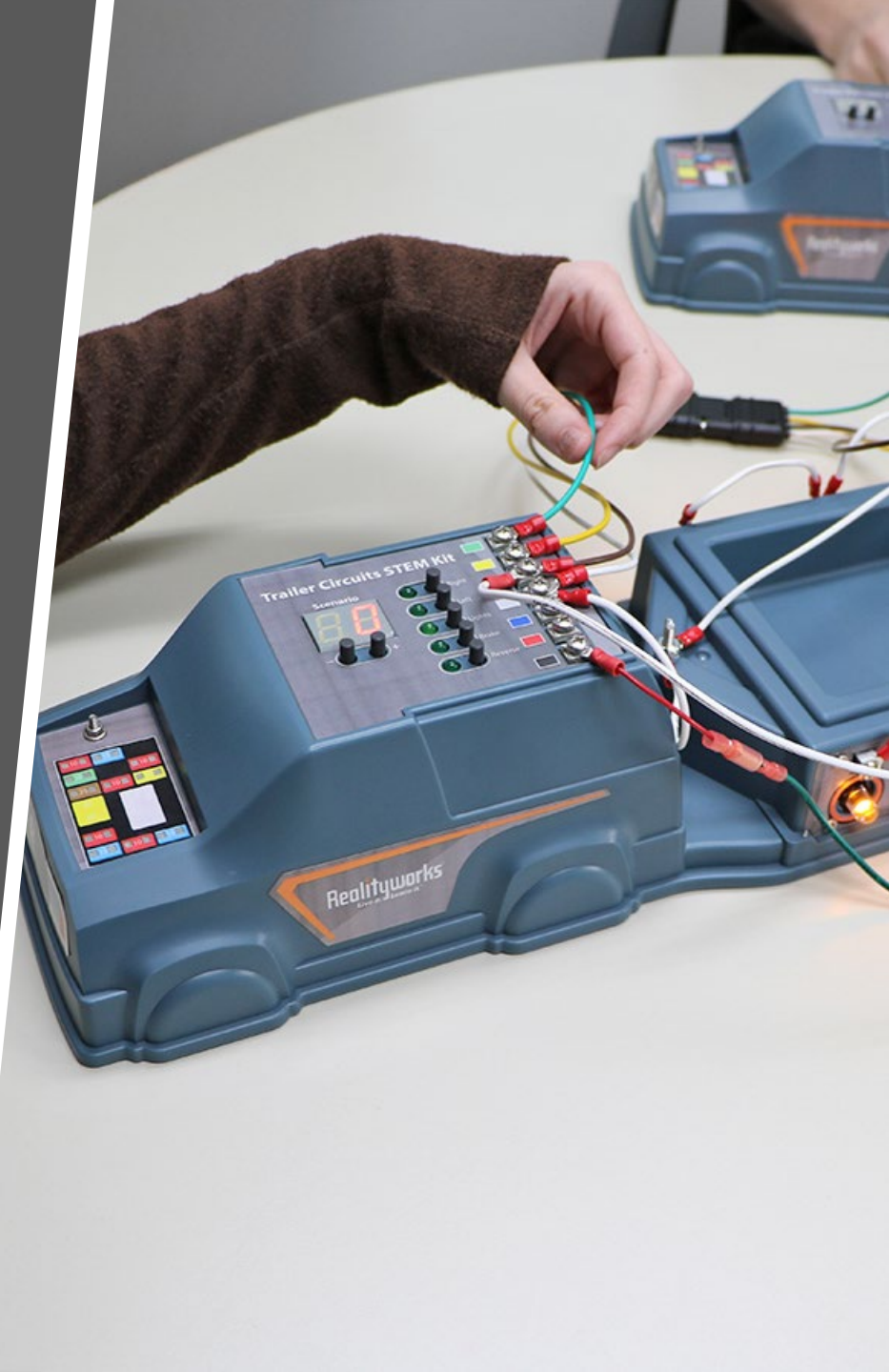




Lesson 7: How to Troubleshoot Electrical Circuits

Trailer Circuits STEM Kit Curriculum

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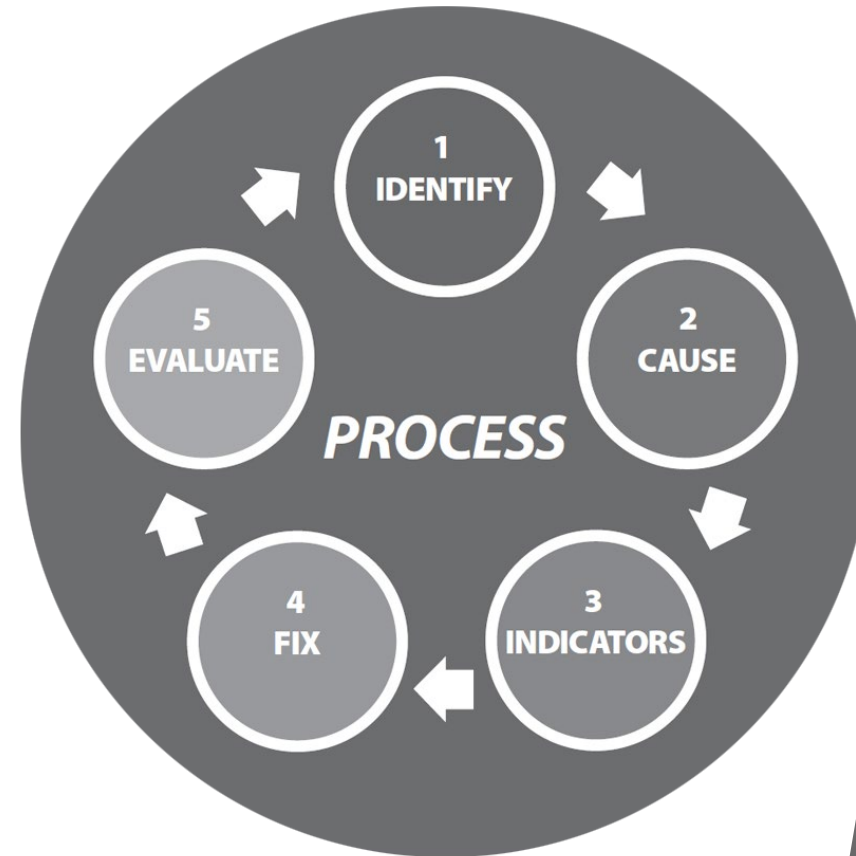
What Is Troubleshooting?

- When something is not working, troubleshooting is the process we use to fix the problem
- Having a process is important
 - **A process helps us focus and be productive, avoiding frustration and helplessness**
 - This is true for all challenges
- Practicing troubleshooting here will help you be successful when troubleshooting your real-world problems



What Is Our Troubleshooting Process?

1. **Identify** the problem.
2. Examine likely **Causes**.
3. Look for **Indicators**.
4. Try different ways to **Fix** it.
5. **Evaluate**... is it still a problem?



What Are our Troubleshooting Tools?

Auto Light Tester:

- Can tell you if **power** is flowing in circuit section

Multimeter can check...

