

Webinar:

Shockingly Effective: Teaching Electricity for Real-World Learning



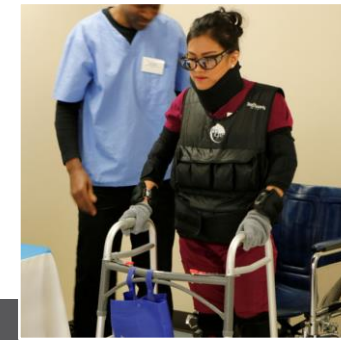
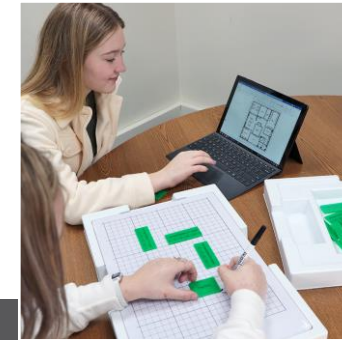
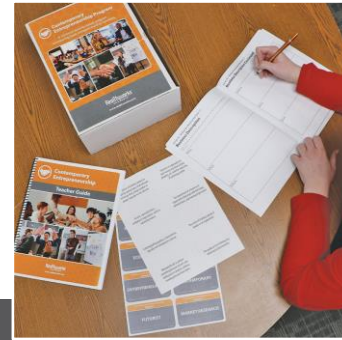
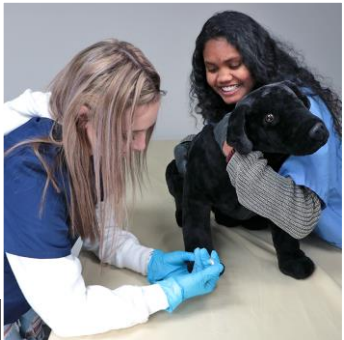
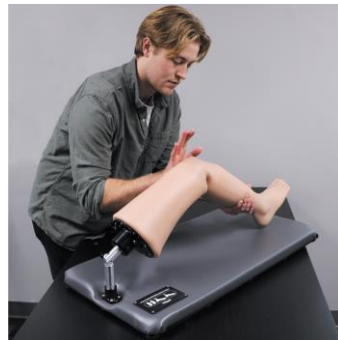
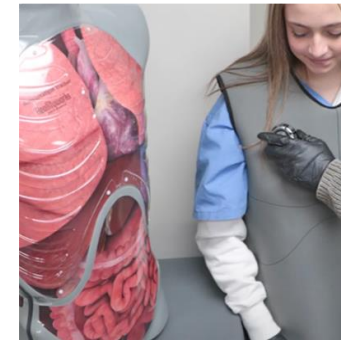
With Todd Hunter

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Who is Realityworks?



We partner with educators, administrators and industry leaders to ensure our offerings meet their needs and make lessons truly meaningful.

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Presented by

Todd Hunter

STEM and Career Exploration Product Manager

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Webinar Agenda:

- A. Why Teach Electrical Concepts Hands-On?
- B. Where to Start?
- C. Trailer Circuit STEM Kit
- D. Electrical Wiring Kit
- E. Safe and Effective Implementation
- F. Resources & Support





Why Teach Electrical Concepts Hands-On?



Understanding the Invisible

Common Approach:

1. Electrical Theory
2. Circuit Diagrams
3. Build a circuit with wire, battery, DC motor or light.

Result = Little transference.

Transference = *Ability to apply knowledge or skills learned in one context to a different context.*

For example:

- A student learns Ohm's Law in class → can they apply it when building an Arduino-connected circuit?
- A student practices problem-solving with resistors in a textbook → can they reason through a wiring issue in a real breadboard circuit?



Types of Transfer

Researchers like Barnett & Ceci (2002) and Perkins & Salomon (1988) have categorized transfer in a few ways:

Type	Description	Example
Near Transfer	Applying learning in similar contexts	Solving another series circuit after practicing one
Far Transfer	Applying learning in very different contexts	Using circuit reasoning to understand how a fuse works in a house
Forward Transfer	Using learning in the future when a need arises	Recalling circuit reasoning when building a new device
Backward Transfer	Recalling past learning when in a new situation	Thinking back to how a sensor circuit worked when programming a new one

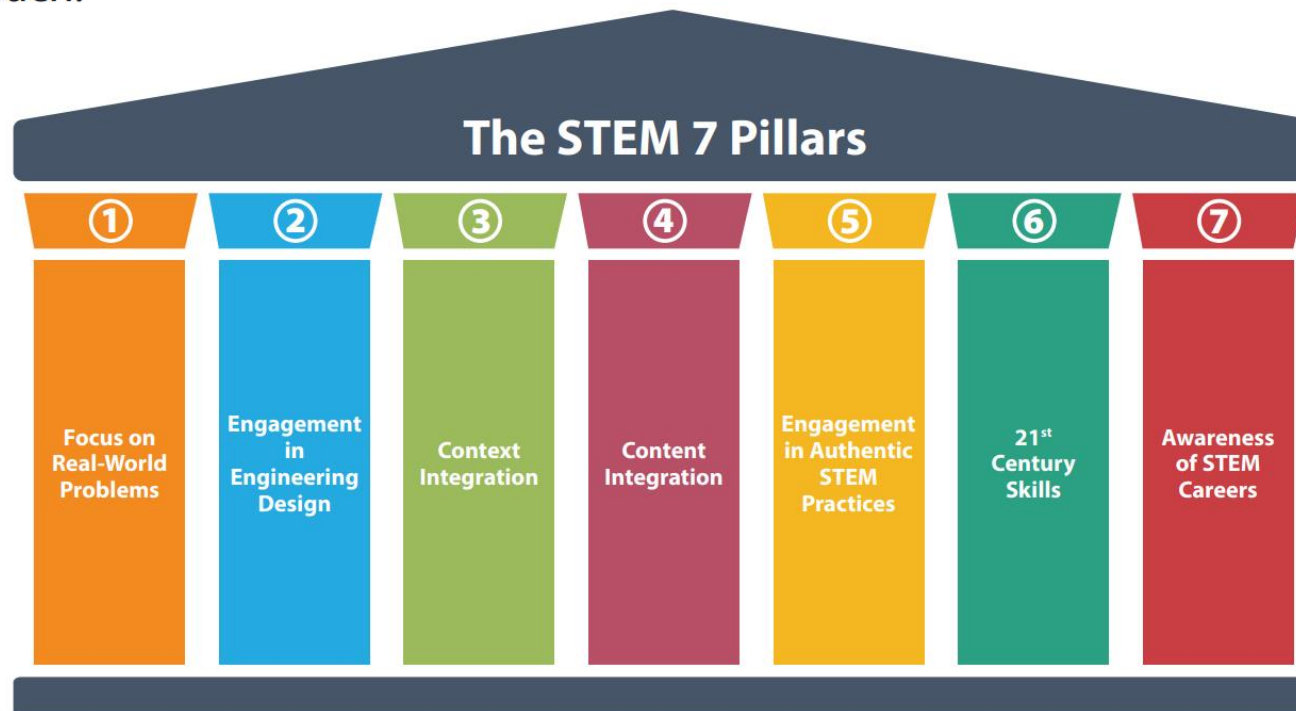


Where to Start?



The STEM 7 Pillars: A Framework for STEM-Powered Learning

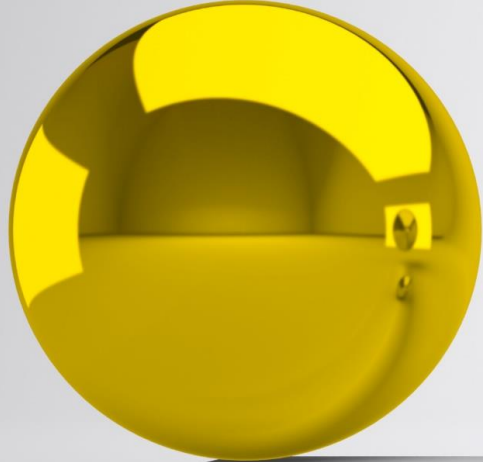
Realityworks adheres to a framework known as the “STEM 7 Pillars” when designing tools and resources that promote STEM education. These pillars ensure that students engage with meaningful, real-world problems, develop critical thinking and engineering skills, and are prepared for future careers in STEM fields. Let’s explore each pillar and how Realityworks’ products fit into this powerful approach.



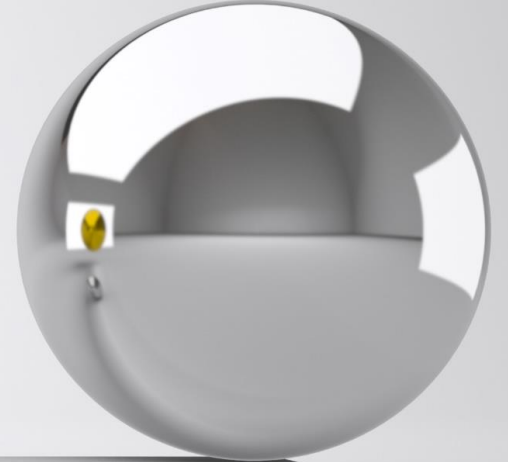
*Adapted from
Gillian Roehrig
UMN-Twin Cities*

The Balancing Act

**Electrical
Concepts
& Content**



**Transference
Driving
Experience**





Trailer Circuit STEM Kit





Trailer Circuits STEM Kit

The Trailer Circuits STEM Kit is the ideal solution for educators who want to make learning electricity engaging, tangible, and safe. Teaching electricity can be challenging—its invisible nature often makes it hard for students to grasp how it powers the world around them. This kit transforms the mystery of electricity into a concrete set of skills through the real-world context of wiring a trailer, making the learning process both accessible and practical.

