

Trailer Circuits STEM Kit Curriculum



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The Trailer Circuits STEM Kit and its curriculum safely teach learners the basics of electricity, skills to build circuits, and how to apply their understanding to properly wire and troubleshoot trailer circuits. This curriculum guides students through a learning experience that connects content to context, putting their newfound skills and understanding into action.

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.

Curriculum Structure

The *Trailer Circuits STEM Kit Curriculum* is composed of the following lessons. Approximate lesson times are included.

Lesson	Title	Approximate Time
One	DC Electricity Basics	50 minutes
Two	Circuit Types and Wiring Skills	50 minutes
Three	Wiring the 4-Way Flat Harness	50 minutes
Four	Testing with a Multimeter and Auto Light Tester	50 minutes
Five	Wiring the 7-Way Round Harness	50 minutes
Six	Connecting the 7-Way Round Harness	50 minutes
Seven	How to Troubleshoot Electrical Circuits	50 minutes
Eight	Practice Troubleshooting with Scenarios 2-10	50-80 minutes
	Total	6-8 hours

Lesson Structure

Each lesson begins with a Lesson Overview, Lesson Objectives, and a Lesson at a Glance table, which lists lesson activities, materials needed, suggested preparation steps, and approximate class time.

Lesson Components

FOCUS

Students take quick primers in the form of pre-assessments to get students focused and ready to engage. These assessments are short-response questions that elicit prior-knowledge thinking and can serve as a good, whole-class opening discussion or a quick LMS check-in.

LEARN

This curriculum has been developed to give you freedom to implement as you see fit. The slide presentations can be used to support teacher-guided, whole-class learning, or teams of students can use the presentations to work independently. Many educators upload the presentations into their LMS for easy student access and freedom of pacing.

As students follow the guided lessons in the slide presentations, they should complete the corresponding section of their student workbook.

REVIEW

Similar to the FOCUS section, these are short-response questions that can be used as an exit-ticket or as you see fit.

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

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Lesson 1: DC Electricity Basics Pre-Assessment</i> • <i>Lesson 1: DC Electricity Basics Pre-Assessment – Answer Key</i>	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• <i>Lesson 1: DC Electricity Basics</i> slide presentation • <i>Lesson 1: DC Electricity Basics</i> student workbook activity • <i>Lesson 1: DC Electricity Basics</i> student workbook answer key • Calculators (optional)	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• <i>Lesson 1: DC Electricity Post-Assessment</i> • <i>Lesson 1: DC Electricity Post-Assessment – Answer Key</i>	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson One – DC Electricity Basics

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students take a pre-assessment to see what they know about DC electricity basics.

Materials:

- *Lesson 1: DC Electricity Basics Pre-Assessment*
- *Lesson 1: DC Electricity Basics Pre-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the pre-assessment to complete. Use this as you see fit, having them self- or peer-grade.

Name: _____ Class: _____

Lesson 1: DC Electricity Basics

Pre-Assessment

1. Which property of electricity causes harm to humans?
2. Which type of electricity would you find in a standard household outlet?
3. Electricity is the energy of _____ moving.
4. If a circuit is powered by a 12V battery and carries a load of 2 amps, what is the resistance of the circuit? **(Show your work for full credit)**

Name: _____ Class: _____

Lesson #1: DC Electricity Basics Pre-Assessment – Answer Key

1. Which property of electricity causes harm to humans?

Current

2. Which type of electricity would you find in a standard household outlet?

Alternating Current (AC)

3. Electricity is the energy of _____ moving.

Electrons

4. If a circuit is powered by a 12V battery and carries a load of 2 amps, what is the resistance of the circuit? (**Show your work for full credit**)

$$R = E / I \quad R = 12 \text{ V} / 2 \text{ Amps} \quad R = 6 \text{ Ohms}$$

Lesson One – DC Electricity Basics

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students review a slide presentation to learn about DC electricity.

Materials:

1. *Lesson 1: DC Electricity Basics* slide presentation
2. *Lesson 1: DC Electricity Basics* student workbook activity
3. *Lesson 1: DC Electricity Basics* student workbook activity answer key

Facilitation Steps:

1. Students should have access to the PPT slides for Lesson 1: DC Electricity Basics. These can be uploaded to your LMS for individual or group work, or you can work through the slides collectively as a whole class.
2. As students work through the slides, they should complete the corresponding lesson one questions in their student workbook.
3. Optional: If you choose to go over the presentation as a class, you can find notes for some slides below.

Slide 23: Math Tool

Use to further discuss the math. This uses V. Remember to transition to E for volts.

Slide 27: Electrical PIE Chart

This includes power, which is watts, horsepower.

Note: Use E, not V, for voltage. E is far more common in the real world. You will see V used in some early education, easier, but then confusing for most information on the web and real life.

4. Once finished viewing the lesson one slides and completing lesson one workbook questions, students should have the opportunity to check their work against the answer key. You can do this by:
 - a. Posting a printed key in the room for them to compare answers with.
 - b. Going over the answers as a class.
 - c. Exchanging workbook activities and having a peer review it.

Lesson One – DC Electricity Basics

REVIEW: Post-Assessment

5 minutes

Purpose:

Students take a post-assessment to see what they learned throughout the lesson.

Materials:

- *Lesson 1: DC Electricity Basics Post-Assessment*
- *Lesson 1: Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete, using it as you see fit. You can have students self- or peer-grade, or some teachers prefer to digitize the assessment through their LMS.

Name: _____ Class: _____

Lesson 1: DC Electricity Basics

Post-Assessment

Instructions: Complete the following questions. Choose one answer per question. Show your work when completing calculations.

1. Which property of electricity causes harm to humans?
 - a. Voltage
 - b. Watts
 - c. Amps
 - d. Ohms
2. Which type of electricity would you find in a standard household outlet?
 - a. Alternating Current
 - b. Direct Current
3. Electricity is the energy of _____ moving.
 - a. Protons
 - b. Neutrons
 - c. Gluons
 - d. Electrons
4. If a circuit is powered by a 6-V battery and carries a load of 0.30 amps, what is the resistance of the circuit?
(Show your work for full credit)
 - a. 20 Ohms
 - b. 1.8 Ohms
 - c. 5.7 Ohms
 - d. 0.05 Ohms
5. What is a load in any electrical circuit?
 - a. The Battery
 - b. The wire
 - c. A device that uses both amps and volts
 - d. The ground of the circuits system

Lesson 1: DC Electricity Basics Post-Assessment – Answer Key

Instructions: Complete the following questions. Choose one answer per question. Show your work when completing calculations.

