Apparatus Competition

2010 AAPT Summer Meeting

Portland, OR

Modulated Laser Lab Assembly Kit

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Abstract

This kit is designed to be a lab kit that can be assembled repeatedly by groups of students in upper elementary or middle school. The components are mounted and color coded for easy assembly and the purpose of each component is briefly described in the procedure outline. The circuit can be taken apart and easily stored for repeated lab or outreach activity use.

Construction of Apparatus:

Electrical Components are mounted on double banana plugs. The breadboard is a piece of durable polycarbonate. The laser diode is biased for a low safe power output. The diode can be modulated by any iPod or sound source that takes a mini plug. Included is a low cost fiber optic where the coupling is a small piece of heat shrink that slips over the diode.

Use of Apparatus:

Introduction to Laser Modulation Communication and Electrical Circuits.

The construction is made up of purchasing colored double banana plugs and mounting circuit components onto the banana plugs which plug into color coded jacks on a breadboard. One note found during construction. Not all iPods have the same output impedance! The latest iPods have a low impedance of around 5 Ohms. The older iPods and laptop headphone outputs have a much higher impedance of hundreds of ohms. It becomes important to isolate the iPod from the circuit to make sure no damaging currents can flow to the iPod. You can do this in two ways, use a coupling capacitor to block the DC current, which can affect the audio quality, or use a resistor to minimize the current flowing to the iPod. I opted for the resistor so I can still have a direct coupled audio range with low current.

The use of the apparatus is to display how a laser diode can be modulated and a brief introduction to electrical circuits. The use of fiber optics to guide a signal is also included.

The educational value is to also excite students in upper elementary and middle school students to science.

Lab Write-up for Upper Elementary and Middle School students

<u>Modulated Laser and Laser Communications: Introduction:</u>

NOTE: NEVER LOOK DIRECTLY INTO A LASER EMITTING DEVICE!

Something really cool about lasers is that you can modify their brightness with almost any electrical signal, including, say… the output of an iPod! The pattern of the music output by the iPod causes the brightness of the laser to change in the same pattern. Essentially, the laser is transferring the music visually instead of by sound! So, if you point this laser at a solar cell (which picks up changes in brightness of light and transfers them into electrical signals) connected to a amplifier, you can play your music by sending it through the laser!

So, how does one build such a thing?

Building the Music-Playing Laser

In front of you there is a plastic board with different colored jacks connected by wires. We call this the breadboard. When all the pieces are attached, the breadboard forms an electrical circuit, which is necessary to make your laser to work!

In the kit, there are different colored plugs with various things attached to them. Those things are the components needed to create your music-playing laser, and each one has a purpose explained below.

1. All electronic devices, including lasers, need sources of power—in this case it is a 3-volt battery. The chemicals in the battery create a difference in voltage between the two terminals, which is what "pushes" current into the circuit and thus into the laser. Take the red colored plug with the 3-volt battery attached and plug it into the breadboard where you see the two red colored jacks*. (Be sure to connect the + side of the plug into the + side of the jack).*

2. Electric components are designed to operate at a particular voltage and current. In order to establish the correct current, we install a component called a "resistor". A resistor does just what you would think--it "resists" the flow of current. In this circuit the resistor will have two jobs. The first is to limit the current going through the laser diode and establish the correct operating voltage across the laser diode. A resistor's second job will be to couple the changing voltage from the iPod to the laser diode. Take the **black** colored plug with the resistor (a cylindrical looking thing with stripes) and plug it into the breadboard where you see the two **black** colored jacks.

3. We want to make sure that no current from the battery is transferred to the iPod connected to the circuit. This is the purpose of the second "resistor" which limits the current from the battery going to the iPod. Take the blue colored plug with the second resistor attached and plug it into the breadboard where you see the two blue colored jacks.

4. Next, we need a plug that will send the signal from the iPod to the laser. This is called a "mini-cable" and is usually found on the end of headphones. Take the green colored plug with the mini cable and plug it into the breadboard where you see the two green colored jacks.

5. Finally! The Laser! Take the yellow colored plug with the laser diode attached and plug it into the breadboard where you see the two yellow colored jacks. . *(Be sure to connect the + side of the plug into the + side of the jack).* **Remember, never look directly at the laser diode or point it at any person.**

Hearing the Light!

Your circuit is now complete and you should detect light coming from the laser. Shine the laser on the index card included in the kit.

Point the laser at the solar cell mounted on the small amplifier located in the kit. Turn the amplifier on and you should be able to hear a popping sound anytime you block the laser light. (Note, if you hear loud buzzing, it is probably coming from fluorescent lights in the room. Turn of the lights or adjust the cell away from the fluorescent lights.) Pass the comb in front of the laser and listen to the sound! The teeth in the comb blocks the laser light, so when the comb passes through the laser beam traveling to the solar cell, the laser light is actually being turned on and off. Note that digital communication signals transferred by lasers are signals where the light is being turned on and of very quickly.

Now connect an iPod (or other musical source) that has a headphone jack to the mini-cable from the breadboard. Turn the volume up on the iPod until you can hear the music from the amplifier. Start dancing! You can stop the music by blocking the laser beam!

Optical Fiber.

Laser communications must be done over large distances and the light also needs to be guided. This is accomplished with the use of fiber optics. Place the fiber optic over the laser diode and observe that there is light coming out of the other end of the cable. Point the light at the solar cell and you can again hear the music form the iPod even though there is a loop in the cable. You can direct the light in any direction. Fiber optics also ensure that the laser beam is not interrupted or dispersed during its travels

So ends your intro journey into circuits and laser communications.