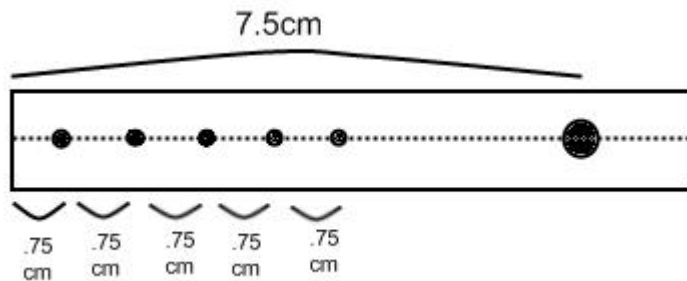


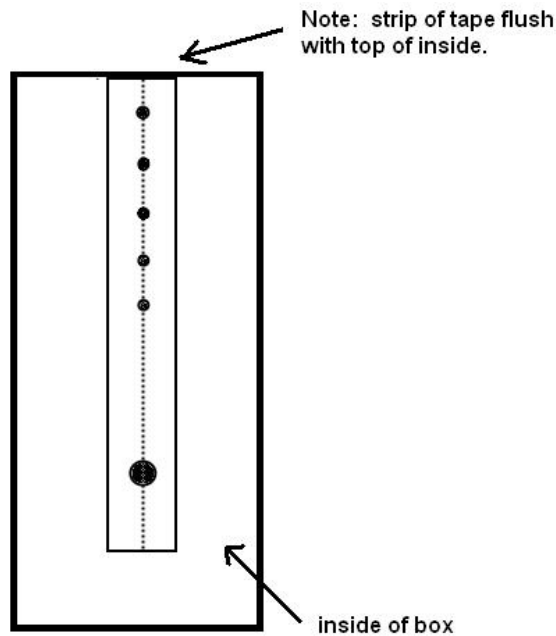
Building the LED Reference Box

Adapted by Ashley N. Subolefsky and Frank R. Vozzo, Ph.D

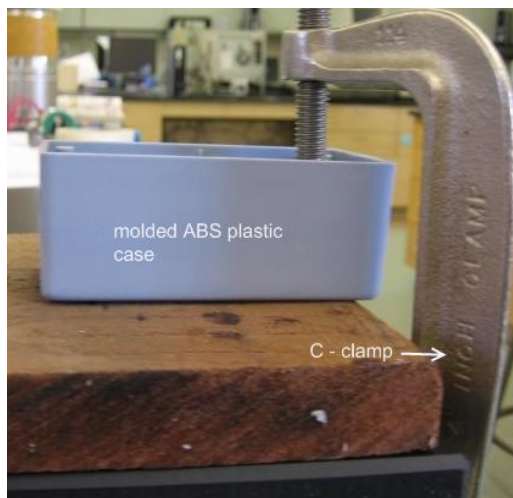
1. Cut a piece of masking tape about 9cm in length making sure that it is rectangle (approximately all 90° angles).
2. Using a ruler draw a straight line down the center of the piece of tape.
Note: It is important that this is a straight line. This will ensure the holes for the diodes are lined up properly.
3. Now mark 5 dots on the strip of tape each spaced 0.75cm apart going down the length of the tape, starting with the first dot 0.75cm from the top.
4. Next mark another dot 7.5cm from the top of the strip.
Note: Make this mark somewhat bigger or a different color in order to distinguish it from the other 5 dots.



