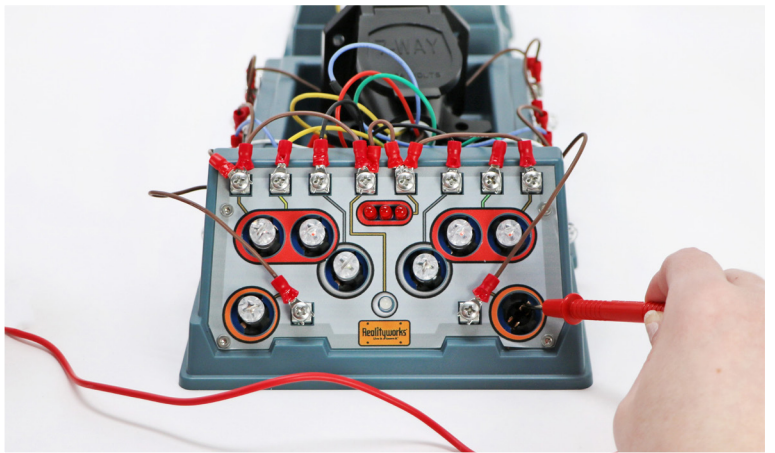




Trailer Circuits STEM Kit

Student Workbook



Name: _____

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Lesson 1:

DC Electricity Basics

Instructions: As you follow the Lesson 1: DC Electricity Basics slide presentation, complete the following questions.

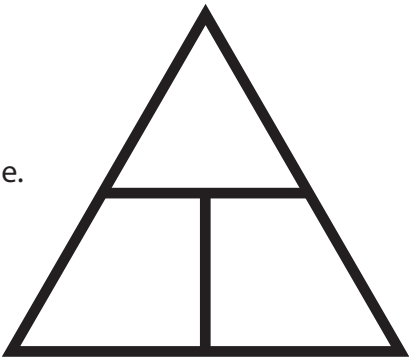
1. How many mA of current will result in the “cannot let go” phenomena?
2. Fill in the blank: Electromagnetism is one of the ____ fundamental forces of the Universe.
3. Electricity can be thought of as the movement of what through a material?
4. Complete the missing fields in the table below:

Electrical Property	Equation Variable	Unit	Definition
Voltage			
Current			
Resistance			
Power			

5. Load: In your kitchen... what are 4 appliances might make up the load of a kitchen circuit?
6. Would you find AC or DC if you measured the current in the wall outlet's circuit?
7. What kind of current is used to charge your phone's battery?
8. What is the difference between AC and DC, and which would you find in the circuits powering a vehicle's trailer?

Lesson 1:

DC Electricity Basics



9. Ohm’s Law: Draw in the missing variables of the Ohm’s Law equation triangle.
10. Practice: If V is 6 volts and R is 2 Ohms, what is the current?
11. Practice: If I is 3 Amps and R is 4 Ohms, what is the voltage?
12. Instead of using V to represent Voltage, electricians use what capital letter instead? _____