1. Which property of electricity causes harm to humans?
 - a. Voltage
 - b. Watts
 - c. Amps**
 - d. Ohms

2. Which type of electricity would you find in a standard household outlet?
 - a. Alternating Current**
 - b. Direct Current

3. Electricity is the energy of _____ moving.
 - a. Protons
 - b. Neutrons
 - c. Gluons
 - d. Electrons**

4. If a circuit is powered by a 6-V battery and carries a load of 0.30 amps, what is the resistance of the circuit?
(Show your work for full credit)
 - a. 20 Ohms**
 - b. 1.8 Ohms
 - c. 5.7 Ohms
 - d. 0.05 Ohms

5. What is a load in any electrical circuit?
 - a. The battery that provides electricity
 - b. The wire the electricity travels on
 - c. A device that uses both amps and volts**
 - d. The ground of the circuits system

Lesson Two – Circuit Types and Wiring Skills

Lesson Overview

Students will be introduced to circuit types, states, and their characteristics. Then, they dive into building a simple circuit on the Trailer Circuit Trucks as they learn how to work with the electrician's tools and materials.

Lesson Objectives

After completing this lesson, participants will be able to:

- Understand what circuits are and their states
- Identify series and parallel circuits as well as their properties
- Build a simple circuit on the Trailer Circuits Truck

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• <i>Lesson 2: Circuit Types and Wiring Skills Pre-Assessment</i> • <i>Lesson 2: Circuit Types and Wiring Skills Pre-Assessment – Answer Key</i>	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• <i>Lesson 2: Circuit Types and Wiring Skills</i> slide presentation • <i>Lesson 2: Circuit Types and Wiring</i> student workbook activity • <i>Lesson 2: Circuit Types and Wiring</i> student workbook answer key • White and blue wire spools • Red 3-way connectors • Wire cutter tool • Ruler • Trailer Circuits Trucks	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• <i>Lesson 2: Circuit Types and Wiring Skills Post-Assessment</i> • <i>Lesson 2: Circuit Types and Wiring Skills Post-Assessment – Answer Key</i>	2. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Two – Circuit Types and Wiring Skills

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students take a pre-assessment to see what they know about circuit types and wiring.

Materials:

- *Lesson 2: Circuit Types and Wiring Skills Pre-Assessment*
- *Lesson 2: Circuit Types and Wiring Skills Pre-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the pre-assessment to complete, using it as you see fit. Have students self- or peer-grade.

Name: _____ Class: _____

Lesson 2: Circuit Types and Wiring Skills

Pre-Assessment

1. What is a circuit?
2. What does it mean to say something is electrically polarized?
3. When you flip a light switch off, what state is the circuit now in?
4. How are series and parallel circuits different?
5. What do you need to do to the end of a wire after it has been cut and had its insulating sheath stripped off?
6. What can you use to split 1 wire into 2 pathways for electricity to flow?
7. Finish this sentence: Whenever you are building circuits, the power should always be turned ____.

Lesson 2: Circuit Types and Wiring Skills Pre-Assessment – Answer Key

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. What does it mean to say something is electrically polarized?

There are two areas of different electrical charge

3. When you flip a light switch off, what state is the circuit now in?

Open

4. How are series and parallel circuits different?

Many ways. The simplest answer is a series has only 1 path for current to flow and a parallel has 2 or more paths for current to flow.

5. What do you need to do to the end of a wire after it has been cut and had its insulating sheath stripped off?

Twist it so it isn't splayed.

6. What can you use to split 1 wire into 2 pathways for electricity to flow?

A Red 3-Way Connector

7. Finish this sentence: Whenever you are building circuits, the power should always be turned ____.

OFF

Lesson Two – Circuit Types and Wiring Skills

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete workbook activities to learn about circuit types and wiring skills.

Materials:

- *Lesson 2: Circuit Types and Wiring Skills* slide presentation
- *Lesson 2: Circuit Types and Wiring Skills* workbook activities
- *Lesson 2: Circuit Types and Wiring Skills* workbook activities answer key

Facilitation Steps:

1. Students should have access to the *Lesson 2: Circuit Types and Wiring Skills* slide presentation. These can be uploaded to your LMS for individual or group work, or you can work through the slides collectively as a whole class.
2. As students work through the slides, they should complete the corresponding lesson two questions in their student workbook.

Slides 1-29 correspond with the student workbook and do **not** need the Trailer Circuits Trucks to complete. Slide 30 to the end is where students begin working with the materials and tools as they build a simple circuit on the Trailer Circuits Trucks.

Having students work in groups for the hands-on section of the lesson is most efficient. Encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities with more experienced students serving as helpers and peer guides.

3. Once finished viewing the lesson two slides and completing lesson two workbook questions, students should have the opportunity to check their work against the key.

Check their trailer to make sure they have successfully wired the electric brake system. You will know it is working if both green LED lights glow when you push the brakes button on the control panel.

Lesson Two – Circuit Types and Wiring Skills

REVIEW: Post-Assessment

5 minutes

Purpose:

Students take a post-assessment to see what they learned about circuit types and wiring.

Materials:

- *Lesson 2: Circuit Types and Wiring Skills Post-Assessment*
- *Lesson 2: Circuit Types and Wiring Skills Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.
2. Prior to starting lesson three, the newly installed white and blue wires should be removed from the Trailer Circuits Trucks. They can be used again later by other students or when connecting the seven-way harness.

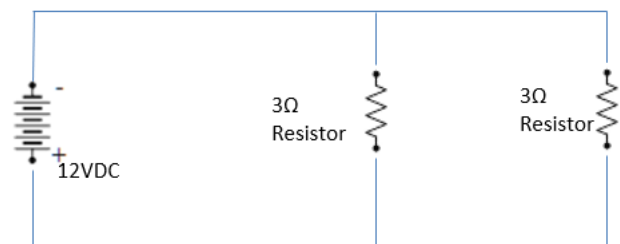
Name: _____ Class: _____

Lesson 2: Circuit Types and Wiring Skills Post-Assessment

Instructions: Complete the following questions. Choose one answer per question. Show your work when making calculations.

1. When charges flow in a DC circuit, which direction do they flow?
 - a. Negative to positive
 - b. Positive to negative
 - c. Down with gravity
 - d. Randomly
2. Which of the following is electrically polarized by design?
 - a. An apple
 - b. A glass of soda
 - c. A battery
 - d. A pack of dental floss
3. When you flip a light switch on, what state is the circuit now in?
 - a. Open
 - b. Closed
 - c. Combined
 - d. Shorted

4. What kind of circuit does the image to the right represent?
 - a. Series
 - b. Parallel
 - c. Combined
 - d. Open



5. What shape should you bend a wire before installing it around a terminal screw?
 - a. A
 - b. F
 - c. J
 - d. K

6. What can you use to split 1 wire into 2 pathways for electricity to flow?
 - a. Duct tape
 - b. Red 3-way connector
 - c. Screw terminal
 - d. Hot glue

7. Forgetting to turn a circuit's power off while wiring may result in what dangerous and destructive phenomena?
 - a. Series circuit
 - b. Open circuit
 - c. Short circuit
 - d. Parallel circuit

Lesson 2: Circuit Types and Wiring: Post-Assessment – Answer Key

Instructions: Complete the following questions. Choose one answer per question. Show your work when making calculations.

