Electricity Show Outline

Idea	Who	Slide	Demos
Intro.	All	Terms	
Voltage	V	Voltage	Balls, balloons
Current	C	Current	Ladder, tennis ball, foam peanuts, Jacob's ladder
Resistance	R	Resistance	Balloons, 1^{st} row of students
Ohm's law	E	Math problem	
Circuit	All	Circuit picture	Clear light bulb, variable transformer, ammeter
Data	All	Graph	Clear light bulb, variable transformer, ammeter
Normal bulb	E		25 W bulb in previous circuit
Series	All	Series	Series circuit
Parallel	All	Parallel	Parallel circuit
Deduction	All	A-B-C	A-B-C circuit
High voltage	V	White screen	Van de Graaf, insulating stand, volunteer
High current	C	Capacitor	Capacitors, meter, power supply
Low resistance	R	Jumping ring	Liquid nitrogen, tongs, electromagnet, light bulb, Wide aluminum ring, split ring
Finale	E	Can crusher	Can, apparatus
Hands-on	All		Hair van de Graaf (V) Shock van de Graaf (C) Bicycle generator (R) Circuits at tables (E)

Equipment supplied by Custodian

- Projection Screen
- Overhead projector (to shadow project Van de Graaf)
- Ladder (the taller the better)
- Long tables at front for demos
- Tables (any size) at back and sides of room for circuits

- ## **Electricity Script**

Four presenters. "V" is the voltage person (dressed in red), "C" is the current person (dressed in blue), "R" is the resistance person (dressed in green), and "E" is the electricity person (not dressed in a solid color). If there are only three presenters, "V" assumes the "E" role. Note that the show is not meant to be performed verbatim. This script is intended as a helpful starting point for an accurate, entertaining show.

Terms slide.

E: Welcome to our physics assembly about electricity. My name is ... and I'm a student studying ... at UC Irvine.
V: My name is … and I'm a student studying …. I'm dressed in red and am going to teach you about voltage.
C: My name is ... and I'm a student studying ... at UC Irvine. I'm dressed in blue and am going to teach you about current.
R: My name is ... and I'm a student studying ... at UC Irvine. I'm dressed in green and am going to teach you about resistance.

Medicine and tennis balls, balloons with + and -. Voltage slide.

V: I get to go first and explain what voltage is. I'm going to start with something that isn't electricity but is like electricity. I have here a heavy ball. Gravity is pulling this ball down toward the center of the earth. Gravity is holding it down here on the ground. But I can lift it up. I can pull it up with a force, do work on it, and lift it up to a height. When I do that I give the ball energy. The ball is up at a height. The force of gravity is still pulling on it so, when I let it go, it rushes back to the ground.

I can do the same thing with this lighter tennis ball. Gravity is pulling this ball down onto the ground too. But I can pull it up to a height. I don't have to do as much work to lift it up, so the tennis ball doesn't have as much energy, but I can lift it just as high. When I let it go, it rushes back to the ground too.

Electricity is similar. Two different charges - a plus and a minus charge - pull on each other and want to be right next to each other. But, I can pull against the electric force and pull them apart, giving them energy. When I let them go, they rush back together, just like the ball rushes back to the earth.

I can lift the ball to different heights. What we call voltage is like the height of the ball. Sometimes I pull lots of charges apart - that's like lifting a heavy ball. Sometimes I pull a few charges apart-that's like lifting the tennis ball. How far apart I pull them is the voltage.

Ladder, tennis hall, box of foam peanuts, Jacob's ladder. Current slide.

C: I get to explain about current. Current is how many charges cross a certain point each second. Let's pretend this tennis ball is a charge. I climb this ladder and give it a voltage. When I let it go, it wants to rush back to the ground. When it crosses Tony's arms, that's a current. But it's not very much current. This time I'll give a lot more charges this high voltage. When I let them go, I have a lot of charges crossing Tony's arms. I have a lot of current.