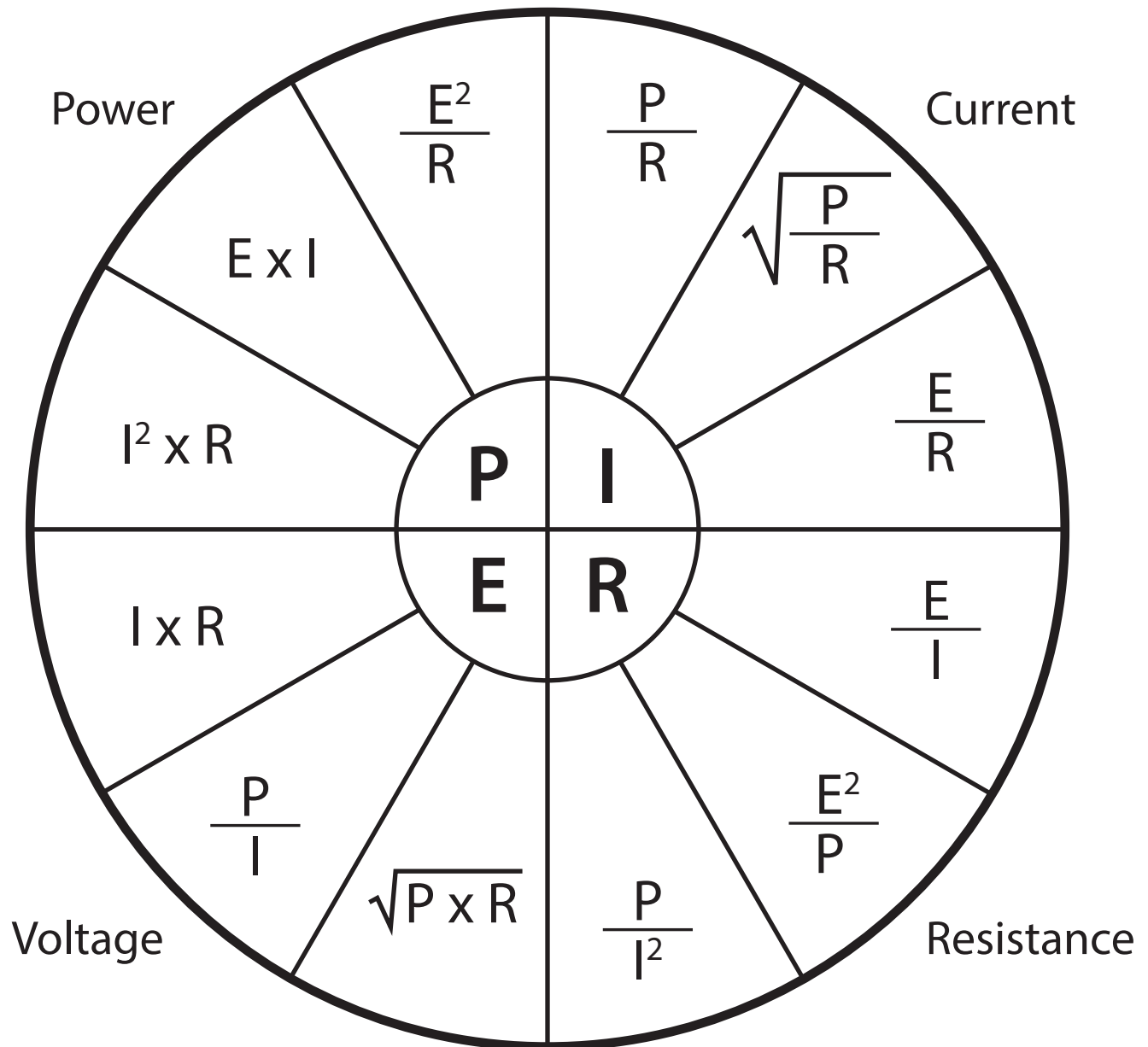
For Questions 12 – 16, practice using the PIE Chart to solve the following:

#	Solve For:	You Know:	Equation to use:	Work	Answer
example	E	P = 10 W I = 2 A	$E = P/I$	$E = 10\text{ W} / 2\text{ A}$	$E = 5\text{ V}$
12	E	P = 2 W I = 4.5 Ohms			
13	A	E = 24 V R = 12 Ohms			
14	R	E = 3 V P = 3 W			
15	P	E = 4 V R = 2 Ohms			
16	A	P = 125 W R = 5 Ohms			

Lesson 1:

DC Electricity Basics

17. If a 12 V battery is powering an LED with a resistance of 2 Ohms, what is the current draw and power used?



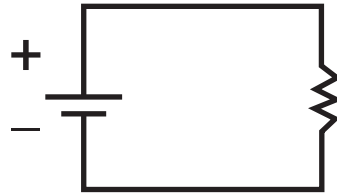
Lesson 2

Circuit Types and Wiring Skills

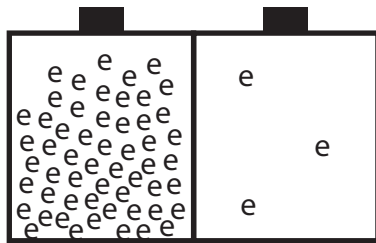
Instructions: As you follow the Lesson 2 slide presentation, complete the following questions.