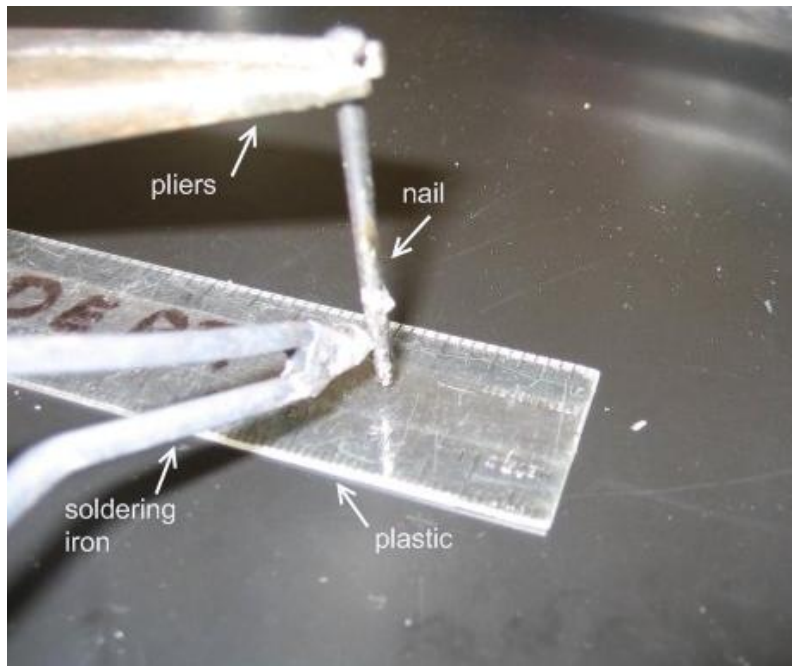
5. Obtain the molded ABS plastic case. Remove the back and the bag of screws, set these aside for later.
6. On the inside of the box place the tape strip centered and flush with one of the width wide sides of the inside of the box.



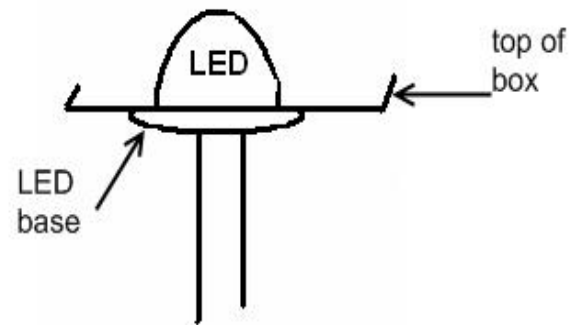
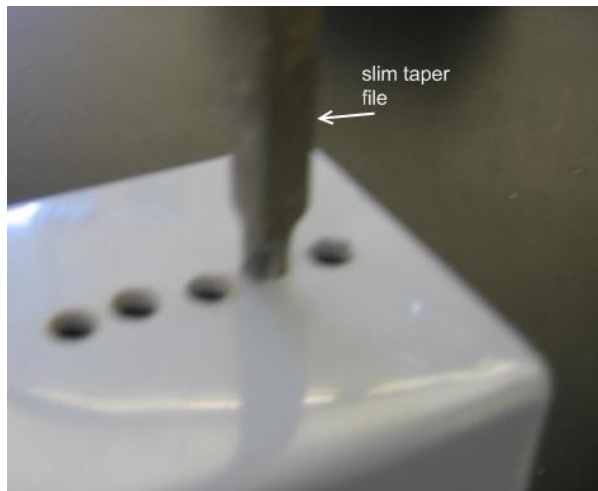
7. Obtain a soldering iron, a nail, and a pair of pliers.
8. Using a C-clamp fasten the box (with the tape strip side facing up) on top of a piece of scrap wood and to the tabletop.



9. Use the pliers to hold the nail in place with its tip touching the first dot on the tape strip.
 10. Take the soldering iron to the nail, causing the nail to heat and melt a small hole in the plastic to serve as a guide for the drill bit. Be careful not to touch the sides of the ABS plastic case because they will melt.
- Note: Make sure the nail is held at a right angle to ensure a proper guide for the bit.



11. Repeat this step for the remaining 5 holes (including the dot at 7.5cm).
 12. Next obtain a drill and a 3/16 in. drill bit.
 13. Maintaining the same set-up as in step 7, drill completely through the plastic using the melted holes as guides.
- Note: Once again, make sure that the drill is held at a right angle to ensure a clean hole for the diodes.
- Note: ONLY DO THIS FOR THE FIRST 5 HOLES.
14. Obtain a 1/2 in. drill bit.
 15. Use this bit to drill the remaining hole located at 7.5 cm.
 16. Once this hole is drilled, the tape strip can be removed.
 17. Obtain one of the diodes that will be used later on to test the sizing of the holes.
 18. Using a slim taper file, enlarge the holes as necessary from the FRONT side of the box (the side opposite of the side that was drilled).
- Note: The diodes should maintain a snug fit in the holes.