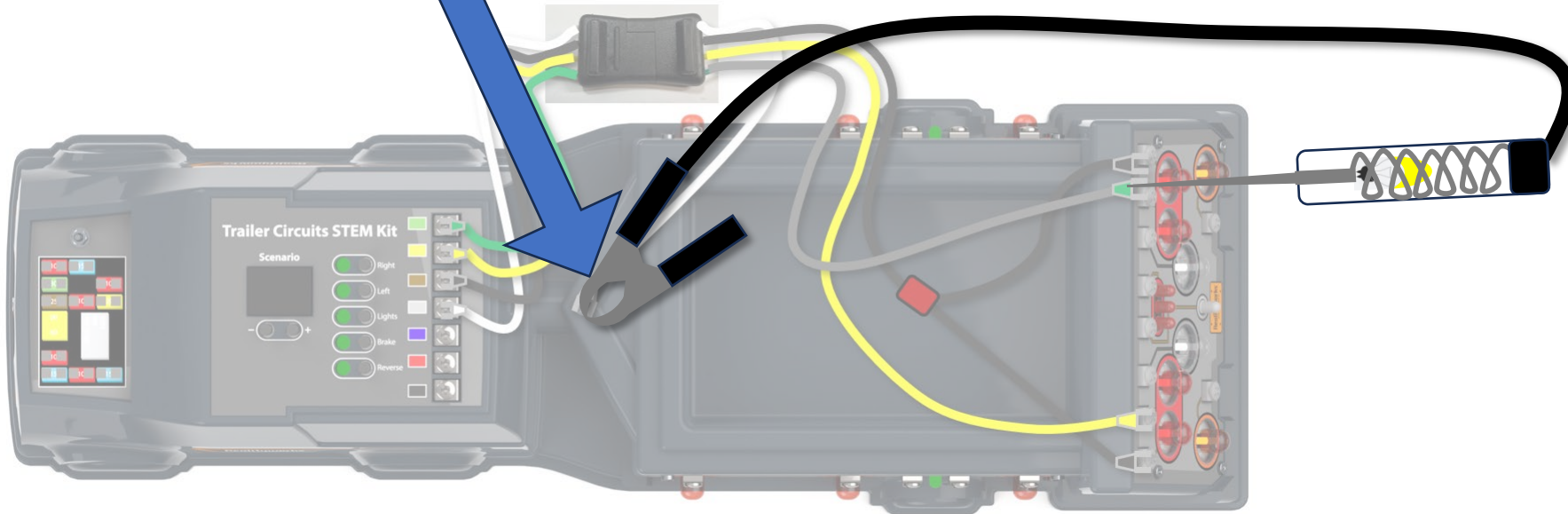
- **Continuity:** Is the **circuit** path complete?
- **Voltage:** Is there **voltage** in a circuit section?
- **Current:** Is **current** flowing through this part of the circuit?



Remember: Using the Auto Light Tester

Ground clamp
must be attached
to the ground post.

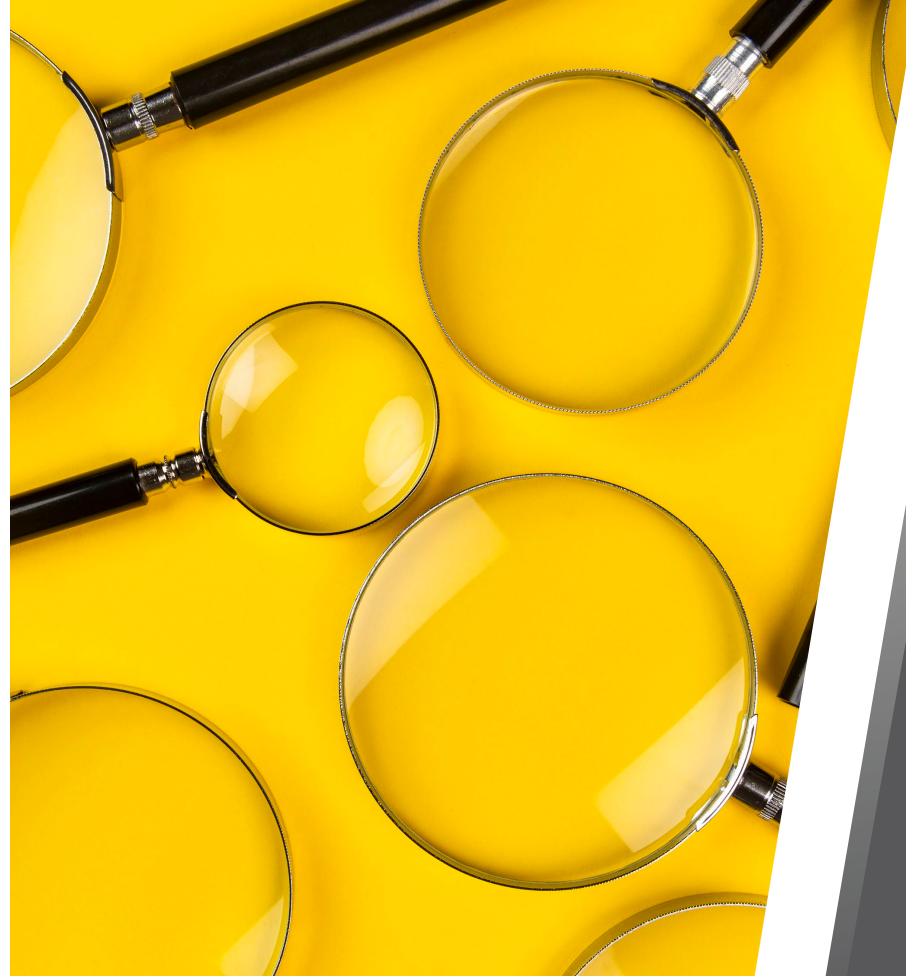
1. Power the Trailer Circuits Truck on.
2. Touch the prong to any vehicle terminal.
 - Auto Light Tester should light up = power is flowing!
 - If not, it is **faulty** (*break in the circuit exists somewhere between the 2 points being touched*)



Where Do We Begin?

When you notice something is wrong, not acting the way it is supposed to... with a **trailer this usually means a light is not working.**

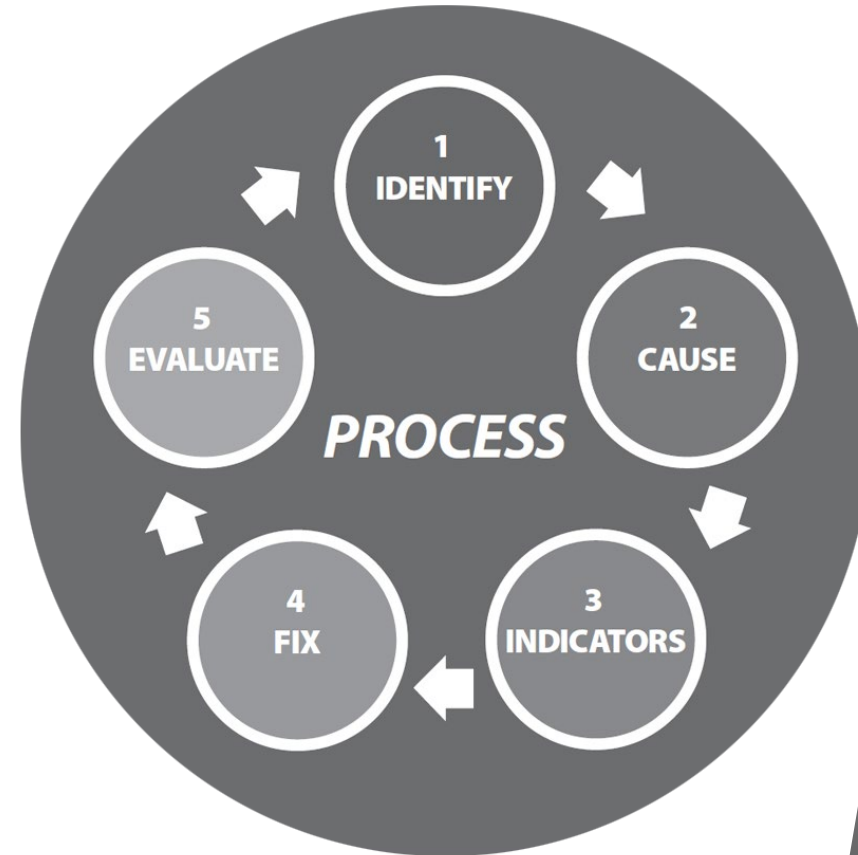
Take time to **Identify** exactly what the problem is, notice its behaviors and see what triggers it. These are all clues that will help you.



When a Circuit is not Working...

What are some common causes, indicators, and fixes?