1. What is a circuit?

2. Explain: How do you know that this is a complete circuit?



3. Draw In: What are the polarities of the two terminals of this battery?



4. Draw In: If a wire was connected between these two battery terminals (shown above), draw with arrows which way the current would flow.

5. What are the 3 different states that a DC circuit can be in?

a.

b.

c.

6. Why can't current flow in an open circuit?

Lesson 2

Circuit Types and Wiring Skills

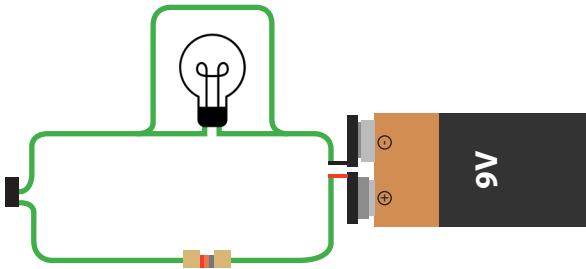
7. How do switches and/or buttons change the state of the circuit?

8. How are these two circuit states different?

a. Short Circuit:

b. Dead Short:

9. Circle the short in this circuit:



10. Why will the light bulb most likely not work in this circuit?

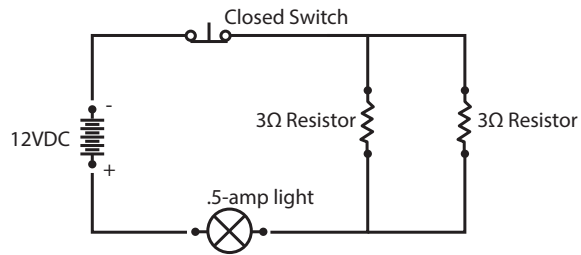
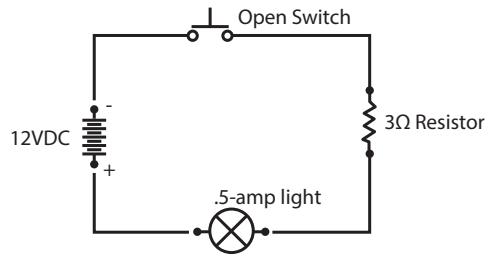
11. Complete this table as you learn about Series and Parallel circuits:

	Number of Pathways for Current to Flow	Voltage	Current	Resistance
Series Circuit				
Parallel Circuit				

Lesson 2

Circuit Types and Wiring Skills

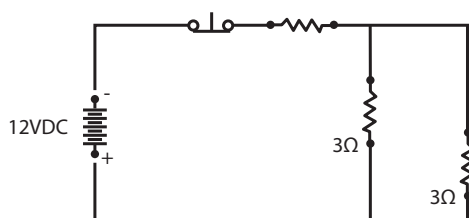
12. Label these circuit types: Series or Parallel



13. Why is wiring multiple objects in Series not ideal?

14. Looking at the circuit diagram on the right shown above, if the battery is supplying ____ V, how much voltage is each resistor getting?

15. What is the best way to describe this circuit?



16. Why would you want to use a parallel circuit to power the electric brakes and all the lights on a trailer?

Lesson 3

Wire, Wiring Skills, and the 4-Way Flat Harness

Instructions: Follow the Lesson 3 slide presentation and complete the following questions.

1. What is the relationship between resistance and electrons?

2. Fill in the table as you learn about these concepts:

Concept:	What is it?	Materials Used
Conductors		• • •
Insulators		• • •

3. Why do you think it wouldn't be a good idea to use steel as a conductive material for wire? What properties of copper and aluminum make them better than steel?