***Learning Experience =
HIGH TRANSFERENCE***



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Unboxing the TCK



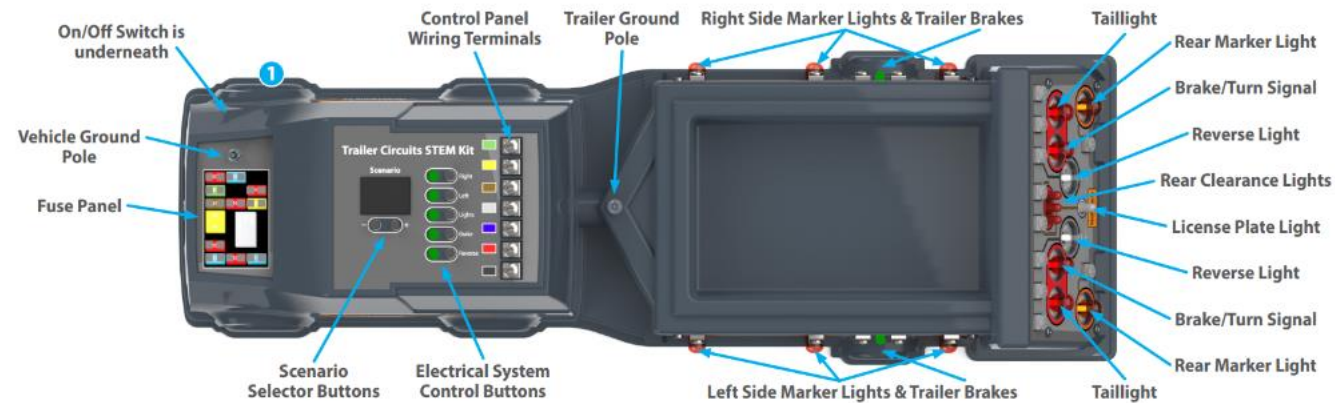
Trailer Circuits STEM Kit



Visual Checklist:

- | |
|------------------------------------|
| 1) Trailer Circuits Trucks |
| 2) 4-way Harness |
| 3) 7-way Harness Vehicle Side |
| 4) 7-way Harness Trailer Side |
| 5) Multimeter |
| 6) Wire Stripper and Crimping Tool |
| 7) Screwdriver* |
| 8) Auto Light Tester |

*Screwdriver type may vary



Meet the Electrician

Author



Jeff Wagner is a semi-retired electrician with 25 years of experience in the industry. Over the course of his career, he contributed to electrical construction projects totaling over \$100 million. In addition to his hands-on work, Jeff has developed and written many online adult education classes, covering topics such as NEC Code updates and Electrical Exams for Class A, B, and C licenses with endorsements.

As a young man, Jeff served in the U.S. Army, providing personal security for several NATO generals and dignitaries. A lifelong fitness enthusiast, Jeff is passionate about running, biking, martial arts, and yoga. He also enjoys archery, excelling with multiple recurve bow styles.

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Where does this fit in my school?

- **STEM**
- **Automotives**
- **Robotics**
- **Engineering**
- **Science**
- **Physics**
- **Physical Science**
- **Agri Tech**
- **Automotive Tech**
- **Electricity**

Lesson 1: DC Electricity Basics

Trailer Circuits STEM Kit: Why Its Safe

- Engineers have designed this kit to *behave* just like the 12VDC system you would find in a car or truck
- This kit will measure, light up, and show all the same values that you would see if you were working on an actual vehicle
- But... its powered by 4 AA batteries and controlled by a complex circuit board that electrical engineers designed to keep you safe
- If you have ever watched someone incorrectly try to “jump” a dead car’s battery... you probably saw a lot of sparks and maybe even heard some painful yelling.

...That WILL NOT happen with this Kit.

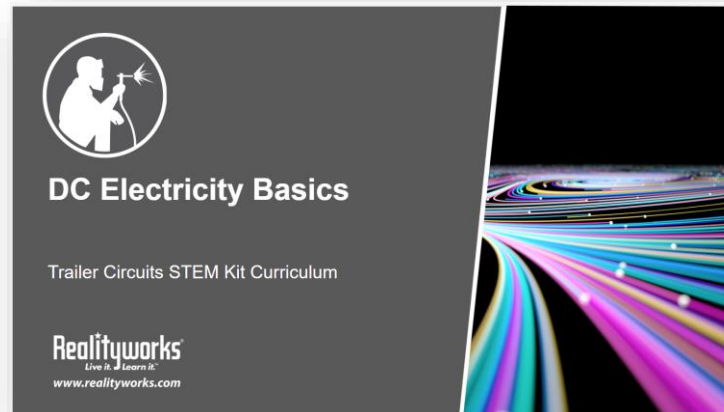
We encourage you to learn, experiment, test, connect, and figure it out safely here, so you are ready to safely work on a real car in the future.

Trailer Circuit STEM Kit sets you up for success

3 Simulators + Teacher's Consumables Box



LMS Ready Student Slideshows



Lesson One – DC Electricity Basics

Lesson Overview

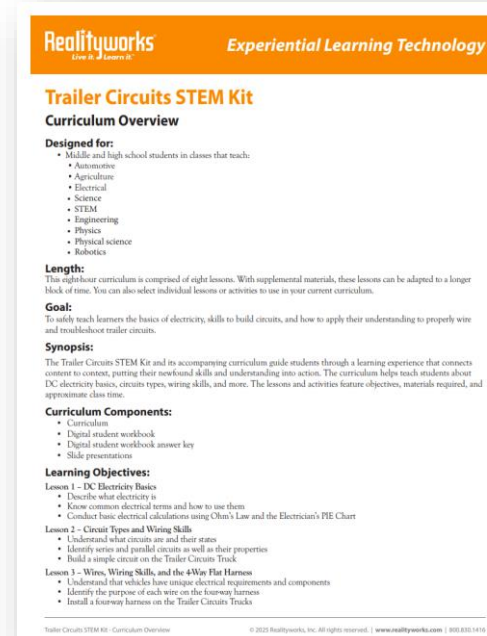
Students will be introduced to the physics of electricity, the measurable properties of voltage, current, resistance, and power. They will also develop the ability to do simple electrical calculations with Ohm's Law and the Electrician's PIE Chart.

Lesson Objectives

After completing this lesson, participants will be able to:

- Describe what electricity is
- Know common electrical terms and how to use them
- Conduct basic electrical calculations using Ohm's Law and the Electrician's PIE Chart

Teacher's Guide & Keys



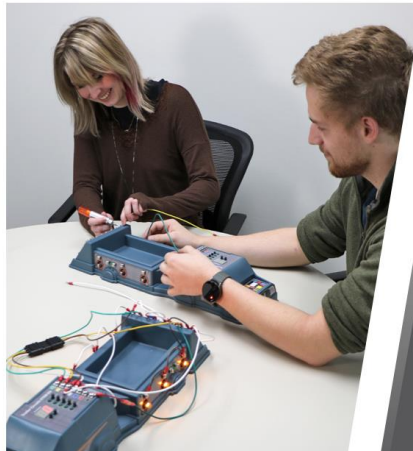
Student Workbook



Lesson 2: Circuit Types and Wiring Skills

Start Wiring the Trailer Circuits Trucks

- We will use the Trailer Circuits Trucks to build and test:
 1. Simple series circuits
 2. Simple parallel circuits
- Look under the truck and ensure the power switch is off
- Rule 1: Never work on or build circuits with live power



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You Will Need These Tools



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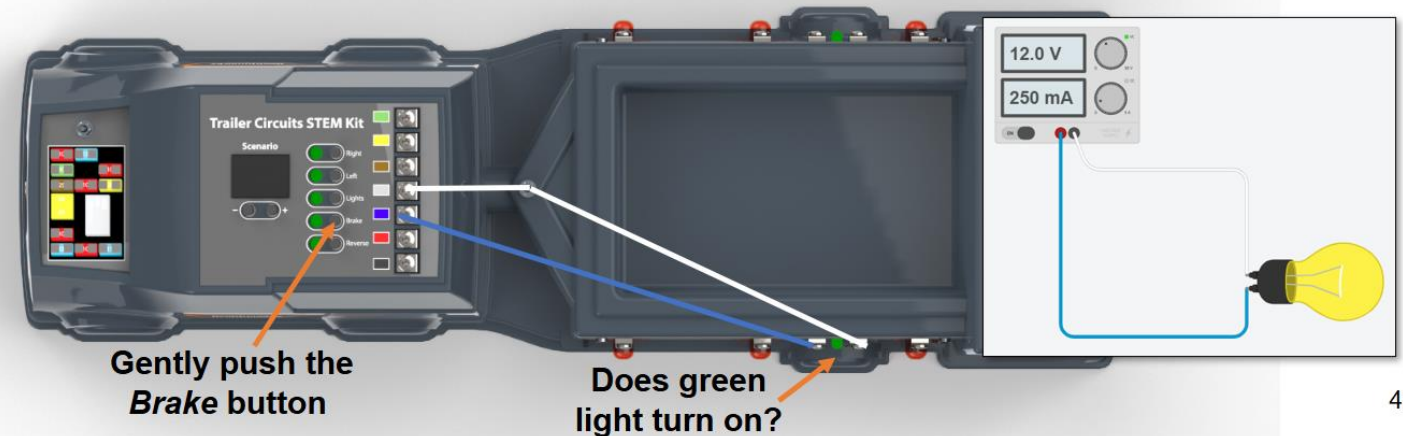
Follow Along with the White and Blue Wires

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Series Circuit: Step 8

Test the circuit.

