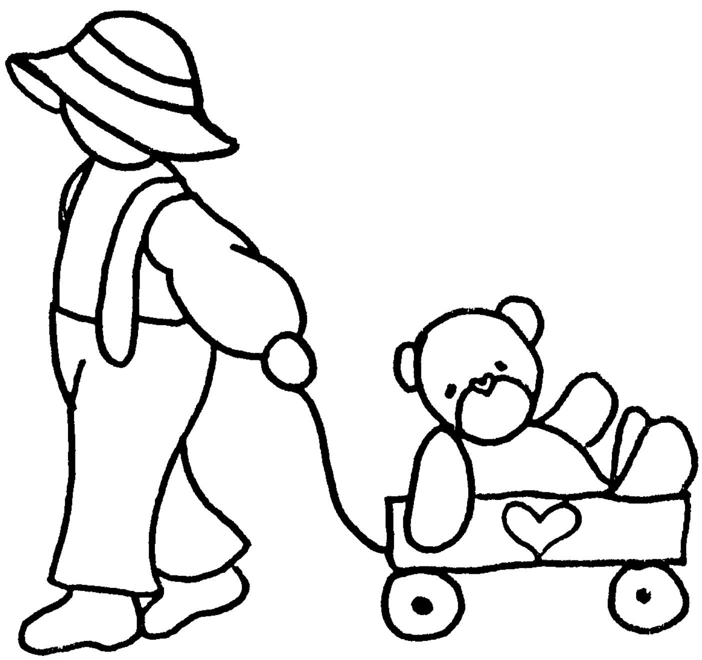
Applied Science

Our Technological World

FOURTH GRADE

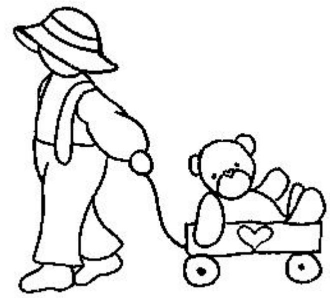
PHYSICS



3 WEEKS
LESSON PLANS AND
ACTIVITIES

APPLIED SCIENCE
OVERVIEW OF FOURTH GRADE

SCIENCE AND MATH



WEEK 1.
PRE: *Exploring conceptual science.*
LAB: *Predicting volume.*
POST: *Measuring linear and curved surfaces.*
WEEK 2.
PRE: *Collecting and analyzing data.*
LAB: *Comparing qualitative and quantitative data.*
POST: *Exploring optical illusions.*
WEEK 3.
PRE: *Comparing and contrasting the subfields of science.*
LAB: *Investigating human senses by collecting data.*
POST: *Comparing and contrasting inventors and scientists.*

PHYSICS

WEEK 4.
PRE: *Comparing electricity and magnetism.*
LAB: *Designing an electric circuit.*
POST: *Investigating the historical development of electricity.*
WEEK 5.
PRE: *Exploring magnetism.*
LAB: *Describing the force produced by a magnet.*
POST: *Exploring the uses of magnetism.*

TECHNOLOGY

WEEK 6.
PRE: *Investigating the electronic industry.*
LAB: *Constructing circuit boards.*
POST: *Comparing parallel and series circuits.*
WEEK 7.
PRE: *Investigating electromagnetism.*
LAB: *Designing an electromagnet.*
POST: *Exploring electrical power.*

BUILT ENVIRONMENT

WEEK 8.
PRE: *Exploring communications.*
LAB: *Discovering methods of communication.*
POST: *Exploring the uses of electromagnets.*

APPLIED SCIENCE - PHYSICS (4A)

PRE LAB

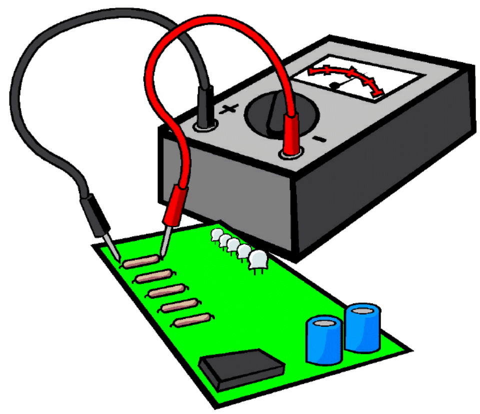
Students compare electricity and magnetism.