What I just showed you is a pretend current. We can't normally see electrical current. But we can sometimes - when there is lightning - then there is so much current flowing in the air that it makes the air very hot and we can see it. This machine, called a transformer, pulls the charges apart and makes a real high voltage, high enough to make current flow through the air. Turn on Jacob's ladder, then turn it off. There's a big voltage between these wires. When the charges rush between the wires, they make an arc and we can see the current flow.

Balloons, ~10 students (usually ½ of first row). Resistance slide.

R: I'm the resistance person. Resistance gets in the way, it tries to stop currents from flowing. I need some volunteers to help me explain the idea. OK, I'd like the front row here to stand up. Don't stand in a straight line; spread out a little bit. Now, I'll take our pretend charges and give them a voltage by pulling them apart. When I let them go, they want to rush back together. But now, there is stuff in the way that slows them down. That's what resistance is: it's something that slows the current down. (Sit back down please.)

***Ohm's law problem slide*.**

E: We use math a lot when we do science. I want to teach you an equation about electricity that we often use. It's this: voltage equals current times resistance. Now, when we do math, we don't want to write out a lot of words, so we use letters to write our equation. Here's our equation written with letters.

V: Here's my part, the red V for voltage,

C: I'm the blue C for current,

R: and I'm the green R for resistance.

E: Let's do a math problem. How many of you know how to multiply? Oh good, you can do this problem.

C: If the current is 2,

R: and the resistance is 100,

V: How big is the voltage?

E: Raise your hand if you know the answer. Right. Two times one hundred is two hundred. That's an equation or formula that tells us how the voltage is related to the current and the resistance.

***Circuit pictures, clear light bulb, variable transformer, ammeter*.**

E: Now I want to give you a picture. This is like what happens in a light bulb.

V: I'm the voltage, so I pull the balls apart and lift them up to a height.

C: I'm the current, so I'm the balls as they move around in this circuit.

R: I'm the resistance, so I try to block him from moving around.

E: It's like this in a light bulb.

V: There's a battery. That's the part where the charges are pulled apart and given a voltage.

C: There are wires that the current flows through.

R: There's a light bulb. That's the resistance that blocks the current.

E: We have a real circuit like this here.

V: This transformer makes the voltage that pulls the charges apart,

C: Here are the wires that I flow through,

R: and here is the resistance-you can barely see it-it's this tiny wire inside the light bulb-the filament-that will slow the current down.

Graph slide.

E: In science we like to measure things. We are going to measure how much current we get when we have different voltages.

V: I'm going to change the voltage here. How are they going to tell how much current there is?

C: Two ways. The students can read out the number on the meter for us. They can also see the light from the light bulb. When it's brighter, there's more current.

R: That's because I get hot when I'm stopping all that current.

E: OK, let's make our measurements. What's the voltage?

V: Right now, my voltage is zero; I haven't turned it on yet. How much current is there?

C: Zero. I'll write that down.

E: Now turn the voltage up to 40.

V: 40 volts.

C: How much current is there now? OK, I've got that down.

R: There's not much current yet. The light bulb isn't very bright. I'm cool.

E: Now turn the voltage up to 80.

V: It's 80 volts.

C: How much current is there now?

R: There's a lot more current. I'm getting hot.

E: Let's make the voltage 120.

V: 120 volts.

C: How much current is there now?

R: I'm broiling! Look how bright that light bulb is.

E: How many of you have ever made a graph? Did you know that we make graphs all the time in science? We're going to graph our measurements.

V: This is my part of the graph, the x axis. Here are my voltages: 0, 40, 80, 120.

C: Here's my part of the graph, the y axis. My currents are ....

E: The points are kind of hard to see so we could draw a line between them like this. There. That's a graph of our data.

25 W bulb in previous circuit

E: Now another thing we often do in science is different experiments to learn how things work. We're going to do some experiments with 25-W light bulbs. But first, just so you'll know how they normally look, I'm going to put a 25-W light bulb in here. See that's what it is normally like.

***25 W bulb in previous circuit, series picture, series light bulbs*.**

R: I'm going to connect my light bulbs in different ways. Here I have four light bulbs all hooked together.

V: My voltage is the same as over there.

R: But this time, instead of just going through one light bulb, the current has to go through four light bulbs to get back to ground.