4. When choosing wire for a vehicle or trailer, what properties must a wire have?



5. What do we call the component to the right ?

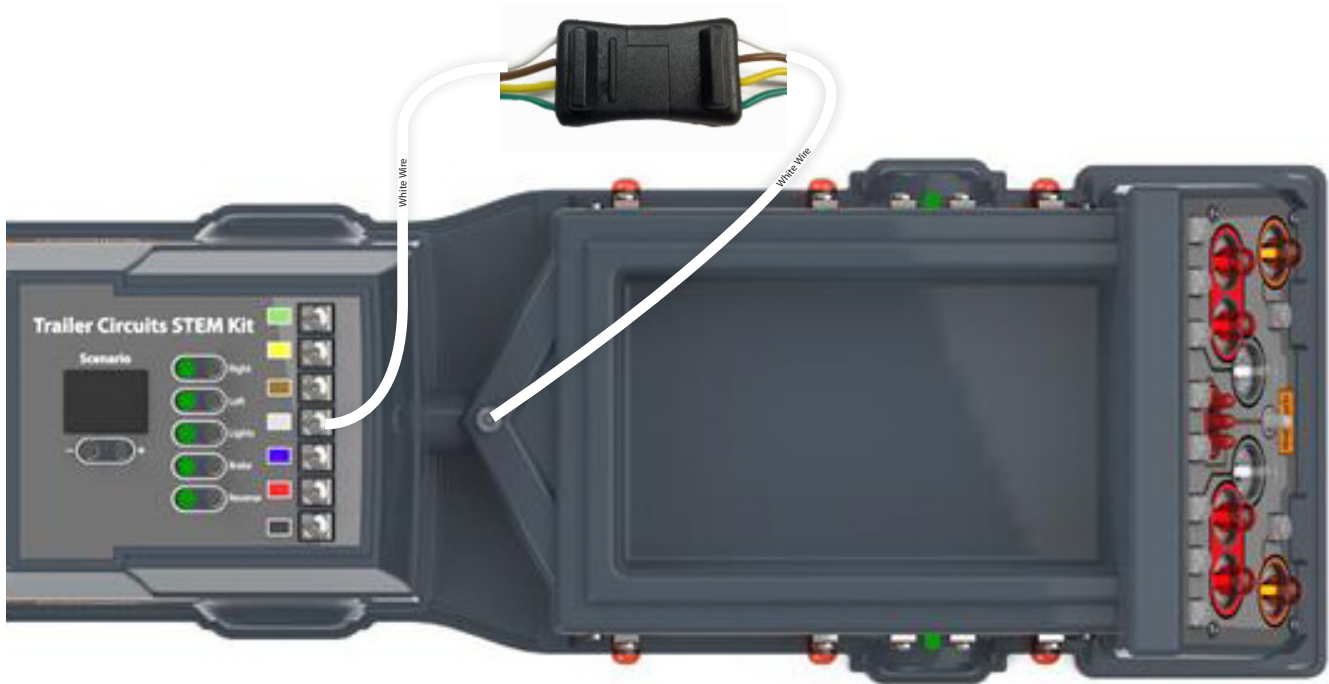
6. 4-Way Flat Harness: Fill in this wire color code table:

4-Way Harness Wire Color	Powers What?
Green	
Yellow	
Brown	
White	

Lesson 3

Wire, Wiring Skills, and the 4-Way Flat Harness

7. On the diagram below, draw and label the wire connections needed to fully connect the vehicle to the trailer with the 4-way flat harness. The white wire has been drawn in for you.



8. At the end of the slide presentation, you will find a “Try This: No Ground” exercise. Follow the instructions on the slide, then answer these questions:

- By removing the ground, this circuit went from a _____ state to an _____ state.
- When the white wire was disconnected from the ground pole, what happened to all the lights?
- Why did this happen?

Lesson 4

Testing with a Multimeter and Auto Light Tester

Instructions: As you follow the Lesson 4 slide presentation, complete the following questions.

