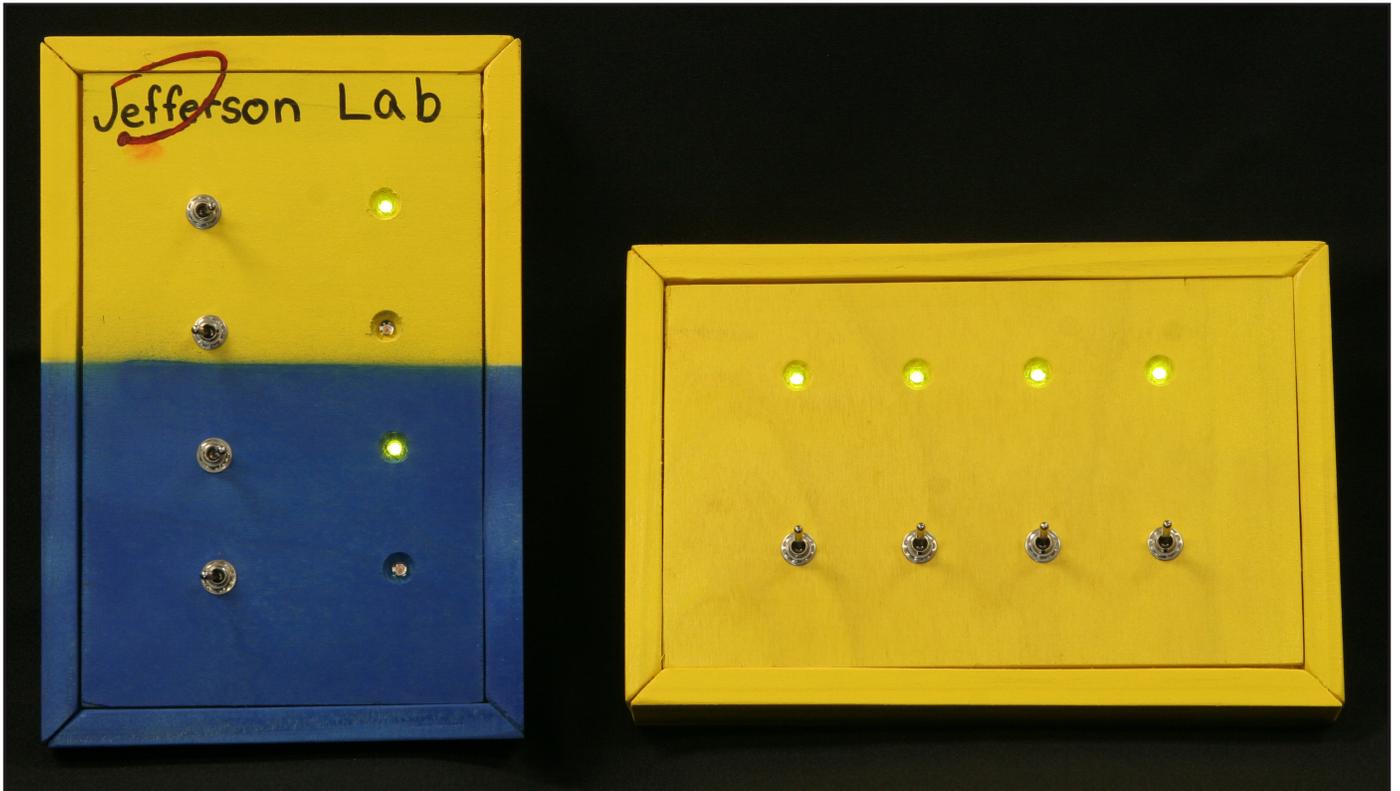


# Electric Avenue

## Parallel and Series Circuits



# Parallel and Series Circuits

## Background

There are two general types of electrical circuits: parallel and series. Parallel circuits contain more than one complete pathway for the flow of electricity. One pathway can be blocked without impeding the flow of electricity in the other branches. Series circuits, however, contain only a single pathway for the flow of electricity. Breaking a series circuit anywhere along its path disables the entire circuit.

## Overview

A small box is constructed and fitted with four light emitting diodes (LED) and four toggle switches. The way in which the LEDs react to the switches depends on how the components are wired. Ideally, several of these devices would be constructed. While all of the devices would look identical, they could be wired differently. Students could then deduce the underlying circuitry by watching the behavior of the LEDs.

