the Science Shelf

Electricity Curriculum for a Montessori Classroom
- Children's House Level -

The

For all Children's House

Introduction

Lesson 1: Safety - batteries and outlets

Lesson 2: History - Benjamin Franklin

Static Electricity

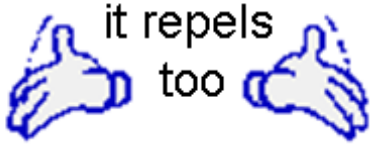
separating salt & pepper,
bending water

it attracts

puffed rice and paper dolls

it does both at the same time
(… but let them figure that out)

balloons



it repels
too

electrometer

you can measure it

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For 2nd – 3rd years

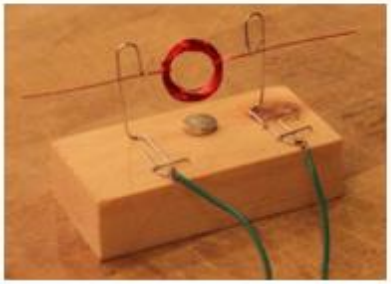
Current Electricity

Transition to Current

Simple light circuit, conductivity test, switches

transition to motors: magnets revisited, electromagnet

Introduce snap circuits



motors

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Electricity Curriculum for a Montessori Children's House
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Bold = To be presented in Jan 2016 MSM conference

Scheduling

I like to schedule these as weekly half-hour lessons. (With well-behaved and uninterested children, it's over in 15 minutes; with lots questions it easily goes to a half hour.) I begin them in the winter (December or January) for a couple of reasons. First, static electricity works really well in the winter when the air is drier, not so well later in the year with more humidity in the air. Second, if first-year children will be receiving the lessons, it is best if the classroom is thoroughly normalized, methods of cleaning up wet & dry spills, etc. is established. With 1 lesson a week, these lessons can go up to the end of the school year:

Week#	Lesson
1	Intro to Electricity; Batteries and Outlets
2	The Story of Benjamin Franklin and his Kite
3	Intro to Static elec; Separate Salt & Pepper
4	Bending Water; Sticky Balloons
5	Crispies & Tissue Dolls; Electrometer
6	Transition to Current
7	Simple Light Circuit
8	Light Circuit with a Switch
9	Short Circuit; more switches

Week#	Lesson
10	Snap circuits: light with & without switch
11	Short Circuit revisited for snap circuits
12	More Snap Circuits
13	Magnets & compasses
14	Electromagnet
15	Simplest Motor
16	Visible Motor
17	Snap circuits motor with attachments
18	& beyond: Advanced Exploration (indiv/small group lessons)

Sequence & Requirements

The sections should be done in order, though not all lessons in a given section are necessary. The static electricity section is not a prerequisite for any other lesson, but rules and concepts for other sections are more advanced. The last 2 sections (motors and advanced exploration) both require an understanding of current electricity in order to be useful.

Sequence by section:

Introduction: The order within introduction section is not important; some teachers elect not to do it at all. The safety lesson is considered necessary by some, but an invitation for 3-year-olds to explore outlets by others. Use your judgment! The Franklin lesson ties in history & nature (lightning); not necessary but good for associating to known things.

Within **Static** electricity, order is not so important, other than do the introduction first. I include introduction along with another lesson in a single session.

For **current** electricity, the sequence is more important. When transitioning to snap circuits, make sure to start back with the simplest circuit again, because the material looks so different.

Motors presume an understanding of **current** electricity, and the sequence within this section is important.

Advanced exploration lessons can be done in any order; this section has the **current** electricity section as a requirement, but not **Motors**.

