

## Diluted by Distance Lab

### Teacher's Guide

**Topic:**

Light and Color

**The following information is provided to the student:**

**Question:**

What is the mathematical equation relating the illuminance on a surface and the distance between the surface and the source?

**Purpose:**

To determine the mathematical equation relating the illuminance (**E**) on a surface and the distance (**d**) the surface is from a light source.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. The Data section and Conclusion section are similar to other labs performed this year; review the Wait! Hmmm. Gee. Lab (Newton's Laws Unit), F-m-a Lab (Newton's Laws Unit), Ut Tensio, Sic Vis Lab (Newton's Laws Unit), It's a Breeze Lab (Vectors and Forces Unit), Modified Atwood's Machine Lab (Vectors and Forces Unit), Stopping Distance Lab (Energy Unit), Voltage-Current-Resistance Lab (Circuits Unit), How Much? Lab (Refraction Unit), The Lens Equation Lab (Refraction Unit), and the Period of a Pendulum Lab (Waves Unit). The Discussion of Results section should include a discussion of how the experimentally-derived equation was developed. It should be compared to a theoretical equation found in a textbook or online site.

**Materials Required:**

Computer interfaced light probe; mini mag-lite; meter stick.

**Description of Procedure:**

A computer interfaced light probe is zeroed and prepared to collect data. The lens cover is removed from a mini mag-lite so as to expose the bare bulb. A meter stick is secured to the table. The room lights are turned off. The sensor of the light probe is placed at the end of the meter stick. The filament of the mag-lite is placed at the 1-cm mark on the meter stick. The illuminance is recorded. The filament mag-lite is moved to the 2-cm mark on the meter stick and a new illuminance is recorded. The process is repeated for several distances in order to collect an extensive illuminance-distance data set. The data are analyzed in an effort to obtain a mathematical equation relating the two quantities.

**Alternative Materials and Procedure:**

Many schools still have stand-alone light sensors which provide an analog readout of the illuminance. These can be used in place of the computer interfaced light probes. If used, a regular 60-Watt light bulb might be a better source of light than a mini mag-lite bulb.

**Safety Concern:**

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

## The Laboratory

### Suggestions, Precautions, Notes:

1. This lab serves as an effective assessment of students' ability to conduct a controlled investigation of the effect an independent variable (distance) upon a dependent variable (illuminance). After defining terms, it might be wise to sit back, stay out of the students' way and observe to see if they have acquired such a skill.
2. Many students may have learned how to use a Graphing Calculator to plot a data set and to perform linear regression, power regression and exponential regression analysis on the set. Take advantage of the good work of our colleagues in the Math department and allow students to complete the data analysis on their calculators.
3. Performing a linear regression analysis on the data set will not result in a high correlation coefficient. Power regression will be necessary.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>L5. Diluted by Distance Lab</b>	<b>Score</b>
____ Included, labeled and organized all parts of the lab report. ____ Data section includes a table of distance-illuminance data; included column headings and units. Graph of E vs. d is sketched; the results of a linear or a power regression analysis are shown and equation is written. Data appear reasonably accurate. ____ Conclusion stated the experimentally-derived equation relating the illuminance and the distance. ____ Discussion of Results describes the process used to determine the experimentally-derived equation. Includes an error analysis comparing the experimentally-derived equation and the theoretical equation.	____/____

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

Readings on the inverse square law of light radiation are not currently available.

### Connections to Minds on Physics Internet Modules:

There are currently no sublevels of Minds on Physics on the topic of the inverse square law of light.