

INTENSITY OF A WAVE

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• How do we **define** and **calculate** "INTENSITY" of a wave and the **factors** which govern the intensity.

- symbol I
- units Wm^{-2}
- define \therefore Intensity is defined as **Power** of a wave falling on a **unit area**

• formula $I = \frac{P}{A}$ since $P = \frac{E}{t}$

$$I = \frac{E}{t \cdot A}$$

Factors which affect the Intensity of a wave

- (1) Amplitude (A)
- (2) distance from the Source (d)

• Intensity is known to be **directly proportional** to the **square of the Amplitude** of the wave, hence

$$I \propto A^2$$

$$I = KA^2$$

A = double
I = increases 4 times

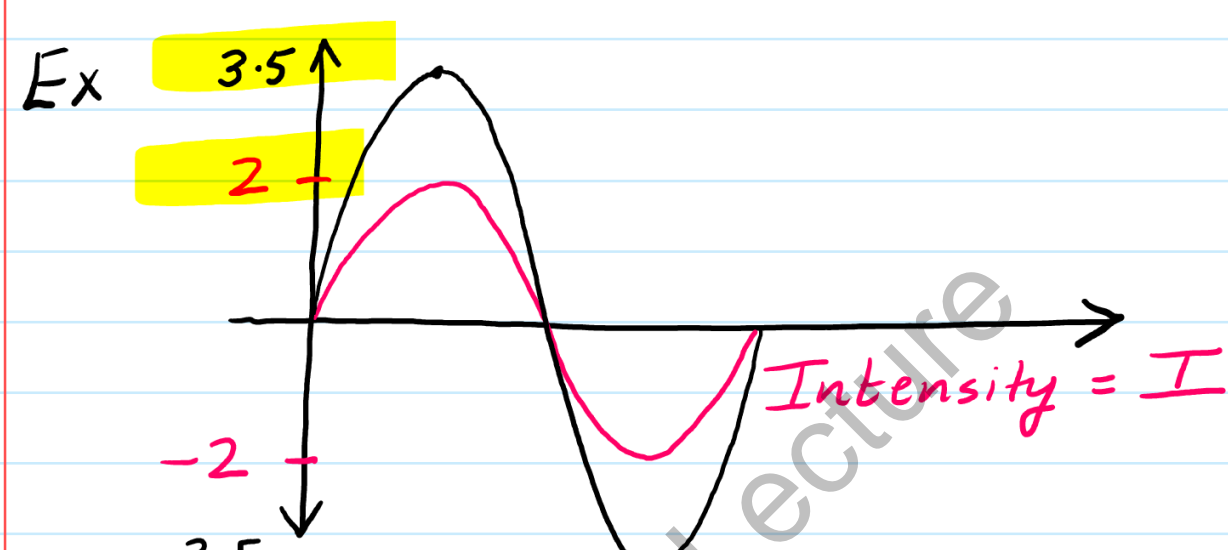
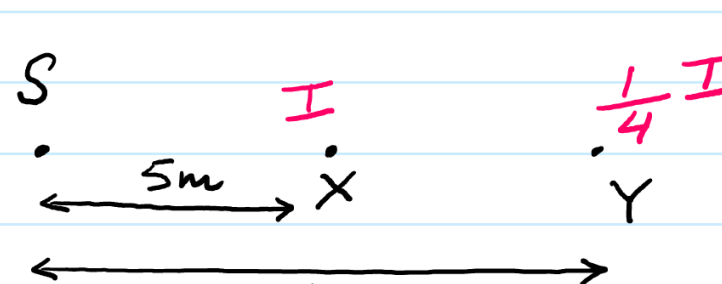
A = Trice
I = increases 9 times

• Intensity is known to be **inversely proportional** to the **square of the distance** from the source, hence

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

$$I = \frac{K}{d^2}$$

one-fourth \rightarrow (double)²



Construct a Second wave on the same diagram which has **THRICE the Intensity** and is **IN PHASE** with the first wave.

$$I = KA^2$$

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

$$② \leftarrow 3I = K(A)^2$$

$$3I = \frac{I}{4}(A)^2 \quad \therefore A = 3.5$$

Hence calculate the **Resultant Intensity (y)** if these waves were to interfere **constructively**? (give your answer in terms of I).

