Solar Cooker Lab—Instructor's Guide

Motivation:

The purpose behind this solar cooker lab is to increase STEM education and to promote social awareness. Students will learn the basic principles of heat transfer all while building a tool that could greatly increase someone's quality of life. Solar cookers are great in that they are built from readily available materials (cardboard, plastic wrap, aluminum foil, etc.), they are powered by the sun (a free and unlimited energy source), and they showcase all three types of heat transfer (radiation, convection, and conduction).

Layout of the lab:

This lab is meant to be semi-open ended in order to develop the students' creativity and problem solving skills. That is why the lab procedure is made of general statements and questions instead of step by step instructions of how to build a solar cooker. It is suggested that the teacher present the students with the brief background of solar cookers and why they are useful. Then, offer them a variety of materials (different sized boxes, plastic sheeting/plastic food wrap/Plexiglas, different colored paints, etc.) and ask the students to build their own solar cooker using the general steps provided in the lab procedure. After they have built a solar cooker, they can test how well it works by placing a cup of water in it and seeing how it heats up or by placing something like a marshmallow in it and watching melt.

Pre-Requisites:

A background in heat transfer would help in the understanding of the lab but is not necessary to complete the lab.

Time Breakdown:

Pre-lab – 20-30 minutes

Lab Procedure

Build a solar cooker – 30 minutes

Test cooker – Several hours to let the cooker heat up in the sun enough for it to cook something

Parts List:

Parts should be found from common, everyday items to ensure a low cost lab. If items must be purchased, they should be as affordable as possible.

Materials:
Boxes (2 per solar cooker)- 1 large and 1 smaller box
Newspapers- any type of paper/insulator can be used
Aluminum foil
Black paint/paint brushes
Black paper
Plexiglas- glass or plastic food wrap can also be used [$3-$10]
Duct Tape [$3]

Recommended Tools:
Scissors

Optional:
Heat lamp (for poor weather) [$250]

Pre-Lab Answers:

Heat Gain

Greenhouse Effect: The trapping of the sun's warmth in the lower atmosphere due to the fact our atmosphere lets visible radiation from the sun through easier than infrared radiation coming off the earth's surface

Glass orientation: The glass is important as it allowed the visible sunlight to come through, but helps trap heat inside the box. The glass should seal the top of the box in order to avoid heat from leaking out. The more directly the glass faces the sun, the more solar heat gain achieved by the solar cooker.

Reflectors: the reflectors are there to try to concentrate sunlight into the box. This way, the light is used more efficiently and the box can heat up faster.

Heat Loss

Convection: The way heat is transferred due to the movement of matter. i.e – hot air rising, cold air falling.

Radiation: Transfer of energy through electromagnetic waves. Infrared, visible light, UV rays.

Conduction: When heat moves from a heat source to a heat sink. The different between convection and conduction is that matter doesn't move in conduction. The heat transfers through contact.

Heat Storage

Insulation: It's better to have multiple layers. This is more efficient at trapping heat in because it leaves air in between the layers where heat can stay trapped instead of having just one layer which will lose any heat that passes through it.

Heat absorption: Black is the color that absorbs the most heat. This is because black absorbs all wavelengths and reflects nothing.