1. When charges flow in a DC circuit, which direction do they flow?

a. Negative to positive

- b. Positive to negative
- c. Down with gravity
- d. Randomly

2. Which of the following is electrically polarized by design?

- a. An apple
- b. A glass of soda

c. A battery

- d. A pack of dental floss

3. When you flip a light switch on, what state is the circuit now in?

a. Open

b. Closed

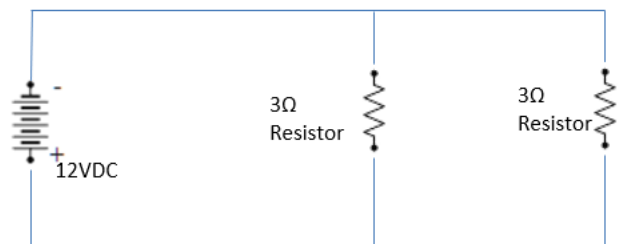
- c. Combined
- d. Shorted

4. What kind of circuit does the image to the right represent?

a. Series

b. Parallel

- c. Combined
- d. Open



5. What shape should you bend a wire before installing it around a terminal screw
- a. A
 - b. F
 - c. J**
 - d. K
6. What can you use to split 1 wire into 2 pathways for electricity to flow?
- a. Duct Tape
 - b. Red 3-way connector**
 - c. Screw Terminal
 - d. Hot Glue
7. Forgetting to turn a circuit's power off while wiring may result in what dangerous and destructive phenomena?
- a. Series circuit
 - b. Open circuit
 - c. Short circuit**
 - d. Parallel circuit

Lesson Three – Wires, Wiring Skills, and the 4-Way Flat Harness

Lesson Overview

Students will look at vehicle-specific wiring considerations, then work to wire, install, and test a standard four-way wiring harness.

Lesson Objectives

After completing this lesson, participants will be able to:

- Understand that vehicles have unique electrical requirements and components
- Identify the purpose of each wire on the four-way harness
- Install a four-way harness on the Trailer Circuits Trucks

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment • Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment – Answer Key	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness slide presentation • Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness student workbook activity • Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment • Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment – Answer Key	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Three – Wires, Wiring Skills, and the four-Way Flat Harness

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students take a pre-assessment to see what they know about wires and wiring skills.

Materials:

- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment*
- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the pre-assessment to complete.

Name: _____ Class: _____

Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment

1. How is a conductor different from an insulator?
2. Vehicle wiring must stand up to a lot of harsh conditions outdoors. What properties must vehicle wire have?
3. The four-way flat harness has four different colored wires. What colors are they?
4. What color is the ground wire?
5. What will happen to all the trailer's lights if the ground wire becomes disconnected?

Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Pre-Assessment – Answer Key

1. How is a conductor different from an insulator?

Conductors allow electrons to flow easily.

Insulators resist the flow of electrons.

2. Vehicle wiring must stand up to a lot of harsh conditions outdoors. What kind of properties must vehicle wire have?

- **Flexible insulation**

- **Usually rated to 80C (176F) or higher**

- **Resistant to grease, oil, acids, water, fungus, and solvents**

3. The four-way flat harness has four different colored wires. What colors are they?

Green, yellow, brown, white

4. What color is the ground wire?

White

5. What will happen to all the trailer's lights if the ground wire becomes disconnected?

They will all go out; the circuit is not complete. Its state is "open".

Lesson Three – Wires, Wiring Skills, and the four-Way Flat Harness

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete workbook activities to learn about the four-way flat harness.

Materials:

- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness* slide presentation
- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness* student workbook activity
- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness* student workbook activity answer key
- Trailer Circuits Trucks accessories

Facilitation Steps:

1. Students should have access to the slide presentation for lesson three. Given the hands-on, detailed nature of this lesson, it is recommended to give students access to the presentation on their device, allowing them to work as a team effectively and at their pace.

2. As students work through the slides, they should complete the corresponding lesson three questions from the student workbook.

Slides one through nine correspond with the student workbook and do **not** need the Trailer Circuits Trucks to complete. Slide 10 to the end is where students begin working with the materials and tools as they build a simple circuit on the trailer circuits truck.

Having students work in groups for this section of the lesson is most efficient. Encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities, with more experienced students serving as helpers and peer guides.

3. Once finished viewing the lesson three slides and completing the corresponding workbook questions, students should have the opportunity to check their work against the key.

Check their trailer to make sure they have successfully wired the four-way flat harness as shown in Slide 28.

Lesson Three – Wires, Wiring Skills, and the four-Way Flat Harness

REVIEW: Post-Assessment

5 minutes

Purpose:

Students complete a post-assessment to see what they learned from the lesson.

Materials:

- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment*
- *Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.
2. Leave the four-way flat harness connected to the Trailer Circuits Trucks, as students will use it in the next lesson.

Name: _____

Class: _____

Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. What is the purpose of the sheath covering the metal of a wire?
 - a. To enhance conduction of the wire
 - b. To insulate the metal conductor
 - c. To absorb moisture
 - d. To conduct electrical energy
2. How is vehicle wiring different than wires that you might find in your house or inside a toy?
 - a. Vehicle wire must be able to withstand harsh conditions outdoors
 - b. House wiring is much stronger than vehicle wiring
 - c. Toy wiring is not as conductive as vehicle wiring
 - d. Vehicle wiring is made to carry much higher voltages than household wiring
3. For the four-way flat harness, which color and light connections are incorrectly matched? Select all that apply.
 - a. Green = Taillights
 - b. Yellow = Left Turn and brake lights
 - c. White = Ground
 - d. Black = Reverse
 - e. Brown = Right turn and brake lights
4. Which statement best explains why the lights will not work if the white wire is not properly connected?
 - a. White is how the charges get from the car battery to the lights; without it, there is no way for charges to get to the lights
 - b. White is the ground and provides the path for all light circuits to return to the battery
 - c. White is a switch wire; it is purposefully used to turn the lights on and off
 - d. White creates a short circuit when disconnected
5. Imagine that you are renting a trailer to use for the weekend that uses a four-way flat harness. You hook the trailer up to your vehicle and test the lights with a friend, who is standing behind the trailer as you test each light category. Your friend tells you, "When you said, 'Left blinker,' the right one turned on... and when you said, 'Right blinker,' the left one turned on." What do you think is the reason for this?
 - a. The brown and green wires are going to the wrong lights
 - b. The white and brown wires are mismatched
 - c. The yellow and green wires are switched
 - d. The yellow and white wires are mismatched