1. Turn on the Trailer Circuits Truck using the switch on the bottom. Ensure batteries are installed.
2. Gently push the **Brake** button. You should see the green light turn on.
3. If the green light turns on, ***you successfully built a series circuit!***



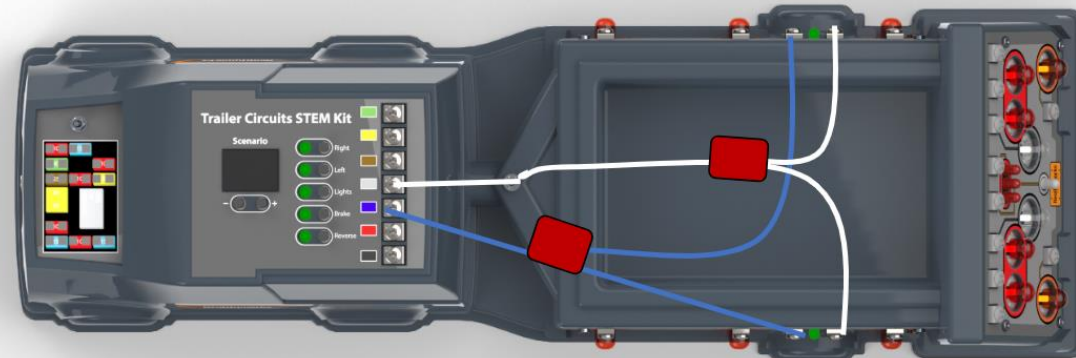
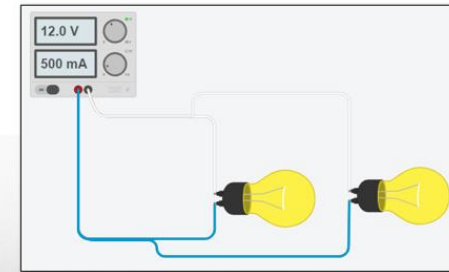
Series Circuit

Follow Along with the White
and Blue Wires
+ Red 3-Way Connector

Parallel Circuit: Step 8

Test

1. Power on the Trailer Circuits Truck with the switch underneath.
2. Gently push the *Brake* button.
3. Do both green brake lights turn on?

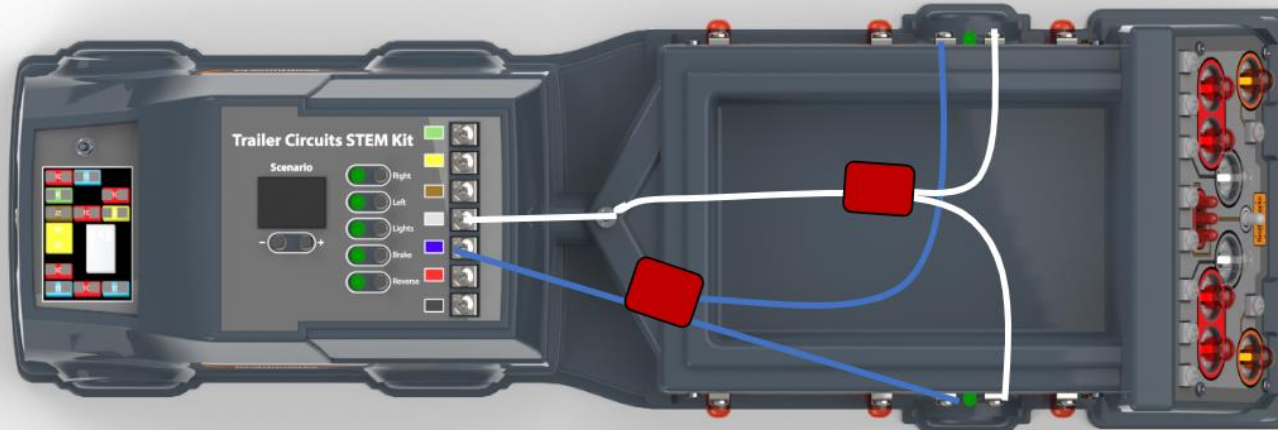
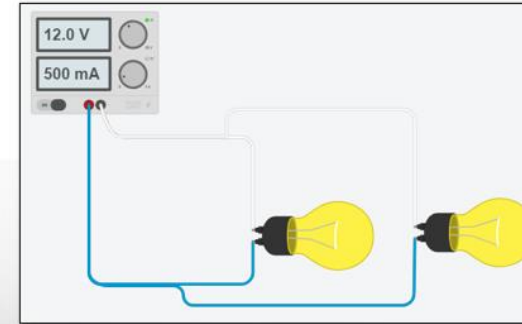


Parallel
Circuit

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Test

1. Power on the Trailer Circuits Truck with the switch underneath.
2. Gently push the *Brake* button.
3. Do both green brake lights turn on?



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Parallel Circuit

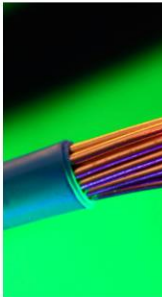
Next Step: Prepare for the 4-way Harness

Resistance, Insulators, and Conductors

- **Resistance** of electrical circuit
- **Conductors** allow electricity to flow through them
- **Insulators** prevent electricity from flowing and can be used to protect wires and components
- We choose the right materials for the job

Conductors: Copper and Aluminum

Copper is a good conductor of electricity. Aluminum is also a good conductor but is not as good as copper.



Commonly Used Vehicle Wire Types

Various wires are used throughout a vehicle. Properties of Wires:

- Multi-stranded
- Flexible insulation
- Usually rated for 90° C
- Resistant to moisture, fungus, and abrasion
- Important information on the wiring diagram

5 Types of Commonly Used Wire in Vehicles

GPT or Primary Wire

- The most common general purpose automotive wire
- Multi-stranded
- Usually rated to 80° C
- Trailer wire is GPT wire

SXL Wire

- Cross-linked poly-jacketed can withstand higher heat, abrasion, aging

Battery Cable

- 6 AWG – thick, can carry high current
- Connects to the vehicle's battery and major electrical system components

Motor wire (1015 or hook-up wire)

- This has finer strands than GPT wire, higher temp rating
- Resistant to grease, oil, acids, solvents

Speaker Wire

- Intended for low voltage and should never carry a large load
- Looks similar to lamp cord

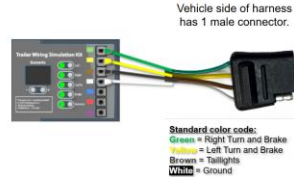
Step 1: Prepare the Wire Ends

1. Remove ½" of the sheath from all the wire ends.
2. Instead of J-hooks, we will use U-shaped crimp terminals.
3. Slide a crimp terminal over the end.
4. Crimp (smash) the terminal down using the crimp tool on the wire cutter as shown.
5. This should secure the terminal to the wire.
6. Repeat for all the wire ends, so each wire on both sides ends with a u-shaped crimp terminal.



Step 2: Connect the Vehicle Side

Use the screwdriver to secure the wires to the vehicle's terminals, matching the colors as shown.



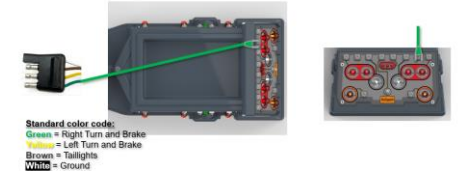
Step 3: Connect the Trailer Side – Ground

Use your fingers to securely tighten the white wire to the trailer's ground post.



Step 4: Connect the Trailer Side – Right Turn/Brake

Use the screwdriver to securely tighten the green wire to the right light brake terminal.



Start

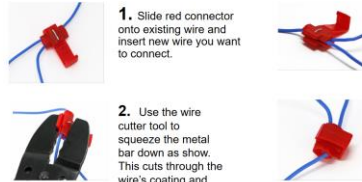
Step 7: Connect the Trailer Side – Right Taillights

1. Measure and cut an 8" length of brown wire off the spool.
2. Strip ½" off one end of this brown wire and install a U-shaped crimp terminal.
3. Connect this crimp terminal to the right taillight terminal.
4. Use a red 3-way snap connector to connect this new brown wire to the existing brown wire on the trailer, as shown below.



How to Use Red 3-Way Connectors

1. Slide red connector onto existing wire and insert new wire you want to connect.
2. Use the wire cutter tool to squeeze the metal bar down as shown. This cuts through the wire's coating and electrically connects the 2 wires' conductive cores.
3. Confirm that metal bar is fully squeezed down.
4. Wrap plastic snap over the connector so it snaps shut.



Step 6: Connect the Trailer Side – Left Taillights

Use the screwdriver to securely tighten the brown wire to the left taillight terminal.

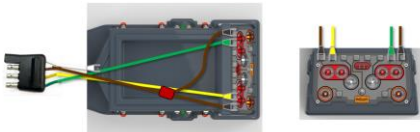


Step 5: Connect the Trailer Side – Left Turn/Brake

Use the screwdriver to securely tighten the yellow wire to the right left brake terminal.



Step 8: Connect the Trailer Side – Confirm Connections



Step 9: Connect the Harness

- Plug the 2 sides into each other, as shown below
- You may need to twist 1 of them, so they line up correctly



