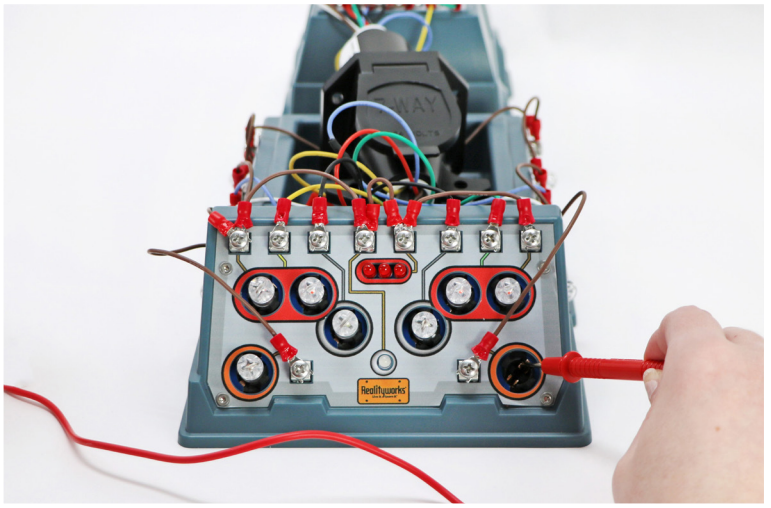
Trailer Circuits STEM Kit

Student Workbook - Answer Key



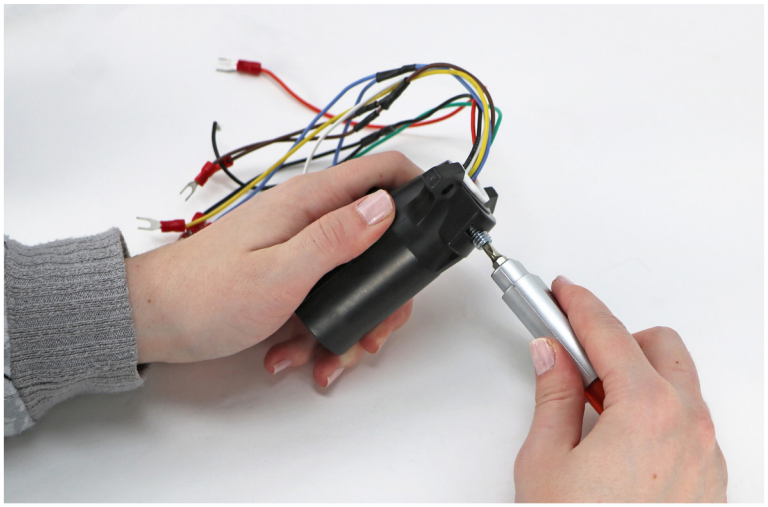


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Table of Contents

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Realityworks®
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2709 Mondovi Road
Eau Claire, WI 54701 USA
800.830.1416
+1.715.830.2040
www.realityworks.com

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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?

10 – 40 milliAmps

2. Fill in the blank: Electromagnetism is one of the **four** fundamental forces of the Universe.

3. Electricity can be thought of as the movement of what through a material?

Electrons

4. Complete the missing fields in the table below:

Electrical Property	Equation Variable	Unit	Definition
Voltage	**V (later we switch it to E)**	**Volts**	**Electrical pressure, or potential energy, created between areas of fewer electrons and more electrons**
Current	**I**	**Amps**	**Current (or amperage) is the amount of electrons flowing through a circuit**
Resistance	**R**	**Ohms Ω**	**A measurement of the amount of opposition to current flow that exists in a circuit object**
Power	**P**	**Watts**	**A measure of energy or work that can be done**

5. Load: In your kitchen… what are 4 appliances might make up the load of a kitchen circuit?

Refrigerator, toaster, microwave, electric stove/oven/range, electric griddle, coffee maker, air fryer

6. Would you find AC or DC if you measured the current in the wall outlet's circuit?

AC

7. What kind of current is used to charge your phone's battery?

DC

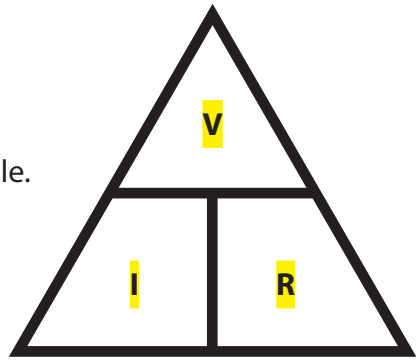
8. What is the difference between AC and DC, and which would you find in the circuits powering a vehicle's trailer?

AC means the current switches direction; DC means the current is always flowing the same direction. Trailers are DC.

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?