OBJECTIVE:

1. Exploring physics.
2. Comparing electricity and magnetism.

VOCABULARY:

atom
electricity
electron
magnetism
neutron
phenomena
physics
proton



MATERIALS:

Safe and Simple Electrical Experiments by R. Graf (reference for teacher)

BACKGROUND:

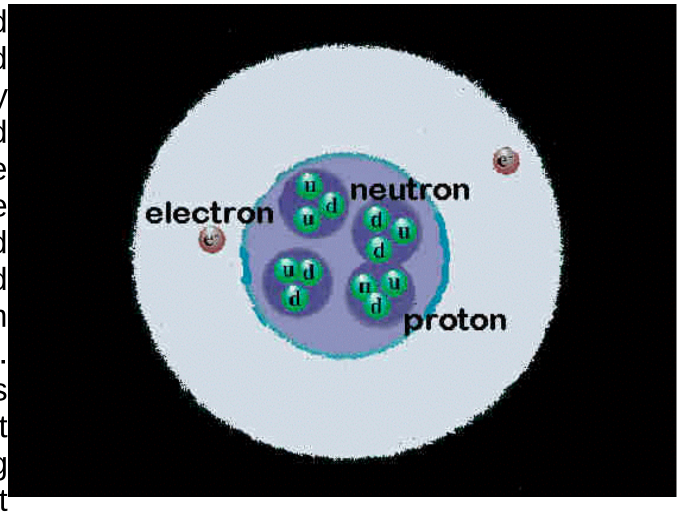
The field of physics is generally broken into discrete categories of mechanics, heat, energy, sound, light, magnetism, electricity, optics and those of atomic or nuclear structure. These traditional topics reflect the historical development of physics throughout the years in search for a unified field theory. A unified theory which can explain how all these forces and energy, in the Universe, work together. The search of a grand unified theory of all matter, sometimes border on ingenuity than it does on concrete facts. Recent theoretical investigations point to symmetry as an underlying law of physics. This "supersymmetry" could have been broken as the Universe evolved. Physicists are now trying to put the symmetry back together. This almost sounds fun!

Physics is a fundamental science which explains most phenomena that occurs in our world. Physics can be explained as the study of matter and energy. Physics is made up of many different components.

PROCEDURE:

1. Ask students what "phenomena" can be considered physics. Make a list of their answers on the board and try to draw out the following topics: motion, force, energy, matter, sound, electricity, magnetism, light and atoms.

2. Introduce electricity and magnetism. Explain that electricity and magnetism are not completely understood. There are many proposed theories but no one knows the complete answer. Discuss the structure of the atom. Make sure students understand that the nucleus contains protons and neutrons. The outer shells of the atom have electrons that spin in different orbits. It is the movement of these electrons when they "escape" from the atom that cause electricity; and the spinning direction, when still part of the atom, that causes magnetism. Electricity and magnetism are fundamentally related through electrons. Students will learn that electricity can make magnetism and magnetism can make electricity. It is important to repeat this to your students. Review some of the third grade labs if students seem confused.



2. Electricity is energy produced through the movement of electrons. Electricity has no color, weight, or odor. Electricity produces energy in the form of a "charge." If the charge is not controlled, it is called "static electricity." If the charge is controlled it is called an "electrical current."

3. Magnetism is a force that is produced because of the spin of electrons in the same direction. Magnetism has no color, weight, or odor. Ask students to give examples of observable electrical and magnetic forces and write them on the board. Students should remember basic principles from the third grade. Refresh their memory.

ELECTRICITY	MAGNETISM
circuit	magnet
lamp	lodestone (magnetite)
sparks	generators
static	compass
turn on appliances	magnetic resonance image (MRI - machine that looks at the image of your body without surgery)

APPLIED SCIENCE - PHYSICS (4A)

LAB

Students explore insulators and conductors of electricity.