Step 10: Confirm and Power On

1. Check your complete setup.
2. Turn on the power switch underneath the Trailer Circuits Truck.



4-Way Harness

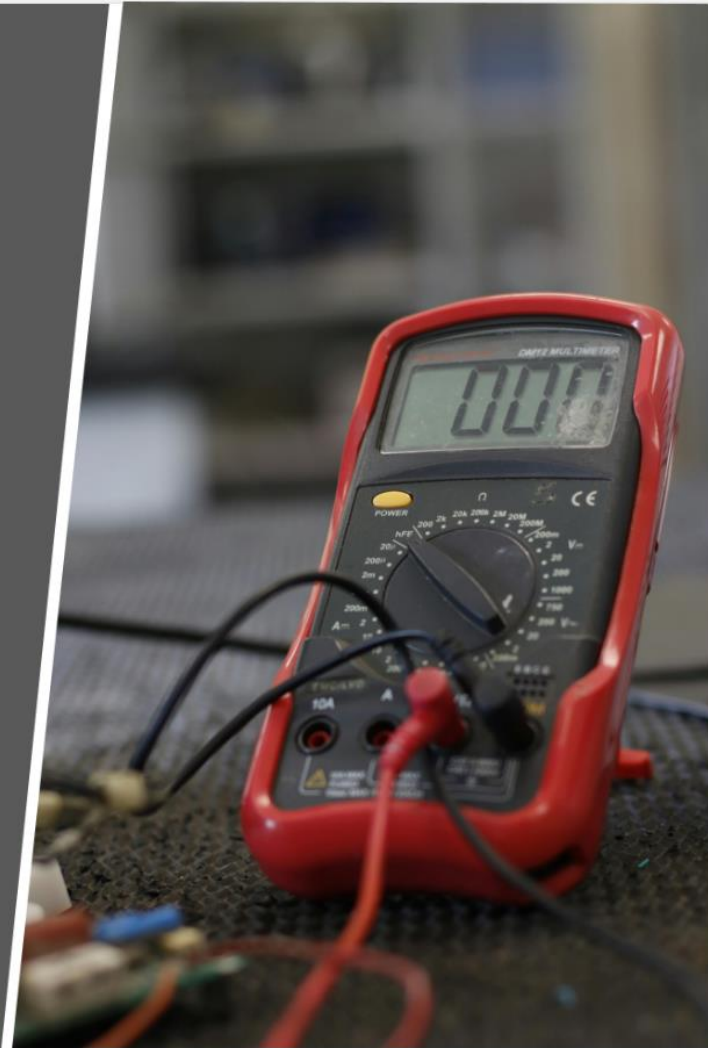
ACTIVATE NEXT LEVEL! Lesson 4



Testing with a Multimeter and Auto Light Tester

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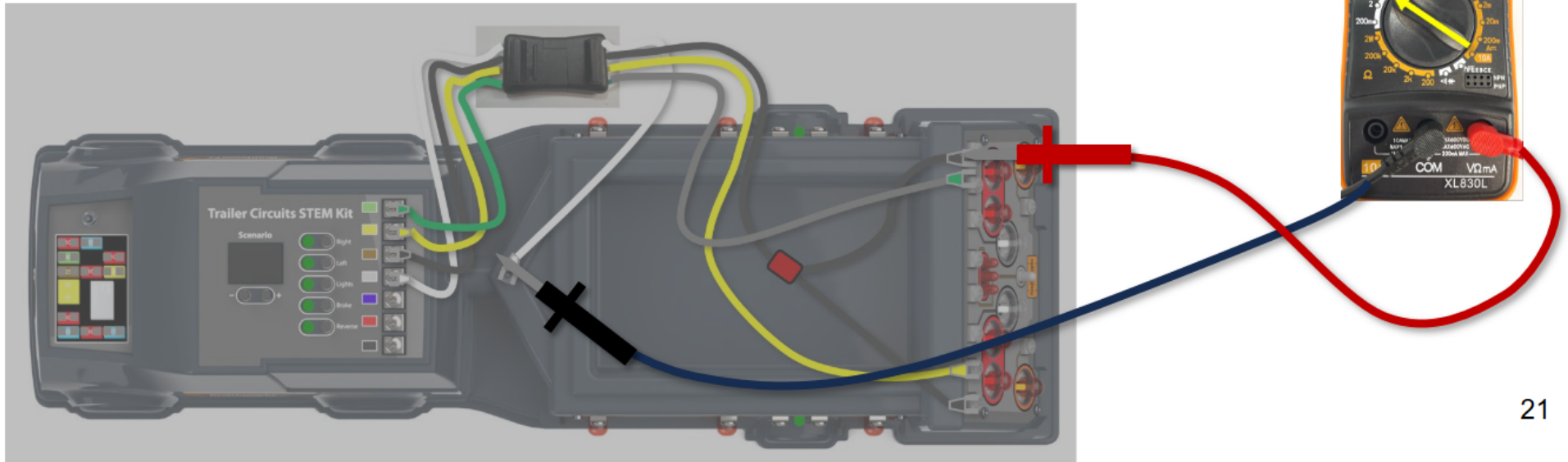
You Will Need These Items

1. Multimeter
2. Auto light tester
3. Trailer Circuits Trucks with 4-way flat harness installed and tested

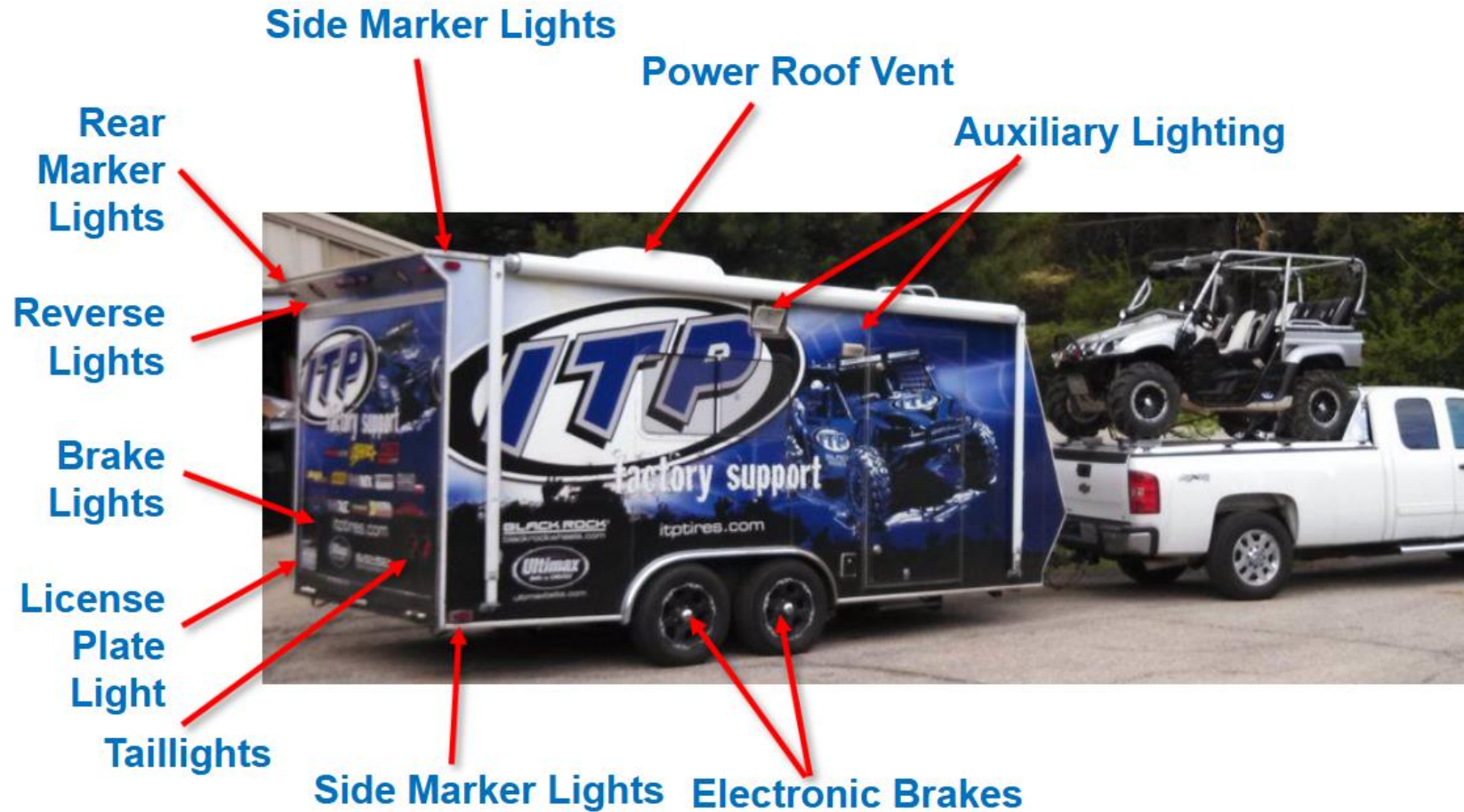


Measuring Voltage: Try it!

1. Turn on the Trailer Circuits Trucks with the 4-way flat harness installed.
2. Turn on the taillights by gently pushing the Lights button on the control panel.
3. With the taillights on, place the multimeters probes as shown:
 - **Red Probe:** Right taillight terminal (brown wire)
 - **Black Probe:** Trailer ground post
4. The multimeter should read **12 V**. *This means there is a potential difference of 12 V between these 2 points on the circuit.*



Sometimes, a 4-Wire Harness is not Enough



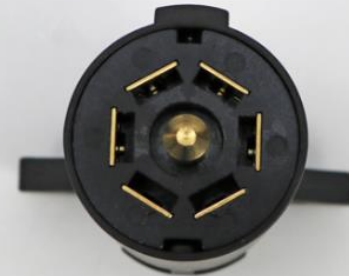
ACTIVATE NEXT LEVEL! Lesson 5



Wiring the 7-Way Round Harness

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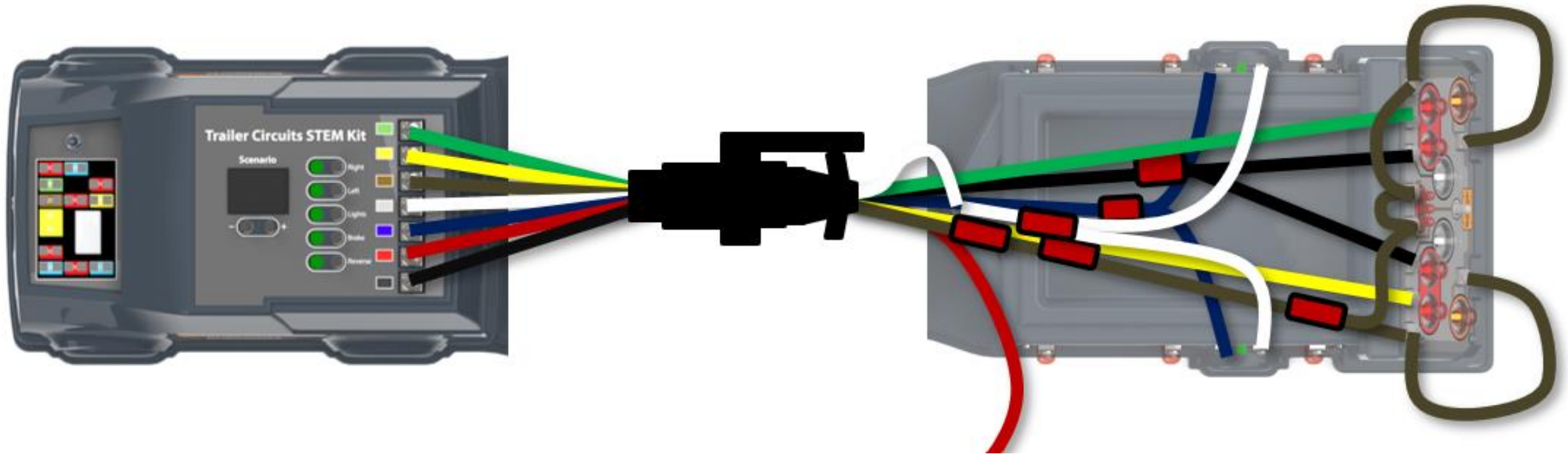
How to Wire a 7-Way Round Harness

You will need the following:

- 7-way harness (both sides) →
- Screwdriver
- Wire cutter
- 7 U-shaped crimp terminals
- 14 wires (2 of each color, 15" long pieces of each wire)
 - Green
 - Yellow
 - Brown
 - White
 - Blue
 - Red
 - Black



Connect + Test Your 7 Way Harness.



