The AM Radio: An Exploration of Communication Using Radio Waves
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Purpose:
This lesson is designed as a unit in which students will examine the components that are used to make a primitive AM radio. In circuit and radio construction students often are asked to assemble parts together onto a prefabricated board without ever knowing what the parts are or what function they perform. This lesson is designed so that students examine each main component on an individual basis, and then learn how each component performs a function when combined in a complex circuit. When possible, the students will construct each component out of materials readily available from the local hardware store and from their homes. This will be done in order to take the mystery out of what the components are made of and how they work. Finally, students will expound on knowledge of circuitry and the electromagnetic spectrum to transform the invisible concept into a tangible working model. From there the application of these technologies and the application of these technologies to their lives will become even more pertinent and meaningful.

Materials and Methods:
This unit will consist of a combination of lectures, inquiry labs, theoretical exploration, and construction projects.

The materials for each subsection of this unit will be listed in detail under each assignment. Most materials will consist of things found readily around the house such as copper wire, batteries, aluminum foil, graphite pencil cores, and wax paper.

Students will be responsible for contributing funds for purchase of any kits or materials that must be acquired through catalogue or mail order. Most of the other materials are of negligible costs and should be supplied by the instructor out of the school funds. Should students be unable to afford these supplies, school funds must be used in accordance with the provisions of the NCLB act.

This unit is designed to encompass approximately two weeks, but may be modified to fit curriculum guidelines. It is also designed to be student motivated, with each student learning at their own pace. The best management plan for this unit is a weekly completion grid for each class in which that weeks expected work load is listed and students can check off components of that work load once they have been completed and have gained approval from the instructor.

Georgia State Education Standards Covered
1.1-1.4 Science Process skills and laboratory safety
2.5 Explores applications of a microprocessor for the analysis of laboratory data and simulation of mechanical phenomena.
12.1 Describes types of wave phenomena and modes of propagation, (e.g., electromagnetic and mechanical, longitudinal, and transverse).
12.4 Observes and illustrates wave phenomena using various types of equipment, such as ripple tank, slinky, soft rope, signal generator or oscilloscope.
15.1 Evaluates development of the science and technology of wave mechanics that affect the quality of life.
16.1 Relates principles of electrostatic forces, charge, distance and field intensity by making calculations.
17.2 Draws diagrams of simple electric circuits and uses electronic components to build simple circuits.
17.6 Analyzes complex circuits using Ohm’s Law and Kirchoff’s Law.
20.1 Analyzes development of the science and technology of high technology electronics that affect the quality of life.
20.2 Appraises evidence that the demand of society and government for more and better high-technology electronics is driving technological research.
24.3 Identifies multiple types of sources (e.g., scientific journals, newspapers, directories, audiovisuals, government publications and yearbooks, computer data bases, online resources, and other electronic media) for information on a specific topic.
24.4 Uses appropriate and available retrieval systems (e.g., periodical index, computer resources, glossary, appendix, bibliography, and graphic data) to locate sources.
24.9 Quotes, paraphrases, or summarizes information without plagiarizing.
24.10 Compares and synthesizes information obtained from multiple types of sources.

**Lesson Schedule**

**Day 1 -**

**Objective** – Students will familiarize themselves with the concepts associated with the used of AM radio and its components

Read entire article “How Radio Works” available on line at [http://electronics.howstuffworks.com/radio.htm](http://electronics.howstuffworks.com/radio.htm)

Discuss as a group the topics covered in the article and assess using a simple worksheet to indicate acquisition of needed information.

**Day 2**

**Objective**- Students will observe the transmission of a simple AM signal using a battery and a coin.

Using materials and instructions listed below, students will construct the following simple AM receiver: (copied from URL listed above)

**The Simplest AM Receiver**

In the case of a strong AM signal, it turns out that you can create a simple radio receiver with just two parts and some wire! The process is extremely simple – here’s what you need:

- **A diode** - You can get a diode for about $1 at Radio Shack. Part number 276-1123 will do.
- **Two pieces of wire** - You’ll need about 20 to 30 feet (15 to 20 meters) of wire. Radio Shack part number 278-1224 is great, but any wire will do.
- **A small metal stake** that you can drive into the ground (or, if the transmitter has a guard rail or metal fence nearby, you can use that)
• **A crystal earphone** - Unfortunately, Radio Shack does not sell one. However, Radio Shack does sell a Crystal Radio Kit (part number 28-178) that contains the earphone, diode, wire and a tuner (which means that you don’t need to stand right next to the transmitter for this to work), all for $10.

