

Investigation

A light in the distance

You will have noticed that the intensity of a light diminishes as you get further away from it. We will investigate the relationship between distance from a light source and its intensity

Materials

TI Graphing Calculator with DataMate program installed

CBL2 interface

Light probe

Clamp and stand

Tape measure

Scotch tape

40 Watt light source

Starting the DataMate Program and setting up

1. Use the following steps to start the DataMate program on your calculator:



TI—73, TI—82, and TI—83 Calculators:

Press **PRGM** then press the calculator key for the number that precedes DATAMATE. Press **ENTER**. An introductory screen will appear, followed by the main screen.

TI-83 Plus Calculators:

Press **APPS**, then press the calculator key for the number that precedes



DATAMATE. Press **ENTER**. An introductory screen will appear, followed by the main screen.

2. Plug the Light Probe into channel **CH 1** on the CBL2 interface.
3. Start the DataMate program. Press **CLEAR** to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading.
4. Press **1: SETUP** and using the cursor buttons,  or  (be patient it's a bit sluggish!) select **MODE** press **ENTER**.
5. In the **SELECT MODE** menu choose **3: EVENTS WITH ENTRY**.
6. Press **1: OK** to return to the main screen.

Collecting data

1. Arrange the light so that it is shining along the bench. Unroll the tape measure to 1 metre and tape it to the table. Fix the light probe in a clamp and stand and place it at 0 cm. Place the lamp at 20cm. Aim the light probe so that is pointing at the centre of the light source.
2. Select **2: START** to begin data collection. Press **ENTER** to record your first measurement. Then enter the distance 20. Press **ENTER** again.
3. Move the lamp to 30cm and press **ENTER**. Then type in the distance 30. Press **ENTER** again and you will find the calculator producing an autoscaled scattergram of the measurements.
4. Continue to take measurements at 40cm, 50cm, 60cm, 70cm and 80cm
5. You may stop data collection at any time by pressing the **STO→** key
6. This may seem like a simple experiment but there are several sources of potential error in carrying it out. Identify as many sources of error as possible. Reduce the number of errors where possible, find ways of avoiding them or try to compensate for them.
7. To repeat an experimental return to the main screen press **ENTER**.

Analysing the data

1. Describe the overall shape of the line set out by the scattered points on the graph. (Is it linear or curved? Which way does the trend go?)
2. Use the cursor keys  or  to examine the data points and record the light intensity for each of the distances.

3. Theoretically there is a relationship between the light intensity and the distance of the light source:

$$I = \frac{A}{d^2}$$

Where I is the light intensity, d is the distance from the light to the probe and A is a constant (the power of the light bulb).

If this equation was correct what should the relationship be between the measurements taken at:

- (i) 20cm and 40cm?
 - (ii) 30cm and 60cm?
 - (iii) 40cm and 80cm?
4. Compare the relationship between your measurements and the predictions made by the equation.
 5. You will certainly find a difference between your measurements and those predicted by the equation. There are two possibilities, either there is an error in the experiment or the equation is incorrect. Here we are searching for possible sources of error. List as many as sources of error as you can find.
 6. One possible source of error is the measurement of the distance between the probe and the light. Try several measurements placing the probe at exactly 50cm from the lamp. Describe the variations that you observe in your results.
 7. Describe what you can do to minimise this sort of error.
 8. Try to determine the degree of error in the results when the light is placed at 55cm rather than 50cm.
 9. Another possible source of error could be the presence of another light source. How could you correct the error caused by this extra source of light?
 10. Repeat the experiment trying to eliminate or minimise as much as possible the errors in the experiment.