Using a Multi-Meter

Name: _____
Date: _____

Description

This activity will provide students with the knowledge and skill of wiring a three way switch with non-metallic cable to the National Electric Code.

Materials:

Incandescent lamp

12 v. Lamp

12V. Battery

1 ½V. batteries.

3 way switch

Tools

Multi-meter

Directions:

Review the attached guide first. Complete the worksheet for each station.

DC Voltage

1. Set the meter to DC voltage.
2. Measure and record the voltage of the lead acid battery (car battery).
    a. Battery A: _____ V
3. Measure and record the alkaline batteries.
    a. Battery B: _____ V
    b. Battery C: _____ V

12 Volt AGM Battery State of Charge	
Level	Voltage
100%	13.00 Volts
90%	12.75 Volts
80%	12.50 Volts
70%	12.30 Volts
60%	12.15 Volts
50%	12.05 Volts
40%	11.95 Volts
30%	11.81 Volts
20%	11.66 Volts
10%	11.51 Volts
0%	10.50 Volts

Resistance

4. Set the meter to the resistance scale.
5. Measure and record the resistance in the two AC Lamps.
    a. Lamp A: _____ ohms
    b. Lamp B: _____ ohms
6. Measure and record the resistance in the DC Lamp.
    a. Lamp C: _____ ohms

Continuity

7. Set the meter to the resistance scale.
8. Measure and record the resistance in the two AC Lamps.
    a. Lamp A: _____ ohms
    b. Lamp B: _____ ohms
9. Measure and record the resistance in the DC Lamp.
    c. Lamp C: _____ ohms
10. Determine how a 3-way switch works. Using the multi-meter test each pair of terminals and determine which terminals are connected (have continuity or a "closed" circuit) with the switch in one position. Record your results. Repeat with the switch in the other position. Record your results.

Position	Test	Result
1	A-B	
1	B-C	
1	A-C	
2	A-B	
2	B-C	
2	A-C	

The terminal that is "common" to both tests of a closed circuit is the "common" terminal. For example if your results were:

Position	Test	Result
1	A-B	Closed
1	B-C	Open
1	A-C	Open
2	A-B	Open
2	B-C	Closed
2	A-C	Open

"B" is always connected to the closed circuit so it would be "common" to both positions of the switch. You can describe what you find this way:

a. With the switch in position 1; A and B are connected. With the switch in position 2; B and C are connected. A and C are never connected.

AC Voltage

11. CAUTION: You will be measuring high voltage.
12. Set the meter to AC voltage.
13. Identify the hot (short slot), Neutral (long slot), and Ground (round) slots on a duplex receptacle (outlet). Measure between the three contacts in the outlet and record the voltage.
    b. Hot-Neutral: _____ V
    c. Hot to Ground: _____ V
    d. Neutral to Ground: _____ V

Multi-meter Work Sheet

1. How does the resistance vary with wattage in the AC lamps?

   _____

2. Is the DC Lamp good?

   _____

3. If a fully charged lead acid battery is about 12.5 volts, what is the charge condition of this battery?

   _____

4. A fully charged alkaline battery will be > 1.5 volts. What is the condition of these batteries?

   _____

5. Explain the voltage reading between the hot and ground.

   _____

6. Explain the voltage reading between the hot and neutral.

   _____

7. Explain the voltage reading between the neutral and ground.

   _____

Using a Multimeter

The multimeter (volt-ohm-meter, VOM) is the basic troubleshooting tool for electrical systems and controls. The two most common functions are to test continuity (is the circuit connected) and voltage.

Testing Continuity

Turn the power OFF to the circuit of whatever it is you are testing before performing the test. This is extremely important.

On your multimeter you will notice a bunch of different settings. You are going to want to set your tester to read ohms. This is the symbol that looks like "Ω", commonly known as the Greek Omega symbol.

If you look at your tester when the probes are not touching anything, you should see a reading of infinity or OL. Touch the two probe tips together and you should see the reading change to zero. If your tester features an audio alert, it too will sound as you touch the probes together.

Now what you are going to want to do is touch one probe tip to one end of the item to be tested and the other probe tip to the other end. If the circuit is "closed," the tester will read zero and you should hear the audio beep if it has that feature. If the circuit is "open," the tester's reading will not change.

Here is a clarification on what an "open" or "closed" circuit means:

Open circuit: When the circuit is not complete, meaning that no voltage is able to flow through. This can be caused by a blown fuse, resistor or a switch.

Closed circuit: When the circuit is complete, meaning that voltage is able to flow through it.

You can perform a simple continuity test on a light switch that is not wired to anything. With the switch off, probe the terminals. You should not get a reading on your tester. But, when you turn the switch on, you will notice that the tester will read zero and the beep should be heard, signaling that the circuit is closed or complete.

Testing Voltage

CAUTION: Voltage is tested on live circuits so a shock hazard exists. Always test carefully.

Determine if you are testing AC or DC. DC is common on cars and machinery. Set your meter to the appropriate test

DC Voltage Setting

AC Voltage Setting

Some meters will have ranges so set the range to the appropriate voltage range.

Multi-Meter Teaching Notes:

Collect the items for the stations. Most of these can be stored for reuse. Label the items as needed. Troubleshooting encourages critical thinking. Broken parts are particularly useful to see if students can troubleshoot.

Station Setup:

- AC Voltage: Any outlet or use a power strip.
- DC Voltage: Use a new and a discharged alkaline battery (ex. D or AA cell). Lead acid battery could be installed in a vehicle.
- Resistance: For the DC lamp any car or trailer lamp will work. If it is broken this is OK. AC Incandescent lamps. Choose lamps of different wattage (ex. 40 and 100).
- Continuity: You need a 3 way switch.

Agricultural Standards Met:

4.0 Technology. Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments:
- 4.6 Differentiate among, select, and apply appropriate tools and technology.

5.0 Problem Solving and Critical Thinking. Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques:
- 5.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.
- 5.3 Use critical thinking skills to make informed decisions and solve problems.

6.0 Health and Safety. Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials:
- 6.1 Know policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities.
- 6.2 Understand critical elements of health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.
- 6.4 Maintain safe and healthful working conditions.
- 6.5 Use tools and machines safely and appropriately.
- 6.6 Know how to both prevent and respond to accidents in the agricultural industry.

B1.0 Students understand personal and group safety:
- B1.1 Practice the rules for personal and group safety while working in an agricultural mechanics environment.
- B1.2 Know the relationship between accepted shop management procedures and a safe working environment.

B3.0 Students understand the basic electricity principles and wiring practices commonly used in agriculture
- B3.1 Understand the relationship between voltage, amperage, resistance, and power in single-phase alternating current (AC) circuit.
- B3.2 Know how to use proper electrical test equipment for AC and direct current (DC)
- B3.3 Know analyze and correct basic circuit problems (e.g. open circuit, short circuit, incorrect grounding)

B3. 4 Understand proper basic electrical circuit and wiring techniques with nonmetallic cable and conduit as defined by the National Electric Code
B3.5 Interpret basic agriculture electrical plans.

Alternate Tools/Materials:

Many different items can be tested.

Safety Review:

High voltage circuits will be tested.

Project Time:

Demonstration: 15-20 minutes
Build: 30 minutes

Demonstration Notes:

1. Review the scales on the meters.
2. Explain how to use the probes
3. For resistance it will be important to get a good connection. Show students that they can measure the resistance of there bodies so they should not touch both probes.
4. Review the stations.