- Knowing these will help you troubleshoot quickly
- Look back to this section of lesson 7 as a resource when you are troubleshooting



Cause: Faulty Bulb

- Indicators:
 - 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 2 metal poles on the base of the bulb
 - If it beeps/flashs, the bulb is not burnt out
- Fix:
 - Replace the bulb
 - If the new bulb works, you have just confirmed that the problem was a bad/burnt bulb



Cause: Faulty New Bulb

- Indicators:
 - Bulb does not light up, but it is brand new
 - Auto light tester tells you power is getting there
 - Multimeter shows that the bulb has continuity
- Fix:
 - Check for corrosion or damage to the socket
 - Something is preventing charges from making a complete circuit through the bulb
 - Clean any corrosion, dirt, or rust

Cause: Loose Connections

- Indicators:
 - Something is not working
 - The device has experienced many 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
- Fix:
 - Check and tighten connections
 - **Terminals:** Did the screws wiggle loose? ***Tighten them***
 - **Harness:** Did the 2 sides separate? ***Squeeze them together***
 - **Red Connectors:** Did they come unsnapped or did a wire fall out? ***Fix them***
 - **U-Shaped Crimp Terminal:** Did the wire fall out of the terminal? ***Re-crimp or attach a new one***

Cause: Corrosion

- Indicators:
 - 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, and dirt reduce the flow of current
- Fix:
 - Clean the connections
 - Ensure power is off
 - Use wire brush, rag, and/or pencil eraser to clean the metal parts that electricity needs to flow through (wear gloves)
 - Reconnect and tighten



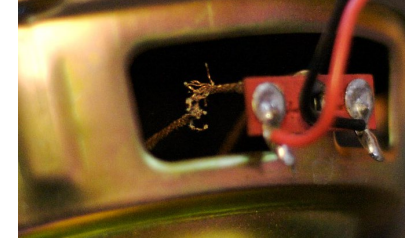
<https://openverse.org/image/df38d8ce-f85e-41f0-9e84-083b0d058ea3?q=wire+corrosion>

Cause: Broken Wire

- Indicators:
 - Something is not working
 - Visually see a break or disconnect.
 - Auto light tester shows power does not flow on 1 side of the break but flows on the other side that still receives voltage
 - Multimeter continuity fails
 - Multimeter measures 0 V across light/fixture
- Fix:
 - Repair the break
 - Ensure power is off
 - Reconnect
 - Install new wire if severely damaged, using butt splice to attach new to old



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<https://openverse.org/image/84abf6ba-c736-41ce-b347-2d2a91ef8c3e?q=broken+wire>



<https://openverse.org/image/f7764ea1-1ec9-4bd0-aa8b-f2e524d66a4f?q=wire+corrosion>



Butt Splice

Cause: Faulty Ground

- Indicators:
 - 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
- Fix:
 - Repair the ground connection
 - Ensure power is off
 - Address whatever is preventing the ground from forming a complete circuit



Ground wire on trailer taillight connecting the circuit to the ground, which is the trailer's frame.

Cause: Connector Damage

- Indicators:
 - 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
- Fix:
 - Replace both sides of the connector
 - Sometimes individual pins can be repaired



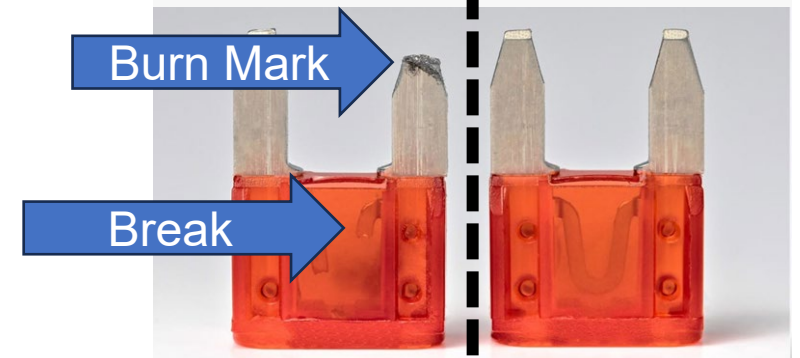
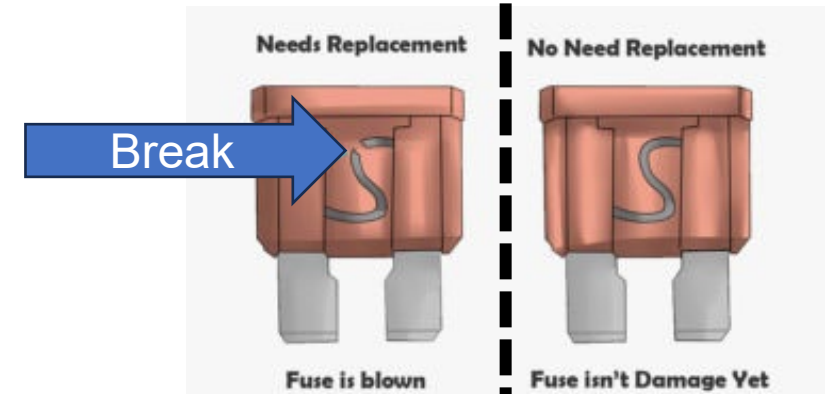
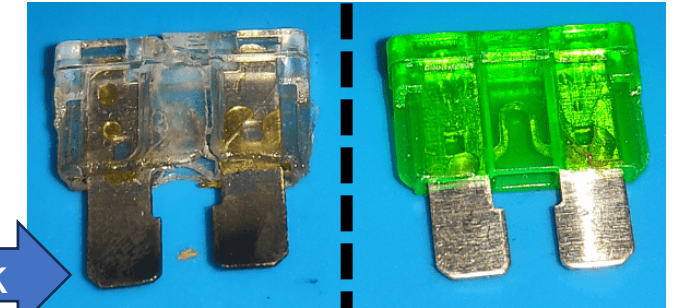
These pictures show a connector similar to what you will find in many vehicles.

This connector shorted, resulting in high heat that melted the plastic. It must be replaced.

Cause: Blown Fuse

- Fuses protect circuits from damage caused by too much current flowing
- Fuse will “blow” before damage can occur in the rest of the circuit
- Indicators:
 - Something is not working
 - Testing shows no power to circuit anywhere
 - Fuse has a burn mark
 - Fuse shows a break
 - Multimeter continuity fails
- Fix:
 - Replace the fuse
 - Ensure it is rated for the same amperage

Blown Fuses | Good Fuses



Testing Fuses on the Trailer Circuits Truck

- Fuses are marked with their maximum current rating
 - If more than 10 amps flow through this fuse, it will blow 
- The Trailer Circuits Truck has a fuse panel located on the front of the vehicle
- Fuse panels in vehicles can be found in many places: under the hood, behind a panel in the dash or glove compartment, etc.
 - Every vehicle is different
- **Testing Fuses:**
 - Multimeter: Continuity (as shown to the right)
 - Auto Light Tester: Touch the ground pole and check both poles of the fuse
 - If both poles light up the tester, the fuse is good