1. When the light glows in the auto light tester, what is it telling you?
2. When testing with the auto light tester, you should carefully use it on circuits that are on / off. (circle one)
3. When using the multimeter, you must be very intentional about where you place the metal probes because you are working with a live circuit. What can happen if not used properly?
 - a.
 - b.
 - c.
 - d.
 - e.

6. Complete the table below:

Multimeter Dial Measurement	Sketch the Dial's Symbol
DC Volts	
Resistance	
AC Voltage	
DC Current	
Continuity	

5. Explain what it means to check a circuit for continuity:

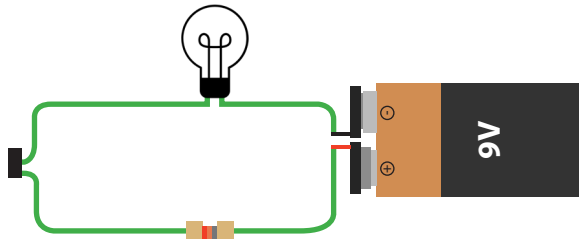
Lesson 4

Testing with a Multimeter and Auto Light Tester

6. When testing for continuity, if the meter does not beep/flash what do you know about this circuit?

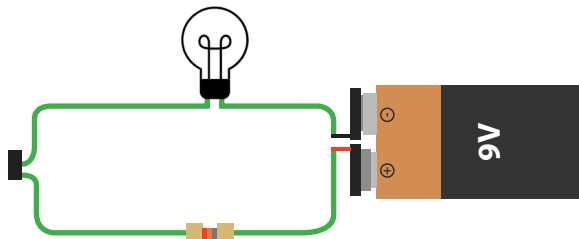
7. Draw the following into the diagram below:

- Where the red and black probes should go to measure the voltage between the battery and the light bulb in this circuit.
- Label the red and black probes.
- Draw how the multimeter's dial should be set to make this measurement.



8. Draw in the following:

- Where would you put the probes in this circuit to measure the voltage used by the light bulb, switch, and resistor?
- Label the red and black probes.
- Draw how the multimeter's dial should be set to make this measurement.



Lesson 4

Testing with a Multimeter and Auto Light Tester

9. First, draw where you would put the probes to measure the voltage of these 4 batteries connected in series. What voltage would you find if 4 AA batteries are connected in series?



Voltage: _____

10. Measuring Current: Left Taillight Socket

- What current do you measure flowing through the socket when the taillight buttons is **not** pushed?
- What current is measured when it is pushed?
- What does this tell you about the circuit?

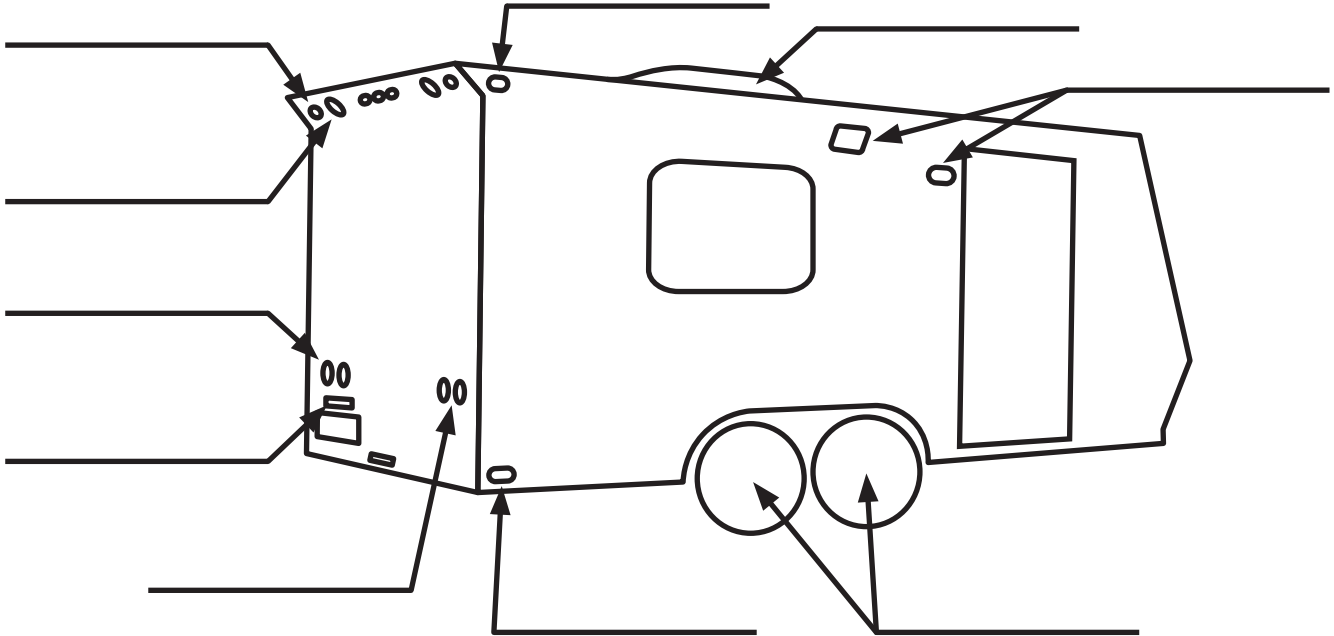
11. Imagine you did the steps in Question 10 above, but even when you pushed the button to turn the taillights on, no current was measured.