I = V/R I = 6V / 2 Ω I = 3 Amps

11. Practice: If I is 3 Amps and R is 4 Ohms, what is the voltage?

V = I x R V = 3 Amps x 4 Ohms V = 12 Volts

12. Instead of using V to represent Voltage, electricians use what capital letter instead? **E**

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

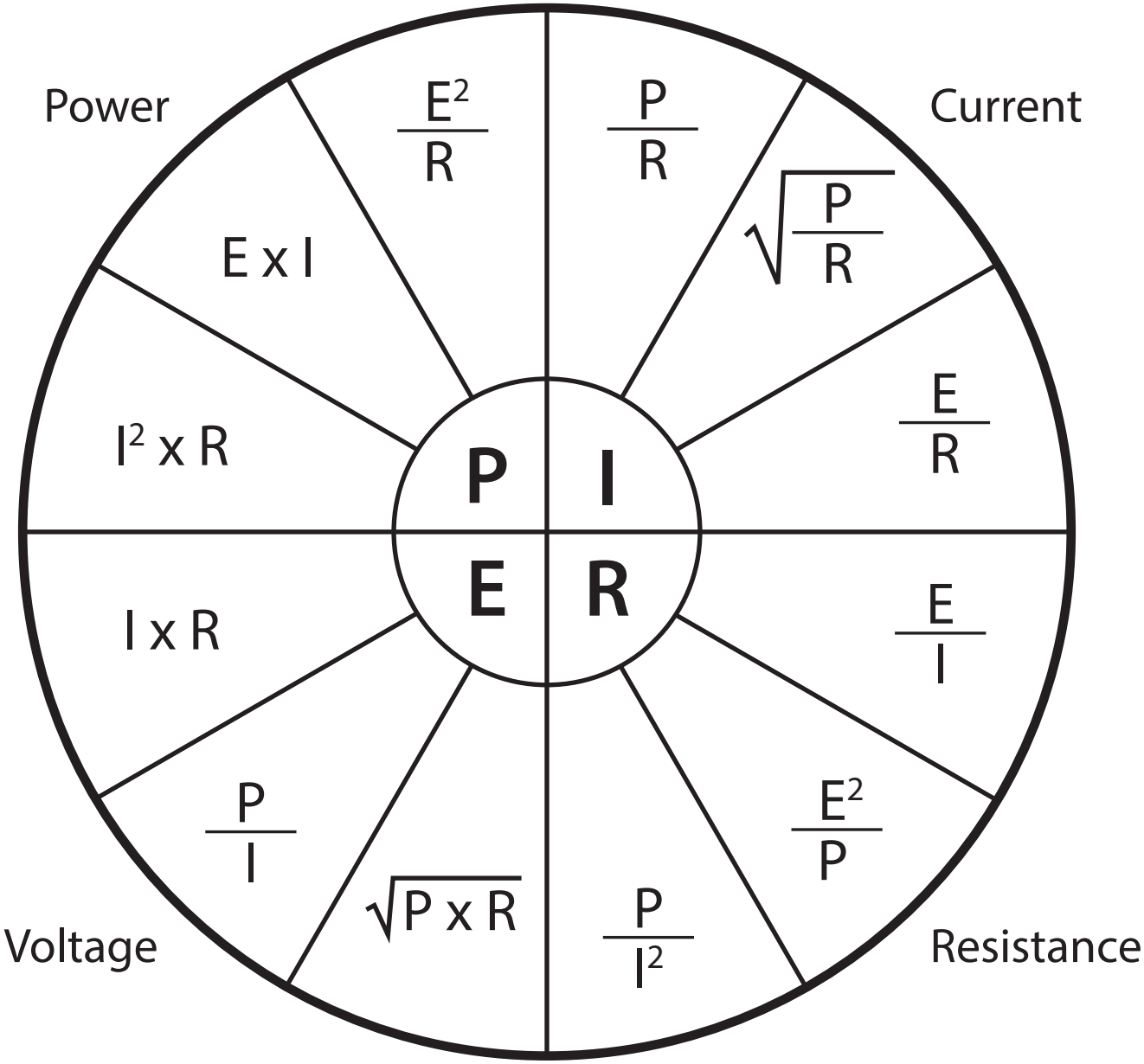
#	Solve For:	You Know:	Equation to use:	Work	Answer
example	E	P = 10 W I = 2 A	E = P/I	E = 10 W / 2 A	E = 5 V
12	E	P = 2 W I = 4.5 Ohms	**E = P/I**	**E = 12 W / 4 .5 Ohms**	**E = 3.44 V**
13	A	E = 24 V R = 12 Ohms	**I = E / R**	**I = 24 V / 12 Ohms**	**I = 2 amps**
14	R	E = 3 V P = 3 W	**R = E2 / P**	**R = (3 V)² / 3 W**	**3 Ohms**
15	P	E = 4 V R = 2 Ohms	**P = E2 / R**	**P = (4 V)² / 2 Ohms**	**8 watts**
16	A	P = 125 W R = 5 Ohms	**I = √(P/R)**	**I = √(125 W/ 5 Ohms)**	**5 amps**

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?

I = E/R I = 12V / 2 Ohms I = 6 Amps

P =… so many ways to solve this! But all should get same answer of P = 72 Watts



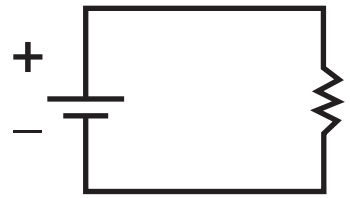
Lesson 2

Circuit Types and Wiring Skills

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

1. What is a circuit?

A circuit is a complete path for current to flow, from a source of current through a load and back to the source of the current.

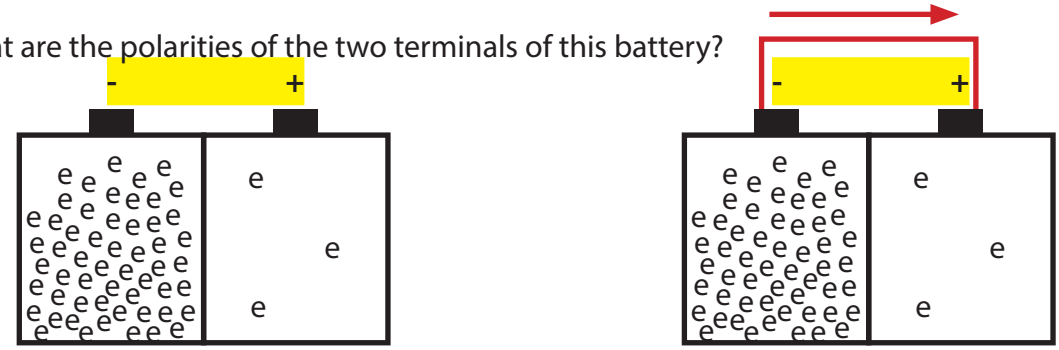


2. Explain: How do you know that this is a complete circuit?

There is a complete path, with no breaks,

for current to flow out of the battery and back to the battery = a loop.

