GUTing the Light Sensor From a Distance

Math Concepts

- Measurement
- Manual fitting data to model, use of built-in regressions or other statistical analysis
- Geometry

Materials

- TI-73
- CBL 2™
- Unit-to-unit cable
- Light Sensor
- Motion sensor or CBR wit CBL 2 to CBR cable
- Light source such as MagLite or lamp
- Toy car (optional)
- TI Connect™ with TI Connectivity Cable USB

Overview

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Data Collection

1. The idea of a Grand Unified Theory (GUT) comes in part from the prevalence of the inverse square ($1/R^2$) relationship found in many areas of science.

- One area is the intensity of light, as a function of distance. That is, light intensity drops as the inverse square of the distance from the light source.
- In this investigation we will collect light and distance as we move away from a light source.

2. Using a bright light source, such as a MagLite® that you can focus on the light sensor, or a lamp without a shade, set up the motion and light sensors so that there "eyes" are pointing at the light source.

- It helps to have a box, or some backing to have the sonic signal bounce off of, at the same distance as the light source.
- In addition, we need to have the light regularly impending on the light sensor. We also want to smoothly move the sensors away from the light source, by sliding the sensors along the floor, or strapping them to a small car, that rolls easily on the surface.

- Secure the light and motion sensors to insure they are both the same distance from the light source. Make sure that you start at least 50 centimeters away from the light source and that other lights are either turned off or away from the light sensor, so they would add to the intensity readings.

3. Plug the sensors into the CBL 2, with the Light sensor in CH 1, and the Motion Sensor or CBR in the DIG/SONIC port. Connect the TI-73 to the CBL 2 and run the DataMate program.

- If the sensors are not recognized, or if there are residual setting from past experiments, press [CLEAR] on the TI-73 to do this. See Figures 1 to 3.

4. The default settings for the Time Graph might work for your experiment, so select option 2:START from the Main screen if you wish (press [2]), or select option 1:SETUP to change the MODE Time Settings.

- If we decide to start, the experiment begins immediately. Listen and look for the sounds and lights from the CBL 2.
- When the experiment starts, smoothly move the sensors away from the light source in a starting line.
- Once the data collection is over you will have choices to look at different graphs.
- You may wish to select option 2:SELECT REGION from the GRAPH menu if you did not start moving the sensors at the very start of the experiment.
- Point at the graph you would like to view and press [ENTER] or select option 4:MORE.
- See Figures 4 and 5.

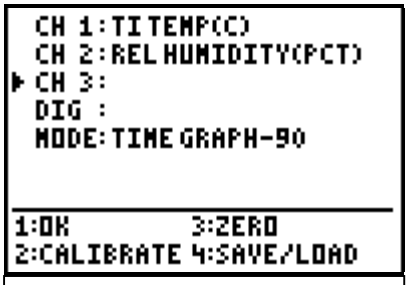


Figure 1

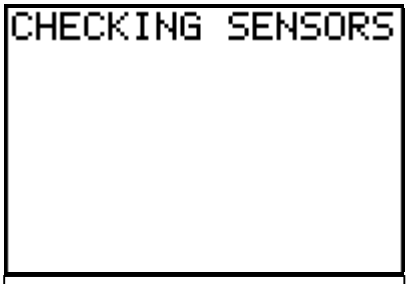


Figure 2

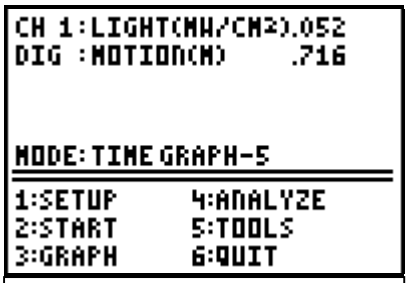


Figure 3

Figure 4

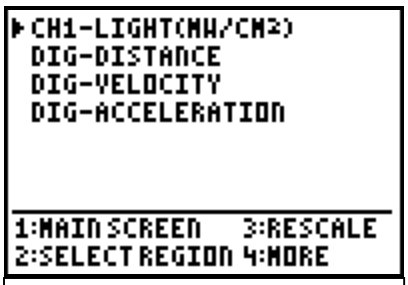


Figure 5

5. If this data is not what you want, either repeat the experiment or modify the Time Settings and then run the experiment.
   - If the data is to your liking save the experiment by selecting the option 4:SAVE/LOAD from the SETUP menu. See Figures 6 and 7.