- What does this tell you about the circuit?
- Beyond current, what other test/measurement could you perform that would confirm this hypothesis regarding the state of the circuit?

Wiring the 7-Way Round Harness

Instructions: As you follow the Lesson 5 slide presentation, complete the following questions.

1. On this diagram , label all the places on a trailer that must have electricity delivered to them via wires and the wiring harness:



2. 7-Way Harness: Label these two pictures as Vehicle Side and Trailer Side.



- ### 3. Why does each side have set screws on them?

- #### 4. Why does each side have a strain relief mechanism?

Lesson 5

Wiring the 7-Way Round Harness

5. Thinking about possible wiring and circuit failures that could happen with real-world use over time, what are 4 places on the wiring harness that might fail, breaking your circuit, and causing your trailer to not work as expected?

a.

b.

c.

d.

6 **Continuity Check:** For each wire, record your testing results in the table. Check the box in the Continuity Test column if the meter confirms continuity with a beep/flash.

Wire Color	Continuity Test
Green	☐
Yellow	☐
Brown	☐
White	☐
Blue	☐
Red	☐
Black	☐

Lesson 6

Connecting the 7-Way Round Harness

Instructions: As you follow the lesson 6 slide presentation, answer the following questions.

1. Why should the Trailer Circuits Truck be powered off before you start making connections with the harness?
2. Review: Brown and White – Try This Question (see Slide 11)

a. When you pulled the bulb out of the socket, did any of the other brown-connected lights change?

b. What does this tell you about the circuit you have used to wire all the brown-connected lights? Is it a series or parallel circuit, and how do you know?

3. As you work through this lesson, create a 7-Way Wiring Color Key by filling in this table.

Wire Color	What does it connect to?
Green	
Yellow	
Brown	
White	
Blue	
Red	
Black	

Lesson 6

Connecting the 7-Way Round Harness

4. Continuity Check: For each wire, record your testing results in the table. Check the box in the Continuity Test column if the meter confirms continuity with a beep/flash.

Wire Color	Continuity Test
Green	☐
Yellow	☐
Brown	☐
White	☐
Blue	☐
Red	☐
Black	☐

5. Light System Check: Just like you would check the lights on a trailer after getting everything connected to the vehicle, test the light systems one at a time. Check the box to record that each system works as expected.

