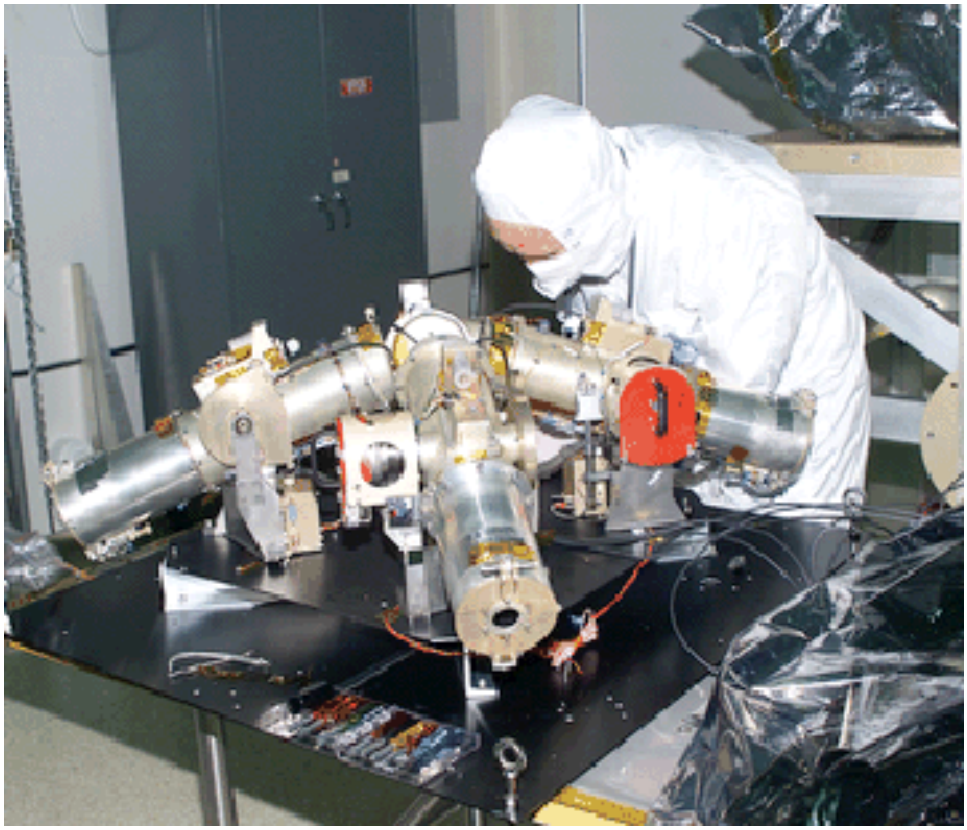
LESSON 6



INDEPENDENT INVESTIGATION

Purpose: Students will choose an inquiry into the nature of light, design a procedure to investigate their question, revise the procedure based upon peer review, collect data, and report their results and conclusions.

Benchmarks for Science Literacy:

- **Scientists differ greatly in what phenomena they study and how they go about their work. Although there is no fixed set of steps that all scientists follow, scientific investigations usually involve the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence.** 1B/1 (6-8)
- If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributable to any one of the variables. It may not always be possible to prevent outside variables from influencing the outcome of an investigation (or even to identify all of the variables), but collaboration among investigators can often lead to research designs that are able to deal with such situations. 1B/2 (6-8)
- **Sometimes scientists can control conditions in order to focus on the effect of a single variable.** When that is not possible for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns. 1B/3 (9-12)
- Investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories. 1B/1 (9-12)

National Science Education Standards:

Grades 5-8

Science As Inquiry-Understanding 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.**

- **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.
- **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.

Grades 9-12

Science as Inquiry – Abilities Necessary to do Scientific Inquiry

- COMMUNICATE AND DEFEND A SCIENTIFIC ARGUMENT. **Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments**.

Background:

Based upon research over the past decades, Benchmarks for Scientific Literacy, and National Science Education Standards support student inquiry. All of the activities in this unit have been building toward this independent investigation. Students have been engaged in partial inquiry since the beginning activity. Early activities were more guided, helping students to learn steps of the inquiry process. The last activity, **Mystery Light**, required them to design their own experiment to answer a given question. Peer Review techniques were introduced as a tool to aid in inquiry. Journal assignments, Predictions, Inquiry Reflections, and Prediction Reflections helped them to become more aware of their own problem-solving process. Short-answer conclusions developed into essay conclusions that required more student organization. In Lesson 6 students will define the problem, design and conduct the experiment, and present their results. Because of the structure of this unit, teachers may choose to

use this final investigation as an assessment tool. If you choose to do this, design a rubric that reflects assessment of process, organization, communication, use of previous knowledge about light and light spectra, and analysis of data.

For many students this will be difficult. They may not have internalized the skills necessary for productive experimentation. They will need your coaching and guidance. Complete the Student Assignment with dates to provide a road map with checkpoints. Add additional checkpoints if you wish. For example, some teachers require students to submit rough drafts of critical steps. If a group loses focus or direction, remind them of some of the models for good design they have used in the past. Ask them questions. How much guidance you choose to give will depend upon how you are using this independent investigation.

Many teachers find inquiry difficult because they believe they must know all of the content that students study. However, we cannot know everything. In research the students become the experts in their own field. Your role is not to give answers! You are not there to provide answers or solutions! Your role is to guide and coach them in the process. However, you do need to be alert for possible safety issues.

Overview of Student Assignments for Independent Investigation

1. **Independent Investigation** provides the schedule and basic guidelines for a laboratory investigation in which the students provide the problem to be solved by the investigation and the design of the investigation.
1. **Peer Review in the Science Classroom** (Appendix) provides a process that aids the students in the development of more effect designs for inquiry.
1. **Lab Report Format**, **Journal Article Format**, and **PowerPoint/Webpage/Poster Presentation** (Appendix) are three different formats from which you can choose for student presentation of results of their investigation.
1. **Prediction Reflection** (Appendix) asks your students to reflect upon their process, their thinking, what went right, and what they would improve.

Materials:

- **Independent Investigation** instructions and timeline
- Evaluation criteria in the format you choose
- **Prediction Reflection**
- Assorted materials to be determined by students

Preparation and Procedure:

1. Establish dates for completion of activities and add to student assignment, **Independent Investigation**, in the Due Date column. Hand out **Independent Investigation**. Hold a conversation with the students. Make certain that your expectations are clear. Explain your role in the investigation. Answer questions about each of the tasks. Announce which presentation format you will require them to use when they report their findings. This will allow them to work on the lab report, journal article or PowerPoint©/poster presentation as they do the research. Establish research groups. Three students per group is an ideal number. Students need to agree upon and tightly define the question they will research. They may use questions generated from the opening journal assignment to Lesson 4, or they may develop another question.
2. Examine problem proposals carefully. If you believe that the problem will be impossible for them to solve or the procedure necessary may not be safe, explain your concerns and ask them to redefine the problem.
3. Schedule enough time for Peer Review because each team will need to explain their problem before they explain their procedure.
4. Impress upon students that, if they need equipment from you, they must provide you with a materials list as soon as possible. Encourage them to be creative. Scientists can't go to a science supply catalog and order "an instrument to reveal the secrets of the universe"; they must design tools from materials at hand.
5. Schedule time to met with each group frequently to coach them and problem solve with them. They will need some fresh ideas. You do not need to be an expert in each topic! You should not be solving problems for them.