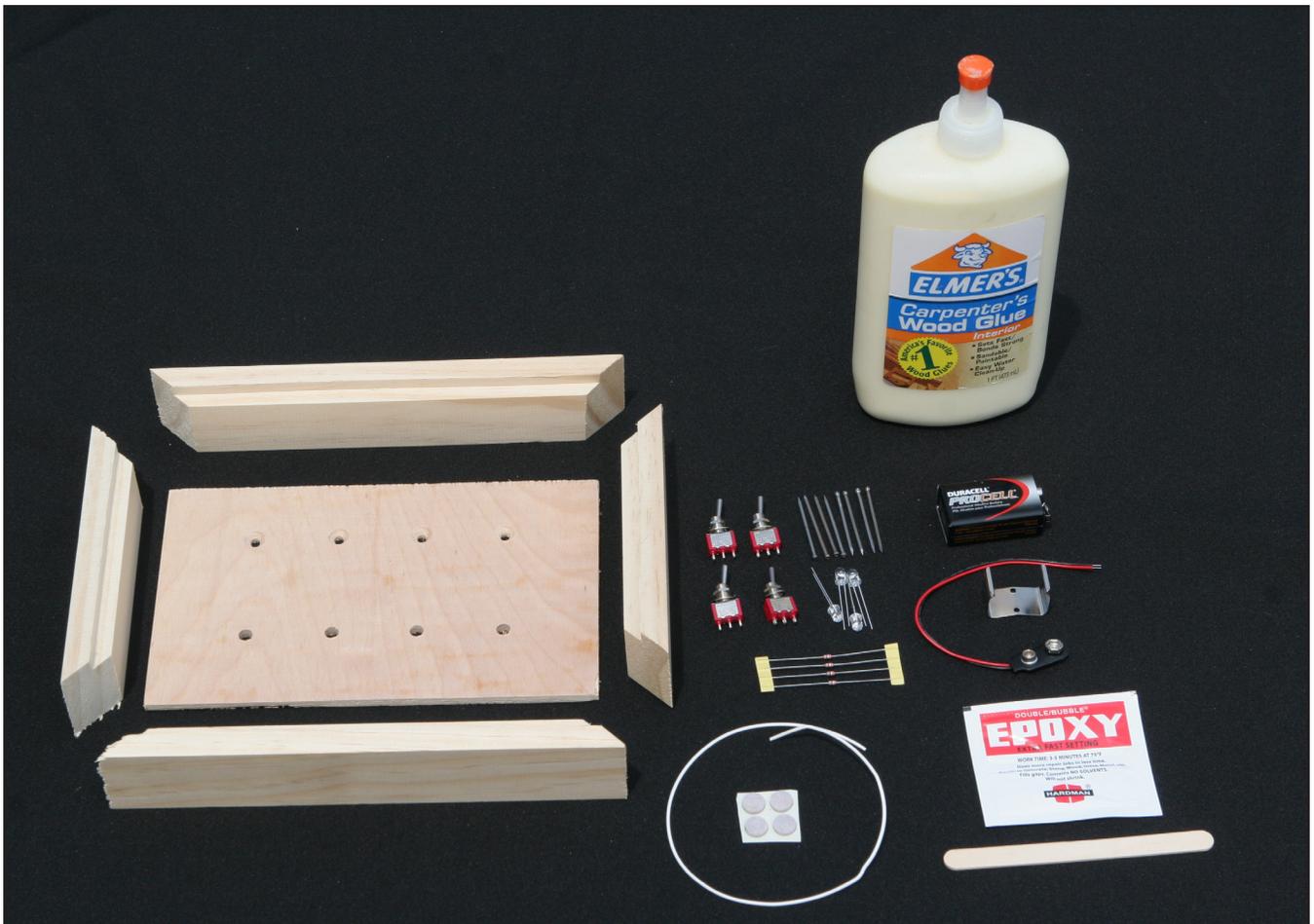
Three sample circuits can be found in Appendix B and Appendix C. The LEDs used in our devices have a forward voltage drop of 2.2 Volts and an operating current of 20 milliamps. If the LEDs you obtain vary greatly from these specifications, the resistors will need to be resized.

Don't be afraid to design your own circuits or even create 'expert' versions of this device using more than four switches and/or LEDs. Just remember that using a single 9 Volt battery limits the number of LEDs that can be wired in series on a single circuit branch to four, assuming each LED has a forward voltage drop of 2.2 Volts. Your mileage may vary, depending on the components you obtain.

Have fun!

## Component List

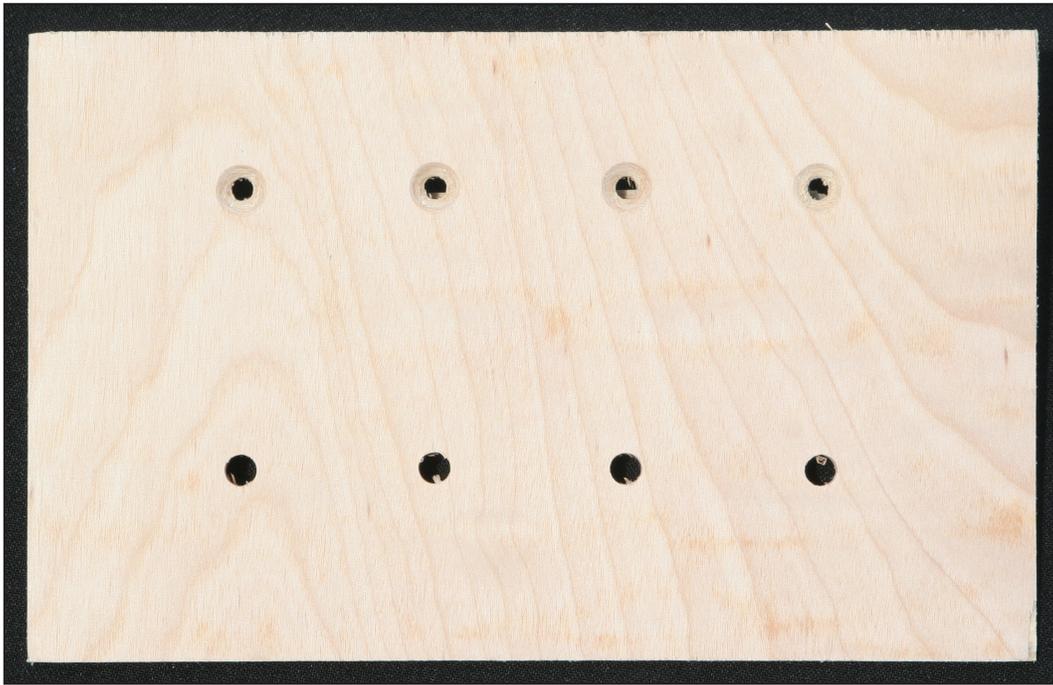
- 1 × 2 plank of white pine (roughly 30 inches needed)
- ¼" thick plywood (roughly ½ square foot needed)
- 1½" 4d finishing nails (about 8 needed)
- 22 gauge hook-up wire (roughly 1 foot needed)
- green LEDs (T-1 ¾ package, 4 needed)
- toggle switches (SPDT or SPST, 4 needed)
- ¼ Watt resistor(s) (exact numbers and values depend on the type of circuit being built)
- 9 Volt battery (1 needed)
- 9 Volt battery connector (1 needed)
- 9 Volt battery holder (1 needed)
- adhesive feet (4 needed)
- 5 minute epoxy (1 packet needed)
- wood glue



