Solar Cells 1 : Power Output vs. Lamp distance

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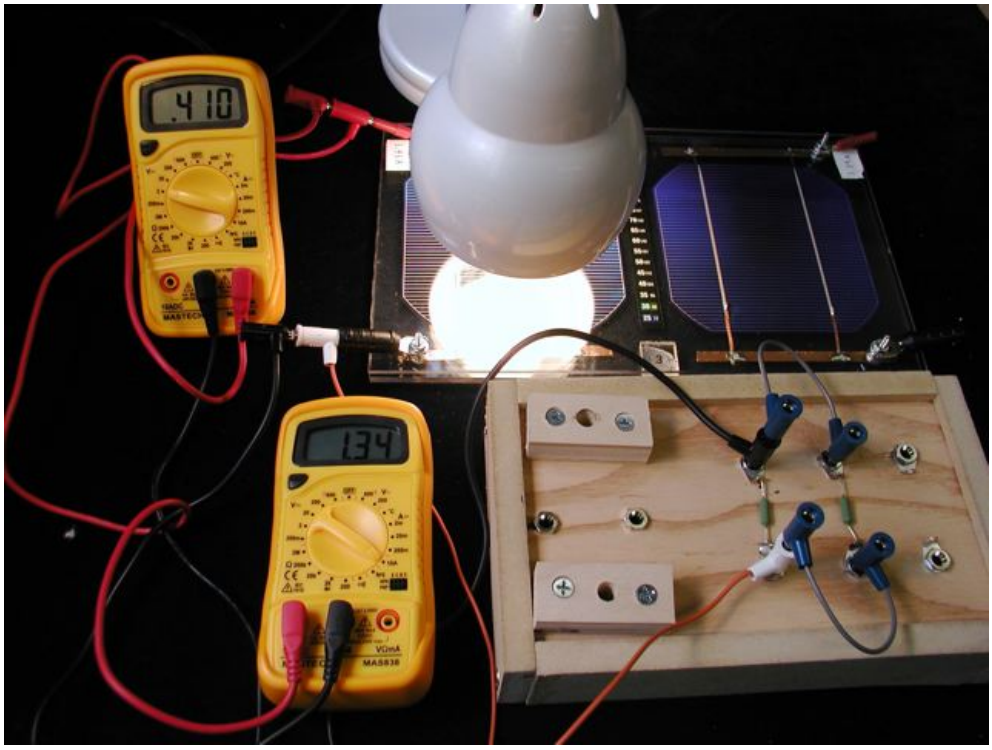
- To investigate the PV cell output current dependence on the distance between the PV cell and an incandescent lamp.
- To understand better the impact of Einstein's Photoelectric Effect on the principal operation of PV cells.
- The Development of the PV activities is sponsored by the Meyer Fund for Sustainable Development, The Dept. of Physics and the Dept. of Chemistry University of Oregon.

MATERIALS

- PV Cell Module
- Electrical Leads
- DC ammeter
- DC voltmeter
- 1 Lamp



Part I: Short Circuit Current – Measuring the flow of *electrons* in a solar cell

Background: When light hits a solar cell the light is converted to "excited" electrons. The solar cell operates by collecting these electrons as electrical current and generating a voltage (i.e. electricity!). Here we will MEASURE the current as we change the brightness of the light (intensity). Current is measured in Amperes or "Amps".

