



Title:	Foutan Board Circuit
Original Version	8 July 2001
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Authors:	Jim Overhiser, developed from a STANYS presentation Edited by Dorrie Bright
Appropriate Level:	General and Regents Physics
Abstract:	This lab uses Foutan Circuit Boards, consisting of a battery and a network of switches and light bulbs, to help students explore the structure and behavior of series, parallel, and compound circuits. They are asked to predict the switch positions on a picture of the board which would be needed to light certain bulbs, and then they test their predictions by using the Foutan Board.
Time Required:	80 minutes (2 class periods)
NY Standards Met:	<ul style="list-style-type: none"> • 4.1n A circuit is a closed path in which a current (DC) can exist. • 1.4o Circuit components may be connected in series or in parallel. Schematic diagrams are used to represent circuits and circuit elements.
Special Notes:	<p>Make sure the batteries are fresh at the start of the activity.</p> <p>Created by the CNS Institute for Physics Teachers via the Nanoscale Science and Engineering Initiative under NSF Award # EEC-0117770, 0646547 and the NYS Office of Science, Technology & Academic Research under NYSTAR Contract # C020071</p>

Xraise Outreach for CLASSE

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Behavioral Objectives:

Upon completion of this lab a student should be able to:

- draw a schematic diagram of series, parallel, or compound circuits from actual physical circuits.
- identify the differences between
- describe the basic characteristics of series and parallel circuits
- construct functional series, parallel, and compound electric circuits (consisting of a battery, light bulbs, and switches) starting with a verbal description of the desired circuit.

Class Time Required: 40 minutes (1 class period)

Materials Needed:

- Series, parallel and compound circuit Foutan Board

Assumed Prior Knowledge of Students: simple circuit components and circuit schematics