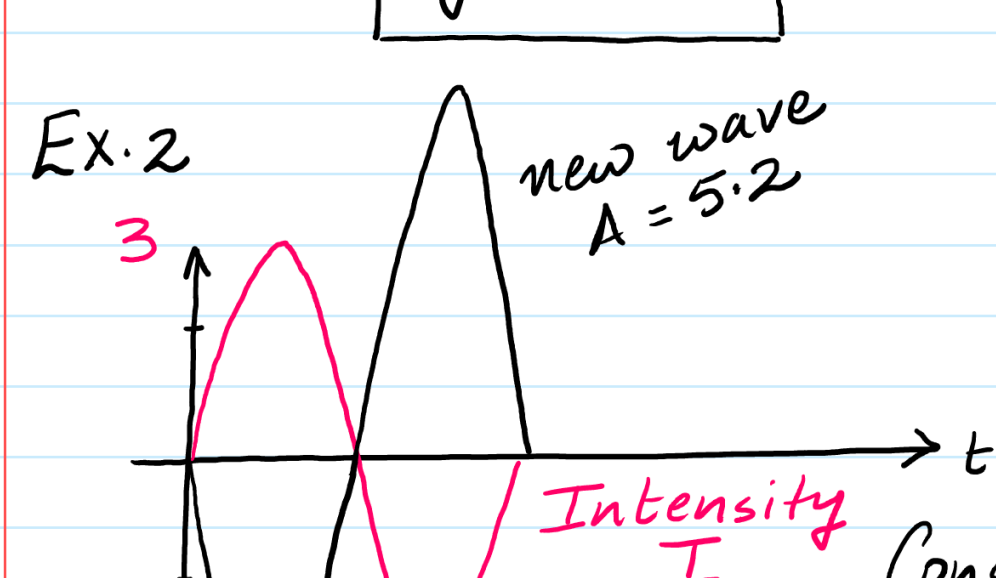
Resultant Amplitude = $2 + 3.5 = 5.5$
Resultant Intensity = y (find)

$$I = kA^2$$

$$y = k(5.5)^2$$

$$y = \frac{I}{4}(5.5)^2$$

$$y = 7.6 I$$



Construct a second wave which has **Thrice the Intensity** and is **out of phase** with the first wave.

$$① \leftarrow I = k(3)^2$$

$$k = \frac{I}{9}$$

$$② \leftarrow 3I = k(A)^2$$

$$3I = \frac{I}{9}(A)^2$$

$$A = 5.2$$

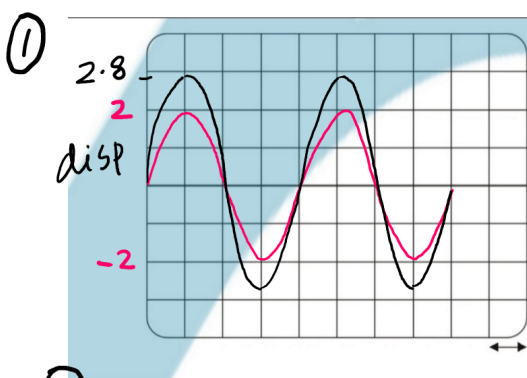
Hence cal. the **Resultant Intensity (z)** if the two waves interfere **destructively** give your answer in terms of I

Resultant Amplitude = $5.2 - 3 = 2.2$
Resultant Intensity = z (find)

$$I = kA^2$$

$$z = \frac{I}{9}(2.2)^2$$

$$z = 0.5 I$$



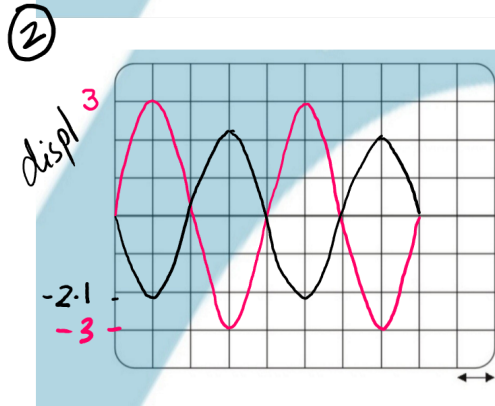
Construct a second wave whose Intensity is **Twice** and it is **In phase** with the first one