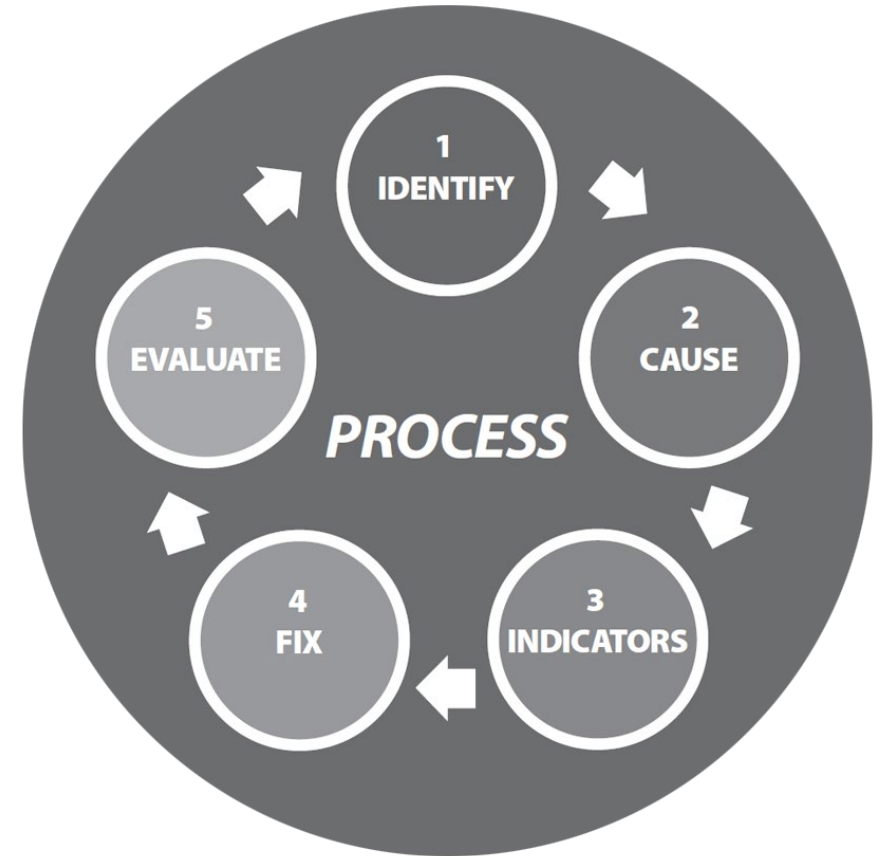


Cause: Short Circuit to a Light Bulb

- Indicators:
 - Bulb does not power on or 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
- Fix:
 - Remove the short
 - Prevent accidental current flow
 - Repair/cover/replace bare wires
 - Can use electrical tape

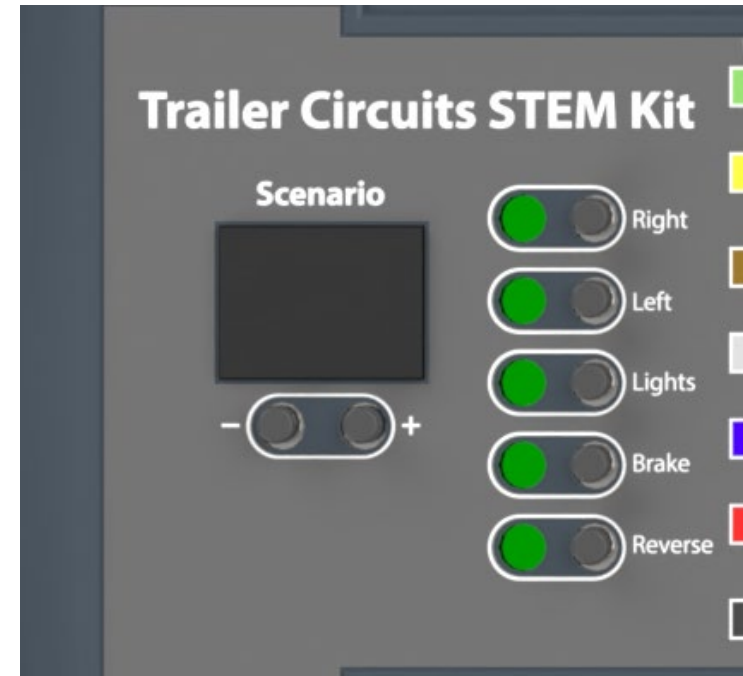
Troubleshooting

1. Notice and **Identify** a problem.
2. Consider 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)
 - **If the problem is gone**, you have successfully completed the troubleshooting process!
 - **If the problem is still there**, repeat the process.



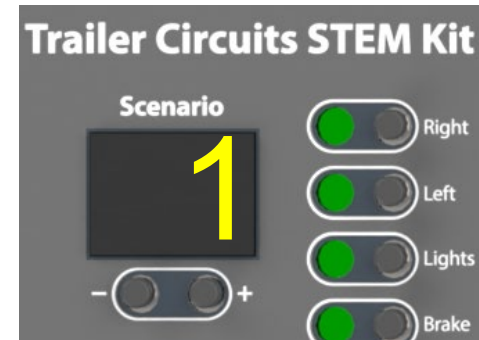
Let's Try Troubleshooting: Scenario 1

- You will need:
 - Trailer Circuits Trucks with connected and correctly functioning 7-way round harness
 - Auto light tester
 - Multimeter



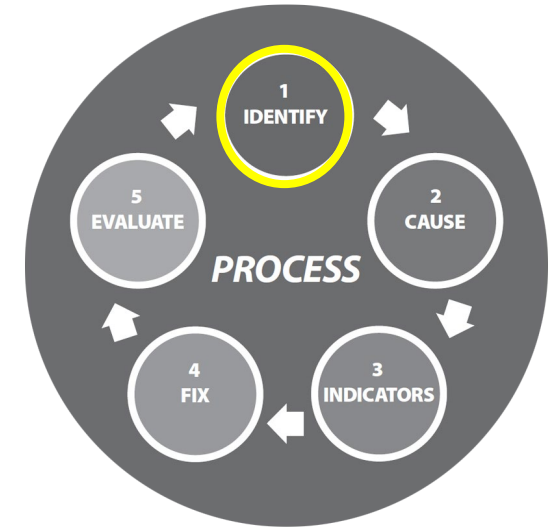
Let's Try Troubleshooting: Scenario 1 – Activate

1. Turn on the Trailer Circuits Truck
2. Ensure all light systems are powered off
3. Push the + button to change the Scenario # to 1
4. Systematically test all the different lights by activating each system one at a time



Scenario 1: Identify

As you test the different light systems, what have you identified as the problem?



Identify: Lower right marker light is not working

Scenario 1: Causes

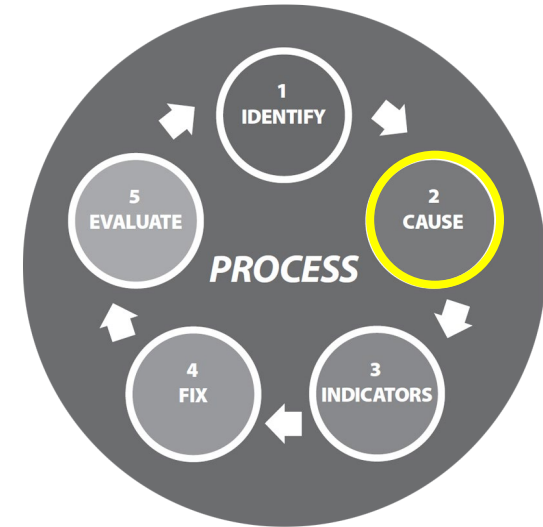
What are the possible causes of this problem?



Identify: Lower right marker light is not working.

Causes:

- Faulty bulb
- Loose connection
- Corrosion
- Broken wire
- Faulty ground
- Connector damage
- Blown fuse
- Short circuit



Scenario 1: Indicators

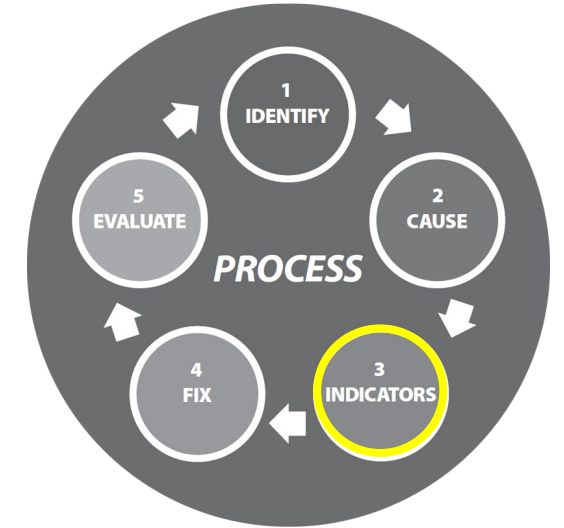
**What indicators
can we find to
help us identify
potential issues?**



Identify: Lower right marker light is not working.

