

**ILLINOIS** Extension college of agricultural, consumer

& ENVIRONMENTAL SCIENCES



## 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 / (Narrative in bold) 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. Lets look at the finished product, so we can see what our projects will look like.	Review terms.	Review terms
5.	Unassembled parts for the AC/3-Way Switch lesson. Here are all the parts we need to build a 3-Way switch, lets make sure we all have what we need.	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. Here are some common electrical tools, make sure you have these tools ready to use to complete our 3-way switch.	Show slide- check to make sure you have tools.	Review slide- find individual or shared tools.
7.	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. 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. Lets look at this picture of a correctly installed clamp- does yours look like this?	Show slide.	Review slide and check that clamps are installed correctly.
9.	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.	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
	icity Kit Lesson Plan for use with CD Rom Electrifying Experiments Lesson Four	Duilding a 2 May Cuitab	

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

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

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

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		hood, as shown. Trim	hood, as shown. Trim
		back the wires to the	back the wires to the
		proper length as need to	proper length as need to
		fit inside the plug.	fit inside the plug.
28.	Remove just enough insulation from each wire on the power cord	Remove just enough	Remove just enough
	(there are three) to get them under the screws. The black wire	insulation from each wire	insulation from each wire
	goes to the brass screw, the white wire goes to the silver screw,	on the power cord (there	on the power cord (there
	and the green wire goes to the green screw.	are three) to get them	are three) to get them
		under the screws. The	under the screws. The
		black wire goes to the	black wire goes to the
		brass screw, the white	brass screw, the white
		wire goes to the silver	wire goes to the silver
		screw, and the green	screw, and the green
		wire goes to the green	wire goes to the green
		screw.	screw.
	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. (*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.	Attach the plug end to the	Attach the plug end to the
	If the light bulb comes on and can be switched off and on from either	plug hood. Tuck the wires	plug hood. Tuck the wires
	switch-you have wired the project correctly. This is only mentioned	inside and push the power	inside and push the power
	because if there are problems with the project- it is easier to trouble	cord through the hood and	cord through the hood and
	shoot prior to securing the switches, lamp holder and covers in the final	secure the hood with the	secure the hood with the
29.	step.	hood clamp screws.	hood clamp screws.
		After checking your wiring	After checking your wiring
		on both switches and lamp	on both switches and lamp
	After checking your wiring on both switches and lamp holder, then	holder, then secure	holder, then secure
	secure switches, lamp holder and covers to metal boxes with	switches, lamp holder and	switches, lamp holder and
	furnished screws.	covers to metal boxes with	covers to metal boxes with
30.		furnished screws.	furnished screws.
	After securing covers place a good light bulb in lamp holder,		
31.	this is a completed lab prior to testing.	Review slide.	Review slide.
32.	A successful project! Either switch should be able to turn the	Review Slide.	Review Slide.
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	Light bulb on and off.		

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.