Wave Interference

IB PHYSICS | WAVES - SOUND

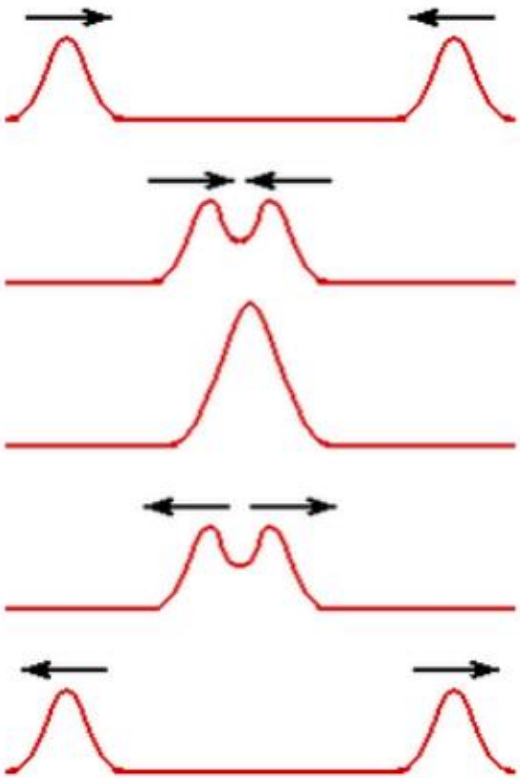
Interference

When several waves are in the same location, they combine to produce a new wave that is different from the original waves.

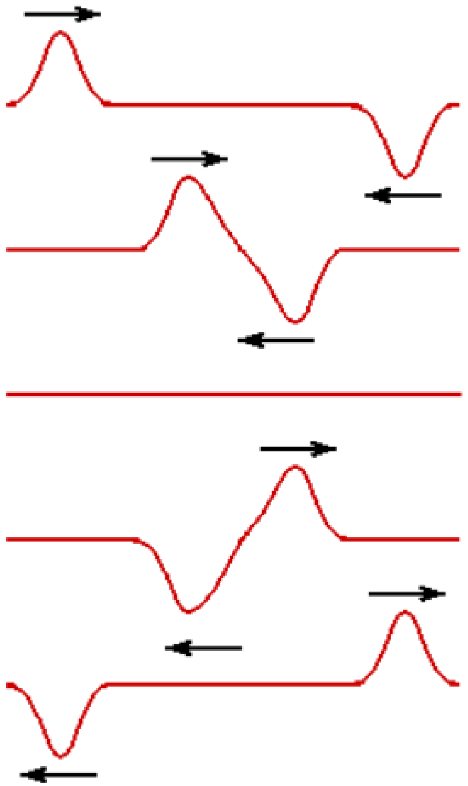
After waves pass by one another continue on __unchanged__

