"Phun" with Photosynthesis

Brief Description:

Students will use light-sensitive beads to observe how sunlight can cause rapid physical and chemical changes in what it strikes. They will calculate the total surface area of leaves exposed to the sun on a saw palmetto plant. They will calculate how many photoelectric cells would equal the solar energy capturing ability of the saw palmetto plant they measure. The students will then design and make a tree using photoelectric cells as leaves.

Objective:

Students will be able to:

1. Explain that photosynthesis is a crucial process for all living things on earth.
2. List the steps in the process of photosynthesis by making a flow chart.
3. Produce measurable electricity by placing photoelectric cells into a tree form.
4. Explain why photoelectric cells are an environmentally sound way to produce electricity.

Time:

Lesson: up to 50 minutes
Lab/Field Observation: up to 100 minutes
Solar Project: 100 to150 minutes

Materials:

- Photoelectric cells (12)
- Graph paper in centimeters squared
- Light-sensitive beads
- Scissors
- Materials to make tree frame: wooden base, dowels, tape, wire, etc.

Vocabulary:

element, atom, ion, nucleus, electron, catalyst, enzyme, NADP, ADP, ATP, rubisco, energy levels and photoelectric cells

Photosynthesis Equation:

Carbon Dioxide + Water $\xrightarrow{\text{(Light)}}$ Sugar + Oxygen

$$6CO_2 + 6H_2O \xrightarrow{\text{(Light)}} C_6H_{12}O_6 + 6O_2$$

Procedure:

1. The students will go outside where they can readily observe the green world around them. The green is reflected because red and blue are absorbed in the light spectrum and therefore we see green.
2. The steps of photosynthesis will be reviewed and the importance of this process for all living things on the surface of the earth will be expressed.
3. Use light-sensitive beads to show students ultraviolet (UV) light. The beads will remain white while indoors because incandescent and flurescent lights will not affect them. The beads will turn a bright color when exposed to UV light. This allows the students to see a reaction to UV light other than a sunburn on their skin.
4. Students will complete a *Pre-Lab* assignment to reinforce their knowledge needed for the photoelectric tree build project.
5. Give each student a copy of the *Field Observations/Lab*. The class will look at a saw palmetto plant, determine the total number of leaves on the plant, calculate the surface of a leaf using graph paper, and calculate the total surface area of the leaves on the entire plant. This is the total area of the plant exposed to light.
6. Give each student a copy of the *Solar Project* handout. Students will look at the similarities of energy changes involved in the palmetto plant capturing sunlight and sunlight hitting photoelectric cells. The students will make a tree using photoelectric cells and compare the electric energy produced.
7. Optional: Take students on a photosynthesis walk. Look at the advantages of different leaf shapes and sizes, how all plants strive to get their leaves exposed to the sun, and what happens to plants when they are deprived of sunlight.

*Lesson created by The Savanna Preserve State Park Life Program in collaboration with the St. Lucie School System.

Florida Standards:

SC.7.P.11.2, SC.7.P.10.1, SC.7.L.15.2, SC.8.L.18.1, SC.8.N.3.1, LAFS.68.WHST.3.7, LAFS.68.WHST.4.10, SC.912.L.17.19, SC.912.L.17.20, SC.912.L.18.7, SC.912.P.10.1, LAFS.910.WHST.3.7, LAFS.910.WHST.4.10, LAFS.1112.WHST.3.7, LAFS.1112.WHST.4.10

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Pre-Lab

Name: _____ Date: _____

1. What is the difference between a lead blade and a frond?

2. How does a photoelectric cell compare with photosynthesis?

3. How do you think the surface area of plant leaves will compare with the surface area of photoelectric cells in their ability to capture solar energy?

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Field Observations/Lab

Take students outside to observine saw palmetto plants. Place students into groups.

How many leaf blades are on one palmetto frond?

How many fronds are on a palmetto plant?

What is the total number of leaf blades on the palmetto plant?

Remove one leaf blade from the palmetto plant per group to take to the classroom to use on assessment questions.

Aim the photoelectric cell array directly at the sun and record the meter reading in milliamperes.

