



**ACTIVITY CONTENTS:**

**Solar Cell**

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## Solar Cell Introduction

**Discovery Question:** Does the solar energy that reaches the earth vary with weather conditions?

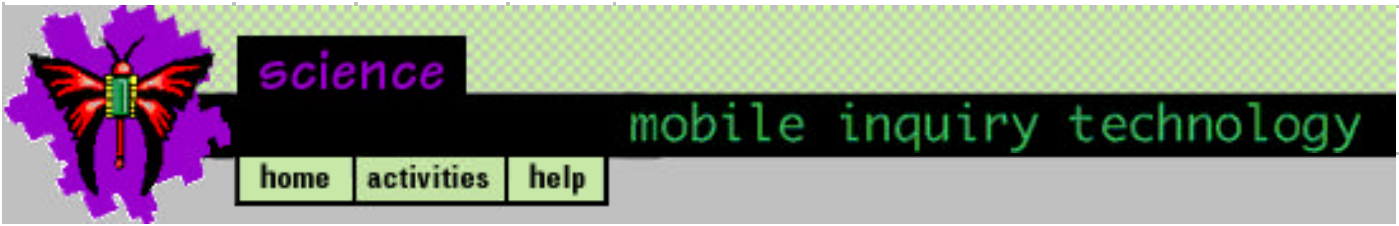


This activity enables you to investigate the changes in the amount of sunlight at ground level with a solar cell.

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## Solar Cell Thinking About the Problem

### Does the solar energy that reaches the earth vary with weather conditions?

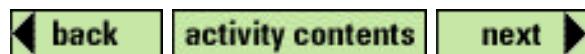
You know that electricity is used in many different ways in our lives. Electric power plants send electricity to homes, schools, and factories. These plants are expensive to run and frequently cause pollution. We run other devices with batteries or electric cells. As you know these eventually run out of power and we throw them away...more garbage and more expense. Many people have proposed using the energy from the sun to run electrical devices. It might be a never-ending source of electricity.

A nifty device developed to capture the energy from the sun is a solar cell. In fact, a solar cell can convert the energy from the sun into very small amounts of electrical energy. But will it work well under all weather and climate conditions? By using a solar cell and a multimeter you can investigate whether the changing conditions of the atmosphere over a given period of time affect the power of a solar cell.

Have you ever experienced a day when it starts out sunny, is overcast for most of the afternoon, and then ends with a clear sky? Do you remember days when it started out warm and then turned cold? These are known as weather conditions. "Weather" refers to the atmospheric conditions in a specific place at a specific time. As weather conditions change, does the amount of solar rays reaching the earth change?

A solar cell is usually made of silicon. When the energy of the sun hits the surface of the solar cell it creates an energy flow from the solar cell to power devices like solar calculators. In this activity you will use a multimeter to measure the amount of energy from the sun captured by the solar cell.

Discuss with your group members how you would set up an investigation to find out if the weather conditions affect the output of a solar cell. Think carefully about what you want to measure, how often you want to take the measurement, and how you will record your data. Be prepared to present and explain your plan to the class and answer questions.





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## Solar Cell Materials

- multimeter
- silicon solar cell with soldered leads (Radio Shack Cat. No. 277-1201)
- 2 ohm resistor
- masking tape
- thermometer for outside air temperature

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## Solar Cell Safety

- Be careful not to cross the wires while testing the solar cell.
- **Never** look directly at the sun.

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## Solar Cell Investigation I