Foutan Board Circuit

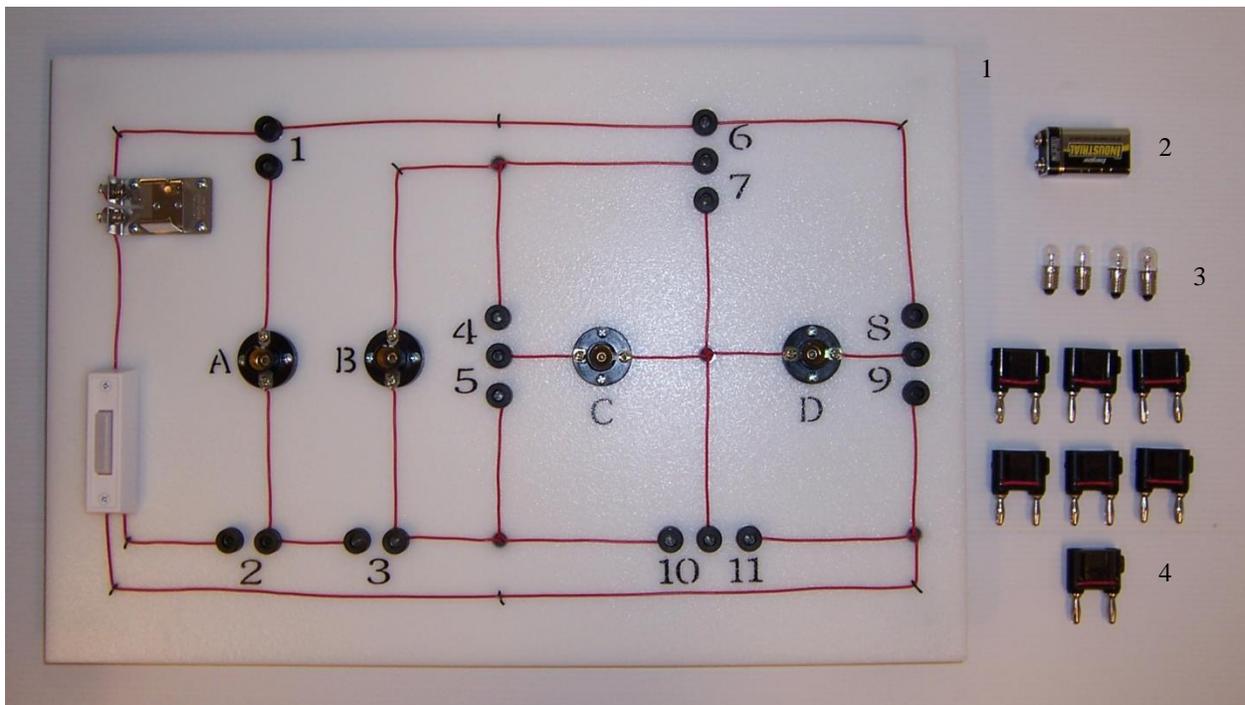


Photo ID	Quantity	Item
1	1	Foutan Board, compound
2	1	9V battery
3	4	Mini light bulbs
4	7	Connector plugs

FOUTAN BOARD CIRCUIT

The following diagram is a circuit diagram (Figure 1) for a study tool called the Foutan Board. You will need to become familiar with the traditional symbols from the diagram and the actual parts of the Foutan Board that you will be using in this lab.

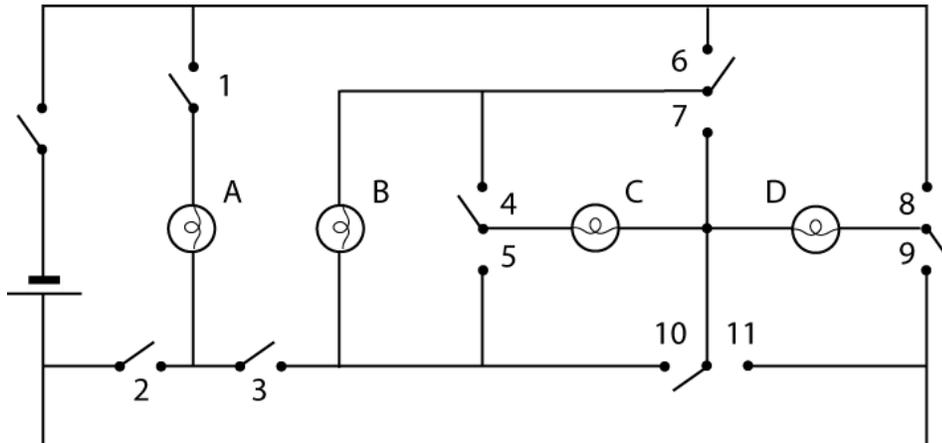


Figure 1: Foutan Circuit Board

To complete a circuit you will insert a banana connector in the two sockets adjacent to the numbered switch you wish to close (Figure 2). For the switches that have three sockets, you must choose which connection you need to make and cannot choose both (Figure 3).



Figure 2

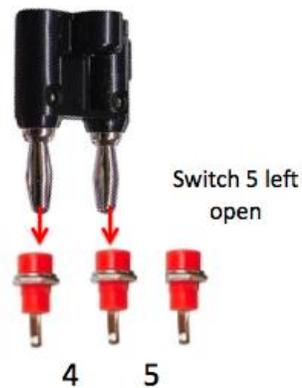


Figure 3

Below is a chart of 30 different bulb combinations that you will try to accomplish using the circuit board. Your challenge before you begin using the Foutan Board will be to predict which

switches you will need to close to construct the 30 circuits as described to achieve your desired results.

