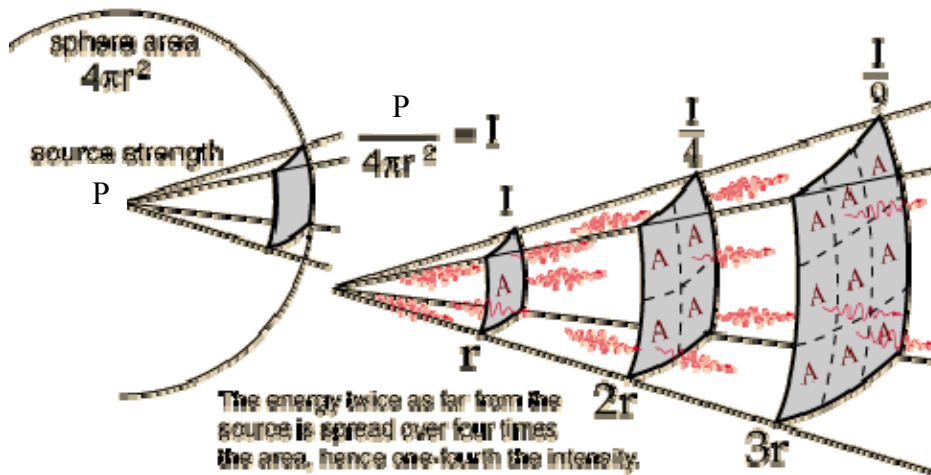


Inverse Square Law

As one of the natural phenomena which obeys the general inverse square law, the light from a point source can be put in the form shown below. The inverse square law applies when conserved quantities like a force such as gravity is originating from a point source, or energy is radiating from a point source. As the radius of the sphere increases the power is distributed over an increasing surface area ($4\pi r^2$).

$$I = \frac{P}{4\pi * r^2}$$

where I is called intensity and P is called power.



If you have determined the amount of light per unit area reaching 1 meter, then it will be one fourth as much at 2 meters.

(Source) <http://hyperphysics.phy-astr.gsu.edu/hbase/vision/isql.html>

Measurement of Power as a Function of Distance

Purpose: Measure how the power decreases as the distance from the source increases.

Student Info:

- 1) Designed for Physical Science (9/10) and/or Physics (11/12)
- 2) Prior Knowledge: Graphing, Inverse Functions, Surface Area of a Sphere
- 3) Suggested Websites:

<http://hyperphysics.phy-astr.gsu.edu/hbase/vision/isql.html>

http://en.wikipedia.org/wiki/Inverse-square_law

<http://csep10.phys.utk.edu/astr162/lect/light/intensity.html>

Teacher Info:

- 1) Prior Knowledge: VSRT Operation
- 2) Vocabulary: Inverse, inverse square law and gravitation
- 3) Suggested Website(s)
<http://hyperphysics.phy-astr.gsu.edu/hbase/vision/isql.html>

Time Required:

- 1) Setup \approx 10 min
- 2) Activity / Lab \approx 30 min
- 3) Data Analysis \approx 30 min
- 4) Discussion / Wrap Up \approx 30 min

Materials Needed:

- 1) VSRT System (See Appendix I)
- 2) Compact Fluorescent Light (CFL)
- 3) Meterstick (100cm) or tape measure (10 feet or more)

**Procedure:**

- 1) Place the active LNBFs next to each other (\sim 2.5 inch baseline from center to center).
- 2) Construct a data table in your lab notebook to record the distance of the bulb from the detectors and the power reading at that distance.
- 3) Record the measurements between 24 and 72 inches at intervals of 6 inches.

Data Table:

Distance “d” in [feet]	Measured *Power [K]	Inverse Square Fit ** a / d ²	% Difference
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0			

* See Basic VSRT Operation for a discussion of Power [K].

** a = 16 x (Power at d=4 feet)

Graphing:

- 1) Using a computer or graphing calculator, graph the Power [K] vs. distance.
- 2) On the same graph, plot the inverse square law fit “a/d²” vs. distance.
- 3) Sketch the curve fit for the measured data and compare to the theoretical curve.

Calculations:

- 1) Calculate the “a” fit coefficient : a = 16 x (Power at 4 feet)
example: $81.25 \times (4)^2 = 1300$
- 2) Determine a / d² {for each measured distance}
- 3) Find % difference = { (Measured – Fit) / Fit } x 100%

Questions:

1. If the output of the bulb is essentially constant, why do the power values diminish with increasing distance?
2. What is the average percent difference between the measured and theoretical power values?
3. In words, what does this mean?
4. What is the correlation between the measured and theoretical curves?
5. In words, what does this mean?
6. The detectors are sensitive to radio waves ($\lambda \approx 1$ inch). The radio source is a light bulb; would you expect a similar result for a photosensitive detector? Explain.
7. Compare the measured power at 4 feet to the measured power at 2 feet. How does this compare to the theoretical expectation?
8. What are the sources of error? Is there evidence for the saturation of the detectors?