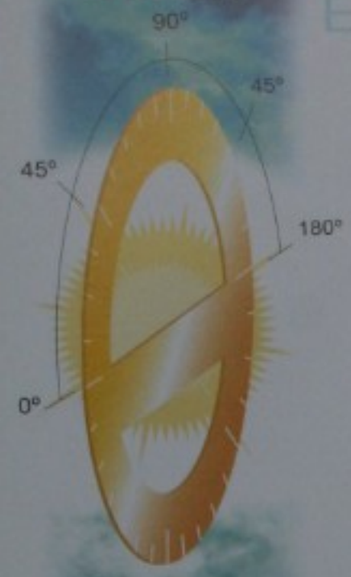


Experiment 03

An Absolute Measurement from a Relative Sensor
Or The Reflectivity of a Mirror

Objective

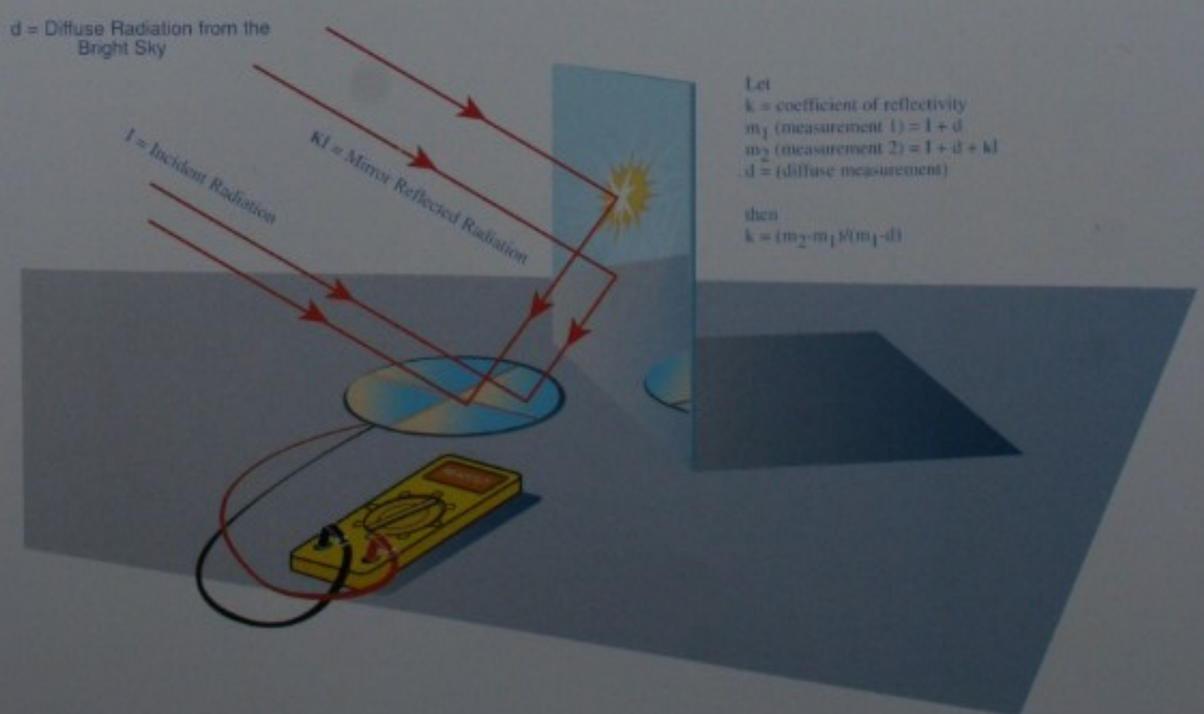
When a solar module is short circuited, it generates a current that is directly proportional to the amount of light falling on the module. With appropriate calibration, it would be possible to use the short circuit current as a direct measure of the incident illumination. If the solar module has not been calibrated it is still possible to use the direct proportionality of the short circuit current to determine the ratio of the illumination between two light sources. In this experiment, the student will take two "relative" measurements of light intensity using a solar module and then derive the "absolute" value for the reflectivity of a mirror.