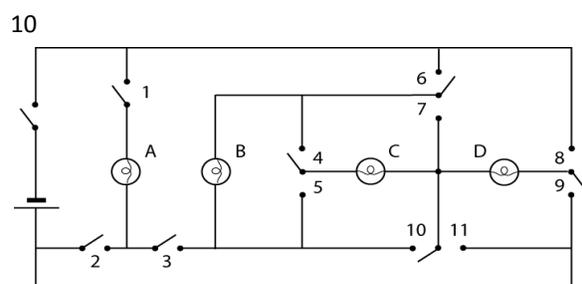
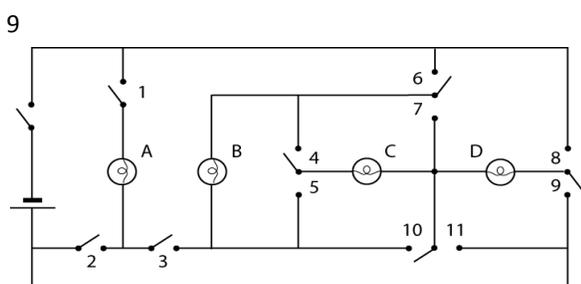
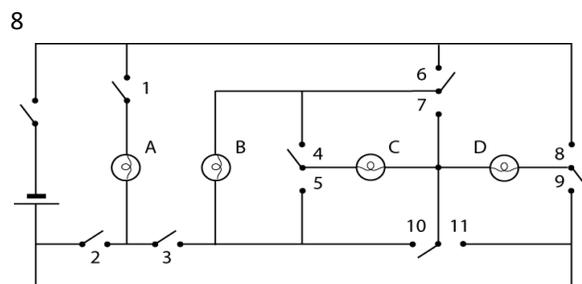
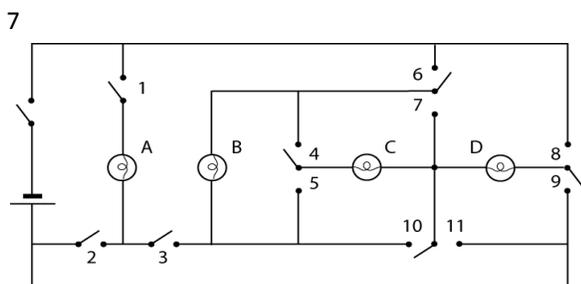
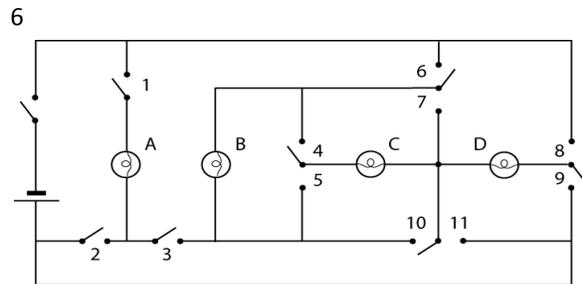
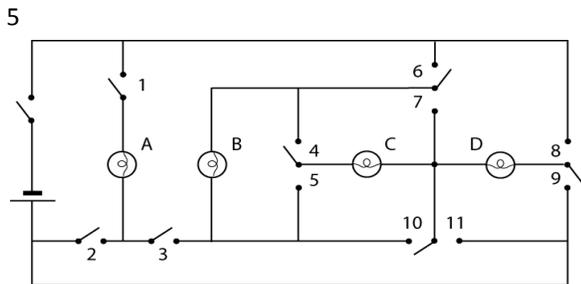
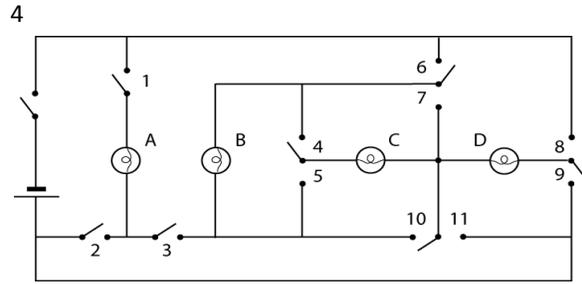
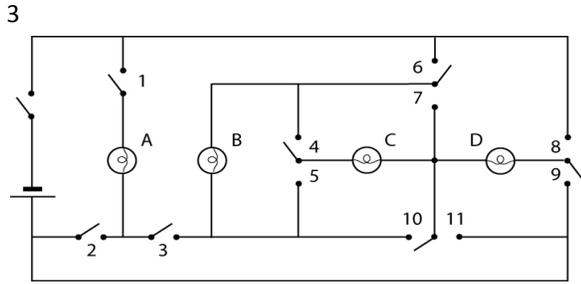
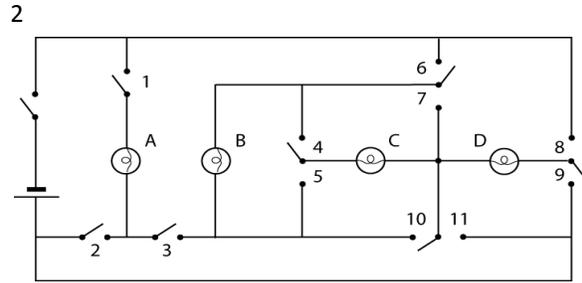
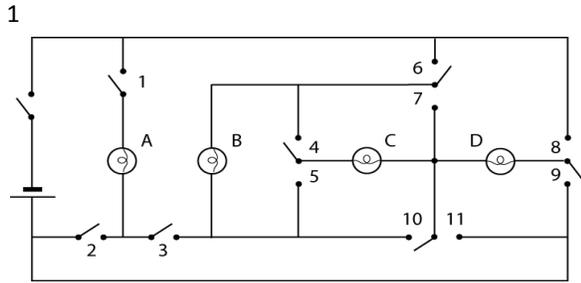
For each task, do the following:

- Check the switches you will close to accomplish the task and place an 'x' in the corresponding box.
- Outline the circuit on the numbered circuit board sheets or each task.

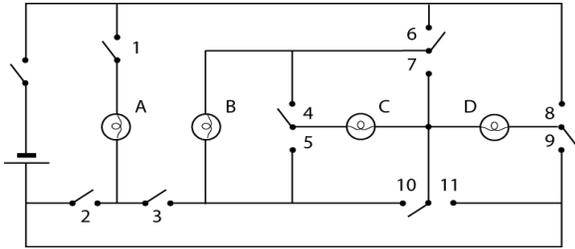
After you have completed these two (2) parts, check your predictions with the Foutan Board.
Review with your teacher how you can check for the series vs. parallel arrangements by removing certain bulbs.

- Using a colored pencil, fill-in the blocks for the correct switches for each of the 30 combinations so you can compare the actual result to your original predictions.

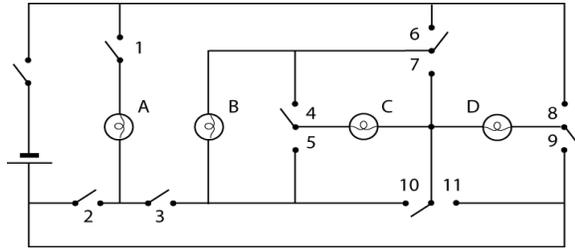
		Closed switches (Prediction)										
	Lighted bulbs	1	2	3	4	5	6	7	8	9	10	11
1	A only											
2	B only											
3	C only											
4	D only											
5	A & B in series											
6	A & C in series											
7	A & D in series											
8	B & C in series											
9	B & D in series											
10	C & D in series											
11	A & B in parallel											
12	A & C in parallel											
13	A & D in parallel											
14	B & C in parallel											
15	B & D in parallel											
16	C & D in parallel											
17	A, B, & C in parallel											
18	A, B, & C in series											
19	A, B, C, & D in parallel											
20	A, B, C, & D in series											
21	B, C, & D in parallel											
22	B, C, & D in series											
23	A, C, & D in parallel											
24	A, C, & D in series											
25	A, B, & C in series & D in parallel w/ them											
26	B & C in series & A in parallel w/ them											
27	A & B in parallel & C in series w/ them											
28	A, B, & C in parallel & D in series w/ them											
29	C & D in series w/A & B in parallel											
30	A & D in series w/ B & C in parallel											



