Extension Activity – Air and Water

Title of Activity - Inverse Square Law

Concepts/Principles Covered –

The **Inverse Square Law** states that a specified physical quantity (like intensity) is inversely proportional to the square of the distance from its source. Based on geometry, any point source which spreads its effect equally in all directions without a limit to its range will demonstrate this relationship. The further away from the source, the larger the sphere of influence becomes. This relationship applies to light intensity, sound, gravitational, and electrical forces.

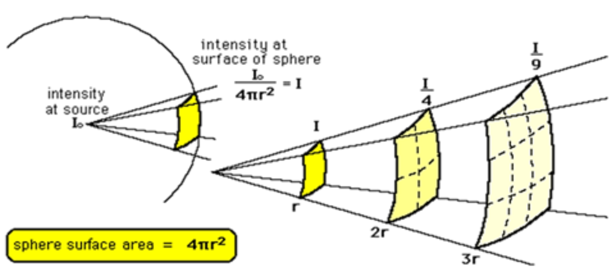
Assuming that a point source of light disperses its energy equally in all directions, to identify the points in space where the energy is of the same intensity, draw a sphere around the point source. The relationship between radius of the sphere and its surface area is an inverse square relationship. For a source of light this means that **intensity or brightness** will depend on $1/r^2$.

If you double the distance from the source, the brightness will not decrease by half, but will decrease to one fourth its original value. If we triple the distance from the source, the brightness will decrease to one ninth the original brightness. It is not necessary to look at the entire sphere; this exercise isolates one segment of the light and evaluates how brightness is affected by distance.

With a point source of light, we can define brightness (B) as a function of the amount of light (L, Luminosity) divided by the area (A) illuminated.

As we change the distance from the source, we can measure the relative brightness, B.
$B_x = L/A_x$ for any distance x and $B_0 = L/A_0$ for the original distance. Since L is constant then relative

brightness is $$\frac{B_x}{B_0} = \frac{L/A}{L/A_0} = \frac{A_0}{A_x}$$



(https://www.cyberphysics.co.uk/general_pages/inverse_square/inverse_square.htm)

Short Description –

Learn about the Inverse Square Law using a simple experiment to indicate how the brightness of a light source changes with distance.

Standards Covered -

4-PS4-2**:** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

CCSS.MATH.CONTENT.4.MD.C.6: Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

MS-PS4-2: Develop and use a model to describe how waves are reflected, absorbed, or transmitted through v

HS-PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulombs Law to describe and predict the gravitational and electrostatic forces between objects of various materials.

HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Length - 60 minutes

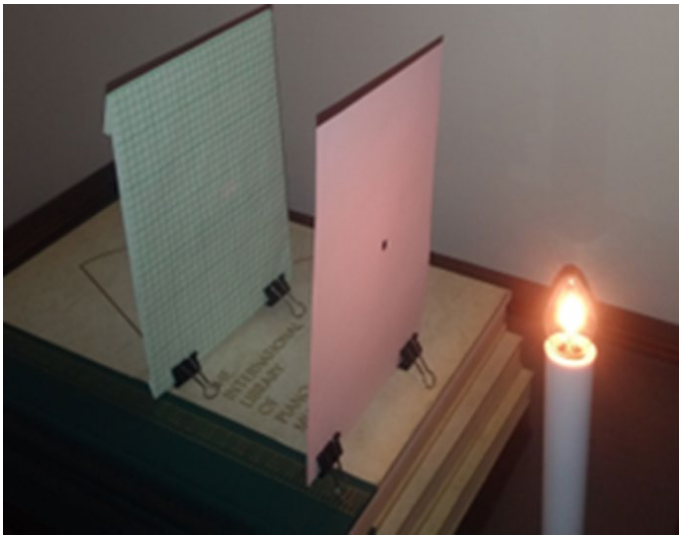
Age Group – Grades 6-12

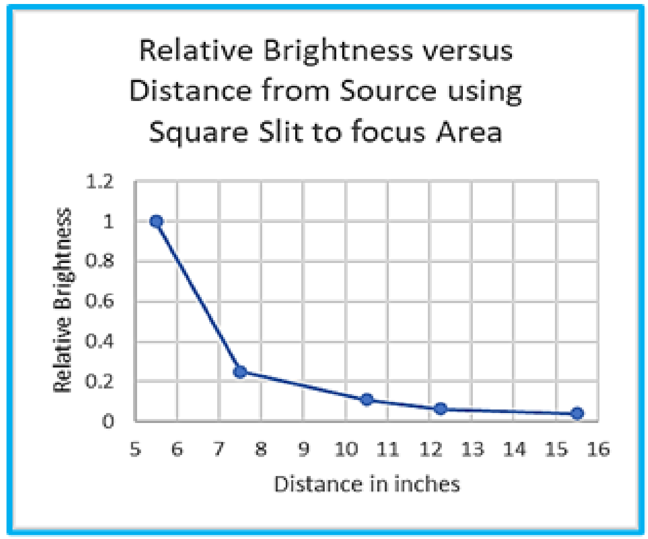
Materials and Supplies -

- Incandescent light in a holder
- Cardstock, two 5”x7” pieces
- Graph paper
- Binder clips
- Measuring tape

Step-by-step Instructions -

- Use a single incandescent bulb, and two pieces of card stock, standing vertically, using binder clips to keep erect.
- Attach graph paper to one piece of card stock.
- Measure the size of one block on the graph paper and carefully cut a same-sized hole in the other piece of cardstock. Record A, the area of one block.
- Align the two pieces of cardstock in the path of light so that the beam is focused and only one block on the graph paper is illuminated. Record distance, D, from the light to the graph paper.
- Move the graph paper further away from the source to illuminate four squares, then nine, 16, and 25, each time recording the number of squares and the distance between the source and graph paper. Plot by hand or using a graphing program.





This relationship applies to light intensity, sound waves such as in Navy sonar, as well as gravitational and electrical forces. The pull of the Earth's gravity decreases proportionally to $1/r^2$ (or inversely proportional to r^2), where r is distance from the center of the Earth. The attraction or repulsion between two electric charges decreases proportionally to $1/r^2$, where r is the distance between the two charges.