C: So you are going to block me four times instead of one?

E: In science, we like to make guesses about what will happen-the fancy word for a guess is a hypothesis-before we do the experiment. How many of you think the four light bulbs will be brighter than that one? (Raise your hands.) How many think they will be the same? How many think they'll be dimmer?

V: I'll turn on my voltage.

C: They are dim. I can hardly get any current through them.

R: That's because I'm four times as strong.

V: (Pointing to picture). The voltage is the same.

C: But now I have to go through all these light bulbs before I get back.

R: There is a lot more resistance.

E: Now we're going to do another experiment. When I unscrew this light bulb *(unscrew light on simple circuit)*, the light goes out.

R: That's because the wires aren't connected anymore. The resistance is huge. I'm infinitely strong-no charges can go through me anymore.

E: It's kind of like there's a bridge and the bridge is open so nothing can get across. What will happen when he unscrews one of the four light bulbs? Let me see your guesses, your hypotheses. How many think the other lights will get brighter? Stay the same? Get dimmer?

R: They all go out.

C: That's because now when I'm flowing through the circuit and get to this light bulb, the unscrewed one, I can't get across. I'm completely blocked, so there is no current anywhere in the circuit.

Parallel picture, parallel light bulbs.

R: I've got another experiment here. This time all four of the light bulbs are connected across the voltage.

V: You mean I apply my voltage across all of these at once? So the current can go through this light bulb or through that one or through that one without having to go through any of the others.

C: So I only have to go through one bulb to get to ground.

R: Right. The resistance in each part is one light bulb.

E: How bright will it be this time? Will they be brighter than our single bulb? All the same? Or dimmer?

R: They are all the same as a single bulb.

C: It's like each path is separate. I can go this way or that way and the other paths don't care.

E: What will happen if you unscrew one of the bulbs when they are arranged this way? Will the others get brighter? Stay the same? Go out?

R: The other ones stay the same.

C: This time, if this one is cut and has an infinite resistance, I can still go through these other paths, so these lights don't change.

Puzzle picture, A-B-C circuit.

E: OK. Now we've learned a lot about how light bulbs work. Let's see if we can use what we've learned to predict what will happen in a different situation. Scientists like puzzles like this. The current can either flow through these two light bulbs that are hooked together, light bulb A and light bulb B, or the current can go through this different path through light bulbs.

V: The voltage is the same across both of these paths.

C: Which light bulb will be brightest? A? B? C?

R: It's C. On the top path, I have two light bulbs so my resistance is 2. On the bottom path there is only one light bulb, so my resistance is 1. I'm not as strong so more current flows through the bottom path.

E: Here's our next puzzle. What will happen when I unscrew light bulb A? What will happen to B? What will happen to C?

R: Light bulb B goes out. I became huge here at light bulb A so no current could get through. But unscrewing A didn't change the path through C at all, so it stayed the same.

E: Finally, what will happen when I unscrew light bulb C? Will A go out? B?

R: Nothing happens to A or B. This gate is open and no current can go through C. But nothing has changed on this path, so its current stays the same.

V: Well, we've performed a lot of experiments with light bulbs to show how science is done. The next part of the show is for fun. I'm going to show you a high voltage.

C: And I'm going to show you a high voltage and a high current.

R: And I'm going to show you a low resistance.

van de Graaf, shadow project, insulating stand.

V: This is called a van de Graaf generator and it makes a very high voltage. But it's safe. I need a volunteer. It needs to be someone with dry, clean, light, long hair. OK, come on up. Stand on this platform. It's safe: I've done this many times. Put your hand on the dome. Turn it on. This generator really does what I was pretending to do at the beginning of the show: it takes charges and pulls them apart so they have a high voltage. What's your name? The charges go up to this dome, then some of them travel along Tamara's arm and spread out on her body. Some of them end up on her hair. Now we know that two different charges attract-they try to come back together. But what if the two charges are the same? That's right, they repel, they try to move apart. Look. Why is Tamara's hair standing up? The charges on her hair are trying to get as far apart as possible. Let's have a round of applause for Tamara.

Capacitor boom.