Lesson 3: Wires, Wiring Skills, and the four-Way Flat Harness Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. What is the purpose of the sheath covering the metal of a wire?
 - a. To enhance conduction of the wire
 - b. To insulate the metal conductor**
 - c. To absorb moisture
 - d. To conduct electrical energy
2. How is vehicle wiring different than wires that you might find in your house or inside a toy?
 - a. Vehicle wire must be able to withstand harsh conditions outdoors**
 - b. House wiring is much stronger than vehicle wiring.
 - c. Toy wiring is not as conductive as vehicle wiring.
 - d. Vehicle wiring is made to carry much higher voltages than household wiring.
3. For the four-way flat harness, which color and light connections are incorrectly matched? Select all that apply.
 - a. Green = Taillights**
 - b. Yellow = Left Turn and Brake Lights
 - c. White = Ground
 - d. Black = Reverse (no black on four-way!)**
 - e. Brown = Right turn and brake lights**
4. Which statement best explains why the lights will not work if the white wire is not properly connected?
 - a. White is how the charges get from the car battery to the lights; without it there is no way for charges to get to the lights
 - b. White is the ground and provides the path for all light circuits to return to the battery**
 - c. White is a switch wire. It is purposefully used to turn the lights on and off
 - d. White creates a short circuit when disconnected
5. Imagine that you are renting a trailer to use for the weekend that uses a four-way flat harness. You hook the trailer up to your vehicle and test the lights with a friend, who is standing behind the trailer as you test each light category. Your friend tells you, "When you said, 'Left blinker,' the right one turned on... and when you said, 'Right blinker,' the left one turned on." What do you think is the reason for this?
 - a. The brown and green wires are going to the wrong lights
 - b. The white and brown wires are mismatched
 - c. The yellow and green wires are switched**
 - d. The yellow and white wires are mismatched

Lesson Four – Testing with a Multimeter and Auto Light Tester

Lesson Overview

After being introduced to the auto light tester and multimeter, students will use the wired Trailer Circuits Trucks to learn how to put these two diagnostic tools to use.

Lesson Objectives

After completing this lesson, participants will be able to:

- Understand what the auto light tester and multimeter are capable of measuring
- Know how to effectively use both tools safely
- Be able to measure voltage, current, and check for continuity with the multimeter

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• <i>Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment</i> • <i>Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment – Answer Key</i>	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• <i>Lesson 4: Testing with a Multimeter and Auto Light Tester</i> slide presentation • <i>Lesson 4: Testing with a Multimeter and Auto Light Tester</i> student workbook activity • <i>Lesson 4: Testing with a Multimeter and Auto Light Tester</i> student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• <i>Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment</i> • <i>Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment – Answer Key</i>	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Four – Testing with a Multimeter and Auto Light Tester

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students complete a pre-assessment to see what they know about testing with multimeter and auto light testers.

Materials:

- *Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment*
- *Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment – Answer Key*

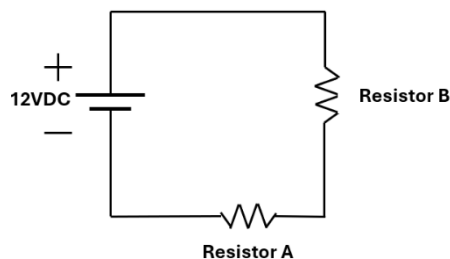
Facilitation Steps:

1. Provide students with the pre-assessment to complete.

Name: _____ Class: _____

Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment

1. How can you tell if a circuit is in an open or shorted state?
2. Why must you be careful when testing circuits that are possibly live?
3. When a multimeter detects continuity, what does that tell you?
4. Why does the auto light tester glow?
5. Where should the multimeter probes be placed in this circuit to measure the voltage drop between the Resistor B and the battery? Draw in the black and red probes.



Lesson 4: Testing with a Multimeter and Auto Light Tester Pre-Assessment – Answer Key

1. How can you tell if a circuit is in an open or shorted state?

Things are not working because the circuit is not complete (open), or the current is not flowing through the circuit components (shorted).

2. Why must you be careful when testing circuits that are possibly live?

You might accidentally create a high-current short that can cause damage and injury.

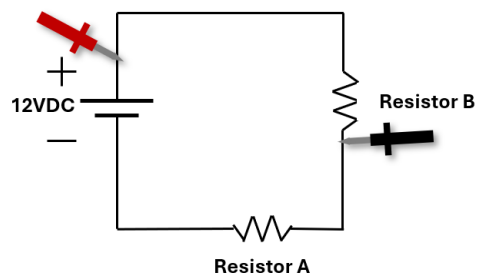
3. When a multimeter detects continuity, what does that tell you?

Continuity tells you that there is a continuous, complete path for current to flow along between the two probes.

4. Why does the auto light tester glow?

The light bulb in the tester glows because you have created a circuit path through the tester, allowing the circuit's charges to flow through the light in the handle. These charges make the bulb produce light.

5. Where should the multimeter probes be placed in this circuit to measure the voltage drop between the Resistor B and the battery? Draw in the black and red probes.



Lesson Four – Testing with a Multimeter and Auto Light Tester

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete a workbook activity to learn about testing with a multimeter and auto light tester.

Materials:

- *Lesson 4: Testing with a Multimeter and Auto Light Tester* slide presentation
- *Lesson 4: Testing with a Multimeter and Auto Light Tester* workbook activity
- *Lesson 4: Testing with a Multimeter and Auto Light Tester* workbook activity answer key
- Trailer Circuits Trucks and accessories

Facilitation Steps:

1. Students should have access to the slide presentation for this lesson. Given the hands-on, detailed nature of this lesson, it is recommended to give students access to the presentation on their device, allowing them to work as a team effectively and at their pace.

2. As students work through the slides, they should complete the corresponding questions from the student workbook.

Having students work in groups for this lesson is most efficient. We encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities with more experienced students serving as helpers and peer guides.

3. Once finished viewing the slides and completing the workbook questions, students should have the opportunity to check their work against the answer key.

Lesson Four – Testing with a Multimeter and Auto Light Tester

REVIEW: Post-Assessment

5 minutes

Purpose:

Students take a post-assessment to what they've learned throughout the lesson.

Materials:

- *Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment*
- *Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.
2. The next lesson will **not** need the four-way installed. Students should remove the harness from the Trailer Circuits Trucks.
3. Have students “clean” the four-way harness up for the next group of students by removing what they added. The extent of this cleaning is up to you.

For maximum learning, we suggest removing all U-hook terminals and extra wires by snipping them off. If the wires of the four-way harness are getting too short, the butt connectors can be used to extend the wires for continued use.

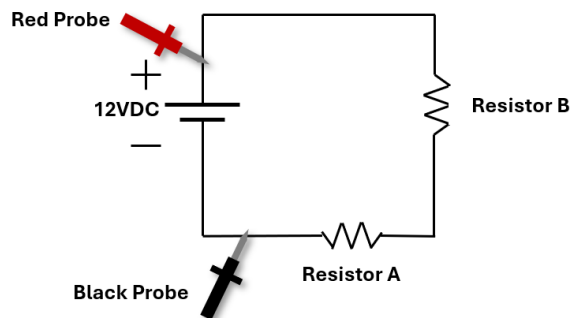
Alternatively, you can easily buy a replacement four-way harness from many sources.

