Engineering 103:
Solar Powered Cell Phone Case

Group 13: Jonathan Palko, Sameer Parihar, Eno Shira, Wenhan Tan

Advisor: Richard Knight
Fellow: Gabriel Burks

Table of Contents

Key Aspects of the Project

- Novel Solution
  - Using solar power to charge phones
  - Completely renewable
- Convenience
  - No need to find an outlet
 - Able to charge during the daytime

Design Objectives

- Create a solar cell system that rates approx. 5 V and 0.5 A
  - Aim is to match charging time of desktop/laptop computer
  - 2.5 Watt power
- The solar cell system powers a 2500 mAh battery that charges phone through USB

Timeline

| Task	1	2	3	4	5	6	7	8	9	10
Background Research	X	X	X	X						
Ordering Parts			X	X	X					
Construction of Phone Case				X	X	X	X			
Testing/Data Collection						X	X			
Additional Testing / Prototype Remodeling							X	X		
Final Report Preparation								X	X	X

4

How Does a Solar Panel Work?

- Photovoltaic
    - Electrons become excited when they absorb light
    - Conversion of light energy into electric energy
    - Closely related to the photoelectric effect
- Output
    - Generates direct current (DC)
    - No need for filtration
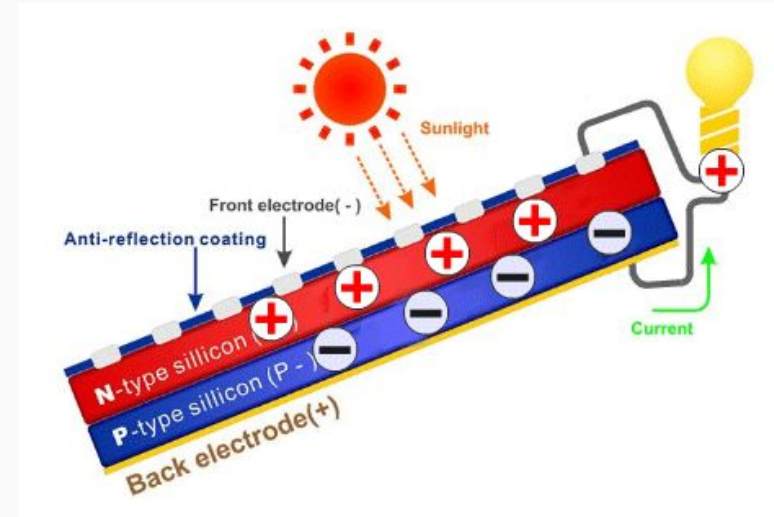
SolarEnergyFactsBlog, photovoltaic effect [GIF Image]. Retrieved from: http://solarenergyfactsblog.com/photovoltaic-effect/

Gil Knier. "How do Photovoltaics Work?". Science.nasa.gov. [Online]. Available: https://science.nasa.gov/science-news/science-at-nasa/2002/solarcells