Light System	Light Test Check			
Left Turn Signal Light	☐ Rear Left Turn Light			
Right Turn Signal Light	☐ Rear Right Turn Light			
Lights	☐ Left Side 3 Marker Lights ☐ Right Side 3 Marker Lights	☐ Left Rear Lower Marker Light ☐ Right Rear Lower Marker Light	☐ License Plate Light ☐ Rear Upper 3 Clearance Lights	☐ Left Taillight ☐ Right Taillight
Brakes	☐ Left Brake Light	☐ Right Brake Light		
Reverse	☐ Left Reverse Light	☐ Right Reverse Light		

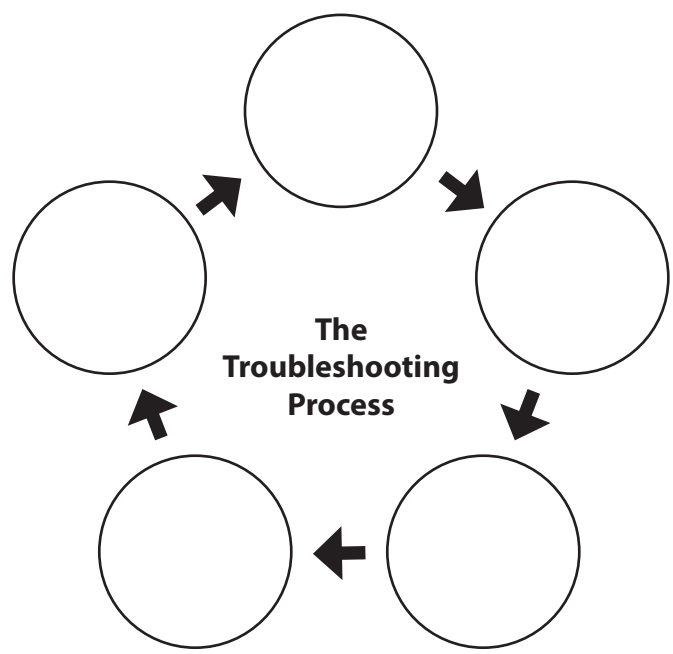
Lesson 7

How to Troubleshoot Electrical Circuits

Instructions: As you follow the Lesson 7 slide presentation, complete the following questions.

1. Why is it important to follow a process when troubleshooting?

2. Fill in the circles with the steps of our troubleshooting process:



3. Why do the arrows connect the last and first step of the Troubleshooting Process?

4. Troubleshooting Tools Table: Complete the missing fields:

Tool	What Does It Measure?	What Can It Tell You?
Auto Light Tester		
Multimeter		

Lesson 7

How to Troubleshoot Electrical Circuits

5. Fill in this table to build a Causes Key for your troubleshooting practice later.

Causes?	Indicators to look for	The Fix
Faulty Bulb		
Faulty New Bulb		
Loose Connections		
Corrosion		
Broken Wire		
Faulty Ground		
Connector Damage		
Blown Fuse		
Short Circuit		

Lesson 7

How to Troubleshoot Electrical Circuits

6. Looking For Indicators: 5 Question Test Routine

#	What is Question?	What Tool Do You Use?	How do you do the test?	What Does the Test Tell You?
1	Is power getting to the light's terminal?			
2	How much voltage is getting to the light's terminal?			
3	Is there power at the light's socket?			
4	What's the voltage at the light's socket?			
5	Is the light grounded correctly?			

7. How do we know that in Scenario 1 the lower right marker light was not working because the bulb was dead? What evidence did you see that tells you this when you identified indicators?

Lesson 8

Practice Troubleshooting with Scenarios 2-10

Instructions: As you follow the lesson eight slide presentation complete the following questions.

1. Review: Fill in the blanks from the Troubleshooting Process:

- 1) Notice and _____ a problem.
- 2) Considered the different _____ of that problem.
- 3) Look over and test the circuit for _____.
- 4) Attempt a _____.
- 5) Power on the circuit and _____... Identify if the problem still exists.
 - a. If the problem is _____, you have successfully completed the troubleshooting process!
 - b. If the problem is still there, _____ the process.

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 2: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 3: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 4: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 5: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 6: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 7: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 8: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 9: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit

Lesson 8

Practice Troubleshooting with Scenarios 2-10

For scenarios 2 - 10, document your observations, thinking, and testing by completing the scenario's Troubleshooting Table.

Scenario 10: Troubleshooting Table	
Identify	
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit



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