OBJECTIVE:

1. Exploring how electricity works.
2. Designing an electrical circuit.

VOCABULARY:

circuit
conductor
current

MATERIALS:

Applied Science - Physics (4A) or non conductors and conductors
alligator clips
bulb holders
bulb
batteries

BACKGROUND:

Electricity is the movement of electrons which creates a current. A circuit is a closed or undisturbed path of electrons through a wire made up of material that conducts electricity. A bulb in a circuit will only light if it is in a closed circuit.

Electricity will not go through all materials. If electricity goes through and completes a circuit, it is called a conductor. If electricity doesn't go through to complete the circuit, it is called a non-conductor (or insulator). Insulating materials have electrons so closely bound to the nucleus of the atom that a steady electric current is greatly reduced. In a conductor, usually metals, the "free" electrons can move from atom to atom to permit passage of an electrical current. If there is a restricted flow of electrons through special conditions, it is called a semiconductor. In this lab, students can only detect a conductor or nonconductor.

Students will try and determine how to complete a circuit. They have learned about parallel and series circuits in the third grade. If they have forgotten, review those labs. Parallel and series circuits have to do with the direction of the flow. In series circuits, the flow goes from one light to another light. The lights get progressively dimmer because there is not enough voltage to light them all brightly. Only a parallel circuit can maintain the voltage to each bulb at the same intensity.

PROCEDURE:

1. Explain to students that they are going to be working with electricity in the form of a current. The energy that creates the current is contained in the battery. This energy is stored in the form of chemical energy.

2. Explain how electricity has made our lives easier. By operating machines, electricity has freed humans from otherwise tedious tasks. Also discuss how our lives would be affected if electricity could no longer be produced. Have students create a list of things that will and will not work without electricity. Students will be surprised at the amount of machines that use electricity.

3. This lab looks at the circuit by investigating the battery. A battery is the energy source that creates free electrons. There are several types of batteries on the market, but no matter which battery you use, the information needed will be on each battery. The size of the battery is also labeled. Each battery, no matter how large, is one cell or a series of cells. One cell gives 1.5 volts of electricity. A six-volt battery will have a series of 4 cells of 1.5 volts. If available, show examples of other types of batteries.

4. For this lab, give each group a battery holder, 2 batteries, a miniature light bulb and different conductors and non-conductors that are provided in the module. You may want to add different materials you have available.

5. ANSWERS:

Exercise I

1. D
2. 1/2 volts (some may be 1.5 volt)
3. Chemicals that produce free electrons
4. Note: the side with the "bump" is always positive
5. If the lightbulb brightens, then the battery is charged.
6. Same thing happens. You can reverse wires and the same reaction occurs.
7. A circuit
8. Because the flow of electrons goes like the arrows in the diagram.
9. The bulb should be a little brighter.
10. Add them up 1.2 + 1.2 = 2.4 volts

Exercise II

You can determine if a substance conducts electricity by testing it with a set up like a circuit. If the bulb lights up, it is conducting electricity.

APPLIED SCIENCE - PHYSICS (4A)

PROBLEM: How can one determine if a substance conducts electricity?
PREDICTION:____
MATERIALS: miniature light bulb, battery, battery holder
EXERCISE I. Look at one battery.

1. What size is it? ____
2. How many volts does it have?____
3. What is in the battery? ____
4. Draw a picture of the battery, label + and -.

5. Put the ends of the miniature light bulb to the ends of the battery. Is your battery charged? How do you know?____
6. Reverse the wires? Record what happens? _________________________________
7. What have you completed? ____
8. Put two batteries in a battery holder. Draw how to arrange the cells. Why do you think they are put in this way? ____
9. Use the miniature light bulb on each of the ends of the holder. Is there a difference between 2 cells versus 1 cell? Describe.

____

10. How many volts does 2 batteries working together have?

____

EXERCISE II. Use the miniature light bulb, one battery, and various conductors and non-conductors. Try to determine if a material is a conductor. Record what you find below by listing the material and then stating if you think it conducts electricity or not.