Name: _____ Class: _____

Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

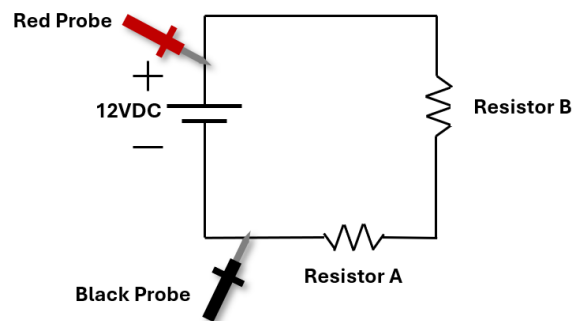
1. If an auto light tester does not glow, what do you know?
 - a. The circuit is closed
 - b. The circuit is open
 - c. There is power flowing in the circuit
 - d. There is too much power flowing in the circuit
2. The black probe should always be plugged into which port of the multimeter?
 - a. Left 10A
 - b. Middle COM
 - c. Right VmA
3. How do you know that the multimeter has confirmed continuity?
 - a. It shocks you
 - b. It will show 000 on the screen
 - c. It makes a sound and flashes
 - d. It will flash the continuity symbol on the screen
4. Looking at the diagram below, if the multimeter is set to measure 20VDC with its probes in these locations, what voltage should the multimeter measure if the circuit is complete?
 - a. Less than 12 V
 - b. 12 V
 - c. More than 12 V



Lesson 4: Testing with a Multimeter and Auto Light Tester Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. If an auto light tester does not glow, what do you know?
 - a. The circuit is closed
 - b. The circuit is open**
 - c. There is power flowing in the circuit
 - d. There is too much power flowing in the circuit
2. The black probe should always be plugged into which port of the multimeter?
 - a. Left 10A
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 - a. It shocks you
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 - a. Less than 12 V
 - b. 12 V**
 - c. More than 12 V



Lesson Five – Wiring the 7-Way Round Harness

Lesson Overview

Students will learn how to dismantle, wire, and rebuild the trailer and vehicle sides of the seven-way round harness. They will conclude the lessons by testing their work with the multimeter for continuity.

Lesson Objectives

After completing this lesson, participants will be able to:

- Dismantle and reassemble both sides of the seven-way round harness
- Know how to wire both sides of the seven-way round harness
- Test their wired harness for continuity with the multimeter, proving that it is wired correctly

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• Lesson 5: Wiring the seven-Way Round Harness Pre-Assessment • Lesson 5: Wiring the seven-Way Round Harness Pre-Assessment – Answer Key	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• Lesson 5: Wiring the seven-Way Round Harness slide presentation • Lesson 5: Wiring the seven-Way Round Harness student workbook activity • Lesson 5: Wiring the seven-Way Round Harness student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• Lesson 5: Wiring the seven-Way Round Harness Post-Assessment • Lesson 5: Wiring the seven-Way Round Harness Post-Assessment – Answer Key	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Five – Wiring the 7-Way Round Harness

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students complete a pre-assessment to see what they know about wiring seven-way round harnesses.

1. Provide students with the pre-assessment to complete.

Materials:

- *Lesson 5: Wiring the seven-Way Round Harness Pre-Assessment*
- *Lesson 5: Wiring the seven-Way Round Harness Pre-Assessment – Answer Key*

Facilitation Steps:

Name: _____ Class: _____

Lesson 5: Wiring the 7-Way Round Harness Pre-Assessment

1. Why do some trailers need more wires than you would find on a four-way flat harness?
2. What is the purpose of set screws?
3. Why does the seven-way round harness have a spring-loaded cover?
4. How can you use the multimeter to confirm that the wiring in the harness is secure and will effectively allow the current to flow from the vehicle to the trailer?

Lesson 5: Wiring the 7-Way Round Harness

Pre-Assessment

1. Why do some trailers need more wires than you would find on a four-way flat harness?

Bigger trailers have more complex electrical systems, which require more wires coming from the vehicle to control all those systems.

2. What is the purpose of set screws?

Set screws hold parts in place, preventing accidental disconnection.

3. Why does the seven-way round harness have a spring-loaded cover?

1: Protection from the harsh outdoor environment

2: Safety latch to prevent accidental disconnection while the trailer is in use

4. How can you use the multimeter to confirm that the wiring in the harness is secure and will effectively allow current to flow from the vehicle to the trailer?

A continuity test with the multimeter will confirm that there is a complete path through the harness for each color wire.

Lesson Five – Wiring the 7-Way Round Harness

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete a student workbook activity to learn about wiring a seven-way round harness.

Materials:

- *Lesson 5: Wiring the 7-Way Round Harness* slide presentation
- *Lesson 5: Wiring the 7-Way Round Harness* student workbook activity
- *Lesson 5: Wiring the 7-Way Round Harness* student workbook activity answer key

Facilitation Steps:

1. Students should have access to the slide presentation. Given the hands-on, detailed nature of this lesson, it is recommended to give students access to the slides on their device, allowing them to work as a team effectively and at their pace.
2. As students work through the slides, they should complete the corresponding questions from the student workbook. It is most efficient to have students work in groups.

Encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities, with more experienced students serving as helpers and peer guides.

3. Once students have finished viewing the slides and completing the workbook questions, students should have the opportunity to check their work against the key.

Lesson Five – Wiring the 7-Way Round Harness

REVIEW: Post-Assessment

5 minutes

Purpose:

Students complete a post-assessment to see what they learned during the lesson.

Materials:

- *Lesson 5: Wiring the 7-Way Round Harness Post-Assessment*
- *Lesson 5: Wiring the 7-Way Round Harness Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.

Name: _____

Class: _____

Lesson 5: Wiring the 7-Way Round Harness

Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. What color wires are in the seven-way harness but not the four-way? Select all that apply.
 - a. White
 - b. Yellow
 - c. Black
 - d. Brown
 - e. Green
 - f. Red
 - g. Blue
2. Which of the following could happen if the set screws become loose on the seven-way harness? Select all that apply.
 - a. The wiring terminals become loose and may result in a poor disconnection
 - b. The two halves of the harness will separate
 - c. When connecting or disconnecting the two halves, there will be loose connections that may prevent good electrical conduction
 - d. The harness halves may break when roughly handled during use
3. When connecting the two halves together, why is it important to engage the spring-loaded cover?
 - a. To keep water from shorting out the connections
 - b. To prevent accidental disconnection during trailer use
 - c. To keep the cover out of the way
 - d. To provide a ground connection between the vehicle and trailer
4. Imagine installing the seven-way round harness onto a truck and trailer and then testing the lights. When testing, you notice that multiple lights do not work. Which of the following could be possible reasons for this? Select all that apply.
 - a. The two halves of the harness are not fully pushed together
 - b. There is a loose screw in one side of the harness' wiring terminal
 - c. There is dirt or corrosion on the metal leads of the harness wiring terminal
 - d. One or more wires were pulled out of the wiring terminal on one side of the harness

Lesson 5: Wiring the 7-Way Round Harness

Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. What color wires are in the seven-way harness but not the four-way? Select all that apply.
 - a. White
 - b. Yellow
 - c. **Black**
 - d. Brown
 - e. Green
 - f. **Red**
 - g. **Blue**
2. Which of the following could happen if the set screws become loose on the seven-way harness? Select all that apply.
 - a. **The wiring terminals become loose and may result in a poor disconnection**
 - b. The two halves of the harness will separate
 - c. **When connecting or disconnecting the two halves there will be loose connections that may prevent good electrical conduction**
 - d. **The harness halves may break when roughly handled during use**
3. When connecting the two halves together, why is it important to engage the spring-loaded cover?
 - a. To keep water from shorting out the connections
 - b. **To prevent accidental disconnection during trailer use**
 - c. To keep the cover out of the way
 - d. To provide a ground connection between the vehicle and trailer
4. Imagine installing the seven-way round harness onto a truck and trailer and then testing the lights. When testing, you notice that multiple lights do not work. Which of the following could be possible reasons for this? Select all that apply.
 - a. **The two halves of the harness are not fully pushed together**
 - b. **There is a loose screw in one side of the harness' wiring terminal**
 - c. **There is dirt or corrosion on the metal leads of the harness wiring terminal**
 - d. **One or more wires were pulled out of the wiring terminal on one side of the harness**

Lesson Six – Connecting the 7-Way Round Harness

Lesson Overview

Using the seven-way round harness that they prepared in the previous lesson, students will now work to connect each harness side to their respective terminals. Students will be challenged to put their skills into action as they wire a complex trailer's electrical system.