5
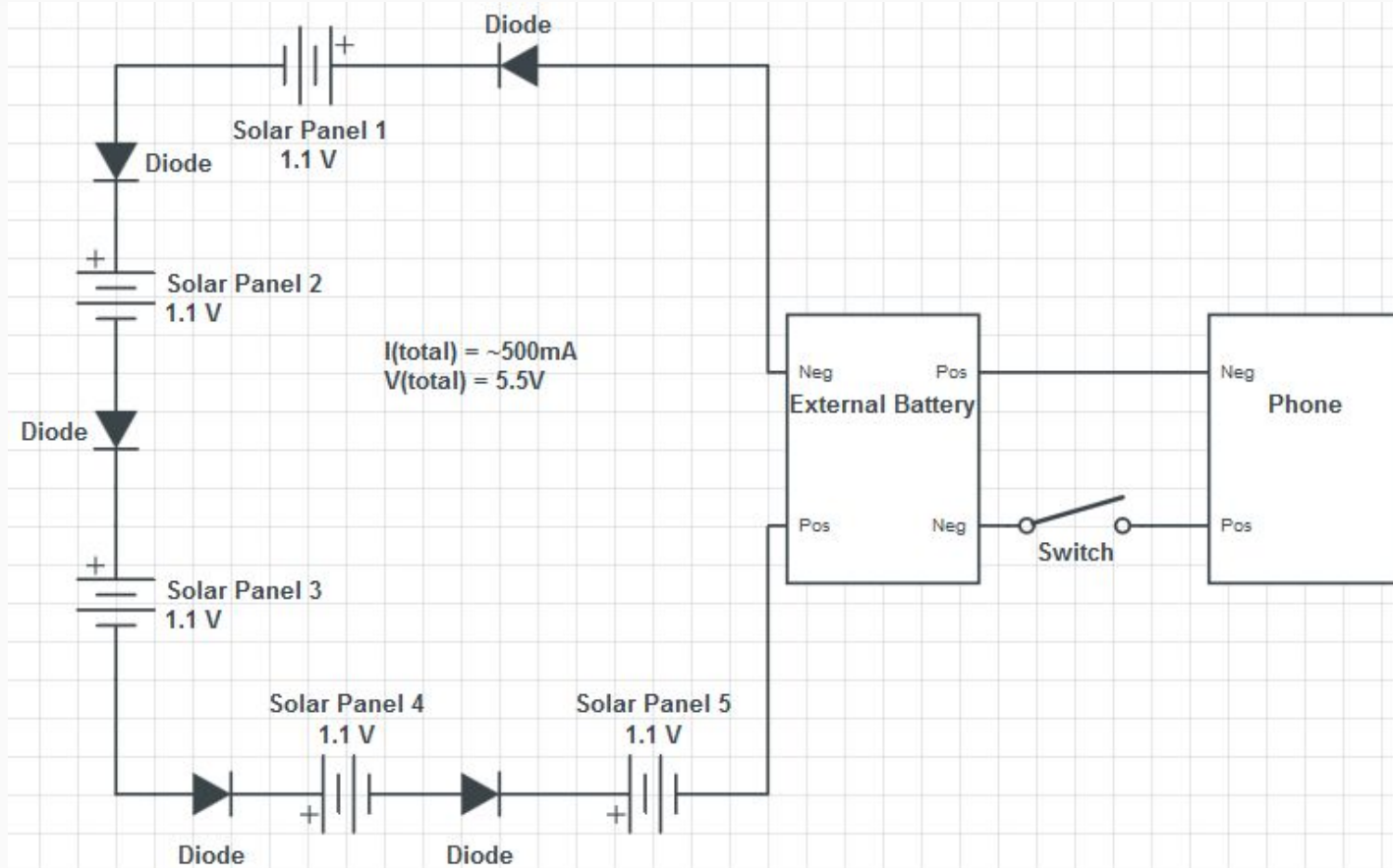
Pertinent Equations

DC Series Circuit Analysis

- Total potential difference across a series circuit is additive
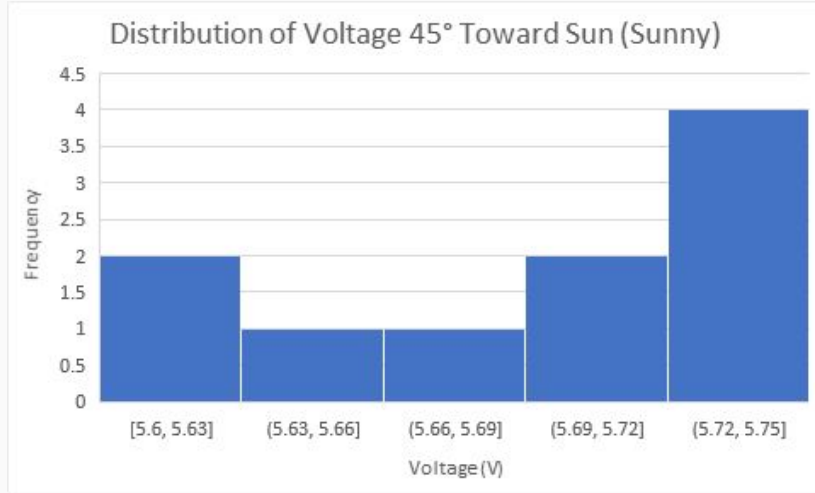- Current across a series circuit is constant

$$V_{total} = V_1 + V_2 + V_3 + \dots$$

$$I_{total} = I_1 = I_2 = I_3 \dots$$

H. Young, R. Freedman and A. Ford, *University Physics with Modern Physics*, 14th ed. Pearson Education, Inc., 2016, p. 849-850.