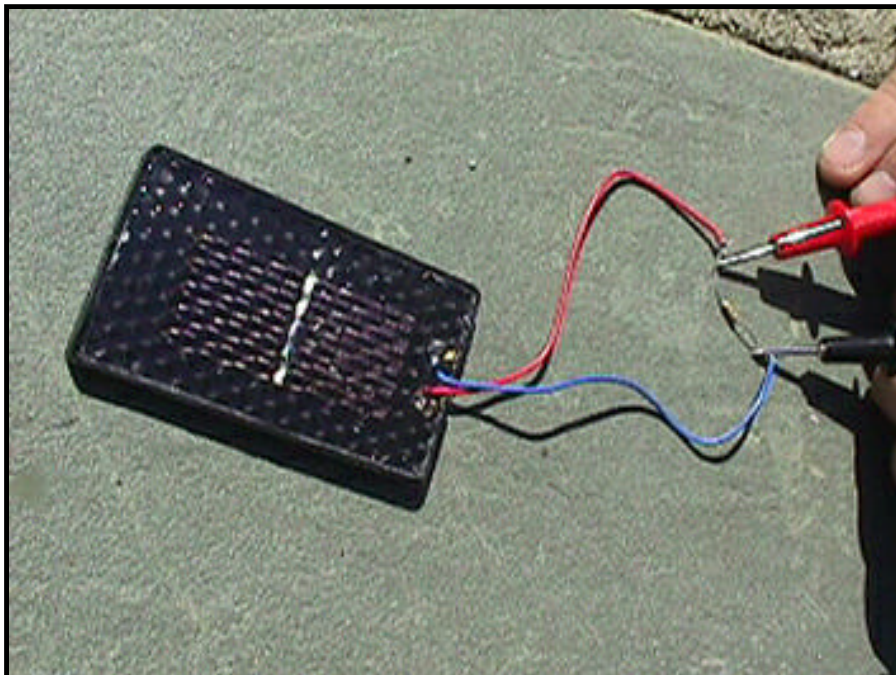
### First Day of Solar Readings

#### Making predictions

1. Before you set up the multimeter and solar cell, observe the weather conditions that you think might affect the amount of voltage produced by your solar cell.
2. Based on those observations, make a prediction about whether the solar readings will change over a 20-minute period.
3. Record your predictions using the word processor. Refer to [Technical Hints](#) to see how to use a word processor.

#### Collecting data

1. Before you go outside, create a spreadsheet to record your observations. Refer to [Technical Hints](#) to see how to create a spreadsheet.
2. Once outside, two students from each group should attach the multimeter to the lead wires on the solar cell across a resistor as shown. You may need to use masking tape to make sure the connections are secure.



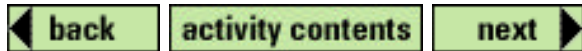
3. On your spreadsheet make the following recordings:
  - Use the multimeter Program to record the voltage every two minutes for 20

minutes. Refer to [Technical Hints](#) to see how to use CC DMM program.

- At the same time you take a voltage reading, record the air temperature near the solar cell.
- At the same time you take a voltage reading, record the cloud cover. Make an estimate of how much of the sun is covered by clouds: no clouds/ full sun, 3/4 sun, 1/2-sun, 1/4, full cloud cover. Remember that you should **not** stare directly into the sun. It can cause damage to your eyes!

### Creating a graph

1. Once back inside, transfer your voltage readings into a spreadsheet. Refer to [Technical Hints](#) to see how to transfer collected data to a spreadsheet.
2. Make an x-y line graph of the voltage readings. Refer to [Technical Hints](#) to see how to make an x-y line graph.
3. Answer Questions 1- 5 in "Analysis".



## Solar Cell Investigation II

### Second Day of Solar Readings

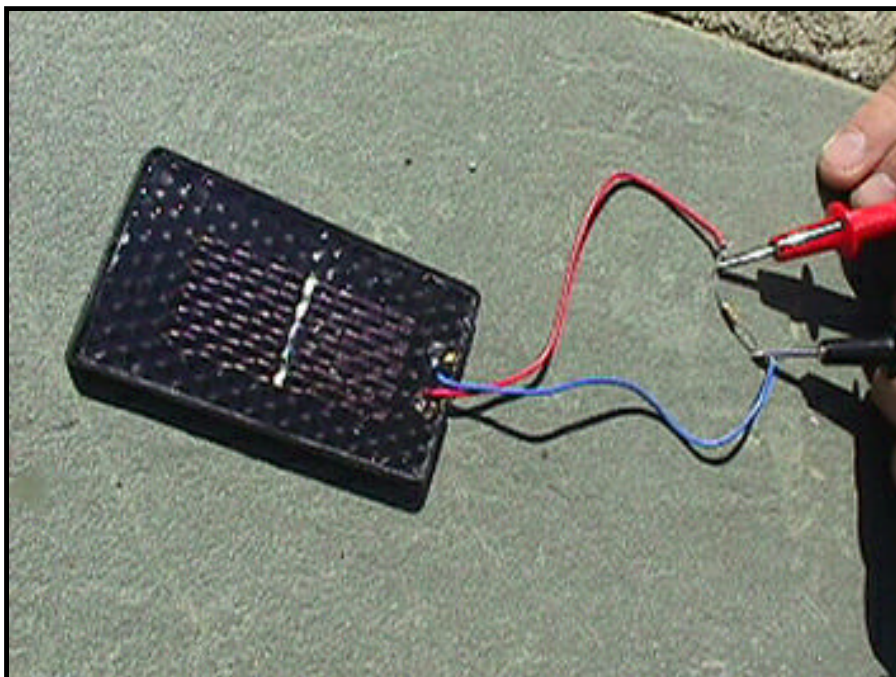
You will conduct the same investigation today. Are the cloud conditions the same or different? Repeat the same experiment that you did before. Remember, if it is going to be a fair test you must do it exactly at the same time as the first day.

