Berkeley Engineers and Mentors

Music LED Box Lesson Plan

Introduction:

There are many applications to circuitry. They are used to make our cell phones vibrate, turn our computers on, allow sound to be emitted from headphones, among other things. Even now, there is a lot of potential in this field for what could be done. We are just going to be touching the tip of the iceberg with week's project.

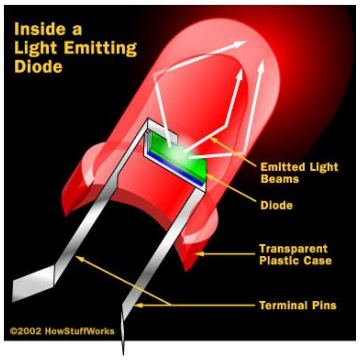
Objective:

To create a Music LED Box that lights up with the beat of the music. This lesson plan will be used in conjunction with last week's lesson plan to help reinforce previous ideas and expand upon them.

Background Information:

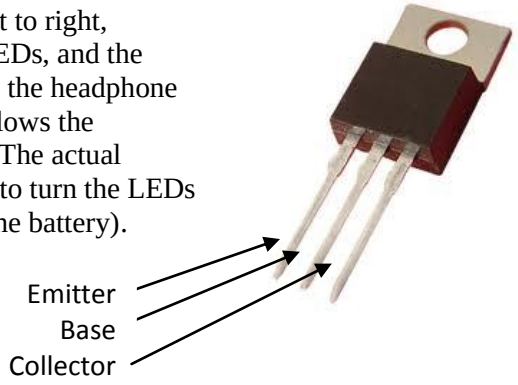
1) **Ohms Law:** Ohm's Law is given by V = IR, where I is the current, V is the potential difference measured across the resistance and R is the resistance of the conductor in Ohms. A resistor is like a water wheel: it slows down the flow of water but turns it into work (heat). A battery is like a pump. It moves water uphill to a certain elevation (voltage). Likewise, a voltage drop is like a drop in elevation.

2) **Diodes:** A diode is an electrical junction made from two different semiconductors connected together, "n-type" and "p-type". The important thing is that a diode acts like a **one-way street.** If you have a positive voltage applied across the diode (voltage at the positive terminal minus at negative terminal) then current will flow and the light will turn on. If you apply a voltage the opposite direction then no current will flow.



Diodes do NOT follow Ohms law in general. You would expect the voltage drop across a diode to scale with the current (V=IR). This is not the case. If the diode is "on" (positive voltage) then the voltage drop will be roughly constant. This is eloquently called the "on voltage." If the diode is "off" (negative or 0 voltage) then the voltage drop will just be whatever you've applied to it.

3) **Transistors:** A transistor is a little more complicated than a diode physically, but intuitively all that matters is that **a transistor acts like a gate valve.** If you "turn on" the valve, current can flow. If you "turn off" the valve, then no current will flow. If the base-emitter voltage is positive (voltage at "base" pin minus voltage at "emitter" pin) then the valve opens. If the base-emitter voltage is negative or zero, then no current will flow. The transistor is composed of three parts: a base, a collector, and an emitter (left to right, looking at it). The collector and emitter are connected to the LEDs, and the base is the switch, and it is connected to the audio input. When the headphone jacks provide enough power (aka, when it is loud enough) it allows the electrons to flow through the transistor and light up the LEDs. The actual voltage flowing into the headphones is very small, not enough to turn the LEDs on. However, we use this to trigger a bigger circuit (given by the battery).



Helpful videos/instructions include:
http://www.instructables.com/id/Music-LED-Light-Box/,
http://www.youtube.com/watch?v=1TUYNuh-iqQ.

5 Step Design Process:

1. ASK
What do you want to get done? What have others done? What are the constraints?

2. IMAGINE
How would you do it? Brainstorm solutions. Choose best one. Which mechanism(s) will be best?

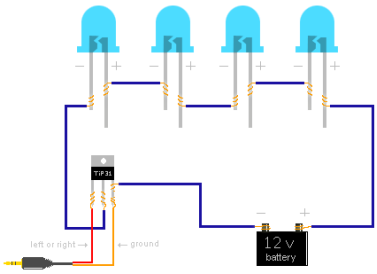
3. PLAN
Draw it out. Make a list of materials.

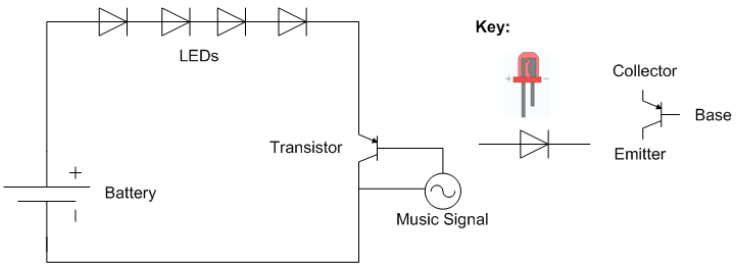
4. CREATE
Follow plan and create it. Test it out!

5. IMPROVE
What works? What doesn't? (You might need to go back to step 1 and go through the whole design process in improving).

Teaching Procedure:
1) Introduce objective and go over some of the ideas presented last week. Discuss how a transistor works.
2) Show examples of the Music LED Box (like the Youtube video, or ones built beforehand).
3) Break up into groups of students and mentors to create the LED music light box using the 5 step design process established used.
4) Wrap-up, what have you learned today? Review and quiz students about electrical engineering and circuitry.
5) Discuss other applications for circuitry such as the LED touch table (http://www.youtube.com/watch?v=IkmpIXd9Q90) , or a LED box that changes color.

Materials (/box)
- 12v Battery
- 3.5 jack headphone cable
- tip31 transistor
- Headphone splitter
-Male to Male Audio Cable
- 4mm LED's
- Electrical Wire (or Breadboard)
-Electrical Leads
-Plastic Bottle
-Music Source





Caution: DO NOT connect single LED's to the voltage source--you will burn them out!

Procedures

1. Give the breadboard and materials to the mentees. For the main portion of the body, horizontal rows are electrically connected; for the narrower partitions, the vertical columns are connected.
2. Allow the mentees to try out their own circuits, while giving them advice. The circuit necessary is above in two forms, one being more abstract than the other.
3. Once the circuit is completed and working using the audio cable, the next step is to make the actual compartment. Cut up a bottle in half and put the completed breadboard into it. Make two holes for the audio cable and the audio splitter.
4. Connect to a music source and enjoy!

Resources: http://www.instructables.com/id/Music-LED-Light-Box/