

CIC Lesson Plan

Lesson Name Conductors and Insulators

Developed by Jeffrey Johnson

For Grade 5

Related CA Science Standards and Vocabulary

Specific standards and new vocabulary related to lesson

CA Science Standard(s):

All matter is made of atoms
Common properties of metals

Vocabulary Definitions:

Current – the flow of electric charges moving from one place to another
Electron – the particle that carries electric charge through materials
Conduct – to allow the flow of current through a material.
Property – something that tells us about a material (e.g. color, texture)
Conductor (“good” conductor) – a material in which currents can flow. Copper wire is a good conductor.
Insulator (“poor” conductor) – a material in which currents can’t flow very well. Glass and people are insulators.
Metal – an element (something made out of 1 kind of atom) that has certain properties – conducts heat and electricity, reactive (combine easily with other elements), combines easily with other metals, and when dissolved will make a solution conductive.

Introduce and Engage

Making personal connections, engaging curiosity, building connections to kids’ experiences

Personal Introduction: *What do you do for work, hobbies, play? Why are you interested in this topic?*

I am a graduate student in physics at UC Davis studying how magnetic fields affect moving particles in **plasmas**. I worked for a long time at Lawrence Livermore Laboratory programming supercomputers to study how materials behave when they get *really* hot.

I like music. I play the French horn in a brass quintet and I also play piano and drums. I also enjoy hiking, camping, and snow skiing.

Building Connections to Kids’ Experiences: *Can you think of an experience most kids would have related to your topic? Is there something to show that will grab their attention? Or can you pose a mystery with a question about something they see everyday?*

We all know what metals are, or at least we can give examples of them (fish examples from the class). But what makes metals different from other materials (*non-metals*)? One of the defining properties of metals is that they can *conduct* electricity better than non-metals. How do they do this?

To explore this, we’ll talk about electricity and how it moves. Electricity is everywhere in our lives. How many people have electricity in their homes? What do we use it for? How does it do the things that we want it to do? We’ll try to understand why some materials can conduct electricity while others can’t. This will tell us why, for example, we can’t connect our stereo to an outlet with a piece of string. If any kids have built circuits before, they’ll be familiar with some of the material in this lesson.

Afterwards, we’ll discuss (very briefly and roughly) the chemical structure of metals and point out where they live on the periodic table, and we’ll try to connect this structure to the model that we explore for explaining conductivity.



Learning Experiences

What kids will see, do, hear, touch, taste or make.

Any combination of demonstrations, hands-on activities, and pictures that helps kids explore new ideas. Describe specific experiences in the order you plan, including instructions you need to give students.

We'll start by making a simple circuit model with kids acting as electrons moving through a wire to light up a "light bulb" (me, the teacher, or a student). Students who have built circuits will recognize this at some level.

Then we'll "zoom in" to the wire carrying the electrons so that it's really wide compared to the students. I'll sketch a simple picture of how electrons move through a material consisting of a set of fixed ions. The ions in a conductor have all the electrons that they need already, so they don't care if other electrons pass by. By contrast, the ions in an insulator want more electrons, so they capture them as they go by.

The best way to demonstrate this model, of course, is to have the kids break up into groups of electrons and ions and mimic current flow in a conductor. The electrons will attempt to move through the ions from a starting line to a finish line and will "try" to find an ion partner. An ion partners with an electron by gently grabbing that electron with their hand, and an ion can grab as many electrons as they have free hands (up to 2, of course). Ions may only move very slowly (by waddling or stepping one foot in front of the other), and electrons can steer themselves at a brisk walk, but may not slow down or stop. The number of electrons that reach the finish line is a measure of how good our conductor is.

We will explore the difference between conductors ("good" conductors) and insulators ("poor" conductors) by changing the rules of how ions can capture electrons. In a conductor, the ions have no free hands to capture electrons, since their hands are already full of other electrons (represented by oranges). In an insulator, the ions have both hands free to capture electrons that go by. In a material that "kind of" conducts electricity, an ion might only have one hand free to capture electrons. We'll demonstrate this in three or four "heats" in which electrons move through materials with varying numbers of insulating and conducting ions.

If we have the time, the interest, and the preparation, we can discuss the relationship of conductivity to the periodic table and discuss how stingy certain rows of elements are with their electrons, or we can explore the effects of different temperatures on conduction. Really, though, the major idea lies in the motion of electrons through ions in a conductor.

Sharing Experiences & Building Ideas

How kids will share experiences and build links to ideas and vocabulary.

Sharing and Interpretation: *Ideas for questions to invite sharing and guide interpretation of experiences.*

- If you were an electron, would you rather live in a conductor or an insulator?
- When an ion captures an electron, where does that electron's energy go?
- Why can't we use string to connect a stereo to an electrical outlet?
- Why do you think salt water conducts electricity better than regular water? [there's a metal in salt! Sodium is a metal, and it's part of sodium chloride or table salt.]

Closing Statements: *connect experiences to larger world, big ideas, vocabulary.*

We've seen how copper wires can conduct electricity while pieces of string can't. Whether a material is a conductor or an insulator depends upon whether its ions have enough electrons to be "satisfied." Materials that don't have enough electrons will grab them if they see them, while materials with "enough" electrons will let them pass through freely.

Most of the elements on the periodic table are metals. [Show on Periodic Table] That means that they have all the properties of a metal, including conductivity, the property we've been thinking about. Metals all have "enough" electrons so they can let electricity pass freely.



Follow-On Activities

Ideas for follow-on activities, your favorite kid books, things to notice

Write a letter about what you learned. Include drawings!

If the teacher talks subsequently about the periodic table, they can talk about how the number of electrons to an ion varies as you move from left to right and then ask the kids which elements they would expect to conduct electricity. This is a bit of a conceptual jump but it would be interesting to see if anyone made the connection.

Hands-On Exploration of Metals' Properties: Go to web address below and look at **All Topics**, select **Metals**.
<http://www.chemistry.org/portal/a/c/s/1/wondernetdisplay.html?DOC=wondernet/index.html>

Great Background on Metals in Periodic Table for Students/Teacher to Read:
http://www.chem4kids.com/files/elem_metal.html

Materials and Preparation in Classroom

Required materials and classroom set-up for complete lesson.

Volunteer Brings:

Large periodic table

Name tags with "electron" or "ion" printed on them.

Electron placeholders for conductor ions (oranges, say).

Some sort of symbolic "switch" to tell the electrons to start running (a whistle for the teacher?).

Oranges

Classroom Needs:

An enthusiastic group of kids.

A chalkboard.

A space where we can run around and cause chaos.

Set-Up Requirements:

