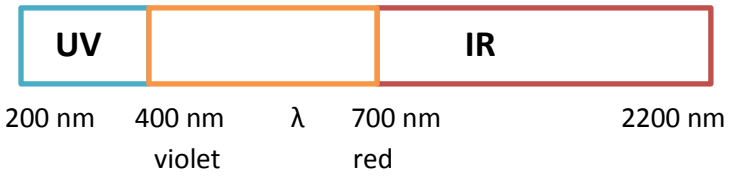
20. "Light smaller than the violet light of the visible range, that is shorter wavelength than 400 is called…?" (Answer: ultraviolet)
21. "Ultraviolet or UV light goes from about 200 to 400 nanometers."
22. Add the UV side to the above drawing like this:



23. "Would UV light be more or less energetic than visible light?" (Answer: more because it is shorter wavelength.) "We know the because UV light is strong enough to give you a bad sunburn or skin cancer. Visible light won't do this. The 'ULTRA' in ultraviolet indicates that the light is MORE energetic then visible."
24. "Light that is longer wavelength than the visible range, longer than red light is called….??? (Answer: infrared). Is infrared light more or less energetic than visible light? (Answer: less

because it has a shorter wavelength.) Why is it called INFRA red? (Answer: because it is less energetic than visible light.)

25. Add the IR section to the drawing.



26. Sometimes I like to add that very energetic light has very small wavelengths like X-rays. We know they are high in energy because X-rays can go right through us! On the other hand, radio and TV waves are huge – often meters long, and of very low energy.