Analysis

1. Explore the three graphs looking at the Time vs. Light, Time vs. Distance, and then Distance vs. Light.
   - From this last graph, select a model that fits the data.
   - Select option 4:ANALYZE from the Main Screen and the option 2:CURVE FIT from the ANALYZE OPTIONS menu. Press 4 2. See Figures 8 and 9.

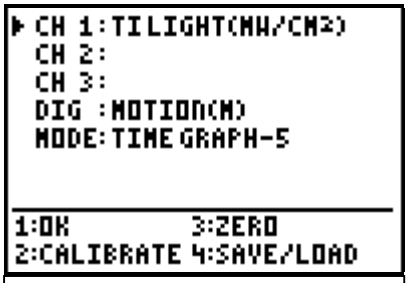


Figure 6

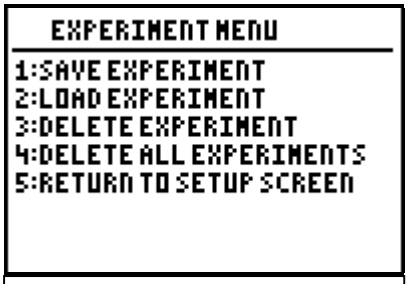


Figure 7

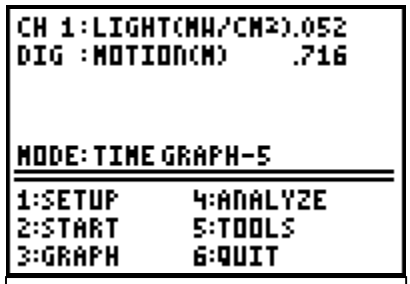


Figure 8

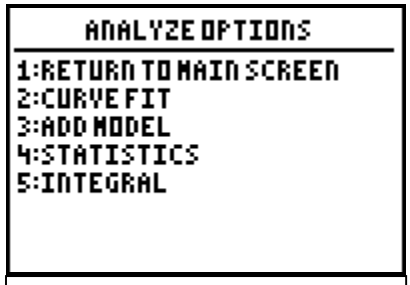


Figure 9

2. Or you may leave the program and set up the plot, with the model Y = A/X in the [Y=] menu. See Figures 10 to 13.

Going Further

1. Use the EVENTS mode to get discrete data points over a distance from the light and motion sensor.
2. This will allow you to determine a better orientation of the sensors with the light source.

