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UNIVERSITY OF ILLINOIS  
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## LESSON PLAN

Title: *Exploring Electricity, Building a 3-Way Switch*

Lesson Level: *Intermediate*

Time Frame: *One hour*

Objectives: *The student will explore the basics of building a 3-way switch, with supervision and instruction, and accompanying slide presentation from CD Rom, “Electrifying Experiments”.*

Supplies: *See supply list on slide five of accompanying CD Rom, “Electrifying Experiments”.*

Beginning Narrative: **Today we are going to build a 3-Way Switch. Residential wiring commonly uses 3-way switches in areas where there is more than one entrance or exit. Remember to pay close attention because there are lots of steps and we need to work together on each step. Try as hard as you can to stay with the class and don’t work ahead of everyone else.**

Slide	Step by Step Guide / ( <b>Narrative in bold</b> )	What You Do or Show	What Participants Do
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1.	This is the title slide		
2.	Visual representation of common AC wire used for residential and farm wiring. (2 conductor with a ground)	Display slide.	View the slide.
3.	Visual representation of additional common AC wire used for residential and farm wiring. (3 conductor with a ground)	Display visual.	View visual/slide 3.
4.	Completed Lab board with parts labeled. Definition of basic terms. <b>Lets look at the finished product, so we can see what our projects will look like.</b>	Review terms.	Review terms
5.	Unassembled parts for the AC/3-Way Switch lesson. <b>Here are all the parts we need to build a 3-Way switch, lets make sure we all have what we need.</b>	Review slide and get supplies ready.	Review slide and get supplies ready.
6.	Common tools for AC electrical work- need to be supplied by instructor. Tools can be shred in id needed. <b>Here are some common electrical tools, make sure you have these tools ready to use to complete our 3-way switch.</b>	Show slide- check to make sure you have tools.	Review slide- find individual or shared tools.
7.	<b>Lets start our 3-Way switch. Start with the lab board and 5 wire restraint clamps. Clamps will be installed in the knockout holes of the 3 metal wire boxes.</b> The knockout holes are already in place, and wire restraint clamps are screwed in to the metal box holes.	Demonstrate how the collars are taken off of the metal clamps- and the clamps are inserted into the holes of the three metal boxes, and the collars are screwed onto the clamps.	The collars are taken off of the metal clamps- and the clamps are inserted into the holes of the three metal boxes, and the collars are screwed onto the clamps.
8.	Close look at wire restraint installed through knockout hole. <b>Lets look at this picture of a correctly installed clamp- does yours look like this?</b>	Show slide.	Review slide and check that clamps are installed correctly.
9.	<b>To tighten a wire restraint use a flat blade screw driver and force the locknut of the restraint tight. The clamps are installed for two safety reasons; to keep the wires from being pulled out of the boxes and to keep the wires from being cut by the metal edges on the boxes.</b>	Show slide and demonstrate tightening.	Tighten the wire restraint with the screwdriver.
10.	Using wire strippers and the 2 conductor wire with ground	Pick up the 2 conductor	Pick up the 2 conductor

	remove insulation as shown above. <b>OK, we are going to remove about one and a half inches of insulation from our 2 conductor wire. Be careful with the wire strippers- they are sharp.</b>	wire with ground, and use the wire strippers to remove 1.5 inches of insulation from around the wire.	wire with ground, and use the wire strippers to remove 1.5 inches of insulation from around the wire.
11.	<b>We are going to strip the outer insulation from both ends of the 2 conductor wire and thread both stripped ends through the wire restraint as shown.</b>	Strip the outer insulation from both ends of the 2 conductor wire and thread both stripped ends through the wire restraint as shown.	Strip the outer insulation from both ends of the 2 conductor wire and thread both stripped ends through the wire restraint as shown.
12.	<b>Starting with the AC load (light bulb) octagon box, strip and make loops on the individual conductors. See following slides for details...</b>	Strip about an inch of insulation and make loops on the individual black and white and copper wires. (Copper wire has no insulation to remove).	Strip about an inch of insulation and make loops on the individual black and white and copper wires. (Copper wire has no insulation to remove).
13.	Close-up view: <b>Strip individual wires using strippers. Notice 14 AWG marking on stripper is used with the 14-gauge wire.</b>	View slide and point out how wire strippers have wires sizes marked.	Use wire strippers to complete step 12.- if not done already.
14.	Making the Loops with the needle nose pliers. <b>Lets make a small loop at the end of our stripped wires- with our needle-nose pliers.</b>	Make loops with pliers.	Make loops with pliers.
15.	<b>We are attaching the copper (grounding wire) to the octagon box with the green screw. Remember to put the wire on clockwise so it will tighten as the screw is tightened.</b>	Attach copper ground wire to octagon box with the green screw.	Attach copper ground wire to octagon box with the green screw.
16.	<b>Attach the Black (hot wire) wire to the brass terminal of the lamp holder.</b>	Attach black wire to the brass terminal.	Attach black wire to the brass terminal.
17.	<b>Attach the white (neutral wire) wire to the silver screw of the lamp holder.</b>	Attach the white (neutral wire) wire to the silver screw of the lamp holder.	Attach the white (neutral wire) wire to the silver screw of the lamp holder.
18.	<b>Now we are going to take a piece of 3 conductor with ground wire and strip about 4 inches of the insulation off of the wire. And, route</b>	Take a piece of 3 conductor with ground	Take a piece of 3 conductor with ground