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. **Open**

   b. **Closed**

   c. **Short**

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

The path (loop) is broken; the charges cannot complete a full loop.

Lesson 2

Circuit Types and Wiring Skills

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

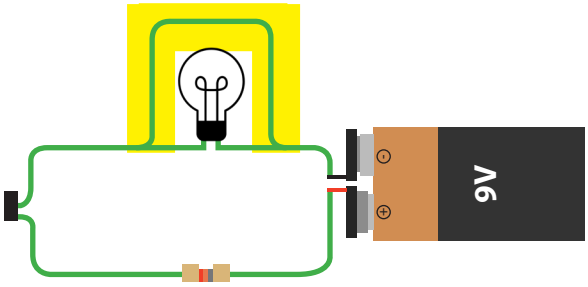
Switches and buttons allow users to purposefully open or close the circuit by moving a piece of conductive material (metal) up or down. Off = open. On = closed.

8. How are these two circuit states different?

   a. Short Circuit: **Current continues to flow.**

   b. Dead Short: **Everything in the circuit turns off because there is no current flowing.**

9. Circle the short in this circuit:



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

Electricity is like water and follows through the easiest path possible. The short has created an easier path for the charges to flow, which means no charges are flowing through the light bulb.

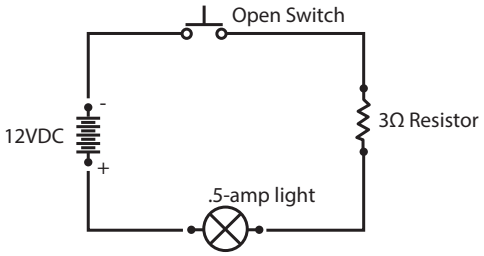
11. Complete this table as you learn about Series and Parallel circuits:

	Number of Pathways for Current to Flow	Voltage	Current	Resistance
Series Circuit	1	Divided up between the circuit components	Stays the same throughout the whole circuit	Each component's resistance adds together
Parallel Circuit	2+	The same in each branch of the circuit	Each component's current adds together	Each component's resistance adds together as its reciprocal

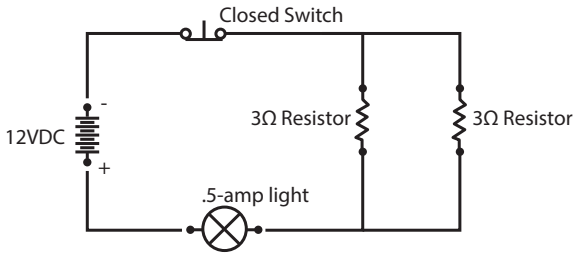
Lesson 2

Circuit Types and Wiring Skills

12. Label these circuit types: Series or Parallel



Series



Parallel

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

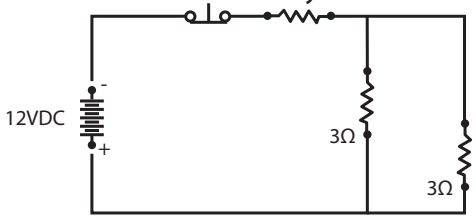
1. Because voltage adds up, you will need a large, high-voltage battery to power the circuit if multiple objects are wired in series.

2. Because there is only 1 loop for current to flow along, if 1 part breaks (a light bulb burns out) then the whole loop is broken and nothing will work anymore.

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

12 V… because Voltage is the same in a parallel circuit's branches.

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



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

Two Main Reasons:

1. A parallel circuit means that even if a light bulb burns out, the electric brakes will still get power… and brakes always need to be working for safe operation.

2. A parallel circuit keeps voltage the same throughout, so you can power everything with just 12 V.

Lesson 3

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

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

1. What is the relationship between resistance and electrons?

The higher the resistance, the harder it is for electrons to move (electricity to flow)

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

Concept:	What is it?	Materials Used
Conductors	**Materials with low resistance**	• **Gold** • **Aluminum** • **Copper**
Insulators	**Materials with high resistance**	• **Rubber** • **Glass** • **Plastic**

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?

Steel oxidizes (rusts), which is a chemical reaction, that can eventually break the steel wire.

Copper and aluminum are much more chemically stable, less likely to oxidize.

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

Flexible

high temperature rated

resistant to grease, oils, acids, water, fungus, and solvents.

