



## Uncovering the Secrets of Light

Hands-on experiments and demonstrations to see the surprising ways we use light in our lives. Students will also learn how engineers and scientists are exploring new ways in which the colorful world of light can impact our health, happiness and safety while saving energy and protecting the environment. These activities are described elsewhere. This document provides background information such as where to obtain the apparatus that is used, descriptions of how to build things, etc. This information is presented in the same order as the activities.

### Resources and Background Information

1. Turning on an LED by connecting it correctly to a battery. (The instructions are in the write up.)
2. Optical Communication – Using LED flashes to remotely control electronic components such as televisions and to give music a ride on a light beam.
  - a. The transmitter and receiver circuits are described in great detail in the write up for Project 4 in the RPI course ENGR-4300 Electronic Instrumentation which can be found at [http://www.ecse.rpi.edu/courses/S10/ENGR-4300/EIexp-project/proj\\_4.pdf](http://www.ecse.rpi.edu/courses/S10/ENGR-4300/EIexp-project/proj_4.pdf)
  - b. The original reference for this project is Gordon McComb's book *The Laser Cookbook* which is available used on Amazon and elsewhere.
  - c. The design of the transmitter and receiver can be easily modified to accommodate using only LEDs or other constraints. Contact Prof. Connor for additional info.





Amazon (\$309)



Amazon (\$149)



Edmund (\$2)



Amer 3B (\$293)



OPL (\$90)



Project Star (\$40)



CENCO (\$8.70)



teachersource.com (\$11)



teachersource.com (\$53)



Gyroscope.com (\$60)



From cereal box (\$0)

3. Observing the colors produced by different sources of light.

- a. It is exceptionally useful to observe the spectra from all readily available light sources (e.g. incandescent, fluorescent, neon signs, etc.). The simplest way to do this is to use a hand spectroscope. The nicest small ones are used by gemologists and are available from places like American 3B Scientific for about \$300  
[http://www.a3bs.com/spectrophotometer/hand-spectroscope-with-amici-prism-u8472660.p\\_83\\_113\\_657\\_0\\_8528.html](http://www.a3bs.com/spectrophotometer/hand-spectroscope-with-amici-prism-u8472660.p_83_113_657_0_8528.html)
- b. A very inexpensive spectroscope from Edmunds for about \$2  
[http://scientificsonline.com/product.asp\\_Q\\_pn\\_E\\_3120400](http://scientificsonline.com/product.asp_Q_pn_E_3120400)
- c. There are many other choices because this is an exceptionally useful device. Some of the options are shown above including the one that can be made for free using a cereal box, a CD and some duct tape. Instructions and activities for the cereal box spectrometer can be found on Prof. Connor's education and outreach page  
<http://hibp.ecse.rpi.edu/~connor/EOD/> under project ideas.



Target (but not on their website now)

Amazing1.com (\$80)

4. Light Saber – A discharge lamp that shows us that we are conductors just like wires and that can magically turn on a special kind of lamp without touching it.
  - a. The light saber is a plasma discharge tube driven by a high voltage pulse source in the handle. It is called a Fire Saber at Information Unlimited and is available on their webpage [http://www.amazing1.com/plasma\\_fire\\_saber.htm](http://www.amazing1.com/plasma_fire_saber.htm) for \$80 or less if you purchase one shorter than 36”.
  - b. The light saber is able to turn on touch lamps because it puts out so much electrical noise (such noise is usually called EMI for electromagnetic interference).
  - c. Note that Information Unlimited has a very large number of fun but quite dangerous items for sale. Be sure to think of who will be using them.



5. USB Microscope – Using light to see small things, especially how displays work.
  - a. The USB microscope is from BigC.com and is called the Dino Scope. It is about \$350 from thinkgeek.com It is model AM-411T which has 8 built in LEDs for illumination.
  - b. The Veho is more than adequate and is about \$50 on Amazon. There are other options too.
6. Pulse Width Modulation – Controlling light by turning it on and off. Bright light comes from having it on more than off. (Instructions are in the write up.)



Etherwave Theremin (\$400)



Amazon (\$400)

7. Theremin – A musical instrument that is played without touching it.
- A Theremin can be purchased from Moog <http://www.moogmusic.com>
  - They can also be built from plans or kits. There is a ton of info online.
  - Some kind of amp is required, but basically any guitar practice amp will do.



Edmunds (\$30)



(sunglasswarehouse.com \$14.41)

8. Flat Panel Displays – What is polarized light and how do we use it to make TV and computer displays?
- Polarizing demo disks from Edmunds (\$30 pair)
  - Polarizing filters for camera lenses are good but tend to be expensive, but some people already have them. Polarizing sunglasses can also be cheap. Check out [sunglasswarehouse.com](http://sunglasswarehouse.com)
  - Rectangular disks from <http://www.gemsociety.org/store.htm> (\$6 pair)
  - Maybe the best price is the OSA Optics Discovery Kit available from Edmunds for \$18 (the kit contains two polarizing filters and lots of other cool optics stuff)  
<http://www.edmundoptics.com/onlinecatalog/displayproduct.cfm?productid=1865>



## SMART LIGHTING ENGINEERING RESEARCH CENTER

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9. Magnetic Levitation – Using a light beam and a magnet to make a ball float in space
  - a. The specific demo used is no longer available. However, you can build your own (not all that easily, actually) following instructions found many different places, but maybe the best is [http://web.mit.edu/klund/www/papers/ACC04\\_maglev.pdf](http://web.mit.edu/klund/www/papers/ACC04_maglev.pdf)
  - b. There are many magnetically levitated globes sold that work on the same principle, but it may not be so obvious how the sensors work on many of them.
10. Coin Flipper – One magnet makes another magnet with the opposite pole so they can rapidly repel one another. (This is generally too complex and a bit dangerous to build for most people.)
11. Color Mixing – All online and the info is in the activity write up.
12. Observing Audio Signals with the Mobile Studio. – See the write up.



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