#### Making predictions

1. Predict the change in solar readings during 20-minute period.
2. Record your predictions along with the weather conditions in the word processor. Refer to [Technical Hints](#) to see how to use the Word Processor.

#### Collecting data

1. Before you go outside, create a spreadsheet to record your observations. Refer to [Technical Hints](#) to see how to create a spreadsheet.
2. Once outside, two students from each group should attach the multimeter to the lead wires on the solar cell across a resistor as shown. You may need to use masking tape to make sure the connections are secure.



3. On your spreadsheet make the following recordings:
  - Use the multimeter Program to record the voltage every two minutes for 20

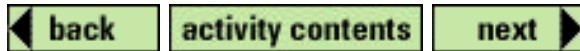


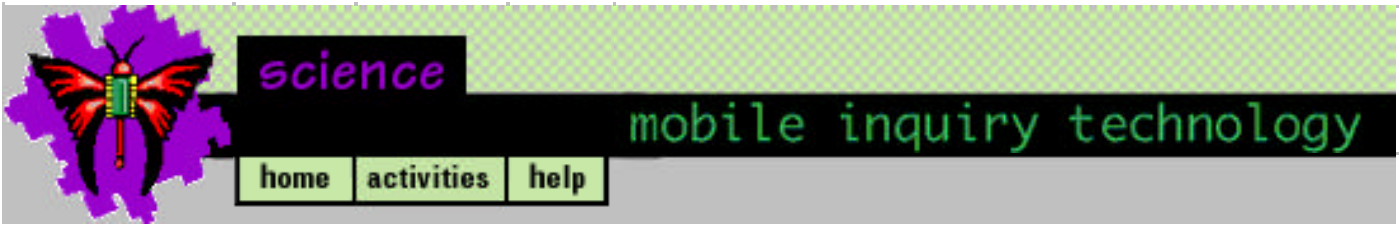
minutes. Refer to [Technical Hints](#) to see how to use CC DMM program.

- At the same time you take a voltage reading, record the air temperature near the solar cell.
- At the same time you take a voltage reading, record the cloud cover. Make an estimate of how much of the sun is covered by clouds: no clouds/ full sun, 3/4 sun, 1/2-sun, 1/4, full cloud cover. Remember that you should not stare directly into the sun. It can cause damage to your eyes!

### Creating a graph

1. Transfer your voltage readings into a spreadsheet. Refer to [Technical Hints](#) to see how to use to transfer collected data to a spreadsheet.
2. Make an x-y line graph of the voltage readings. Refer to [Technical Hints](#) to see how to make an x-y line graph.
3. Answer Question 6 in "Analysis".





## Solar Cell Technical Hints

- Using a word processor
- Creating a spreadsheet
- Using the multimeter (CC DMM) program
- Transferring collected data to a spreadsheet
- Making an x-y line graph