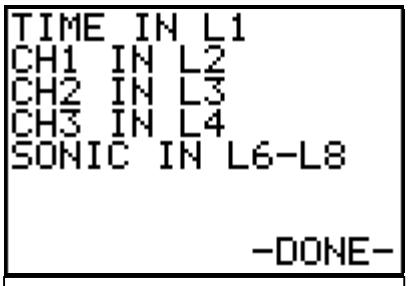


Figure 10

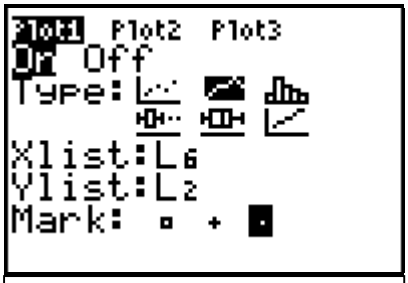


Figure 11

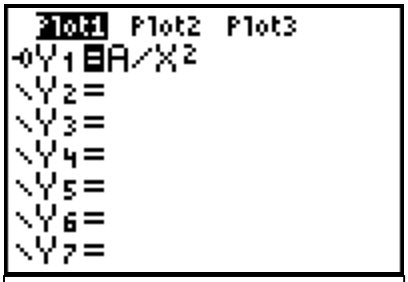


Figure 12

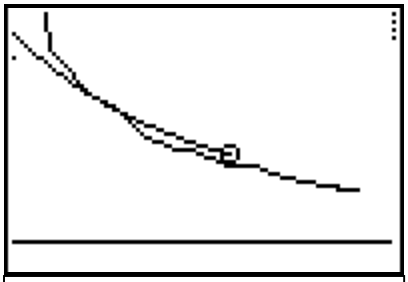
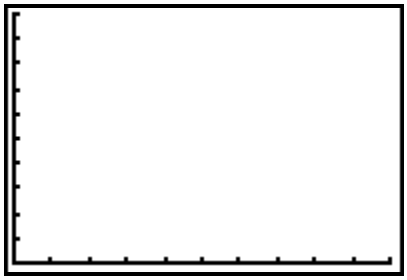
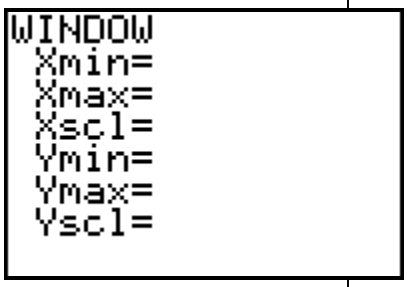


Figure 13

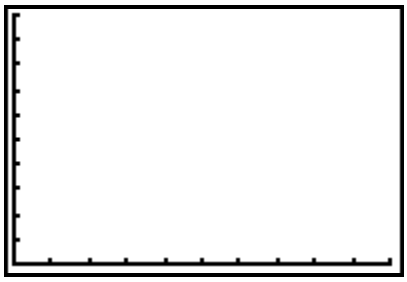
Student Data Reporting Sheet

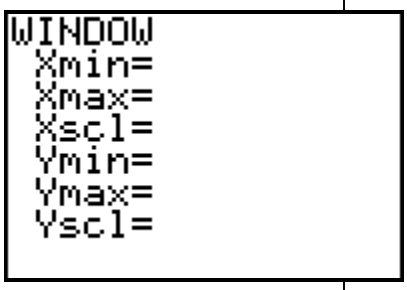
1. Make a sketch of the setup with the position of the sensors relative to the light source clearly marked.
2. Give the settings for your experiment:
   - Time Interval = _____
   - Number of Samples = _____
   - Experiment Length (in appropriate units) = _____
3. Make a sketch of the three graphs generated from the experiment and give the window settings.
   - Time vs. Light (Intensity). Use Figures 14 and 15 to graph your answers.



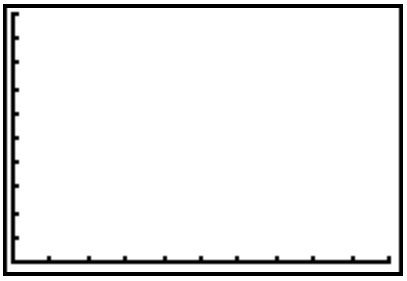


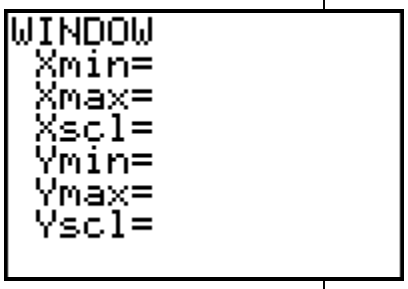
   - Time vs. Motion (Distance). Use Figures 16 and 17 to graph your answers.





c) Distance vs. Intensity. Use Figures 18 and 19 to graph your answers.





4. Give your best-fit equation for the Distance vs. Intensity graph and use it to predict the values in the table below.

- $Y = A/X^2$

Distance (meters)	Intensity (mW/cm^2)
2	
0.25	
4	
	0.77

5. Give the units for the values and variables in the equation from above:

- Y = _____
- X = _____
- A = _____