	<b>the wire through the switch box that has the 2 conductor cable already in it- as shown on the slide.</b>	wire and strip about 4 inches of the insulation off of the wire. And, route the wire through the switch box that has the 2 conductor cable already in it- as shown on the slide.	wire and strip about 4 inches of the insulation off of the wire. And, route the wire through the switch box that has the 2 conductor cable already in it- as shown on the slide.
19.	<b>What we are going to do – is called switch box grounding. Take the bare copper wire from each one of the cables and attach it to the metal box using a green grounding screw as shown.</b>	Take the bare copper wire from each one of the cables and attach it to the metal box using a green grounding screw as shown.	Take the bare copper wire from each one of the cables and attach it to the metal box using a green grounding screw as shown.
20.	<b>Once you have stripped the white wires and they are twisted together- we will take a yellow wire not and twist it onto the bare white wires.</b> (This is the same principal as when we had two white wires under the same terminal in our Direct Current lesson).	Strip the ends of the white wires and take a yellow wire nut and twist it onto the bare wires.	Strip the ends of the white wires and take a yellow wire nut and twist it onto the bare wires.
21.	<b>Now we are going to gently fold the white wires and push them down into the metal box as shown. Now we have three free wires in this box- 2 black wires and a red wire. We are going to strip about one inch of insulation off of each of the three wires and create loops at the end of each of the three wires. Now we are going to take a 3-Way switch- and notice that the 3-Way switch has three terminals on its side (three screws). We are going to attach a black wire from the lamp to the common (dark) terminal on the 3-Way switch. (Remember the screw tightens in a clockwise motion). Now the remaining black and red wires from the other cable are attached on the other free terminals (screws).</b>	Gently fold the white wires and push them down into the metal box as shown. Strip about one inch of insulation off of each of the three wires and create loops at the end of each of the three wires. We are going to attach a black wire from the lamp to the common (dark) terminal on the 3-Way switch.	Gently fold the white wires and push them down into the metal box as shown. Strip about one inch of insulation off of each of the three wires and create loops at the end of each of the three wires. We are going to attach a black wire from the lamp to the common (dark) terminal on the 3-Way switch.
22.	<b>The lamp and one switch are now completely wired. Now remove about 4 inches of the insulation off of the other end of the 3 conductor wire and loop the wire through the wire restraint on the other switchbox. Your project should look like the picture.</b>	Now remove about 4 inches of the insulation off of the other end of the 3 conductor wire and loop the wire through the wire restraint on the	Now remove about 4 inches of the insulation off of the other end of the 3 conductor wire and loop the wire through the wire restraint on the