Causes:

- Faulty bulb
- Loose connection
- Corrosion
- Broken wire
- Faulty ground
- Connector damage
- Blown fuse
- Short circuit



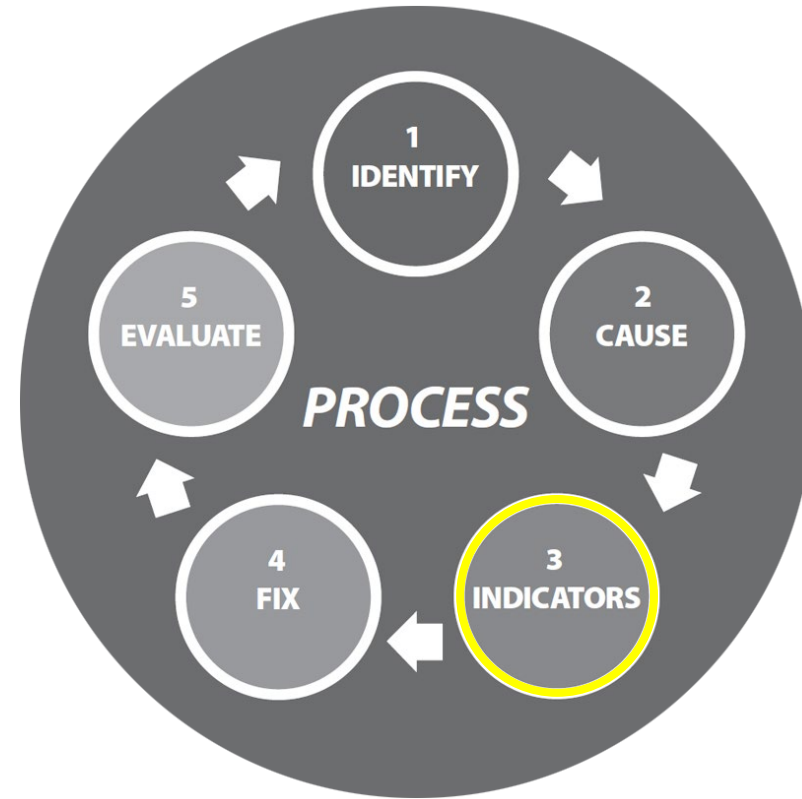
Indicators: The bulb is not working. What can we test to give us a better idea of what is wrong?

Looking For Indicators: Use a 5-Question Test Routine

We will use five questions to develop our circuit-testing skills and look for indicators.

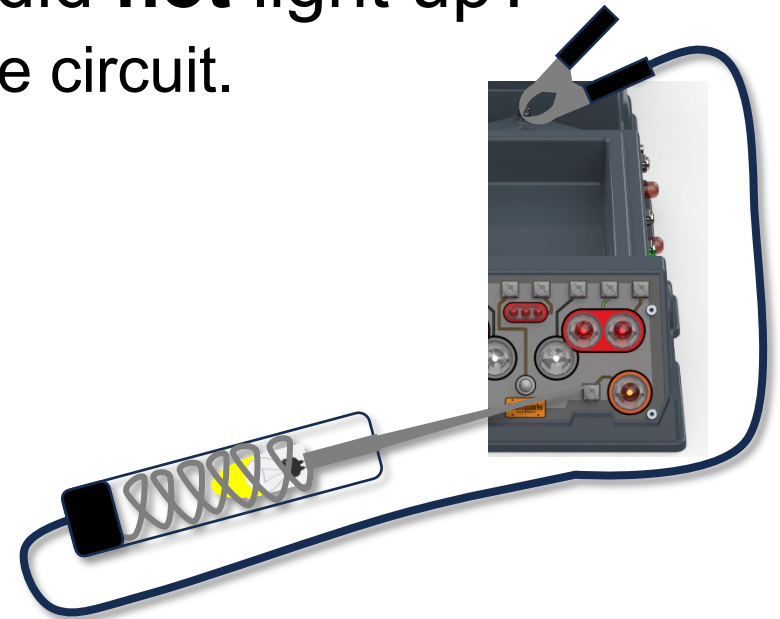
For each question, we will look at two slides:

- First slide
 - Description of the test
- Second slide
 - Visual model of the test



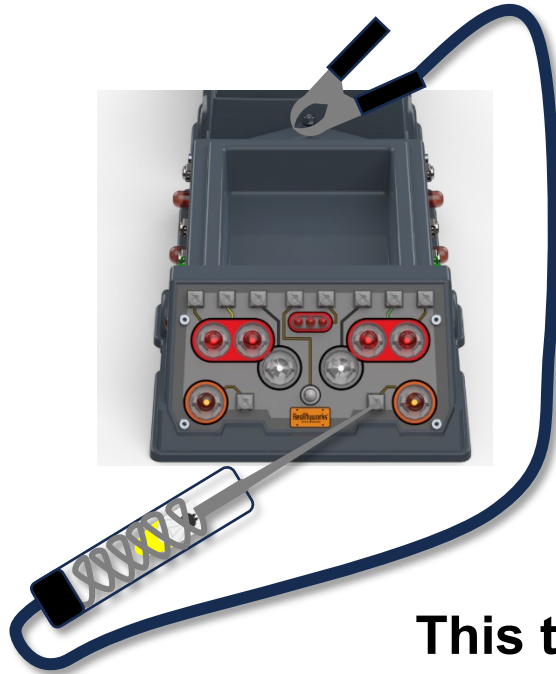
Testing Question 1: Is Power Getting to the Light's Terminal?

- **With the auto light tester**, connect the clamp to the ground post and touch the probe to the light's terminal (where the brown wire connects as shown)
 - **Test Results:** Auto light tester should turn on, telling you that there is power flowing through the brown wires to this terminal
- What would it mean if the auto light tester did **not** light up?
 - **Answer:** Power is **not** flowing to this point in the circuit.

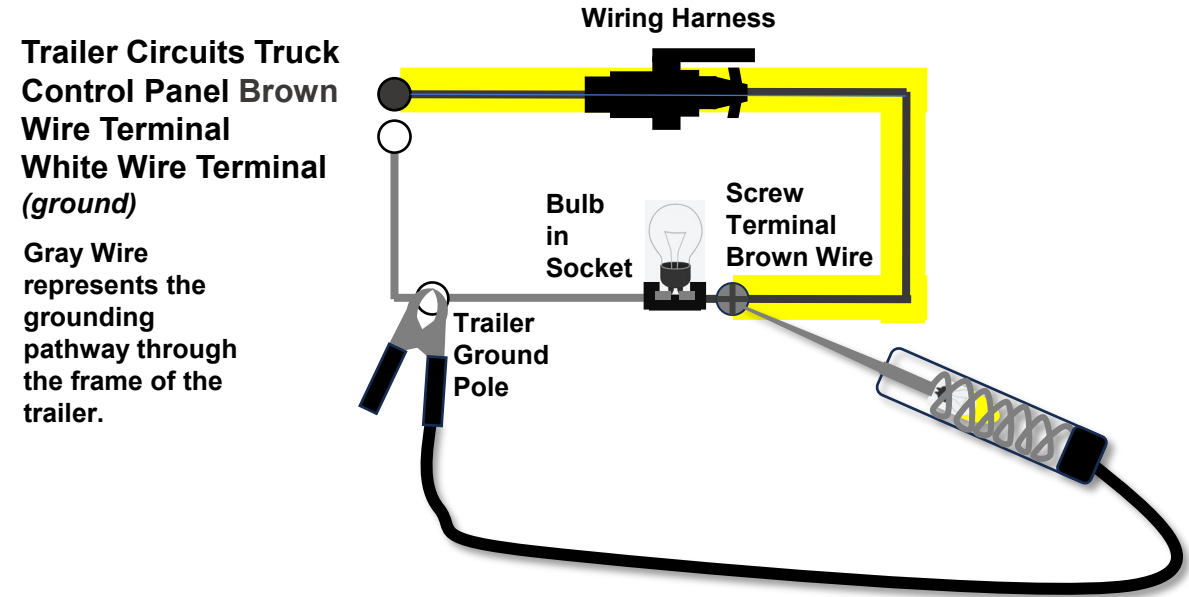


Visualizing Question 1: Is Power Getting to the Light's Terminal?