MATERIAL	CONDUCTOR/NONCONDUCTOR	BRIGHTNESS OF BULB

CONCLUSION:____

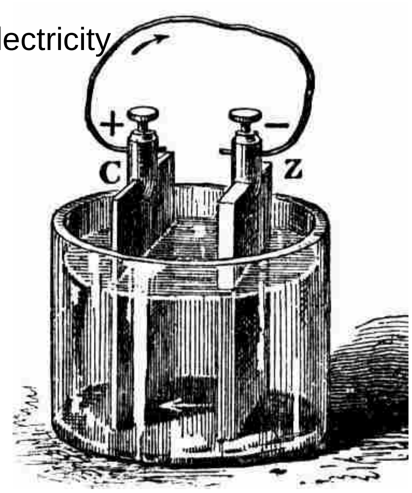
APPLIED SCIENCE - PHYSICS (4A)

POST LAB

Students search the internet for the history of electricity and magnetism.

OBJECTIVE:

1. Investigating the historical development of electricity.
2. Exploring early investigators of electricity.



Voltaic cell

VOCABULARY:

electricity
magnetism

MATERIALS:

Internet

BACKGROUND:

The history of electricity goes as far back as the founder of the Chinese empire in 2637 BC all the way to the present. Without electricity, our society would be a very different one. Humans have learned to control the electron to create wild and wonderful displays. Have students imagine life without electricity - there would be no elevators, toasters, or video games. Computers, light bulbs, television, and radio would only be in the minds of dreamers. We are a world dependant on the electron.

Rumor has it that Hoang-ti, the founder of the Chinese empire, used a magnetic chariot. In 600 B.C., Thales of Miletus, a Greek scientist and philosopher, discovered the magnetic properties of amber. In 1492, Christopher Columbus discovered that the declination of the compass needle varies for different parts of the world. In 1660, William Gilbert published *De Magnete,* six volumes describing the Earth as having the properties of a huge magnet. He coined the term "electricity" from the word "electron," the Greek word for amber. Even back then, people somehow noticed that electricity and magnetism were closely related.


A. Volta

In 1729, Stephen Gray, an English experimenter, discovered conductors and nonconductors and formulated the use of insulation. In 1733, Charles Francois de Cisternay Du Fay of Paris, discovered two kinds of electricity - vitreous (positive) and resinous (negative). He also discovered that like charges repel and unlike charges attract. In 1747, Benjamin Franklin advanced the understanding of electricity and invented the lightning rod.

In 1771, Luigi Galvani, an Italian physiologist, discovered that electricity is part of the living body. He discovered that dead frog legs "jumped" when electricity was put on nerve ends.

There next came a series of people who discovered the crucial understanding of electricity that took our society into the technological age. Emphasize that these people lead the way, step by step, to the electronic age of today.


Michael Faraday

In 1785, Charles Angustin de Coulomb advanced the theory that electrical charges can be mathematically calculated. In 1800, Allesandro Volta (Italian), discovered the first practical method of generating electricity. In 1819, Hans Christian Oersted, a Danish physicist, discovered a magnetic field is caused by electric current. In 1820, Andre Marie Ampere (French), established and proved the relationship between electricity and magnetism. In 1821, Michael Faraday (English physicist), developed an understanding of how electricity and magnetism may create what is later called a motor.

There was then a rapid increase of knowledge from people such as George Simon Ohm (German), Joseph Henry (American), Karl Friedrich Gauss (German), Heinrich Emil Lenz (Russian), Samuel Morse (American), James Maxwell (Scottish), Alexander Graham Bell (American), Thomas Alva Edison (American), Heinrich Hertz (German), Nicola Tesla (American) and Guglielmo Marconi (Italian). The names continued and expanded, and the electronic revolution took place.

Note there are few prominent women in these fields. This was because they were usually not allowed to take part in such subjects. The Chinese, Arabs, Africans, Australians and other parts of the world were not part of this revolution because of lack of communication from the center of discoveries (Europe) and the rest of the world. In addition, politics and wars were disrupting the "inventiveness" of many of these parts of the world.

Remember, people who invent and who can think about life, usually have their other human needs being cared for. It is difficult to think of "new" things if you are starving or just trying to survive. Nations at peace usually invent. Also countries that stress the individual are usually more inventive.

PROCEDURE:

1. You may want to give students a research project on learning about an historical point in electricity. Note that electricity and magnetism's history are intertwined.