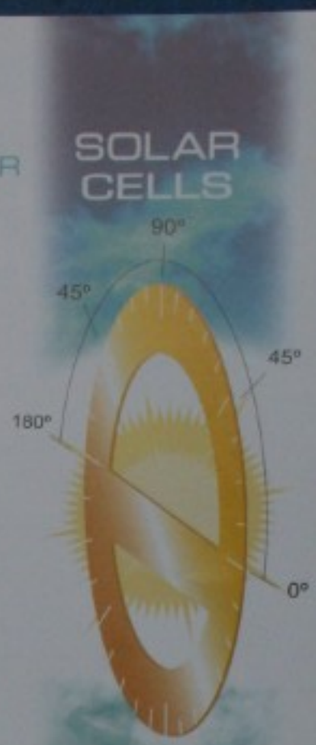
Value

Students become familiar with the concept of linearity. The principle of superposition can be used to describe the changes in short-circuit current produced by the additional light from the mirror.

Note

A mirror is positioned vertically on a horizontal table so that the reflection of the sun on the table is in the same direction as the sun. With the bottom of the mirror flat on the table, move the mirror in such a way that the sunrays striking the mirror reflect right back into the sun. Leaving the bottom of the mirror in position, adjust the top of the mirror so that the mirror is vertical. Use a semicircular protractor and adjust the mirror to 90 degrees from the horizontal.





Equipment

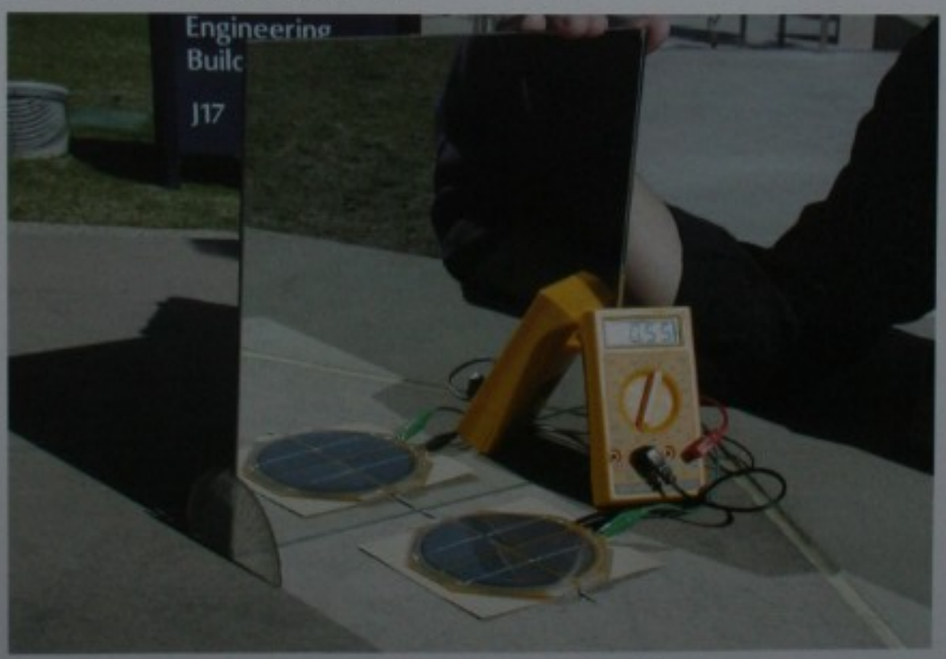
One 4-cell solar module, one multimeter (in current mode) with alligator clips, one mirror 300 x 300mm, semicircular protractor, horizontal table and a piece of circular cardboard.

Method

On a horizontal table, place the solar module face up. In bright sunshine measure the short circuit current of the solar module (measurement m_1). To measure the diffuse radiation from the bright sky, from one or two metres away cast a shadow with the circular cardboard directly onto the solar module and measure the current (measurement d). (It is assumed that the diffuse component of sunlight does not change with the mirror in place.)

Place a mirror near the solar module such that sunlight reflects off the mirror and onto the solar module (oriented as in the note on the prior page). Adjust the mirror such that it is 90 degrees to the plane of the table and facing the sun (the shadow of the mirror should be square or rectangular rather than a rhombus). Measure the short circuit current of the solar module (measurement m_2).

Through superposition, the magnitude of illumination on the solar module due to the mirror is $m_2 - m_1$ (the diffuse components of m_2 and m_1 are assumed to be identical and are cancelled out by the subtraction). The measurement m_1 contains a diffuse component that is measured by shading the cell. The coefficient of reflectivity of the mirror is the ratio of the light from the mirror and the incident light from the sun on the solar module: $k = (m_2 - m_1)/(m_1 - d)$.



Measurement m_2: Solar Module, Meter & Mirror.