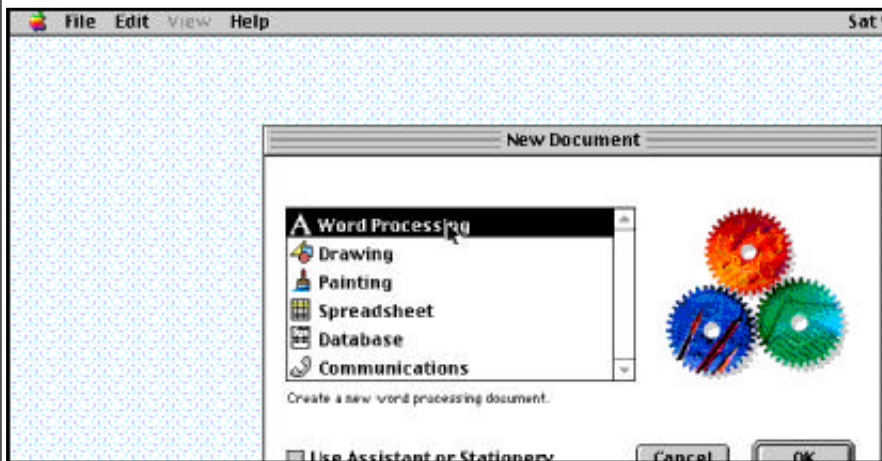




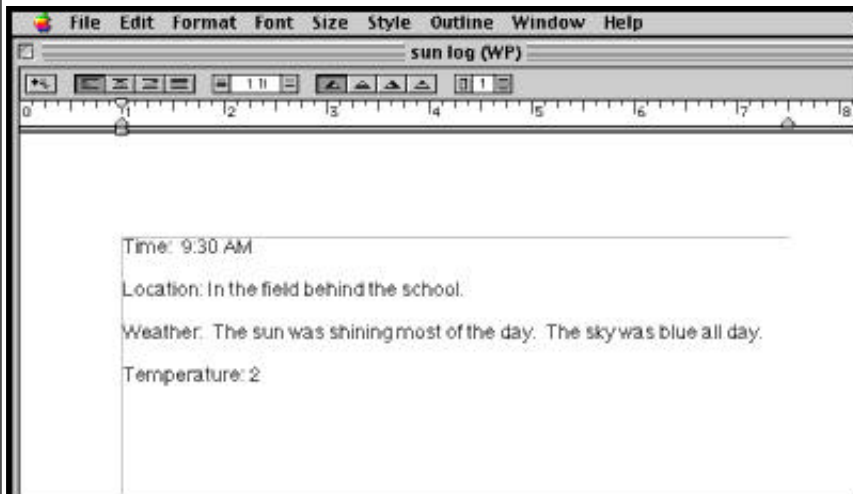
## mobile inquiry technology Solar Cell Technical Hints

### To open the word processor:

Open ClarisWorks word processor by double clicking on the ClarisWork icon and selecting Word Processing.



Write into the document that opens. To change the font, style or size of the words, highlight the text that you wish to change and select from the menus at the top of the screen.

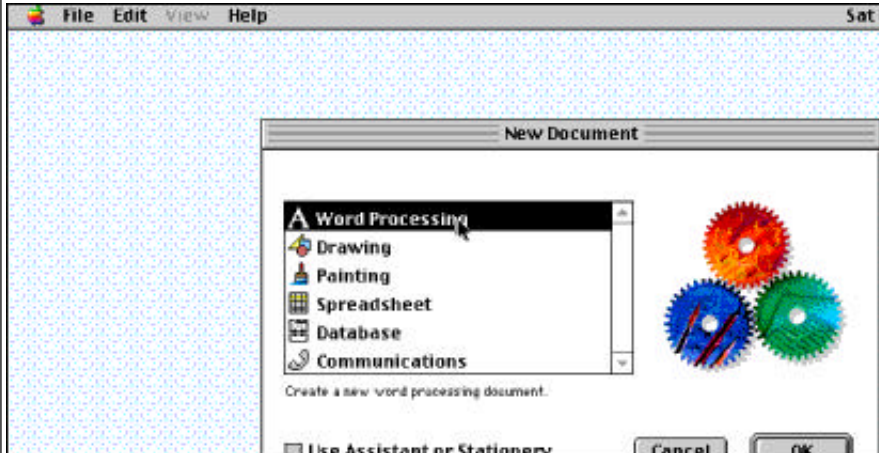




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### To create a spreadsheet:

1. Select the spreadsheet option in ClarisWorks.



2. You will be taking voltage measurements for 20 minutes or 1,200 seconds. Every two minutes or 120 seconds you will record cloud cover and air temperature. Create a spreadsheet that starts at 0 seconds and covers 1,200 seconds.
3. Title Column A as time, Column B as voltage, Column C as cloud cover, and Column D as air temperature.