You now need to find and be near an AM radio station's transmitting tower (within a mile/1.6 km or so) for this to work. Here’s what you do:

• Drive the stake into the ground, or find a convenient metal fence post. Strip the insulation off the end of a 10-foot (3-meter) piece of wire and wrap it around the stake/post five or 10 times to get a good solid connection. This is the ground wire.
• Attach the diode to the other end of the ground wire.
• Take another piece of wire, 10 to 20 feet long (3 to 6 meters), and connect one end of it to the other end of the diode. This wire is your antenna. Lay it out on the ground, or hang it in a tree, but make sure the bare end does not touch the ground.
• Connect the two leads from the earplug to either end of the diode, like this:

![Antenna diagram](image)

Now if you put the earplug in your ear, you will hear the radio station -- that is the simplest possible radio receiver! This super-simple project will not work if you are very far from the station, but it does demonstrate how simple a radio receiver can be.

Here's how it works. Your wire antenna is receiving all sorts of radio signals, but because you are so close to a particular transmitter it doesn’t really matter. The nearby signal overwhelms everything else by a factor of millions. Because you are so close to the transmitter, the antenna is also receiving lots of energy -- enough to drive an earphone! Therefore, you don't need a tuner or batteries or anything else. The diode acts as a detector for the AM signal as described in the previous section. So you can hear the station despite the lack of a tuner and an amplifier!

**Day 3-7 – Notes** – signal oscillators, capacitors, and inductors

**Objective** – Students will become familiar with the construction and operation of a capacitor and inductor.

Students will construct their own capacitors and inductors.

Students will use these constructed components in a simple circuit and observe their effects using a small light bulb.
Students will use mathematics and DMMs to predict values for and measure capacitance and inductance in simple circuit components.

**Activities**
1. Notes – signal oscillators, capacitors, and inductors
2. Read the following articles:
3. Construct your own capacitor using the directions available at the following:
4. Construct your own inductor using the following instructions:
5. Read the following article:
   - [http://electronics.howstuffworks.com/oscillator.htm/printable](http://electronics.howstuffworks.com/oscillator.htm/printable)

6. **Construction and inquiry lab**: Using the information in the article and previously acquired information, construct a simple circuit using a bread board or aluminum strips or copper tape on cardboard. Adjust the arrangement of a voltage source, the capacitor, the inductor, and a light bulb in order to show the effects of each component on the work load (light bulb). The goal will be to show how energy will be stored in the capacitor and moved back and forth by the inductor after an initial charge is placed in the circuit by the battery. Students will test their components and analyze their data by comparing observed values to values obtained through equations for inductance and capacitance.

**Days 8-9:**

**Objectives**
- Students will explain the roles of the diode, capacitor, and inductor in receiving radio signals.
- Students will construct a more complex AM radio out of household items using the following instructions:
  - [http://www.scitoys.com/scitoys/scitoys/radio/radio.html#crystal](http://www.scitoys.com/scitoys/scitoys/radio/radio.html#crystal)

**Days 10 – 12**

**Objectives**
- Students will discuss the advent of the transistor in modern electronics and its implications.
- Students will observe the effect of a transistor in a circuit.
- Students will construct a simple transistor AM radio and analyze its performance.

**Activities**
- Notes: The history, operation, and application of transistors
- Lab: Transistors in circuits – students will build a simple circuit on a bread board and insert transistors into different circuit configurations in order to analyze their performance.

**Construction project**: AM radio kit assembly – students will assemble an AM radio using prefabricated circuit boards and components.

**Extensions**: This unit can obviously be expanded out to include other construction projects and contests, research papers, and can be used as a gateway into other modern electronics concepts such as fabrication of passive components in ICs, etc.