All of the components have been gathered. All of the wood has been cut and holes for the hardware have been drilled.

## Base Construction

1. Cut a  $5\frac{7}{8}$ "  $\times$   $8\frac{3}{4}$ " panel from the  $\frac{1}{4}$ " plywood.
2. Use the drill pattern found in Appendix A to drill the appropriate holes in the plywood panel.



Holes for the LEDs (top) and toggle switches (bottom) have been drilled in the plywood panel.

3. Make the front and back sections of the base by cutting two  $8\frac{3}{4}$ " long pieces from the  $1 \times 2$  white pine board. Miter cut both ends of both pieces to a  $45^\circ$  angle. Cut a groove on the top, inside portion of both pieces, roughly  $\frac{1}{4}$ " deep and  $\frac{7}{16}$ " wide, to accommodate the plywood panel.



The front and back sections of the base.

4. Make the right and left sections of the base by cutting two  $5 \frac{7}{8}$ " long pieces from the  $1 \times 2$  white pine board. Miter cut both ends of both pieces to a  $45^\circ$  angle. Cut a groove on the top, inside portion of both pieces, roughly  $\frac{1}{4}$ " deep and  $\frac{7}{16}$ " wide, to accommodate the plywood panel.



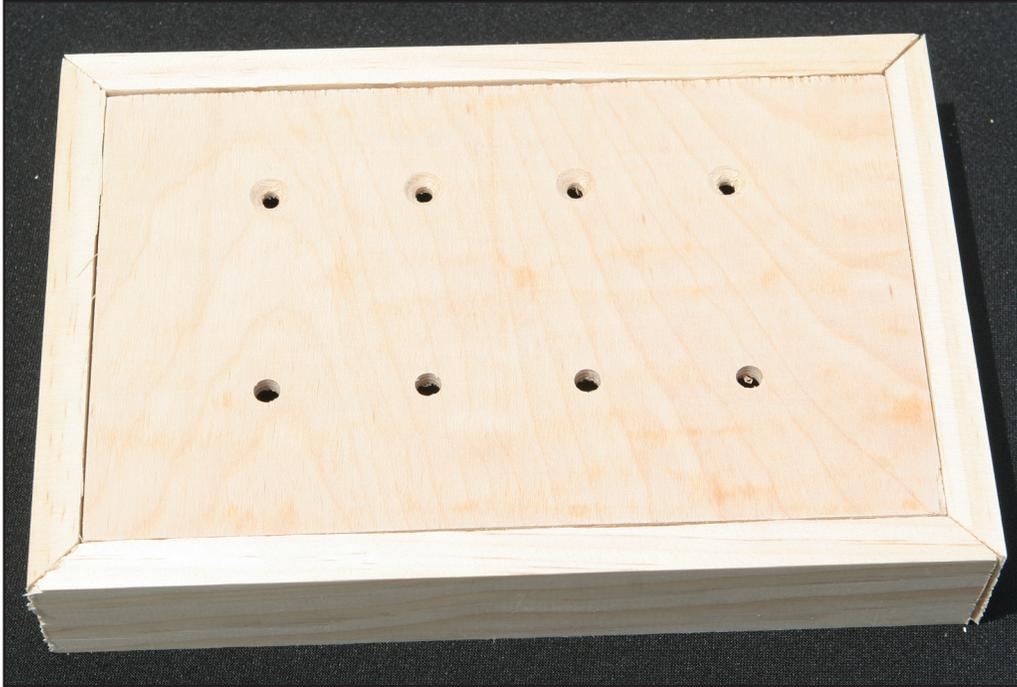
The right and left sections of the base.

5. Join the four sections of the base together. Use wood glue and finishing nails to secure the joints.



The pieces of the base have been joined together.

6. Use wood glue to attach the plywood panel to the base.



The plywood panel has been glued to the base.

7. Paint the base, if desired.
8. Attach four adhesive feet to the bottom of the base.
9. The base is now complete. It's time to install the hardware!