RED?

**Auxiliary Power Systems for Trailers
= No connection on Simulator**

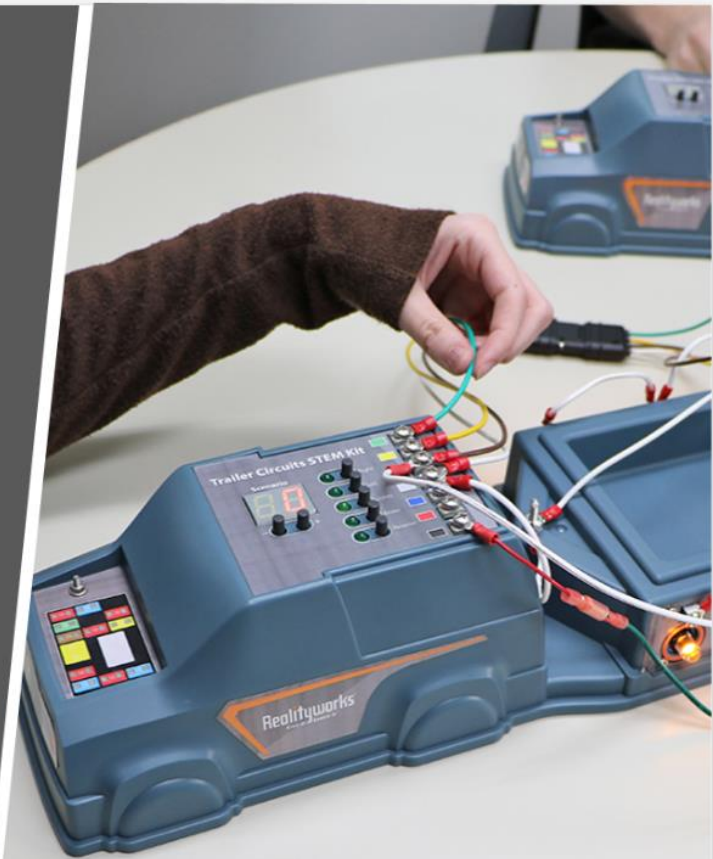
ACTIVATE NEXT LEVEL! Lesson 7



How to Troubleshoot Electrical Circuits

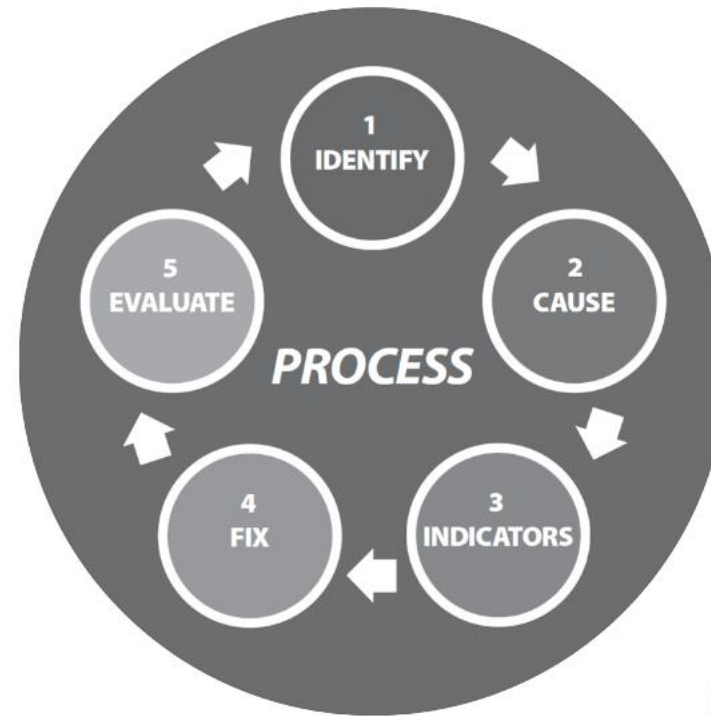
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What Is Our Troubleshooting Process?

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?



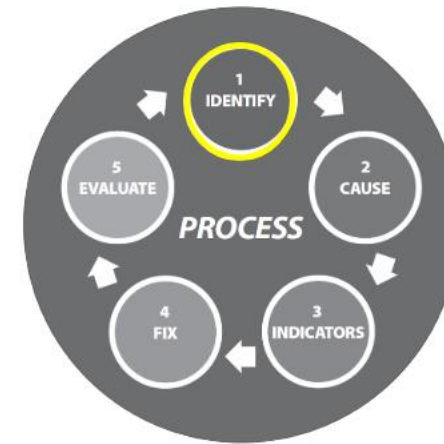
Let's Try Troubleshooting: Scenario 1 – Activate

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

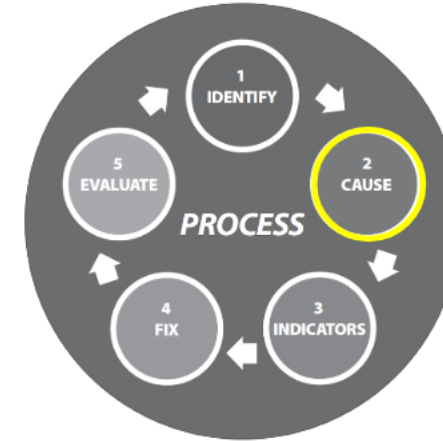
What are the possible causes of this problem?



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: 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

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.

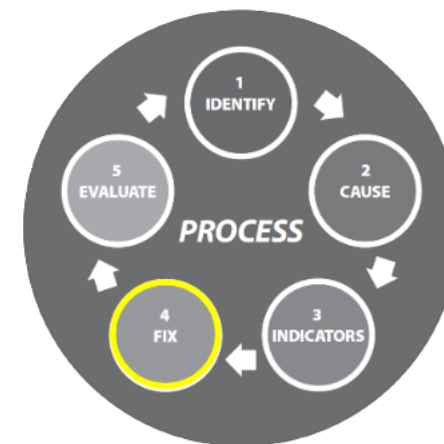
Identify: Lower right marker light is not working.

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



10 Scenarios

Scenario 2: Activate

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

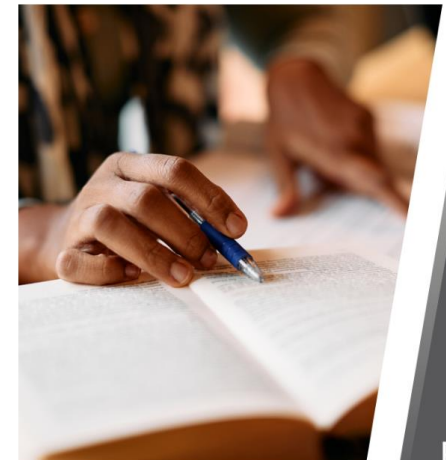


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Scenario 2

- Use your student workbook to guide your troubleshooting process
- Fill in the Troubleshooting Table for Scenario 2
- Go to the next slide once you think you know what the problem is in this scenario



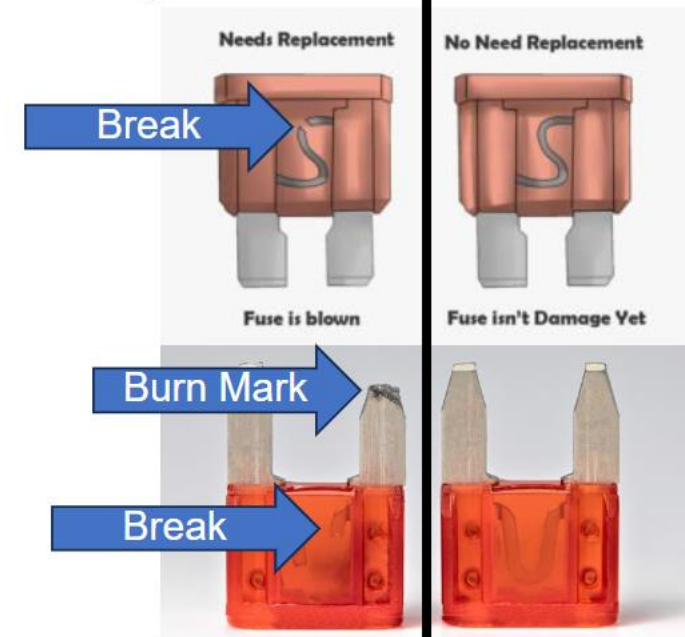
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Cause: Blown Fuse

- 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



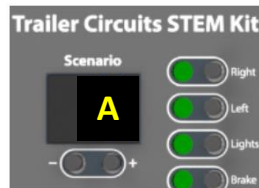
Testing Fuses on the Trailer Circuits Truck

- 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



Assessment Mode

1. **Select** the Troubleshooting Scenario you want... don't let the students see!
2. Quick momentary **push** down on – and + keys under numeric display.
3. Unit enters **Assessment Mode**; Shows “A”
4. Students complete the Troubleshooting **Test**.



Name: _____ Class: _____

Lesson 8: Troubleshooting Test

Instructions: Complete the following questions as you troubleshoot the mystery scenario.

