INTENSITY : WAVES

How do we define and calculate the "intensity" of a wave?

- Symbol I
- Units : Wm^{-2}
- Definition : Intensity is defined as power of a wave falling over a unit area
- Formula : $I = \frac{Power}{Area}$ or $I = \frac{Energy}{Time \times Area}$

FACTORS THAT AFFECT THE INTENSITY :

1. Amplitude (A)
2. Distance from the source (d)

AMPLITUDE :

- Intensity is known to be directly proportional to the square of the amplitude of the wave, hence ...

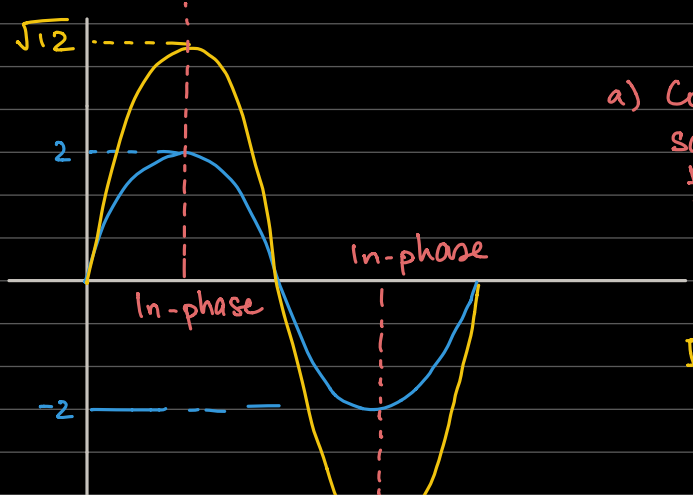
$$I \propto A^2$$
$$I = kA^2$$

DISTANCE FROM SOURCE :

- Intensity is known to be inversely proportional to the square of the distance from the source, hence ...

$$I \propto \frac{1}{d^2}$$
$$I = \frac{k}{d^2}$$

Example :



a) Construct a second wave on the same diagram which has thrice the intensity and is IN-PHASE with the first wave

$$I = k(2)^2$$
$$\frac{I}{4} = k \quad (1)$$

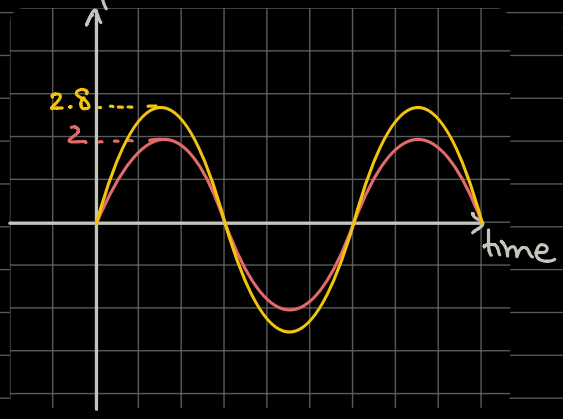
$\sqrt{12}$

$$3I = k(A)^2$$
$$3I = \frac{IA^2}{4}$$
$$12I = IA^2$$
$$\sqrt{12} = A$$
$$3.46 \approx A$$

b) Hence, calculate the resultant intensity (y) if these waves were to interfere constructively. (Ans. in terms of I)

$$y = kA^2$$
$$y = k(5.5)^2$$
$$y = \frac{I}{4}(5.5)^2 \rightarrow \underline{\text{Ans}}$$

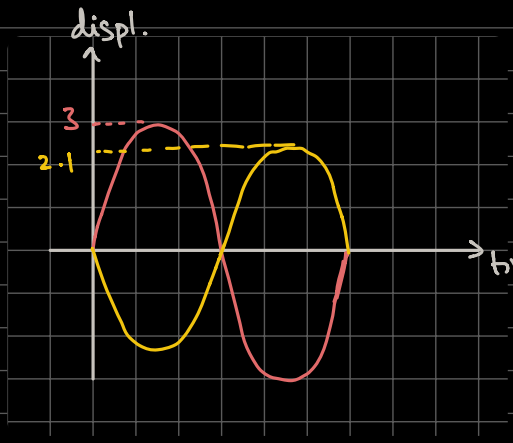
(1)



