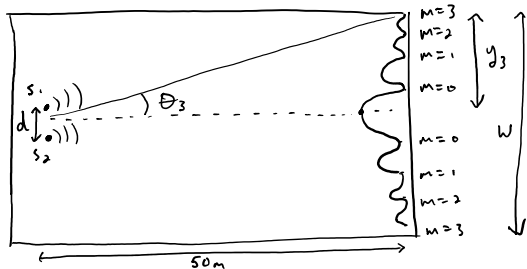


Week 2 Quiz

Monday, April 5, 2021 1:57 PM

Anna and her cold tempered sister want to measure the dimensions of the rectangular theater in which they will be performing. They stand side by side on the stage, two meters apart. Both of them sing a perfect high C (C₅) note at 1046.5 Hz out into the theater. They have enlisted you to help them measure. You pace out a distance of 50 meters from the sisters to the back of the theater, but as you try to measure the full width of the theater, you lose count of your steps. However, you remember that you heard the high C note get louder 7 times during your walk across the full width of the back of the theater. You also remember that on either edge of the theater, the note was rather quiet. (hint: the speed of sound is 343 m/s)

(a) Not wanting to be encased in ice, you inform the sisters of the theater's width. What is the width of the theater? Make sure to include one or more physical representations (diagrams) of the situation!



* Double slit interference pattern.
 * Destructive interference @ endpoints
 find λ : $f\lambda = v \Rightarrow \lambda = \frac{v}{f}$, eq. (i)
 find θ_3 : $d \sin \theta = (m + \frac{1}{2})\lambda$, eq. (ii)

$$\theta_3 = \sin^{-1} \left(\frac{7\lambda}{2d} \right)$$

find y_3 : $L \tan \theta_m = y_m$, eq. (iii)

$$y_3 = 50m \tan(\theta_3)$$

$$W = 2y_3 = \boxed{70m}$$

(b) Is your answer reasonable? Make an order of magnitude sensemaking argument for (or against!) the reasonableness of your answer.

7m would be too small ← "what is this, a concert hall for ants"
 700m would be too big ← "yes, your seats are past the nose bleed section"

70m is on the same order of mag as the length 50m
seems reasonable!

(c) If you wanted to hear more loud and quiet areas across the back of the theater, would you move the sisters closer together or further apart? Explain why.

L, λ , m's constants

as per eq. (iii), if $\theta_m \downarrow$, $y_m \downarrow$, and more fringes fit into hall
 w/ eq. (ii), if $\theta_m \downarrow$, $d \uparrow$, move them further apart

Rubric

Part (a)

- 1 pt - physical representation
- 1 pt - identify double slit setup (or PLD approach)
- 0.5 pt - $f\lambda = v$ eq.
- 0.5 pt - correct wavelength
- 1 pt - identify need to study dark fringes
- 1 pt - $d \sin(\theta) = (m + 1/2)\lambda$ eq.
- 1 pt - $L \tan(\theta) = y$ eq.
- 0.5 pt - $w = 2y$ eq.
- 0.5 pt - correct answer and units

Part (b)

- 1 pt - sensemaking analysis

Part (c)

- 1.5 pt - explanation
- 0.5 pts - answer