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

U-hook crimp terminal

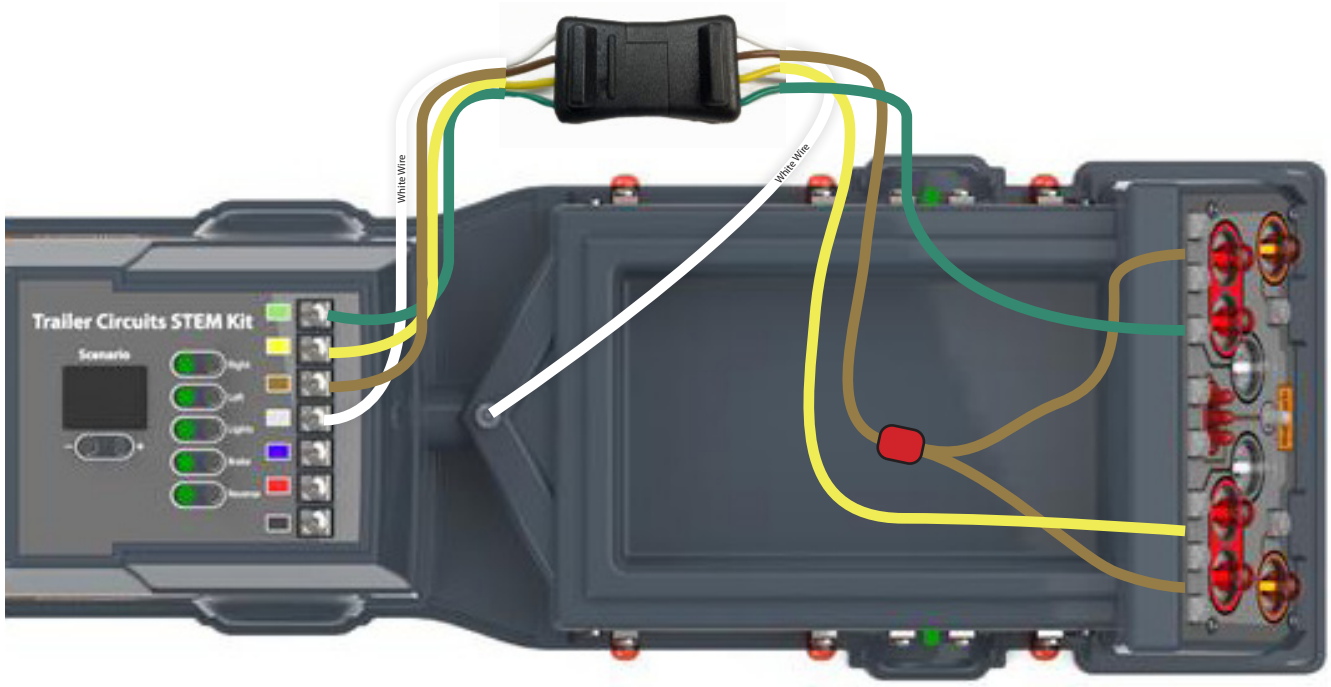
6. 4-Way Flat Harness: Fill in this wire color code table:

4-Way Harness Wire Color	Powers What?
Green	**Right Turn and Brake**
Yellow	**Left Turn and Brake**
Brown	**Taillights**
White	**Ground**

Lesson 3

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

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:

   a. By removing the ground, this circuit went from a **closed** state to an **open** state.

   b. When the white wire was disconnected from the ground pole, what happened to all the lights?
   All should turn off.

   c. Why did this happen?
   Removing the ground is the same as taking away the circuit path back to the battery. With no path back, the charges do not have a complete loop, and therefore, there is no current in any of the circuit pathways.

Lesson 4

Testing with a Multimeter and Auto Light Tester

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

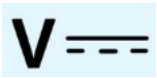
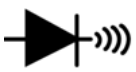
1. When the light glows in the auto light tester, what is it telling you?

Voltage is present; the circuit has a complete path for current to flow along.

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. **Dangerous short circuits.**
   b. **Causing damage to the meter.**
   c. **Causing damage to the circuit.**
   d. **Blowing the fuse in the meter.**
   e. **Shocking yourself.**

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:

Continuity tells you if a complete electrical path exists between the two points you touch with the red and black probes.