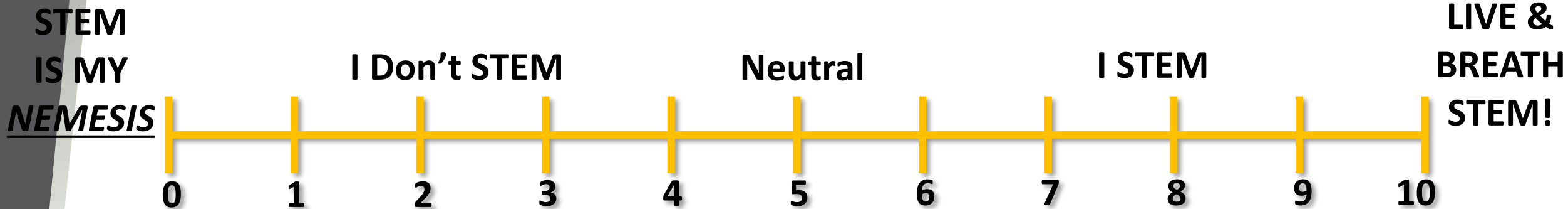
1. What problem have you identified?
2. What are potential causes of this problem?

Conduct the 5 Question Test Routine

3. Is power getting to the light's terminal?
4. How much voltage is getting to the light's terminal?
5. Is there power at the light's socket?
6. What's the voltage at the light's socket?
7. Is the light grounded correctly?
8. What do you think the fix is?

Skills, Exposure, and Knowledge:

- Conceptualizing real-world electrical circuit systems
- AC and DC power
- Series Circuits
- Parallel Circuits
- Ohm's Law
- Electrical terminology: voltage, current, resistance, conductors, insulators,
- Safe Practices
- Cutting, stripping, de-soldering, J-hooks, crimping, splicing 3-ways, terminals, mounting.
- How to wire a trailer and vehicle with the 4-way harness.
- How to test and evaluate an electrical system.
- How important Ground is.



Skills, Exposure, and Knowledge:

- How to use the Auto Test Light
- How to use the Multimeter
- How to wire a 7-way towing harness
- How to wire a complex trailer
- How to test electrical systems with Auto Test Light
- How to test electrical systems with Multimeter
- How to measure continuity, voltage, and current
- How to troubleshoot electrical circuits
- What common causes of circuit failure are
- 5 Question Test Routine
- How to check fuses

STEM
IS MY
NEMESIS

I Don't STEM

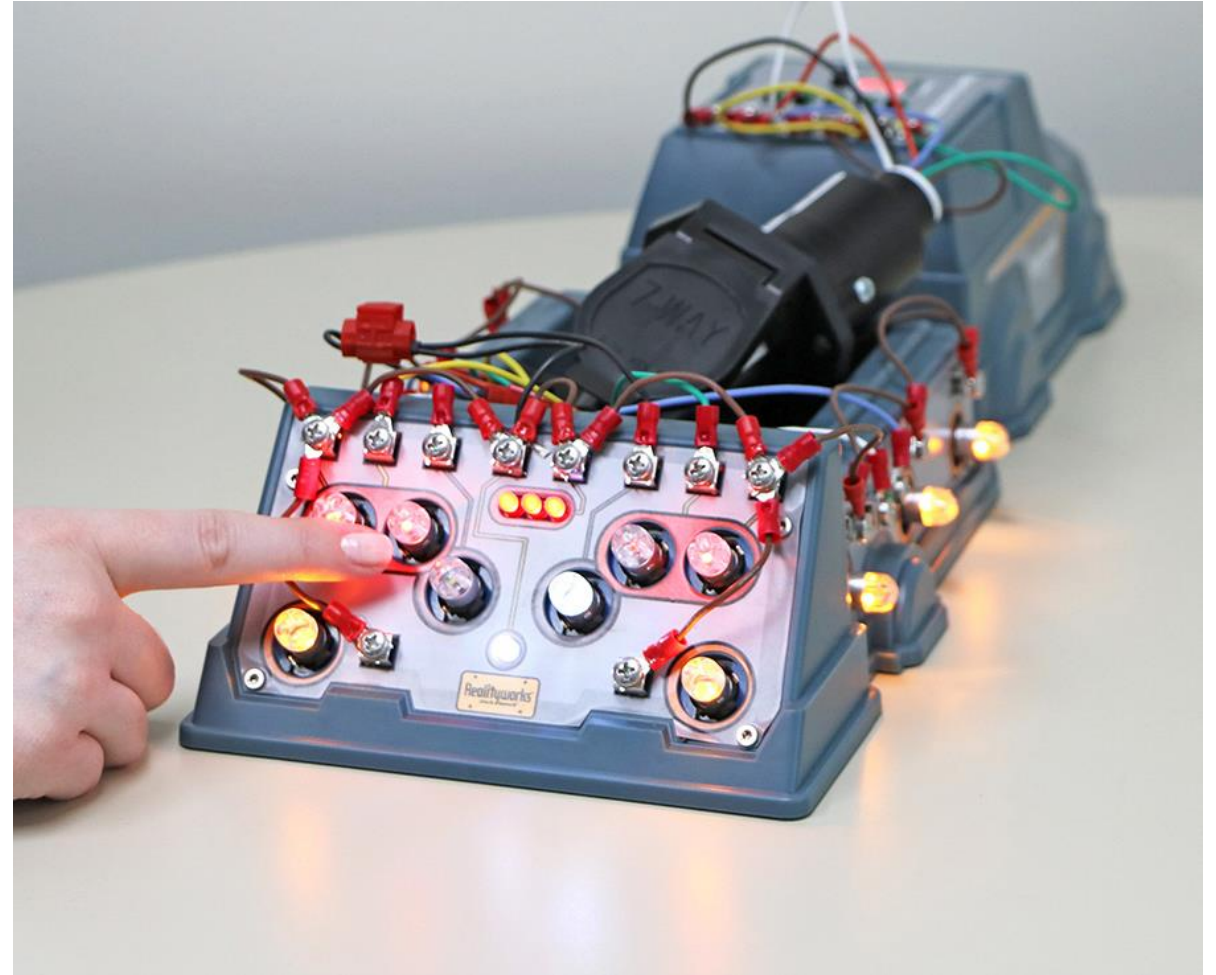
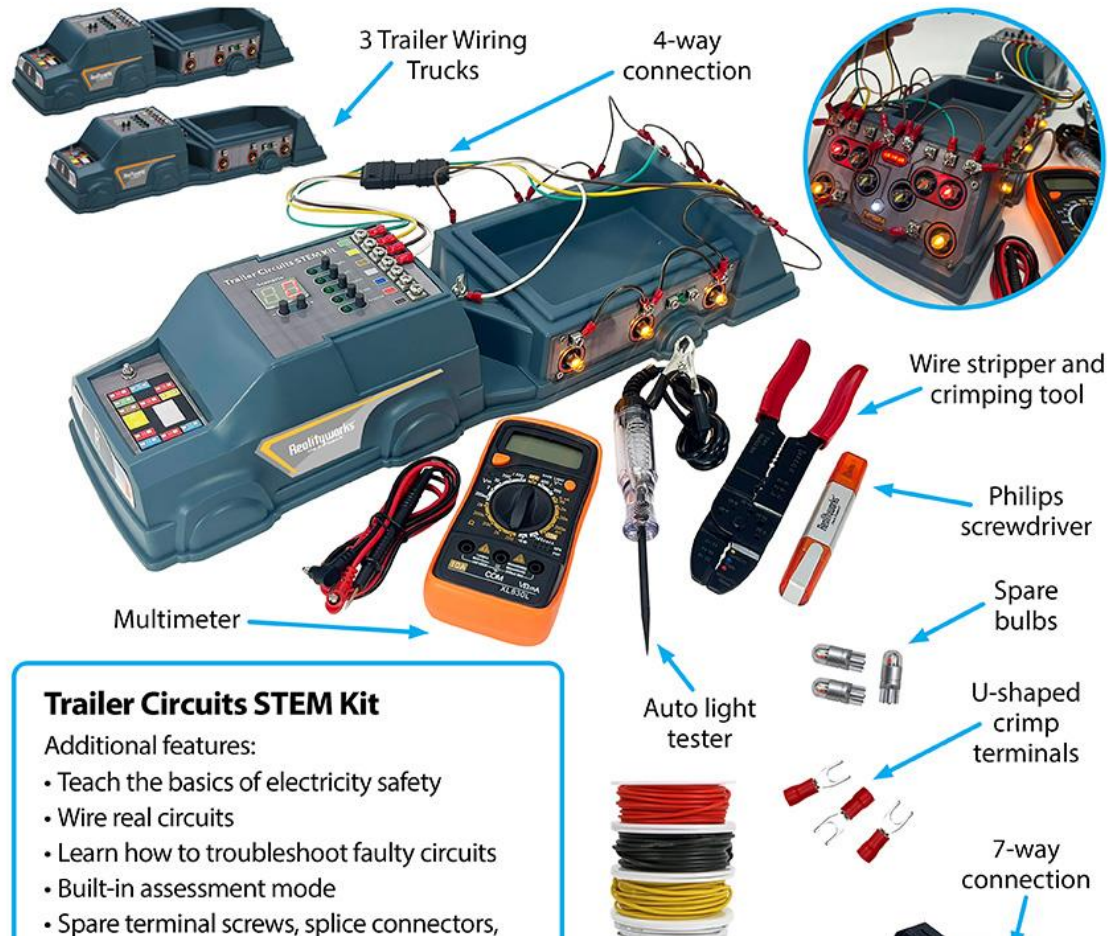
Neutral

I STEM

LIVE &
BREATH
STEM!



Trailer Circuits STEM Kit => High Transference





Electrical Wiring Kit



Electrical Wiring Kit

Teachers said...