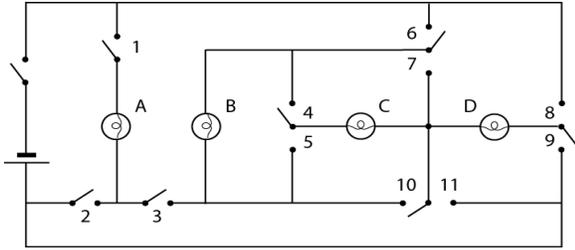
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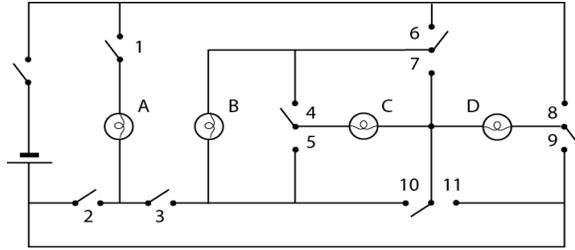
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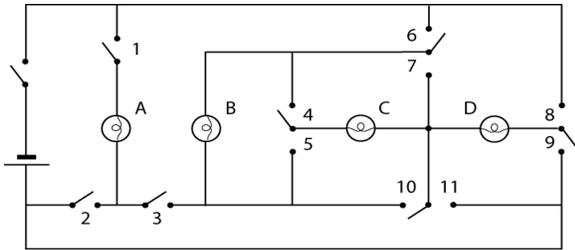
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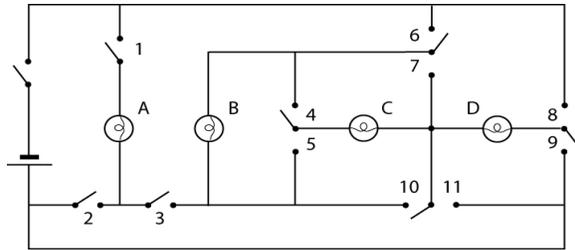
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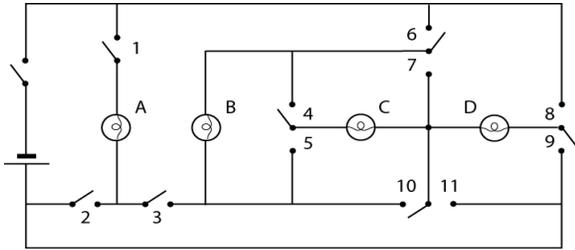
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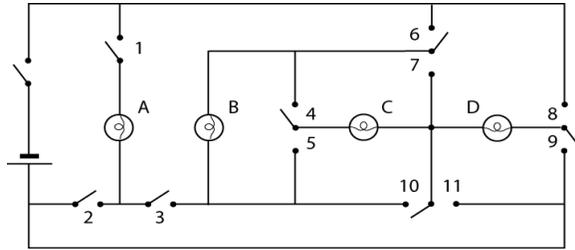
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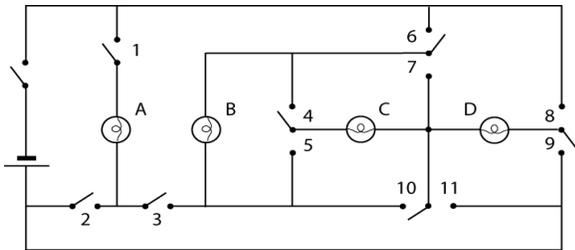
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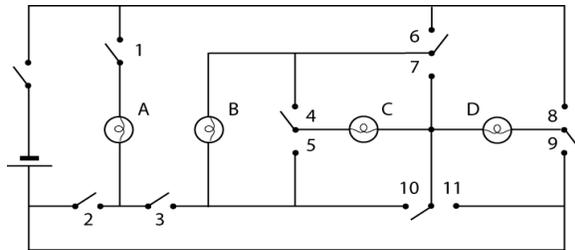
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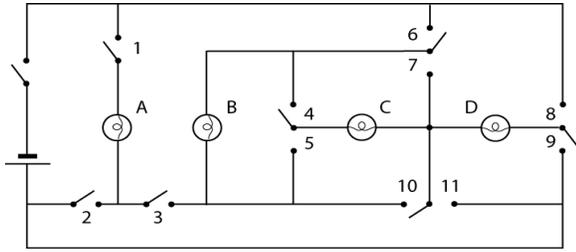
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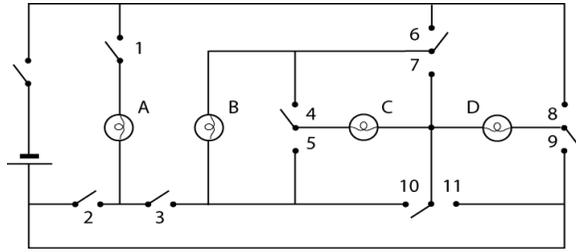