		other switchbox	other switchbox
23.	<b>Now we are going to take our black flexible 3 conductor wire and remove about 4 inches of the insulation from one end, and route the stripped end through the remaining wire restraint on the metal box.</b>	Take our black flexible 3 conductor wire and remove about 4 inches of the insulation from one end, and route the stripped end through the remaining wire restraint on the metal box.	Take our black flexible 3 conductor wire and remove about 4 inches of the insulation from one end, and route the stripped end through the remaining wire restraint on the metal box.
24.	<b>Attach the bare cooper wire from the 3 conductor cable to the rectangular metal box using a green grounding screw as shown. (remember to attach in a clockwise motion)</b>	Attach the bare cooper wire from the 3 conductor cable to the rectangular metal box using a green grounding screw as shown.	Attach the bare cooper wire from the 3 conductor cable to the rectangular metal box using a green grounding screw as shown.
25.	<b>The black flexible wire is called a power cord—this card plugs into an outlet in our home or farm. We need to attach the power cord ground (green wire) under the 3-Way switch green terminal. (In a clockwise fashion)</b>	Attach the power cord ground (green wire) under the 3-Way switch green terminal.	Attach the power cord ground (green wire) under the 3-Way switch green terminal.
26.	<b>The power card attaches to the dark terminal of the 3-Way switch. The red and black wires from the 3 conductor wire attach to the two remaining terminals, just like the first switch we wired. Now we have two white wires left- they are twisted together and secured by screwing a yellow wire nut over them as shown.</b>	The power card attaches to the dark terminal of the 3-Way switch. The red and black wires from the 3 conductor wire attach to the two remaining terminals, just like the first switch we wired. Now we have two white wires left- they are twisted together and secured by screwing a yellow wire nut over them as shown.	The power card attaches to the dark terminal of the 3-Way switch. The red and black wires from the 3 conductor wire attach to the two remaining terminals, just like the first switch we wired. Now we have two white wires left- they are twisted together and secured by screwing a yellow wire nut over them as shown.
27.	<b>Now we need to get the other end of the power cord and slide the power cord through the plug's hood, as shown. Trim back the wires to the proper length as need to fit inside the plug.</b>	Now we need to get the other end of the power cord and slide the power cord through the plug's	Now we need to get the other end of the power cord and slide the power cord through the plug's

		hood, as shown. Trim back the wires to the proper length as need to fit inside the plug.	hood, as shown. Trim back the wires to the proper length as need to fit inside the plug.
28.	<b>Remove just enough insulation from each wire on the power cord (there are three) to get them under the screws. The black wire goes to the brass screw, the white wire goes to the silver screw, and the green wire goes to the green screw.</b>	Remove just enough insulation from each wire on the power cord (there are three) to get them under the screws. The black wire goes to the brass screw, the white wire goes to the silver screw, and the green wire goes to the green screw.	Remove just enough insulation from each wire on the power cord (there are three) to get them under the screws. The black wire goes to the brass screw, the white wire goes to the silver screw, and the green wire goes to the green screw.
29.	<b>Attach the plug end to the plug hood. Tuck the wires inside and push the power cord through the hood and secure the hood with the hood clamp screws.</b> (*Note to teachers- now would be a good time to go back and have the students tighten the clamps on the metal boxes if they have not already done so.) Additional Note**The lamp and 3-Way switches are now a functional, complete circuit. If you plug the cord into a ground fault interrupted circuit—you can test for continuity/correctness. If the light bulb comes on and can be switched off and on from either switch- you have wired the project correctly. This is only mentioned because if there are problems with the project- it is easier to trouble shoot prior to securing the switches, lamp holder and covers in the final step.	Attach the plug end to the plug hood. Tuck the wires inside and push the power cord through the hood and secure the hood with the hood clamp screws.	Attach the plug end to the plug hood. Tuck the wires inside and push the power cord through the hood and secure the hood with the hood clamp screws.
30.	<b>After checking your wiring on both switches and lamp holder, then secure switches, lamp holder and covers to metal boxes with furnished screws.</b>	After checking your wiring on both switches and lamp holder, then secure switches, lamp holder and covers to metal boxes with furnished screws.	After checking your wiring on both switches and lamp holder, then secure switches, lamp holder and covers to metal boxes with furnished screws.
31.	<b>After securing covers place a good light bulb in lamp holder, this is a completed lab prior to testing.</b>	Review slide.	Review slide.
32.	<b>A successful project! Either switch should be able to turn the</b>	Review Slide.	Review Slide.

	<b>Light bulb on and off.</b>		

Summary: **We have learned about house current, grounding, and some safe wiring methods for residential wiring. We have had hands-on experience working with plugs, light switches, alternating current wires, and commonly used tools in the electrical industry.**