12B Lab 3A Solar Cells

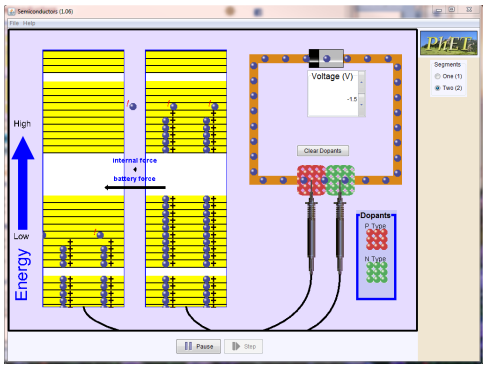
Names:
1.)
2.)
3.)

**Learning Objectives:**

- A PN junction can operate as a Light Emitting diode or as a light "harvester"
- The frequency of the incoming light is important in the process of harvesting
- A PN junction will operate most effectively when you have the correct "load"
- A PN junction will operate as a constant current source to a point
- Harvest some light to do some work

**Activities:**
Shine three different colored LED's into a yellow LED
Create a VI graph for the

**Warm up:** Run the p-n junction simulation at
http://phet.colorado.edu/en/simulation/semiconductor

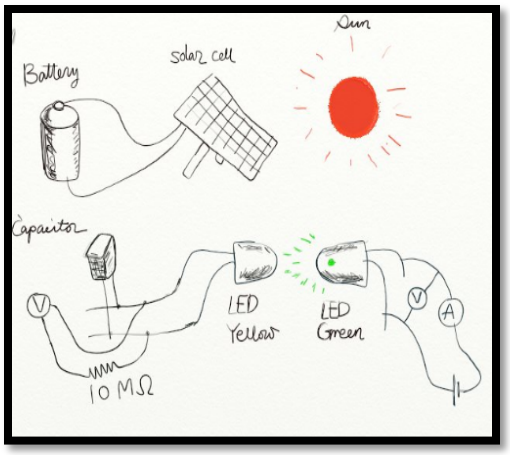



1. Build a p-n junction and play with the amplitude of the voltage. With respect to the direction of the p-n junction, which direction one should apply a voltage so that the current start to flow?

2. Identify in the simulation: which process would cause light emitting and what determines the color of the emitted light?

**Introduction:**

A p-n junction in principle can be used for both light emitting and light harvesting. At a semiconductor p-n junction, conducting electron and holes could be placed at different energy levels. In a light emitting diode (LED), the conducting electrons and holes are made to "recombine" and release the energy in the form of photons. In a solar cell, the reverse process occurs, where the energy of photons is used to create electron-hole pairs and place them in different energy levels. This lab demonstrates these energy conversion processes with simple LED setups.




**Procedure:**

Observe light emission from LEDs

Make sure the power source is off and the voltage is set at the lowest end. Connect the power source to the circuit. Use a 100 ohm resistor to limit the current. Plug LEDs of various colors in the breadboard circuit. Pay attention to the polarity, try both direction and see if you get light or not. Figure out which side is p which side is n, draw it here:

Harvest light by using LED reversely

Use a green LED as the source of light. Arrange a yellow LED in the circuit as the light harvesting device, as shown in the above diagram. Make sure the two LEDs are pointing to each other for the maximum light collection. Add a capacitor (.33 μF) as our battery and connect a voltage sensor to monitor the voltage across the capacitor. Test the circuit and make sure you get a reasonable readings.

Now play with the input voltage and record the response of the system. Particularly, start from zero input voltage and slowly increase to ~3 Vs, hold for a short while let the capacitor charge, and then quickly reduce it to zero while watching how current leaks out of the charged capacitor (why it's leaking?).

Attach you plot to the report.

After collecting the above data, switch the green and yellow LEDs (maintain the right polarity) and see the response of the circuit.

Does the yellow LED still light up?
Does the Green light collect light and convert it to current? Why?

## Solar Cells with Load

The current that you get from a solar cell will change depending on a number of factors. If it is cloudy, temperature, the angle of incidence, and also the "load". The load refers to how much resistance is in the circuit with the solar cell. Investigate how the solar cell reacts to different loads. Design an experiment that will allow us to see the IV characteristics of a solar cell. We recommend using the large panel as your solar cell, and the desk lamp as the "sun". Careful not to put it to close since the bulb gets very hot. (This activity may take a bunch of trials to get it right)

Attach the IV graph for a varying load on the solar cell:

Label on the graph where the circuit has its minimum resistance (short) and where it has the most resistance (open).

Imagine that you will use this solar cell to heat up water by running current through a resistor. What value of resistance would be best to use in your hot water heater? How do you know? (Hint: Can you calculate what the resistance of the circuit and compare that to some performance measure of the circuit?)

## Challenges:

Light an LED with a solar cell

Charge a capacitor so you can use your LED at night

Charge a capacitor and run a motor. Try and lift a weight the fastest, and also try to lift the most weight.