

<b>Teacher(s):</b> Suzanne McClung	<b>Unit Title:</b> Option C: Energy
<b>Subject:</b> Chemistry	<b>Lesson Title:</b> Factors Affecting Power Output by Photovoltaic Cells
<b>Grade Level(s):</b> IB 2 (Senior – 3 <sup>rd</sup> year of chemistry)	<b>Lesson Length:</b> 2-90 minute blocks with 30 minutes for wrap up in a 3 <sup>rd</sup> class period
<b>Date(s):</b>	

- **Learning Goals**

- Students will make observations of voltage and current in a solar panel system
- Students will calculate power of a solar panel system
- Students will determine the effect of a factor on the power produced by a solar panel system (Factors may include: distance of panel from light, number of panels in system, method of wiring (series vs. parallel) in circuit, light intensity, angle of panel to light source, shading of panel, temperature of panel)
- Students will design and conduct their own experiment to determine the effect of their chosen factor

- **Energy Connection**

- Students will measure and record values for voltage and current and calculate power values for solar panels.

- **Connection to Standards**

From IB Chemistry Guide for Assessments Starting in 2016:

**C.4 Solar energy**

**Nature of science:** Public understanding—harnessing the sun’s energy is a current area of research and challenges still remain. However, consumers and energy companies are being encouraged to make use of solar energy as an alternative energy source.

**C.8 Photovoltaic cells and dye-sensitized solar cells (DSSC)**

**Understandings:**

- Solar energy can be converted to electricity in a photovoltaic cell.

**Applications and skills:**

- Explanation of the operation of the photovoltaic and dye-sensitized solar cell.

- **Materials and Resources**

- “Factors Affecting Power Output by Photovoltaic Cells” student handout
- “How to Write a Formal Lab Report” student handout
- Materials will vary based on independent variable chosen by student: (\*items required by all lab groups)
  - Light source (high power halogen lamp) \*
  - 3 solar panels\*
  - 2 multimeters\*
  - Low power DC bulb (X-mas tree light)\*
  - 8 wires with alligator clip ends\*
  - Protractor\*

- Ruler\*
  - Thermocouple (for students studying effect of temperature)
  - Ice (for students studying effect of temperature)
  - Window screening (for students studying effect of shade/cloud cover)
  - Paper (for students studying effect of shade/cloud cover)
  - Cardboard (for students studying effect of shade/cloud cover)
  - Students may request other materials during planning time or bring items from home
- **Procedure** [List all necessary steps for the lab or activity.]
    - Prior to this lesson, students have learned about electric circuits (current, voltage, power, resistance) and have had hands-on experience with constructing them and measuring current and voltage.
    - Students are given time in small groups to brainstorm factors that could affect power output of a photovoltaic cell. After this brainstorming, each student will choose one of the factors as an independent variable. They will then be given “planning play time” in which they conduct preliminary trials to determine all the levels of their independent variable and controlled variables.
    - After “planning play time,” students will be required to write up a pre-lab. The pre-lab contains all the sections of a formal lab report through a blank data table.
    - In the following class period, students must have their pre-lab stamped before beginning data collection.
    - Students will collect data and write a formal lab report to document their findings
  - **Technology Integration**
    - Spreadsheets for data collection and analysis
  - **Modeling & Guided Practice**
    - Teacher will demonstrate the use of the equipment prior to giving students brainstorming and “planning play time.” One solar panel will be connected to a DC bulb. The light source will be shone onto the solar panel and students will be reminded about how to connect the multimeters to measure current and voltage.
  - **Checks for Understanding**
    - During planning play time and data collection, teacher will circulate around the room and ask questions of students to guide them. The teacher will not tell them how to adjust their procedures but help them to make good decisions about their procedures with leading questions.
  - **Independent Practice**
    - Prior to this lesson, students will have practiced calculating power with current and voltage data.
  - **Assessment & Closure**
    - Students will reproduce the graphs from their lab reports on chart paper and present them to the class and explain their results

- Students will turn in a full formal lab report which will be evaluated using IB internal assessment criteria