**Activity 4.1.1 Inverse Square Law of Light**

We know a street light gets dimmer  the farther we walk away from it and we all know when we walk away from a camp fire it seems to get dark really quickly.  How much dimmer is it getting as we move away? This lab will let us answer that question with a mathematical model that differs from ones we have met earlier in this course.

**What You Need:**

* Must have a point source of light for this activity. **A Mini-Maglite™ flashlight** will accomplish this. (Or make your own light source see instructions at <http://www.nasa.gov/pdf/583137main_Inverse_Square_Law_of_Light.pdf> or

[**https://www.cfa.harvard.edu/seuforum/mtu/MTUinversesquare.pdf**](https://www.cfa.harvard.edu/seuforum/mtu/MTUinversesquare.pdf))

* **Centimeter ruler**
* **Calculator and Graph paper (master provided)**
* **Data Table (master provided)**
* **Box --- see Teachers Notes**

**Procedure:**

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| (15 minutes or more) 1. Expose the bulb of the Mini-Maglite™ by removing the front reflector assembly.
2. http://www.exploratorium.edu/snacks/inverse_square_law/inverse_square_3_199x117.gifKeep the distance between the bulb and the card with the 1 cm square hole constant at 10 cm. The size of the squares on the graph paper will determine the area of each square you make. If you use graph paper with 1/2 cm on a side per square, then the area should be 1/2 \* 1/2 = 1/4 cm2 for each square. Illuminate 4 squares, measure the distance from the light source, and find the area. Check to see if your answer is correct by looking at the data table on pg. 3.

Next illuminate 4 cm2. Measure the distance from the light source, fill in the table for distance from the light source and how many squares are illuminated. Next illuminate 9 cm2, fill in the table for distance from the light source and how many squares are illuminated.1. Make a conjecture: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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2. How does distance affect the amount of light that falls on each square? Brightness is the amount of light received per area. The amount of light given off by the bulb (called luminosity) and passing through the hole in the card always remains constant. We want to calculate the brightness relative to some standard brightness (the brightness of the bulb on the graph paper at 10 cm). The relationship mathematically is as follows.

Let: Brightness = B, Area = A, and amount of light (Luminosity) = L. B0 = standard brightness and A0 is the area at the standard distance of 10 cmThen:B = L/A for any distance and B0 = L/A0 for your standard distance (10 cm)Set up a ratio:  $\frac{B}{B\_{0}}$ = $\frac{\frac{L}{A}}{\frac{L}{A\_{0}}}$ then $\frac{B}{B\_{0}}$ = $\frac{L}{A}$ \* $\frac{A\_{0}}{L}$ (L cancels out because it is the same value)Therefore, relative brightness is B/B0 = A0/A. At a distance of 10 cm the area illuminated was 1 cm2 Therefore, A0 = 1 and **B/B0 = 1/A** **6.)** Make a graph of the relative brightness as a function of distance. Examine your graph, and use it and the questions in number 7 to determine a model relating brightness and distance. **7.)**Examine your first and third columns. 1. How is the size of the image produced related to the distance of the source light (flashlight)?
2. Note at a distance of 10 cm, 1 square cm is illuminated. At 20 cm (think of as 2 (10)) about 4 square cm are illuminated and at 30 cm (think of as 3(10)) about 9 square cm are illuminated. So not only is the area increasing as the distance increases but the area is proportional to the\_\_\_\_\_ \_\_\_ of the distance.
3. How did the intensity (brightness) of light change with distance?

. 1. The brightness coming through the hole is constant but is spreading over a larger

area and from part a) we have guessed that the area is proportional to the \_\_\_\_\_\_\_\_ of the distance. Now we know the brightness is decreasing so it is sensible to guess that the brightness is decreasing as the \_\_\_\_\_\_\_\_\_\_\_\_ of the distance.

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| **Distance** **From Bulb** **(cm)**  | **# of Squares****Illuminated**  | **Area** **Illuminated****(cm2)**  | **Relative** **Brightness** **(cm-2)**  |
| **10** | **4** | **1** | **1** |
|  |  | **4** |  |
|  |  | **9** |  |
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