Second wave:
Twice the intensity
In-phase with the first wave

$$I = k2^2 \qquad 2I = KA^2$$
$$\frac{I}{4} = k \qquad 2I = \frac{I}{4}A^2$$
$$\sqrt{8} = \sqrt{A^2}$$
$$2.8 = A$$

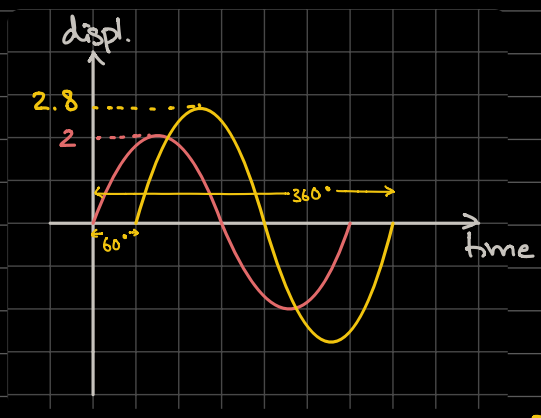
2.



Second wave:
Half the intensity
out of phase with the first one

$$I = k3^2 \qquad \frac{1}{2}I = kA^2$$
$$\frac{I}{9} = k \qquad \frac{I}{2} = \frac{I}{9}A^2$$
$$\frac{9}{2} = A^2$$
$$\frac{3}{\sqrt{2}} = A$$

3.



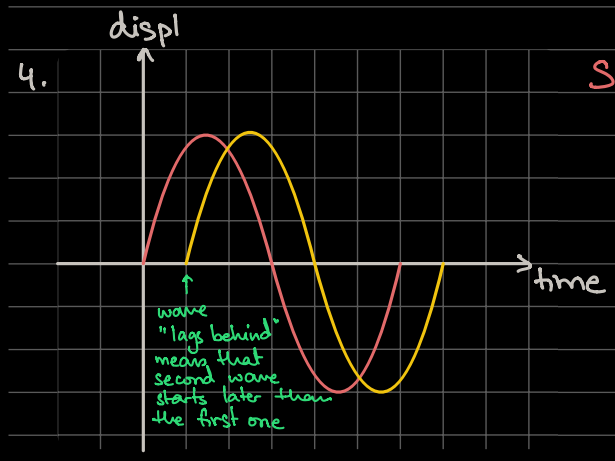
Second wave:
twice the intensity
phase difference of 60° with the first one

$$I = kA^2 \qquad 2I = \frac{I}{4}A^2$$
$$I = k2^2 \qquad 8 = A^2$$
$$\frac{I}{4} = k \qquad \sqrt{8} = A$$
$$2.8 = A$$

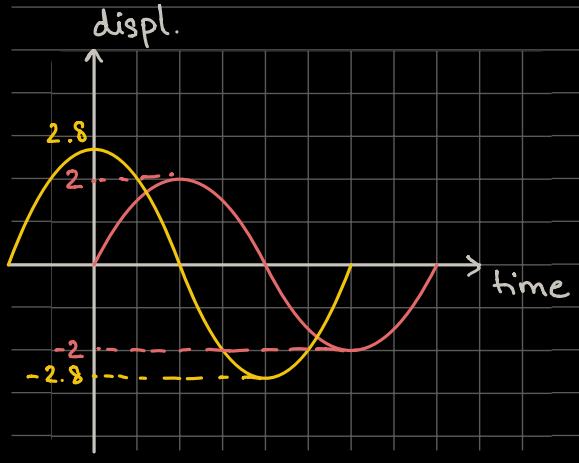
Phase diff. of 60°
6 boxes = 360
1 box = 60°

↳ shift wave one box to the right

4.



Second wave :
Same intensity
But it lags behind the first wave by 60°



Second wave :
twice the intensity
leads the first wave by 90°

8 boxes = 360
2 boxes = 90
↳ to the left

$I = kA^2$
$I = k2^2$
$\frac{I}{4} = k$

$2I = \frac{I}{4} A^2$
$8 = A^2$
$\sqrt{8} = A$
$2.8 = A$