



	Wire Diagram	Switch & Circuit Prototypes	The Light-House Build & Blueprint
Student Experience	<p>Students use circuit schematics to create a wire diagram for their house.</p> <p>Students must get diagram approved by "the city" (teacher) in order to get project materials.</p>	<p>Students receive essential project materials (listed below) and must build prototypes of their series and parallel lights circuits, including switches.</p> <p>They determine a way to power both prototyped circuits from the same voltage source.</p>	<p>Students design and build a functional model of their "dream house." Minimum requirements: 2 lights in series, 3 wired in parallel, and 1 stand-alone light, powered from a 9V battery with individual off and on switches.</p> <p>Students create design poster showing wire diagram and blue building blueprint.</p>
Material	--	<p>For each student:</p> <p>6 Christmas lights + wire</p> <p>3 paper clips</p> <p>6 brads</p> <p>Section of cardboard or foam core</p>	The cart
Big Idea	Diagrams allow engineers, architects, and contractors to analyze the performance of a circuit before building it.	The three "branches" of lights are in parallel with each other so they may operate independently.	<p>Engineering requires an planning, prototyping, and analysis.</p> <p>Blueprints are accurately-scaled diagrams of structures or machines.</p>
Connection to Culminating Activity	The approved circuit diagram will guide the wiring of lights, switches, and voltage source in the house.	The prototypes allow students to quickly test switches on their series and parallel circuits.	--
Time	One 55-min period	One 55-min period	Two 55-min periods, plus time (~1 week) for students to work on projects at home.

Physics –Electricity – The Light-House Project

CA Standards:

PH5. a.	Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
PH5. b.	Students know how to solve problems involving Ohm's law.
PH5. c.	Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula $\text{Power} = V \text{ (potential difference)} \times I \text{ (current)} = I^2R$.

These lessons are not intended to be a complete unit, but rather a learning activity guide for concept attainment. Teachers should supplement these lessons with appropriate reading material and problem sets.

The idea and student handouts for the Light-House project were generously shared by Bree Barnett Dreyfuss, who teaches physics at Amador Valley High School in California.



Lesson Plans for Light-House Culminating Project

Prior Knowledge:

- Students know the requirements for a circuit (closed, conducting loop & voltage source)
- Students can create circuits with resistors in parallel and series, and can describe how adding additional resistors affects the voltage, current, and effective resistance of that particular circuit configuration
- Students know and can apply Ohm's Law for circuits ($V = IR$)

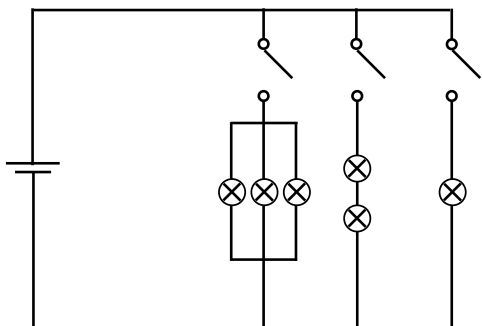
1. Wire Diagram

Objective: Students will create wire diagrams for their electric buildings.

Engage and Explore

1. Students are asked to respond these questions...
 - a. Do you think the electrical appliances in your house/apartment are in series or in parallel with each other? How do you know?
 - b. How do you think electricians know how to correctly install lights and electrical outlets in a building?
2. Teacher provides support (as needed) in guiding students towards creating the correct wire diagram for the electric building (One switch controls a single lamp, one switch controls two lamps in series, and one switch controls three lamps in series, with all three branches in parallel with each other, connected to a 9-V voltage source).
3. Students submit wire diagrams to "The City Inspector" (the teacher) for approval.

One representation of wiring (there are many different ways this can be drawn and still be correct):





2. Switch and Circuit Prototypes

Objective: Students will prototype series and parallel circuit sections and test switches.

Switch Prototype tutorial (Bree Barnett Dreyfus): <http://www.youtube.com/watch?v=o0MDBbH9eGk>

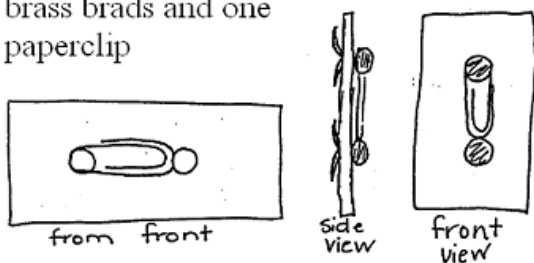
Explain

1. Show examples of circuit diagrams drawn by various students in the class (students will place circuit elements in different locations on their page, and the various branches of the circuit will be arranged differently from student to student), and ask whether these circuits are really the same, even though they don't look identical.
2. Have students create two non-identical looking diagrams of two lamps in parallel
 - a. Ask whether the physical wiring must match the exact "picture" of the wiring diagram, of whether the actual circuit may look slightly different and still function the same as the schematic.

