

Circuit Boards

Welcome to 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 if you did 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 the back side with marker for you to keep. Students that don't bring in cardboard will sit, watch everyone else have fun, bother no one, and fall behind in the project.
2. **Make these yourself!** About a week before this lesson, sit down and make one of each board. You'll be amazed after you do so just how much better you understand the project. They can also serve as examples for you to hold up so students can see how one was made.
3. **Get foil ready-** cut 8 sheets of aluminum foil that are 24 inches long. Cover the back side of the foil with strips of masking tape (this is so it won't tear easily). Mark and cut each sheet into 8 cm high (by 24 inch long) 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).
4. **Student materials-** 4 D batteries, 4 battery holders (item #WW46481M00 at sciencekit.com), 6 wires with gator clips (item #WW47889M00 at sciencekit.com), small sand paper squares (each 2 inch by 2 inch, 150 grit; use them to knock the rust off gator clips if needed), 4 rulers, 4 scissors (sharp-tipped)
5. **Piles of things to be taken from** (students will count out their own lights, fasteners, etc...)
 - Box of lights- a couple of weeks before this project have students bring in old Christmas lights that



don't work any more. Depending on how much prep you want to do, you can prep the lights for them, or they can do their own. If you're doing it: cut lights so that each has about 2 inches of wire on both sides coming off. Strip the last ½ inch of insulation to expose the copper wire. 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
 - Handouts- “Student Handout-Circuit Boards”- one for each student
 - Make “Take” signs out of paper and black marker- telling how much to take: 1 baggie, 4 lights, how to cut lights, 15 fasteners. You can see a couple of these in my picture above.
6. **Find a big box** to put each class period's projects in at the end of each class. Paper boxes are a perfect size.
 7. **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.
 8. **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 through the “take” stations

1. Materials students need today- foil strips (8cm wide) to be cut, scissors, rulers (an 18 inch ruler is ideal, but 12 inch 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:
 - Have one student per group mark two centimeter increments on the foil, as shown on the PowerPoint (see last page).
 - Another student in the group can then cut along those lines. Every student will then cut their 2 cm wide piece of foil in half long ways so they end up with 2 one-centimeter wide by 24 inch-long pieces of foil.
3. While that cutting is going on, have groups rotate in and out of 2 identical stations set up to fill bags with fasteners & lights (they can cut and strip their own lights if you didn't it for them).
4. Have students test light bulbs to make sure they work using the batteries, battery holders, and gator clip wires.



5. Students also need to 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.

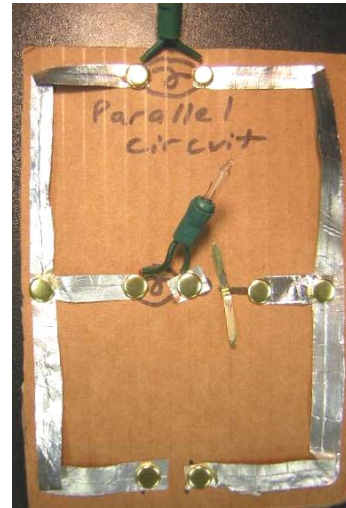
Day 2- Make the SERIES CIRCUIT board

1. Start the PowerPoint
2. As shown in it, have them draw an outline first, establish system of wiring
3. Poke holes, insert fasteners, lay and cut foil, insert lights as shown in the PowerPoint
4. Most classes will finish making the series board with 10 minutes to spare. Those done first can help others (NOT do it for them!).



Day 3- Make the PARALLEL CIRCUIT board

1. Make parallel board. Students should be able to work without needing too much help at the beginning. They'll need you to help more with problems they're having. If students have problems, it'll likely be in the middle where the "switch" is. The switch is just a paper fastener that's been put in backwards, so it bridges a gap between the rest of the run.
2. Answer questions located on the back side of student handout.
3. After checking the rubric to make sure they're finished, students can they bring their boards to you.
4. Check their lights with a 9-volt by touching the contacts on the 9-volt to the 2 bottom center contacts on their boards.



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

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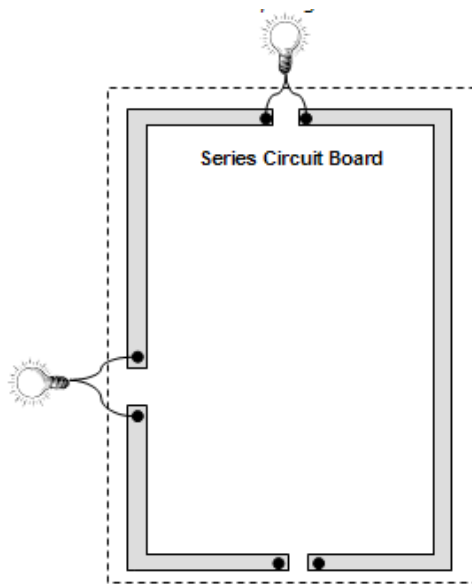
Circuit Board Project

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

Requirements:

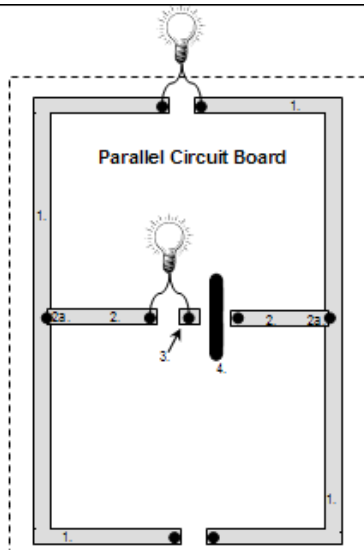
- Each circuit has 2 lights on it
- Each circuit board is labeled at the top center as "Series Circuit" or "Parallel Circuit"
- Battery contacts (2 paper fasteners) are spaced 2 cm apart at the bottom center
- There are gaps between battery contacts, and beneath all lights, meaning: *no conductors may 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



Things to check:

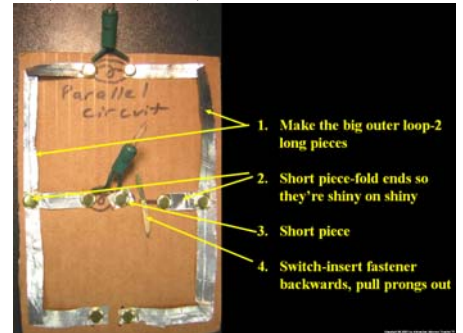
- Battery contacts-2 cm apart
- No prongs touch on the back
- Gap below lights and in between battery contacts (you can see cardboard)
- Lights come on when you touch hot wires to battery contacts (middle on "switch")
- Title?



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

Come back and visit InteractiveScienceTeacher.com to upgrade this lesson with:

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 cardboard
- All foil is 1 cm wide
- The Parallel circuit has a switch (a second paper fastener) that controls 1 light

Handout: 1. all connections are made following steps! 2. don't let any copper touch cardboard! 3. cut-back prongs on the underside

Things to check:

- Do all wires connect to 2 on an set
- Do a prong touch on the back
- Do all bottom lights and in between battery contacts (you can see cardboard)
- Do lights come on all on you touch but when in battery contacts (not on "back")
- BTA?

Series Circuit Board

Parallel Circuit Board

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

