Part 1

ELECTROMAGNETIC SPECTRUM

Chapter One

INTRODUCTION: EXPLANATIONS OF THE ELECTROMAGNETIC SPECTRUM CHART FOR CLASSROOM STUDY

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These lesson plans include a chart that is one-meter long (almost 40"). The EM spectrum has been simplified and color-coded so students from age ten to adult can experience (and become more aware of) the relationship between their own human electrical energies and those of the Sun and Earth. The first lesson begins with an overall view of the chart. When showing it to the class, please refer to this color key:

1) Black: All of the Electromagnetic Spectrum frequencies generated by the Sun are shown in black letters on white. Those EM frequencies that most strongly influence human energies include red lines with the black. Only the Aurora (Northern or Southern Lights) is written in pink on white with a black line under it. That is to emphasize the dazzling colors that we could see moving in the sky over both the North and South Pole when frequencies from the Sun interact with the Earth's magnetic field.

(Aurora Borealis is in the North and the Aurora Australis is in the South)

2) Red: Energies generated by Humans are written in red and dark red on the yellow strip on the bottom of the chart. They can be measured electrically, but some are pulses, such as the cranial-sacral rhythm.

3) Green: Energies generated by the Earth are written in green on white.

4) Blue: Energies of sound are written in white on blue at the bottom of the chart, because they travel at different speeds through air and water. If you speak on the telephone, for example, your voice is initially transmitted through the air as compression waves that travel much slower than light (about 330 meters per second). The telephone converts these compression waves into electrical signals that are transmitted at the speed of light to the telephone of the person with whom your are speaking, where your voice is converted back to compression waves that move slowly to the receiver's ear. The slow compression waves of audible sound have wavelengths thousands of times longer (not shown on the chart) than their electromagnetic counterparts.

5) Brown: Size and distance are written in brown on yellow at the top of the chart

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The chart has been designed to provide a fundamental concept for realizing our natural human interactions with Earth and Sun. However, this chart shows only the approximate frequencies of each item, not the exact number, and because of the large type and color, it includes only the simplest items for ease of understanding. Electromagnetism is one of the major forces in the universe. It is fundamental to life, itself. The legal definition of death is when the brain's electrical activity stops completely. When we study electromagnetism, we are studying an intrinsic part of ourselves.

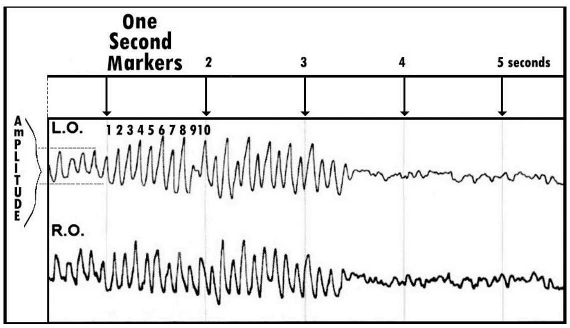
While showing the chart, the teacher needs to provide only a <u>short</u> definition of the major terms on the next page. The students will be asked to create a wall-sized chart and the explanation of the details will become an intrinsic part of that learning activity. When they choose their projects and then tack their names and project choices on the chart, the material will become personal.

1) **Logarithm** -- Each number is multiplied by ten -- 1 X 10 X 10 x 10, etc., or as illustrated by the sequence 1 - 10 – 100 – 1000.

2) **Wavelengths** -- These are measured in Meters. 1 Meter = 39.37 inches
-- 1 Meter = 10^{5} nanometers, and 1 nanometer = 10^{-9} meters
-- The range of this chart is from 10^{11} Meters to 10^{-5} nanometers.)

3) **Frequencies** -- These are measured in cycles per second, called Hertz (**Hz**).
-- The range of this chart includes the known frequencies from .001 Hz to 10^{17} MHz.
-- 1000 Hz = 1 Kilo-hertz (**KHz**).
-- 1000 Kilo-hertz = 1 Mega-hertz (**MHz**) = or 1 million Hz.

