Activity P32: Variation of Light Intensity (Light Sensor)

<table>
<thead>
<tr>
<th>Concept</th>
<th>DataStudio</th>
<th>ScienceWorkshop (Mac)</th>
<th>ScienceWorkshop (Win)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminance</td>
<td>P32 Vary Light.DS</td>
<td>P54 Light Bulb Intensity</td>
<td>P54_BULB.SWS</td>
</tr>
</tbody>
</table>

**Equipment Needed**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Light Sensor (CI-6504A)</td>
<td>1</td>
<td>Fluorescent light source (AC)</td>
<td>1</td>
</tr>
<tr>
<td>Flashlight (or other DC light source)</td>
<td>1</td>
<td>Incandescent light source (AC)</td>
<td>1</td>
</tr>
</tbody>
</table>

**What Do You Think?**

The purpose of this activity is to compare the variation in intensity of light from light sources. How does the light from a DC light source compare to light from an AC light source? How does the light from a fluorescent tube compare to the light from an incandescent bulb?

*Take time to answer the ‘What Do You Think?’ question(s) in the Lab Report section.*

**Background**

Electric light bulbs are powered by a voltage of 60 Hz (or 50 Hz in some countries) sinusoidal wave. The maximum amplitude of the voltage, and thus a maximum brightness, occurs twice per cycle because an electric bulb is excited when the voltage increases, regardless of the polarity of the voltage. An electric bulb will have maximum intensity 120 times per second (or 100 times/second). It will also have minimum intensity 120 times per second (or 100 times/second).

Fluorescent lights blink on and off at a particular frequency. The light intensity from incandescent bulbs powered by AC fluctuates as well. The light intensity from an incandescent bulb powered by DC should not vary.

**SAFETY REMINDERS**

- Follow directions for using the equipment.

**For You To Do**

In this activity, use the Light Sensor to measure the intensity of light from light bulbs powered by AC or DC. There are three parts to the activity: Part A = Fluorescent bulb, AC; Part B = Incandescent bulb, AC; and Part C = Incandescent bulb, DC.

Use DataStudio or ScienceWorkshop to monitor and display the variations, if any, in the light intensity. Compare the light intensity of fluorescent and incandescent lights powered by AC, and an incandescent light powered by DC.
PART I: Computer Setup

1. Connect the ScienceWorkshop interface to the computer, turn on the interface, and turn on the computer.

2. Connect the Light Sensor cable into Analog Channel A on the interface. Connect the Light Sensor to the cable.

3. Open the document titled as shown:

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- The DataStudio document has a Workbook display. Read the instructions in the Workbook.
- The ScienceWorkshop document opens with a Scope display of voltage from the Light Sensor in Channel A and a Frequency Spectrum (FFT) display for the same sensor. It also has a Digits display for the voltage from the Light Sensor.
- The data measurement is set at 5000 Hz (set by the Sweep Speed control in the Scope display). The Frequency Spectrum (FFT) is set to 256 data points.

PART II: Sensor Calibration & Equipment Setup

- You do not need to calibrate the Light Sensor. However, you may need to adjust the sensitivity of the sensor, depending on the brightness of the light source and how close the sensor is to the source.

Adjusting Light Sensor Sensitivity

- The Light Sensor has a GAIN switch on the top of the sensor box. The GAIN switch selects the amount of amplification for the signal that is sent to the interface. The settings are 1, 10, and 100. The setting of 10 amplifies the signal ten times and the setting of 100 amplifies the signal one hundred times.

Try the following to become more familiar with the Light Sensor:

- Place the Light Sensor on a table so the port on the sensor is below an overhead light. Set the GAIN switch to 1.
- Start monitoring data. Move the Digits display of Input Volts so you can see it clearly.
- Switch the GAIN to 10 and observe the value of Input Volts in the Digits display. Then switch to 100 and observe the value of Input Volts.

NOTE: The maximum voltage from the sensor is 4.9 V for any GAIN setting.

- Cover the Light Sensor port and observe the value of Input Volts.
- Return the GAIN setting to 10. Pick up the sensor. Observe the value of Input Volts as you move the Light Sensor closer to the overhead light source. Observe what happens when you move the Light Sensor farther from the light source.
- Click STOP to stop monitoring data.
Equipment Setup

1. Place the Light Sensor within a few feet of a fluorescent bulb that is powered by AC.
2. Turn on the fluorescent bulb.

PART IIIA: Data Recording – Fluorescent Bulb, AC

1. Start monitoring data. (Hint: In DataStudio, click the ‘Start’ button. In ScienceWorkshop, click the ‘MON’ button.) Arrange the Scope display, the Digits display, and the Frequency Spectrum (FFT) so you can see them clearly.