- *How do I teach this in a classroom setting?*
- *I don't have space for this!*
- *How do students know they did it correct?*
- *I can't be everywhere at once?*
- *Students are too scared to do this!*
- *I don't have time to build this or get it all ready to teach with.*



Electrical Wiring Kit

Use the Electrical Wiring Kit to:

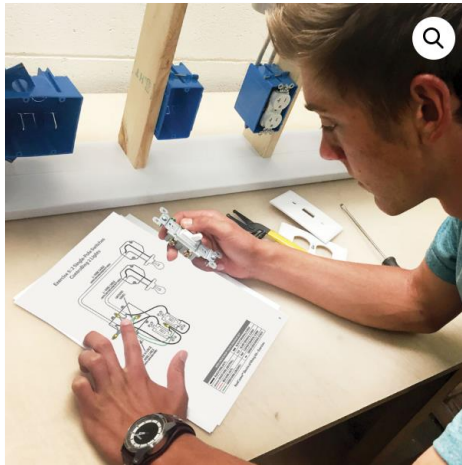
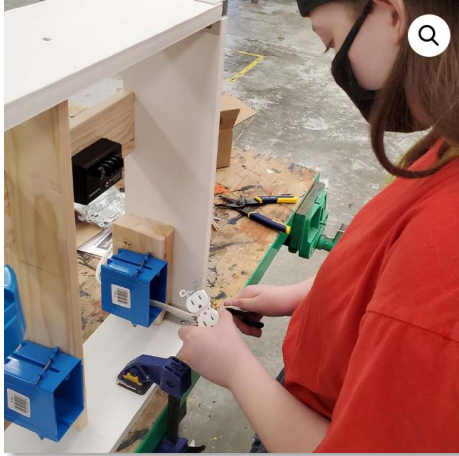
- Teach electrical wiring basics
- Demonstrate correct wiring techniques
- Conduct student-led electrical wiring exercises
- Safely identify and correct issues at a glance
- Improve classroom management and safety

**Builds the stage for
FORWARD TRANSFER**



Classroom Implementation

Realityworks®
Live it. Learn it.™
100% EMPLOYEE-OWNED



Electrical Wiring Kit



- **Battery powered:**
- ***No wall connection needed***
- **Safe Testing**
- **Provides immediate assessment**

Electrical Wiring Kit



Experiential Learning Technology

RealCareer™ Electrical Wiring Kit

Curriculum Overview

Designed for:

- High school students
- Post-secondary students
- Workforce development programs

Length:

This 13-hour curriculum is comprised of 3 lessons, 12 exercises and 4 enhancement exercises

Goal:

To give students general electrical wiring training and assessment on how to do proper household and commercial wiring.

Synopsis:

This kit and accompanying curriculum provide general electrical wiring training for common household and building wiring. This program will safely train students on electrical wiring, provide repetitive practice and assessment to increase wiring skills, introduce standard electrical symbols and electrical theory.

Curriculum Components:

- Teacher guide with 3 lessons
- Presentation slides
- Student exercises - set of 12 with 4 enhancement exercises

Learning Objectives:

Lesson	Title	Approximate Time
1	Electrical Safety – Personal safety, personal protective equipment, circuit safety, end user safety	60-70 minutes
2	Electrical Principles – Current, Voltage, Series and Parallel Circuits and Power	60-70 minutes
3	Basic Wiring Skills – The home electrical system, fixtures, wire, reading prints and troubleshooting	60-70 minutes

Exercises (with Electrical Wiring Kit accessories)	Title	Approximate Time
1	Wire a single outlet	10 minutes
2	Wire two outlets in different boxes	25 minutes
3	Wire a single-pole switch controlling a single light	20-25 minutes
4	Wire a single-pole switch controlling two lights	40-45 minutes
5	Wire two single-pole switches controlling two lights	45 minutes
6	Wire an outlet, light with pull chain – power through outlet	25-30 minutes
7	Wire a single-pole switch, light and outlet using 14-3	30-35 minutes
8	Wire an outlet and switch in double gang box with a light in another box, power from light	30-35 minutes
9	Wire 3-way switches with one light	30 minutes
10	Wire 3-way switches with one light, with power through light	30-35 minutes
11	Wire 3-way switches with one light, with power entry through both switches first	30-35 minutes
12	Wire 3-way switches with one light, with power entry through light first then switches in series	35 minutes

Enhancement Exercises (extra wiring accessories needed)	Title	Approximate Time
1	Wire two single-pole switches with two lights, with power entry through a light	60-65 minutes
2	Wire 3-way switches with two lights, with power entry through both switches	60-65 minutes
3	Wire single-pole switch with two lights and two outlets, power through switch	60-65 minutes
4	Wire a split-circuit outlet	60-65 minutes

Electrical Wiring Kit

RealCareer™ Electrical Wiring Kit Curriculum

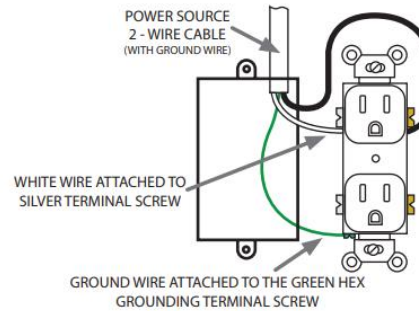
Name: _____ Class: _____

Lesson 2: Worksheet 1

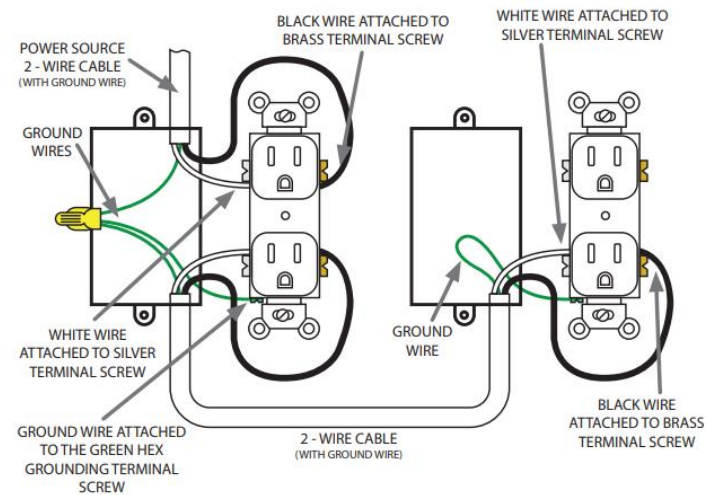
Answer the following questions as you view the accompanying slide presentation.

1. If a load has a resistance of 5 ohms, how much current will it draw from a 120-volt power supply?
2. If a load is drawing 1.5 amps from a 120-volt supply, what is the load's resistance?
3. A 23-ohm load is drawing 5.0 amps. What is the supply voltage?
4. If an appliance has a cord that can only handle 10 amps, how much voltage needs to be applied to it to deliver 2400 watts?
5. A 120-volt toaster draws 1200 watts. How many amps is this?
6. How many watts can a 15-amp circuit deliver before tripping the 120V circuit breaker?
7. How many amps does a 60-watt light bulb draw from a 120-volt supply?
8. If a load draws 42 amps from a 120-volt supply, how many amps will it draw from a 240-volt supply to receive the same power?
9. A cell phone charger claims to draw 0.35 amps from a 120-volt outlet. How many watts is this?
10. A 50-foot length of wire has a resistance of 0.08 ohms. If 10 amps are flowing through the wire, what is the voltage loss across this length of wire?

Exercise 1: Single Outlet



Exercise 2: 2 Outlets in Different Boxes



WIRE AND SCREW COLOR DIAGRAM KEY			
— BLACK WIRE (HOT)		BLACK TERMINAL SCREW	
— WHITE WIRE (NEUTRAL)		SILVER TERMINAL SCREW	
--- RED WIRE (HOT)		COPPER TERMINAL SCREW	
— GREEN WIRE (GROUND)		GREEN GROUNDING SCREW	

Electrical Wiring Kit



Builds the stage for FORWARD TRANSFER



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Safe and Effective Implementation



Electricity is SCARY!



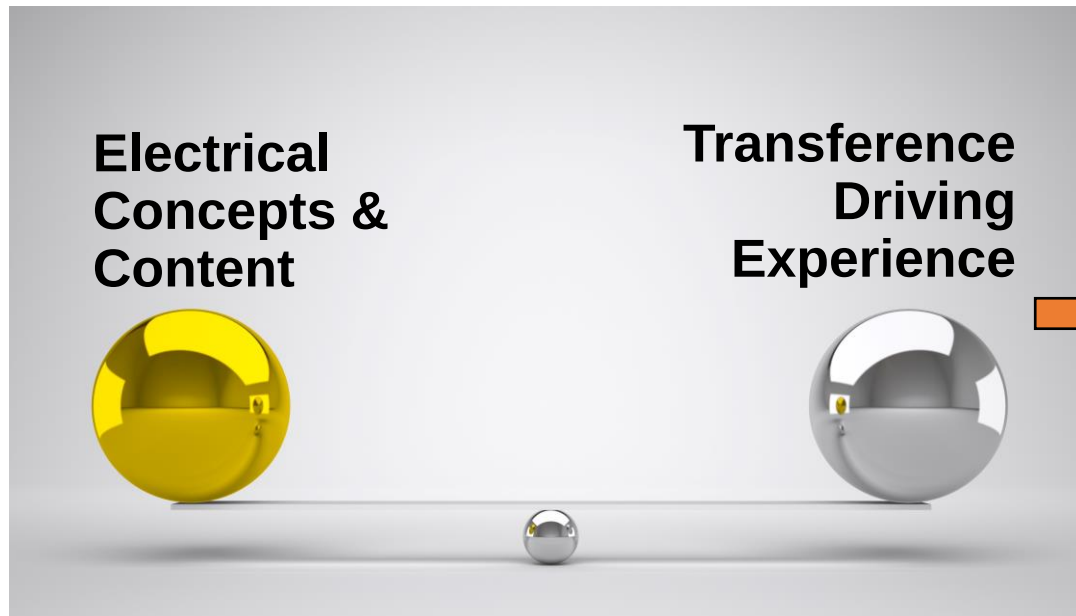
**Ineffective
Implementation**



**Disengaged
Learners**

Safety + Success is so important!