Elaborate

3. Have students create and test the prototypes to ensure that the switches and lights function as intended.
4. Teacher should provide feedback to students as to whether the series and parallel light circuits are constructed correctly.

Switches made from 2
brass brads and one
paperclip





3. Light-House Build & Blueprint

Objective: Students construct light-houses according to circuit requirements, and create blueprints that accurately depict their buildings.

Evaluate

1. Have students brainstorm what they would have in their ultimate “dream house.” They can create a list of themes or desirable features to include. Students should sketch the layout of the structure and the rooms (doors, windows, stairs, etc.).
2. Students are given time in class to acquire materials from the T4T cart and explore potential uses for the various materials.
3. Students create full electric building model.
4. Students create design poster “selling” their house to the public, explaining the purpose of each room and the theme of the entire building. Design poster must include approved circuit diagram and floor plan, front elevation, and side elevation blueprints of the house.

*During all activities teacher serves as a facilitator of student learning (i.e. student centered instruction). Most tasks should be completed by students after simple directions, or facilitated questions to enhance student learning.

**Use of student handouts serves as guidelines for students.

Accommodations

All individual accommodations for students should be met with respect to your particular students and classroom dynamics and will vary from class to class and group to group. Facilitator should always differentiate instruction by providing the necessary blend of guidance and exploration for each student group and their specific needs.



Light-House Project

The idea and student handouts for the Light-House project were generously shared by Bree Barnett Dreyfuss, who teaches physics at Amador Valley High School in California.

Building a house requires several steps and lots of responsibility. You must (1) design your house, (2) get the plans approved by the city, (3) determine your materials for construction and actually construct it. After your building is completed (4) a building inspector must approve of its construction and (5) a real estate agent will evaluate its design to prepare it for sale. Each step has specifics that you will have to meet in order to move on to the next step and earn full points. For this project, you will construct and wire a model building according to the requirements below. *Most materials are available from your teacher and excess should be returned.*

1. Building Design

Design your building with any school appropriate theme and in any way you like, *as long as it meets these minimum criteria:*

- Your building must have *at least* two rooms (or definitive spaces) connected by a doorway or passage and an outdoor space with a light.
- Your building must be *at least* 4" x 6" x 1' (close to the size of a shoebox)
- Your building must have the following circuits in these separate spaces:
 1. *A series circuit room:* two lights in series with a switch in one room
 2. *A parallel circuit room:* three lights in parallel with a switch in one room
 3. *A single outside light* with a separate switch

2. Approval of Building Plans (Circuit Diagram)

You must provide one diagram for the complete circuit in your building (all rooms). It must:

- be labeled and be complete including all electrical components for each circuit using accurate circuit symbols learned in class.
- be neat & drawn with a straight edge ruler and fill an entire piece of 8.5"x11" paper.

When your design is submitted to the City it will either be **approved or denied**. If it is denied, meaning it was not made correctly, you must **resubmit your design** *before* you begin construction. The City will use the following form to approve or deny the design:

The building plan (circuit schematic) must clearly show one room with two lights in series, one room with three lights in parallel and an independent outside light all operating from a single 9 V battery using three independent switches.		
Date submitted:	<input type="checkbox"/> Denied	<input type="checkbox"/> Approved
Resubmitted on:	<input type="checkbox"/> Denied	<input type="checkbox"/> Approved

3. Construction Phase

Upon approval of your building plan (circuit diagram) by the City (your teacher) you may begin the actual construction of your building. Structural materials can include but are not limited to: cardboard, foamboard, shoeboxes, etc. To earn *full credit*, each circuit mentioned above must be present and working in class when attached to a single 9V battery (or power supply set to 9V). How you construct your building is up to you as long as it still meets the requirements. There will be a few open build workshops after school if you need help. The following are building suggestions:

- Switches can be made from brads and paper clips.
- Your house will be powered by a 9V battery so make an obvious **two leads** to attach your battery to during testing if you do not supply your own battery.
- Each circuit must be able to work independently from the other but must all be able to be on at the same time *without moving the battery*.
- Insulated wire and lights from holiday lights will be provided.