• NOTE: It is likely that you will see a value in the Digits display, and a spectrum in the Frequency Spectrum display, but nothing in the Scope display. This is because the trigger control in the Scope is on, and the trigger level may be set too low for the voltage produced by the Light Sensor.

2. Adjust the Scope display until you see the trace of voltage from the Light Sensor:
   • First, adjust the trigger level.

   In DataStudio, move the small triangle (the ‘Trigger Level’ pointer) on the left side of the display up or down to the desired voltage level. In ScienceWorkshop, click in the space along the left edge of the Scope display that is above the Trigger Level pointer. When you click above or below the Trigger Level Pointer, it “jumps” to the spot you clicked. The value in the Digits display will indicate the approximate trigger level you need.
Second, adjust the vertical position of the trace of voltage.

In DataStudio, click the up or down arrows next to ‘Offset’. In ScienceWorkshop, click the ‘UP/DOWN Arrows’ in the right side of the Scope display.

Finally, adjust the Sensitivity (volts per division) if needed.

In DataStudio, click the arrows to increase or decrease the sensitivity. In ScienceWorkshop, click the Vertical Scale buttons in the right side of the Scope display.
3. Use the Frequency Spectrum to measure the frequency of the signal from the Light Sensor. Record the value of the frequency in the Lab Report section.
   - Make the FFT display (Frequency Spectrum) active. In DataStudio, click the ‘Smart Tool’ button. In ScienceWorkshop, click the ‘Smart Cursor’ button. Move the cursor/cross-hair to the top of the first peak in the display area. In DataStudio, the frequency is the first number in the ordered pair. In ScienceWorkshop, the frequency is shown below the horizontal axis.

4. Click the STOP button to stop monitoring data.
5. Save the trace that is displayed on the Scope. Click the Scope to make it active.
   - In DataStudio, click the ‘Transfer’ button ( ). The data in the Scope is automatically added to the data list.
   - In ScienceWorkshop, click the ‘Data Snapshot’ button ( ) in the right side of the Scope display. The Data Cache Information window will open. Enter appropriate information for the Long Name, Short Name, and Units. Click OK to return to the Scope.
   - The Short Name for the Data Cache will appear in the Data List in the Experiment Setup window. (NOTE: You can display and analyze the Data Cache in any display that can show recorded data such as the Graph, Table, or FFT.)

PART IIIB: Incandescent Light – AC

Repeat the activity using an incandescent light connected to an AC power supply.
PART IIIC: Incandescent Light – DC

Repeat the activity using a battery operated flashlight.
Analyzing the Data

1. Set up a Graph display to show data for the AC fluorescent light, AC incandescent light, and DC incandescent light.

   • Hint: In DataStudio, do the following:
     - Click ‘Add Display…’ from the Experiment menu.
     - Select ‘Graph’ from the ‘Please Choose…’ window. Click ‘OK’.
     - Click and drag ‘Data’ from the Data list to the new Graph display.

   • The Graph automatically rescales to fit the data. Repeat the process for the other runs of data.

   • Hint: In ScienceWorkshop, do the following:
     - Click the Display Menu. Select New Graph from the Display Menu.
     - In the new Graph display, click the Vertical Axis Input Menu button ( ). Select Data Cache, Fluorescent AC from the Input Menu.

     - The Graph will show the data seen in the Scope display for the fluorescent bulb powered by AC.

     - Click the Add Plot Menu button ( ) in the lower left corner of the Graph. Select Data Cache, Incandescent AC from the Add Plot Menu.
• A new plot will be added to the Graph. It will show the data seen in the Scope display for the incandescent bulb powered by AC.

• Click the Add Plot Menu button again. Select Data Cache, Incandescent DC from the Add Plot Menu.

• A third plot will be added to the Graph.
Lab Report - Activity P32: Variation of Light Intensity

What Do You Think?

The purpose of this activity is to compare the variation in intensity of light from light sources. How does the light from a DC light source compare to light from an AC light source? How does the light from a fluorescent tube compare to the light from an incandescent bulb?

Data Table

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorescent, AC</td>
<td></td>
</tr>
<tr>
<td>Incandescent, AC</td>
<td></td>
</tr>
<tr>
<td>Incandescent, DC</td>
<td></td>
</tr>
</tbody>
</table>

Questions

1. How does the frequency of light intensity variation for the fluorescent AC bulb and the incandescent AC bulb compare to the accepted value for AC frequency?

2. How does the fluctuation of an incandescent bulb run on 60 Hz (or 50 Hz) AC differ from the fluorescent bulb?

3. How does the fluctuation of a light bulb run on 60 Hz (or 50 Hz) AC differ from the incandescent bulb powered by DC?