LABORATORY ACTIVITY
EARTH & SPACE SCIENCE TOPIC

Module 1

The Solar Constant for the Earth

Module 2

Distance to the Moon

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Module 1

The Solar Constant for the Earth

Purpose

With this activity, you will let solar radiation raise the temperature of a measured quantity of water. From the observation of how much time is required for the temperature change, you can calculate **the amount of energy absorbed by the water** and then relate this to **the energy output of the Sun**.

Equipments & Materials

1. Insulated jar (try to minimize heat loss to the environment with your design) with a hole drilled in it to accept a thermometer
2. Thermometer with a range up to at least 50^0 C
3. Stopwatch
4. Metric measuring cup and balance
5. Fresh water
6. Black color of water soluble ink (optional)

Procedures

1. Try to do the data collection as close to noon as possible on a clear, cloudless day.
2. Prepare the jar with 150 ml of water with a few drops of the black ink (if it is possible) to make it fairly black.
3. Insert the thermometer and let the temperature stabilize to a mean air temperature by placing the jar in the shade for 20 – 30 minutes or until a check every 2 – 3 min shows no temperature change.
4. Shade the jar as you move the unit into the sun and set it so that the surface is as perpendicular to the incoming solar radiation as possible. As you unshade the collector, begin recording the time and the temperature (See data sheet).
5. Allow the jar to absorb the sun's rays for about 20 min or at least enough time to get a 3 – 4^0 C temperature rise. Record the elapsed time and temperature rise.
6. Cool the unit by placing it under running water and repeat the procedure at least two more times so that you have three total sets of data.
7. Measure the size of the jar's surface that is exposed to the sun and express the area in square meters.

Data Sheet and Calculations

Follow the calculations on the data sheet. These will give you a step-by-step method for determining the solar constant from the data you have gathered from your simple collector.

Volume of water used :____________________litre
Mass of water used :____________________kilogram
Exposed surface area :____________________m^2

Trial #	Initial Temp. (^{0}C)	Final Temp. (^{0}C)	Δ Temperature (^{0}C)	Elapsed Time (second)
1				
2				
3				

1. What is the average raise of temperature (ΔT/s)?
2. By remembering the specific heat of water, what is the energy absorbed by your water per second (J/s)?
3. What is the average energy collected per unit of surface area of your collector ($J/s.m^2$)?

However your result is uncorrected solar irradiation for the Earth's surface. Both the Earth's atmosphere and the jar have absorbed some of the incoming solar radiation and therefore won't show up as energy absorbed by the water. If other materials are used for your collector, then these next calculations may not be valid and more research will probably be necessary.

4. Multiply your uncorrected solar irradiation by 1.4 to correct for the atmosphere. What is the final result?

The accepted value of the solar constant (at Earth's distance) is about 1376 W/m^2.

5. What is your % difference? What do you think the value of the correcting factor for the material you used as a collector?

Discussion

1. Detail as many reasons as possible why your value of the solar constant differs from the accepted value?
2. Use the formulas for surface areas of spheres and the value of Earth-sun distance to find how much energy is being released per second from the surface of the sun!
3. What can you conclude according to the activity you have just done?

Module 2

Distance to the Moon

Purpose

With this activity, you will measure the angular size of the Moon using a cross-staff and then use basic mathematics to calculate the distance to it. You will also learn about the shape of the orbit of the Moon.

Equipments & Materials

1. Cross-staff (available at Earth & Space Laboratory - N220)

Procedures

1. Aim your cross-staff in the direction of the fullmoon. In the **Data Sheet and Calculations** section, you are provided with fullmoon data during a year in 2012.
2. Measure the angular size of the fullmoon. Record the value which is expressed in degree unit and repeat for another fullmoons until the end of the semester.
3. Once you have the diameter of the Moon (refer to your astronomy textbook) and its angular size, by using **small angle approximation formula** you can calculate the distance to the object.

Data Sheet and Calculations

Fullmoon #	Measured Angular Size (degree)	Calculated Distance (km)
1^{st}		
2^{nd}		
3^{rd}		
4^{th}		

Table 1. Fullmoon during a year in 2012 as seen from Bandung

Fullmoon #	Date	Moonrise Time (local time)
1^{st}	January, 9	18:08:47
2^{nd}	February, 8	18:27:06
3^{rd}	March, 8	17:52:51
4^{th}	April, 7	18:13:37
5^{th}	May, 6	17:50:35
6^{th}	June, 4	17:33:58

Fullmoon #	Date	Moonrise Time (local time)
7th	July, 4	18:20:30
8th	August, 2	17:58:32
9th	August, 31	17:31:24
10th	September, 30	17:48:02
11th	October, 30	18:04:50
12th	Nopember, 28	17:37:28
13th	December, 28	17:58:32

1. What is the average angular size of the Moon?
2. What is the average distance to the Moon?

The accepted value of the average distance to the Moon is 384,400 km.

3. What is your % difference?

Discussion

1. What do you think about the shape of Moon's orbit?
2. Can you determine the farthest and the nearest distance to the Moon by using this kind of activity? How do you do that?
3. What can you conclude according to the activity you have done?