**How you are testing
on the Trailer
Circuits Truck**



**Simplified model of
what you are testing**



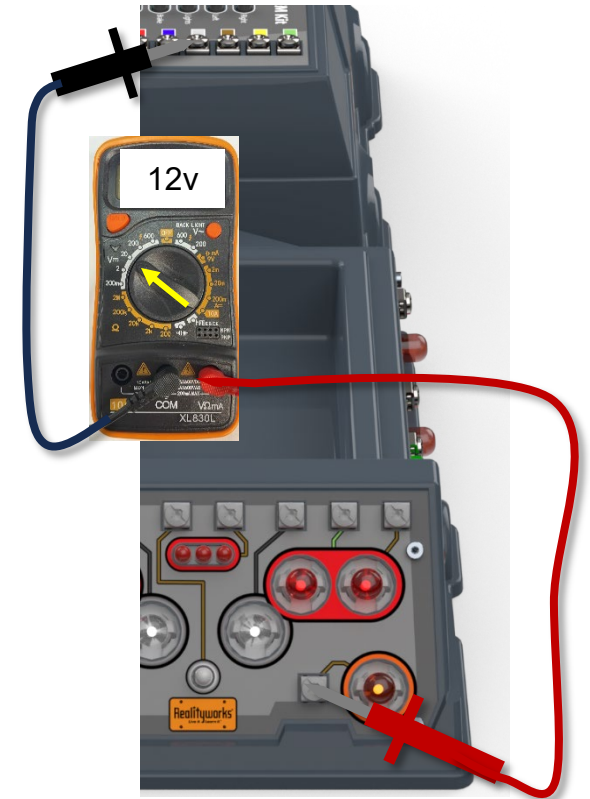
This test tells you that the highlighted part of the circuit is good, because charges are flowing through it, then through the test light to the ground.

Testing Question 2: How Much Voltage is Getting to the Light's Terminal?

With Multimeter:

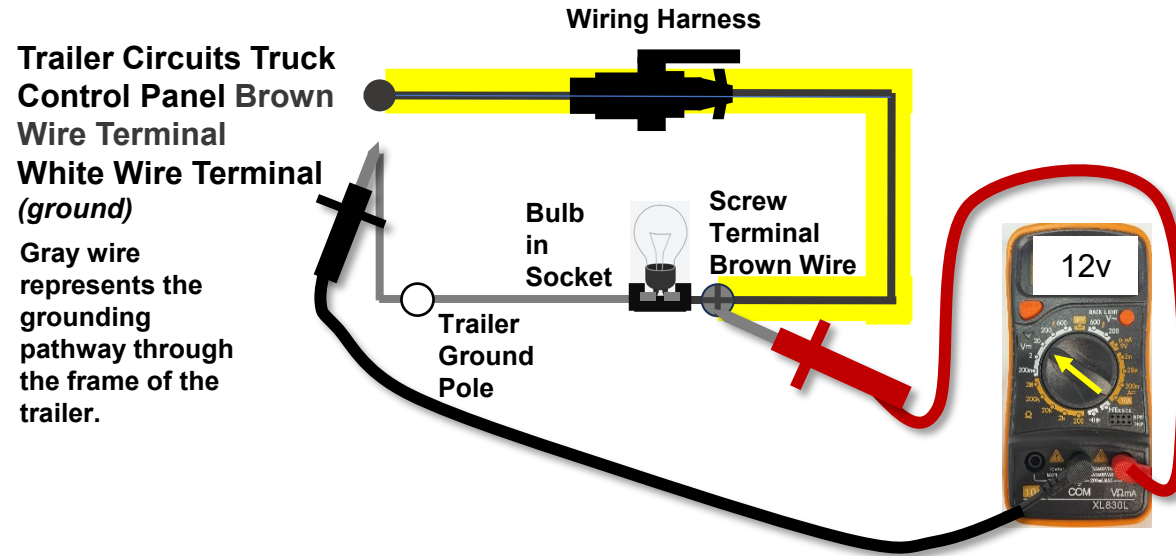
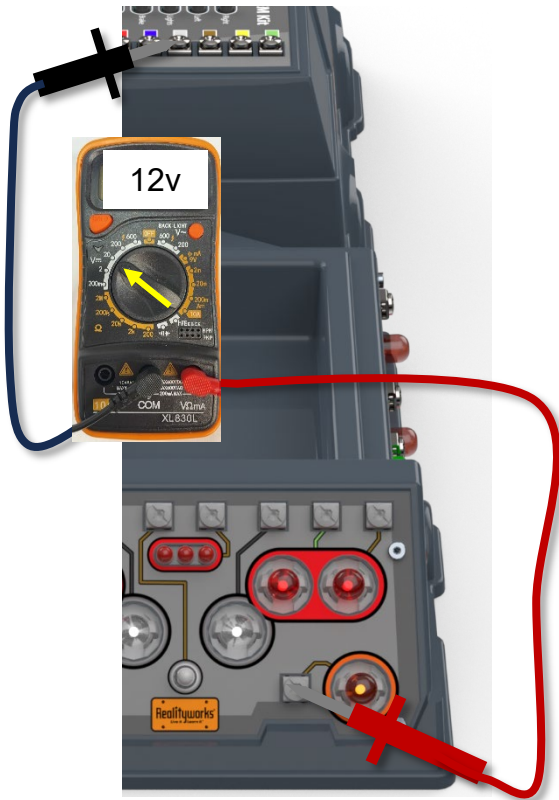
1. Set the dial to 20VCD
2. Touch the black probe to the white terminal on the control panel (equivalent to touching the - terminal on battery)
3. Touch the red probe to the light's brown wire terminal

Test Results: The meter should read about 12 volts... telling you that yes there is power flowing through the brown wires to this terminal



What would it mean if the meter read 0 V instead?

Visualizing Question 2: How Much Voltage is Getting to the Light's Terminal?



This test tells you that the highlighted part of the circuit is good, because you have measured that 12 V of electrical energy is traveling to the brown terminal.

Testing Question 3: Is There Power at the Light's Socket?

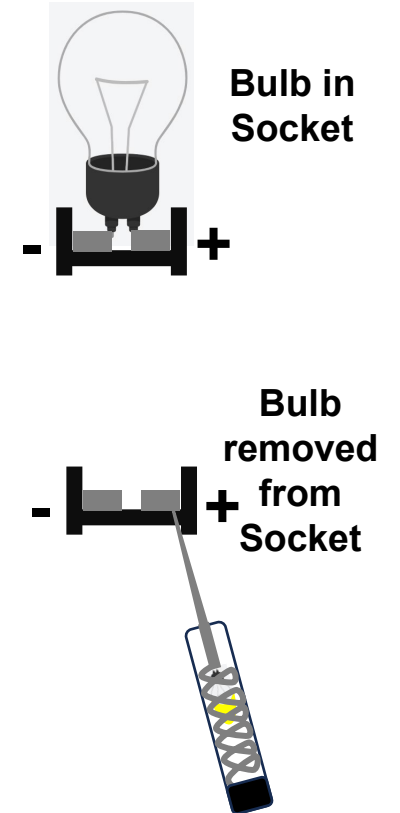
With the auto light tester, gently remove the light bulb from its socket with your fingers. In the socket, you will notice two metal terminals. When the bulb is installed normally, it connects these terminals, allowing current to flow between them by passing through the bulb.

Connect the clamp to the ground post and touch the probe to one of the socket's terminals (where the brown wire connects as shown).