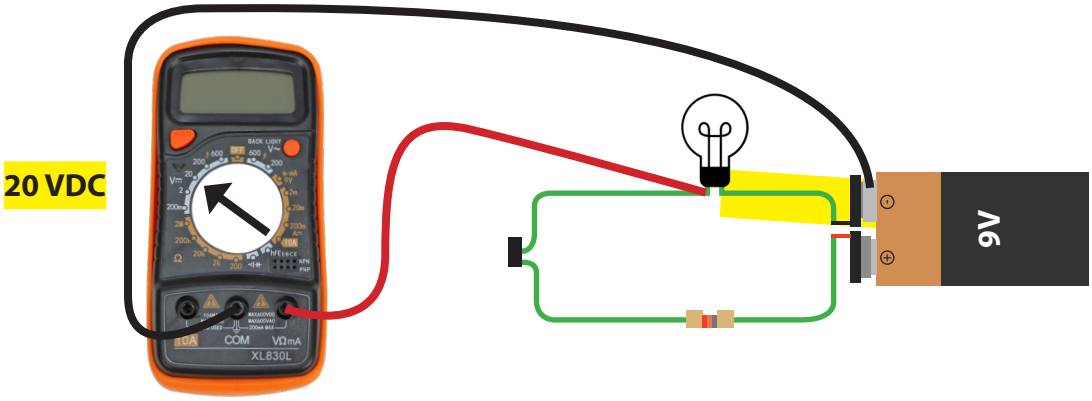
Lesson 4

Testing with a Multimeter and Auto Light Tester

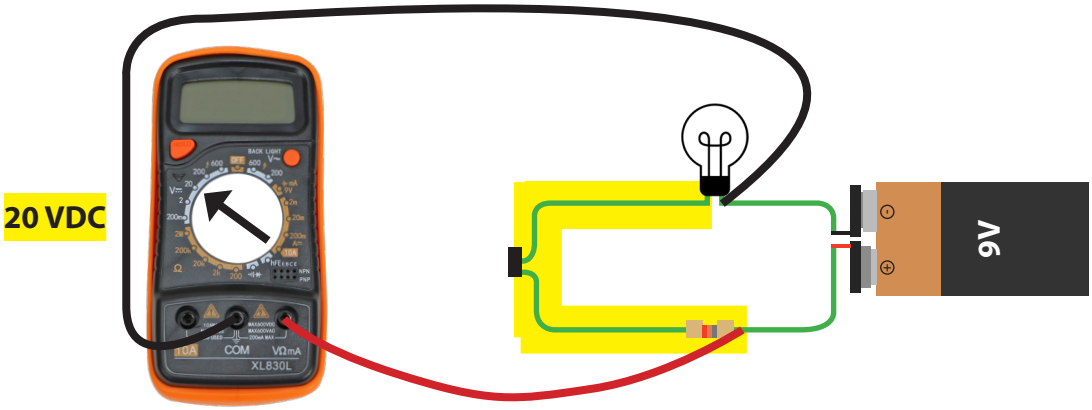
6. When testing for continuity, if the meter does not beep/flash what do you know about this circuit?

There is a break somewhere in the path between the two multimeter probes

7. Draw the following into the diagram below:
   a. Where the red and black probes should go to measure the voltage between the battery and the light bulb in this circuit.
   b. Label the red and black probes.
   c. Draw how the multimeter's dial should be set to make this measurement.



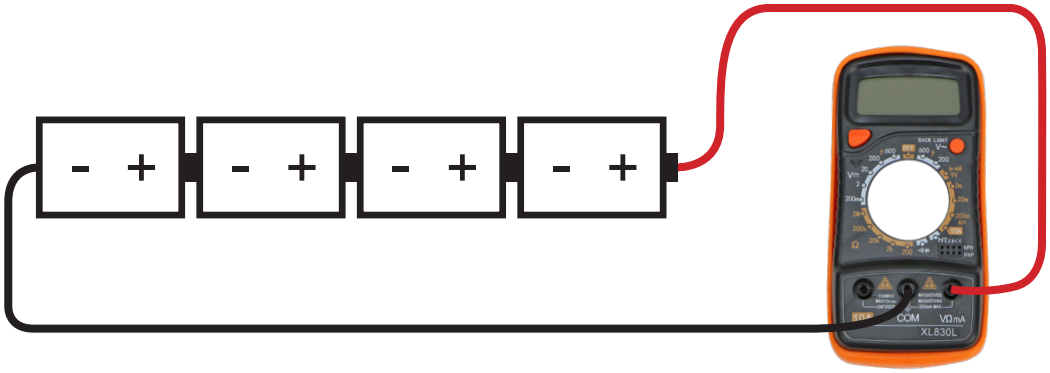
8. Draw in the following:
   a. Where would you put the probes in this circuit to measure the voltage used by the light bulb, switch, and resistor?
   b. Label the red and black probes.
   c. Draw how the multimeter's dial should be set to make this measurement.



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: **6 V Each**

AA supplies 1.5 V, and in series, the voltage adds together; 1.5 V x 4 = 6 V

10. Measuring Current: Left Taillight Socket

    a. What current do you measure flowing through the socket when the taillight buttons is **not** pushed?

    Should be 0 Amps

    b. What current is measured when it is pushed?

    Should be a positive value of mA

    c. What does this tell you about the circuit?

    That the circuit is working as expected; current is flowing, and a complete path exists when the button is pushed.

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.

    a. What does this tell you about the circuit?

    There is a break somewhere else that is preventing a complete path from existing.

    b. Beyond current, what other test/measurement could you perform that would confirm this hypothesis regarding the state of the circuit?

