ELECTROMAGNETIC SPECTRUM

NAME _____ SCHOOL _____

DATE STARTED_____ DATE COMPLETED_____

PREREQUISITE: Simple Electromagnetic Devices course recommended.

HOW TO DO THIS COURSE: Do the steps one at a time, in order. When you finish a step, put your initials and the date on the sign-off line on the right. A split line means to get a pass (and an initial) from another student (or your Academic Supervisor if it says that). Essays are turned in to the Academic Supervisor.

PURPOSE: Get acquainted with the pervasiveness of electromagnetic phenomena and familiarized with some of the applications of them.

ESTIMATED TIME: 10 hours.

MATERIALS NEEDED FOR THIS COURSE

Study booklet, *Electromagnetic Spectrum*, with these data sheets (DS):
3620 3625
Exam: 3627, 8872 (answers)
Other references:
Encyclopedia or access to Internet.
Other materials:
An electromagnet, a switch, 1.5-volt D battery, a magnetic compass, a length of rope (at least 10 feet) or if available a "wave spring" (a long tight coil of wire used to demonstrate wave phenomena, available from science supply stores or catalogs), an instant camera and film or a digital camera, an electric space heater, toaster or stove with a visible heating element, a prism, a big cardboard box, a large sheet of butcher paper or newsprint.

A. THE ELECTROMAGNETIC SPECTRUM

1. READ: DS #3620 Simple Electromagnetic Devices. _____

2. READ: DS #3625 The Electromagnetic Spectrum, section "The Spectrum." _____

3. DEMONSTRATE: Get an electromagnet and hook it up to a battery with a switch. Place a magnetic compass near the electromagnet and turn the electromagnet on and off. Watch what happens to the compass needle. Repeat this with the compass and electromagnet in various positions until you find a position of the compass where you can clearly see the effect of turning the electromagnet on and off. With the compass in that position, turn the switch on for a second or two and then off for a second or two. Continue this for a while and notice the motion of the compass needle. Get the idea of being able to do this a million times a second—if you could, you would be sending a radio signal. _____

4. DEMONSTRATE USING CLAY: frequency ____ ____

B. THE LOW END OF THE SPECTRUM

1. READ: DS #3625 The Electromagnetic Spectrum, section "The Parts of the Spectrum: The Low End," to the subheading "Radio and TV." _____

2. DEMONSTRATE: A changing electromagnetic action, with the changing electromagnetic influences going outward at the speed of light. Show the effect of a complete cycle. _____

3. READ: DS #3625 The Electromagnetic Spectrum, subsections "Radio and TV" and "Receiving Radio Signals." _____

4. DEMONSTRATE: Tie one end of a rope (or a wave spring) to a fixed object (something like a tree if doing this outdoors, or a table leg if indoors). Pull the rope out straight but not too tight, and stand holding the free end ten feet or more from the fixed end. Now give the free end of the rope one short, sharp sideways jerk, and observe what happens. About how long does it take the pattern of motion to move to the other end of the rope? Do this demonstration several times if necessary until you can give the rope the kind of jerk in which a smooth wave of motion shows up clearly. _____

5. DEMONSTRATE: With the rope set up as in the last demonstration, take the free end and move it back and forth rapidly until you get a clear pattern of wave motion throughout the length of the rope (this may take practice). Once you get a clear wave pattern, have someone take a picture of it with an instant camera. You should have a smooth pattern of back and forth motion, which is repeated two or three or more times down the length of the rope. The length from one wave to the next of this pattern is the wavelength of the motion. Get checked on demonstrating a clear wave pattern (show it with either the rope or the photo). ____ ____

6. DEMONSTRATE: Repeat the demonstration you just did, only move the rope back and forth at a quite different frequency (slower or faster). What effect does this have on the wavelength? Explain the relationship between frequency and wavelength. ____ ____

7. DEMONSTRATE: Draw a diagram (or several) that shows what is happening in a radio transmitting antenna, what influence it causes, what makes a receiving antenna receive, and what happens in the receiving antenna. Turn your diagrams in to your supervisor. **Supervisor pass.** ____ ____

8. READ: DS #3625 The Electromagnetic Spectrum, subsection "Microwaves and Heat." _____

9. DEMONSTRATE: Microwave energy going into a substance and causing it to heat up by making electrons move back and forth. _____

10. DEMONSTRATE: The difference in penetration between microwaves and infrared waves, and why. ____ ____

11. DEMONSTRATE: Look at the heating element of an electric space heater, toaster or electric stove. Turn it on and hold your hand about 6 inches from the heating element (close enough to feel the heat, but not touching it). Notice the dull red light given off by the heating element when it is hottest. Notice also that heat is radiated to your hand even when the element is not quite so hot and there is no light. What is this heat radiation called? _____

C. LIGHT

1. READ: DS #3625 The Electromagnetic Spectrum, section "The Parts of the Spectrum: Light." _____

2. DEMONSTRATE: Cut a straight horizontal slit in the side of a big cardboard box, and set up the box so a beam of sunlight comes through the slit onto a piece of white paper. Make sure the box shades the paper from other strong sources of light. Hold a prism in the beam of sunlight so that the light passes through the prism and is spread out in a spectrum on the paper. Tilt the prism to get the best spectrum. Write down all the colors you see on the paper, in the order they appear. (You should be able to distinguish six main colors, going from red to violet.) Which color goes straightest through the prism? Which is deflected the most? According to what you read, which color of light has the highest energy? What appears to be the relationship between the amount of energy and the deflection? _____

3. RESEARCH: Find out at least six uses of lasers. _____

D. THE HIGH END OF THE SPECTRUM

1. READ: DS #3625 The Electromagnetic Spectrum, section "The Parts of the Spectrum: The High End," to the subheading "The Dual Nature of Electromagnetic Radiation." _____

2. DEMONSTRATE: How x-ray shadows can be used to make pictures of bones inside a body. _____

3. READ: DS #3625 The Electromagnetic Spectrum, subsection "The Dual Nature of Electromagnetic Radiation." _____

4. DEMONSTRATE: Why it becomes more useful to think of electromagnetic radiation as made up of particles when dealing with the high end of the spectrum. _____

5. READ: DS #3625 The Electromagnetic Spectrum, subsection "Radioactivity and Cosmic Rays." _____

6. ESSAY: Research the uses of radioactive materials (materials that give off gamma rays), and the subject of handling them, including the handling of wastes from nuclear power plants. Why is handling radioactive materials a problem? What are some of the solutions? What do you think is the best solution for handling wastes from nuclear power plants? Write an essay discussing what you have learned and concluded. _____

E. FINAL APPLICATION

1. PRACTICAL APPLICATION: On butcher paper make a large chart of the electromagnetic spectrum. Use the chart on the last page of DS #3625 The Electromagnetic Spectrum as a reference. Locate on your chart all of the types of electromagnetic energy you have studied on this course and write in what you now know about them. Study your chart, and then on a separate sheet of paper list the names of the ten energy bands in order from lowest to highest without referring to the chart (you do not need to list the frequencies, although you may if you want to). If you don't get them all right, repeat making the list until you can do it easily. Recite the list by heart to your supervisor. **Supervisor pass.** ____ ____

I have done all the steps of this course. I understand what I studied. I can use what I studied.

Student _____ Date_____

The student has completed the steps of this course and knows and can use what was studied.

Academic Supervisor _____ Date _____

The student has passed the exam for this course.

Examiner _____ Date_____