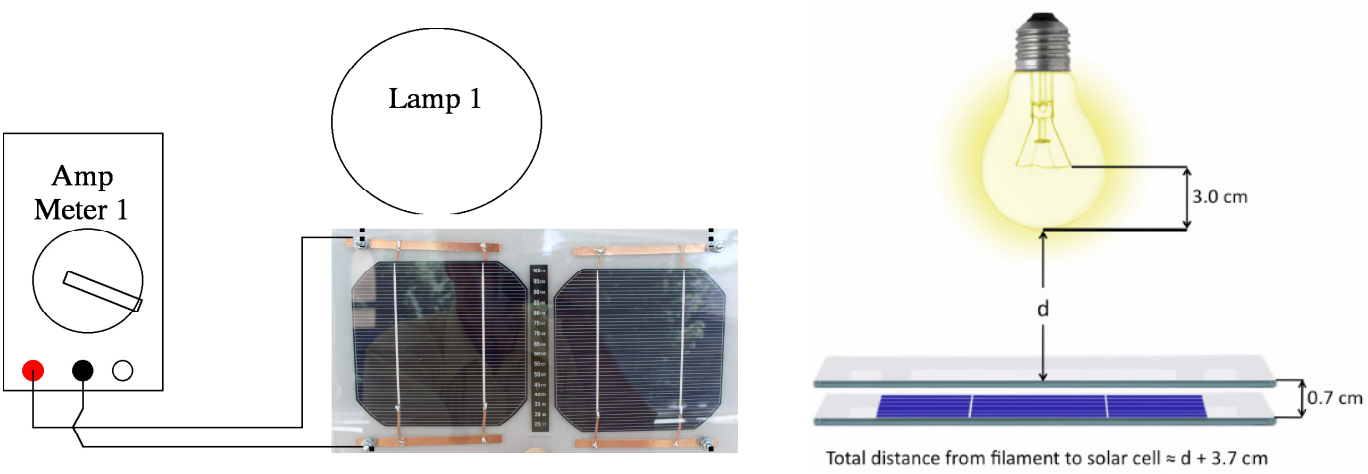


Figure 1: Measuring current as for different distances to the lamp.

1. **Connect one Solar Cell to the Amp meter shown in above.** The red connector is the positive + output of the solar cell. The + output connects to the 10ADC input on the amp meter. The negative black output connects to the COM input of the meter input of the meter. Set the meter dial to the 10 A setting. Place the desk lamp as **CLOSE AS YOU CAN** to the PV cell. Measure the distance between the bulb surface and the PV Module. You need to add 3.7 cm to your measured distance to have the actual distance between the filament inside the bulb and the solar cell surface located underneath the module's protective cover. Enter the measured distance and short circuit current measured by the meter in Table 1 below. (If your current reading is zero check your connections and meter settings or call over an instructor for assistance.)

2. **Collect Data!** Vary the distance of the lamp to the cell by placing the lamp on blocks or books (or work with a partner). **Each time, record the distance between the lamp and the bulb and the output current in Table 1.**

