



Unit 2: Electrical Circuits

This unit will take approximately 4-5 weeks. The pace is always determined by the ability of your students. Some areas can be skipped or used as enrichment, while other areas include more challenges to those more advanced students.

This timeline is based on 55-minute periods.

Outline	Teacher Notes:
<p>Day 1 Today's Objective: This introduces a context for learning electrical circuits. Activity: Framing Questions – White board Due: None</p>	<p>Whiteboard Framing Questions, but don't spend a lot of time. You want students to begin thinking about circuits. Make sure to look at the page, Student Misconceptions.</p>
<p>Day 2 Today's Objective: To determine how adding resistors in a series circuit affect the current. Activity: Whiteboard the Pre-Lab Discussion Lab: Current in Series Circuits Lab Due: None</p>	<p>This is a full hour lab. You will have to introduce the lab, then show students how to "interrupt" the circuit in order to measure current. If you are using holiday lights, the 10A setting works the best. Be sure to put the probe into the 10A hole at the bottom of the multimeter. Be sure to read the Teacher Guide for information about fuses and safety features.</p>
<p>Day 3 Today's Objective: To plot current through a circuit on a current vs. position graph. Activity: Begin Student Summary Page Practice 2.1 Comparing Currents in Circuits Due: Current in Series Circuits Lab</p>	<p>Start with reviewing the Lab Show the Reading Page: Current in Series Circuits. This is a very informative resource that includes information about circuit breakers and electron flow through the wires of a series circuit. Finish with filling out the Student Summary Page: Comparing Two Circuits.</p>
<p>Day 4 Today's Objective: To find and calculate the total resistance in a series circuit. Lab: Resistance in Series Circuit Lab Practice 2.2 Circuit Challenge Due: Practice 2.1</p>	<p>Start with a quick review of their Practice 2.1. Review problem 4 in class, but there isn't a need to whiteboard this assignment. Begin with the Pre-Lab Discussion, and immediately move to showing students how to measure resistance using the multimeter. Numbers will fluctuate unless you use an alligator clipped to both the meter probe and the resistor. After completing the lab, discuss their results and that resistors in series combine by addition.</p>
<p>Time constraints due to lab length may alter the weekly quiz this week.</p>	<p>It is also important to note that the math in the next few labs is not difficult, but should be evaluated by the teacher before assigning the</p>



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	problems to the students.
<p>Day 5 Today's Objective: To test the factors that can affect the amount of resistance in an electrical device. Activity: Whiteboard Pre-Lab Discussion Lab: What Causes Resistance? Lab Part 1 Due: Practice 2.2</p>	<p>Quickly review the Practice 2.2 in class. The Pre-Lab discussion is key. Whiteboard the Pre-Lab Discussion and generate a list of factors that might affect resistance. Including predictions if the relationship is direct or inverse. Next, design an experiment that will test these factors, starting with type of material. You will only get through Part 1 of this lab in class.</p>
<p>Day 6 Today's Objective: To predict and test wire diameter and identify how it affects resistance. Lab: What Causes Resistance? Lab Part 2</p>	<p>Quickly review what students learned from the previous lab. Today's lab is similar to the previous lab activity and should not be difficult for students to follow. This should lead to the discussion of the variables that affect resistance and practical applications. Electrical Circuits Quiz #1. Use the Labs and Practice pages to generate questions on current and resistance (conceptual).</p>
<p>There is an option to adapt the curriculum here. If you are looking to save time, or not get into the math, you can just use the conceptual concepts generated by the labs. If you want to assign Practice problems, look at problems 7, 8 and 9 and ask, "Which one will have more resistance?" If this is the case, move on to Day 8.</p>	<p>Review Quiz #1. If you have a strong class, and want to challenge them, take them through the formula for calculating resistance. The Reading pages have lots of examples of this. If this is the case, continue with Day 7.</p>
<p>Day 7 Today's Objective: Using rho, length and cross sectional area to find the resistance in a wire. Activity: Review the Reading Page: Resistance Practice 2.3 Calculating Resistance Due: What Causes Resistance Lab?</p>	<p>Review Part 1 and 2 of the lab and show how this leads to the formula $R = \frac{\rho L}{A}$. Show the examples found in the Reading Page: Resistance. Have the students work through some of these on their own. You might do some of the problems from the Practice: 2.3 in class.</p>
<p>Day 8 Today's Objective: To measure the voltage across a resistor and draw conclusions on how multiple resistors in series affect the voltage. Activity: Have students whiteboard different parts of the lab. Lab: Voltage in Series Circuit Lab Due: Practice 2.3</p>	<p>Start with the Pre-Lab Discussion and show students how to measure the voltage across a resistor. If you use holiday bulbs, the resistance may vary a little bit between bulbs. Have students discuss similarities in their responses to the lab questions. Return to the Student Summary Page and summarize their findings.</p>
<p>Day 9</p>	<p>Review Voltage in Series Circuit Lab.</p>