4) **Rhythms** -- Human energies and sounds are measured in frequencies and rhythms, but they don't have the same wavelengths as the Sun's electromagnetic frequencies that travel at the speed of light.
-- Sound waves travel through air and are much slower than light. Example: When lightning strikes far away, we see the flash in the sky seconds before the sound reaches our ears.
-- Rhythms of music and pulses of light can influence the rhythms of our bodies and minds.



The illustration at left is a short section of an EEG chart recording (reduced in size) to illustrate brainwave signals from both sides of the head. Both sides show a relatively steady 10-Hertz frequency. The brainwaves between 8 and 12 Hz are called Alpha rhythms. When a person is producing these signals, s/he is usually calm and relaxed. Ten peaks of each cycle in one second have been counted to show you. Between the 3rd & 4th markers, the frequency and the amplitude (power) change to a mixture of frequencies with much lower amplitudes that here only look like wiggly lines.

5) **Amplitude** -- This represents the power output of frequency, and is measured in volts (**V**). An electrical circuit might be as much as 50,000 **V** or more. However, brainwaves might be from 15 to 100 microvolts, so the measurement of brainwaves requires a sensitive instrument to detect them.

6) **Relationship between the frequency and wavelength --** As the frequency becomes Faster, the wavelength becomes shorter, and as the frequency becomes slower, the wavelength becomes longer. The right end of this chart extends as far as is known, which includes the shortest wavelengths of Secondary Cosmic Rays at 10^{-5} nanometers (as small as the diameter of an electron) and the fastest frequencies up to 10^{17} Megahertz The left end of this chart shows the slower frequencies and the distance to the Sun, which is farther than 10^{11} Meters (that is 10 x the last number 11 times = or 1,000,000,000,000 Meters).

Rhythms of music, other sounds, colored and/or flickering lights (such as TV or strobe lights) also influence the energies of our bodies directly. Creative projects to show how these might affect our brainwaves and heart rhythms should be included in the choice of projects and suggestions for doing them are included here. Young students are interested in creating projects around these themes, because they are especially relevant.

There are many EM frequencies used in science and technology that are not included here. The more advanced students might choose to do a project about them. The teacher may encourage a student to study one or more of them for extra credit, but only after the student has grasped the significance of the basic concepts originally presented.

Suggestions for Teacher Advanced Preparation

The library or the Internet will help the teacher find Electromagnetic reference material for help in answering student's questions. The teacher need not supply all the answers, since it is better to encourage students to do their own research. Show the student what and where the available references are. Many students with computers are already acquainted with these useful technologies. Nevertheless, the teacher should check projects for known accuracy. There are fine videos for inspiration (See References).

Teachers should collect some of these suggested materials in advance, though all of them may not be needed, depending on the space and time available for the lessons.

1) Reference Materials: See a partial list on the last page for References.
2) A roll of butcher paper (24 to 30" wide) that is already marked in 1" or 2" squares. The marks are extremely helpful. If only blank paper is available, the vertical lines have to be measured by hand, which takes a lot of time. Only five horizontal lines are needed for titles. (Check with school supplies or ask a paper company.)
3) Marking pens in different colors.
4) Prisms to separate the different frequencies of sun light into a rainbow.
5) Theatrical jels in the primary colors of light – Red-Orange, Blue-Violet, and Green. Use each one with the 3 projectors (or 3 spot lights). When these lights all shown on one screen, students will enjoy making shadows on the white surface, to reveal the six colored shadows plus black. This is fun. **(Colors of paint & light are on page 37.)**
6) Ask a printing process company for an end papers of old color-printing jobs. The end paper usually shows the primary colors of ink used to make all the colors of the print. These are: Cyan, Lemon Yellow, and Magenta (true red). Find the colors of paint or ink that match these colors as closely as possible, so the student can mix them to simulate colors of light. (Many school paint boxes have only fire engine red, deep blue, and yellow orange, which when mixed do not provide the right relationship of color between light and pigment, because they are not real primary colors.)
7) DVD, CD and audio tape players, microphones and video camera for projects that involve sound or film. (Available in most school audio-visual depts.)
8) Gather as large a variety of Biofeedback or Neurofeedback instruments as possible. Be brave and ask for donations of instruments (or money to buy them) from parents, administrators, alumni, or local businesses.
9) A video camera can provide exciting feedback and is usually more complementary to students than they expect it to be, especially if they are filmed when they are looking, elsewhere, during a discussion, for example. Teacher supervision strongly advised.
10) Actual plates of X-rays, MRIs, or CAT scans. Ask students if any have these.
11) A large enough magnet to distort a TV picture. Use a smaller magnet under a white paper to show magnetic field lines of iron filings on top of the paper. This project can demonstrate the magnetic field lines around the Earth and how they create the aurora (Northern Lights) with the Sun. Google National Geographic for pictures of the aurora.

