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| **TEXAS CTE LESSON PLAN**[www.txcte.org](http://www.txcte.org) |
| **Lesson Identification and TEKS Addressed** |
| **Career Cluster** | Science, Technology, Engineering & Mathematics |
| **Course Name** | AC/DC Electronics |
| **Lesson/Unit Title** | Resistance (Resistors): Understanding Color Codes |
| **TEKS Student Expectations** | **130.405. (c) Knowledge and Skills**(7)The student develops an understanding of basic alternating current (AC) electricity principles. (D)The student is expected to identify the purpose and application of a transformer(8)The student implements the concepts and skills that form the technical knowledge of electronics using project-based assessments. (C)The student is expected to demonstrate an understanding of magnetism and induction as they relate to electronic circuits(D) The student is expected to perform electrical-electronic troubleshooting assignments |
| **Basic Direct Teach Lesson**(Includes Special Education Modifications/Accommodations and one English Language Proficiency Standards (ELPS) Strategy) |
| **Instructional Objectives** | * Define resistance
* Interpret resistor color codes
* Demonstrate how to use the color code chart for resistors
* Read the value and tolerance of a resistor using the color code chart
* Explain tolerance
* List the factors affecting resistance
* Apply Ohm's Law
* Analyze the relationship between resistance, voltage, and current
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| **Rationale** | The students will be able to explain resistance and tolerance. Students will also show they are able to interpret the resistor color codes to determine the resistance and tolerance of a given resistor |
| **Duration of Lesson** | Teacher’s Discretion |
| **Word Wall/Key Vocabulary***(ELPS c1a,c,f; c2b; c3a,b,d; c4c; c5b) PDAS II(5)* | * Resistors
* Resistance
* Carbon composition
* Voltage
* Current
* Breadboard
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| **Materials/Specialized Equipment Needed** | **Instructional Aids*** *Resistors Color Code* handout
* *Resistance Value and Tolerance Range* handout
* *Resistance Value and Tolerance Range Answer Key*
* *Resistors Color Code Activity* handout
* *Resistors Color Code Activity Answer Key*
* *Resistors Exam*
* *Resistors Exam Key*

**Materials Needed*** Assortment of different values of resistors and breadboards (one per student).
* Multimeter and leads
* Resistor 470W
* Resistor 1.0KW
* Resistor 1.5KW
* Resistor 1.0MW
* Breadboard
* Breadboard wire pack (pre-trimmed wires for making connections on the breadboard)
* 6V battery pack (includes 4 – “AA” batteries)

**Equipment Needed*** Computer and projection unit
* Color printer for handouts and quiz
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| **Anticipatory Set**(May include pre-assessment for prior knowledge) | The student should be able to see different shades of colors.**Ask:** What does the word resistance mean?**Say:** Resistance is the opposition to current flow. The symbol is the letter R, and the unit is measured in ohms (symbol ).**Ask:** What is a resistor?**Say:** The resistor is used to create desirable voltage drops and limit current values in electronic circuitry. |
| **Direct Instruction \*** | 1. Basic Definitions

**NOTE:** Begin Resistance: Using the Resistor Color Code. * 1. Resistors are components used in electronic equipment.
	2. They resist or limit the flow of current.
	3. The common carbon composition resistors are all brown with wire leads coming out of each end.
	4. On the outside they all look alike. Inside they may be 10 ohms or 10 mega ohms
	5. The color bands on the outside tell the value on the inside
	6. Resistors are a linear device
1. Resistor Types Overview
	1. The two basic types of resistors are fixed and variable.
	2. Fixed resistor values are nearly constant, or constant within a defined tolerance range.
	3. When actual resistance value is outside the tolerance range, the resistor is “bad” and needs to be replaced.
	4. Variable resistors are designed to have an adjustable value.
	5. The adjustment varies the controlled value of voltage or current, similar to a volume control.
2. Symbols and Characteristics
	1. A fixed resistor has a zigzag line symbol.
	2. A variable resistor has an arrow through (or pointing toward) the zigzag line.
	3. Note that a real resistor looks like a tube or a cylinder.
	4. Show pictures and examples of actual resistors.
	5. Note that the size of the resistor has nothing to do with resistance value.
	6. Resistance itself is represented by the letter R, but the unit of resistance has its own name, Ohm (symbol is Ω).
3. Resistor Color Code Chart
	1. Resistors typically come in a standard package that looks like a tube or a cylinder, with leads sticking out each end.
	2. An internal mixture of carbon and filler determines the actual resistance amount, but you cannot tell the resistance value from the size or shape of the package itself.
	3. Color bands that encircle the entire resistor package indicate the resistance.
	4. The bands can be read regardless of the way the resistor is placed in the circuit.
	5. Each color represents a number.
	6. The placement of the bands indicate whether the number is part of the numerical value, or a multiplier, or a tolerance.
	7. Students need to know this resistor color code; the easiest way to memorize it is to use a mnemonic aid.
	8. Wikipedia also has a good color code chart and description: http://en.wikipedia.org/wiki/Resistor\_color\_code
4. Identifying and Reading the Color Bands
	1. Notice the color bands are not in the center of the resistor.
	2. There are two common methods used to identify the first band.
	3. The first method is to have a small gap between bands.
	4. The other method is to have the bands start close to one end of the resistor.
	5. The band closest to the end is band one.
	6. The value is read from a group of bands (typically three bands); then after the small gap is the single tolerance band.
	7. Resistor manufacturers will use one method or the other (but not both).
	8. On some resistors, there is a fifth band. This band can be another value band for a more accurate resistance value or an indication of the failure rate (required for military use).
5. Understanding Resistor Color Codes (Distribute the Resistors Color Code handout and have students work in pairs to complete.)
	1. The only way to learn the color code is to practice reading them from examples.
	2. Start with examples, but also have students look at pictures of real resistors.
	3. The best practice is to have a variety of real resistors students can see and touch.
	4. Students must be able to identify the first color band, and then apply the resistor color code to determine resistor value.
	5. Pictures can be shown reversed. Therefore, we use pictures and not words to have students practice applying the color code.
6. Resistor Tolerance (Distribute the Resistance Value and Tolerance Range handout and have students complete the handout before moving to resistor measurement.)
	1. Resistor tolerance has been mentioned several times in this lesson because it is an important concept that is also confusing.
	2. Tolerance is the range of values a resistor may have and still be a good resistor.
	3. A resistor marked 100,000 ohms with a tolerance of 20 percent can vary from that value by 20,000 ohms. (100,000 x 0.2) With an ohm meter, the resistor measuring between 80,000 ohms and 120,000 ohms is still good.
	4. Tolerance is one reason the ohmmeter measures resistance other than what is marked on the resistor. The tighter the tolerance, the closer the resistor is to the value marked on the resistor.
7. Resistor Measurement
	1. Actual resistance value of a resistor must be measured with a multimeter (or ohmmeter).
	2. The measured value is often different from the indicated value (the indicated value is from the color code).
	3. If the measured value is within the tolerance range of the resistor, the resistor is still good.
	4. Students should practice measuring resistance values not only to see how resistance values can differ from indicated value but also to gain experience with using a meter.
	5. Print or have students create a chart to compare actual measurement to indicated value using whatever resistors you have on hand.
8. Resistor Size vs. Resistor Resistance Value (Distribute and have students take the *Resistors Exam*. Grade exam using answer key)
	1. Resistance value depends on the amount of carbon mixed in with filler when the resistor is manufactured.
	2. The carbon mixture values do not affect the size or shape of the resistor.
	3. Heat is generated in the resistor as it consumes power in the process of restricting or limiting current.
	4. The more power a device consumes, the hotter it gets.
	5. At some point, as the temperature rises, the device will burn up.
	6. A larger surface area means the device will give off more heat, meaning it will stay cooler for a given amount of heat.
	7. This heat formula can be used for a variety of calculations at the teacher’s discretion, but is used here only to illustrate the relationship between heat and temperature.
	8. Have students take the Resistors Exam
9. Team Challenge
	1. The team challenge involves building a circuit using resistors on a breadboard and then measuring electrical values.
	2. This can be an extension/enrichment activity depending on the lab supplies available.