    Auto Test Light

    Multimeter Continuity

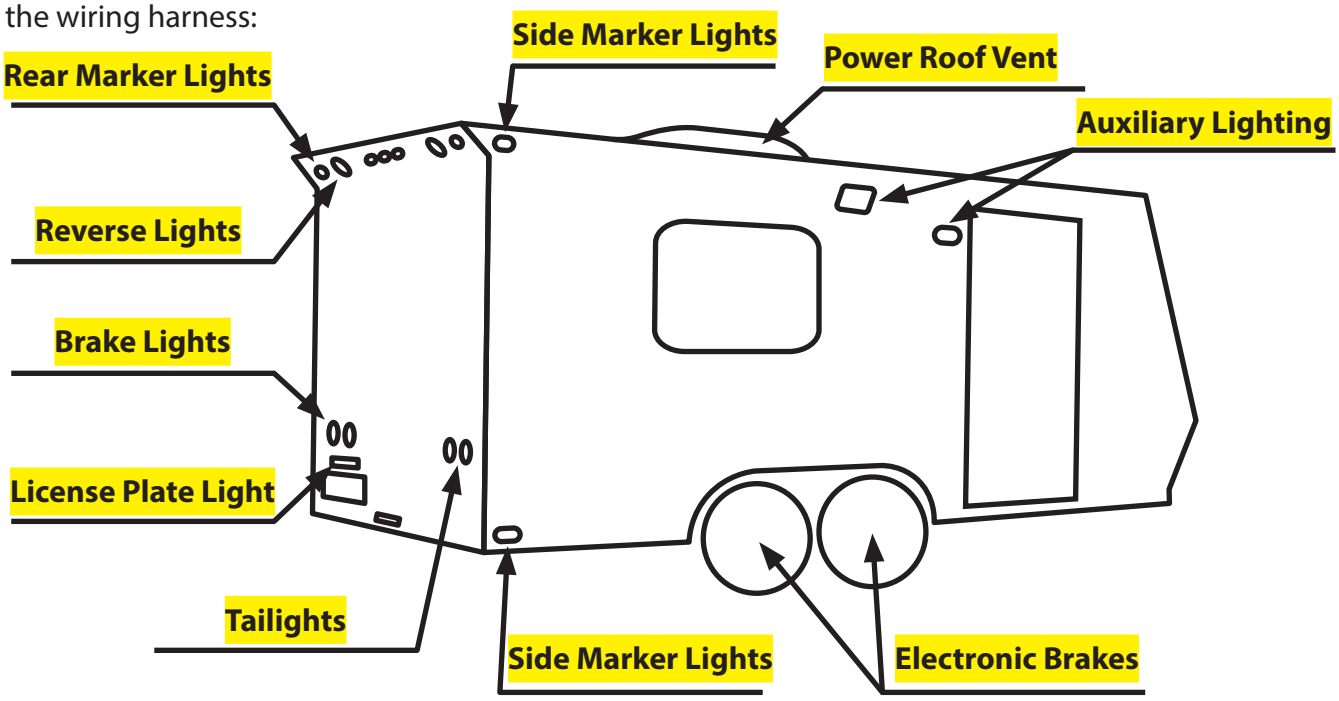
    Multimeter Voltage

Lesson 5

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.

Trailer Side

Vehicle Side

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

The set screws secure the wiring terminal into the harness body, ensuring the wires stay firmly attached when the harness is pulled on

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

The strain relief helps reduce the stress placed on wires when the harness sides are pulled on during use

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. **A wire comes loose in the wiring terminal**
   b. **A wire breaks inside the harness**
   c. **A pin on the vehicle side of the harness breaks or bends**
   d. **The spring-loaded safety latch mechanism breaks, allowing the harness parts to disconnect during use**

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?

To prevent accidental short circuits

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?

   If wired correctly in parallel, all the other brown lights should have stayed on.

   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?

   We know it's parallel because even with the light removed, the circuit path is complete, and charges can make the full loop. If it were a series circuit, with only one path, removing the bulb would have created a break in the single path and none of the lights would receive power

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	**Right Turn Signal and Brake Light**
Yellow	**Left Turn Signal and Brake Light**
Brown	**Side and Rear Marker/Clearance Lights, Taillights, License Plate Light**
White	**Ground**
Blue	**Electric brakes on each wheel**
Red	**12-V Accessory Systems: All the other electronic things that a trailer might have (fans, lighting, pumps, etc.)**
Black	**Reverse**

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

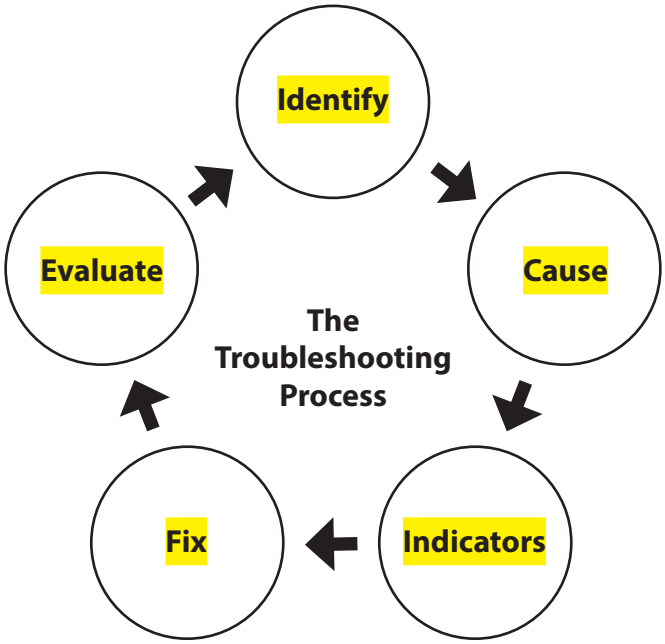
How to Troubleshoot Electrical Circuits

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

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

A process helps us focus and be productive, avoiding frustration and helplessness.

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?

Because your fix might not work when you evaluate your efforts, so you might need to go through the process again now that you have removed one possible solution.

4. Troubleshooting Tools Table: Complete the missing fields:

Tool	What Does It Measure?	What Can It Tell You?
Auto Light Tester	Power	Tells you if part of the circuit is complete
Multimeter	Continuity	Tells you if the circuit path is complete
	Voltage	Tells you if there is voltage in a circuit section
	Current	Tells you if there is current flowing through a part of the circuit

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	• Bulb does not light up. • Does the bulb look like it is burnt out inside? • Auto light tester tells you that there is power flowing to the bulb from the control panel, which means this part of the circuit is good. • Multimeter: Can check continuity of the bulb by touching the probes to the two metal poles on the base of the bulb. If it beeps/flashes, the bulb is not burnt out.	Replace the bulb
Faulty New Bulb	• Bulb does not light up, but it is brand new, the auto light tester tells you power is getting there, and the multimeter shows that the bulb has continuity.	Check for corrosion or damage to the socket
Loose Connections	• Something is not working. • The device experienced lots of vibration (very common with vehicles/trailers). • Trace the circuit path with your finger and look for places where connections happen that could be broken/loose/failed. • Auto light tester shows that power does not make it past a specific spot in the circuit.	Check and tighten connections

Corrosion	• Something is not working.
	• Metal is covered in corrosion, rust, and/or dirt.
	  • Corrosion is a naturally occurring chemical reaction as electricity interacts with air, metal, and moisture.
	  • Vehicles are always likely to corrode.
	  • Corrosion, rust, dirt reduces the flow of current.
		Clean the connections

Broken Wire	• Something is not working. • Visually see a break or disconnect. • Auto light tester shows power does not flow on 1 side of break but flows on the other side that still receives voltage. • Multimeter continuity fails. • Multimeter measures 0 V across light/fixture.	Repair the break
Faulty Ground	• Something is not working. • Auto light tester shows that power reaches to the light. • Multimeter continuity fails. • Usually coincides with loose connection, corrosion, or broken wire.	Repair the ground connection