2. Use the Internet or books in the library for students to search more on the evolution of electricity.

3. If you don't have books or internet, discuss the information given in the "Background," and have the students write a paragraph summary.

APPLIED SCIENCE - PHYSICS (4B)

PRE LAB

Students made a magnet with a hammer and piece of steel.

OBJECTIVE:

1. Exploring magnetism.
2. Making a magnet.

VOCABULARY:

attract
magnetism
north
repel
south

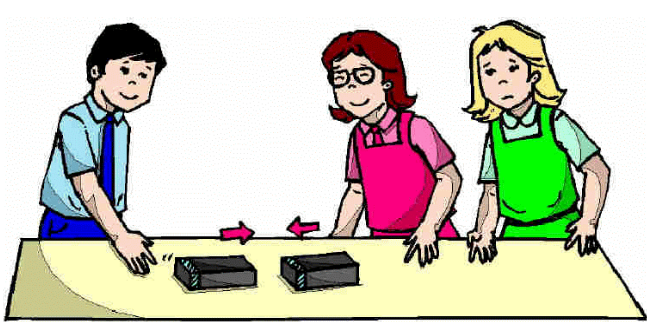
MATERIALS:

piece of steel or iron
hammer
iron files

BACKGROUND:

A Medieval seaman's code declares that any sailor caught tampering with the ships lodestone ".....shall, if his life be spared, be punished by having the hand which he most uses, be cut and fastened by a dagger or knife thrust through it, to the mast or principal timber of the ship....." In the history of science, this strict code is vivid evidence of human's early dependence upon magnetism. Lodestone was used for navigational purposes in a compass and without a compass, captains could not find north.

Explain that a magnet has a north pole and a south pole. North and south will attract, but "like" poles will repel each other. Magnetism is created when electrons "spin" in the same direction. In some substances this occurs naturally, but in most substances it does not. Items can be magnetized by hitting them so that all the electrons "spin" in the same direction.



The Earth acts as a huge magnet. As a result, pieces of iron or steel which lie in a North - South direction often became magnetized by "induction." Induction means the "forcing" of an object. If such objects are jolted while in this position, their molecules line up and they become more easily magnetized. Thus, some materials can be magnetized by tapping them with a hammer.

PROCEDURE:

1. Gently tap one end of an iron rod or bolt about 20 times while holding it in a North - South position. Then try to pick up some iron files. Best results are obtained if the rod is located along the earth's magnetic lines of force. Since we are in the Northern Hemisphere, tilt the north end of the rod downward. It may be necessary to try various angles of inclination before the rod is properly aligned with the Earth's magnetic line of force. If you live near a railroad track, a discarded iron tie works great.

2. Try this experiment with your students and see if it works. Sometimes it sounds easier than it is and conditions have to be ideal. Some students will get it to work, others won't. Have the students try and figure out why it did or didn't work. Have students experiment at home under supervision. Make sure they hammer the piece of iron, and not their fingers!

3. You may want students to present the information they researched in the Post Lab.

APPLIED SCIENCE - PHYSICS (4B)

LAB

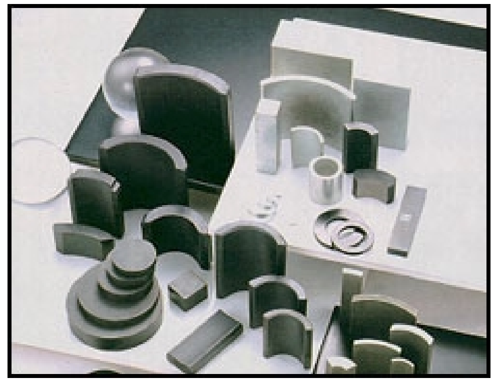
Students experiment with magnetic forces.