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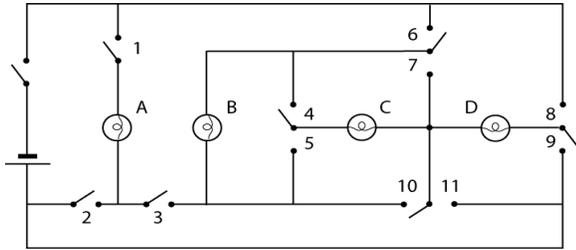
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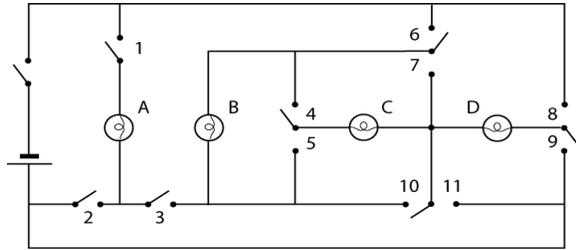
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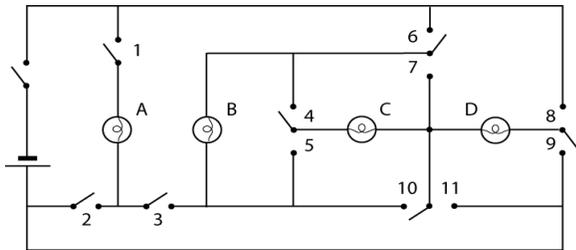
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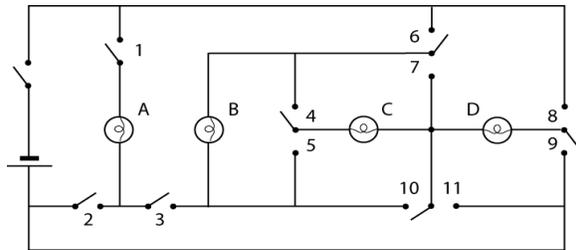
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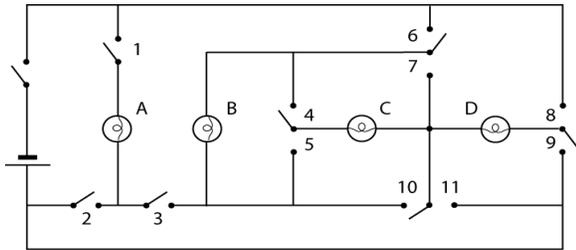
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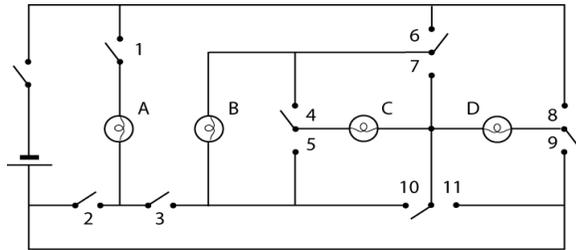
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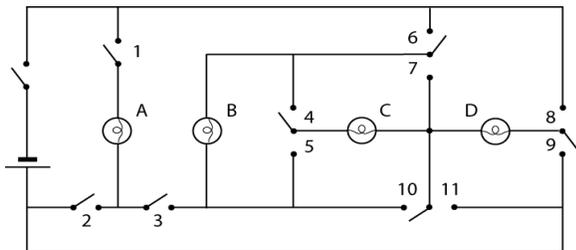
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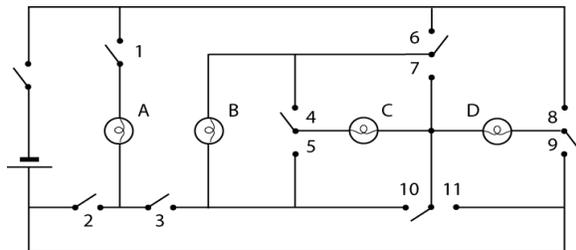
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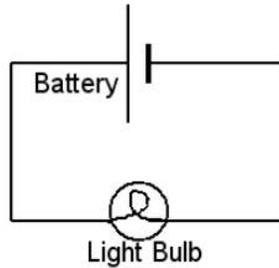