Technical Specifications

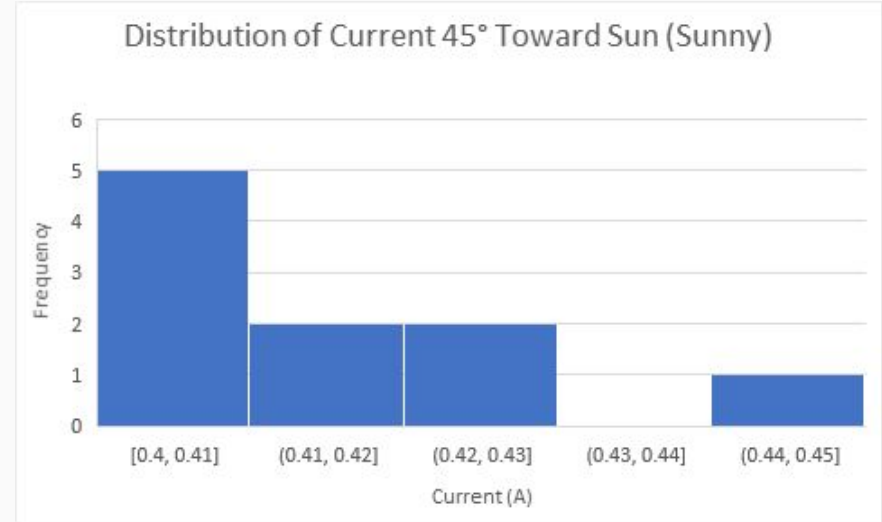|	
Solar Panels (5)	Output: 1.1V/0.5A
Battery (1)	Capacity: 3.7V/2500mAh Input: DC 5V/1A Output: DC 5V/1A
Phone Case (1)	Dimensions:

Experimental Data
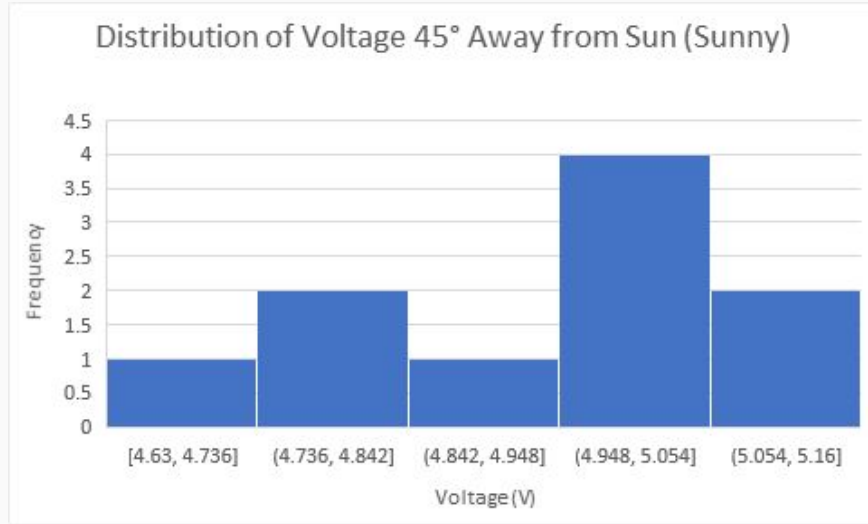

Mean: 5.70

Standard Deviation: 0.0534

95% CI: 5.66 - 5.73

Mean: 0.417

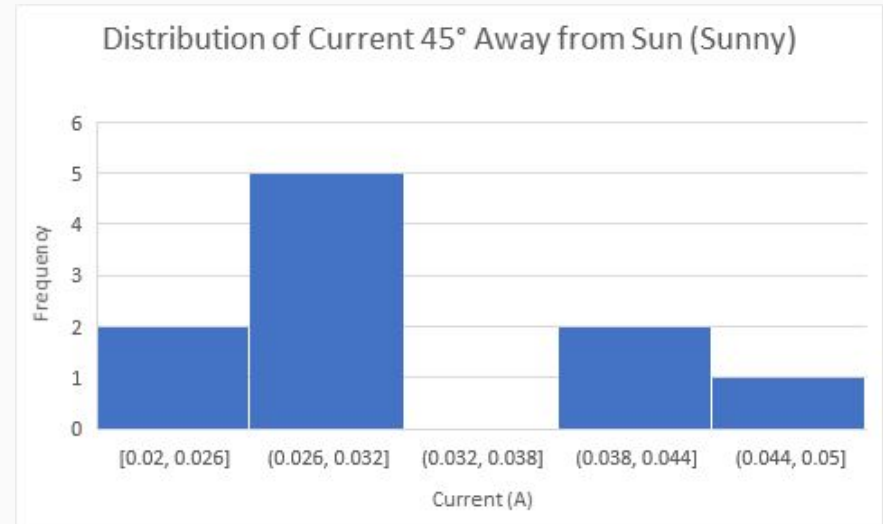Standard Deviation: 0.0163

95% CI: 0.407 - 0.427

Experimental Data (Cont.)