Aims and Language Introduced

	Lesson	Aims	Language
Intro	I1: Batteries & Outlets: safety	To understand batteries are OK to touch, not outlets; associate known (bead, water quantity) with unknown (electricity quantity)	battery, outlet, electricity
	I2: Benjamin Franklin and his Kite:history	Associate known (lightning, money, batteries) with unknown (electricity discovery, Ben Franklin)	Benjamin Franklin, lightning, scientist
Static Electricity	S1: Intro to Static Electricity	Introduce static electricity concept, making electricity in the classroom	static electricity
	S2: Separate Salt & Pepper	1st application of static electricity at work; associate known (transfer, sorting) with unknown (electricity); attraction concept	attract
	S4: Sticky Balloons	Introduce repulsion, concept of charges	repel, plus, minus
	S5: Climbing Rice Crispies & Dancing tissue Dolls	Introduce concurrent attraction & repulsion	
	S6: Static Electrometer	Introduce concept of measuring electricity	
Current Electricity	C1: Transition to current	Introduce concept of current (water)	current
	C2: simple light circuit	Associate known (water current, plus and minus) with unknown (electricity current); First application of current electricity	wire, current electricity, light, bulb
	C3: Light Circuit with a switch; conductivity tester	Introduce switch, concept of a schema	switch, open / closed circuit
	C4: Short circuit	Introduce concept of short circuit vs doing some work	short circuit
	C5: Different types of switches	Show that different looking switches all do the same thing; link to known (wall switch) as well as reinforce safety	toggle, knife, wall switches
	C6: Snap circuits: light	Associate known (light circuit) with unknown (new material)	
	C7: short circuit revisited	reinforce short circuit concept, more complex short circuits	
	C8: Snap circuit: light with different types of switches	add more complex circuits	
Motors	M1: Transition to Motor:magnets (review/depth)	introduce polarity, magnetic attraction & repulsion; associate known (north pole) to unknown (the earth is a giant magnet)	magnet, north, south, pole
	M2: Discovery of electromagnetism as a single force	illustrate electricity having an effect on magnetism	
	M3: Electromagnet	introduce permanent magnet vs electromagnet	electromagnet
	M4: Simplest motor	show magnet / electromagnet interaction makes a coil spin	motor, coil
	M5: Visible motor	application, more complex motor, still with visible magnets	
	M6: Snap Circuits motor: color wheel	enclosed motor, new application	
	M7: Hovercraft	enclosed motor, new application	hover, hovercraft
	A1: Selected Snap-Circuit projects for readers	various (parallel vs. serial circuit, etc.)	various

Materials

Lesson	From The Science Shelf	From Your Classroom
I1: Batteries & Outlets: safety	matching cards, outlet image	tray, basket, batteries
I2: Benjamin Franklin and his Kite: story	Image of Ben Franklin with kite (coloring) & portrait (to put up)	tray, coloring materials for coloring work
S1: Intro to Static Electricity		
S2: Separate Salt & Pepper		salt, pepper, materials to rub,bowls, trays, spoon
S4: Sticky Balloons		balloons, string, long rod, 2 chairs, materials to rub
S5: Climbing Rice Crispies & Dancing tissue Dolls	plexiglas & frame, wood blocks, dolls, krispies	cookie sheet, brush, dustpan, small tubs, materials to rub
S6: Static Electrometer	Electrometer: jar, hangar, tin foil, electrical tape, mylar	materials to rub
C1: Transition to current	river land/water work: tub, clay	digging tool, 'tray, pitcher, sponge, bucket
C2: simple light circuit	battery, wires, light & bulb	screwdriver
C3: Light Circuit with a switch; conductivity tester	knife switch any-material switch	battery, tray
C4: Short circuit	laminated cards	tray
C5: Different types of switches	more wires, more switches, instruction cards	battery, tray
C6: Snap circuits: light	snap circuits (subset), instruction cards	battery, tray
C7: short circuit revisited	laminated cards	battery, tray
C8: Snap circuit: light with different types of switches	snap circuits (additional pieces), instruction cards	battery, tray
M1: Transition to Motor:magnets (review/depth)	magnets, paper clips, compass, "North" card	bowl, plastic lid, optional: magnetic & non-mag. objects
M2: Discovery of EM	apparatus, compass	battery, tray
M3: Electromagnet	electromagnet, compass	battery, tray
M4: Simplest motor	simplest motor	battery, tray
M5: Visible motor	visible motor	battery, tray
M6: Snap Circuits motor: color wheel	snap circuits (additional pieces), instruction cards	battery, tray
M7: Hovercraft	motor, propeller, wires	battery, paper plate, tape
A1: Selected Snap-Circuit projects for readers	snap circuits (additional pieces), instruction cards	battery, tray

Lessons from the first half of static electricity section follow.

Section 2: Static electricity

General information for teachers

Please read this box, if you read nothing else.
Static electricity doesn't work much at all in high humidity! The reason for this is water molecules in the air act as a conductor, "short-circuiting" the desired interactions. Static electricity works best in the winter when the air is drier. Right after winter break is a great time to start.

Static Electricity is a *stationary* electric charge that builds up on an object such as a capacitor (human-made) or a thundercloud (natural). It is called "static" because it *mostly* stays in the same place, and an object is said to be *charged* (negatively or positively) because it retains the electric charge. When we see activity as a result of static electricity, the object is discharging, or losing *some* of its charge – though it still remains charged (usually only for a minute or less with our work).

When you rub 2 objects of certain types together, one will tend to lose electrons to the other. The one that received electrons will be negatively charged, while the other will be positively charged. The negatively charged thing is usually the one that you can do interesting things with. The chart on the next page gives you some ideas for materials to use. Remember, you want one thing closer to the "+" end of the scale, and one closer to the "-" end.

