32 *Inverse Square Law*
Absolutely Relative

Purpose

To investigate how light intensity varies with distance from the light source.

Required Equipment and Supplies

Apple II Series computer
interface box with light probe
LabTools software
3-socket outlet extender
3 night lights with clear 7-watt bulbs
2 ring stands
2 clamps
meterstick
Data Plotter graphing program

Discussion

The light from your desk lamp may seem almost as bright as the sun. If your desk were only a meter away from the sun, your lamp would not seem bright at all. The *brightness* of the sun is far greater than that of the lamp, but the intensity of the lamp is almost as great as that of the sun.

The intensity of light decreases with its distance from the source. In this experiment you will use a light probe to measure the intensity of light at various distances to see how the intensity of light varies with distance.

Procedure

Step 1. Install three night lights in a 3-outlet extender. Use a clamp to secure the extender on a ring stand at least 20 cm above the table. This height is necessary to minimize the effect of the light reflected from the table surface.

Clamp the light probe to another ring stand so that it is at the same height as the night lights and is directly facing them about 30 cm away. Connect the light probe to the interface box. For best results, reduce ambient light to a minimum (turn off room lights and cover windows, if possible). The setup is shown in Figure 32.1.

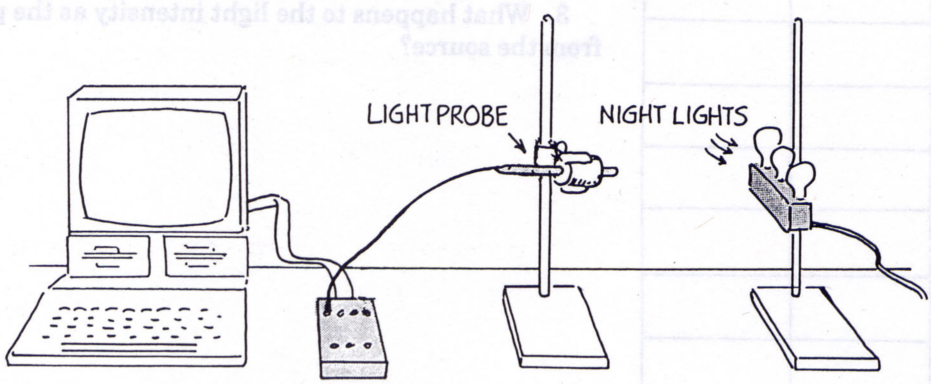


Figure 32.1

Data Table 32.1

BULB	RELATIVE INTENSITY
A	
B	
C	
A+B	
A+C	
B+C	
A+B+C	

Step 2. Boot the *LabTools* disk. Select the "Light Meter" program from the main menu. Follow the instructions provided in the "Light Meter" program. The computer will now automatically measure the intensity of light falling on the light probe and display the intensity.

Turn on the center bulb (bulb A). Calibrate the light probe by selecting "Calibrate." *Vary the orientation of the light probe slightly at this distance until you obtain a maximum reading.* Pressing [Return] calibrates the probe. The computer automatically compares all light intensities to bulb A at this distance. All future intensity readings are therefore expressed in percentages.

Now turn off bulb A and turn on one of the side bulbs (bulb B). Leave the light probe in the same position. Record the intensity reading in Data Table 32.1. Turn off bulb B and turn on the third bulb (bulb C). Record the intensity reading.

Step 3. Predict what intensity the light probe will read when you turn on bulbs A and B.

predicted intensity reading = ________

Try it and record your data.

actual intensity reading = ________

Step 4. Now try all other combinations of the bulbs to complete Data Table 32.1.

1. How do the intensity readings for the different bulb combinations compare to their individual intensity readings?

2. What might account for any differences in the readings?

Data Table 32.2

BULB A	
DISTANCE	INTENSITY
30 cm	

Step 5. Take an intensity reading with the light probe 30 cm away from bulb A. *Be sure to always orient the probe towards the light source so as to give a maximum reading.* Take nine more readings with the light probe, moving it 5 cm farther away from the bulb each time. Record your data in Data Table 32.2.

3. What happens to the light intensity as the probe gets farther away from the source?

Step 6. Plot the light intensity vs. distance for bulb A. If available, use *Data Plotter* to plot the graph.

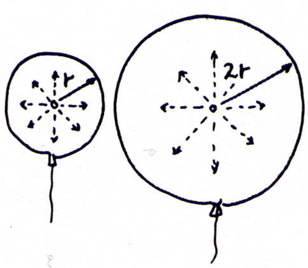
4. What does the graph look like? What relationship does your graph suggest between the light intensity and the distance?

Step 7. Use *Data Plotter* to vary the power of the x-y values so that the plot of intensity vs. distance is a straight line.

5. What powers of your data result in a straight line graph? Is the slope negative or positive?

6. What relationship does your graph suggest between the light intensity and the distance?

Analysis



7. Imagine a point source of light, such as a small 1.5-volt flashlight bulb, at the center of a balloon of radius *r*. All the light leaving the bulb strikes the inside surface of the balloon. Also imagine the same light source inside a balloon with twice that radius, 2*r*. All the light leaving the bulb again strikes the inside surface of the balloon. Does the brightness of the bulb increase, decrease, or remain the same?

8. How many times greater is the inside surface area of the larger balloon than that of the smaller balloon?

9. If all the light spreads out evenly onto the inside surface of the larger balloon, what is the intensity of the light on the inside surface of the larger balloon as compared to that for the smaller balloon?

10. Two bulbs, one four times brighter than the other, are 1 meter apart. The brighter bulb is positioned on the 100-cm mark and the dimmer bulb on the 0-cm mark. Where on the meterstick is the illumination from each bulb the same?