Tuesday, April 2, 2019 10:07 PM

General Two Source Interference

Foundation Stage (GI.2.L1)

Lecture 1
Introduction and Two Source Interference

Textbook Chapters (* Calculus version)

- **BoxSand** :: KC videos (Optics)
- **Knight** (College Physics : A strategic approach 3rd) ::
- ***Knight** (Physics for Scientists and Engineers 4th) ::
- **Giancoli** (Physics Principles with Applications 7th) ::

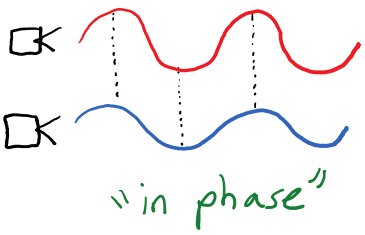
Warm up

GI.2.L1-1:

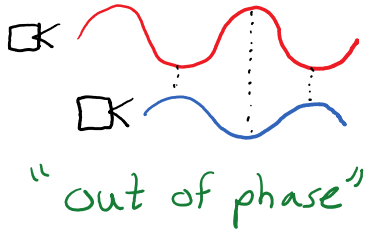
Description:

Learning Objectives: [?] - Can you identify the objectives from the previous lecture, and this lecture, that this question is relevant to?

Problem Statement:



PLD = 0



PLD = $\frac{1}{2}\lambda$

Constructive interference

sound – louder

light – brighter

Conditions for Const. & Destructive Int.

Path length Diff. PLD

Const. if $PLD = |PL_1 - PL_2| = m\lambda$, $m = 0, 1, 2, 3 \ldots$

Dest. if $PLD = |PL_1 - PL_2| = \left(m + \frac{1}{2}\right)\lambda$, $m = 0, 1, 2, 3 \ldots$

Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Path length difference
- Coherent
- Constructive
- Destructive

Key Equations

Constructive	Destructive
PLD = m λ	PLD = $(m + \frac{1}{2})\ \lambda$

Key Concepts

- Coming soon to a lecture template near you.

Questions

Act 0: Two Source Interference

GI.2.L1-2:

Problem Statement: Two sources separated in space …blah …blah …blah. Interference question.

(a) Density of the medium

(b) Ratio of the path lengths

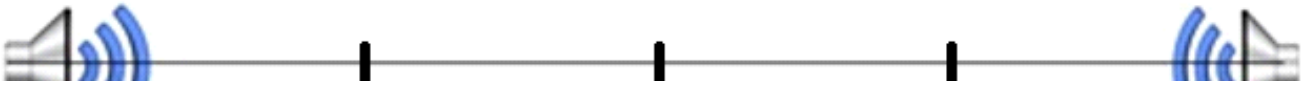
(c) Path Length Difference

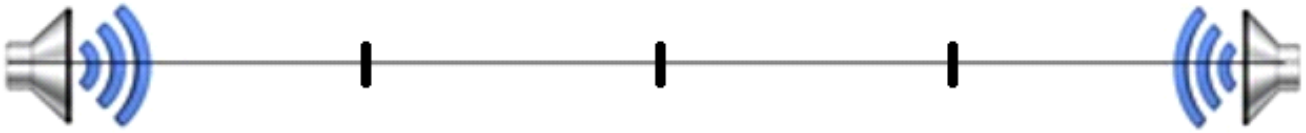
(d) 42 Hz

(e) Depends on what the wave tastes like

GI.2.L1-3:

Problem Statement: Two speakers, 4 m apart, produce identical 343 Hz sound waves. Mark with an X, one location along the line that connects them, where constructive interference occurs.





GI.2.L1-4:

Problem Statement: How many constructive interference points exist between the two speakers?

GI.2.L1-4:

Problem Statement: Which of the following images is displaying a wave interference effect?

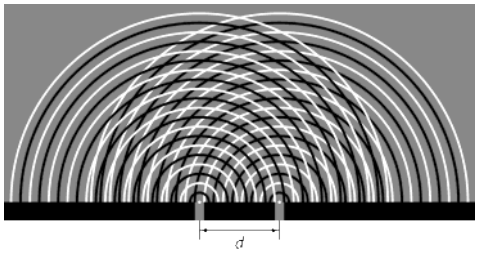
1)

2)

3)

4)

5)



GI.2.L1-5:

Problem Statement: In order to exhibit spatial interference effects, which of the following statements must be true?

1. Must have coherent sources
2. Sources must have the same power
3. Observer must stand still
4. Both sources must produce traveling waves
5. Only one wave is needed
6. Two or more waves are needed

Act I: Path Length Difference

GI.2.L1-6:

Problem Statement: What analysis tools are used when determining Path Length Difference (PLD)?

1. Calculus
2. Geometry
3. Free-body diagrams
4. Pigs
5. Linear algebra
6. Slide rule

GI.2.L1-7:

Problem Statement: Here are two different mathematical models used when determining extrema in two source interference.

Match each to the appropriate type of interference.

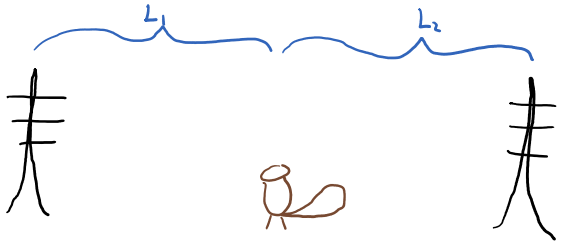
1) $\text{PLD} = m\,\lambda$	A) Completely Constructive
2) $\text{PLD} = \left(m + \frac{1}{2}\right)\lambda$	B) Completely Destructive

Act II: One Dimension

GI.2.L1-8:

Problem Statement: Benny is in his dam in the middle of the valley. On each side of the valley is a radio antenna that is broadcasting the racquetball championship (OSU is playing as they do every year). When Benny is holding his radio in his den, the radio is exactly at the midpoint between the two radio antennae.