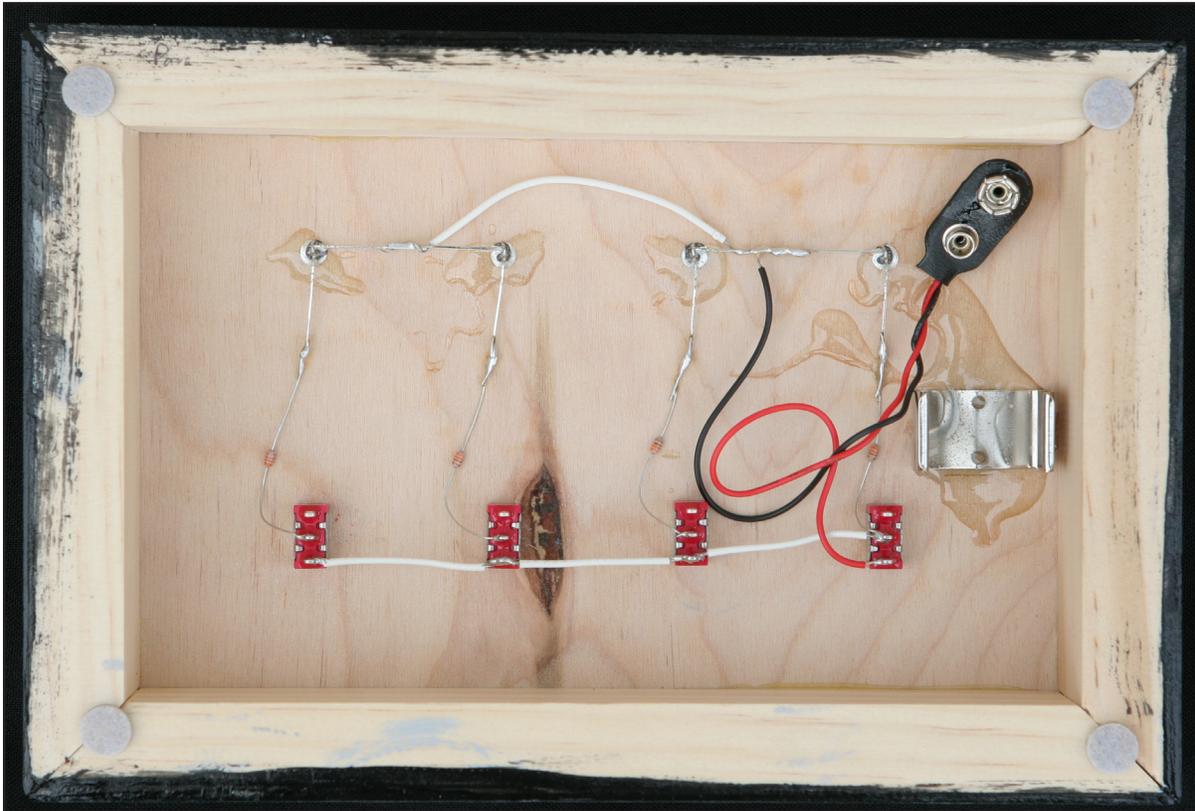
## Assembly

1. Install the four LEDs and the four toggle switches in their respective holes.



LEDs and toggle switches have been installed.

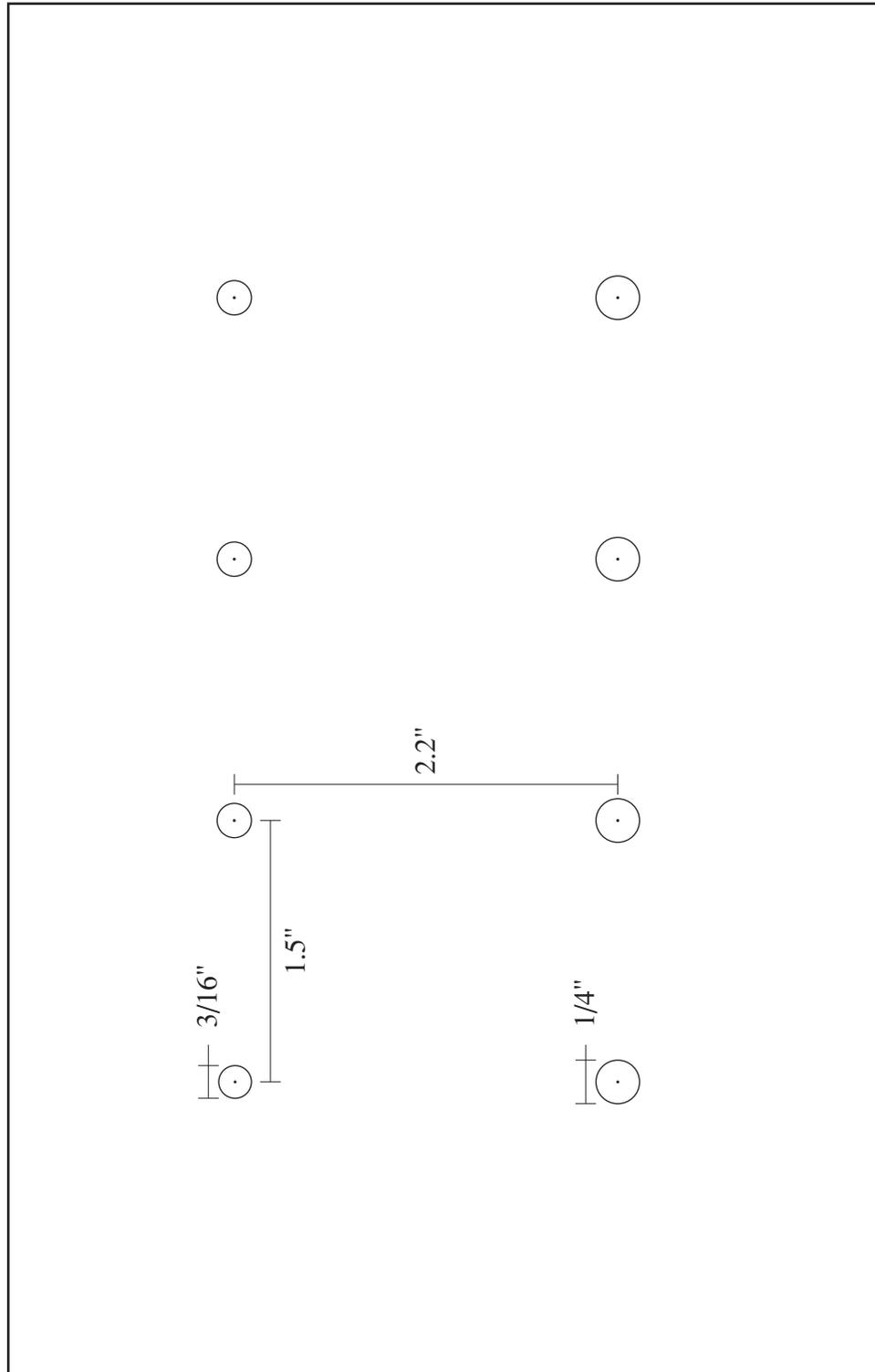
2. Flipping the base over so that you can access its interior, wire the LEDs and switches together to make the kind of circuit you desire. Sample circuits can be found in Appendix B (Point to Point Wiring Guides) and Appendix C (Circuit Diagrams).
3. Once the wiring is complete, secure the 9 Volt battery clip and the LEDs to the base with epoxy.



