Lab 3 – Measuring how sound intensity changes with distance

Objective: Measure how sound intensity changes with distance using computer generated sound and an oscilloscope

Materials:
*Computer with speakers and software to generate different tones
*Microphone
*Oscilloscope
*Meter Stick

Procedure:
1) Increase the volume on the computer until you hear a sound.
2) Move the microphone to a distance of about 10 cm from the speaker.
3) Adjust the "Volts/Div" and "Time/Div" setting on the oscilloscope until you clearly see the sound wave – adjust until the wave amplitude barely fits on the screen
4) Record the amplitude (voltage) of the wave
5) Move the microphone to distances of 1, 2, 3, 4, 6, 8, 10, 12 cm from the speaker and repeat step 4 each time - make SURE you keep track of the volts/div if you change it, and don't change the volume on the computer during the measurements

Data:

Distance	Volts/Div	Number of Divisions in Amplitude	Amplitude (Volts)	Intensity ($Volts^2$)

Questions:
1) Make a graph of Intensity ($Volts^2$) versus distance – put intensity on the y-axis and distance on the x-axis.
2) How does sound intensity change with distance from the speaker? (Hint: try graphing distance on the x-axis and distance, 1/distance, and $1/distance^2$ on the y-axis – which one of these graphs looks the most like your graph of Intensity?)
3) Why does sound intensity change with distance from the speaker? Explain using your measurements.

Bonus:
How did the intensity of the sound waves you measured change with distance from the speaker? Can you think of any other quantities that we've learned about that change like this? Do you see any similarities between intensity and other quantities we've learned about?

Sound wave intensity follows something called an inverse square law. Basically, an inverse square law is any equation that says some physical quantity varies as one over the square of the distance from the source of that quantity. The force of gravity, sound wave intensity, Coulomb forces (force between two charged particles), and radiation intensity are examples of some quantities that obey inverse square laws.

Challenge question: We learned that sound wave intensity is an inverse square law

$$Intensity = \frac{Power}{4\pi r^2}$$

This equation works for sound waves in three dimensions. Can you come up with a new equation that would work for sound waves in two dimensions?
(Hint: When sound waves expand out from a source, what shape do they make? How would this change in 2D, like if the waves were forced to stay on a flat plane?)