Electricity is SCARY!



**REAL WORLD
LEARNING
EXPERIENCE**

**SAFE &
POSITIVE
EXPERIENCE**

**MIXED
ABILITY
TEAMS**

**DEFINED
TEAM
ROLES**

Apprentice

- Less experienced
- Manages tools and materials
- Prepares wires, connectors, etc.

Electrician

- Guides the apprentice without **DOING** the work.
- Uses tools to make the circuit connections.
- Manages safety: power on/off
- Uses measurement tools as directed by Engineer

Engineer

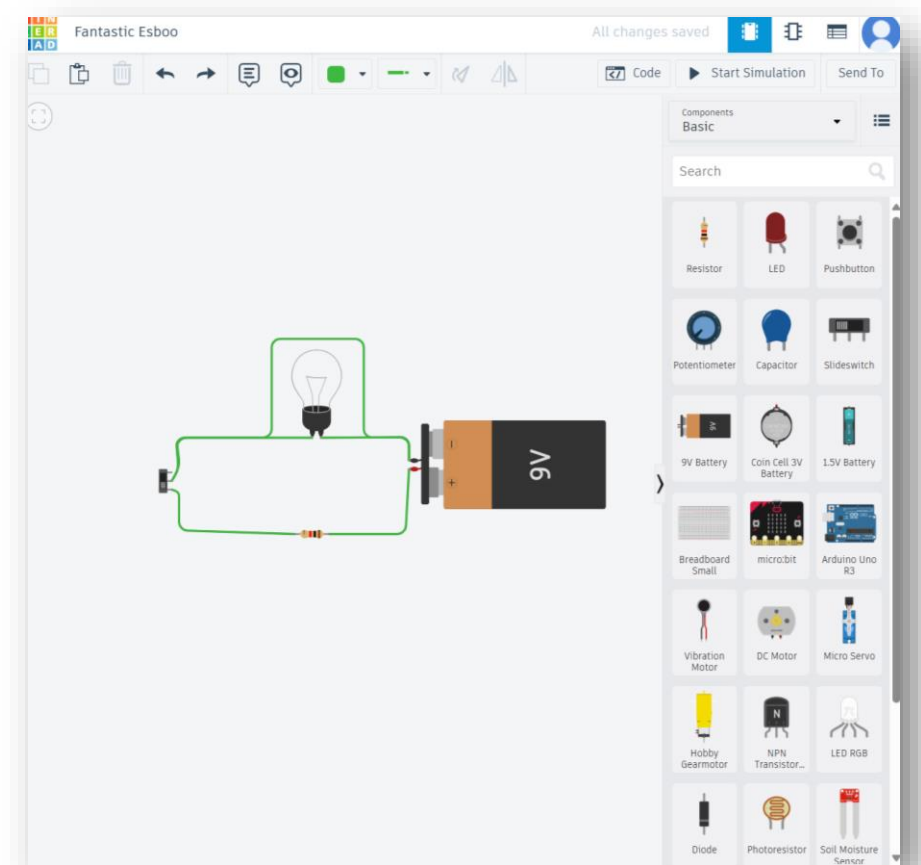
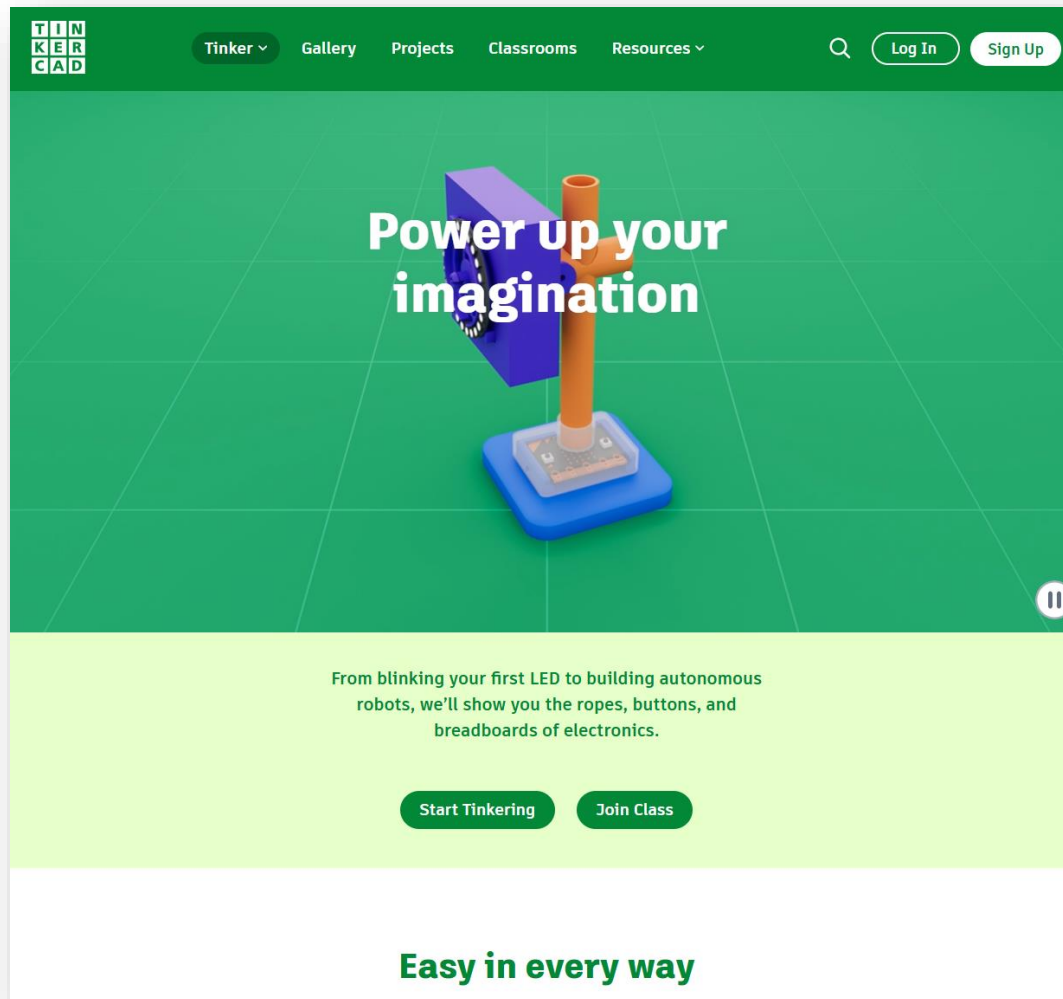
- Directs the team's work by managing the student slide decks and engineering notebook.
- Makes sure team is doing the right work.
- Provides guidance to Apprentice and Electrician.



Resources & Support



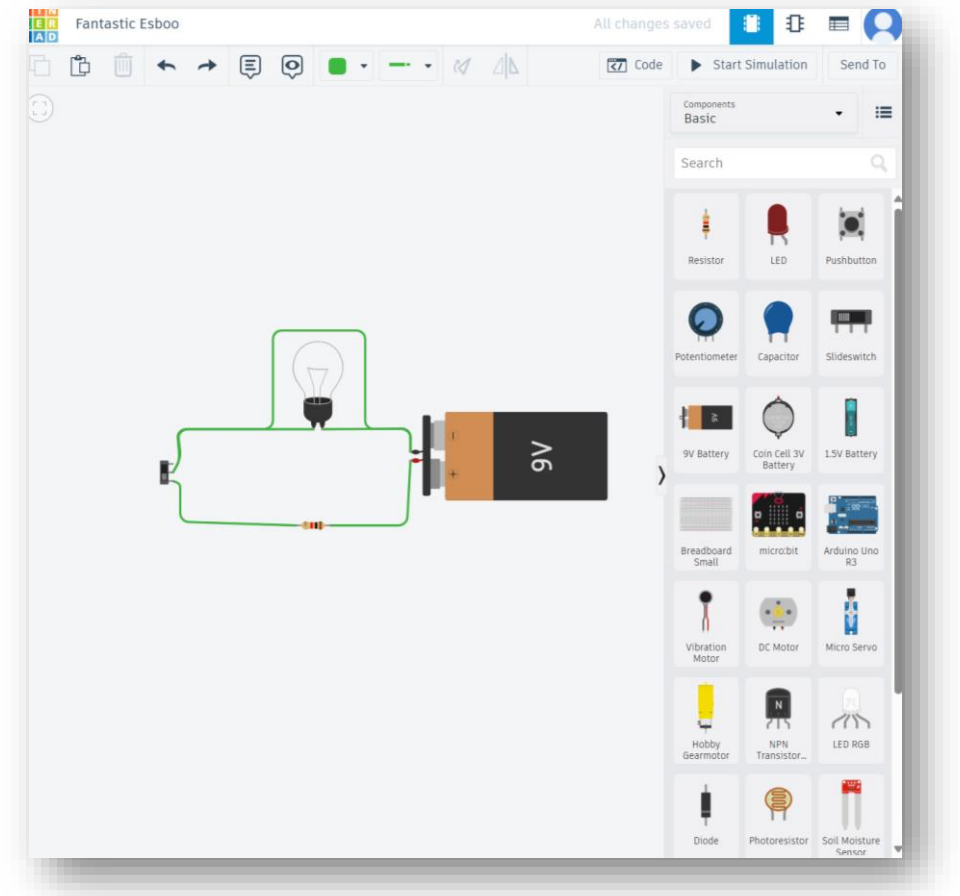
Building Circuits: Tinkercad.com



Building Circuits: Tinkercad.com

Design Challenges Involving Circuits

- Step 1:** Sketch It On Paper
- Step 2:** Build It In Tinkercad
- Step 3:** Test It in Tinkercad
- Step 4:** Build It In Real Life
- Step 5:** Compare + Test Tinkercad Model to Real Prototype



RESOURCES: Realityworks.com



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Wiring Kit



RC Tractor
Pull
Challenge



Measurement
Math
Training Kit



NEW Trailer
Circuits
STEM Kit

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Questions?