The person who wants to perform the experiment must also be the one who charges the object. If one person charges (for example) a comb and then hands it to another person, it does not stay charged! Like the carpet-and-doorknob, when the second person touches the object, the charge is transferred; it's just too small a spark to notice.

Use various materials to see what does/doesn't work. Wool and paper towels both work very well losing electrons and becoming positively charged; plastic & vinyl, especially combs, balloons, flatware, do well accepting electrons and becoming negatively charged. These negatively charged objects are the ones you do the rest of the work with. Make sure to try your materials out!

The shelf setup I used was a departure from the Montessori standard of having all necessary materials on 1 tray, though you could do it that way.

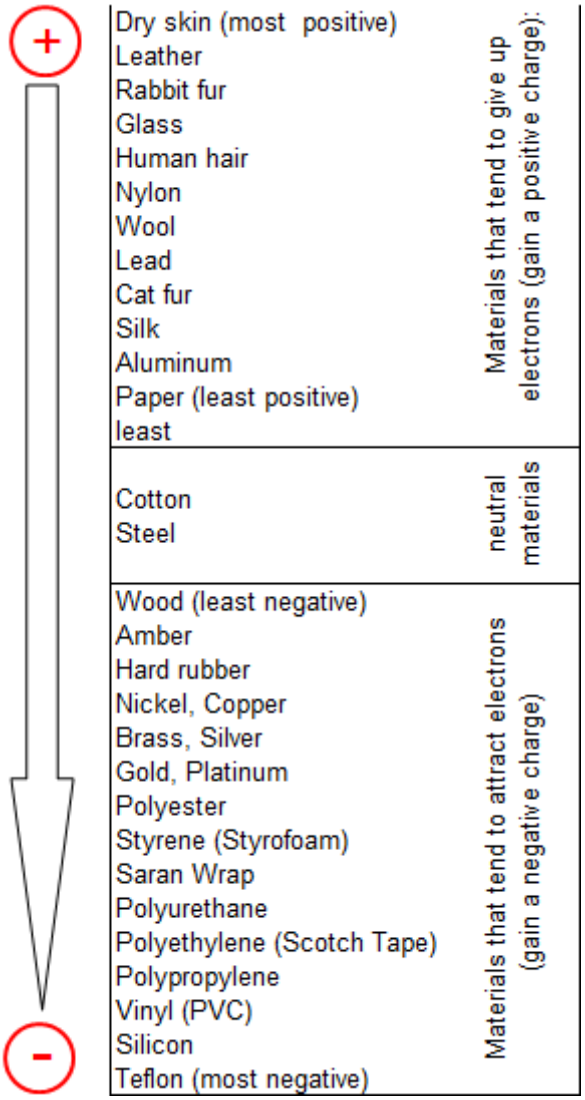
I use a container for objects to rub:

…and another container for materials to rub things with.

These two baskets are used for all of the static electricity activities. This work is good to have late enough in the year that sharing of scarce resources is familiar to the children. Less is better in this case. Make sure to include only a very few materials that *won't* work: only 1 or 2 non-working materials in each container. Otherwise experimentation will result in a lot of failures, which is frustrating. Once the children have settled on their "favorite" materials, add some more (still keeping the number of non-working ones low), or invite the children to try various materials from the classroom for their experiments.

Materials for Static Electricity Charging

The table below suggests materials that might be good, and not so good, for static electricity work. Materials close to the middle won't work, while materials near the top and bottom will probably work fine. This list is far from comprehensive, for example I found paper towels work very well on the "+" end.



Now on to the fun stuff…

Static 1: Introduction to Static Electricity (mini-lesson)

Note This lesson can be included as part of the first static electricity lesson.

Aims: To introduce the concept of static electricity; the idea of making a small and safe amount of static electricity in the classroom; and that rubbing 2 things together makes static electricity.

Preparation: None; Materials: None

Presentation to the child:

Review a few key things you have discussed in any previous lessons, such as: Can we see or smell or hear electricity? (No) What is something important that Ben Franklin did? Where is electricity in nature? (lightening, electric eels). "Lightning is dangerous, because it's a lot of electricity. So we don't go outside in a lightning storm. But we can make electricity in the classroom, and it is safe, because it's just a little bit of electricity."