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<p>Today's Objective: To construct a mathematical relationship between current voltage and resistance. Lab: Connecting Voltage, Current and Resistance Lab Due: Voltage in Series Circuit Lab</p>	<p>Go through the Reading Page: What is Voltage? Identify the difference between current and voltage. At the end of the lab students will need to be able to calculate slope, so you may have to review this procedure. Students will derive $R = \frac{V}{I}$, then can rearrange the equation to derive Ohm's Law.</p>
<p>Day 10 Today's Objective: To apply Ohm's Law to a circuit and calculate voltage, current and resistance when the other two quantities are given. Activity: Class discussion and whiteboarding Practice 2.4 Ohm's Law Problems. Due: Connecting V, I and R Lab</p>	<p>Review the previous days lab and follow with the Reading Page: Ohm's Law. As a class, assign students some of the problems from Practice 2.4. Be sure to do some of the problems from Part 3 in class. Assign the rest as homework.</p>
<p>Day 11 Today's Objective: To review Ohm's Law Activity: Whiteboarding and working problems in class (Practice 2.5) Practice 2.5 Series Circuits and Graph Problems Due: Practice 2.4</p>	<p>Whiteboard the 2.4 Practice problems. This is a good time to assess what they have learned about for Ohm's Law and Resistance. Quiz #2. If students are still struggling, assign the Reading Page: Ohm's Law and Series Circuits. Perform some of the Practice 2.5 in class if there is time.</p>
<p>Here is an opportunity to skip some of the content. If the students are picking up on the calculations, just pick a few problems from the Practice 2.6 and assign them in class.</p>	<p>Review Quiz #2. If students are struggling with some of the content, Assign pages 1-4 of the Practice Page 2.6. Pages 5 and 6 are additional problems that you may assign or can use as assessment questions.</p>
<p>Day 12 Today's Objective: To construct pictorial, mathematical and graphical representations of a series circuit. Activity: Whiteboard practice 2.5 Practice 2.6 Ohm's Law for Series Circuits Due: Practice 2.5</p>	<p>Whiteboard the Practice 2.5 in class. Evaluate the students and decide on the depth of content you expect. Assign problems from Practice 2.6 accordingly.</p>
<p>At this point, you may decide that you don't want to delve into parallel circuits. We recommend that you show students some of the differences between a series and a parallel circuit.</p>	<p>Performing the Parallel Circuit Lab will identify some of those differences, and can lead to valuable discussions as to their importance, the wiring of your house for example.</p>
<p>Day 13</p>	<p>Whiteboard the assigned problems from the homework 2.6. At the</p>



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<p>Today's Objective: To review current, voltage and resistance in a series circuit.</p> <p>Activity: Whiteboard Practice 2.6</p> <p>Due: Practice 2.6</p>	<p>end of class, have students fill out their Student Summary Page: Comparing Series and Parallel Circuits.</p>
<p>Day 14</p> <p>Today's Objective: To construct a parallel circuit and compare and contrast them to a series circuit.</p> <p>Lab: Parallel Circuit Lab</p>	<p>Have students complete the Parallel Circuit Lab, and use a class discussion for the Pre-Lab, but whiteboard the Post-Lab discussion answers. Provide a lot of practical applications for what they have learned.</p>
<p>Day 15</p> <p>Today's Objective: To design and construct a circuit that will produce bulbs with different brightness.</p> <p>Activity: Practice 2.7</p> <p>Due: Parallel Circuit Lab</p>	<p>Start with the Student Summary Page: Comparing Series and Parallel Circuits. Review some of the discussion from the previous day. Do the Practice 2.7 in class. Have students use materials to provide evidence that they have a correct answer. Whiteboard their answers in class keeping in mind, that there may be multiple correct answers for some of the problems.</p> <p>This also might be a good time to assess students on the similarities and differences between series and parallel circuits. Quiz #3.</p>
<p>Day 16</p> <p>Today's Objective: To measure current as it travels through the branches of a parallel circuit.</p> <p>Lab: Current in a Parallel Circuit Lab</p>	<p>Review Quiz #3.</p> <p>Have students do the Pre-Lab Discussion and then discuss as a class. After students have completed the Post-Lab, have students discuss or whiteboard the big ideas.</p> <p>Return to Student Summary Page – Comparing Series and Parallel Circuits and add to their list.</p>
<p>Day 17</p> <p>Today's Objective: To identify how multiple devices in parallel can affect the current in a circuit.</p> <p>Activity: Discuss Reading Pages</p> <p>Practice 2.8 Series and Parallel Circuits</p> <p>Due: Current in a Parallel Circuit Lab</p>	<p>Start with the Reading Page: Parallel Circuits. This can be useful in understanding why breakers blow when they use too many electrical devices on one circuit. The <i>PhET</i> simulation is a good tool to use here.</p> <p>From the Practice 2.8, do problems 1,4 and 6 in class and assign the rest as homework.</p>
<p>Day 18</p> <p>Today's Objective: To identify how bulb brightness and current are different between series and parallel circuits. To also be able to identify short circuits.</p> <p>Activity: Whiteboard Practice 2.8, Start on Practice 2.9</p>	<p>Whiteboard Practice 2.8</p> <p>Practice 2.9 is a review of everything they've learned so far. Perform some of these in class, and assign other problems for homework. Use the teacher guide to identify similar problems.</p>