All wiring is complete and the LEDs and battery clip are secured to the base with epoxy.

4. Attach a 9 Volt battery to the connector and place it in the battery clip. If all has gone well, your device should now be working!

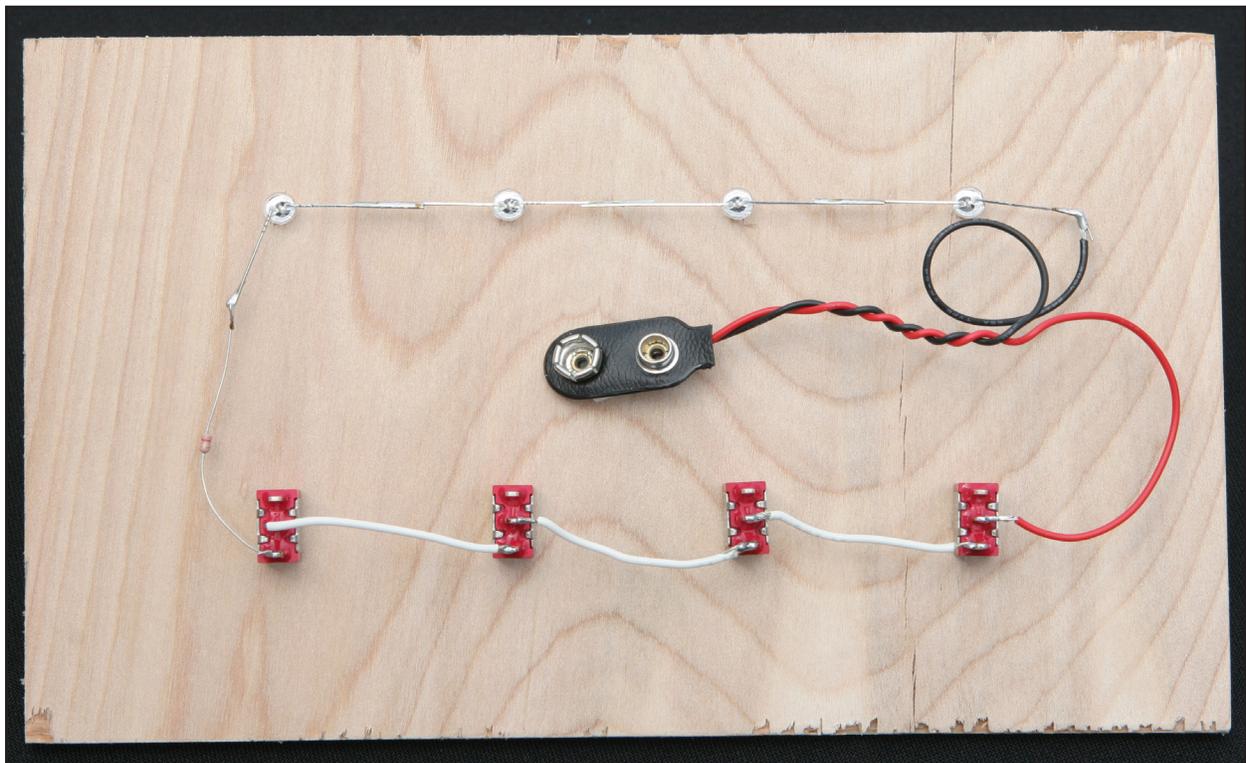
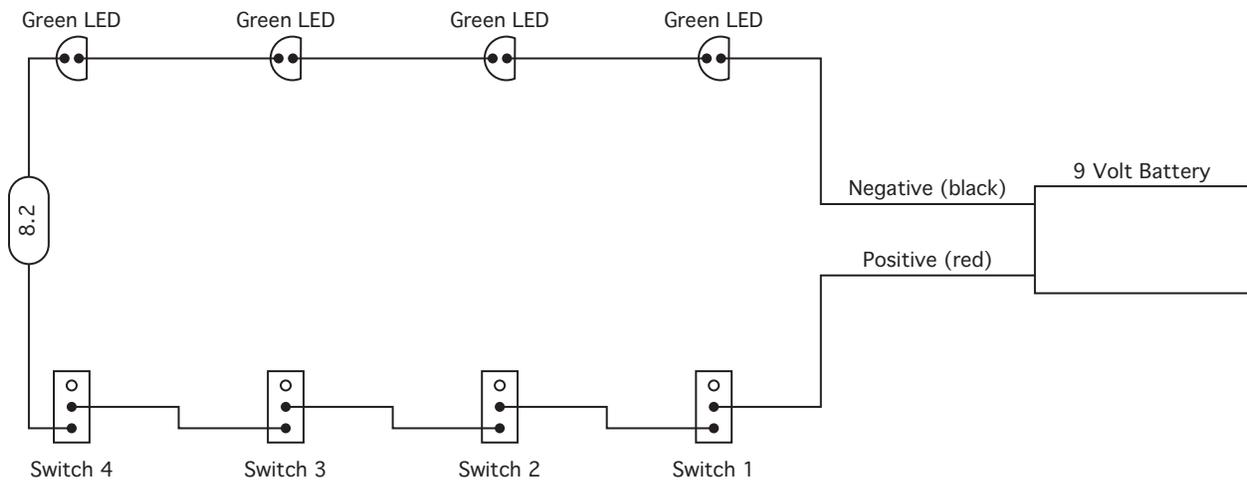
# Appendix A - Top Plate Drill Pattern