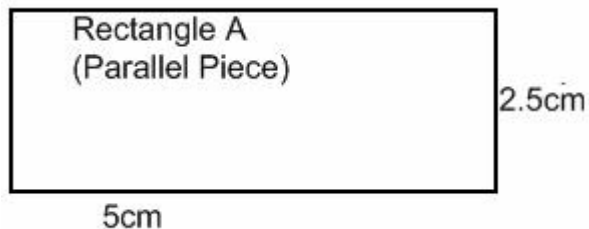
19. Obtain the push button switch to be used and repeat Step 18 for the larger hole at 7.5cm making sure the button maintains a snug fit.

Note: Remove washer and bolt before attempting to make it fit.

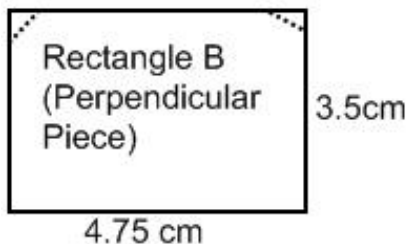
20. Obtain the sheet of plastic. Draw one rectangle 5cm x 2.5cm (RECTANGLE A or the parallel piece). Draw another rectangle 4.75cm x 3.5cm (RECTANGLE B or the perpendicular piece).

21. Using the plastic cutter cut out the two rectangles.

22. Set Rectangle A aside.



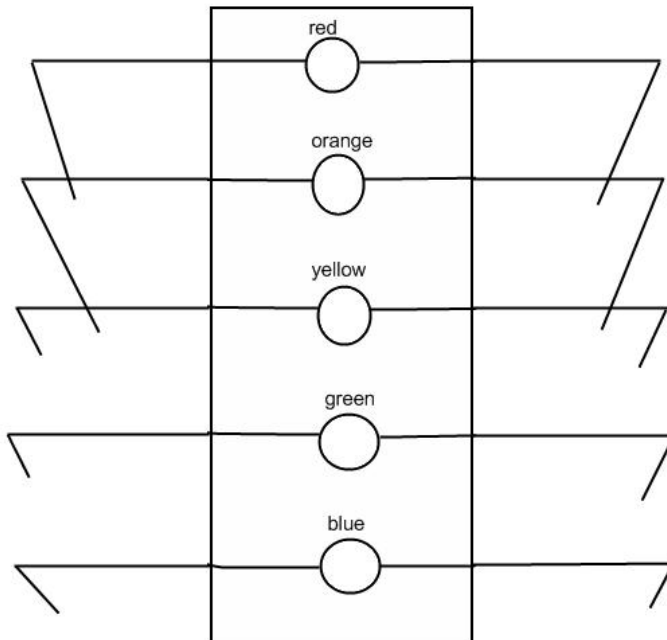
23. Cut off a small right triangle with a base of about 0.75cm from two adjacent corners of Rectangle B.



Note: Dotted lines indicate the corners to be cut off.

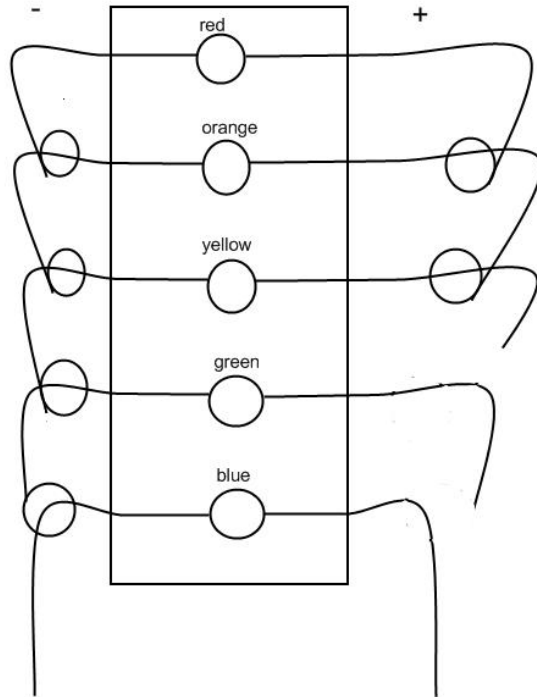
24. Tape Rectangle A centered to the inside of the box over the 5 drilled holes.
 25. Turn to the front side of the box and using a sharpie mark 5 dots through the drilled holes onto the plastic sheet.
 26. Remove the plastic from the box.

