Green Engineering

GNG1103 – Engineering Design

Objective

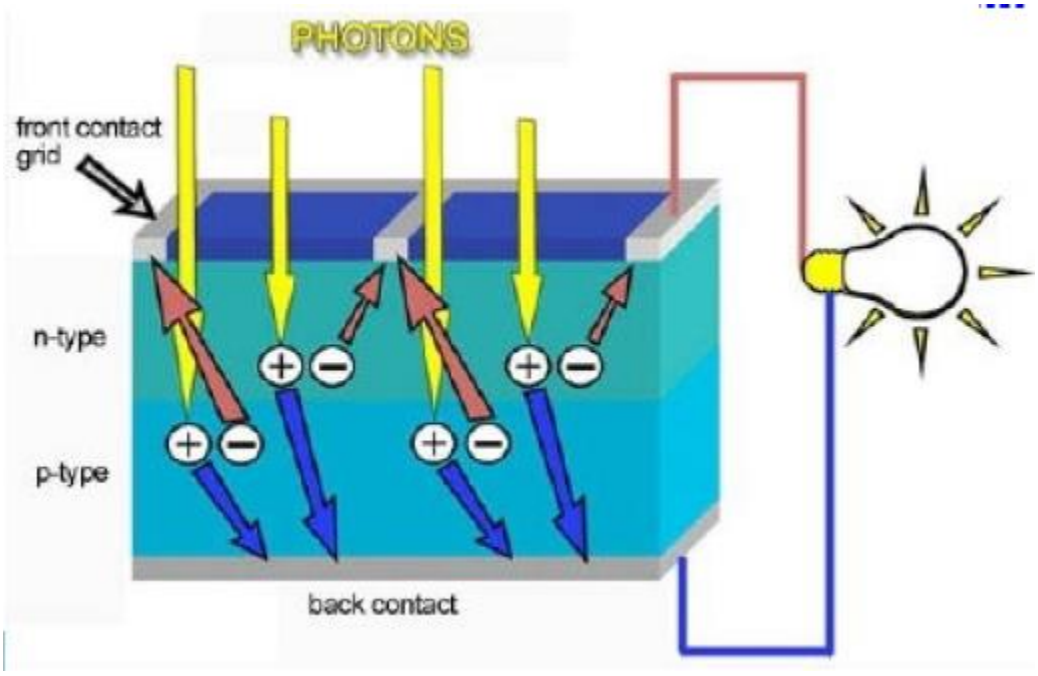
This lab is on green engineering and includes a solar cell experiment.

Background

Solar energy is a powerful renewable energy source, earth absorbs 4 million exajoules of energy (1 ex=10^18) BUT only uses 327 exajoules, 1 hour of energy could satisfy needs for 1 year. There are many uses for solar energy which include solar thermal energy to heat water, solar thermal electricity in parabolic troughs (transform water to steam to power turbines), solar cells/photovoltaic energy (converts light to electricity), etc.

What is electricity? A coulomb is an electric charge, current is like water flowing through a hose (coulomb/ s), voltage is like pressure in the hose (Joules/coulomb), power is watts (Joules/s) and energy is watt.hr (Joules). Circuits are made to power components with electricity and can be arranged in series (increase voltage) or in parallel (increase current). Solar cells can act as that power source.

Solar cells work by having electrons (negative particles) knocked loose when sun hits the cell and move towards the treated surface causing an electron imbalance in the cell and a flow of electricity.



Apparatus and Equipment Overview

The equipment that will be used in this lab includes:

- 1 x Fan
- 1 x Incandescent light bulb
- 1 x Multimeter
- 4 x Connector wires
- 6 x Nuts
- 1 x Green LED
- 5 x Alligator clips
- 1 x Photovoltaic panel (One solar cell provides about 1.5V and 120mA)
- 1 x Work lamp
- 1 x Laminated booklet sheets

Pre-Lab Questions

What are the 2 units in electricity that are most commonly used?

How is current and voltage affected in a series circuit?

How is current and voltage affected in a parallel circuit?

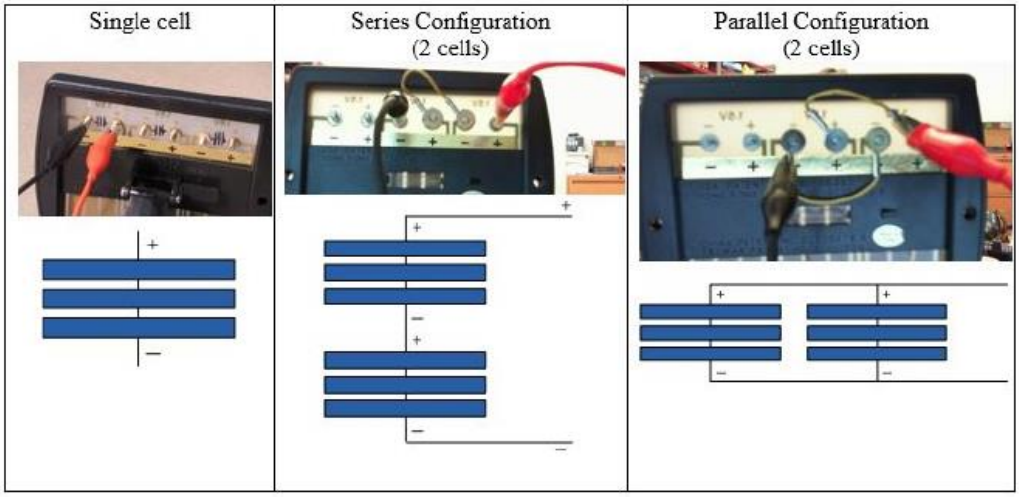
Why is solar energy unreliable and what is a solution to mitigate it?

