LESSON 1: SENSING THE INVISIBLE

THE HERSCHEL EXPERIMENT

LESSON OVERVIEW

GRADE LEVEL
5 - 8

DURATION
1-2 hours

ESSENTIAL QUESTION

Are there forms of light other than visible light emitted by the Sun?

LESSON SUMMARY

In this lesson, students find out that there is radiation other than visible light arriving from the Sun. The students reproduce a version of William Herschel's experiment of 1800 that discovered the existence of infrared radiation. The process of conducting the experiment and placing it in the historical context illustrates how scientific discoveries are often made via creative thinking, careful design of the experiment, and adaptation of the experiment to accommodate unexpected results. Students discuss current uses of infrared radiation and learn that it is both very beneficial and a major concern for planetary explorations such as the MESSENGER mission to Mercury.

OBJECTIVES

Students will be able to:

- Construct a device to measure the presence of infrared radiation in sunlight.
- Explain that visible light is only part of the electromagnetic spectrum of radiation emitted by the Sun.
- Follow the path taken by Herschel through scientific discovery.
- Explain why we would want to use infrared radiation to study Mercury and other planets.
- Explain how excess infrared radiation is a concern for the MESSENGER mission.

Figure 1. Portrait of Sir William Herschel, who discovered the existence of infrared radiation in 1800. (Picture credit: NASA/IPAC; http://www.ipac.caltech.edu/Outreach/Edu/herschel.gif)

Concepts

- Visible light consists of different colors.
- Sunlight consists of invisible forms of light in addition to visible light, one of which is infrared light.
- Scientific discoveries are sometimes made by chance, as a by-product of another investigation.

MESSENGER Mission Connection

The MESSENGER mission to Mercury uses infrared light to study properties of the planet, and it is therefore beneficial to the mission. However, too much infrared radiation is detrimental to the spacecraft and its instruments, and engineers are faced with this problem when designing the MESSENGER spacecraft and mission.

WARNING

Do *not* look directly at the Sun!

This lesson is about the Sun and sunlight, but be sure to remind students frequently ***never* to look directly at the Sun!** Looking for even a few seconds can cause permanent damage to the eyes, and longer exposure can cause blindness. Note that sunglasses do *not* provide an adequate safeguard against looking directly at the Sun.

Standards & Benchmarks

National Science Education Standards

Standard B3 Transfer of energy

▲ The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Related Standards

Standard G1 Science as a human endeavor

▲ Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity—as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Standard G2 Nature of science

▲ Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

Standard G3 History of science

▲ Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.

Benchmark 4F2 Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors.

Benchmark 4F5 Human eyes respond to only a narrow range of wavelengths of electromagnetic radiation—visible light. Differences of wavelength within that range are perceived as differences in color.

Benchmark 12C3 Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, and temperature, and choose appropriate units for reporting various magnitudes.

Related Benchmarks

Benchmark 1B1 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.

Benchmark 1B4 New ideas in science sometimes spring from unexpected findings, and they usually lead to new investigations.