27. Create the same set-up as described in Step 7, but replace the plastic box with rectangle A plastic piece.
 28. Using the same “hot nail” technique as described in Steps 8 & 9, create the guides for the drill bit.
 29. Obtain the drill and a 1/8 in. drill bit.
 30. Follow the directions in Steps 12 & 13 to drill the 5 holes in the plastic.
 31. Obtain the 5 colored LEDs (Red, orange, yellow, green, and blue).
 32. Following the directions in Periodic Properties Lab in Steps 1 – 7 determine the positive side of the LED (the side attached to the positive wire of the battery snap when the LED lights up). Mark the side with a sharpie.
- Note: Short diode prong is usually the negative prong and the long diode prong is usually the positive prong.
33. Return to Rectangle A.
 34. Set the diodes in the holes of Rectangle A with the diode face on one side of the plastic and the wiring coming through the holes to the backside of the plastic sheet.
- Note: Make sure they are in the correct order. From top to bottom: red, orange, yellow, green, and blue.
- Note: Make sure all positive wires are on one side and all negative wires are on the other.
35. Now, using pliers, bend each of the diode wires into an “L” shape excluding the final diode (the blue one).

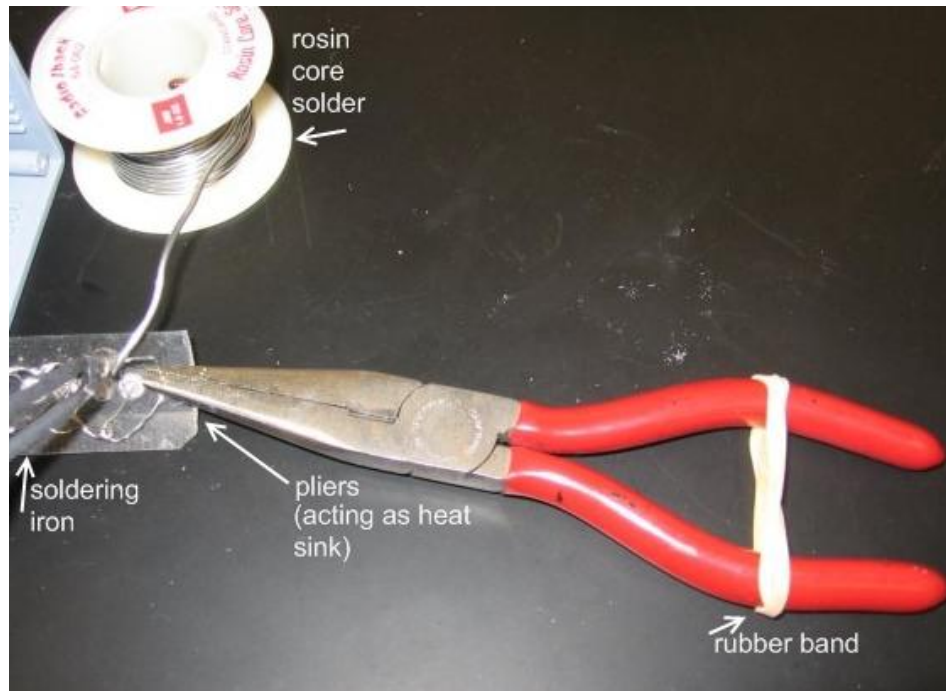


36. Using the bottom of the L (or the smaller portion, the one parallel to the length wise side of the rectangle) loop one diode to the next. LEAVE THE POSITIVE