Connector Damage	• Something is not working.
	• Internal Damage:
	  • Melting from power surge
	  • Possibly from not powering off when making other repairs
	  • Improper pin alignment (was forced together)
	• External Damage:
	  • Melting
	  • Casing cracks with age, exposure to elements, and/or abuse
		Replace both sides of connector

Blown Fuse	• Something is not working. • Testing shows no power to circuit anywhere. • Fuse has a burn mark. • Fuse shows a break. • Multimeter continuity will fail when you test a blown fuse.	Put in a new fuse
Short Circuit	• Bulb does not power on, or it flashes on/off intermittently. • Testing shows that power flows to and from the bulb, but it can be inconsistent. • Metal of wires touching where it should not be, worn away plastic insulation, pinched together wires	Remove the short and prevent accidental current flow

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?	Auto Light Tester	Connect the clamp to the ground post and touch the probe to the light's terminal (where the brown wire connects)	Auto light tester should turn on, telling you that there is power flowing through the brown wires to this terminal
2	How much voltage is getting to the light's terminal?	Multimeter	• Set the dial to 20VCD • Touch the black probe to the white terminal on the control panel (equivalent to touching the - terminal on battery) • Touch the red probe to the light's brown wire terminal	The meter should read about 12 volts, telling you that there is power flowing through the brown wires to this terminal
3	Is there power at the light's socket?	Auto Light Tester	With the bulb removed from the socket, connect the clamp to the ground post and touch the probe to the one of the socket's terminals (where the brown wire connects).	One socket terminal should turn the test light on, telling you that there is power flowing through the brown wires to this socket. Other socket terminal should not activate the test light. This makes sense because, without the bulb, there is no way for charges to get across the gap between the 2 socket terminals.
4	What's the voltage at the light's socket?	Multimeter	1. Set the dial to 20VCD. 2. Remove bulb from socket. 3. Touch the black probe to the white terminal on the control panel. 4. Touch the red probe to one terminal in the socket. 5. Touch the other terminal in the socket.	Test Results: + terminal: The meter should read about 12 volts, telling you that there is power flowing through the brown wires to this terminal. - terminal: The meter may read randomly between 0 and 12 volts; this is called transient voltage. Think of it as electrical energy that is "left behind" or naturally existing in a circuit.
5	Is the light grounded correctly?	Multimeter	1. Set the dial to 20VCD. 2. Remove bulb from socket. 3. Touch the black probe to the negative terminal of the socket. 4. Touch the red probe to the positive terminal of the socket.	12 V: This means that charges can flow because a complete circuit exists, from the vehicle, through the light socket, and on through the circuit to the ground. 0 V: This means that charges cannot flow, which tells you that the circuit is open (broken).

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?

Because the five questions of our testing routine showed us that the circuit is operating fully as expected, the only possible cause left is the bulb itself. In the real world, you would test the bulb for continuity, but this is only a simulated burnt-out bulb.

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 **Identify** a problem.

2) Considered the different **Causes** of that problem.

3) Look over and test the circuit for **Indicators**.

4) Attempt a **Fix**.

5) Power on the circuit and **Evaluate**… Identify if the problem still exists.

a. If the problem is **fixed**, you have successfully completed the troubleshooting process!

b. If the problem is still there, **repeat** 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	**Left brake light is not working.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes (make sure you activate the brakes when measuring these)** **2. How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes** **4. What is the voltage at the light's socket? 12 V** **5. What is the voltage across the light socket? 12 V**
Fix	**The five-question est tells us that the circuit is fully functioning.** **Look at the causes; which of these could be possible reasons why the left brake light isn't working, even though the circuit is working?** **This is just like Scenario #1… there is something up with the bulb. Most likely one of these happening at the light socket and bulb connection:** **• Faulty Bulb • Faulty New Bulb • Loose Connections • Corrosion**
Evaluate	**Check that the bulb is good by making sure it has continuity.** **Reinstall the bulb back into the Trailer Circuits Truck socket, ensuring the connection is not loose and there is no corrosion getting in the way, and test the brakes.** **In Scenario 2, the Trailer Circuits Truck should notice that you removed the bulb and replaced it. With the bulb reinstalled, the left brake light should now work normally.**
Scenario 2 Troubleshooting Summary: **Our testing showed that the circuit is fully functioning and that the bulb is good. When we put the bulb back into the socket, it began working normally. This leads us to the conclusion that there was a loose/dirty connection in the socket that prevented the bulb from receiving power.**	

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	**No lights are working on the trailer.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? No** **2. How much voltage is getting to the light's terminal? 0 V** **3. Is there power at the light's socket? No** **4. What is the voltage at the light's socket? 0 V** **5. What is the voltage across the light socket? 0 V**
Fix	**Our five-question test shows that the circuit is open (broken) somewhere. Looking at the causes, what are all the possible reasons for this?** **• Broken Wire** **• Faulty Ground** **• Blown Fuse** **Level Up Your Understanding:** **Think of the circuit in 2 halves…** **A. Car battery's + terminal to the bulb.** **B. Bulb to the car battery's – ground terminal.** **In your 5-Question Test Routine, you always used the trailer's ground to test. But what if the break/fault is further along the circuit, between the trailer's ground and the battery?** **Try This:** **Repeat the 5-Question Test, but do not use the trailer's ground. Instead, use the vehicle's ground pin at the front of the vehicle by the fuse panel.**
Evaluate	**5-Question Test Routine with vehicle ground:** **1. Is power getting to the light's terminal? Yes.** **2. How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes** **4. What is the voltage at the light's socket? 12 V** **5. What is the voltage across the light socket? Still 0 V** **Questions one through four tell us that the first half of the circuit, the battery to the bulb, works. Question five tells us that even though power is getting to the socket, it cannot go any further. This means the second half of the circuit is the problem.** **Further, because question one through four showed power flowing when we used the vehicle's ground but not when we used the trailer's ground, we can now conclude that there is a fault/break in the ground between the trailer and the vehicle's battery.**