	A	B	C	D	E	F
1	Time (sec)	Voltage	Cloud Cover			
2	0					
3	10					
4	20					
5	30					
6	40					
7	50					
8	60					
9	70					
10	80					
11	90					
12	100					
13	110					

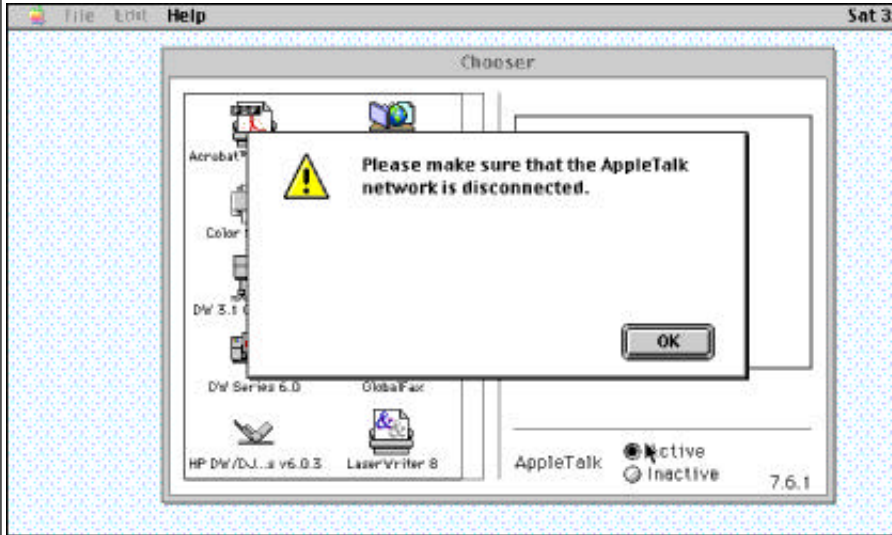
4. Increase the width of the last two columns so that you have space to write by clicking on the top the column divider and sliding it to the appropriate size.

**CLOSE**

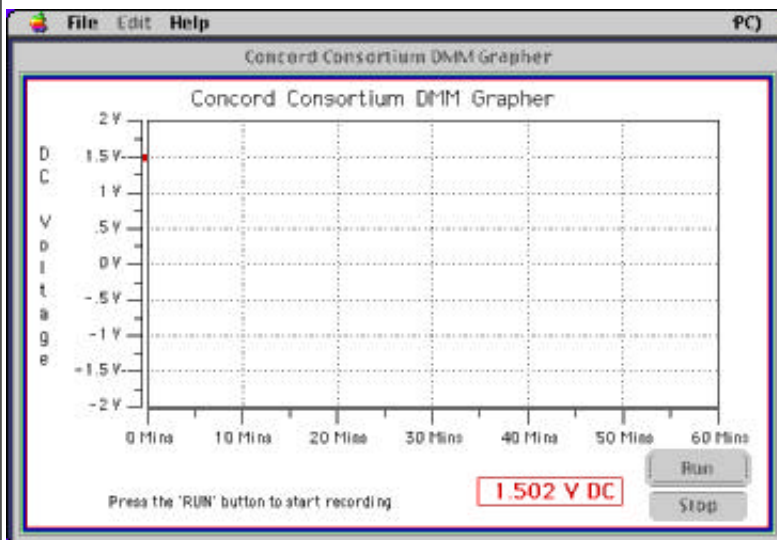


### To use the multimeter (CC DMM) program:

1. Open the Chooser from under the Apple menu. Make sure AppleTalk is inactive.



2. Before opening the software, attach the serial cord to the serial port at the back of the computer.
3. Set the knob on the multimeter to the 2 V (in yellow region) scale.
4. Turn on the multimeter.
5. Open the Concord Consortium Digital MultiMeter (CC DMM) program on the desktop by double clicking on it's icon. Select 60 minute from the Collection Time. You will need to stop the program at 20 minutes. The multimeter will automatically collect data every 10 seconds.

