SOLAR WATER SCIENCE

A. OVERVIEW

Subject	Green Science
Age	6-10
Duration	60 minutes
Content	Solar energy can be captured to provide free clean energy. Understanding transfer of energy from sunlight to water.
Goals	Students will understand : 1. The sun produces energy as heat and light via electromagnetic radiation. 2. Solar energy is a clean energy that does not produce greenhouse gases. 3. Light travels as waves and can be transmitted, reflected, absorbed and refracted.
Objectives	After completing this section, the students will understand light travels as waves. They will discuss the use of solar energy as an alternative energy source.
Materials	Solar water heater kit and instruction sheet 1 small and 1 large plastic bottle Hot, sunny day or a simulated sun (a desk lamp with a 60W incandescent bulb).
Introduction	Background reading – Light as waves, the electromagnetic spectrum and solar energy. Class discussion – Solar energy, transfer of energy from light waves to objects.
Practical	Students will assemble solar water heaters and demonstrate their use to heat water.
Extensions	Open ended discussion/investigation

B. BACKGROUND READING

Set the background reading as a homework assignment the day before the planned solar water heater lesson. This will cover solar energy as the electromagnetic spectrum and behaviour of light. It will provide a springboard for class discussion.

Review

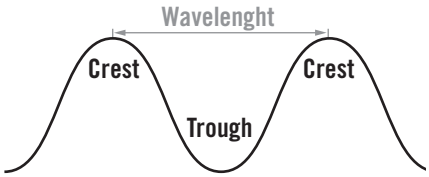
Start the lesson by reviewing the reading.
Points to ensure are understood:

- Solar energy provides heat and light via electromagnetic radiation.
- Properties of light – waves, wavelength, visible and invisible spectrum.
- Light waves can be reflected, refracted, absorbed, transmitted depending on properties of the objects they contact.

Reading material

Light energy and waves

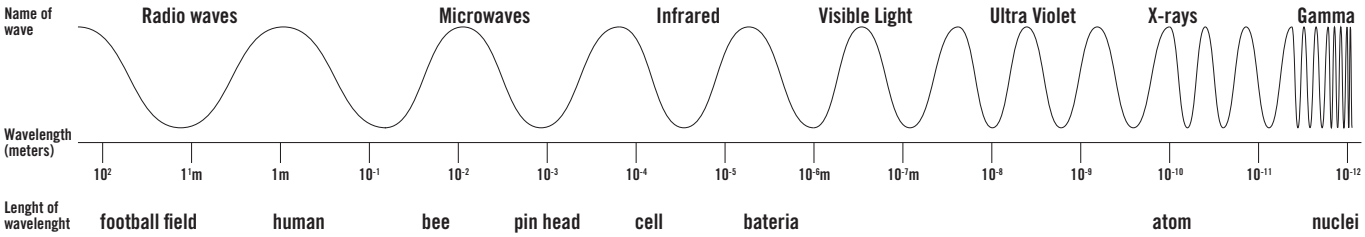
There are two ways of thinking of light; the "particle theory" or light as photons, and the "wave theory" or light waves. In truth, light behaves as both particles and waves – science attempts to explain simply a very complex idea. Let's focus on light as waves to help explain solar energy.



When a wave moves through water from one side of a body of water to the other, the water itself is not moving across the body of water but the wave travels as its energy travels through the water. All waves are traveling energy.

Light waves do not need a medium to travel through. They can travel through a vacuum. A light wave consists of energy in the form of electric and magnetic fields. The fields vibrate at right angles to the direction of movement of the wave, and at right angles to each other. Because light has both electric and magnetic fields, it is also referred to as electromagnetic radiation.

Light waves come in many sizes. The size of a wave is measured as its wavelength, which is the distance between any two corresponding points on successive waves, usually crest-to-crest or trough-to-trough (see diagram). Light comes in a contin-



uous variety of sizes. We call this the electromagnetic spectrum. Visible light is one small part of the spectrum; it occupies only one-thousandth of a percent of the spectrum.

Solar energy
Solar energy travels from the sun as electromagnetic radiation. The sun produces all the wavelengths on the electromagnetic spectrum.

Energy transfer from light wave
When a light wave hits an object, what happens to it depends on the energy of the light wave, the natural frequency at which electrons vibrate in the material and the strength with which the atoms in the material hold on to their electrons. Based on these three factors, four different things can happen when light hits an object.
Reflection - The waves can be reflected or scattered off the object e.g. mirrors.
Absorption - The waves can be absorbed by the object e.g. black objects get warm in the sun.
Refraction - The waves can be refracted through the object e.g. light through a prism.
Transmission - The waves can pass through the object with no effect e.g. glass and visible light in windows.
More than one of these possibilities can happen at once.
What happens when light waves are reflected?
What happens when light waves are absorbed? What happens to the energy from the wave?

C. Class discussion

What are the advantages of solar energy?
- Free and freely available
- Renewable
- Does not produce pollution or greenhouse gases.

What are the disadvantages of solar energy?
- Amount of sunlight is not constant.
- A large surface area is required to collect the energy at a useful rate.

Using what the class knows about light waves ,reflection, absorption, transmission and refraction…
- Can the class design the perfect container to store hot liquids to prevent heat loss?
- HINT – Must reflect the heat energy back into the container and stop heat escaping.
- Can the class design the perfect container in which to heat liquids to encourage heat transfer?
- HINT – Must allow easy transmission of heat to the water from the outside heat source.

D. Practical

Each group of students requires 1 kit and 1 instruction sheet. Select the relevant information from the instructions if necessary.
Each group will also need kit, 1 small and 1 large plastic bottle.
Go through the safety warnings advised in the instructions with the class before assembly.
Check each group's finished model and supervise the class' test runs.

E. Extension

Using what you know about light waves and energy transfer – suggest design improvements to the solar water heater.
HINT - What is happening to the waves of electromagnetic radiation from the sun as they come into contact with each substance in the kit? Reflection, refraction, transmission, absorption...
- How can the water heating be made more efficient?
- How can the storage of the water be improved to prevent heat loss?

Try out the Solar Oven Green Science kit and learn more about heat transfer.

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