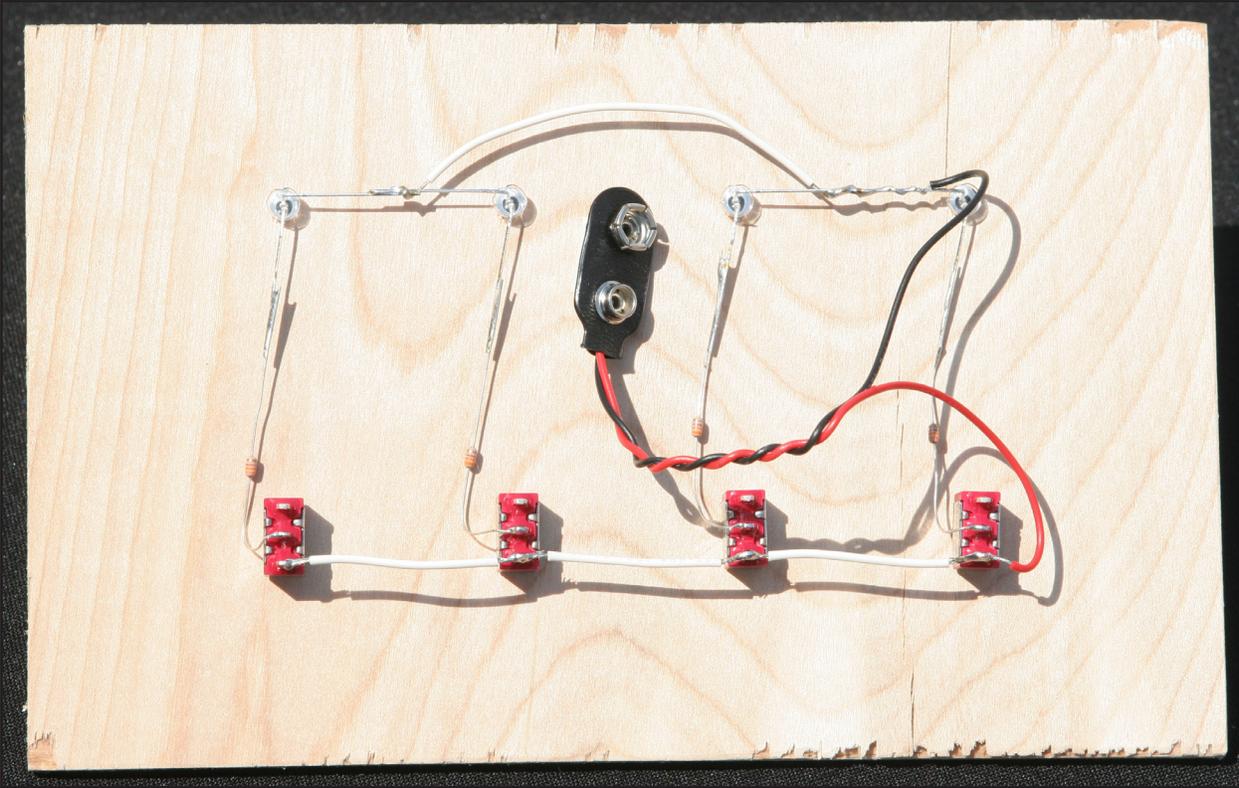
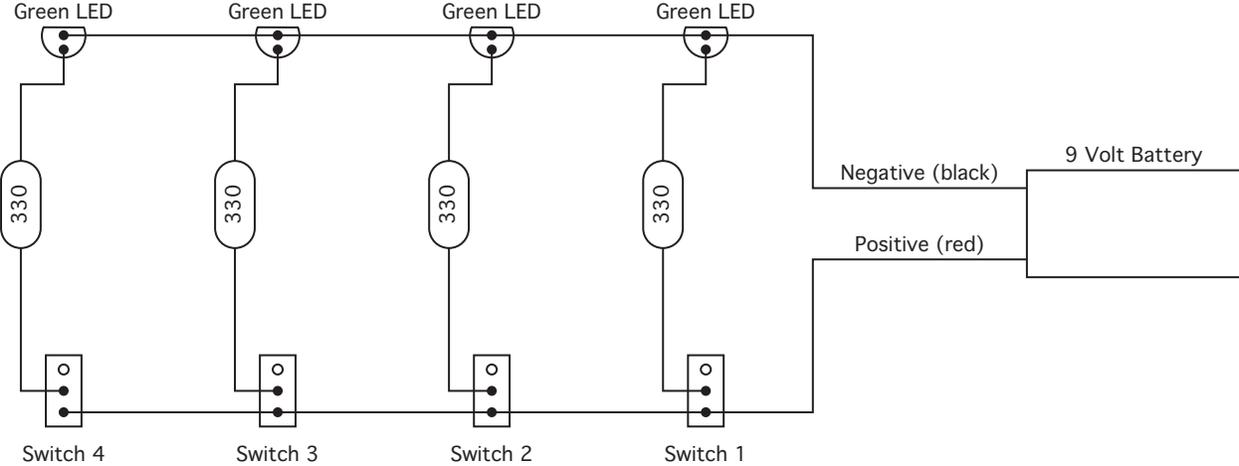
## Appendix B - Point to Point Wiring Guides

