Electron Flow
Program Information

FIELD TRIP OVERVIEW

The focus of *Electron Flow* is on electricity and energy-efficient lighting. The field trip is broken into two 1-hour parts. After a short, 10-minute introduction to the center and topic, half of the students and their chaperones join a docent for a series of hands-on investigations. The other group of students and their chaperone/teaching assistants follow a guided exploration of the gallery space, learning how our rate of electricity consumption has affected the earth's climate. After sixty minutes, the groups switch and experience the other part.

Laboratory Experience

This sequence of four activities builds student understanding of electricity and energy efficiency by starting from a concrete, physical level and working up to the real-world problem of choosing a light bulb. Following a brief review of electricity, students work in small groups to build simple circuits that use hand-crank generators and then D-cell batteries as energy sources. With these circuits, students compare different bulbs and discover through measuring current that these different bulbs require different amounts of energy. Students then determine which bulb is more efficient by using voltmeters and light meters to compare the amount of energy consumed with the amount of light produced by the different bulbs. In the final activity, students apply concepts learned in the previous activities to determine how much more efficient household CFLs (Compact Fluorescent Lamp) are compared to the standard incandescent light bulb.

Introduction: Electron Flow (5 minutes)

The introduction's objective is to raise awareness in the students of how dependent they are on electricity for just about any everyday task: keeping food safe, doing their homework, etc. Following a brief discussion, a scripted slide show provides a quick review of what electricity is - the flow of electrons between a difference of charge.

Activity 1: Electrons on the Move (10 minutes)

After the docent models how to use a hand-crank generator to create current, students physically experience the different levels of energy required to light two lamps (Lamp A and Lamp B) with different voltage requirements. A brief

discussion emphasizes the flow of electrons, the concept of a closed circuit, and begins to make the connection between efficiency and energy consumption.

Activity 2: Measuring Electrons (15 minutes)

Students build on their understanding of current electricity by figuring out how to light both lamps with batteries arranged in series. Students first work together to get both Lamp A (3.6 volts) and Lamp B (6.2 volts) to light using a single battery. They'll notice that both lamps light fairly dimly. A second battery for each circuit allows Lamp A to light approximately twice as bright but Lamp B will remain comparatively dim. Working with voltmeters and light meters, students discover that Lamp A produces the same amount of light as Lamp B but uses far less energy. This discrepancy sparks a discussion about efficiency.

Activity 3: The Difference Heat Makes (10 minutes)

The third activity applies what students learned about efficiency in the previous activity to the real-world problem of choosing a light bulb for their home. Following a procedure similar to the previous activity, students use a WattsUP meter to compare the energy consumed by a standard incandescent light bulb and a CFL. After they use a light meter to measure the light output from both bulbs, students determine that the CFL uses roughly one fourth the energy but produces slightly more light – a dramatic demonstration of an incandescent bulb's inefficiency.

Closure (5 minutes)

The closing activity begins with a review of what electricity is (the flow of electrons between a difference of charge) and the concept of efficiency. Using the incandescent bulb as a prime example of inefficient electricity consumption, the docent discusses with students how other efficient appliances could impact their family's electricity consumption as well as other steps their families could take to reduce their electricity consumption.

Gallery Experience

The gallery experience starts off in front of the "Magic Planet" digital video globe. Through this video, students are introduced to the larger problem of our planet's environmental crisis. The docent then leads the group in a brief discussion pointing out how inefficient and unnecessary consumption of electricity contributes to the crisis. This discussion is intended to set the stage for students to come to the conclusion that simple changes in how we consume electricity can reduce our impact negative on the environment. Student groups continue towards reaching this conclusion by completing a scavenger hunt as they explore the exhibits. As they complete the activity, students identify how they can alter their choices for consuming electricity and thereby reduce their family's impact on the planet.

ACADEMIC STRUCTURE

Outcomes, Essential Questions, and Key Concepts

Electron Flow's instructional framework has three components: essential questions, measurable outcomes, and key concepts. These form the basis for creating links between the RUEC Lab Experience and classroom learning as well as identifying how the lab experience activities can link to the California Content Standards.

Outcomes: What will students do and know?

- Students will understand that a difference in charge creates an electric current.
- Students will know that for an electric current to flow, a circuit must be closed.
- Students will know that voltage is a measure of how much electricity is flowing across a circuit.
- Students will use a multimeter to measure the voltage flowing across a circuit.
- Students will use a light meter to measure the light intensity produced by different lamps.
- Students will use measurements to compare a lamp's energy consumption and determine the more efficient lamp.
- Students will understand the connection between a light bulb's efficiency and it's affect on electricity consumption and the greater problem of global warming and resource depletion.

Essential Questions: What will students think about and investigate?

CONSIDER: What is Electricity? How do we use electricity to do work?
CONNECT: Where does electricity come from? How do you measure electricity?
CONSERVE: How does choosing efficient appliances and bulbs affect how much electricity we use?

Key Concepts: What will be covered?

Positive and negative charge

Open and closed circuits

Efficiency can be thought of as the greatest amount of work done for the least amount of energy consumed.

Correlation to California Academic Standards

California Content Standards

California has two sets of academic and content standards that apply to the *Elements of Waste* field trip experience. The first set, *The California Content Standards,* apply to specific content that must be addressed at each grade level. Due to the limited duration of the field trip, only the science standards can be addressed with any meaningful connection. The suggested school classroom activities for students to do before and after the trip have correlations to additional content areas.

