Doctor, my eyes have seen the light!

Instructions for sending a sound wave on a laser beam

The Electromagnetic spectrum (EMS) covers a lot of different types of light. Not all of the light is visible to humans. In fact, only a very small part of the EMS is visible to us, the visible spectrum or ROYGBV (the rainbow). The types of light that we don't see we refer to as radiation but all types of light are radiation. Most light or radiation comes from stars including the sun.

Many different tools that we use everyday rely on light or radiation to send signals. For example, how many of you have a TV remote control at home? If you haven't already noticed, if you cover the top end (where the signal comes out) and then press the channel up or down nothing happens. That is because you are blocking the radiation or light from reaching the TV light sensor. If you take your finger away and press the button the channel changes. Your remote control is sending a signal in the form of infrared light.

Energy can be neither created nor destroyed (to the best of our knowledge) but it can and does change form all the time. We are going to do a lab that will demonstrate in a physical way, the changing form of the same energy. We will send a sound wave on a laser beam.

Sending a signal with light is very easy. You can send a sound wave on a laser beam and then pick it up and turn it back into a sound wave. To do this you can use something you are all familiar with, a Walkman tape player and a tape of music or other sound recording. The music is recorded on the tape as magnetic pulses that are converted to a voltage when the tape plays. The voltage travels down the wire to the earphones and is converted into mechanical motion which becomes a compression wave that we perceive as sound. Instead of letting the voltage be converted into sound you can turn the voltage into pulses on a laser that we can see since it is red, one of the colors in the visible spectrum.

To receive the signal, use a solar panel. It converts light to electricity. It will take the laser pulses and turn them back into a voltage. The voltage travels through the wire to a small amplifier and will be converted to sound. You have sent a sound wave on a laser beam!

1. Do a parts inventory. You should have the following:
    a. Laser diode
    b. Cassette tape
    c. Walkman with head phones
    d. 4 AA batteries (for battery pack and Walkman)
    e. Fine sandpaper
    f. Wire cutters and wire strippers
    g. Solar panel kit
    h. Mini-amplifier
    i. Connection cord for Mini-amp and solar panel
    j. One 9-volt battery for mini-amp
    k. Solder and soldering iron

    l. Battery pack
    m. Small Phillips head screw driver
2. Cut headphone wires on right side only. The other headphone should remain untouched.
3. Strip about two inches of the headphone wire you just cut. Use fine sandpaper to strip the insulation off the wire until you can see wire with a silver color. Take special care not to use too much force while sanding the wire since the wires break very easily.
4. Connect the red wire from the laser diode to the red wire from the battery pack with solder.
5. Connect the black wire on the laser diode to the red wire on the headphones.
6. Connect the black wire on the battery pack to the black wire on the headphones.
7. If the connection is correct you should have weak laser light once the headphones are plugged in to the Walkman. (Make sure you put the batteries in both the battery pack and the Walkman.)
8. Put the tape in the Walkman and press play. Your laser should get brighter.
9. Take the headphone jack out of the Walkman and you have broken the circuit and the laser should produce no light.
10. Place the 9-volt battery in the mini-amp.
11. Plug in the cord from the solar panel into the amp.
12. Connect the cords from the solar panel to the cord to the amp. (red to red)
13. Turn the amp volume up to full. At this point you should hear fuzz if there is normal room lighting hitting the solar panel.
14. Cover the solar panel with your hand and the fuzz should stop. This verifies that the sound you were hearing was the voltage produced by the solar panel from background lighting, since no sound is emitted from the amp when no light is allowed to enter the solar panel.
15. Turn out the lights and make the room as dark as possible.
16. Connect the headphone jack to the Walkman and press play on the tape.
17. Have a volunteer hold your solar panel on the other side of the room. Point your laser at the solar panel and your amp should produce the exact sound that is on the tape with no fuzz or decrease in sound quality.
18. After you have tested all your connections to make sure they work you should solder them together for stability.

For any questions please contact David Abbott at davida@jlab.org I hope you enjoy teaching this concept to your students. ☺


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