$$I = K(A)^2$$

$$2I = K(A)^2$$

$$K = \frac{I}{4}$$

$$2I = \frac{I}{4}(A)^2$$

$$\therefore A = 2.8$$


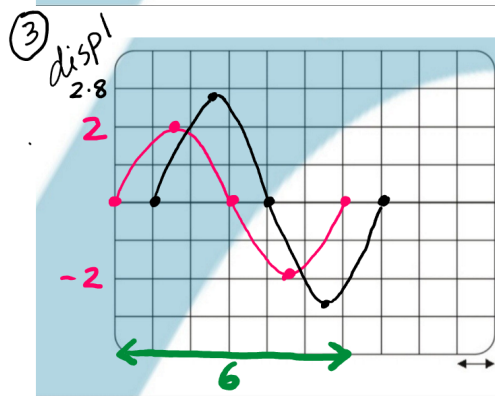
Second wave **half** the Intensity & **out of phase** with the first one?

$$I = K(3)^2$$

$$K = \frac{I}{9}$$

$$\frac{1}{2}I = K(A)^2$$

$$\frac{1}{2}I = \frac{I}{9}(A)^2$$

$$A = 2.1$$


Second wave which has **Twice** the Intensity and has a **phase diff of 60** with the first wave.

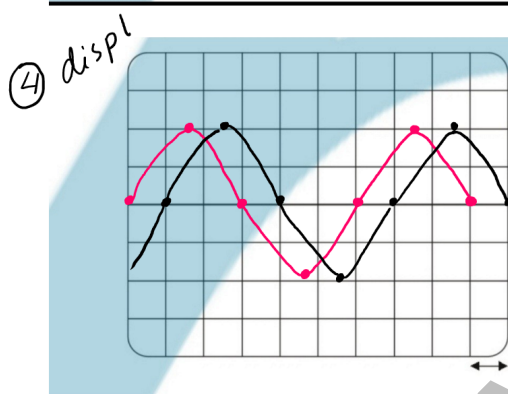
$$I = K(2)^2$$

$$K = \frac{I}{4}$$

$$2I = K(A)^2$$

$$\therefore A = 2.8$$

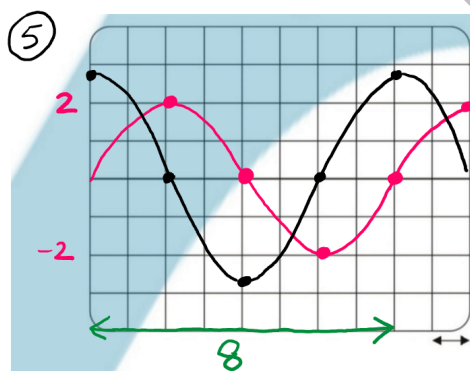
6 boxes \rightarrow 360°
 1 box \leftarrow 60°
 shift Right or Left



Second wave **same Intensity** but it **Lags behind** the first wave by **60**

Construct the second wave **(RIGHT SHIFT)**

On a time scale, if something lags behind then it must start at a **LATER TIME**.



Second wave **Twice Intensity** but it **Leads** the first wave by **90**. Construct 2nd wave

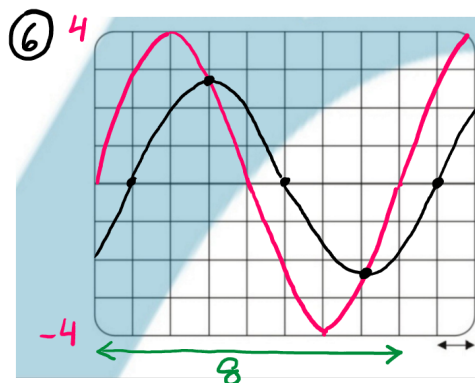
$$I = K(2)^2$$

$$K = \frac{I}{4}$$

$$2I = K(A)^2$$

$$\therefore A = 2.8$$

8 box \rightarrow 360°
 2 box \leftarrow 90°



Intensity **ONE THIRD** New graph **lags behind** by **45**.

$$I = K(4)^2$$

$$K = \frac{I}{16}$$

$$\frac{1}{3}I = K(A)^2$$

$$A = 2.3$$

RIGHT SHIFT.

8 box \rightarrow 360°
 1 box \leftarrow 45°

