

## Circuit Boards

Perhaps the cheapest and most effective way to teach series and parallel circuits. Students build a series and parallel circuit from cardboard, aluminum foil, paper fasteners, and recycled lights



### Prep

1. Have each student bring in **two 3 inch by 5 inch pieces of cardboard**. This is simply too much work for you to do this for them, and you're not asking too much. They can use regular corrugated cardboard (the heavy brown kind) or even cereal boxes. Give them a week's notice. As they bring it in, have them put their names on it with marker for you to keep. Students that don't bring in cardboard will sit, bother no one, and fall behind in the project.
2. **Get foil ready**- cut 8 sheets of aluminum foil that are 24 inches long. Cover the back side of each with strips of masking tape (so it won't tear easily). Mark and cut each sheet into 8 cm wide strips that students at their tables will later cut into 1 cm wide strips later. Each table (with 4 students) will get one 8cm wide by 24 inches long strip of foil backed with tape. This is explained on the PowerPoint (see last page).
3. **Student materials**- 4 D batteries, 4 battery holders, 6 wires with gator clips, sand paper (to knock the rust off gator clips if needed), 4 rulers, 4 scissors (sharp-tipped)
4. **Piles ready to be taken from** (students will count out their own lights, fasteners, etc...)
  - Box of lights- have students bring in old Christmas lights that don't work any more. Depending on how much prep you want to do you can prepare the lights for them, or they can do their own. If you're doing it: cut lights, each with about 2 inches of wire on both sides of the bulb. Strip last  $\frac{1}{2}$  inch of insulation to expose copper wire. You can put students to work doing this for you.
  - Paper fasteners- each student needs 15, so buy accordingly

- Ziploc sandwich bags- each student needs one; this is where students will store their materials
  - Make “Take” signs out of paper and black marker- telling how much to take: 1 baggie, 4 lights, how to cut lights, 15 fasteners.
  - Handouts- “Student Handout-Circuit Boards”- one for each student
5. **Find a big box** to put each class period’s projects in at the end of each class. Paper boxes are perfect.
  6. **Another box** in the back labeled “BAD BULBS!”- for bulbs that don’t work. Don’t let students just throw away what they think are bad bulbs- many times they are still good.
  7. **Two 9-volt batteries** for you to check boards with

**Day 1- is a loose day of getting materials ready. A large class (over 30) will need full class period to rotate though the “take” stations**

1. Materials students need today- foil strips (8cm wide) to be cut, scissors, rulers (18” is ideal, but 12” will also work), black marker, 4 D batteries, 4 battery holders, 6 gator clip wires
2. Have students cut the foil, which will serve as our conductor. To do so, have one student per group mark two centimeter increments, and another cut as shown on PowerPoint. Every student will then cut theirs in half long ways so they end up with 2 one-centimeter wide by 24 inch-long pieces of foil.
3. While that goes on, groups rotate in and out of 2 identical stations set up to fill bags with fasteners & lights (where they cut and strip their own lights)
4. Have students check light bulbs to make sure they work using the batteries, battery holders, and gator clip wires.
5. Have students write their name on their baggies with black marker
6. End of class- put foil, fasteners, bulbs, and cardboard in baggie, then into class box

**Day 2- make the SERIES CIRCUIT board**

1. Start PowerPoint
2. As shown, have them draw an outline first, establish system of wiring
3. Poke holes, insert fasteners, lay and cut foil, insert lights as shown
4. Most classes will finish making the series board with 10 minutes to spare

### Day 3- make the PARALLEL CIRCUIT board

1. Make parallel board. Students should be able to work without too much help. They'll need you to help more with problems they're having.
2. Answer questions located on the back side of student handout
3. Look at rubric, bring it up when you want it graded
4. When students are done, they bring their boards to you. You check lights with a 9-volt, according to the rubric

Use the following as your guide when building the circuit boards.