The diagrams show the components as seen from inside the base. Resistors are represented by rounded rectangles. The flat end of the LED is the cathode. Switches are assumed to be single pole, double throw. Small, dark circles indicate a soldered connection.

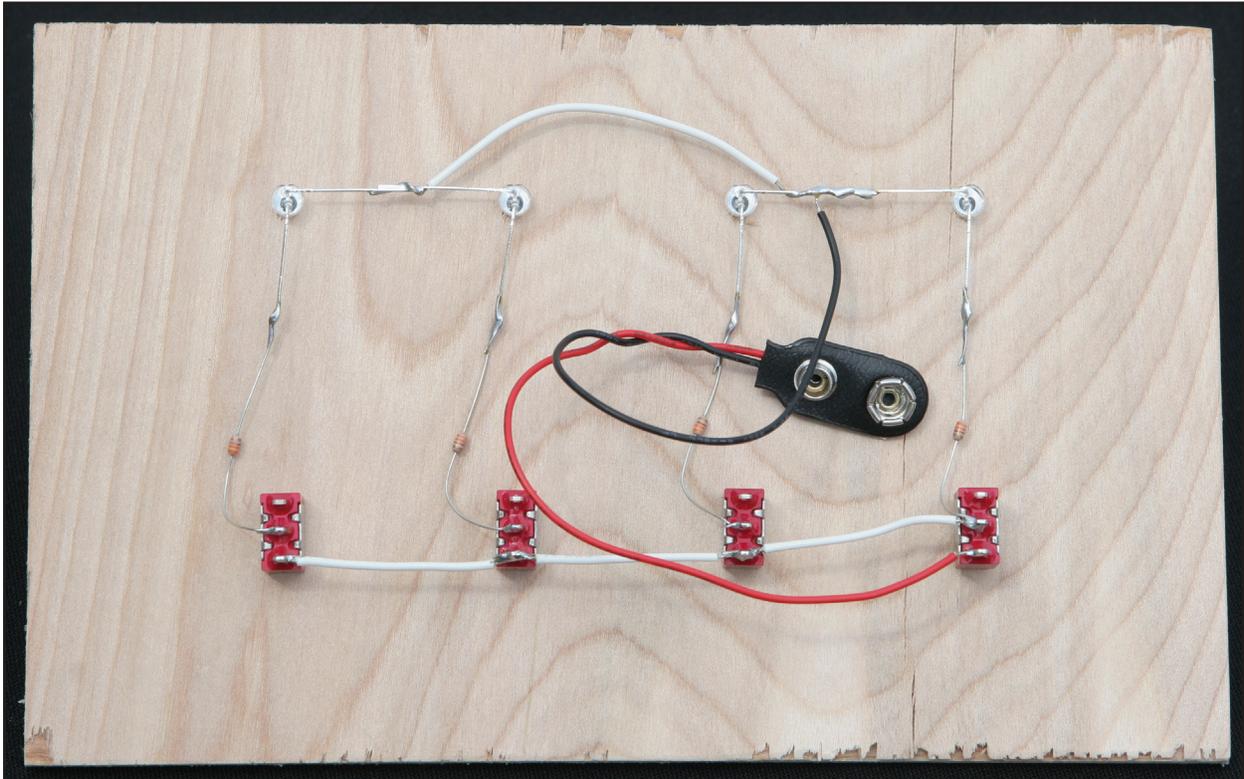
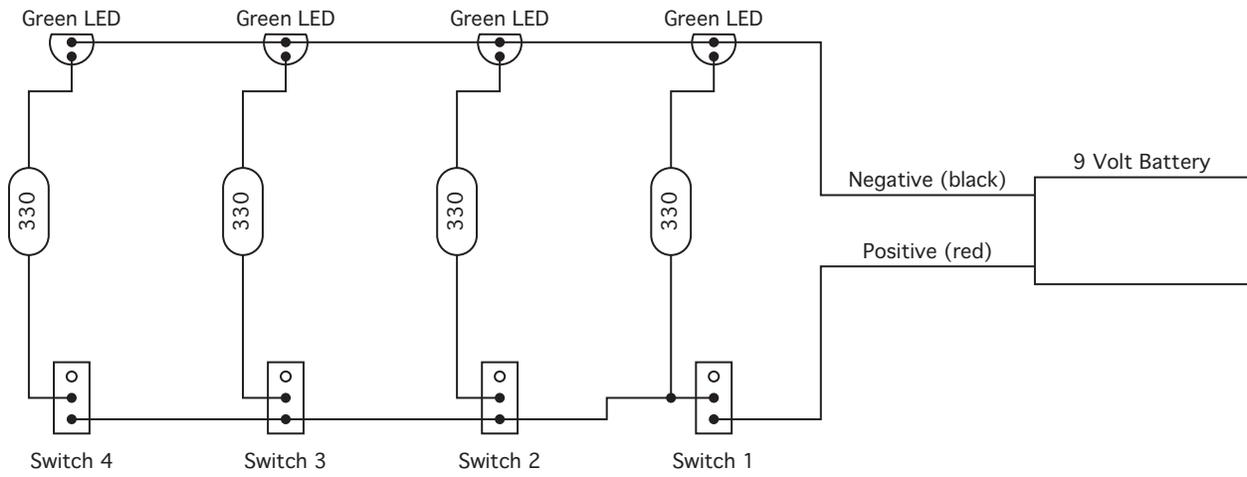
### Sample Series Circuit



