TEACHER INFORMATION

Light at a Distance: Distance and Light Intensity

1. There are currently 2 different combinations of equipment that will work for collecting light data. The most common method, which works for both the TI-83 Plus and TI-84 Plus families of calculators, is to use a Light Sensor attached to a CBL 2 or LabPro.

   The TI-84 Plus calculator has a USB port located at the top right corner. Using the USB port, an EasyLink with a Light Sensor can be connected to collect light data. For more information on EasyLink refer to Page *ix* located in the front section of this book.

2. When connecting an EasyLink to a TI-84 Plus calculator using USB, the EasyData application automatically launches when the calculator is turned on and at the home screen.

3. If you obtain readings of more than 600 or 6000 lux (Vernier sensor, depending on setting) or 1 (TI sensor) move farther away from the light source. Students may need to adjust the range of distances used for data collection, depending on the brightness of the light source. Some students may need help with this in Step 8 of the Procedure. Because of the different light sources that could be used in the lab, the optimum range for data collection will vary.

4. Only a true point light source exhibits an inverse-square dependence of intensity on distance. It is very difficult in a classroom to achieve a true point light source with no reflective surfaces nearby. As a result, you and your student should not consider results incorrect if you do not get an exponent of nearly –2 in the power law fit. In fact, it is unlikely you will obtain a –2 exponent. An extended light source will yield an exponent between –1 and –2. A long straight light, such as a fluorescent tube, will yield an exponent of about –1 at typical distance ranges.

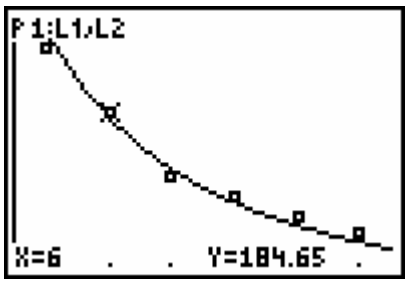
5. An excellent light source for this experiment is the AA-cell size Mini Mag Lite (www.maglite.com). The reflector can be unscrewed and removed completely, revealing a very small and intense near-point light. If another kind of flashlight is used, it is essential that it *not* have a reflector around the bulb, or the source will not behave at all like a point source.

6. It is important that the light be powered by DC (direct current), such as by a battery source. AC-powered lamps exhibit a time-varying flicker that is not detectable by eye, but that may substantially reduce the quality of the data.

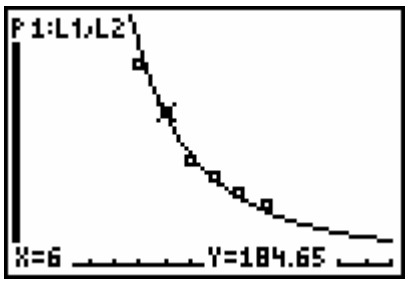
7. The quantity measured by the light sensors is not strictly called “intensity” but we use this common term for convenience.

8. You may want to have students adjust the window range to replot the data to include the origin. The inverse-square nature of the model is more readily visible when plotted this way. (See sample data below.)

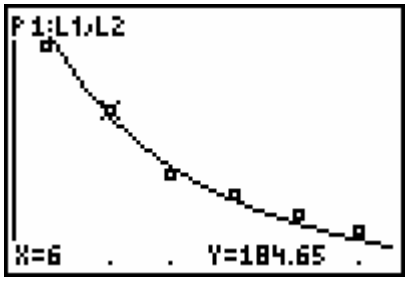
SAMPLE RESULTS



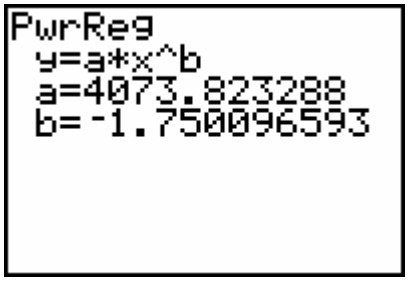
Sample data with inverse-square model



Same sample data replotted over a wider range



Sample data with power law model



Power law fit parameters

DATA TABLE

Left-most point X value X_L	5
Left-most point Y value Y_L	244
Initial model parameter C	6100
Optimized inverse-square model $y = C/x^2$	$y = 6300/x^2$
Power law model $y = ax^b$	$y = 4100x^{-1.8}$

ANSWERS TO QUESTIONS

1. The intensity of the light appears to get smaller with increasing distance. The relationship could be an inverse relationship, or it could be something else.

2. Yes, the data are consistent with a decreasing function such as an inverse function, as the graph is always decreasing but it never crosses the horizontal axis.

3. The inverse-square model fits the data very well.

4. The fit of the general power law looks very similar to the inverse-square fit. The power law fit has to be at least as good as the inverse-square fit, since the power law fit includes the possibility of the inverse-square fit with the exponent taking a value of –2. The fit of the power law model could be better than the inverse-square model *if* the data don't actually have an inverse-square behavior.

5. A brighter bulb would shift increase all readings proportionately. So, *a* and *C* would increase, but *b* would stay the same.