Lesson Objectives

After completing this lesson, participants will be able to:

- Connect the vehicle side of the harness to the correct control panel terminals
- Connect the trailer side of the harness to the correct terminals using advanced wiring skills
- Test the fully wired system for continuity
- Conduct a light test to validate functionality

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment • Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment – Answer Key	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• Lesson 6: Connecting the 7-Way Round Harness slide presentation • Lesson 6: Connecting the 7-Way Round Harness student workbook activity • Lesson 6: Connecting the 7-Way Round Harness student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• Lesson 6: Connecting the 7-Way Round Harness Post-Assessment • Lesson 6: Connecting the 7-Way Round Harness Post-Assessment – Answer Key	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Six – Connecting the 7-Way Round Harness

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students complete a pre-assessment to see what they know about connecting the seven-way round harness.

Materials:

- *Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment*
- *Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the pre-assessment to complete.

Name: _____ Class: _____

Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment

1. When wiring on a real vehicle and trailer, what should you do to make sure you are wiring safely?
2. Is the trailer's electrical system is wired in series or parallel circuits?
3. What does the red wire connect to and power on the trailer?
4. How many states require a vehicle and/or trailer's license plate to be illuminated by a white light?
5. Why do some trailers have a wire for brakes?

Lesson 6: Connecting the 7-Way Round Harness Pre-Assessment

1. When wiring on a real vehicle and trailer, what should you do to make sure you are wiring safely?

Many manufacturers recommend disconnecting the battery in the vehicle maximize safety.

2. Is the trailer's electrical system is wired in series or parallel circuits?

Parallel

3. What does the red wire connect to and power on the trailer?

On the Trailer Circuits Trucks, the red wire does not connect to anything. In the real world, this would power the trailer's electrical accessories, such as fans, interior lighting, etc.

4. How many states require a vehicle and/or trailer's license plate to be illuminated by a white light?

All 50 states require this.

5. Why do some trailers have a wire for brakes?

Most states require any trailer over 3,000 pounds to have brakes installed. These braking systems require power to run, which comes from the vehicle's brake control system through the blue wire.

Lesson Six – Connecting the 7-Way Round Harness

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete a workbook activity to learn how to connect the seven-way round harness.

Materials:

- *Lesson 6: Connecting the 7-Way Round Harness* slide presentation
- *Lesson 6: Connecting the 7-Way Round Harness* student workbook activity
- *Lesson 6: Connecting the 7-Way Round Harness* student workbook activity answer key

Facilitation Steps:

1. Students should have access to the slide presentation. Given the hands-on, detailed nature of this lesson, it is recommended to give students access to the slides on their device, allowing them to work as a team effectively and at their pace.
2. As students work through the slides, they should complete the corresponding questions from the student workbook.

It is most efficient to have students work in groups for this lesson. We encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities with more experienced students serving as helpers and peer guides.

Instructor Note: The red wire is not connected to anything on the trailer side. In the real world, this wire is what powers the electrical accessories of the trailer (fans, interior lighting, etc.).

However, this wire does receive power when the simulator is on. The potential for some open-ended electrical investigation is possible with this wire. Remember that anything you try to power with this, such as one of the spare bulbs we provide, must be grounded to the trailer ground.

3. Once students have finished viewing the slides and completing the workbook questions, students should have the opportunity to check their work against the key.

Lesson Six – Connecting the 7-Way Round Harness

REVIEW: Post-Assessment

5 minutes

Purpose:

Students view a slide presentation and complete a workbook activity to learn how to connect the seven-way round harness.

Materials:

- *Lesson 6: Connecting the 7-Way Round Harness Post-Assessment*
- *Lesson 6: Connecting the 7-Way Round Harness Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.

Name: _____ Class: _____

Lesson 6: Connecting the 7-Way Round Harness Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. When wiring on a real vehicle and trailer, what should you do to make sure you are wiring safely?
 - a. Ground yourself by standing on a metal sheet
 - b. Make sure there is no power in the system, preferably by disconnecting the battery
 - c. Wait until it rains
 - d. Use metal screw drivers to short out the battery before making harness connections
2. Is the trailer's electrical system wired in series or parallel circuits?
 - a. Series
 - b. Parallel
3. What does the red wire connect to and power on the trailer?
 - a. Electrical accessories
 - b. Electric brakes
 - c. License plate light
 - d. Upper marker lights
4. How many states require a vehicle and/or trailer's license plate to be illuminated by a white light?
 - a. Only Minnesota requires this
 - b. 37
 - c. 13
 - d. 50
5. Trailers over what weight must have braking systems?
 - a. 1,000 pounds
 - b. 2,000 pounds
 - c. 3,000 pounds
 - d. 4,000 pounds

Lesson 6: Connecting the 7-Way Round Harness Post-Assessment – Answer Key

Instruction: Complete the following questions. Choose one answer per question.

1. When wiring on a real vehicle and trailer, what should you do to make sure you are wiring safely?
 - a. Ground yourself by standing on a metal sheet
 - b. Make sure there is no power in the system, preferably by disconnecting the battery**
 - c. Wait till it rains
 - d. Use metal screw drivers to short out the battery before making harness connections
2. Is the trailer's electrical system wired in series or parallel circuits?
 - a. Series
 - b. Parallel**
3. What does the red wire connect to and power on the trailer?
 - a. Electrical accessories**
 - b. Electric brakes
 - c. License plate light
 - d. Upper marker lights
4. How many states require a vehicle and/or trailer's license plate to be illuminated by a white light?
 - a. Only Minnesota requires this
 - b. 37
 - c. 13
 - d. 50**
5. Trailers over what weight must have braking systems?
 - a. 1,000 pounds
 - b. 2,000 pounds
 - c. 3,000 pounds**
 - d. 4,000 pounds

Lesson Seven – How to Troubleshoot Electrical Circuits

Lesson Overview

Students will be introduced to the troubleshooting process and learn how to use the auto light tester and multimeter to troubleshoot an electrical circuit. Students will practice this troubleshooting process with guided assistance using the Trailer Circuits Trucks' Troubleshooting Scenario 1.

