Class: Physics 122

Lesson Title: Electric Circuits

Class Size: **16**
Time: **60 mins**

Curriculum Outcomes:
ACP – 3 apply Ohm's Law to series, parallel, and combination circuits
215 – 1 communicate questions, ideas, and intentions; receive, interpret, understand, support and respond to ideas of others
ACP – 4 describe and compare direct current and alternating current

Learning Objectives:

1. Students will demonstrate an understanding of electron flow in terms of current, voltage, and resistance.
2. Students will show understanding of series and parallel circuits, direct and alternating current, Ohm's law, and be able to explain the advantages, disadvantages and mechanics of each.

Materials:

- Pinnies of various colours (or in lieu of pinnies, nametags: Positive, Negative, Battery, Light, Switch, Motor, other mechanical device)
- Flashlight(s)
- Hand-held fan(s)
- Any other mechanical object of your choosing
- *Optional*: 4-7 Volleyballs and sticky notes
- *Optional*: Class set of plastic cups and15-20 small balls (plastic, bouncy, or other material)

Note: There are three possible variations for this activity. The choice described in this lesson plan will be using students as electrons. To see details on two other possible choices see the bottom of this document. If you decide to use one of the other choices of electron mediums, you will require the "optional" materials above.

Preparation beforehand:

- You will need a large enough area that students can form a circle in (maybe by clearing desks, or using the gym or outside space)
- Create the nametags as described above, or obtain pinnies

Introduction:

1. Discuss features of electric circuits that students can recall from memory (possibilities):
    - Series vs. Parallel
    - Electron flows due to being attracted by positive end of battery, repelled by negative end
    - Electron flow create potential for work; if you have a circuit with no resistors, short-circuits
    - Alternating vs. direct current (most battery operated devices require direct, however house-hold plug-in usually use alternating)
2. Explain what a kinulation is (broken up into kinesthetic and simulation). Tell them that these are used to help students learn difficult concepts that are otherwise difficult to picture. It allows students to become part of the demonstration, and therefore easier to remember and learn. Ask students if they would like to try one.

Electric Circuits:

Variation # 1:

1. Have students form a circle (the circuit).
2. Ask them what they might represent in this circuit (either atoms of the circuit, or electrons of the imaginary circuit). For better understanding, explain that today they will be acting as electrons of the circuit.
3. Ask the students what they, as electrons, need in order to motivate them to move (positive force to attract, or negative force to repel, or combination of both). Designate two students as the "+ "and "–" ends of a battery (have them stand side-by-side). Students will now proceed in whatever direction they as electrons will move (toward positive, through the "battery" and away from negative).
4. You can asks students what would happen if a circuit was setup like this, simply wire and a battery (short-circuit) and what they would need to fix the problem. This will bring up the idea that there is potential for work, and something needs to be "worked" in order to not have a short circuit (need resistors).
5. Resistors (lights, fans, motors, etc.) and a switch can then be added into the circuit and students can

proceed to “turn the circuit on” and rotate themselves (as electrons), turning the resistors on while current is flowing.

6. Switch the positions of the “+” and “-“students. Discuss what this would do to the circuit (change direction of flow), as well as which types of objects may be affected (i.e. any battery operated like the fans or flashlight might not work if direct current). Discuss the difference between alternating and direct current and model each within the current setup.
7. Students can then be asked to posit how they would overcome a faulty resistor in a circuit so as to not shutdown the rest of the circuit (change to a parallel setup). Ask students to arrange themselves to overcome this issue (positioning the resistors in parallel).
   a. What would happen to the magnitude of electrons flown through a parallel circuit if one part was inoperable? How much voltage, current would each part of the circuit get in parallel? This will bring up Ohm’s law and provide visual representation of it.
8. This activity can be tailored to include as much or as little about electric circuits as necessary. Students can be asked to give further explanation or model different scenarios as electrons within a circuit.

Variation #2: Instead of students representing the electrons and circulating, students can represent the atoms (stationary) and circulate volleyball(s) as electrons. In this activity, instead of having only a positive and negative student for the battery, one student is also designated as the neutral (or inner) part of the battery. This student’s role is to add sticky notes (representing energy provided by the battery) to the volleyball (electron) as it comes through the battery. When the volleyball (electron) reaches some resistor, the resistor will take a sticky note off of the volleyball to represent the energy being transferred. You can start by circulating one volleyball and then add in more as the class progresses. The rest of the description of the activity is the same as above.

Variation #3: Instead of students representing the electrons and circulating, students can represent the atoms (stationary) and circulate small balls (representing electrons). Each student would be given a plastic cup to represent their capacity for electrons (1 electron) as metal atoms. The rest of the activity is exactly the same except small balls are circulated instead of students. You may wish to add the neutral/inner battery role to be in charge of adding small balls to the circuit, but it is not necessary.

Conclusion – Possible wrap-up questions:

1. What benefits do you see in becoming part of the demonstration of the concept?
2. Is anything clearer to you because of being involved?
3. What type of system (parallel or series) would seem most beneficial for power grids? Can you see any downfalls (costs associated with parallel are greater, but if everyone was on series, one house blowing a fuse could knock out an entire neighborhood)?