Big Idea: Electricity can exist as static electricity or travel as a current through a conductor.

Unit 7: Electricity

Olive: Hi class. Today we're going to talk about electricity.

Phinny: *Grinning.* That's shocking! *Puts his paw up for a high five to Archie.*

Archie bumps his paw with his fist.

Hattie: That's such an old joke, my grandfather used to say it.

Phinny: Yeah, well. Maybe your grandfather had a sense of humor… which makes it all the more tragic you were born without one.

Hattie: Humph!

Olive: Let's show a little respect, Phinny.

Phinny: Hattie should show a little respect, herself - for a comic genius such as I.

Olive: Okay, let's all give Phinny a hand of applause for his joke.

Everybody but Hattie claps. Phinny turns red.

Olive: Now then. Let's start with lightning. What is it?

Hattie: It's electricity.

Olive: Yes. Lightning is a good example of the energy we call electricity. What are some of the other kinds of energy we've been talking about in here?

Lilly: Heat and light.

Olive: Good. Anything else?

Hudson: Wind.

Olive: Good.

Electric energy is divided into two kinds: static electricity and electricity that flows in a current. Static electricity occurs in nature. The most dramatic example is lightning. And we'll get to energy currents in awhile.

Have any of you walked along the carpet in your socks and gotten a shock when you touched something metal?

Phinny: It happens to me all the time.

Olive: It does?

Phinny: Yeah. I'm always getting a shock on my nose when I touch the metal snap on my doggy door.

Lilly: Why don't you quit touching it?

Phinny: I always want to see if it will happen again.

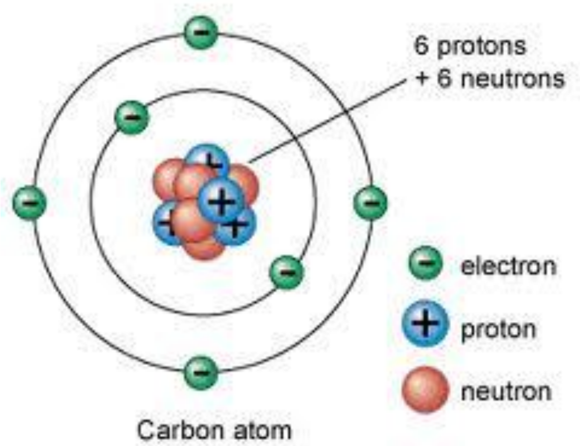
Lilly: And does it?

Phinny: Yes.

Everybody laughs.

Olive: Well let's talk about what is making that happen so Phinny doesn't need to keep running the same experiment over and over again.

Shows picture of atom.



Everything is made up of atoms. But atoms are so tiny it is hard to imagine how small they are.   They are way to tiny to see. A scientist named, Richard Feynman came up with a way to help us out. Imagine that we could expand a hydrogen atom to the size of an apple and we could expand a regular apple as much as we expanded the atom. How big would our apple be?

Phinny: The size of a house.

Olive: The size of the earth.

Archie: Whoa!

Olive: Now, inside the atom are protons, neutrons, and electrons. The protons and neutrons clump together in the center, which is called the nucleus of the atom. If you use your imagination again and imagine one atom stretched to the size of a sports stadium, guess how big its nucleus would be?

Archie: The size of the field?

Olive: It would be the size of a marble. Electrons are smaller than the protons, or the neutrons. And they fly around the nucleus in their own orbits. Electrons have a negative charge, while the protons have a positive charge, and the neutrons are, well, neutral. Electrons can jump from one atom to another.

Lilly: What's a charge?

Olive: Good question. The best way to understand charge is by thinking about magnets. You know that one end of a magnet is positive, and the other end is negative. What happens when you put two magnets together?

Hattie: They will attract each other if their positive and negative sides are together. But positive repels positive, and negative repels negative.

Olive: That's right. And when we say something has a charge it has either a positive or negative charge. If you rub your socks on the carpet on the way to the door, some of the negatively charged electrons in the carpet attach themselves to your feet. Then when you grab the positively charged doorknob, all the electrons rush towards the metal and you get a shock. Since you have hair on your feet, Phinny, your hair would work the same way as socks do.