4. Building Inspection

After your building is submitted, a Building Inspector will use the following checklist to make sure you have met all of the requirements. If your building fails to meet any of these inspection points you will have to pay a fine (a point deduction). In order for the Building Inspector to evaluate your construction, you must first conduct your own inspection and write a paragraph addressing the following requirements.

	Check	Fine
Series and parallel circuits work independently <i>Battery does not have to be moved</i>		-10pts
There is a switch in each room		-10 pts
One room has two lights in series wired correctly		-10 pts
One room has three lights in parallel wired correctly		-10 pts
One outside light works independently and is wired correctly		-10 pts
The house is at least 4" x 6" x 1' (close to the size of a shoebox)		-10 pts

5. Design Evaluation

Every building that is built must be sold in order to turn a profit. Decorating your building can help to insure a quick sale (and full points). Your building is to be decorated neatly, with care and:

- should reflect the purpose of the rooms (i.e. a refrigerator should not be in a bedroom)
- all inside surfaces of your building (walls, floors, etc.) must be covered or colored. Cardboard brown is *not* an appropriate design choice.
- some kind of 3D objects (tables, chairs, beds, etc) must be present in each room. Pictures of furniture is *not* 3D furniture.
- *you may not use premade furniture, toys, people, Legos, etc. Everything must be made for this project.* Suitable materials for furniture include origami, wood, modeling clay, plastic, etc.

In order to determine the design appeal of your building to help prepare it for sale, the real estate agent will use this rubric for evaluation:

Area evaluated:	Description		
<i>Décor</i>	The rooms are well decorated and it is obvious that care was taken to do so. The rooms have an obvious purpose. (10)	There has been some effort made to decorate but the result is not clean or care was not taken. The purpose of the rooms is slightly unclear. (5)	The rooms are sloppily or undecorated. The purpose is not clear. (1)
<i>Furniture & Structure</i>	The furniture appears to be well built and the structure of the building seems solid. (10)	The furniture is questionable or the structure seems of lower quality. (5)	The furniture appears poorly made or unsafe. The buildings structure appears poorly made or unsafe. (1)
<i>Blueprint</i>	The blueprints include a front elevation, side elevation, and floor plan. The drawing is neat, correctly scaled, and clearly labeled. (10)	One of the three required blueprints is missing or done incorrectly. The drawing is slightly messy, missing some labels, or incorrectly scaled (5)	Only one of the required blueprints was done correctly. The drawing is messy and most labels are missing. (1)

Point Value

Your building project will be worth a total of **100 points**. Each aspect of the process that is checked by the City, Building Inspector or Real Estate Agent will be worth points:

- Building Plans (circuit diagram) completed: **10 points**
- Building Inspection passed: **60 points** - any points in inspection fees
- Design Evaluation score: **30 points**



Light-House Project Rubric

Name: _____ Period: _____

1. Approval of Building Plans (Circuit Diagram)

The building plan (circuit schematic) must clearly show one room with two lights in series, one room with three lights in parallel and an independent outside light all operating from a single 9 V battery using three independent switches. (10 pts)

Date submitted:	<input type="checkbox"/> Denied	<input type="checkbox"/> Approved
Resubmitted on:	<input type="checkbox"/> Denied	<input type="checkbox"/> Approved

2. Building Inspection: If your building fails to meet any of these inspection points you will have to pay a fine (a point deduction):

	Check	Fine
Series and parallel circuits work independently; <i>Battery does not have to be moved</i>		-10 pts
There is a switch in each room		-10 pts
One room has two lights in series wired correctly		-10 pts
One room has three lights in parallel wired correctly		-10 pts
One outside light works independently and is wired correctly		-10 pts
The house is at least 4" x 6" x 1' (close to the size of a shoebox)		-10 pts

3. Design Evaluation: In order to determine the design appeal of your building to help prepare it for sale, the real estate agent will use this rubric for evaluation:

Area evaluated:	Description		
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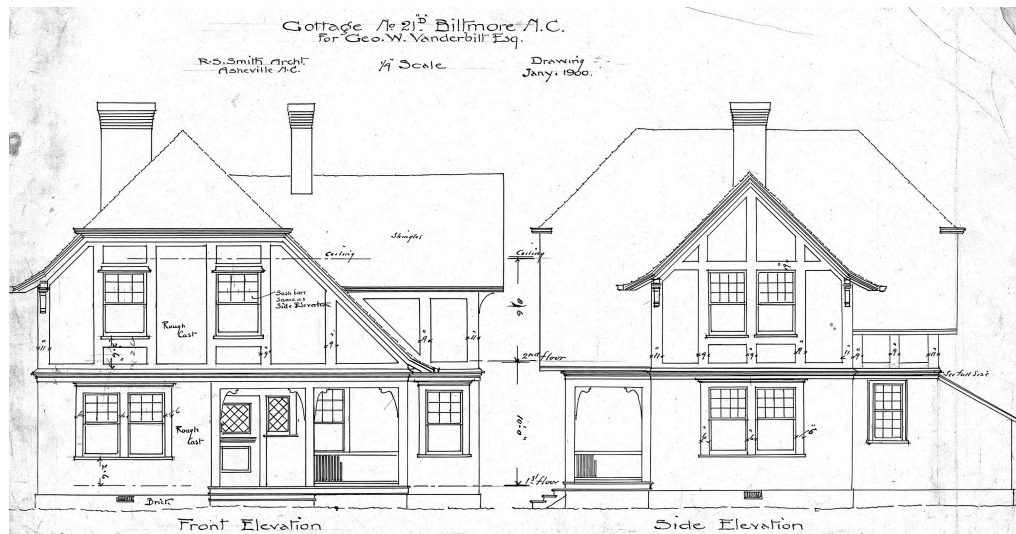
Final Point Value (score):

Building Plans (circuit diagram) completed: _____/10 points
 Building Inspection passed - any points in inspection fees: _____/ 60 points
 Design Evaluation score: _____/ 30 points
TOTAL value: _____/100 points



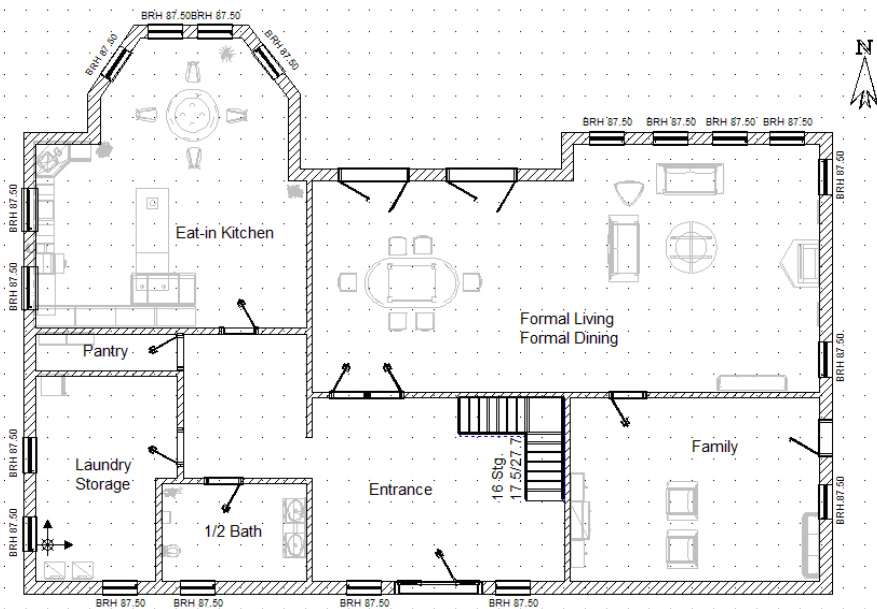
Blue Prints

Elevation: a view of a building seen from side, a flat representation of façade. This is the common view to describe the external appearance of a building.



of a
one

one
most
used



Floor plan: the most fundamental architectural diagram, a view from above showing the arrangement of spaces in building in the same way as a map, but showing the arrangement at a particular level of a building. Technically it is a horizontal section cut through a building, showing walls, windows and door openings and other features at that level. The plan view includes anything that could be seen below that level: the floor, stairs (but only up to the plan level), fittings and furniture.

Scale: Since an architectural drawing must fit on a piece of paper, you must scale down the actual dimensions of the building when you draw the blueprint. For example, if the height of your building is 12", but you need to fit it within an 8" space on your paper, you would use a scale of 2:3. This means that every 2" on your page actually represents 3" of your actual building. The scale is typically expressed as a ratio (e.g. 2:3) or as a fraction (e.g. 2/3), and should be displayed on your page.

Check for understanding: if your drawing scale is 1:2 and the width of a window in your building is 2.8", then what should be the width of the window as drawn on your page?