Activity #10

Title: Infrared (IR) at Work in the Home -Teacher's Copy

Note to the teacher: This is a homework assignment that allows the students to investigate several principles of electromagnetic energy transmission and reception at their own pace with materials found around the typical home. They will have to design and describe their experimental testing techniques and verify their conclusions. Assigning this homework project one week in advance of the collection date should offer ample time to complete the activity.

Science Content Standards: 5-8 addressed by this activity:

Science as Inquiry

CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

GUIDE TO THE CONTENT STANDARD

Fundamental abilities and concepts that underlie this standard include

ABILITIES NECESSARY TO DO SCIENTIFIC INQUIRY

IDENTIFY QUESTIONS THAT CAN BE ANSWERED THROUGH SCIENTIFIC INVESTIGATIONS. Students should develop the ability to refine and refocus broad and ill-defined questions. An important aspect of this ability consists of students' ability to clarify questions and inquiries and direct them toward objects and phenomena that can be described, explained, or predicted by scientific investigations. Students should develop the ability to identify their questions with scientific ideas, concepts, and quantitative relationships that guide investigation.

DESIGN AND CONDUCT A SCIENTIFIC INVESTIGATION. Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables. They should also develop the ability to clarify their ideas that are influencing and guiding the inquiry, and to understand how those ideas compare with current scientific knowledge. Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

USE APPROPRIATE TOOLS AND TECHNIQUES TO GATHER, ANALYZE, AND INTERPRET DATA. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes.

DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment. Students should begin to state some explanations in terms of the relationship between two or more variables.

RECOGNIZE AND ANALYZE ALTERNATIVE EXPLANATIONS AND PREDICTIONS. Students should develop the ability to listen to and respect the explanations proposed by other students. They should remain open to and acknowledge different ideas and explanations, be able to accept the skepticism of others, and consider alternative explanations.

COMMUNICATE SCIENTIFIC PROCEDURES AND EXPLANATIONS. With practice, students should become competent at communicating experimental methods, following instructions, describing observations, summarizing the results of other groups, and telling other students about investigations and explanations.

UNDERSTANDINGS ABOUT SCIENTIFIC INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.

- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.

- Mathematics is important in all aspects of scientific inquiry.

- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.

- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

- Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

Purpose: To design an experiment which will determine the relative IR transparency of several common household materials and also to determine the maximum effective range

Materials: An appliance such as a VCR, DVD player, air conditioner (newer models), television, etc. which can be remotely controlled by an infrared (IR) controller, clear plastic bag, colored (opaque) plastic bag, brown paper bag, facial tissue, notebook paper, cardboard, aluminum foil, tape measure (or yardstick, ruler, etc.)

Procedure: After determining the exact location of the internal IR receiver on your appliance…

- Predict which of the materials listed in the chart below will allow the IR signal to pass through to operate the appliance.
- Design and conduct an experimental procedure that will determine which, if any, of the following materials (listed in the chart below) is transparent to IR energy.
- For those materials that do allow the IR signal to pass through, determine the maximum effective operating range of the remote controller.
- Record all data in an organized and systematic manner and draw valid conclusions from your findings.

MATERIAL	PREDICTION
HAND	
NOTEBOOK PAPER (SINGLE SHEET)	
NOTEBOOK PAPER (DOUBLE SHEET)	
CARDBOARD (SINGLE LAYER)	
CARDBOARD (DOUBLE LAYER)	
ALUMINUM FOIL (SINGLE LAYER)	
ALUMINUM FOIL (DOUBLE LAYER)	
CLEAR PLASTIC BAG (SINGLE LAYER)	
CLEAR PLASTIC BAG (DOUBLE LAYER)	
TISSUE (SINGLE SHEET)	
TISSUE (DOUBLE SHEET)	
OPAQUE PLASTIC BAG (SINGLE LAYER)	
OPAQUE PLASTIC BAG	

(DOUBLE LAYER)	
BROWN PAPER BAG (SINGLE LAYER)	
BROWN PAPER BAG (DOUBLE LAYER)	

Analysis questions:

1. Describe the method you used to determine the location of the internal IR receiver in your appliance.
2. What experimental controls (parts of each trial that remained the same) did you use when testing the various materials in this activity to guarantee valid results?
3. What additional equipment/materials, if any, would be required to rank the materials from best to poorest with respect to their ability to transmit IR energy in this activity?
4. Which materials tested that were opaque to visible light allowed IR to pass through?
5. From your observations (required to answer question #4), why do you suppose astronomers often photograph celestial objects using IR cameras?