C: That's a high voltage demonstration. The voltage there is about 25000 volts. I have a high voltage and a high current demonstration. My voltage is 1500 V and I have a lot more charges, so my current is much bigger. I turned my experiment on awhile ago, and my power supply has been pulling charges apart, giving them a 1500 V voltage for several minutes. They are all together on something called a capacitor, and they want to rush back together. I'm going to take this metal stick and let them jump back together. When I do zap, a lot of current flows. It heats up the air, makes a flash like lightning and a noise the noise is like thunder.

Jumping ring: Liquid nitrogen, tongs, electromagnet, light bulb, aluminum ring, split ring.

R: I'm going to show you about low resistance. I have something here called an electromagnet. It's a kind of magnet that yon can turn on and off. Here's a stick of iron, like a big nail. You probably know that magnets attract iron nails. But right now it isn't being attracted at all. When I turn my electromagnet on, it becomes a magnet and attracts the iron. See. Now another thing happens when I turn on my electromagnet: it makes a voltage that goes around the circle like this. I'm going to use this little light bulb to show you that. I slip it on here. Right now the electromagnet is off, there is no voltage, so there is no current through the light bulb. But, when I turn the electromagnet on, it makes a voltage, and current flows through the resistance in the light bulb. Let me take off the light bulb. Now I have a little ring of aluminum. When there is voltage around it, current will flow around the ring. This makes the aluminum ring act like an electromagnet too. Now you probably know about magnets: north poles attract south poles but two north poles repel each other. These two electromagnets will be like two north poles, they will repel each other. So what will happen to the aluminum ring when I turn on the electromagnet? It jumps up in the air. The voltage makes a current in it, the current turns it into a magnet,and the two magnets fly apart.

What happens if I use this aluminum ring that has a slot in it? Can current flow around this? No, this gap is like unscrewing the light bulb-no current can flow across this infinite resistance. Will this ring jump up? No, it doesn't jump. No current flows, it doesn't become a little magnet, it doesn't jump up.

Now I'm going to put this other ring into liquid nitrogen to cool it down. Liquid nitrogen is very cold. Even though it's cold, it can burn you, so you need to be careful with it. Anyway, I'm putting my ring in there. When metals get colder, there resistance usually gets smaller. Let's think about this. The resistance is going to get smaller, will there be more or less current in the ring when I apply the voltage? There'll be more because I won't be blocking the charges as much. If there is more current, this will be a stronger magnet. What will happen? Let's see. It goes very high! The resistance is less, the current is more, the magnets push apart harder, and the ring flies farther up into the air.

***Can crusher*.**

E: Our last demonstration puts all three of these together: we'll have a high voltage, a large current, and a low resistance. This is another big capacitor, like the one over there. But these charges have been separated and brought to an even higher voltage: ten thousand volts. When we flip this switch a large amount of current will flow through this wire. This coil of wire will become a very strong electromagnet. I am going to put this aluminum can inside the coil of wire. The can has a low resistance, so lots of current will flow through it. It will get very hot, like a hot light bulb. And the magnetic force will be so large that it will crush the can! Ready? *BOOM!* Look the electricity crushed the can.

***Circuits on tables. Bicycle generator. Two van de Graafs*.**

E: That's our assembly. Now you get to do experiments yourself. Stay seated while I explain all of your choices. We have small circuits on the table. The light bulbs are connected in different ways. You can turn on the different circuits and see for yourself which way makes the light bulbs bright and dim. Teachers, I'd like you to supervise this activity for us.

V: We also have experiments with the van de Graaf generator. At this line, if you have the right kind of hair, you can charge up to a high voltage, like the experiment we did for Tamara.

C: This other generator is for shocks, like this. You can feel a small current flow through you. Come out, hold out the back of your hand or arm, and get a shock. It doesn't hurt very much because, even though the voltage is very high, only a little current flows through you.

R: This bicycle is our last experiment. You make the voltage by turning the pedals. As you turn the pedals you drive current through the light bulbs. The more light bulbs there are, the harder you have to pedal, because it takes more energy to push those charges through more resistors. The line for the bike will form over here.

Dismissal.