SUGGESTIONS FOR STUDENT PROJECTS IN ELECTROMAGNETISM

Chapter Two

SUGGESTIONS FOR STUDENT PROJECTS IN ELECTROMAGNETISM

(A) Frequencies and Wavelengths of Visible Light

Each group that chooses this section must begin by listing the ranges and frequencies of the colors of visible light. Hint: wavelengths are 400 nanometers (violet) to 700 nanometers (red).

1) Rainbow group

a) Begin with a prism that separates sunlight into its different frequencies (The teacher may need to provide the prism)
b) Describe why rainbows are formed?
c) What color is always on top of a single rainbow and why?
d) Why do you think that red is usually called a warm color?
e) Why do you think that blue is usually called a cool color?
f) Photograph or paint a rainbow that you have seen (single or double).
g) Write a poem about how you felt when you saw this rainbow.

2) Light show group

a) Set up three spotlights or projectors to show the three primary colors of light using the correct primary jels: Red-Orange, Blue-Violet, and Green. (The teacher may find these at art supply or theatrical supply stores.) (**Refer to color samples on page 37 and Appendix D)**
b) Show all three lights on a white screen, white wall or on a sheet. Allow the students to play with the shadows to show how three lights make seven shadows. This might be done as a performance with rear-projection on a sheet.

3) Colors of light and paint group
(For extra credit only, since it is related, but not part of, the EM lesson)

a) Design a color wheel to show how color is mixed in paint, or obtain a color sample of process printing to show the actual primary colors. (**Refer to color samples on page 37.)** (Hint, the actual primaries for four-color process printing are yellow, magenta, cyan, and black. The red and blue of most school paint boxes are not accurate primary colors. These do not mix properly. Prang once was willing to make up special boxes of paint for my class that would include these colors. Otherwise, you can find them in art stores.
b) Create a design with the 3 primary colors and white and/or black.
c) Create a design with the 3 secondary colors and white and/or gray (or black).

==========

(B) Frequencies and Wavelengths of Invisible Light

(1) Begin listing the ranges and frequencies of invisible light.
a) Which one makes you feel warm?
b) Which one can give you a sunburn, whether you feel warm or not?
c) Why can infrared cameras “see” in the dark?
d) Why do you think ultra-violet light can be used to sterilize water?
e) Compare the use of ultra-violet light with the use of Chlorine to sterilize water.
f) Why do some things look different under ultra-violet light than they do under florescent or incandescent light? Prepare a project to show these differences?

g) If possible take a field trip to a gem and mineral show where minerals can be seen in both daylight and under ultra-violet light.

==========

(C) Frequencies and Wavelengths of Radio Stations

(1) List the ranges and frequencies of both AM and FM?

a) List, in order, 5 AM radio stations with both their call letters and numbers.
b) List, in order, 5 FM radio stations with both their call letters and numbers.
c) What do their numbers and call letters stand for?
d) What are the approximate lengths of radio frequency waves?
e) Why does your local station need booster towers to broadcast its messages?
f) Why do some radios stations have to stop when the sun goes down?
g) What are your favorite stations and why?
h) Develop a local controversial subject for a talk show, and ask members of the class to "call in" with their opinions on that subject. The main job of the host is to keep the controversy balanced, calm and civilized, regardless of personal opinions. GSR training can help the host stay calm. If participants used GSRs, also, anyone who's GSR indicated a loss of temper would lose the debate.

==========

(D) Frequencies and Wavelengths of Television Stations

(1) List the range of frequencies and wavelengths of television?

a) How fast do images change on regular TV or on High Definition TV?
b) Why can some TVs receive CBS, NBC, and ABC, but not Comedy Central?
c) What does it take to add channels to your own TV?
d) Become an announcer for a world news program and write a script for it.
e) Interview two students who have different opinions about how they would organize a perfect learning environment. Use the video camera to record their responses. Give the volunteers a day or more ahead of time to prepare.
f) After watching TV for a long period at home, turn out all the lights in the room and notice if you have an after-image that glows over whatever you see. Use a stopwatch to time how long it lasts. Write about what it looks like. Compare notes with other students and family members.
g) When our eyes are focused on the TV screen for a long time, our brainwaves can become entrained. The steady flickering light of the television screen can cause a hypnotic state. (Advertisers use this potential for hypnosis to repeat their messages over and over again, so that they will be imprinted in our minds for a long time. They plant the desire for us to buy their products whether we need them or not.) Some of us, who watch TV for many hours, are getting brain-washed into a habit of scattered thinking. Write a report about how this might happen to you, or someone you know.
h) Public TV is supported by government funding, foundation grants and listener support, so commercial advertising does not control them. This allows more educational programming. Watch at least two educational programs on PBS and report what you learned from them.
i) Teachers and/or students might be encouraged to create ideas for this subject.

