Laboratory Introduction to Solar Cells: Exploring Solar Powered Water Pumps

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DESCRIPTION: Students explore with a solar cell and a pump to discover how to make the pump run. They will hypothesize and informally test whether they can make the pump run faster or slower.

GRADE LEVEL(S): GRADE LEVEL(S): 3, 4, 5

SUBJECT AREA(S): Science

ACTIVITY LENGTH: 1 hour

LEARNING GOAL(S):

- Students will make observations about how a solar cell needs to be set up to push water through a pump and hypothesize about how energy is changing form as the pump runs.

STANDARDS MET:

Next Generation Science Standards:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

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Student Background:

- This lesson is intended to be the fourth in a solar energy unit, and so my students will already have completed the follow lessons:
  - Introducing Solar Energy: Hypothesizing on Why Solar Beads Change Color
  - What is Renewable Energy and Why is It Important?
  - Energy Changes Form
- Students should be familiar with forms of energy such as light, heat, electrical and motion.
- Students should be familiar with the idea that energy changes form and be able to describe some examples of those transformations.

- It is helpful if students are familiar with the idea of a circuit and the basic concept of electricity as flow of electrical charges.

Educator Background:

- Electrical energy is the flow of electrical charges, often harnessed to do work.
- Sunlight (electromagnetic energy) causes the charges in solar cells to gain energy, and because of an electric field created by the materials that make up the solar panel, the electrons flow in a single direction, generating electricity.
- A solar cell is an invention that converts light to electric current by the photovoltaic effect.
- Kinetic energy is the energy of moving objects or systems. Electricity is a form of kinetic energy – it is the energy of moving electrons. A water pump also has kinetic energy as its moving parts displace water. At this grade level, students may say that the electrical energy is being transformed into motion and need to be guided to understand that the electrons are moving as well.
- Solar and wind are considered renewable energy because they come from sources that can easily be replaced, unlike oil, gas and coal.

Science Kit Materials List:

For each pair of students:

- (1) 1.5 volt SunWind solar cell.
- (1) KidWind pump with PVC tubing

Other Materials List:

- A chart with the title “Evidence that Energy Moves from Place to Place and Changes Form.” Start a two-column T-chart labeled Observations and Conclusions (and a marker).
- For each pair of students:
  - 1 low, flat plastic container of water
  - 1 larger plastic container to pump water into (e.g., plastic shoebox)
  - Several rolls of electrical tape
  - Scissors
  - 1 copy of **Sheet 1** for each student.
- A sunny day and a place to work outside

Vocabulary:

- Evidence – observational clues that support a hypothesis or go do not support a hypothesis
- Conclusion – educated guess based on your evidence and what you know about the topic from reading and talking with experts

Lesson Details:

- Introduce materials. Solicit ideas about how they might work. Go over expectations about how to safely and carefully work with the materials. For example:
    - The electrical tape can be used to secure the pump to the bottom of a plastic container.
    - Electrical tape can be used to secure the wires coming out of the pump to the sides of the container and hold the wires out of the water.
    - Other objects in the water might clog the pump.
    - An effort should be made to keep the solar panels from falling in the water.
- Post and review guiding questions that students should think about as they explore:
    - How do the wires need to be attached to work the pump?
    - Can you find a way to make the pump work more quickly or more slowly?
    - What observations can you make about whether energy is moving from place to place? What is your evidence?
    - What observations can you make about whether energy is changing form? What is your evidence?
- Allow exploration time with the materials. After everyone has had a chance to see the pump working, clean up the materials. Empty excess water from the hoses before putting the pumps away. Have students remove electrical tape from the containers and throw away. Let students know that after we are done exploring the materials, we will be writing answers to some of the guiding questions.
- Pair-share about the guiding questions and share partner's response with the group. Define evidence and conclusions. Go over expectations for written work (Solar Cell Lab 1 Handout). Give students time to write.
- Closure:
    - Share observations and conclusions and write on a T-chart. Model thinking about whether something was an observation or a conclusion.
    - As a group, draw a diagram of the students' conclusions about how energy is moving and changing form.