Phinny: *Grins from ear to ear.* Sometimes it's great to be me.

Olive: Lightning is just a giant spark created when negatively charged electrons jump all at once to something positively charged like a tree, the ground or a positively charge particle in the clouds. The sparks can happen between clouds, inside clouds or between the clouds and the ground. Isn't it surprising that the power of lightning comes from incredibly tiny parts of atoms called electrons, which jump between atoms all at once?

Hattie: It's unbelievable.

Phinny: Does that mean you don't believe it?

Hattie: I believe it, but I can't quite get my mind around it.

Phinny: Maybe that's because your mind is even smaller than an electron.

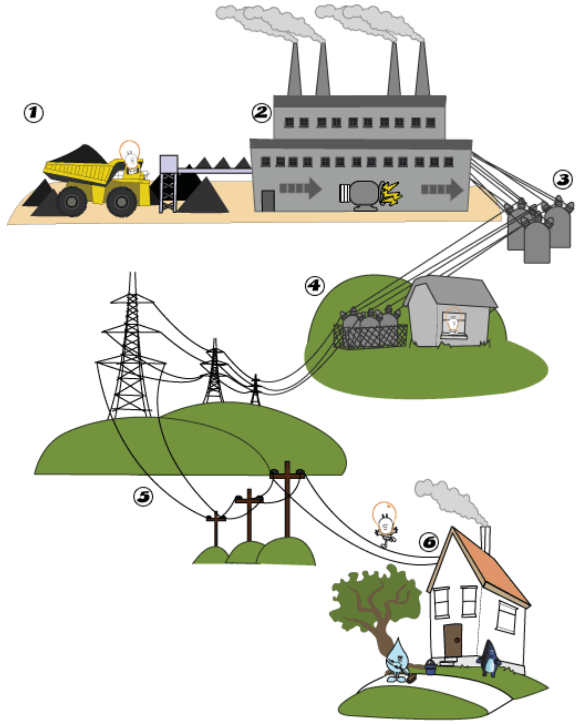
Hattie: At least my mind exists. Yours is just empty space between two giant ears.

Phinny: You're just jealous you don't have hair on the bottoms of your feet!

Archie: *With mock sincerity.* I think we're all jealous of that.

Olive: Uh hum. *Clearing her throat.* Moving right along, we've covered the first form of electricity, static electricity. Let's go on to the form we're most familiar with in modern times, electricity in a current. This is what we use in lamps, toasters, TV sets, radios and other things called appliances, things that run on electricity around the house.

Shows diagram of electrical current.



As you can see here, electrical energy flows from an electrical plant through wires that connect to your home. How do you connect an appliance to that?

Lilly: You plug the cord into an outlet.

Olive: That's right. When we talk about directing the flow of electrons we have to talk about two kinds of materials, "insulators," and "conductors." Electricity flows easily through certain kinds of materials and they are called conductors. What materials conduct electricity?

Hudson: Metal…and water.

Olive: Correct. Electricity flows easily through them. That's why cords have metal wires inside, and why the part of the plug that goes into the wall is made of metal as well. It's also why you have to get out of the water in a lightning storm.

If you think about a cord, the metal wires are placed inside another material, which is an insulator, or something that breaks up the flow of electrons. What insulates an electrical cord?

Hattie: Rubber.

Phinny: Polyvinylchloride.

Hattie: What?

Phinny: You heard me. Polyvinylchloride. It's a plastic.

Olive: How did you come to know that, Phinny?

Phinny: My uncle is an electrician.

Hudson: Isn't your uncle a fox?

Phinny: Your point?

Hudson: He has a job?

Phinny: Yes, he has a job and a tool belt.

Hudson: Well, if he has a tool belt…

Kids laugh.

Olive: I'm glad you could share your expertise with us, Phinny.   Rubber and plastic are good insulators. And apparently they're wrapping wires in polyvinylchloride these days. Anyone know any other insulators?

Archie: Wood.

Lilly: Glass?

Olive: Yes, wood and glass are both insulators. Now, we usually don't start our appliances by plugging them in. What do we use instead?

Hattie: A switch.

Olive: Right. Electricity in a flow must have a path and we call that path a circuit or a loop. Electricity flows in a loop or it doesn't flow at all. That means in the case of a lamp, electricity flows from the outlet into the light bulb and back out to outlet.