OBJECTIVE:

1. Describing the force produced by a magnet.
2. Investigating why some substances are attracted to magnets.

VOCABULARY:

electron
magnetic



MATERIALS:

Applied Science - Physics (4B) or
magnetic and non-magnetic items
bar magnet
logo magnet
ring magnet

BACKGROUND:

Magnetism defies gravity. The stronger the magnet, the less effect gravity has on the object. The stronger the magnet, the more "pull" the magnet has toward objects that are magnetic. This focuses on how the force of magnetism can vary with different objects. Some substances seem not to be affected by magnetism (non-magnetic) whiles others are attracted to it (magnetic). Magnets made out of ALNICO (aluminum, nickel, and cobalt) are much more powerful than steel magnets and are used in almost all loudspeakers manufactured today. Cheap magnets are usually made from iron or an iron alloy and are not permanent. They will lose their magnetism over time.

PROCEDURE:

1. Review the third grade labs if students find magnetism obscure. This lab will take the students a little further in understanding the force of magnetism. Magnetism is a very complex subject, and very important in our society. New advances such as the MRI (magnetic resonance image) can help locate problems inside the human body without an operation. Magnetism helps store images through magnetic tapes. The uses are endless, and in the future magnetism will probably solve many other problems.

2. There are only three common elements that are naturally magnetic: cobalt,

nickel, and iron. Iron is the weakest magnetic element. In 1935, gadolinium was also found to be naturally magnetic. The objective of this lab is for students to explore the mysteries of magnetism by doing several experiments. Use the lab sheet to go over the steps with the students so they can work in groups.

3. Experiment 1. Students should feel the repulsion and attraction of the poles. North/north and south/south repel while north/south attract. The notch on the magnet is North. North is considered the positive side where the magnetism actually begins. South is considered the negative side where the magnetic force reenters the magnet.

4. Experiment 2. Have students put a piece of paper over the magnet. Lightly sprinkle a layer of iron filings over the paper. Have students record the pattern. STRESS that students should not to get iron filings on the magnet. These ALNICO magnets are very strong and it is difficult to clean the magnet. Have students put the files back in the plastic bag at the end of the experiment.

5. Experiment 3. Have students use the magnet on these items to see if they attract or repel. Magnetic items are: paper clip and nail. Non magnetic are: hematite, silicon, shell and glass. (Answers are for kit only).

6. Experiment 4. Discuss how magnetic forces will go through most substances as long as they are thin enough and the magnet is powerful enough.

APPLIED SCIENCE - PHYSICS (4B)

PROBLEM: What type of items do magnets pick up?
PREDICTION:____
EXPERIMENT 1: MAGNETS
1. Can you always stick a magnet to another magnet?____________ Locate the north and south poles of all your magnets. Clue: north on the bar magnet is where the notch is. State where north and south are on the other magnets.
____
____
2. Put the North poles of two magnets together. What happens?
____
3. Put the South poles of two magnets together. What happens?
____
4. Do like poles repel or attract?____
5. What pole will the North pole attract?_____________________________________
EXPERIMENT 2: MAGNETIC FIELD
PROCEDURE: Put the bar magnet under a piece of paper. Sprinkle the filings on top of the paper. Move the magnet slowly. Draw the magnetic field configuration that appears.

EXPERIMENT 3 WHAT IS MAGNETIC? (use bar, logo or ring)
PROCEDURE: Test to see which items are magnetic and which are not. List them accordingly:

magnetic			
nonmagnetic			

What kinds of materials are magnetic?____________________________________
EXPERIMENT 4: MAGNETIC FORCE (1 logo, bar, ring magnets)
1. Are all magnets of equal strength?_______________
2. Can you make a stronger magnet by sticking several magnets together?__________
3. Will a magnet attract things through a sheet of paper?________________________
several sheets? _________________________
Find out whether these items will "block" the magnetic force. Answer yes or no, and comment on your findings.

paper __________________ wood __________________
glass __________________ finger __________________