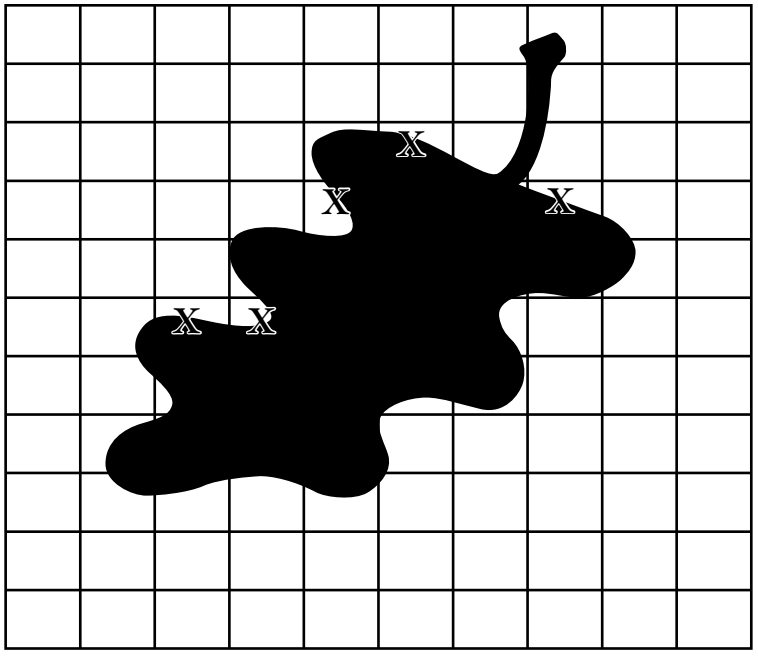
Aim the photoelectric cell array so it is pointing away from the sun and record the meter reading in milliamperes.

Position the photoelectric cell array so it is at a right angle to the sun and record the meter reading in milliamperes.

What is the average of your three milliamperes readings?

Lab Assessment:

- Cut the palmetto leaf blade into pieces so that each person in your group has a piece.
- Each person in the group will lay their piece on graph paper.
- Outline the leaf part with a marker, then remove the leaf part.
- Count the squares the leaf part covered on the graph paper. (Count partially-covered squares that are more than half covered as one square and ignore the squares that are less than half covered.)



1. Record the number of squares covered on your sheet: _____

2. Record the number of squares covered on each of your team member's sheets:
_____, _____, _____, _____, _____

3. Record the total number of squares covered by one leaf blade (add the answers from questions 1 and 2): _____

4. Record the area of the leaf blade in centimeters squared (cm^2). Remember that each square is one cm^2. (should be the same answer as question 3): _____

5. Record the total leaf blade area exposed to sun (both sides of leaf are exposed to sun): _____

6. Total cm^2 of leaf area in the entire palmetto plant exposed to the energy of the sun (multiply answer to question 5 by the number of leaf blades found on the entire plant): _____

7. A table top covers an area of 13,859 cm^2. How many table tops of saw palmetto plants were exposed to energy of the sun? (Divide the answer to question 6 by 13,859): _____

8. A photoelectric cell does only one thing: it uses the energy of the sun to produce electricity and it needs less sun to do that one task. Photosynthesis within a plant lead is much more complex. The energy of sunlight is used to power eighty differential chemical reactions.

   Divide the answer to question 7 by the answer to question 6 to determine how many table tops an array of photoelectric cells would have to cover to capture the same amount of solar energy as one palmetto plant:

9. Now multiply the answer to question 8 by 13,859 (this is the number of tables times the area of a table top in cm^2):

10. Now multiply the answer to question 9 by 13, 859. _____

11. Divide the answer to question 10 by area of the photoelectric cell used: _____

Hint: The answer to question 11 is how many photoelectric cells it would take to capture the same amount of the sun's energy as your saw palmetto plant can capture!

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Solar Project

1. Design and create a solar tree. The leaves will be photoelectric cells. Consider the following:
   - How many photoelectric panels you will need to model the energy captured by the class average calculated for the typical saw palmetto plant. Is that possible with your given materials?
   - If it takes 600 photoelectric cells to equal the one typical plant, what is your ratio for using six cells, or five?
   - The observations you gathered of the movement and placement of the fronds from sunrise to sunset.
   - The arrangement you observed of the saw palmetto frond on your plant.

2. Your tools available are: wooden base, dowels, tape, wire and photoelectric cells.

3. Draw your design and get approval from teacher. Once you gain approval to build, start working together to create your model using the materials given.

4. When ready ask for permission to take your model to a testing station:
   - Position the lamp above your model to represent the sun at the time of day your class meets.
   - Place your model on counter in direct path of light waves and turn on light.
   - Connect milliamp meter to circuit, take measurement and record.

5. Compare your model with those of other classmates and discuss.

Questions:

How many amperes of electric current did your solar tree produce? _____

How well did your tree capture energy of the sun compared to the other solar trees made by your classmates?

_____

_____

Explain how you might alter yours or what made it so successful: _____

_____

_____

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Assessment Questions

1. What was the size of one square on the graph paper you used to measure your saw palmetto leaf blade?
   _____

2. What relationship between leaf blades and fronds on a saw palmetto plant helped you to calculate the number of leaves on one plant?_____
   _____

3. Why did you have to multiply the measured area of the palmetto leaf by two?_____
   _____

4. Describe how you would calculate the surface area of the needles on a pine tree:_____
   _____
   _____
   _____

5. How would planting a large number of trees in a city benefit the people of that city? _____
   _____
   _____
   _____
   _____

Journal Prompt:
Carbon dioxide and other gases in the air enter and exit through the stomata within the leaves of plants. Photoelectric cells can take the place of other sources of electric power. In your journal, record your ideas about how both plants help and how photo-electric cells might help to make the air and thus our whole planet a cleaner place to live.