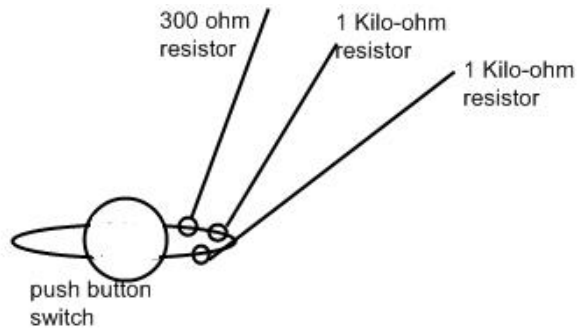
SIDE OF THE BLUE AND GREEN DIODES FREE. THEY ARE ATTACHED TO THEIR OWN RESISTORS



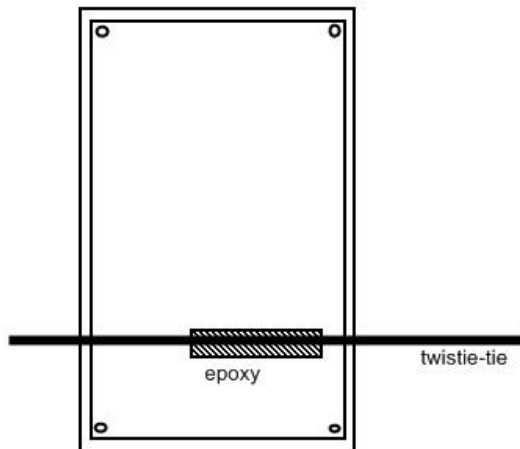
37. It is suggested that before continuing that the connections be tested. See attached *Testing the Connections*; pgs.10-11.
38. Using the solder iron and the rosin core solder, solder each of the loops to secure all of the diodes together.
- Note: Place a pair of pliers at the base of the wire to be soldered and clamp them shut using a rubber band. THIS WILL ACT AS A HEAT SINK.
39. It is suggested that before continuing that the connections be tested. See attached *Testing the Connections*; pgs. 10-11.



40. Place the diode set-up created in Steps 36 & 37 into the spots created for the diodes in the plastic box with the faces of the diodes poking through the holes.
41. Obtain the push button switch and the three resistors necessary for the set-up: (2) $1\text{K}\Omega$ resistors and (1) 300Ω resistor.
42. Loop one end of one of the resistors around the hole of one clip on the switch. Repeat this for the remaining two resistors.
43. Then, just as before, solder each loop separately into place.
44. Then holding the resistors together, pull them and the threads of the switch through the appropriate hole (the hole located at 7.5cm).
45. Place the washer over the resistors and flush against the inside of the box.
46. Next, slip the bolt over the resistors as well and screw the switch snug into place.
47. Now, bend the three resistors so they can be attached to the appropriate positive wires. The 300Ω resistor attaches to the positive wire of the yellow diode. The (2) $1\text{K}\Omega$ resistors attach to the ends of the green and blue positive wires, one to each.
48. Just as done in Step 36, bend the resistor ends to be attached into “L” shapes and loop them around the appropriate positive wires.