Students (with teacher supervision) can roll out about 24 feet of butcher paper on the longest wall of the classroom. It must be <u>securely</u> taped or tacked to the wall. Leave about 15" blank on the end for later use and begin to mark off the rest of the paper into 26 equal areas 10" each (260" = 21.6 ft.). These marks will represent the measurements of meters (top) and Hertz (bottom). Since students are familiar with measurements of inches and feet, inches can be used to <u>represent</u> meters and nanometers, just as I have done on the smaller chart. If metric measuring tools are available, the teacher may choose to use them, instead. Ask student volunteers to mark the numbers in order. After the teacher has checked for accuracy, the major areas must be labeled appropriately, using as a rough guide the smaller colored chart provided. (This one was designed to be 1 Meter long for a handy reference to the actual metric size). From this long chart, students can explore the various frequency areas to decide ahead of time which area they want to choose as a subject for their creative project. Since this EM chart includes not only the spectrum of energies from the sun, but also those from the Earth, from Humans and from sound, students can easily see frequency relationships, even though they have different wavelengths.

Students should self-select partners for their working group (two to four total), and choose a short name for their group. The teacher has three main roles in this adventure. The first one will be to see that each student has a group to work with, unless s/he is such an individualist that s/he really prefers to work alone. No one should be left out. The second one would be to mediate serious arguments that might arise within each group about which creative direction their project will take. The other is to answer questions, if possible, or to provide references for students to find the answers. After the presentation of the lesson has stirred up student enthusiasm, and when at least most of them have become eager to do a creative job, minimal supervision is usually best. After each area on the chart has been discussed briefly, the teacher should ask each group to write a list of their first three choices for their creative research project. Any group will be assigned their first choice if no other group has also chosen it. Since more than one group may want to choose the same area (such as visible light and rainbows, or the frequencies of different television stations, for example), then those names should be drawn randomly, so the distribution of projects is fair. For some complex subject areas, parts of that project could be broken up for simplicity and to accommodate possible limitations of time available and/or student ability. If a group does not get their own choice, they may prefer to study some newer technology that is not on this simplified chart.

After all major areas have been assigned; each student is given a homework assignment to think about that project. School time is scheduled for group members to share their individual ideas about project designs. Hopefully they can agree about an idea, or can combine their ideas creatively. However, if group members can't agree on a single project together, consider allowing members of that group to do different things for the same area. Creative comparisons may stimulate increased focus of attention and learning. Outlines of study for each area may be given to the group, or allow the group to determine their own methods. However, the first requirement of all projects is to state the frequency and wavelengths of EM projects, and the rhythm frequencies of sound projects. These lesson plans below are not static; they are guides for inspiration to encourage as much creativity as possible. The first set of study lessons are offered as suggestions for projects associated with the chart. The second section of lessons plans includes instruction for various forms of biofeedback and neurofeedback training. Both sections relate the vibrations of ourselves to those of our world.

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