CONCLUSION: Why do you think magnets pick up only certain substances?
____

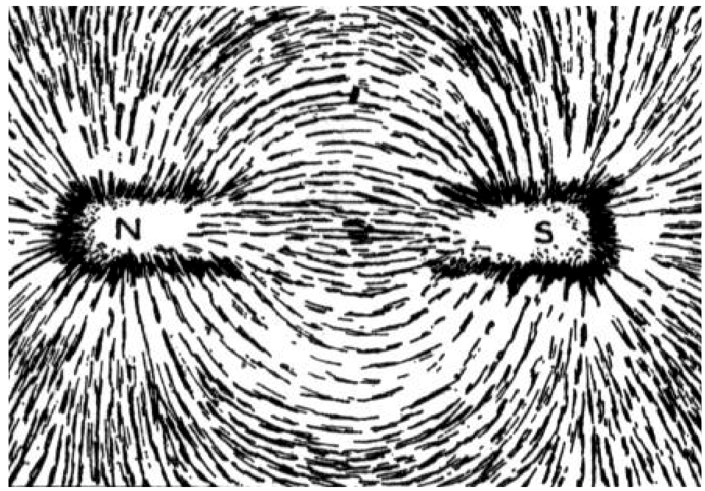
APPLIED SCIENCE - PHYSICS (4B)

POST LAB

Students use the internet to explore the history of magnetic substances.

OBJECTIVE:

1. Investigating the historical development of magnetism.
2. Exploring the uses of magnetism.



VOCABULARY:

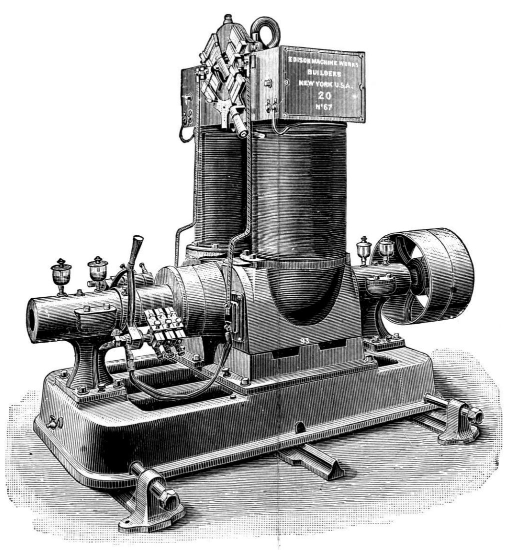
compass
electromagnets
lodestone
magnetite
motor

MATERIALS:

Internet

BACKGROUND:

Discuss the history of magnetism. The ancient Greeks noted magnetism in the mineral magnetite or lodestone. In a Greek myth, a shepherd boy named Magnes, thrust his iron staff into a hole containing magnetite and found to his dismay that he was unable to remove it. (Students can find magnetite if they take a magnet to some beaches and drop it in the sand. What sticks to the magnet is usually magnetite.) Socrates and Plato noted magnetism in some of their writings. It is also said that 2,300 years ago, Ptolemy Philadelphos had a temple at Alexandria made from magnetite so he could suspend a statue in mid-air. His experiment didn't work. Magnetite loses its magnetic quality over time.



Magnetic dynamo

Magnetism gets its name from the Magnates, inhabitants of Magnesia and named by the Greeks, where lodestone is very abundant.

Shen-Kua, a Chinese mathematician and instrument maker, was the first person to mention the use of a compass for navigation. He lived from 1030 to 1093.

In 1600, William Gilbert, a private physician to Queen Victoria, published a book on magnetism. However, this book was more curiosity than a scientific work.

It wasn't until the late 1700's, that scientists (mainly physicists and mathematicians), began to unravel how magnetism works. In the mid 1800's, the relationship between magnetism and electricity was suggested.

In the 1820's, scientists noticed the connection between electricity and magnetism. Joseph Henry and Michael Faraday established the importance of magnetism in relation to electricity. In 1873, James Maxwell wrote a book which illustrated these discoveries. These discoveries led the way for the development of the generator and the motor. The reason that automobiles were not perfected until the 1900's resulted from the fact that the engine was not practical until the end of the 1800's.

PROCEDURE:

1. After discussing this information with students, have them write an essay on what our world would be like without magnets or motors. Include other details in the discussion about various uses for magnets. Magnets make sound possible in loudspeakers. Magnetic tape provides a means to record and store data. Almost all electrical appliances have magnets. Most of our complicated machines use not only electricity, but also magnetism to operate. Ask students to be creative and to really concentrate on thinking and imagining.

2. You may want to use the Internet for students to do searches on magnetism.