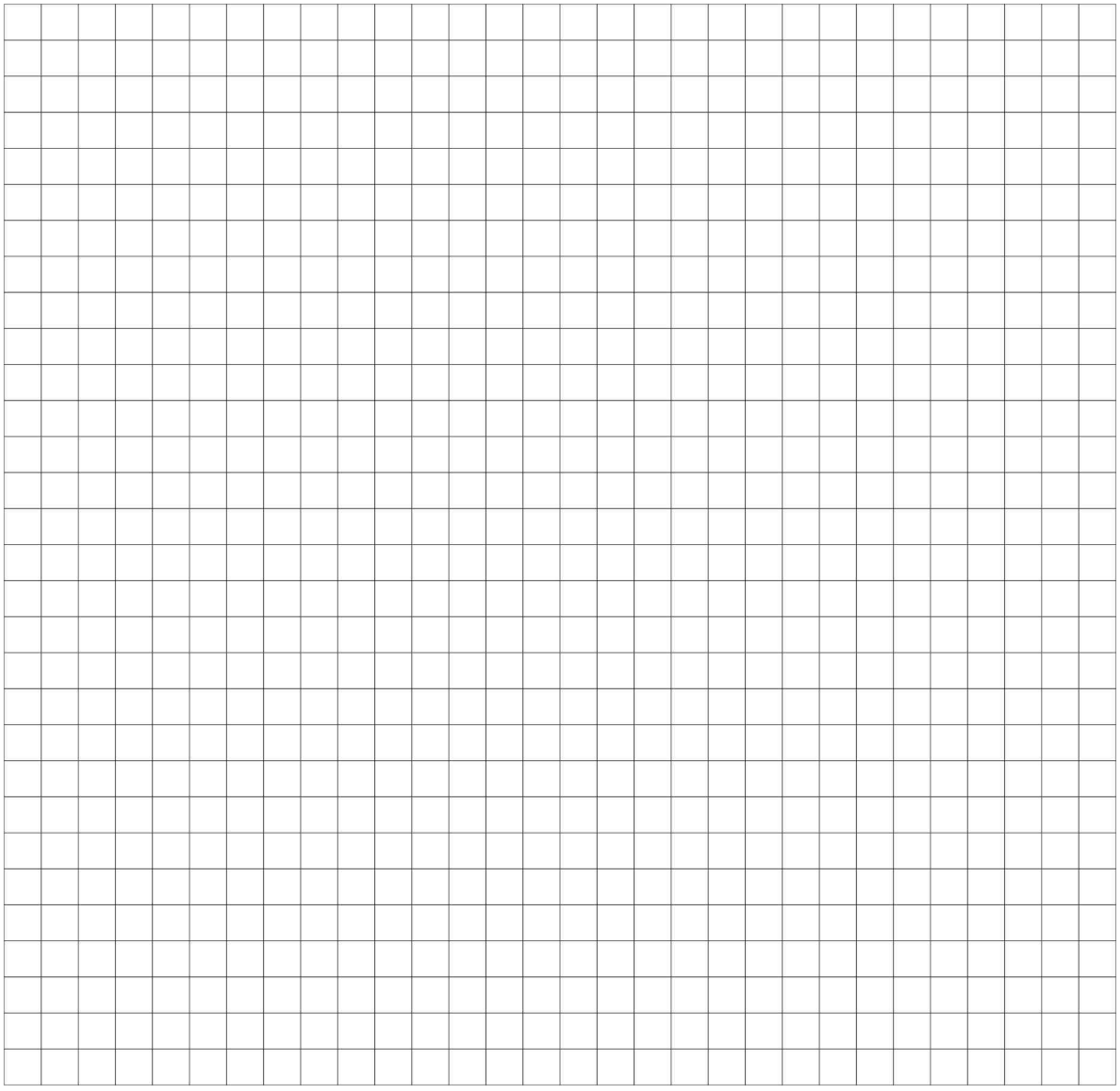
Table 1: Current and Distance

Distance between bulb and PV Module (cm - centimeters)	**ACTUAL DISTANCE (Measured Distance +3.7cm)**	**Current (A - Amps)**

Analysis - Think about your data: Plot a graph of **Current** vs. **Actual Distance** to see what kind of relationship exists. (use a graphing program or the supplied paper.)

What happens to the current when you double the distance between the lamp and the cell? Is the current half as much? Is it less than half of what it was?

Graph Paper: Use to Graph your RESULTS



Don't forget to label your axes with number and units (axes are the sides of the graph that tell you what is on the graph).

Part II: Voltage

Background**:** Voltage is what makes electrons flow. It is like how water pressure makes water flow. Solar cells generate (make) a voltage. Measure how it depends on the amount of light!

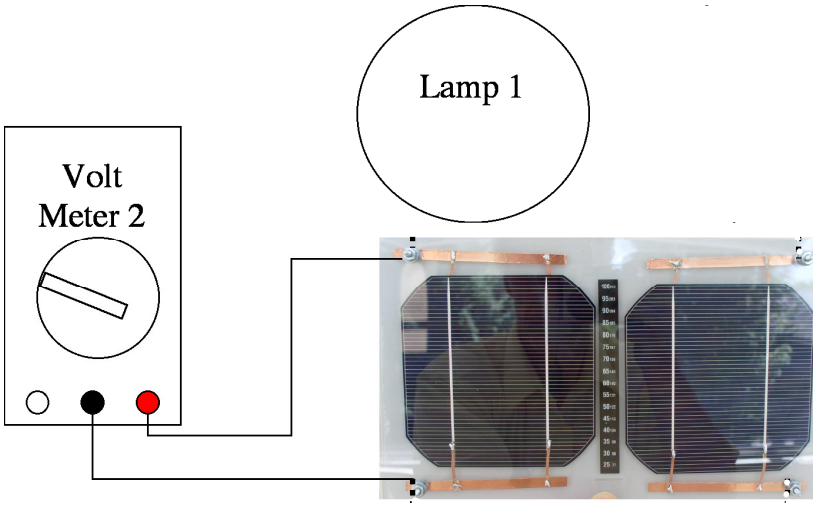


Figure 2: Open circuit voltage measurements One cell.

Voltmeters are connected in parallel with the component you want to measure.