Here is a picture of a simple circuit. You can see the light bulb is not shining so we don't have a closed circuit. What could we do to get electricity to the light bulb?

Lilly: Push that little lever down so it makes contact with the other piece of metal.

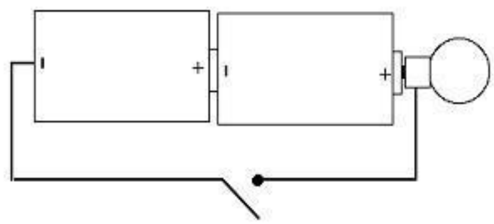
Olive: That's right. We have to close the loop. To keep things simple, we're using a battery and not a whole power plant. But the principle is the same whether the circuit is miles or inches long.

Archie: I like how that lever has a cute little polyvinylchloride tip on it so you could keep from getting shocked if only you had fingers the size of Hattie's.

Olive: *Smiling, knowing what Archie's up to.* And I like how you found a chance to roll Phinny's word off your tongue, Archie.

Archie: *Smiling back.* I aim to please.

Miss Olive brings out a picture and a diagram of a flashlight.



Olive: The picture on the left shows a flashlight and the picture on the right shows the circuit in a flashlight. Does anyone want to explain it to us?

Lilly: I think the two rectangles in the middle are batteries. Now I understand why you put the negative side of one against the positive side of the other.   It's so you get a flow. The electrons flow along the wire. When the switch is up, like this, the light is off. But if you close the switch, you connect the circuit and the light turns on. Right?

Olive: That's exactly right. Good job, Lilly. Does everyone see what Lilly described?

Archie: Yes, but the picture doesn't match the diagram.

Olive: *Looking at the two.* No you're right. What do we need to change?

Phinny: We need to make the diagram of a flashlight, not a kitchen.

Olive: The picture on the left <u>is</u> a diagram of a flashlight.

Phinny: That thing? I thought it was the plans for a kitchen. Right now, I'm just wondering where they keep the refrigerator. I can see the counters and the door, but I don't see where they keep the food.

Olive: Uh…Phinny, are you by any chance hungry?

Phinny: Starving. Even Hattie's starting to look tasty.

Hattie squawks in alarm.

Lilly: *To Phinny.* Did you not hear anything I said?

Phinny: I was trying to listen but seeing that kitchen made me too hungry to concentrate.

Olive: Perhaps, it's snack time Phinny. When you're seeing a kitchen in a diagram of a flashlight, you must be ready to eat.

Phinny chomping on a carrot.

Phinny: Oh, now I see what you're saying. Those counters are batteries, but what is the open door?

Lilly: It's the switch. When it's open the current can't go anywhere. The problem between the picture and the diagram is that in the picture, the flashlight is on, and in the diagram, the switch is open which means the flashlight would be off.

Hattie: It's a little bit like the switch that's open in your brain, Phinny. When it's up, your brain is off and it's up most of the time.

Some kids laugh.

Phinny: My switch must be up right now, because you're looking more and more like dessert.

Kids laugh. Hattie squawks and flies out.

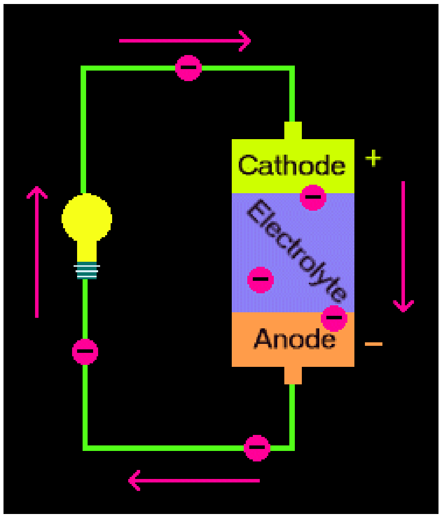
Olive: Okay, we've had our fun. Let's finish up by talking about batteries. How do they work? Hattie, I'd like it if you could join us for this.

Hattie returns grumbling, and keeping an eye on Phinny.

Olive shows picture of battery.