(a) Does Benny get good or bad reception in his den?



(b) Thinking of the mathematical model for constructive interference, which value of m should we pick for the location of Benny's den?

1) 1
2) 2
3) 3
4) 4
5) 0

(c) If the frequency is 15 MHz, what is the wavelength of the radiation?

(Hint: the speed of light in air is 2.998 x 10^8 m/s, and the speed of sound in air is 343 m/s)

(d) Benny walks from his den to his kitchen and then into his bedroom. Assume this is a straight line towards one of the antennae . Assume that he is also carrying his radio for some reason!

He notices the reception is good in the den and the bedroom, but it was poor in the kitchen. Which mathematical model would you use to analyze the interference in the bedroom?

1) $\text{PLD} = m\,\lambda$	2) $\text{PLD} = \left(m + \frac{1}{2}\right)\lambda$

(e) RHS: What m-value should we use for the mathematical model of the interference in the bedroom?

1) 1
2) 2
3) 3
4) 4
5) 0

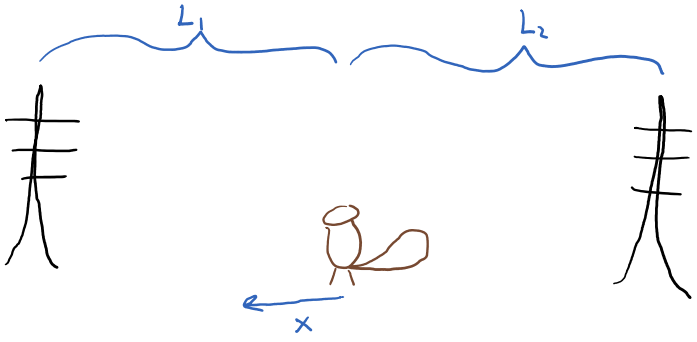
(f) LHS: Which expression could we use for the PLD when Benny is in the bedroom?

1) $(L_1 - x) - (L_2 - x)$

2) $(L_1 - x) - (L_2 + x)$

3) $(L_2 + x) - (L_1 - x)$

4) $(L_1 + x) + (L_2 + x)$



(g) How far is it from the den to the bedroom?

(h) Now consider the kitchen. Which mathematical model would you use to analyze the interference in the kitchen?

1) PLD $= m\,\lambda$	2) PLD $= \left(m + \frac{1}{2}\right)\lambda$

(i) RHS: What m-value should we use for the mathematical model of the interference in the kitchen?

1) 1
2) 2
3) 3
4) 4
5) 0

(j) LHS: Which expression could we use for the PLD when Benny is in the kitchen?

1) $(L_1 - x) - (L_2 - x)$

2) $(L_1 - x) - (L_2 + x)$

3) $(L_1 + x) - (L_2 - x)$

4) $(L_1 + x) + (L_2 + x)$

(k) How far is it from the den to the kitchen?

(l) Using the general equation for all locations, fill out the following two tables for locations of constructive and destructive interference.

Constructive Interference:

m-value	LHS:	RHS:	X_m
0			
1			
2			

3			
4			

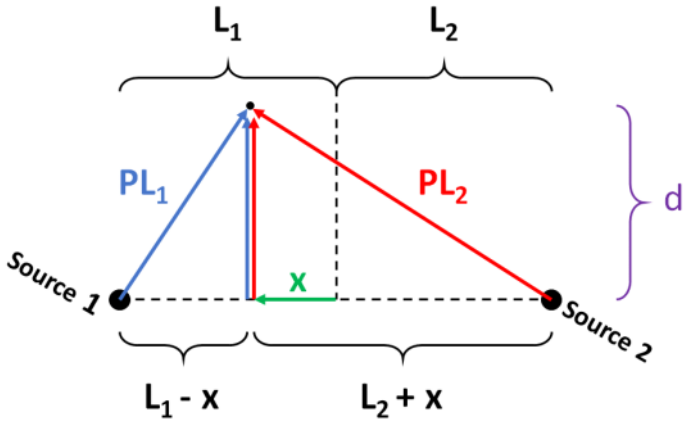
Destructive Interference:

m-value	LHS:	RHS:	X_m
0			
1			
2			
3			
4			

GI.2.L1-9:

Problem Statement: Two sources produce identical spherical waves.

In the 2D plane that intersects the two sources, there is a line along which all points will display constructive interference.



(a) Which old dead Ionian Greek guy would be helpful when analyzing this problem?

1. Bernoulli
2. Coulomb
3. Einstein
4. Pythagoras
5. Newtdog
6. Euler

(b) In terms of given quantities, what is PL1?

(c) What is PL2?

(d) LHS: What is the PLD?

(e) RHS: what do you set PLD equal to for the 3rd constructive maximum?

(f) Suppose $L_1 = L_2 = d = 2$ m and $\lambda = 495.5$ mm and you are 42 m from the perpendicular bisector. If you hear a loud sound, what m-value does this correspond to?

Conceptual questions for discussion

1. Coming soon to a lecture template near you.

Hints

TW.2.L1-1: No hints.

TW.2.L1-2: No hints.

TW.2.L1-3: No hints.

TW.2.L1-4: No hints.

TW.2.L1-5: No hints.

TW.2.L1-6: No hints.

TW.2.L1-7: No hints.

TW.2.L1-8: No hints.

TW.2.L1-9: No hints.

TW.2.L1-10: No hints.

TW.2.L1-11: No hints.

TW.2.L1-12: No hints.

TW.2.L1-13: No hints.