# Sample Parallel Circuit

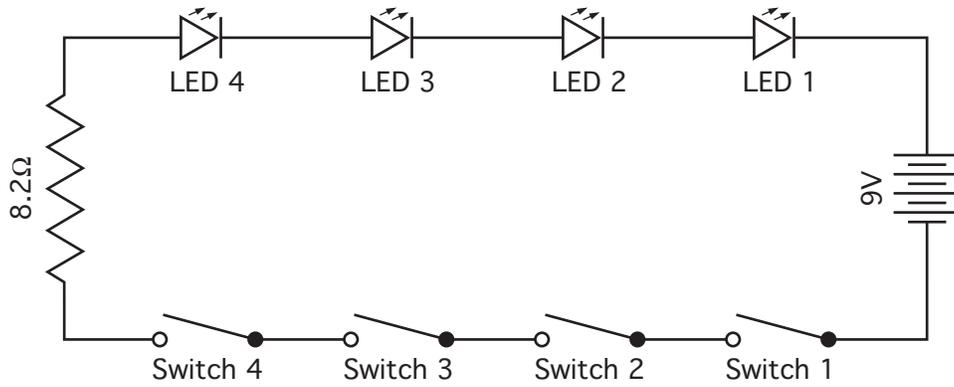


## Sample Hybrid Circuit

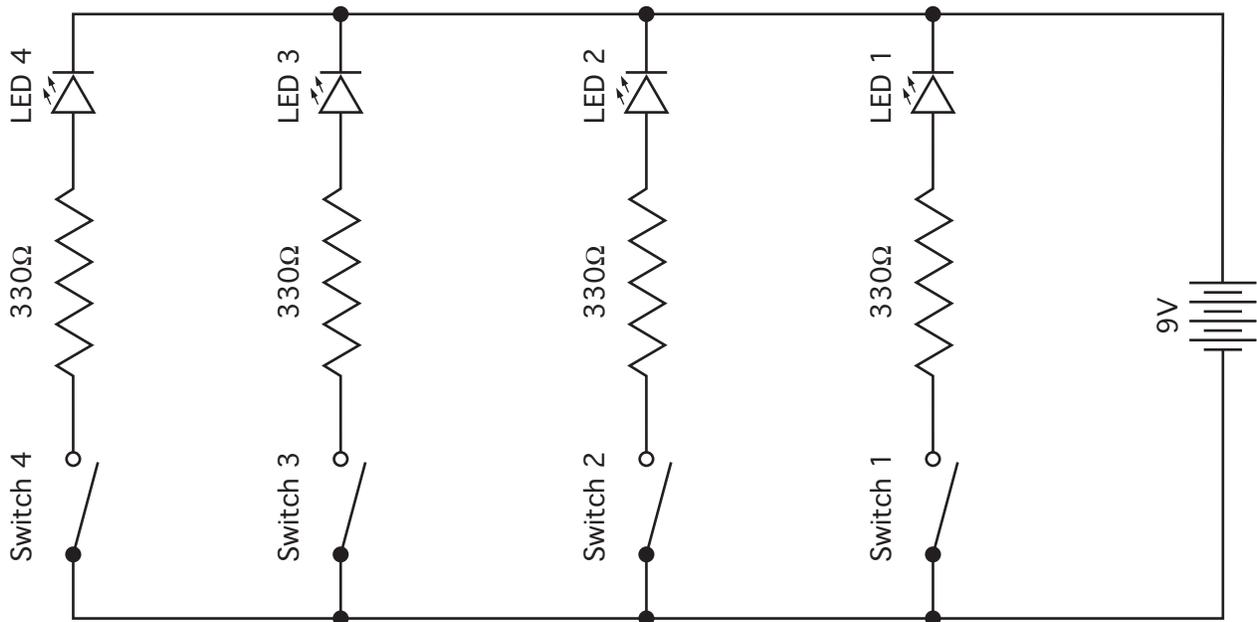


## Appendix C - Circuit Diagrams

### Sample Series Circuit



### Sample Parallel Circuit



# Sample Hybrid Circuit