==========

(E) Weather Radar

(1) List the frequencies of weather radar.

a) How does your TV weather station get its information?

b) If you have a computer and web access, how does the satellite signal get to your computer to show you the weather directly from the satellite?

c) If you have web access, go to Google Earth, to see some views of Earth from Space, and your own house. Report on how you felt about those images.

==========

(F) Frequencies of Cell Phones, Satellite Phones and Land Lines.

(1) What are the frequencies of your home and cell phones if you have them?

a) Are those frequencies different from those of your friends?

b) On what hillside or mountain are the relay stations for your phone located?

c) Where is the office located that provides your phone service?

==========

(G) Frequencies and Wavelengths of X-Rays.

(1) List the frequencies and wavelengths of soft and hard X-rays?

a) Why do you think it is possible for X-rays to pass through the soft tissue of the body? (If possible, include actual X-rays of bones or photographs of them.)

b) Have you ever had an X-ray? Why do doctors recommend against having too many X-rays? Why do you think the X-ray "sees" the bones?

c) What are the differences between an MRI, a CAT Scan and an X-ray?

d) Write a report about different ways that these three technologies are used to help scientists. (Hint: they can identify dead people or explore mummies.)

==========

(H) Frequencies and Wavelengths of Gamma Rays.

(1) List the frequencies and wavelengths of gamma rays?

a) How are gamma rays used to treat cancer patients?

b) What are some of the side effects on the patient?

c) Do you know anyone who has had this treatment?

d) What is the percentage of people who are expected to get cancer as compared to other diseases?

e) What is the percentage people who are cured by them?

f) What are some of the ways that people get cancer?

g) Are there other uses for gamma rays?

h) There are reported cures for cancer that do not use radiation, but use herbs and homeopathic remedies instead. Explore what these might be.

(Hint: Homeopathic organizations often have web sites, see Reference page)

==========

(I) Make a report about the Electrical Appliances in your house.

(This project may help students become aware of our dependence on electricity.)

(1) Which appliances use 110 Volts and which ones use 220 Volts?

a) What is the difference between direct current and alternating current? Make a list of the things that use ordinary 60 Hz alternating current.

b) Report on the different ways that electricity is generated, such as geothermal, wind, hydroelectric, coal, gas and nuclear.

c) A report on the use of Solar Power could be separate from those listed above.

This photo illustrates ten photovoltaic panels (60 Watts each) mounted on a tracking device to follow the sun. They provide the AC/DC electric power that Darrell Lemaire has set up for our family use at home. These panels are connected to special storage batteries and an inverter. The photovoltaic panels and the storage batteries power the energy directly to a direct current (D.C.) refrigerator and the water pumps for house and drip lines for irrigation. The inverter changes the rest of the D.C. energy into alternating current (A.C.) for the computer, lights, sound system, DVD player and shop tools.

This electricity is stable, because there are no power surges. So much so that not a single Christmas tree light has burned out in ten years though these lights are turned on most nights. (Power surges happen on the utility grid, not from solar storage batteries or inverters.) A gas generator charges the batteries when the sun doesn't shine, though it doesn't need to be used for more than an hour at a time.

Hot water comes from a solar panel of a very different type, and from the water pipes that are heated by the wood stove in cold weather. The hot water solar panel is thermal convection filled with antifreeze. The sun warms the panel and the hot antifreeze rises and goes through a heat exchanger, which is around the water tank. The cool antifreeze goes back to the panel to be re-heated by the sun. No valves or controls are needed on this system. The panels are thin stainless steel envelopes, painted black to absorb heat. They are covered with tempered glass to keep the heat in.

d) How does the Master Atomic Clock set clocks (that have the right signal) at home?

e) Microwaves are connected to 60 Hz household current, but produce different frequencies. Write a report on microwaves, and microwave ovens.

THE NORTHERN LIGHTS
AND THE EARTH'S MAGNETIC FIELD

The Aurora (Northern and Southern Lights) are caused when strong energies from the Sun contact the Earth's magnetic field at both the North and South poles. The DVD IMAX movie *"Solar Max"* illustrates this very well. If possible, show this movie to the class. Other good illustrations are found in National Geographic Magazines.

LESSON PLANS FOR MAGNETS AND MAGNETIC FIELDS

1) **Magnets --** The strength of a magnet is measured in Gauss. The strength of the Ionosphere-Earth Waveguide is around .05 Gauss, though it varies from place to place around the world. (See the special lesson on this on page 19 about this.) However, we can study the same properties of magnetism with hand held magnets. Small magnets also have North and South Poles. Hold two of them in your hand and study the way they repel or attract each other.

2) **Magnetic Fields --** This is a common test of magnetic fields: place iron filings on flat stiff white paper that is propped up so that there is space below it. Move a magnet around to watch the way the iron filings line up. Notice the similarity in the lines of force on a map of the magnetic fields of the Earth. From very small to very large, the principle is the same. Magnetic fields have been recorded around a person's head, as well. The eyes have the strongest field. If you move your eyes from side to side during an EEG measurement, they will interfere with the recording of brainwaves.