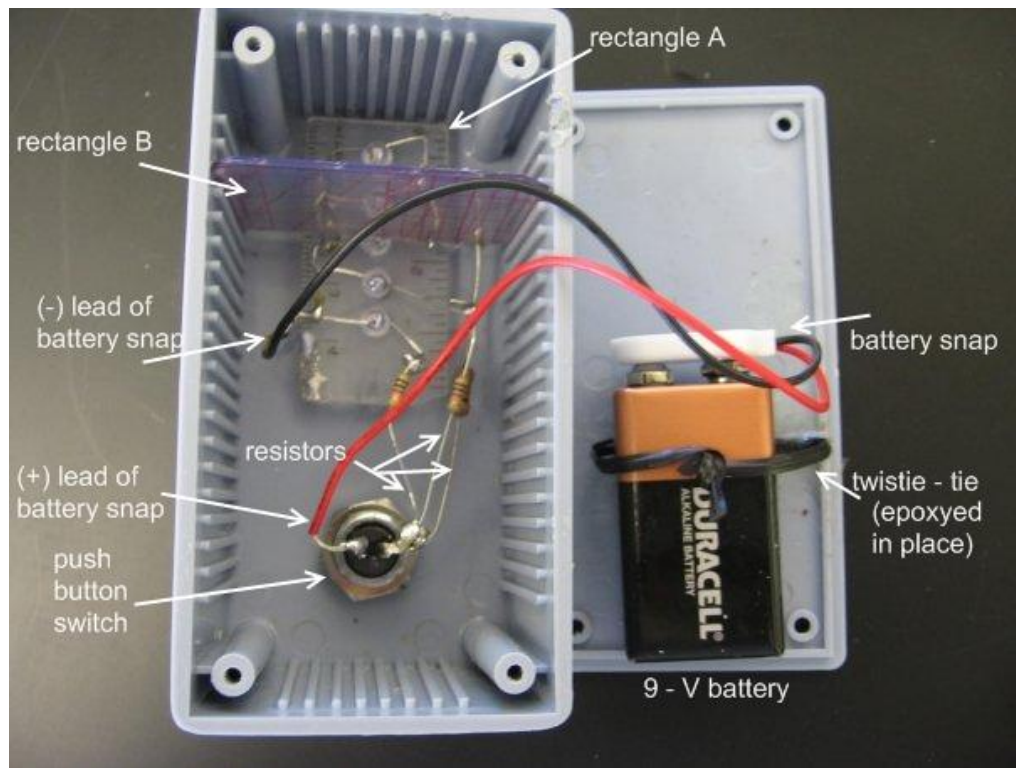


49. Using the soldering iron, solder the loops into place.
 Note: Use the pliers again as a heat sink as described in Step 37.
50. Obtain a battery snap and a pair of pliers.
51. Using the pliers strip off about a ½ in. in length of the insulation from both the negative and positive wire.
52. Following the same “L” shape technique from Step 36, loop the positive wire of the snap to the remaining clip of the push button switch and solder it into place.
53. Using the same technique, loop the negative wire of the snap to the negative end of the final (blue) diode and solder it into place
54. Next, prepare a five-minute epoxy in a weighing boat.
55. Obtain the lid of the box and a twistie-tie.
56. Using a wooden stick spread a fair amount of epoxy onto the inside of the lid in a small area (enough to hold the twistie-tie into place). Quickly center the twistie-tie over the epoxy area and hold in place for about 5 minutes.
- Note: WEAR GLOVES FOR THIS STEP. The epoxy is messy.



