Skills Practice Lab

IN-TEXT LAB—CBL™ VERSION

Brightness of Light

Teacher Notes

TIME REQUIRED One 45-minute period.

BACKGROUND

This probeware version of the Skills Practice Lab "Brightness of Light" from the chapter "Light and Reflection" uses a light probe instead of a light meter.

SAFETY CAUTIONS

Remind students to report all breakage immediately. Students should be instructed not to look directly at a light source.

TIPS AND TRICKS

Each lab group needs a level work surface that is near an electrical outlet and away from any sources of water. Each work area must be at least 1.5 m long.

Students should have the program DataMate® on their graphing calculators. Refer to Appendix B of the textbook for instructions.

Show students how to set up the apparatus. Demonstrate how placing the light sensor at the 0.00 mark on the meterstick allows them to use the markings on the stick to measure the distances directly.

If the students are using a dc power supply, show them how to adjust the voltage. Power supplies should be set at around 5.0 V for this exercise.

CHECKPOINTS

Step 10: The bulb must be securely placed on the meterstick. If necessary, use electrical tape to hold the bulb in position. Students should be able to demonstrate that the light sensor is properly positioned.

Step 11: Students should be able to demonstrate that the power supply is connected correctly and set to the correct level before it is plugged in.

Step 12: Students should enter the value for the distance in meters.

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Skills Practice Lab

IN-TEXT LAB—CBL™ VERSION

Brightness of Light

The brightness, or intensity, of a light source may be measured with a light meter. In this lab, you will use a light meter to measure the intensity of light at different distances from the light source. The measured brightness of a light depends on the distance between the light meter and the light source. This relationship is an example of an inverse-square law. According to the inverse-square law, the brightness of light at a certain point is proportional to the square of the distance from the light source to the light meter. You will use your results from this experiment to investigate the relationship between the distance and the brightness of a light source and to examine the inverse-square law as it relates to the brightness of light. You will use your data to calculate the square of the distance, and you will analyze the relationship using graphs of your data.

OBJECTIVES

Find the relationship between the intensity of the light emitted by a light source and the distance from the source.

Explore the inverse square law in terms of the intensity of light.

MATERIALS LIST

- small, clear incandescent bulb
- meterstick-mounted bulb socket
- black tube to cover bulb and socket
- power supply
- meterstick
- meterstick supports
- support stand
- clamp for support stand
- CBL 2™ or LabPro® interface
- TI or Vernier light sensor
- graphing calculator with link light sensor cable
- black aperture tube for light sensor
- adhesive tape

SAFETY

- Use a hot mitt to handle resistors, light sources, and other equipment that may be hot. Allow all equipment to cool before storing it.
- If a bulb breaks, notify your teacher immediately. Do not remove broken bulbs from sockets.
- Never put broken glass or ceramics in a regular waste container. Use a dustpan, brush, and heavy gloves to carefully pick up broken pieces, and dispose of them in a container specifically provided for this purpose.
- Avoid looking directly at a light source. Looking directly at a light source may cause permanent eye damage.

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Procedure

PREPARATION

1. Read the entire lab and plan what steps you will take.

2. Record your data in the data table below.

Distance	**Intensity**
0.10	
0.15	
0.20	
0.25	
0.30	
0.50	
0.75	
1.00	

Background ______________________

APPARATUS SETUP

3. The values in the first column of your data table represent the distances at which you will take readings.

4. Set up the meterstick, meterstick supports, light source (bulb and socket), and power supply, as shown in **Figure 1.** Carefully screw the bulb into the lamp socket. Tape the meterstick and its supports to the lab table.

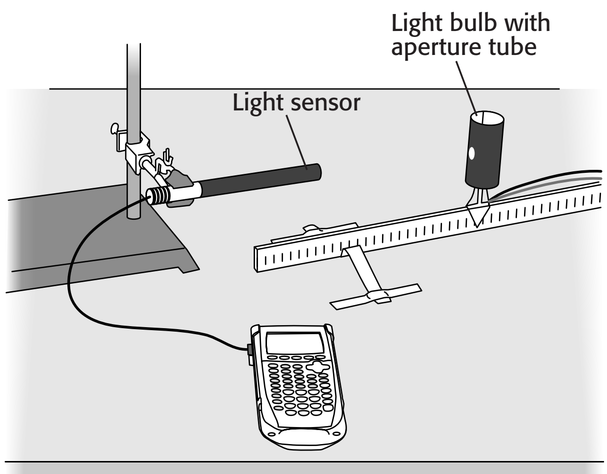

Figure 1

5. Set up the light sensor with aperture, interface, and graphing calculator as shown in **Figure 1.** Set the light sensor directly above the 0.00 m mark on the meterstick, as shown.

