Bay Area Scientists in Schools Presentation Plan

Lesson Name Electricity, Magnetism and The Wall Socket
Presenter(s) Matthew Spencer and/or EEGSA Outreach Program
Grade Level 4 **Standards Connection(s)** Link between electricity and magnetism.

Next Generation Science Standards:

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Common Core Standards:

ELA/Literacy:

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Mathematics:

MP.2 Reason abstractly and quantitatively.
MP.5 Use appropriate tools strategically.
MP.4 Model with mathematics.

FOSS Connections:

Grade 4 Module: *Magnetism and Electricity*
Investigation 4: *Current Attractions*

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (**4-PS3-3**) *Planning and Carrying Out Investigations* Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (**4-PS3-2)**	*PS3.A: Definitions of Energy* The faster a given object is moving, the more energy it possesses. (**4-PS3-1**) Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (**4-PS3-2**),(**4-PS3-3**) *PS3.B: Conservation of Energy and Energy Transfer* Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (**4-PS3-2**),(**4-PS3-3**) Light also transfers energy from place to place. (**4-PS3-2**) Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (**4-PS3-2**),(**4-PS3-4**)	*Cause and Effect* Cause and effect relationships are routinely identified and used to explain change. (**4-ESS3-1**) *Energy and Matter* Energy can be transferred in various ways and between objects. (**4-PS3-1**), (**4-PS3-2**),(**4-PS3-3**),(**4-PS3-4**) *Connections to Engineering, Technology,* *and Applications of Science* *Interdependence of Science, Engineering, and Technology* Knowledge of relevant scientific concepts and research findings is important in engineering. (**4-ESS3-1**)

Teaser:

Why does a light turn on when we plug it into the wall? Electricity practically defines our life from charging our iPhones to washing our clothes, but where does it come from? This lesson explores the link between electricity and magnetism by answering that question through a series of activities: students in small groups will first build a motor then try to understand the workings of how common generators (like those in hand-cranked light bulbs) and share their results. These two activities illustrate the fundamentals of how power is generated and used and will be used to explain how power and energy, critically important parts of our everyday experience, are linked to what they're learning right now.

Objective:

Students should be able recognize that there's a tight link between electricity and magnetism and understand that moving magnets can make electricity and that combining electricity with magnets in special ways can cause physical motion.

Vocabulary:

- Electricity
- Magnet
- Battery
- Motor
- Generator

Materials:

What will you bring with you?

- 3-6 C batteries
- 20 metal paper clips
- Tape
- 3-6 permanent magnets
- fine wire

What should students have ready?

- Paper
- colored pencils and/or crayons
- scissors

Classroom Set-up:

Students should be split into three groups ideally as soon as I arrive. There should be a central presentation area where I will introduce myself and major topics during the visit, but each of the groups of students also need a central area to work.

Classroom Visit

1.

Personal Introduction: 5 Minutes

Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?

I'll introduce myself as an engineer from Berkeley who studies electronics. I'll also probably discuss my background (grew up in Iowa, went to school in Boston, have one dog …) and some of my hobbies (computer games) which can be used as a segue into the importance of electricity.

Topic Introduction: _____10___ Minutes

What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge…

The first and most important question is to ask what students know about electricity. This is followed by asking what they know about magnetism. This section will be handled as a Q&A writing big ideas the students bring up on the board. Regardless of whether the students have been introduced to these concepts I will use this as an opportunity to define electricity (a force that comes out of batteries and the wall) and magnetism (an invisible force that can move electricity or other magnets). Finally, I will make an explicit point of introducing the terms battery, generator and motor as ideas that we're going to explore.

2. Learning Experience(s): __35__ Minutes

What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.

I'll spend 5 minutes of this time explaining to the students how to combine a C-battery, paper clips and wire to make a motor. The student groups will then be given the parts to attempt this themselves (for ~10 minutes) and I will rotate between tables helping the students to build the device. I will have a pre-assembled motor ready to demonstrate in case it's needed to convince unbelievers or for demonstration purposes.

Once time is up I'll use 5 minutes ask students what they thought of the process and what they learned. I'll then make sure that everyone agrees on the fundamental point: electricity from the battery combined with magnetism from the magnet to make the motor spin. Here we define motors – device that combine electricity and magnetism to make motion.

Next the students will be given simple generators (a shake flashlight, a windup flashlight, etc.) and they will be asked to spend 10 minutes drawing what's happening when it works. I'll circulate with some magnets and other tools to suggest experiments the students can use to get better ideas of what is happening.

I've budgeted five extra minutes in this section for setup/cleanup and other miscellaneous delays

3. Wrap-up: Sharing Experiences ___5___ Minutes

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Students will share the drawings that they made (one presenter per group will come to the front of the room) and I'll augment their descriptions with key points about the devices they worked on. I'll

then share the unifying idea that the devices they used are generators, machines which use moving magnets to make electricity.

4. Connections & Close: 5 Minutes

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

This will be a quick, spoken summary of what we did and the major ideas of the day: we built motors which used electricity and magnetism to make motion. The electricity in these came from batteries, which combine chemicals to make electricity. After that, we looked at generators which use motion and magnetism to make electricity. The key point to take is way is that motion, electricity and magnetism are linked.

Time permitting, I'll also mention that generators, almost exactly like the ones in class today, are used to make the electricity that's in the walls and ask the kids to brainstorm ways to make the motion for generating electricity. (Point out that windmills are big spinning machines, burning coal makes steam which can spin things like in steam engines …)

Total 50 – 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to operate generators at each station. Write vocabulary words on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students think of other ways to power their simple generators and physically experiment with their ideas.

Follow-up Possibilities

ELA Activity:
Suggest students write a letter explaining "How we learned about Electrical Power Generation?"

Reading Connections:
- Awesome Experiments in Electricity and Magnetism by Michael Dispezio - More than 70 experiments explore electric charges, static electricity, currents, circuits, switches, and magnetism. Each one includes a brief introduction, a list of materials, directions, and a scientific explanation of the results. http://www.amazon.com/Awesome-Experiments-Electricity-Magnetism-DiSpezio/dp/1402723709
- Experiments with Magnets by Salvadore Tocci - http://www.amazon.com/Experiments-Magnets-True-Books-Science/dp/0516273507

Mathematics Activity:

Students can attach their simple motors to a wheeled object and calculate the velocity of each object.

Other:

Study alternative energy sources. Look at howstuffworks.com (a treasure trove) on the subjects of motors, batteries and generators. Buy motors at Radio Shack (~$5 to $10) and play around with them and batteries.

Here's a list of websites for further exploration

- http://www.exploratorium.edu/snacks/
- http://my.execpc.com/~rhoadley/magreview.htm
- http://www.kidskonnect.com/subject-index/15-science/90-magnets.html
- http://www.kids-science-experiments.com/cat_magnetic.html

Magnets are Fun! (Center of Science and Industry) http://smile.cosi.org/magnets-are-fun-teacher-packet.pdf#page=4