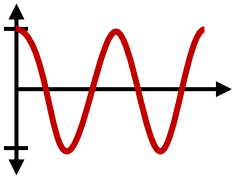
CONCEPT: CALCULATING WAVE INTENSITY

- 1D waves carry energy in a straight line, but 2D & 3D waves spread out energy over a _____ (**A**).

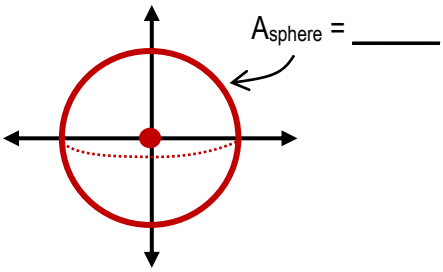
  - **WAVE INTENSITY** is the $\frac{\text{Energy}}{\text{Time}}$ ⇒ **POWER** divided by the **SURFACE AREA.** $I = \frac{\text{P}}{\text{A}} = \frac{\text{P}}{4\pi r^2}$ Units: [$\frac{\text{W}}{\text{m}^2}$]

1D



EXAMPLE: A loudspeaker on a tall pole radiates sound waves in all directions. If the source of the wave produces 500W of power, what is the wave intensity at a distance of 10m?

3D



PROBLEM: A sound source radiates sound waves in all directions. At a distance of 4m from the source, you measure the wave intensity to be 0.06 W/m^2. How much sound energy does the source emit in 1 hour if the power output is constant?

A) 724 J
B) 10,860 J
C) 1.07 J
D) 43,400 J

WAVE INTENSITY
$I = \frac{P}{A} = \frac{P}{4\pi r^2}$
$P = \frac{E}{\Delta t}$

PROBLEM: Wave Intensity also applies to light, which is an electromagnetic wave. If it takes approximately 500 seconds for the light from the Sun to reach the Earth, and intensity of sunlight on the Earth's surface is 1360 W/m^2, what is the total power output of our Sun? (It's safe to assume our Sun radiates light equally in all directions.)

WAVE INTENSITY
$I = \frac{P}{A} = \frac{P}{4\pi r^2}$
(Speed of light) c = 3×10^8 m/s

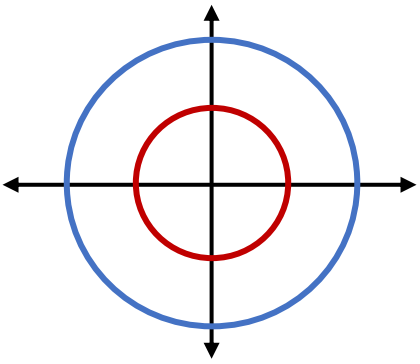
CONCEPT: THE INVERSE-SQUARE LAW FOR INTENSITY

● Some problems ask you to compare the intensity of a wave between different distances.

As waves travel outward (r __):

- Power of source **[stays constant | increases | decreases]**
- Surface Area **[stays constant | increases | decreases]**
- Wave Intensity **[stays constant | increases | decreases]**

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



$$I \cdot 4\pi r^2 = P \quad \rightarrow \quad \_\_\_\_\_ = \_\_\_\_\_ \quad \rightarrow \quad \_\_ = \_\_$$

● This is often referred to as the Inverse-Square Law for Intensity.

EXAMPLE: A siren produces sound waves traveling radially outward. At a distance 15m from the siren, the intensity of the wave is 0.25 W/m^2. Calculate the distance at which the intensity falls to 0.01 W/m^2.

PROBLEM**:** You measure the intensity from a sound source to be 0.3 W/m^2 at a distance of 3.4m**.** What will the intensity be if you walk closer to the source, to a distance of 2.5m?

A) 0.41 W/m^2
B) 0.16 W/m^2
C) 0.55 W/m^2
D) 0.22 W/m^2

WAVE INTENSITY

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

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$