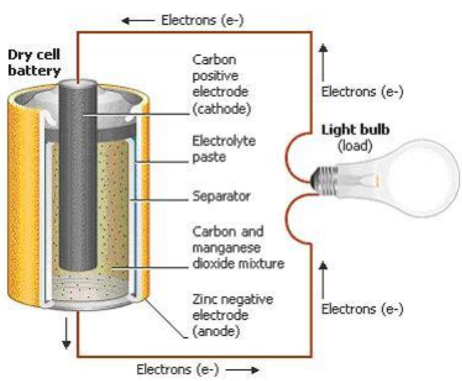
Olive: The first thing to understand is that batteries have a negative and positive end. The positive end is called a cathode, and the negative end is called an anode.

Shows next picture.



Olive: This picture shows a simple circuit of electrons flowing from the anode to the cathode. In the middle, we have another light bulb, and since the circuit is not broken, it is on.

Shows next picture:



Olive: This next picture is more complicated but what I want you to see is what's inside the battery. There is a liquid or paste inside, which is made of chemicals. In this diagram it's called the Electrolyte paste. As the chemicals interact they lose electrons, which want to flow to the cathode, or positive end of the battery. But the rod inside won't allow them to go up it, so instead, they flow out of the bottom and through the circuit, which lights the bulb and returns to the positive end, the place they all wanted to go in the first place. Now, eventually the chemicals in the battery have no more electrons to give up and that's when your battery goes dead and you have to buy a new one with fresh chemicals. Does that make sense?

Phinny: I don't think so. My nose is pretty keen and I don't smell anything.

Olive: Not scents, Phinny, sense, as in "is that clear, do you understand what I just said?"

Phinny: Oh…Perfectly.

Olive: Really? Perfectly?

Phinny: Yeah, that's explains why it's so important to have a positive attitude.

Olive: What do you mean?

Phinny: So you can be a leader and not a follower like those mindless electrons.

Olive: Phinny, do you understand that this has nothing to do with mental attitude but whether an atom has more protons than electrons, or more electrons than protons?

Phinny: Still, I'd rather be high on photons, than down and out on too many electrons.

Olive: *Deflated and not knowing how to get through to Phinny.* Okay…*(Ironically)* Did anyone else get what I said perfectly?

Hattie: I get the battery part. I just can't get over how so much power can come from anything so incredibly tiny as electrons are.

Olive: *Cheering up a bit.* I share your wonder, Hattie. It makes the universe mysterious, indeed.

Phinny: Now that's how I differ. The universe is simple, it's roller skating that's hard to crack.

Archie: Are you still worried about skating on sand?

Phinny: I'm worried about skating at all. You try skating on four legs.

Archie: You've got a point. Why don't you stand up?

Phinny: Right. And why don't you fly? Honestly, it's like nobody thinks the really deep thoughts around here but me. What would you all do without me?

Olive: We couldn't make it without you and Hattie, Phinny.

All the kids join in: Yeah, Phinny. Yeah, Hattie.

Hattie flutters a little bit.

Phinny turns red.

Phinny: Aw, sheesh. Now you've done it. I wasn't made for fame. *Covers his eyes.*

Questions for Lesson 7

1. What is an atom made up of?
   a. Electricity.
   b. A nucleus of protons and neutrons, and electrons, which orbit it.
   c. A proton and an electron.
   d. Air.
2. What is the smallest thing we have studied in these lessons?
   a. Molecules.
   b. Atoms.
   c. Electrons.
   d. Protons.
3. What is the difference between static electricity and an electrical current?
   a. Static electricity doesn't move and a current does.
   b. An electrical current is dangerous and static electricity is not.
   c. Static electricity is dangerous and a current is not.
   d. Static electricity occurs when electrons suddenly jump all at once to a positive material and a current is when electrons flow within a conductor, like a wire.
4. What purpose does a switch hold in an electrical circuit?
   a. It can stop the flow of electrons when it is up.
   b. It can block the flow of electrons when it is down.
   c. It can collect static electricity.
   d. It can control how many electrons can get through at one time.
5. When working with electricity, it is important to know…
   a. What time it is.
   b. What materials act as conductors and what materials act as insulators.
   c. How large atoms are.
   d. Why not that many birds get hit by lightning.

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