Outline	Teacher Notes:
<p>Practice 2.9 Ohm's Law and Parallel Circuits Due: Practice 2.8</p>	
<p>Day 19 Today's Objective: To apply Ohm's Law to common electrical devices found in a home wired in both series and parallel. Activity: Whiteboard Practice 2.9 Due: Practice 2.9</p>	<p>Whiteboard assigned problems from Practice 2.9. The next two sections cover batteries in series and parallel and Electrical Power. Before you move on, it would be good to assess your students' knowledge. Quiz #4</p>
<p>At this point you may decide to skip series and parallel batteries all together. If you decide to continue with series and parallel batteries, continue with Day 20. If you decide to continue with resistance in parallel circuits, continue on Day 21. If you want to skip resistance in parallel circuits but continue with mixed circuits, continue on Day 22.</p>	<p>If you want to cover Electrical Power and Energy, continue on to Day 23. If you decide to skip Electrical Power, then you are finished and you might spend a little time reviewing everything you've covered before providing a unit assessment.</p>
<p>Day 20 Today's Objective: To compare and contrast voltage as provided by two batteries that are connected in series and/or parallel. Lab: Batteries in Series and Parallel Lab Practice 2.10 Arranging Batteries</p>	<p>Have students do the Pre-Lab, but before they begin, have a class discussion about their answers. All of them have seen batteries hooked together in series, but not in parallel. This can be done as a teacher demo, or using the PhET website. If there is time in class, show the videos from the Reading Page: Batteries in Series and Parallel. If not, assign this reading for students to do at home.</p>
<p>Day 21 Today's Objective: To identify how the total resistance in a parallel circuit compares to that of a series circuit. Lab: Resistance in a Parallel Circuit Lab Practice 2.11 Resistance in Parallel Circuits Due: Batteries in Series and Parallel Lab and Practice 2.10</p>	<p>This activity is optional and can be done either qualitatively or quantitatively. The math skills of your students will dictate how you proceed. If you do this quantitatively, continue with the Reading Page: The Resistance of a Parallel Circuit, and assign the Practice 2.11 as homework. You do a couple of these problems in class. If not, continue to Day 23.</p>
<p>Day 22 Today's Objective: To analyze mixed series / parallel circuits, and explain the brightness of the bulbs in the circuits. Lab: Name That Circuit – Application Lab Due: Practice 2.11 (If assigned)</p>	<p>Again, this activity is optional. Have students in their groups discuss problems 1-3, then stop them from continuing until after a class discussion. Then have students complete the rest in class.</p>
<p>Day 23</p>	<p>Review Name that Circuit - Application Lab by either discussion, or</p>



Suggested timeline for instruction-- Unit 2. Electrical Circuits

Outline	Teacher Notes:
<p>Today's Objective: To explain how voltage and current are related to power, and how power and time are related to energy.</p> <p>Lab: Electrical Power Lab</p> <p>Practice 2.12 Power and Energy Problems</p> <p>Due: Name that Circuit – Application Lab</p>	<p>whiteboarding.</p> <p>Start the Pre-Lab Discussion, but stop after problem 3. Steer the students into a discussion that derives $\text{Power} = \text{voltage} \times \text{current}$. You may use the Reading Page: Power and Energy to assist.</p> <p>Do some of the Practice 2.12 in class. Suggesting problems; 1, 4, 6, and 8.</p>
<p>Day 24</p> <p>Today's Objective: To determine how circuits are constructed inside interesting devices.</p> <p>Activity: Whiteboard Practice 2.12</p> <p>Lab: Electrical Widgets Application Lab</p> <p>Due: Practice 2.12</p>	<p>Whiteboard Practice 2.12</p> <p>Optional: As a class, go through the Reading Page: Direct and Alternating Current. Provide as many different “odd” widgets as you can find for the “Electrical Widgets Application Lab. There are 2 examples provided. Swinging LED and Energy Ball</p>
<p>Day 25</p> <p>Today's Objective: Unit 2 Test. Electrical Circuits</p>	<p>Review Electrical Circuits Unit.</p> <p>Unit 2 Assessment</p>