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Post-lab activity:

Recall that a schematic diagram uses symbols for batteries, switches, light bulbs, etc. to simplify or clarify drawing of electric and electronic circuits. Some examples of such symbols and a sample schematic diagram of a simple series circuit are provided here.



1. Draw a simplified schematic (not physical) circuit diagram for each of the following Foutan Board circuits.

<p>circuit #8 (lamps B & C in series)</p>	<p>circuit #17 (lamps A, B, & C in parallel)</p>
<p>circuit #25 (lamps A, B, & C in series and D in parallel with all of them)</p>	<p>circuit #26 (lamps B & C in series and A in parallel with all of them)</p>

circuit #29 (C & D in series and A & B in parallel)	circuit #30 (A & D in series and B & C in parallel)
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- How can you tell by looking whether two lamps are arranged in series? in parallel?
- How can you test whether two lamps are arranged in series? in parallel?
- When the correct switches are closed to create circuit #19 (lamps A, B, C, and D in parallel), all four lamps light up. What happens in the circuit if lamp B is unscrewed?

Use the reference table formulas below, to help answer the following questions.

Series Circuits	Parallel Circuits
$I = I_1 = I_2 = I_3 = \dots = I_n$	$I_T = I_1 + I_2 + I_3 + \dots + I_n$
$V_T = V_1 + V_2 + V_3 + \dots + V_n$	$V = V_1 = V_2 = V_3 = \dots = V_n$
$R_{eq} = R_1 + R_2 + R_3 + \dots + R_n$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$ $1/R_1 + 1/R_2 + 1/R_3 + \dots + 1/R_n$

- This is a little tricky: On some Foutan Boards, you can close the correct switches for circuit #20 (lamps A, B, C, and D in series), make no mistakes, and yet not see the lamps light. Why?

6. Assuming identical bulbs, describe the voltage, current, and brightness in each lamp in circuit #5 (lamps A & B in series) in general terms.
7. Assuming bulb 'A' has more resistance than bulb 'B', describe the voltage, current, and brightness in each lamp in circuit #5 in general terms.

Set up the parallel circuit #17 (lamps A, B, & C in parallel) and then use it as a guide in answering questions 8 – 10:

8. Assuming identical bulbs, describe the voltage, current, and brightness in each lamp in circuit #17 in general terms.
9. Assuming bulb 'A' has more resistance than bulb 'B' which has more resistance than bulb 'C', describe the voltage, current, and brightness in each lamp in circuit #5 in general terms.
10. What happens to the total current in this circuit when one lamp is removed? Explain why.
11. If you could add one more bulb to circuit #19 (creating a 5 bulbs in parallel circuit) describe at least 3 things that would change when the circuit is connected.

The Foutan Boards are wonderful teaching tools, but what do they DO? As we have throughout the course, let's consider a practical application of the concepts you have been mastering through this lab and others, your homework, in-class problem solving, etc. Let's see how strings of 'midgy' lights work.

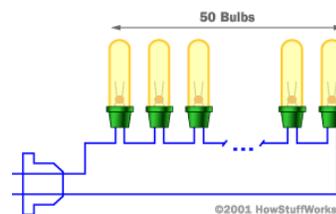
12. How could you determine if a string of lights is wired in **parallel**?

13. How could you determine if a string of lights is wired in *series*?

14. FACT: Holiday mini-lights clearly *look* like they are wired in *series*. However, if one of the lamps goes out...the rest stay lighted! How is this possible? It isn't obvious! Study the picture below and see if you can determine why this is possible. Really study it, discuss your thoughts with your lab partner, and record the key ideas here:



15. A typical strand of 50 mini-lights has lamps that are rated at 2.5V each. If a household circuit is 120V, why are the mini-lights wired in *series*? HINT: 48 would be a perfect number of mini-lights to wire in *series* for maximum effect. (Refer to the *Electricity* page on your Physics reference table.)



16. If I had a 250 light strand of mini-lights with 2.5V lamps and 50 lamps is about the maximum that can be wired in *series*, how could you wire the strand to make it work? (*Construct a circuit diagram to explain your answer.*)