## Circuit Board Project

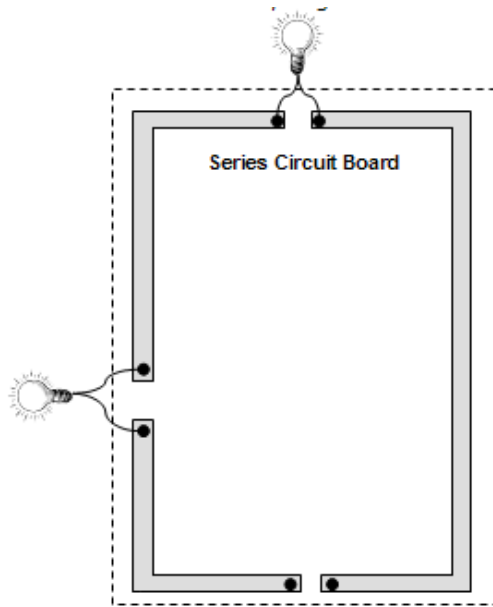
Assignment: Design and construct two circuit boards- one Series and one Parallel.

Requirements:

- Each circuit has 2 lights on it
- Each circuit board is labeled at the top center as "Series Circuit" or "Parallel Circuit"
- Battery contacts (2 paper fasteners) are spaced 2 cm apart at the bottom center
- There are gaps between battery contacts, and beneath all lights, meaning: *no conductors may touch on the underside*
- All foil is 1 cm wide
- The Parallel circuit has a switch (reversed paper fastener) that controls 1 light

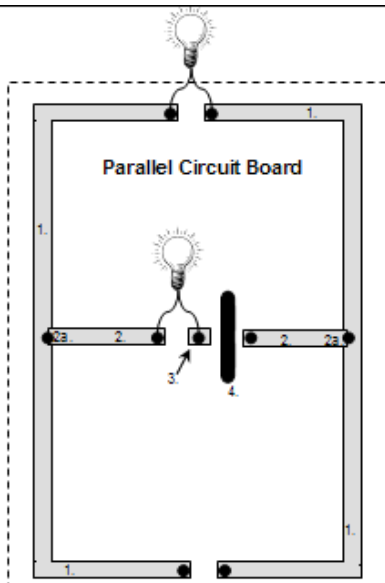
Helpful hints: 1. *all connections are metal touching metal*      2. *don't let any copper touch cardboard*  
3. *un-touch prongs on the underside*

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**Things to check:**

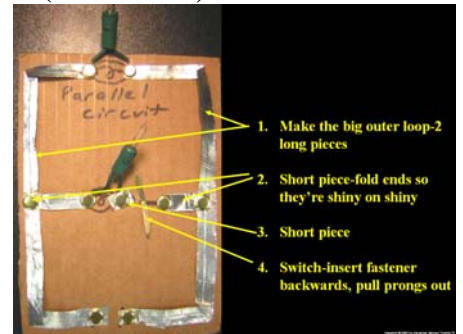
- Battery contacts-2 cm apart
- No prongs touch on the back
- Gap below lights and in between battery contacts (you can see cardboard)
- Lights come on when you touch hot wires to battery contacts (middle on "switch")
- Title?



1. Outer loop-these are long, continuous pieces. Shiny side up
2. Short pieces
  - Shiny side up
  - 2a. -Where it meets the outer loop, fold it back over itself before fastening so you have shiny/shiny touching
3. Short piece of foil
4. Fastener inserted backwards (prong side up). The prongs can turn and either connect or disconnect the middle light

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**PowerPoint-** lead your students through the lesson click-by-click (26 slides!)



## Student Handout

**Circuit Board Project**

**Assignment:** Design and construct two circuit boards: one Series and one Parallel.

**Materials:**

- Each circuit has 2 lights on it
- Each circuit board is labeled at the top center as "Series Circuit" or "Parallel Circuit"
- Battery contacts (2 paper fasteners) are spaced 2 cm apart at the bottom center
- There are gaps between battery contacts, and beneath all lights, meaning no conductors may touch on the underside
- All holes 1 cm wide
- The Parallel circuit has a switch (pre-wired paper fastener) that controls 1 light

**Build steps:**

1. all connections are made "backing under"
2. don't let any copper touch cardboard!
3. all touch points on the underside

**Things to check:**

- All wires contact 2 on an end
- All prongs touch on the back
- All all holes light and in between battery contacts (you can see cardboard)
- All wires under on the top but wires to battery contacts (not on "back")
- All fast.

**Series Circuit Board**

**Parallel Circuit Board**

1. Outer loop- these are long, continuous pieces. They are up
2. Short pieces
  - 2 wires on top
  - 2w. - wires through the outer loop, fold back over itself before fastening so you have straightaway fastening
3. Short piece wired
4. Fastener inserted backwards (prong side up). The prong on top and other prong on bottom of the middle light