Lesson Objectives

After completing this lesson, participants will be able to:

- Use the troubleshooting process to guide their troubleshooting efforts
- Know how the auto light tester and multimeter can aid in troubleshooting
- Use the 5-Question Test Routine to find troubleshooting indicators

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment • Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment – Answer Key	1. Print/photocopy the pre-assessment (one per participant) or load it into your LMS.	5 minutes
LEARN	• Lesson 7: How to Troubleshoot Electrical Circuits slide presentation • Lesson 7: How to Troubleshoot Electrical Circuits student workbook activity • Lesson 7: How to Troubleshoot Electrical Circuits student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS.	40 minutes
REVIEW	• Lesson 7: How to Troubleshoot Electrical Circuits Post-Assessment • Lesson 7: How to Troubleshoot Electrical Circuits Post-Assessment – Answer Key	1. Print/photocopy the post-assessment (one per participant) or load it into your LMS.	5 minutes

Lesson Seven – How to Troubleshoot Electrical Circuits

FOCUS: Pre-Assessment

5 minutes

Purpose:

Students complete a pre-assessment to see what they know about troubleshooting electrical circuits.

Materials:

- *Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment*
- *Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the pre-assessment to complete.

Name: _____ Class: _____

Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment

1. When something is not working as you expect it to, why is it important to follow a troubleshooting process?
2. What are two tools that can help you troubleshoot an electrical circuit?
3. What is the first step to complete when you begin troubleshooting?
4. What are 5 reasons that part of your trailer's electrical system might not working properly?
 - 1)
 - 2)
 - 3)
 - 4)
 - 5)
5. What is corrosion?
6. What do fuses do?
7. If you need to replace a damaged section of wire, what component can you use to install new wire into the section?

Lesson 7: How to Troubleshoot Electrical Circuits Pre-Assessment

1. When something is not working as you expect it to, why is it important to follow a troubleshooting process?

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

2. What are two tools that can help you troubleshoot an electrical circuit?

Multimeter and auto light tester

3. What is the first step to complete when you begin troubleshooting?

Identify the problem

4. What are 5 reasons that part of your trailer's electrical system might not work properly?

1) Faulty/burnt out bulb

2) Loose connections

3) Corrosion

4) Broken wire

5) Faulty/missing ground

6) Connector damage

7) Blown fuse

8) Short circuit

5. What is corrosion?

Corrosion is a naturally occurring chemical reaction as electricity interacts with air, metal, and moisture.

6. What do fuses do?

Fuses protect circuits from damage caused by too much current flowing.

The fuse will "blow" before damage can occur in the rest of the circuit.

7. If you need to replace a damaged section of wire, what component can you use to install new wire into the section?

Butt splice

Lesson Seven – How to Troubleshoot Electrical Circuits

LEARN: Slide Presentation and Student Workbook

40 minutes

Purpose:

Students view a slide presentation and complete a workbook activity to learn how to troubleshoot electrical circuits.

Materials:

- *Lesson 7: How to Troubleshoot Electrical Circuits* slide presentation
- *Lesson 7: How to Troubleshoot Electrical Circuits* student workbook activity
- Trailer Circuits Trucks and accessories

Facilitation Steps:

1. Students should have access to the slide presentation.
2. Given the hands-on, detailed nature of this lesson it is recommended to give students access to the slides on their device, allowing them to work as a team effectively and at their pace.
3. As students work through the slides, they should complete the corresponding questions from the student workbook.

It is most efficient to have students work in groups for this lesson. Encourage students who are not comfortable or experienced with building circuits to engage in the hands-on activities with more experienced students serving as helpers and peer guides.

4. Once students finish viewing the slides and completing the workbook questions, they should have the opportunity to check their work against the answer key.

Lesson Seven – How to Troubleshoot Electrical Circuits

REVIEW: Post-Assessment

40 minutes

Purpose:

Students view a slide presentation and complete a workbook activity to learn how to troubleshoot electrical circuits.

Materials:

- *Lesson 7: How to Troubleshoot Electrical Circuits Post-Assessment*
- *Lesson 7: How to Troubleshoot Electrical Circuits Post-Assessment – Answer Key*

Facilitation Steps:

1. Provide students with the post-assessment to complete.

Name: _____ Class: _____

Lesson 7: How To Troubleshoot Electrical Circuits Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. Why is it important to look for indicators when troubleshooting?
 - a. Indicators tell you who broke the circuit
 - b. Indicators provide clues about how to fix the problem
 - c. Indicators fix the problem
 - d. Indicators control the circuit
2. What are the indicators of a burnt-out bulb? Select all that apply.
 - a. The bulb will not light up
 - b. The circuit to and from the socket is working as expected
 - c. The bulb looks burnt
 - d. The multimeter does not find continuity when you test the bulb's electrodes
3. What is the first step to complete when you begin troubleshooting?
 - a. Fix
 - b. Evaluate
 - c. Causes
 - d. Identify
 - e. Indicators
4. If you try a fix, but during evaluation you find that the problem still exists, how do you respond?
 - a. Give up
 - b. Hire a professional
 - c. Work through the troubleshooting process again, eliminating potential fixes as you try different solutions
 - d. Yell at it because wires can hear you

5. How do you know a fuse needs to be replaced? Select all that apply.
- a. The circuit is not getting power
 - b. The fuse has a burn mark on it
 - c. The fuse wire has a break in it
 - d. The multimeter does not find continuity when the fuse is tested
6. If you need to replace a damaged section of wire, what component can you use to install new wire into the section?
- a. Butt splice
 - b. Duct tape
 - c. Zip tie
 - d. J-hook

Lesson 7: How To Troubleshoot Electrical Circuits Post-Assessment

Instructions: Complete the following questions. Choose one answer per question.

1. Why is it important to look for Indicators when troubleshooting?
 - a. Indicators tell you who broke the circuit
 - b. Indicators provide clues about how to fix the problem**
 - c. Indicators fix the problem
 - d. Indicators control the circuit

2. What are the indicators of a burnt-out bulb? Select all that apply.
 - a. The bulb will not light up**
 - b. The circuit to and from the socket is working as expected**
 - c. The bulb looks burnt**
 - d. The multimeter does not find continuity when you test the bulb's electrodes**

3. What is the first step to complete when you begin troubleshooting?
 - a. Fix
 - b. Evaluate
 - c. Causes
 - d. Identify**
 - e. Indicators

4. If you try a fix, but during evaluation you find that the problem still exists, how do you respond?
 - a. Give up
 - b. Hire a professional
 - c. Work through the troubleshooting process again, eliminating potential fixes as you try different solutions**
 - d. Yell at it because wires can hear you

5. How do you know a fuse needs to be replaced? Select all that apply.

a. The circuit is not getting power

b. The fuse has a burn mark on it

c. The fuse wire has a break in it

d. The multimeter does not find continuity when the fuse is tested

6. If you need to replace a damaged section of wire, what component can you use to install new wire into the section?

a. Butt splice

b. Duct tape

c. Zip tie

d. J-hook

Lesson Eight – Practice Troubleshooting with Scenarios 2-10

Lesson Overview

Students will be guided through Scenario 2 using the troubleshooting process, then practice on their own with Scenarios 3-10. Lastly, students will complete the Troubleshoot Test using the hidden assessment mode in the Simulator. Additional assessment options are also provided.