"Everyone please sit very still." (or: Everyone please watch what I do now" – and sit very still.) Let that go 15-30 seconds, then ask what they just did (or saw you doing). "Right! We weren't doing anything, we were just staying in one place. Another word for staying in one place is static. Can you say 'static'? … "static means something stays in one place, and static electricity *mostly* stays in one place -- but then it jumps to a different place suddenly. Can you say 'static electricity'? That's what lightning is: lots of static electricity jumping from the sky. [If you did the Ben Franklin lesson: Remember, Ben Franklin found out electricity is all over the place but] we cannot see it. But when it jumps to a different place, that's when we can see something happen because the electricity jumped." You can also have the children stand very still, then jump once. "It's easy to make a little static electricity, here is what you do: just rub two things together! But it can't be any two things – only some kinds of things work."

Static 2: Separating Salt & Pepper

Aims:

Direct: separate salt (or sugar) from pepper

Indirect: experiment, experience; discover the attractive property of static electricity; discover that it works with some materials but not others.

Age: 3.6

Preparation: Introduction to static electricity

Materials: .

- Tray, Small bowl containing a little salt and pepper (about 1 tsp each), Two more small empty bowls, brush to brush pepper off the objects.
- Collection of hard objects to rub: these must include a some plastic or vinyl object, preferably a plastic fork*. Also include 1 or 2 objects that don't hold static electricity well, like metal and wood. For example: 2 forks (one plastic, one metal) and 2 spoons (one plastic, one metal). Don't use knives.
- Collection of soft materials to rub the objects with: make sure to include wool, which is considered great, also synthetic materials which are not. I found coarse brown paper towels work well also.

The little corn-cob bowls were great for telling a story about how I only like salt on my corn, and my friend only likes pepper.

* Why a fork?

Most plastic objects work well, but an object with more surface area works better, so combs and forks are most frequently used. A white fork is great because the child can see the pepper appear between the tines of the fork immediately.

Presentation to the child:

Fundamental lesson, presented as a group lesson.

1. "Today we are going to talk about static electricity. Static electricity happens in nature, sometimes in very big ways! Can anyone tell me where static electricity happens in nature?" (lightning, also doorknobs). "Lightning is very dangerous, because it's a lot of electricity. That's why we don't go outside in a lightning storm. But we can make static electricity right here in the classroom, and it is safe, because it's just a little bit of electricity."
2. Ask children to observe you, and sit still for 10 or 15 seconds, "What did I do? … Static means something stays in one place, and static electricity *mostly* stays in one place, but then it jumps to a different place. That is what lightning is: static electricity jumping from the sky. Electricity is invisible. It is always around, but only when it jumps to a different place, that's when we can see something happen.
3. Everyone hold your hands out wide. Then put them together and say "attract" (clapping with big accent on 2nd syllable). Attract means things come together. Static electricity makes things attract, but only some things.
4. Take out the materials, and spoon 1 spoonful of salt-and-pepper into one bowl. Tell a story why you need to separate them "Once I went to dinner at a friend's house, and we had corn at dinner. The corn had salt and pepper on it, and I like salt, but I don't like pepper so much." Or, "Once I was cooking and I put in some salt and some pepper, but I wasn't supposed to have pepper." Etc. "The pieces

are so small! How can I take out just the pepper?" Then I remembered how static electricity makes some things stick together. Even tiny things!

5. Some children may mention balloons at this point, if they haven't already. "But not everything sticks with static electricity, only some things. "The way we make static electricity is to rub two things together. When we do that, we are charging the object, just like you charge a phone. But it doesn't work with everything, only some things. There is a tray of things to rub here, and a basket of materials to rub them with here. If I make static electricity, lets see if I can separate the salt and pepper!"

6. Note: decide based on your children, whether & how to demonstrate. Older children are more likely to use the work without a prior demonstration. If you do end without demonstrating, at least demonstrate how close to hold the object, and make sure to have very few objects, because too many failures will eliminate interest in this work quickly. On the other hand, if you do demonstrate, you run the risk of children using only the materials you demonstrated with. You can tell the children some material will hold even more electricity, and pick up even more pepper.

Points of emphasis: see underlined above

Language: static electricity, rub, charge (also salt, pepper, corn, bowl)

Work of the Child:

Points of interest: the concept of jumping pepper, interesting array of shapes, soft vs. hard, small (pepper & salt) vs. big objects

Points of consciousness: seeing the pepper jump onto the fork

Control of error:

- The child sees the pepper attaching to the object, or not.
- Seeing no more pepper in the mixture bowl

Variations and Extensions:

- You can use sugar and pepper instead. Salt can actually get picked up a little bit, but I hear that sugar won't at all. You could even let them eat the "purified" sugar if you want to deal with the related prep/cleanup work and overactive kids!
- Use different materials (sawdust & dry herbs move. wood chips, sugar, and rice don't move).
- Add more or switch out materials for rubbing
- Try picking up dust off the floor or carpet.. (Note: feather dusters work because they are electrically charged.)

Sources: Marc Allen 2013