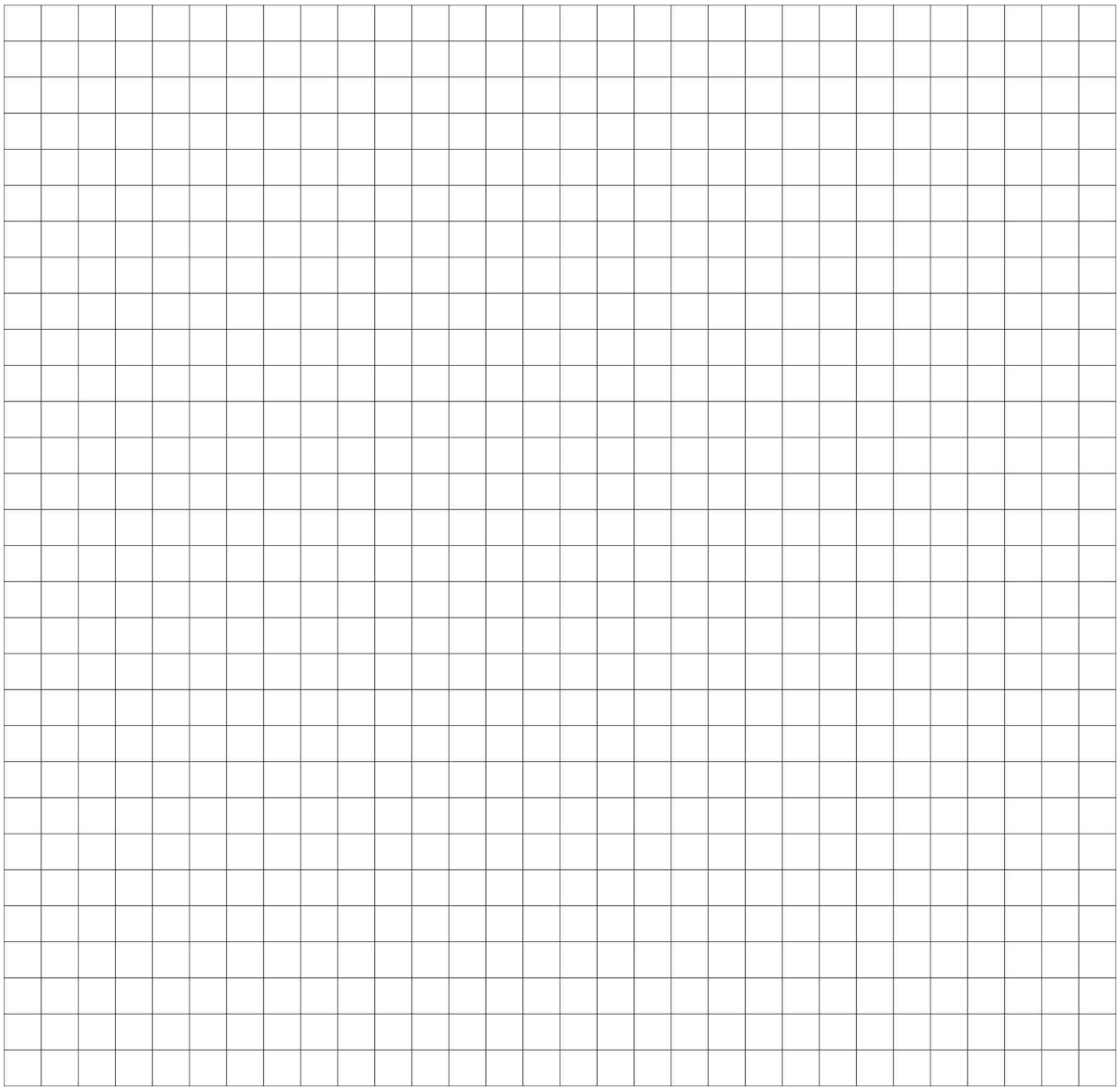
1. Connect one Solar Cell to the meter as shown in Figure 2 above. The red connector is the + output of the cell. The + output connects to the VΩmA input on the meter. The **negative black output** connects to the **COM input** of the meter input of the meter. Set the meter dial to the 2 VDC setting, that is the "2" setting on the left side of the dial. Place the desk lamp close to the PV cell, the same initial distance as in Part I and measure the actual distance between the bulb and the cell and the open circuit voltage measured by the meter. Record these measurements in Table 2. (If your voltage reading is zero check your connections and meter settings or call over an instructor for assistance.)
2. Vary the distance of the lamp to the cell by placing the lamp on blocks or books. Each time, record the distance between the lamp and the bulb and the output voltage in Table 2.

Table 2: Voltage and Distance

Distance between bulb and PV Module (cm)	Voltage

Does the Open Circuit Voltage change? Graph your results.

Graph Paper: Use to Graph your RESULTS



Don't forget to label your axes with number and units (axes are the sides of the graph that tell you what is on the graph).

Wrap-Up:

In this activity you have observed **current (amps) and voltage (volts)** caused by the photovoltaic effect:

(1) The voltage output of the cell is the energy the electrons get from the light hitting the solar cell. When more light hits the cell, more voltage is generated.

(2) The short circuit current is the maximum number of electrons that can flow each second from the cell. The number of electrons available IS DEPENDENT on the intensity or brightness of the light. This is because each electron that flows is the result of one ***photon*** of light. More intense light has more photons!

(3) The shape of the Current vs. Distance graph is a result of how light intensity from a point source diminishes over distance. The current should fall as a $1/r^2$ relation, because the number of photons striking the surface would decrease as a $1/r^2$ relation, like the surface area of a sphere of radius r. You may not see this exact relation here because we are not dealing with a perfect point light source.

Discussion: Write down your comments and what you learned or questions you have after completing Parts I and II.