Lesson Objectives

After completing this lesson, participants will be able to:

- Use the troubleshooting process to guide their troubleshooting efforts
- Use the auto light tester and multimeter to help in troubleshooting
- Use the 5-Question Test Routine to find troubleshooting indicators
- Successfully complete the troubleshooting test

Lesson at a Glance

Activity	Materials	Preparation	Approximate Class Time
FOCUS	• N/A	No FOCUS activity for this lesson as the content is a continuation from the last lesson.	N/A
LEARN	• <i>Lesson 8: Practice Troubleshooting with Scenarios 2-10</i> slide presentation • <i>Lesson 8: Practice Troubleshooting with Scenarios 2-10</i> student workbook activity • <i>Lesson 8: Practice Troubleshooting with Scenarios 2-10</i> student workbook activity • <i>Lesson 8: Practice Troubleshooting with Scenarios 2-10</i> student workbook answer key • Trailer Circuits Trucks and accessories	1. Share the slide presentation with students. 2. Print/photocopy the student workbook activity (one per participant) or load it into your LMS. 3. Ensure the Trailer Circuits Trucks have working seven-way harnesses installed.	40-60 minutes
REVIEW	• <i>Troubleshooting Test</i> • <i>Troubleshooting Test – Answer Key</i> • Trailer Circuits Trucks and accessories	1. Print/photocopy the <i>Troubleshooting Test</i> (one per participant) or load it into your LMS.	10-20 minutes

Lesson Eight – Practice Troubleshooting with Scenarios 2-10

LEARN: Slide Presentation and Student Workbook

40-60 minutes

Purpose:

Students will view a slide presentation and complete workbook activities as they practice troubleshooting circuits on the Trailer Circuits Trucks.

Materials:

- *Lesson 8: Practice Troubleshooting with Scenarios 2-10* slide presentation
- *Lesson 8: Practice Troubleshooting with Scenarios 2-10* student workbook activity
- *Lesson 8: Practice Troubleshooting with Scenarios 2-10* student workbook activity answer key
- Trailer Circuits Trucks with accessories

Facilitation Steps:

1. Students should have access to the slide presentation. Given the hands-on, detailed nature of this lesson it is recommended to give students access to the presentation on their device so they can work as a team effectively and at their pace.

2. As students work through the slides, they should complete the corresponding questions from the student workbook.
3. Once finished viewing the slides and completing workbook questions, students should have the opportunity to check their work against the answer key.

This is a challenging process for students. It may be valuable to temporarily provide them with a copy of the Student Workbook - Answer Key for lesson eight, allowing them to revisit the Trailer Circuits Trucks and make corrections if they missed key indicators while working through the scenarios.

Lesson Eight – Practice Troubleshooting with Scenarios 2-10

REVIEW: Troubleshooting Test

10-20 minutes

Purpose:

Students will complete a Troubleshooting Test to assess their knowledge of trailer circuits.

Materials:

- *Troubleshooting Test*
- *Troubleshooting Test – Answer Key*
- Trailer Circuits Trucks with accessories

Facilitation Steps:

1. Once students are done working through Scenarios 2-10 and confirming their fixes, students are ready to take the Troubleshooting Test using the trucks' Assessment Mode.

Students do not know about the Assessment Mode that exists in the Trailer Circuits Trucks; do not let them see how to activate it.
2. Ensure Trailer Circuits Trucks are powered on and a fully working seven-way round harness installed.
3. Select the scenario you want students to work through and activate Assessment Mode by quickly pressing both + and – buttons. You will know Assessment Mode is activated when the letter “A” displays.

In Assessment Mode, the scenario number will not display, preventing students from memorizing the answers based on the scenario number.
4. Students must use the Troubleshooting Test to show their understanding. The final question on the test is a written “Real-World Communication” response. This could be turned into a separate assignment or task. An assessment rubric is provided.

Optional: Manual Fault Test

The Trailer Circuits Trucks can only simulate a limited variety of certain faults. To emulate real-world faults, you could also have students complete a Manual Fault Test in this way:

1. Have each team wire their simulator with the seven-way harness and confirm successful operation.
2. Without letting other teams know what they are doing, have each team purposefully introduce a fault into the system. This might include a loose or swapped wire in the harness, a poorly crimped connector, a failed three-way splice, etc.
3. Have teams exchange Trailer Circuits Trucks with the hidden faults in place.
4. Have each team complete the Troubleshooting Test using this purposefully faulted trailer circuits truck. Go further by having them make the repair on the truck to finish the testing process.

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?

9. Why do you think this is the fix?
10. How did you evaluate this?
11. **Real-World Communication:** Imagine you are a technician working at a local automobile service center. You are working on a customer's vehicle and trailer, trying to fix their malfunctioning electrical system. Summarize your troubleshooting work as you would to the customer. Using complete sentences, write out what you would say to the customer. Include in your writing responses to these prompts:
 - a. What did you identify as the problem?
 - b. What are likely causes of this problem?
 - c. What specific indicators did you find when testing?
 - d. What did you decide was the best way to fix this problem and why?
 - e. How do you know that the fix worked?

Lesson 8: Troubleshooting Test – Answer Key

Answer Key Instructions: Refer to Lesson Eight in the Student Workbook – Answer Key to match the scenario details for questions one through 10. For question 12, use this rubric to score their answers.

Real-World Communication: Imagine you are a technician working at a local automobile service center. You are working on a customer's vehicle and trailer, trying to fix their malfunctioning electrical system. Summarize your troubleshooting work as you would to the customer. Using complete sentences, write out what you would say to the customer. Include in your writing responses to these prompts:

Scoring Rubric: Troubleshooting Test Question 12				
Prompt	4	3	2	0
What did you identify as the problem?	Prompt is correctly and fully answered in complete sentences, modeling professional customer service language	Prompt is correctly and fully answered in complete sentences	Prompt is correctly answered but not in complete sentences	Prompt needs to be re-written
What are likely causes of this problem?	Prompt is correctly and fully answered in complete sentences, modeling professional customer service language	Prompt is correctly and fully answered in complete sentences	Prompt is correctly answered but not in complete sentences	Prompt needs to be re-written
What specific indicators did you find when testing?	Prompt is correctly and fully answered in complete sentences, modeling professional customer service language.	Prompt is correctly and fully answered in complete sentences.	Prompt is correctly answered but not answered in complete sentences.	Prompt needs to be re-written.
What did you decide was the best way to fix this problem and why?	Prompt is correctly and fully answered in complete sentences, modeling professional customer service language	Prompt is correctly and fully answered in complete sentences	Prompt is correctly answered but not in complete sentences	Prompt needs to be re-written
How do you know that the fix worked?	Prompt is correctly and fully answered in complete sentences, modeling professional customer service language.	Prompt is correctly and fully answered in complete sentences.	Prompt is correctly answered but not answered in complete sentences.	Prompt needs to be re-written.
Total Score for Question 12: ____ / 20 points				