Scenario 3 Troubleshooting Summary: **The fault is somewhere in the ground. We know this because when we use the trailer's ground for testing, we see no power flowing at all. But, when we use the vehicle's ground, we can see that power is flowing to the sockets. This means that the first part of the circuits is closed and functioning. Because there is a fault in the ground, none of the circuits are complete back to the battery.**

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	**Left taillight is not working.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes** **2.How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? No** **4. What is the voltage at the light's socket? 0 V** **5. What is the voltage across the light socket? 0 V**
Fix	**Our five-question test tells us that power is getting to the terminal but not past that point. Which of the causes could make this happen?**
Evaluate	**In the real world, you would visually examine this section of the circuit because you know that the fault is somewhere after the terminal. On the Trailer Circuits Truck, there is no way to "fix and test" a simulated broken wire.**
Scenario 4 Troubleshooting Summary: **We know that power is not getting past the terminal. This tells us that there is a fault somewhere after the terminal, which could be caused by a broken wire, poor/loose/dirty connection, connector damage, corrosion, or short circuit. In the real-world visual inspection would assist in diagnosing this.**	

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	**Right taillight is not working.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes** **2.How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes** **4. What is the voltage at the light's socket? 12 V** **5. What is the voltage across the light socket? 0 V**
Fix	**The fault is occurring after the socket. Which causes could account for this?**
Evaluate	**Testing tells us that the fault is after the socket. In a real-world context, you would evaluate this section of the circuit to assess and address the possible causes that might result in the fault.**
Scenario 5 Troubleshooting Summary: **We know power is getting to the socket, but not past. There is a fault in the ground side of the right taillight 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	**Burnt out right brake light.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes** **2. How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes** **4. What is the voltage at the light's socket? 12 V** **5. What is the voltage across the light socket? 12 V**
Fix	**If the bulb is replaced, it should now work.**
Evaluate	**If the bulb is replaced, it should now work.**
Scenario 6 Troubleshooting Summary: **In the real world, you would test the bulb for continuity, but this is only a simulated burnt-out bulb.**	

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	**Lower left rear marker light is not functioning.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1.Is power getting to the light's terminal? Yes** **2.How much voltage is getting to the light's terminal? 12V** **3.Is there power at the light's socket? No** **4.What is the voltage at the light's socket? 0V** **5.What is the voltage across the light socket? 0V**
Fix	**Same as Scenario 4.**
Evaluate	**See Scenario 4.**
Scenario 7 Troubleshooting Summary: See Scenario 4.	

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	**Nothing works.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? No** **2. How much voltage is getting to the light's terminal? 0 V** **3. Is there power at the light's socket? No** **4. What is the voltage at the light's socket? 0 V** **5. What is the voltage across the light socket? 0 V**
Fix	**Revisit Scenario 3.**
Evaluate	**Even after testing with the vehicle's ground, we see that everything is still not functioning.** **This should lead your thinking back to those Causes. Which of those has the potential to turn everything off fully?**
Scenario 8 Troubleshooting Summary: **There is no power flowing anywhere, which leads us to checking the fuses. When testing the fuses, we found that the yellow 20A fuse is blown, reading 0 V when testing between the vehicle ground and one of its poles.**	

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	**Left side marker light is flashing randomly.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes, consistently on.** **2. How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes, but inconsistently.** **4. What is the voltage at the light's socket? All over, fluctuating between 0 and 12 V.** **5. What is the voltage across the light socket?** **All over, fluctuating between 0 and 12 V.**
Fix	**Testing shows us that the circuit is working, but there is a fault that is randomly opening and closing the circuit, which makes the bulb flash on and off.** **Which of the causes would explain this?**
Evaluate	**In the real world, we would conclude that the flashing is most likely due to a loose connection. We would confirm and tighten any connections in the circuit to see if that made the flashing stop.**
Scenario 9 Troubleshooting Summary: **The bulb is receiving power, but inconsistently. The most likely cause of this is a loose connection**	

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	**Left and right turn signals are swapped.**
Causes	☐ Faulty Bulb ☐ Faulty New Bulb ☐ Loose Connections ☐ Corrosion ☐ Broken Wire ☐ Faulty Ground ☐ Connector Damage ☐ Blown Fuse ☐ Short Circuit
Indicators	**5-Question Test Routine:** **1. Is power getting to the light's terminal? Yes** **2. How much voltage is getting to the light's terminal? 12 V** **3. Is there power at the light's socket? Yes** **4. What is the voltage at the light's socket? 12 V** **5. What is the voltage across the light socket? 12 V**
Fix	**Everything is working electrically, but the signals from the vehicle are going to the wrong place. How would this happen in the real world?**
Evaluate	**In a real-world context, the fix would be to check the wires coming through the harness. You know they are working, but the left turn signal is going to the wrong place, which would be explained by a wrong wire connection.**
Scenario 10 Troubleshooting Summary: **The circuits are all operating, but the turn signals are going to the wrong lights. Somewhere in the circuit, the wires got swapped. To fix it, the wires should be traced to confirm that the yellow wire connects the left turn signal, and the green wire connects the right turn signal.**	

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