*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*none |
| **Guided Practice \*** | * The teacher will use the notes and handouts to explain the resistor color code. The student will observe, ask questions, and analyze the teacher’s demonstration.
* The students will review the color code handouts and clarify any questions with the teacher.
* Students will follow the information given

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| **Independent Practice/Laboratory Experience/Differentiated Activities \*** | * Students will memorize the color codes.
* Students will work in pairs doing the *Resistors Color Code Activity* handout and will use it to refer to.
* Students will complete the *Resistance Value and Tolerance Range* handout.
* Students will take the *Resistors Exam*.

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| **Lesson Closure** | **Question**What does the word resistance mean?**Answer**Resistance is the opposition to current flow.**Question**What is a Resistor?**Answer**Resistors are components used in electronic equipment. They resist or limit the flow of current. The resistor is used to create desirable voltage drops and limit current values in electronic circuitry.**Question**How do you read a resistor?**Answer**Hold the resistor in your hand with the band closest to the end of the resistor to your left. Use the color chart to convert the band colors to get the resistor values, multipliers, and tolerance.**Question**How do you measure the ohm value?**Answer**You measure ohm value with a multimeter. |
| **Summative/End of Lesson Assessment \***  | **Informal Assessment** Teacher monitors individual/group progress as students work on the guided and independent practice. Teacher provides individual help/redirection as needed.**Formal Assessment*** *Resistor Exam*
* *Resistor Exam Answer Key*

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| **References/Resources/****Teacher Preparation** | * Dale, C. (1995). *Basic electricity and DC circuits*. Appendix 4. Interpreting the resistor color code. Indianapolis, IN: Prompt Publications.
* Gerrish, H. and Dugger, W. and Roberts, R. (1999) *Electricity and electronics introduction* *to basic electrical circuit materials*. Tinley Park, IL: Goodheart-Willcox Company Inc.
* Wikipedia: <http://en.wikipedia.org/wiki/Resistor_color_code>
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| **Additional Required Components** |
| **English Language Proficiency Standards (ELPS) Strategies** |  |
| **College and Career Readiness Connection[[1]](#footnote-1)** |  |
| **Recommended Strategies** |
| **Reading Strategies** |  |
| **Quotes** |  |
| **Multimedia/Visual Strategy****Presentation Slides + One Additional Technology Connection** |  |
| **Graphic Organizers/Handout** |  |
| **Writing Strategies****Journal Entries + 1 Additional Writing Strategy** |  |
| **Communication****90 Second Speech Topics** |  |
| **Other Essential Lesson Components** |
| **Enrichment Activity**(e.g., homework assignment) | Students that have mastered the lab assignment, can peer-tutor (one-on-one) any students that are having difficulty understanding the concept of resistor color code. |
| **Family/Community Connection** |  |
| **CTSO connection(s)** | SkillsUSA, TSA |
| **Service Learning Projects** |  |
| **Lesson Notes** |  |

1. Visit the Texas College and Career Readiness Standards at <http://www.thecb.state.tx.us/collegereadiness/CRS.pdf>, Texas Higher Education Coordinating Board (THECB), 2009. [↑](#footnote-ref-1)