Test Results:

- **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

What would it mean if the auto light tester did *not* light up?

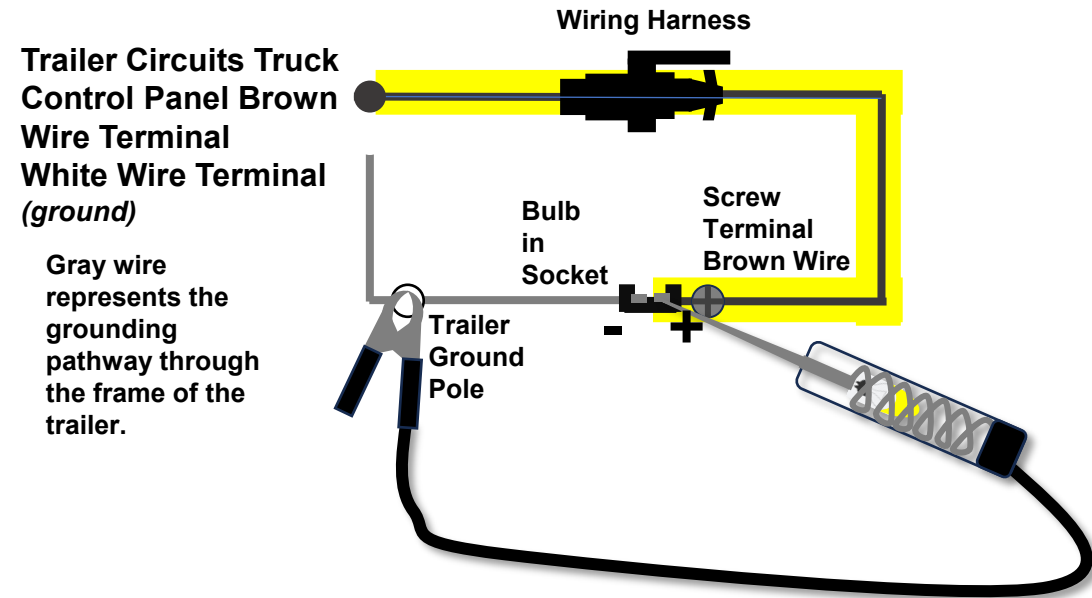


Visualizing Question 3: Is There Power at the Light's Socket?

**How you are testing
on the Trailer
Circuits Truck**



**Simplified model of
what you are testing**



This test tells you that the highlighted part of the circuit is good, because charges are flowing through it, through the test light, and to the ground.

Testing Question 4: What is the Voltage at the Light's Socket?

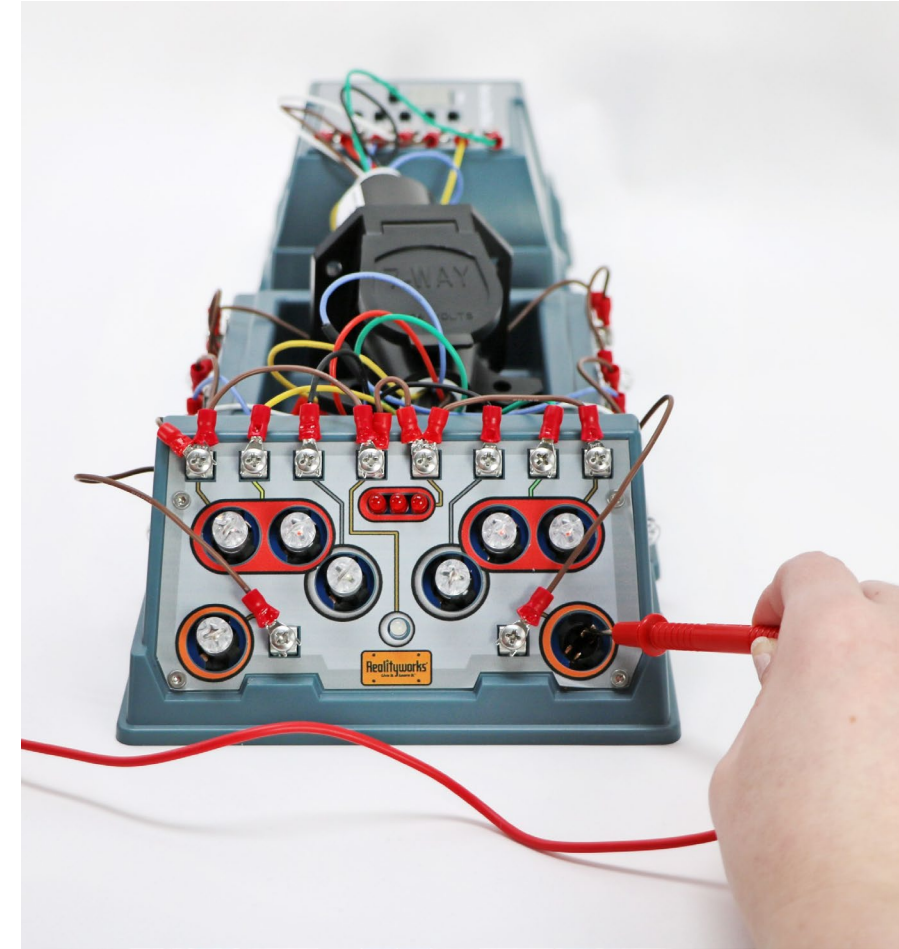
With Multimeter:

1. Set the dial to 20VCD.
2. Touch the black probe to the white terminal on the control panel.
3. Touch the red probe to one terminal in the socket.
4. 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.

What would it mean if the meter read 0 V on the + terminal?



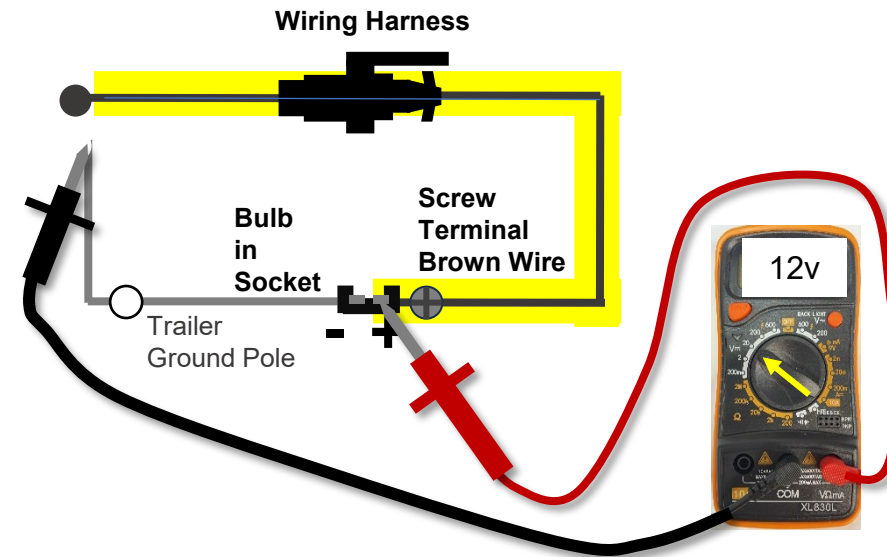
Visualizing Question 4: What is the Voltage at the Light's Socket?

Trailer Circuits Truck Test



Trailer Circuits Truck
Control Panel Brown
Wire Terminal
White Wire Terminal
(ground)
Gray wire
represents the
grounding
pathway through
the frame of the
trailer.

Simplified Test Model



This test tells you that the highlighted part of the circuit is good, because you have measured that 12 V of electrical energy is traveling to the + socket terminal.

Testing Question 5: What is the Voltage Across the Light's Socket?

