SOLAR ENERGY

SUN STRENGTH CALCULATIONS

MONROE

Time Frame:	Standards:
45 minutes Extensions for longer periods of time.	Idaho Standard number 4.2.1

Objectives:

To compare the angle of the Sun as it changes through the day, and compare it to the power it produces, as measured in volts in a small PV cell. Students will understand the difference in solar energy density based upon the Sun's position in the sky based upon time and location.

Background Information:

The amount of energy coming from the Sun will (we can call it "Photon Density" or "Field Strength") be strongest when it is directly over a person, and there is no shadow. This is because the light rays are as concentrated as they can normally be on Earth, and they are not spread out.

One place, and time, where one would not see a shadow, would be at noon, on the equator, on the first day of spring or fall. On that day and time, the sun is halfway between dawn and dusk, and the Earth is tilted neither towards nor away from the Sun. A person would cast no shadow. The angle of the Sun is 90 degrees.

This is calculated by the rather straightforward equation of

Angle of Sun's Rays at Equator on Equinox	less	Site or Location Latitude	equals	Angle of Sun's Rays at Site or Location on Equinox

Sample scenario
A certain town in Arizona has latitude of 32 degrees. What is the angle of the Sun, at noon, on the equinox, and also on the first day of summer, and the first day of winter?

Equinox
90 degrees less 32 degrees equals 58 degrees of Sun angle

Summer
58 degrees **PLUS** 23.5 degrees equals 81.5 degrees of Sun angle

Winter
58 degrees **MINUS** 23.5 degrees equals 34.5 degrees of Sun angle

Remember to add to the **equinox value in the summer, and subtract in the winter**

Practice Calculations:

A farm in Nebraska has latitude of 42 degrees. Determine the noon angle of the Sun on the first day of

a. Spring _____

b. Summer _____

c. Fall _____

d. Winter _____

Answers are: Spring/Fall is 48 degrees, summer is 71.5 degrees, and winter is 24.5 degrees.

Supplies Needed

1. A photovoltaic cell. Any size will do, but generally the larger ones work better because the margin of error is reduced in data collection.
2. A multimeter or voltmeter. Generally the readings will be in the one to six volt range.
3. A thermometer.
4. A stick about 1.2 meters long that can be driven into the ground.

A flat area, outside, that will not be disturbed.

Safety Concerns:

1. Do not ever look directly at the Sun. Damage can be done quite quickly and last forever.
2. Do not set the experiment up in a location that has traffic or other hazards.

Assessment:

1. Each student will complete his/her own data chart and will complete as much of the master data chart as is reasonable.
2. Each student will complete a graph of the data.
   a. Time is on the "x" axis.
   b. Voltage, Temperature and Sun Angle are on the "y" axis.
3. Each student will answer the following questions on a separate sheet of paper.
   a. What correlation seems to exist between time and the Sun's angle?
   b. What correlation seems to exist between the Sun's angle and power?
   c. What correlation seems to exist between the Sun's angle and temperature?
   d. Is there any place on Earth that would NOT benefit from Solar energy.
   e. Where would Solar energy work best?

Procedure:

1. Place the solar cell in an "out of the way" location that will be getting sunlight throughout the day.
2. Place the post into the ground at a depth of 1 meter and at an angle very close to 90 degrees.
3. Attach the metering device and note the voltage produced. Also note the time, the Sun angle, sky conditions and temperature.
   a. Sky conditions may be "rainy", "cloudy", "misty" or other descriptors.
   b. Find the Sun angle.
4. At various times through out the day take additional readings.

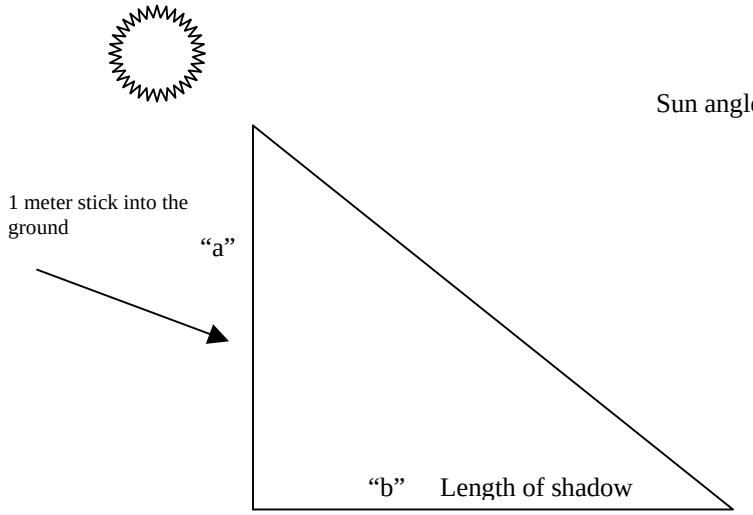
Cooperation:

1. All of the data should be placed on a master data chart that is available to all.
2. Care should be taken by each individual because data taken by one will be used by everyone.

Procedure:

Time	Temperature	Sun Angle	Volts	Sky Conditions

Example:



Example of sun angle: 1 meter stick in ground, with a 1.5 meter shadow.
(1/1.5) x Tangent (inverse) = 33.69 degrees