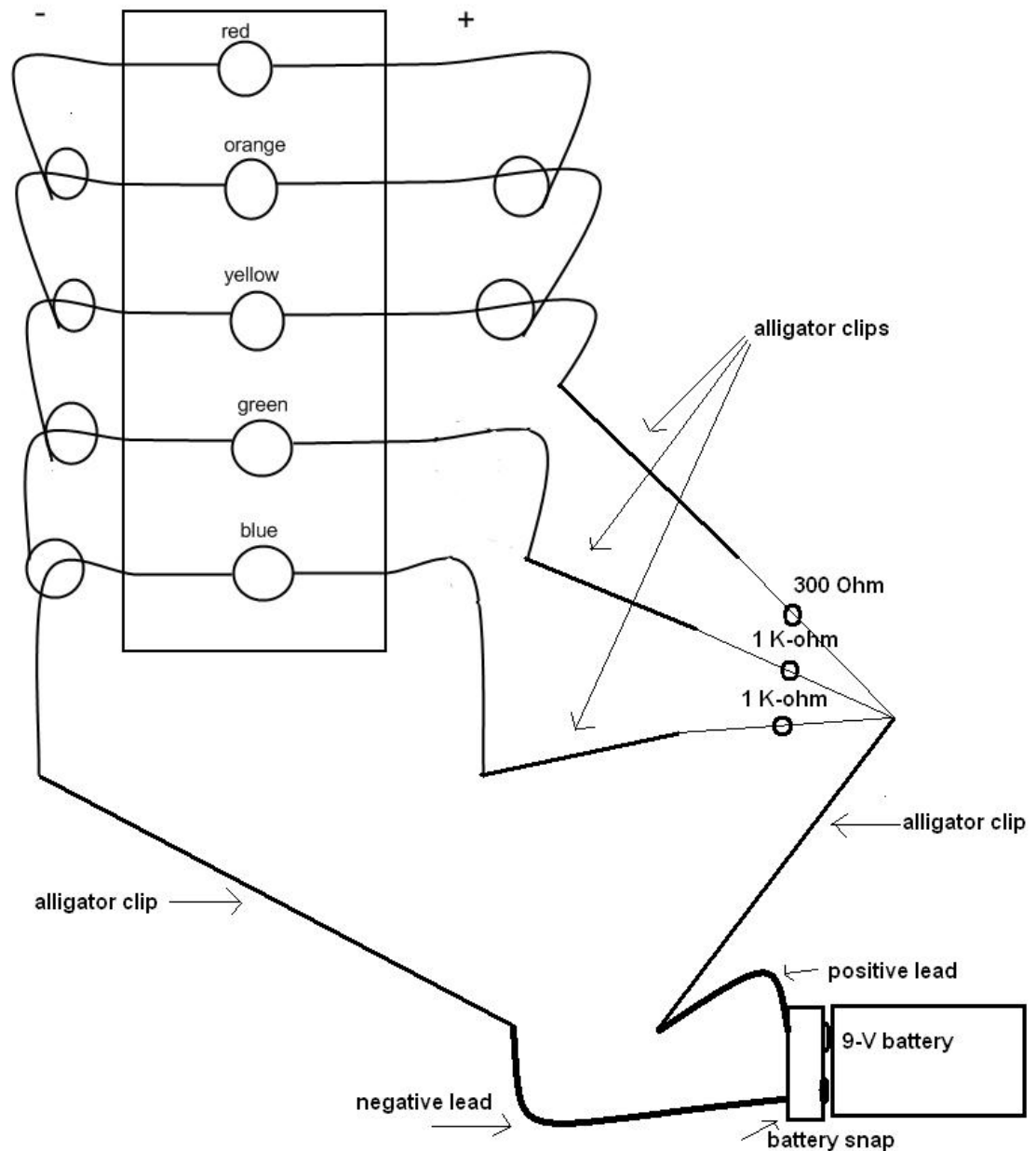
57. Allow this to set until it is completely dry (about 1 hour).
58. Use the twistie-tie to secure a 9-V battery to the lid of the box.

59. Connect the battery snap to the 9-V battery.



60. Place the lid on the box and screw the box shut.

Testing the Connections



- 1) Obtain 5 alligator clips, a 300 Ω resistor, (2) 1-K Ω resistors, a battery snap, and a 9-V battery.
- 2) Attach one end of one clip to the positive prong of the yellow diode. Attach the remaining end of this clip to one end of the 300 Ω resistor.
- 3) Attach another clip to the positive prong of the green diode. Attach the remaining end of this clip to one end of one of the 1-K Ω resistors.

- 4) Attach another clip to the positive prong of the blue diode. Attach the remaining end of this clip to one end of the other 1-K Ω resistor.
- 5) Take another alligator clip. Gather the 3 “free” ends of the attached resistors and place them all together in one clip of this alligator clip.
- 6) Attach the remaining end of this alligator clip to the positive lead of the battery snap.
- 7) Take the last alligator clip and attach one end to the negative prong of the blue diode.
- 8) Attach the remaining end of this alligator clip to the negative lead of the battery snap.
- 9) Hook the 9-V battery to the battery snap. This should complete the circuit and all 5 diodes should light up.

Note: If this is done prior to soldering (i.e. Step 37) this may just be because the loops are not snug enough and have not created a full circuit. Attempt to tighten or move the loops around to see if all 5 diodes will light up.