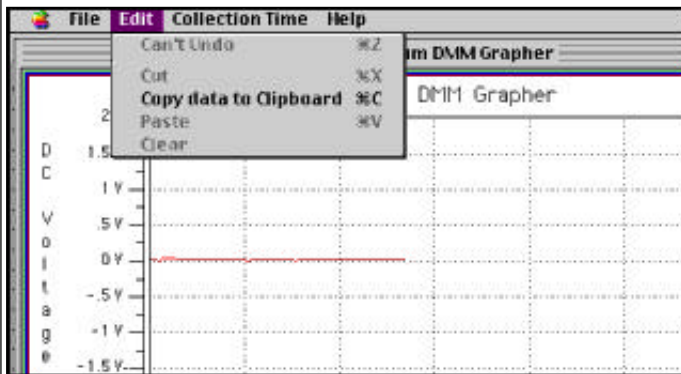




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**Solar Cell Technical Hints**

**To transfer collected data from the CC DMM program to a spreadsheet:**

1. To transfer data from the CC DMM, end the collection at 30 minutes by clicking on the Stop button. Select Copy data to Clipboard from the Edit menu.
2. Open your spreadsheet and select a place away from your titled columns. Choose Paste from the Edit menu. The data automatically transferred is more than is needed for this activity. Highlight just the time and voltage data and select Copy from the Edit menu. Click in Cell A1. Choose Paste from the Edit menu. Highlight the original transfer and press delete on your keyboard.





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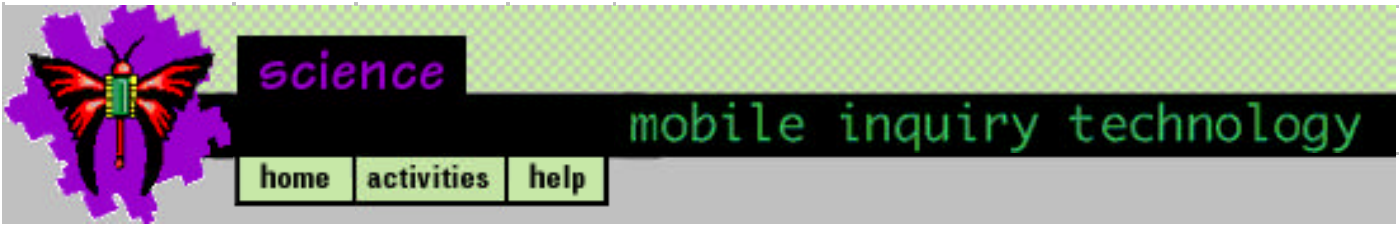
### To make an x-y line graph line graph:

1. Highlight your data in Column A and Column B starting with Cell A1.
2. Select Make Chart from the Options menu. Click on x-y Line graph. If you want to title the graph, double click on the chart and select the Label button. Type D-cell Voltage Over Time.

File Edit Format Calculate Options View Help				
Sunlog (SS)				
A1	Time (sec)			
A	B	C	D	E
1	Time (sec)	Voltage	Cloud Cover	Air Temperature
2	0	0.03		
3	10	0.03		
4	20	0.036		
5	30	0.03		
6	40	0.023		
7	50	0		
8	60	0.001		
9	70	0		
10	80	0.041		
11	90	0.041		
12	100	0.041		
13	110	0.041		
14	120	0.04		
15	130	0.04		
16	140	0.04		

3. To change from x marks the spot to solid circles, double click on the graph and select series. Choose the solid circle.

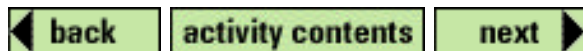
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## Solar Cell Analysis

Use your observation chart and your graph to answer the questions below on paper. Be prepared to present your answers to the class.

1. First discuss your observations with your partners. Then, write a paragraph about any changes you notice in voltage readings during your recording period? (Include details about trends or patterns in the data, the range of the voltage data, the highest and lowest readings, and the mean (average) voltage reading.)
2. After a discussion in your group, write a paragraph comparing your data on cloud cover with your data on voltage over the period of your observations. Make sure to consider how your voltage readings changed when the cloud cover changed.
3. Do you think that cloud cover affects the amount of electricity that a solar cell produces? What evidence do you have to support your ideas?
4. Look at your temperature data. Do you notice any changes in temperature when there were also changes in voltage? Do you think changes in temperature and voltage are related? Why do you think so?
5. Do you think solar cells would be a good source of electrical energy? Why do you think so?
6. Now that you have repeated the investigation a second time, compare your data with that of your classmates. Have you discovered or noticed anything new?  
Reread your answers to questions 1-6. Revise your answers based on your new observations and the discussion you have had in class.







## Solar Cell Further Investigation

- Take solar readings throughout a day. Make a bar chart of your solar day on the computer. How does the angle and position of the sun change your solar readings?
- How does the sunlight that reaches ground level vary during different seasons?