6. Prepare the light sensor for data collection.

a. Connect the light sensor to Channel 1 of the CBL 2™ or LabPro® unit.

b. If your sensor has a range switch, set it to 600 lux.

c. Use the link cable to connect the TI graphing calculator to the interface. Firmly press in the cable ends.

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MEASURING BRIGHTNESS OF LIGHT

7. Turn on the calculator, and start the DataMate® program. Press CLEAR to reset the program.

8. Set up the calculator and the interface for the appropriate data collection mode.

a. Press [▲] once to select MODE and press ENTER.

b. Select EVENTS WITH ENTRY from the SELECT MODE menu to collect light data as a function of distance. In this mode you will trigger the interface to record the light intensity for each position you choose.

c. Select OK to return to the main screen.

9. On the line below your data table labeled *Background*, record the value for the background intensity that appears in the upper-right corner of the calculator screen.

10. Set the bulb and socket 0.10 m from the end of the sensor. Carefully align the sensor clamp and the aperture of the sensor so that the aperture is level, parallel to the meterstick, and at the same height as the hole in the tube that covers the bulb.

11. Set the power supply at 4.5 V, and connect it carefully with the wires from the light socket. ***Do not plug in the power supply until your teacher has approved your setup.*** When your teacher has approved your setup, carefully plug the power supply into the wall outlet to light the lamp.

12. Select START to collect data for the light intensity. Wait five seconds, then press ENTER to collect data for the light intensity. Enter 0.10 as the value of the distance for this trial. Then press ENTER to store this light intensity-distance data pair.

13. Carefully move the bulb to the 0.15 m. Wait five seconds, then press ENTER. Enter 0.15 for distance, then press ENTER to store this light intensity-distance data pair.

14. Repeat this procedure for all the distances in your data table.

15. After the last trial, press [STO►] to stop data collection. Carefully unplug the power supply from the wall outlet.

16. Record the data from all the trials in your data table. Use the arrow keys to trace the graph. The x- and y-coordinates will be displayed as the cursor moves along the graph.

17. Clean up your work area. Put equipment away safely so that it is ready to be used again. Recycle or dispose of used materials as directed by your teacher.

Analysis

1. **Organizing Data** For each trial, find the real value of the measured light intensity by subtracting the background from the measured value.

   Answers will vary. Typical measured values will range from 7 lux to 125 lux for the light meter, and from 10 mW/cm^2 to 350 mW/cm^2 for the interface and Vernier light sensor.

2. **Graphing Data** Using your answers from item 1, make a graph of the intensity plotted against the distance. Use a graphing calculator, computer, the graph below, or graph paper.

   The graph should have a parabolic shape and show that intensity decreases as distance increases.

3. **Organizing Data** For each trial, calculate $1/(Distance^2)$. This value represents the inverse of the distance squared.

   Typical values will range from 1.00 m^{-2} to 100.00 m^{-2}.

4. **Graphing Data** Using your answers from item 1 and item 3, make a graph of the intensity plotted against the inverse of the distance squared. Use a graphing calculator, computer, the graph below, or graph paper.

   The graph should have a straight line pointing up and to the right.

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Brightness of Light *continued*

Conclusions

5. **Interpreting Graphs** Based on your graphs, what is the relationship between the intensity of the light and the distance from the light source? Explain how your graphs support your answer.

The intensity of a light varies directly with the inverse square of the distance from the light source.

6. **Evaluating Methods** What is the purpose of the shields used on the light bulb and the detector? Why are they important?

The shields block out light from the room and direct all light to the meter; This gives higher values to improve the accuracy of the results.

Extensions

7. **Designing Experiments** Devise a way to use this experiment to compare the intensities of light sources of different colors. If there is time and if your teacher approves your plan, perform the experiment, and record your results. Use your data to answer questions 1–5 above for each color. Write a brief report detailing your procedure and evaluating your results. Explain how color affects the intensity of a light source.

Student plans should be safe and complete, including a list of equipment, measurements, and calculations required.