What are the 2 examples of a use for solar energy?

Part A – Solar Panel Basics

You will be wiring the solar panels in series and parallel to measure the current and voltages with the multimeter.

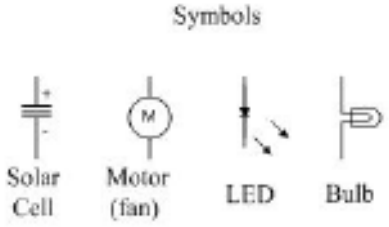
1. Estimate what the voltage and current will be for 2 panels in series and 2 panels in parallel and write it down in the provided table.
2. *Do steps 3-6 twice, the first time by having the lamp close to the panels and the second having it far away.
3. Measure the voltage and current of each individual panel and write it down.
4. Wire the panels in series and measure the voltage and current.
5. Wire the panels in parallel and measure the voltage and current.



Part B – Using Solar Panels

In the next part you will be using 1 or 2 cells to power different components.

1. Draw the circuit for each of the components (fan, incandescent light bulb and LED) with the following symbols.
    a. Note that the fan does not consume a lot of energy and is low voltage, the incandescent bulb consumes a lot of energy (current) and the LED does not consume a lot of energy but has higher voltage requirements.
    b. Also note that the LED is a diode which means that current will only pass in one direction through the component.

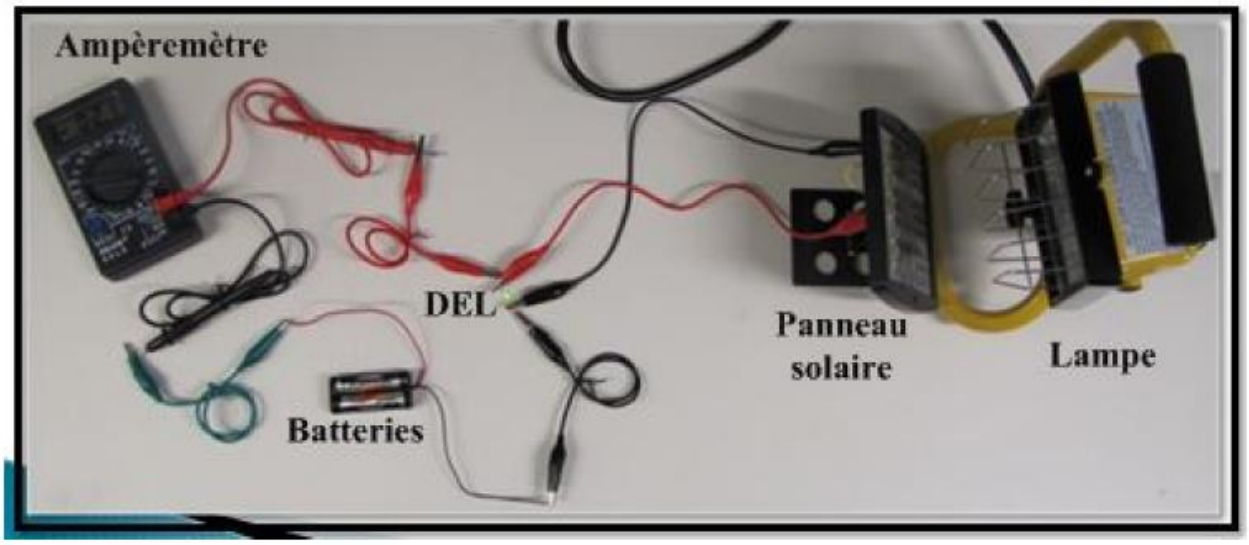


2. Test your theories by wiring all circuits to test them.
3. Test what happens if the lamp is closer or farther from the panels.

Part C – Solar Panel System

Solar panels can be used in a variety of contexts like garden lamps or solar farms however when integrated into a system we need to take into consideration that the sun does not always shine which means it is important to have an energy storage solution.

1. Draw the solar system circuit by following the following picture and using the appropriate symbols.



2. Wire the circuit and test it. The circuit should charge the battery while the lamp is on and the LED should be on when the lamp is off. (It may take 2 minutes to charge the batteries)