Distribution of Voltage 45° Away from Sun (Sunny)

Mean: 4.94

Standard Deviation: 0.173

95% CI: 4.83 - 5.05

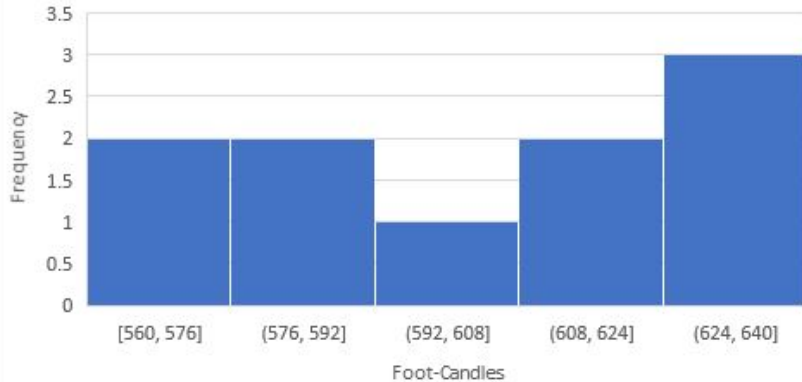Distribution of Current 45° Away from Sun (Sunny)

Mean: 0.0320

Standard Deviation: 0.009

95% CI: 0.0263 - 0.0377

Experimental Data (Cont.)

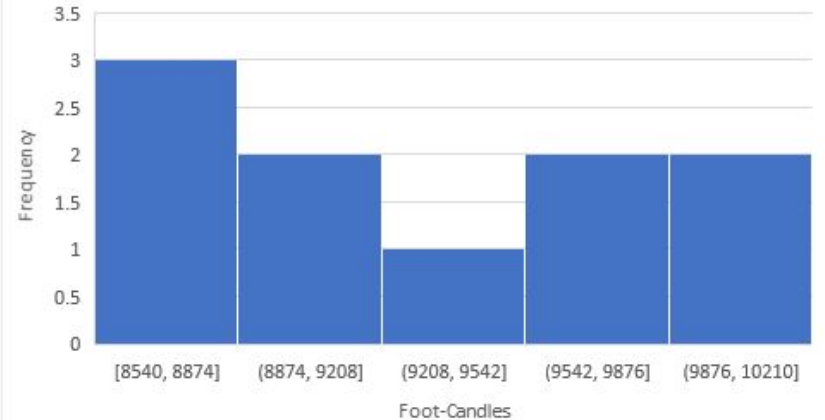

Distribution of Light Intensity 45° Away from Sun (Sunny)

Distribution of Light Intensity 45° Toward Sun (Sunny)

Mean: 602

Standard Deviation: 28.2

95% CI: 584 - 619

Mean: 9260

Standard Deviation: 579

95% CI: 8900 - 9620

Experimental Data - Cloudy Weather (10 Trials)

45 Degrees Away from Sun

Voltage:
     Mean: 3.24 V
     Standard Deviation: 0.023
     95% CI: 3.22 - 3.25

Current:
     Mean: 53.35 mA
     Standard Deviation: 4.68
     95% CI: 50.5 - 56.2

Light Intensity:
     Mean: 768 foot-candles
     Standard Deviation: 30.5
     95% CI: 749 - 787

45 Degrees Toward Sun

Voltage:
     Mean: 3.27 V
     Standard Deviation: 0.0150
     95% CI: 3.26 - 3.28

Current:
     Mean: 60.9 mA
     Standard Deviation: 3.47
     95% CI: 58.7 - 63.0

Light Intensity:
     Mean: 863 foot-candles
     Standard Deviation: 40.0
     95% CI: 838 - 888

Observations

- The voltage recorded stays relatively constant with a change of angle unless facing away from sun
  - The current varies drastically
- The voltage and current during a cloudy day does not change much with a change in angle
  - Light Intensity does not vary as much during a cloudy day
- Light intensity and current are in direct relationship

Sources of Error for Experimental Data

- Varied cloud cover during the testing period
  - Deviation from Gaussian curve
- Angle measurement is just an estimation
  - Changes in angle position per repetition
  - Sun position changes
- Connectivity issues with the multimeter
  - Wires connected to different parts of the test leads
- Connectivity issues are possibly systematic error: impossible to know for sure

Budget

Category	Actual Cost
Solar Panels:	$11.95 (x5 Panels)
Electrical Components: - USB Cable - Heat Sink	$9.64 - $4.99 - $4.65
Battery:	$11.99
Total	**$81.38**

Problems During Building Process

1. Failure of 3D printing the phone case
2. Problems with wire connection to USB
3. Soldering issues
4. CAD design troubles

Team Member Responsibilities

Jonathan Palko

- Circuitry, Soldering and Prototyping

Sameer Parihar

- Circuitry, Soldering and Prototyping

Eno Shira

- Data Collection/Analysis and Graphing

Wenhan Tan

- Assisted in Theory and 3D printing

17

Questions?