Text that is in light gray are the actual standard students must meet. The black text describes how the *Electron Flow* field trip experience helps students move towards meeting each standard.

Fourth Grade

Grade 4, Physical Science - 1a. Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

Students create closed circuits with a hand-cranked generator, batteries, wires, and bulbs.

Grade 4, Physical Science – 1e. Students know electrically charged objects attract or repel each other.

Throughout the lab experience, docent reviews with students that electricity is the flow of electrons between negative and positive charges.

Grade 4, Physical Science - 1g. Students know electrical energy can be converted to heat, light, and motion.

Students use motion to generate electrical energy.

Students consider the heat produced by incandescent bulbs as they compare the efficiency between incandescent bulbs and CFLs.

Grade 4, Investigation and Experimentation - 6d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.

Throughout the lab experience, docent prompts students to predict which lamp will be more efficient and leads students to use different instruments (multimeter, photometer) to test those predictions.

Fifth Grade

Grade 5, Investigation and Experimentation – 6e. Identify a single independent variable in a scientific investigation and explain how this variable can be used to collect information to answer a question about the results of the experiment.

Docent guides students to identify voltage as a variable to use to measure electricity and efficiency.

Grade 5, Investigation and Experimentation – 6f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

Students use multimeters and photometers to measure voltage and light intensity.

Grade 5, Investigation and Experimentation – 6g. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.

Students use charts to record and compare data. Docent presents graphs that represent different the bulbs' different impacts on electricity consumption and greenhouse gas production.

Grade 5, Investigation and Experimentation – 6h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.

Students use activity data and graphs to decide which lamp is more efficient and a better choice for the environment.

Sixth Grade

Grade 6, Investigation and Experimentation *– 7a. Develop a hypothesis.*

Docent guides students to make and test predictions.

Grade 6, Investigation and Experimentation *– 7b. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.*

Students use multimeter, voltmeters, and calculators to collect and process data.

Students record and compare data on class graphs.

Grade 6, Investigation and Experimentation – *7c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.*

Students interpret graphs to determine which light bulb is more efficient.

Education and the Environment Initiative

The EEI is a second set of standards that span across content areas and address environmental issues. Although teachers are mandated to teach environmental education, there is still a lack of state-approved curricula. Below are correlations between the *Keepin' It Clean* field trip experience and the EEI. Again, actual text from the EEI is in gray, correlations are in black.

> **Principle II – Concept b:** Students need to know that methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
>
> > *A discussion at the end of the lab experience centers around how the consumption of energy has direct and indirect effects on the natural environment. The topics raised in this discussion are further emphasized during the gallery experience tied with the lab activities.*
>
> **Principle V – Concept a:** Students need to know the spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.
>
> > *The lab experience focuses on efficiency and the impact choosing a more efficient light bulb has on the production of greenhouse gasses. The gallery experience exposes children to wide range of effect efficient electricity consumption has on the natural systems.*

Correlation to the FOSS Curriculum, 2007 Edition

Electron Flow correlates to this FOSS Module:

***Magnetism and Electricity,* Grade 4 FOSS Module**.

During *Electron Flow*, students will construct and test several circuits in both series and parallel. As they build their circuits and test the efficiency of different light bulbs, they will come to understand that the more efficient light bulb generates less heat than the more inefficient light bulb. This activity may serve as either an introduction or extension to the FOSS lessons *Making Connections* and *Advanced Connections.*

PREREQUISITE KNOWLEDGE

The terms and concepts listed in this section are at the root of this experience. Although students will be able to participate in the activity without previous exposure to these terms and concepts, it will enhance their understanding if you are able to explain these concepts and terms in a child-friendly manner.

Concepts:

- Energy is converted between many forms including light, heat, chemical, motion and electricity.
- The flow of electrons is between the difference of a negative and positive charge.
- For electricity to flow, a closed circuit must be created between the negative and positive charge.
- Electricity must be generated.
- Work is energy that has been used or converted.
- Efficiency can be thought of as getting the most amount of work for the least amount of energy.

Terms:

- Atom – the smallest particle of an element that can exist either alone or in combination with other atoms.
- Circuit – the path electrons follow as they move from a negative to a positive charge.
- Current – the flow of electrons through a circuit.
- Efficiency – getting more work done with less energy.
- Electricity – the flow of electrons from a negative to a positive charge.
- Electron – a tiny particle that has a negative charge and orbits the nucleus of an atom.
- Kilowatt – one thousand watts.
- Kilowatt Hour (KWh) – one thousand watts used over one hour, a unit of measure used by utilities to determine electricity consumption.
- Nucleus – the center of an atom, made up of protrons and neutrons.

TIPS TO GIVE VOLUNTEER TEACHING ASSISTANTS (Chaperones)

Roles & Responsibilities:

- Assist TechTeam instructor with distributing materials and getting your assigned group's attention.
- Monitor whether students are following instructions.
- Assign students tasks so that everyone has a chance to participate.
- Ask questions and model that it's fine not to know an answer or solution.

Tips for a Successful Activity:

- The activities have been designed for visiting teachers and chaperones to be active participants.
- Because there is lots of activity during the lab experience, please be sure you have at least one adult for every 5 – 7 students.
- Provide chaperones with the names of the students they will be helping prior to leaving school.