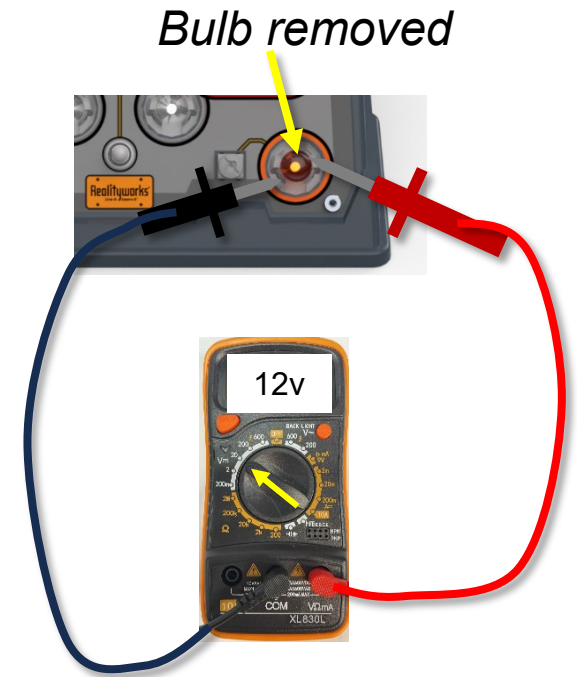
With Multimeter:

1. Set the dial to 20VCD.
2. Remove the bulb from the socket.
3. Touch the black probe to the – terminal of the socket.
4. Touch the red probe to the + terminal in the socket.

Test Results:

- **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
- **0V:** This means that charges cannot flow, which tells you that the circuit is open (broken).

What would it mean if the meter read 0V *and* prior questions 1-4 all showed that the first section of the circuit *is* working?

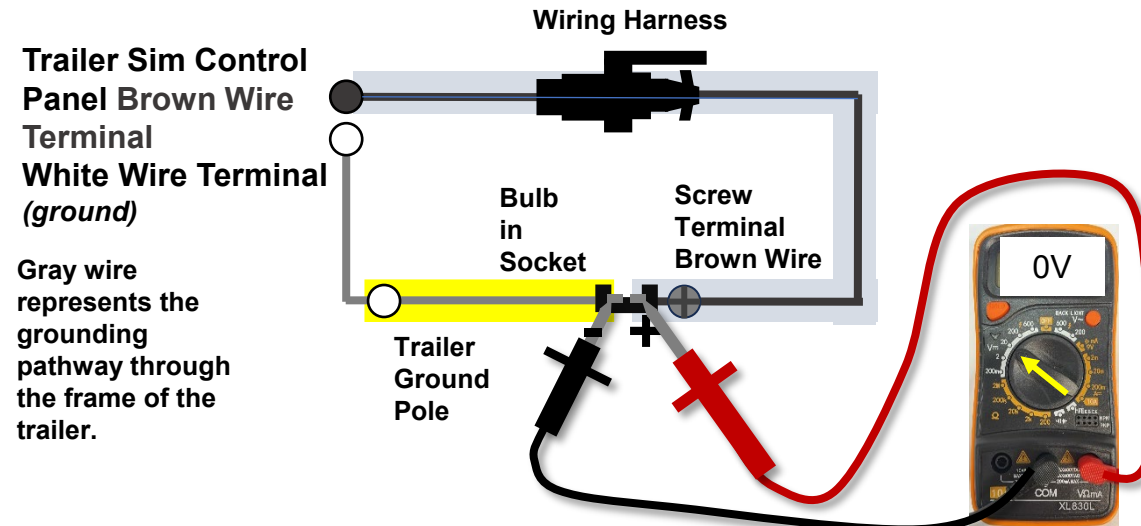


Visualizing Question 5: What is the Voltage Across the Light's Socket?

Trailer Circuits Truck Test



Simplified Test Model



If you read 0 V in this test, but you know the light blue sections are working from Tests 1-4, you can conclude that the ground is faulty (section highlighted in yellow).

Scenario 1: Testing Routine

Problem: Rear Marker Light is Not Working

Question:	What testing showed us:	Answer:
Question 1: Is power getting to the light's terminal?	Auto light tester showed power making it to the brown wire screw terminal at the light.	Yes
Question 2: How much voltage is getting to the light's terminal?	The multimeter measured 12V at the brown wire screw terminal at the light.	12V
Question 3: Is there power at the light's socket?	The auto light tester showed that one side of the socket had power, while the other side did not. This is expected because the bulb was removed, preventing charges from traveling across the socket.	Yes
Question 4: What is the voltage at the light's socket?	The multimeter showed 12V on one side of the socket, and some transient voltage on the other side.	12V
Question 5: What is the voltage across the socket?	The multimeter measured 12V across the socket, confirming that the ground side of the circuit is working, and the circuit is fully intact.	12V

Scenario 1: Indicators

These five testing questions have told us that our circuit is good.

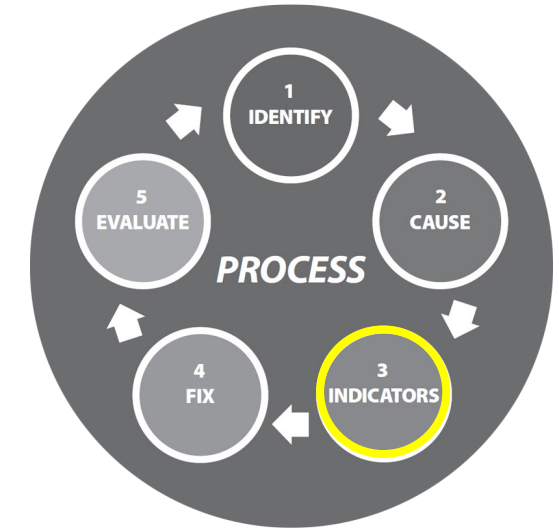
So, what is the only thing on the Causes list that we have not checked?

Clue... we removed it for testing!

Identify: Lower right marker light is not working.

Causes:

- Faulty bulb
- Loose connection
- Corrosion
- Broken wire
- Faulty ground
- Connector damage
- Blown fuse
- Short circuit



Indicators: Testing showed us that the circuit is providing a complete path for charges to flow.

Scenario 1: Indicators

The bulb.

It is the only thing we did not examine or test.

- In the real world, we would examine the bulb to see if it is burnt out
- But this is just a simulation to practice troubleshooting and testing

Fix: Try a new bulb

Evaluate: Test all the lights and see if it works!

Scenario 1 Troubleshooting Summary: The lower right marker light was not working because the bulb is dead.

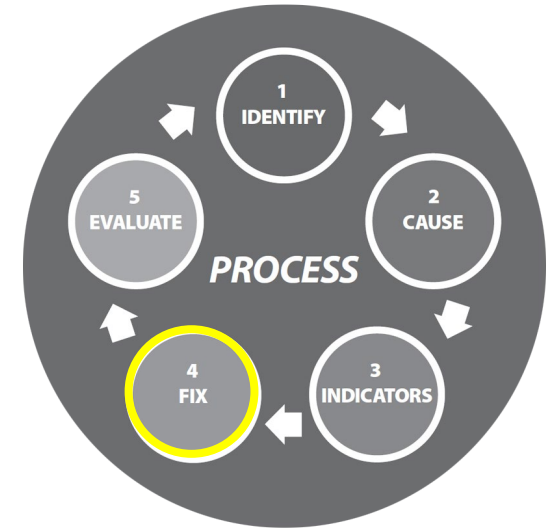
Identify: Lower right marker light is not working.

Causes:

- Faulty bulb
- Loose connection
- Corrosion
- Broken wire
- Faulty ground
- Connector damage
- Blown fuse
- Short circuit

Indicators: Testing showed us that the circuit is providing a complete path for charges to flow.

Fix: Try a new bulb



Congratulations!

- You have used the troubleshooting process to successfully identify the fix for Scenario 1
- The problem was a light not working
- The indicators and our testing led us to the conclusion that Scenario 1 is a burnt-out light bulb



**Done with the student workbook for
Lesson 7?**

**See your instructor to check the key
and/or turn in.**

For more information, please contact Realityworks, Inc.
through email at information@realityworks.com
or call toll free at 800.830.1416



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