3) **Television and magnets --** An exciting way to show the relationship to TV and magnets is to hold a large magnet next to an old TV monitor. Children are always fascinated to see the magnet distort the images. (This may not work with liquid crystal monitors. Test this yourself, and check your answer with your teacher.)

4) **Motors --** Many junior high science textbooks will have some information on the electro-magnetic properties of motors. If they do, it might be easy to combine these lessons. Generators produce direct current (D.C.), but this can be transformed into the alternating current (A.C.) of the household electricity (60 Hz) with inverters.

THE IONOSPHERE-EARTH WAVE GUIDE FREQUENCIES

1) Notice where the Earth radiations relate to those of the Sun in the EM chart. The dominant *Ionosphere—Earth Wave Guide Frequency* is 7.8 Hz. (Other less dominant frequencies are marked in small green lines.) The Ionosphere is the outer part of the Earth's atmosphere, beginning at an altitude of c.55 km (c. 34 miles) and extending to the highest parts of the atmosphere. The Ionosphere-Earth-Waveguide is a standing wave around the Earth, between the Earth and the Ionosphere. Constant lightning strikes around the equator are said to be the cause of it. It is a magnetic pulse measured in gauss, which is different in different places around the Earth - lower in the Philippines and Brazil, higher in Yellow Knife, Canada. The EM Chart also tells you the length of the wave.

2) The Earth's 7.8Hz is also a frequency of human brainwaves. It is at the low end of the alpha rhythm and the high end of the theta rhythm. Shamans say it is possible to focus your brainwaves into that frequency and "tune-in" to the Earth itself. Are you willing to explore this feeling of being part of the Earth, or a tree, a flower, or a rock? To do so, you must also stop your mind from using words.

3) Try this experience in nature where it is quiet. Write about it later. A steady brainwave pattern defines one aspect of focus of attention. A quiet time spent tuning into nature is the primary way for us to find a steady, peaceful state of mind. Practice breathing deeply without thinking about tomorrow or remembering the past, and without thinking in words. This is a major way to learn to increase your ability to focus of attention. Learning to increase your focus of attention in different frequencies is a key to becoming more intelligent.

4) If you have a brainwave analyzer, practice producing alpha/theta brainwaves, and then see if you can still do that outside in nature without the feedback of the machine to tell you when you are doing it.

5) The other Earth frequencies are related to the temperature that the Earth itself produces. We feel the cold on the ground when there is a storm, and we feel the heat on the ground when the Sun shines on it. However, 8 ft. underground the Earth maintains its own constant temperature about 50º F. Long before the development of refrigeration, early pioneers dug cellars to keep their food at this constant cool temperature. (This underground temperature could be warmer in hotter climates, and closer to zero in the permafrost in Alaska.) However, when miners dig as deep as a mile or more under ground, they come closer to the molten core of the Earth, and then the temperatures become much hotter. Study and report on these temperatures of the Earth that do not depend upon the Sun.

SOLSTICES AND EQUINOXES

1) When are the two times per year when we experience the solstices?
2) Why do they occur?
3) When are the two times per year when we experience the equinoxes?
4) Why do they occur?
5) Many cultures celebrate these events. Find out at least one culture that does this and describe their celebrations.

When does the sun rise or set each day?
Where does it come up on the horizon in relation to where you live?

1) How long are the days in the summer, as compared to how long they are in the winter where you live? Why are days longer in winter in Hawaii than they are in Alaska in winter? Why are days longer in Australia, when they are shorter in 0hio?
2) Do you feel differently when the sun shines than you do when it is cloudy, raining or snowing? Which type of weather do you like best?
3) What is your favorite outdoor activity? How often do you enjoy that activity?

When does the moon rise or set during each 24-hour period?
Where does it come up on the horizon in relation to where you live?

1) If you can see the moon rise where you live during 4 days around full moon, keep track of the places on the horizon where that happens, and at what time? Why is the moon at a different place in the sky at 7:00 p.m. each night? Keep a journal for a month of what you have observed. Study your journal to find the answer to the question, "Why does the moon change shape and position every night?"
2) Do you feel differently on full moon nights than you do on the nights the moon doesn't shine? If so, why do you suppose that is?

FULL MOON RISE NEAR THE TIME OF THE EQUINOX
(Report on the differences between the positions of Moonrise and Sunrise)

SUNRISE

SUMMER SOLSTICE **Same group of trees above and below**

EQUINOX **Same pointed hill top above and below**

WINTER SOLSTICE SUNRISE ---- This is near the 40th parallel North

All sunrise photographs were taken from the same place as marked below.

Summer ↓ Spring & Fall ↓ Winter ↓

group of trees pointed hill top