Name that Interference

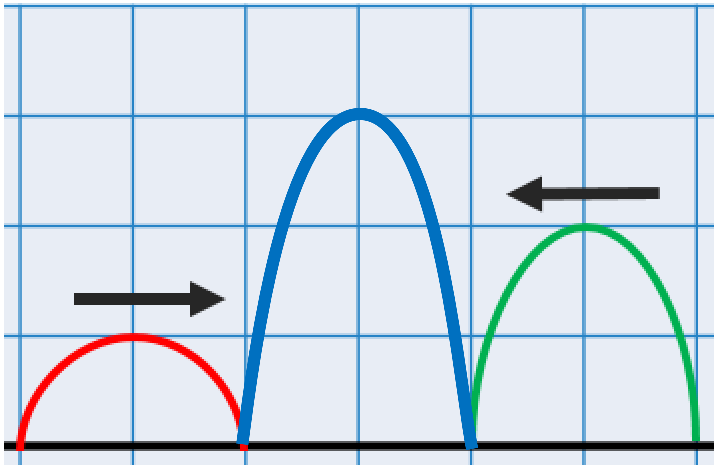
Constructive Interference

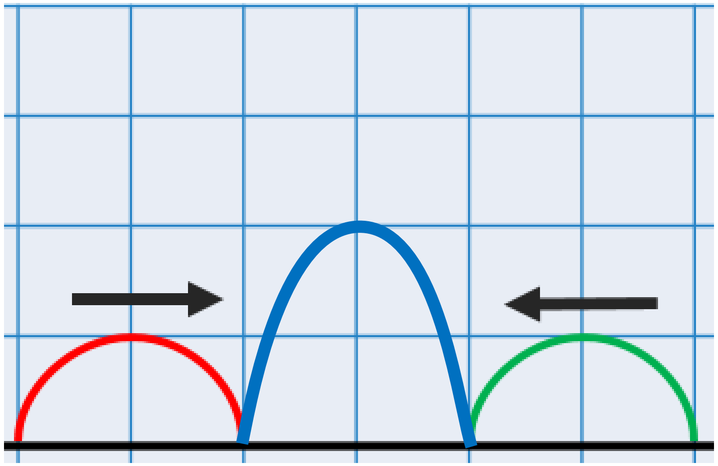


Destructive Interference

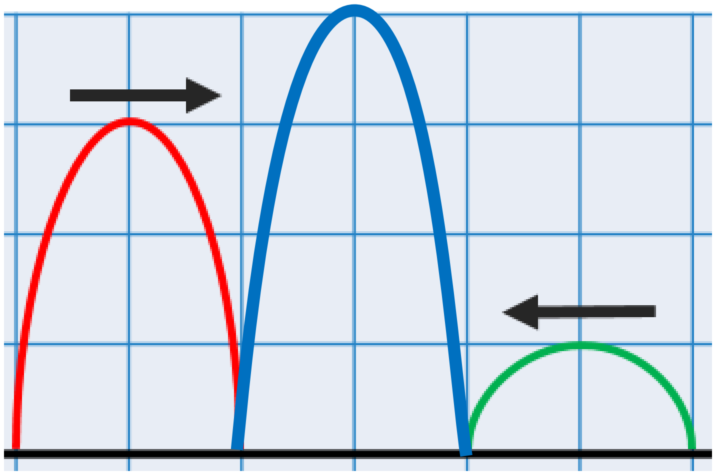


Constructive Interference

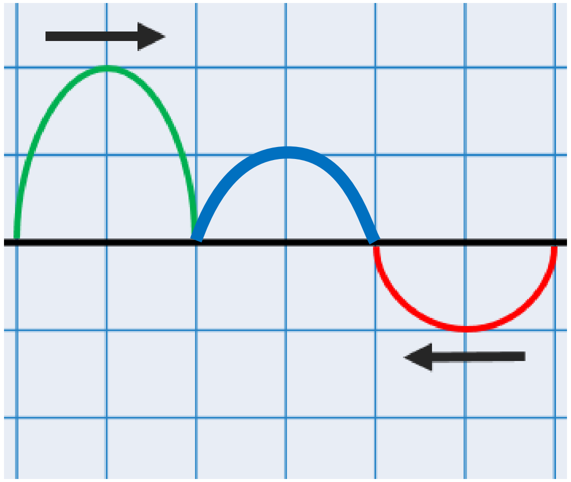


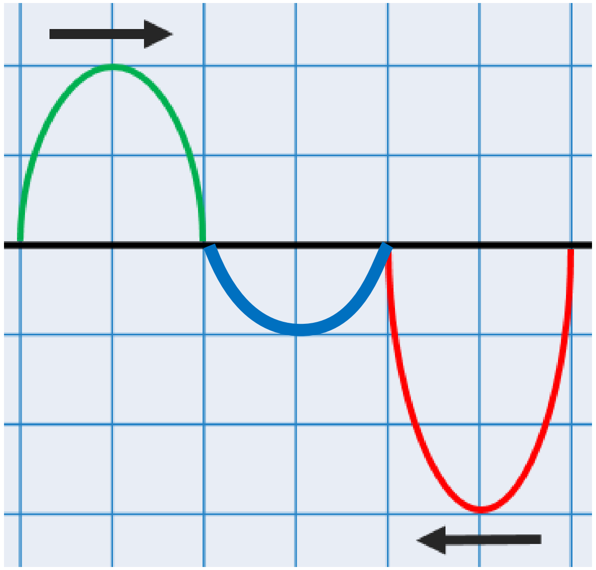


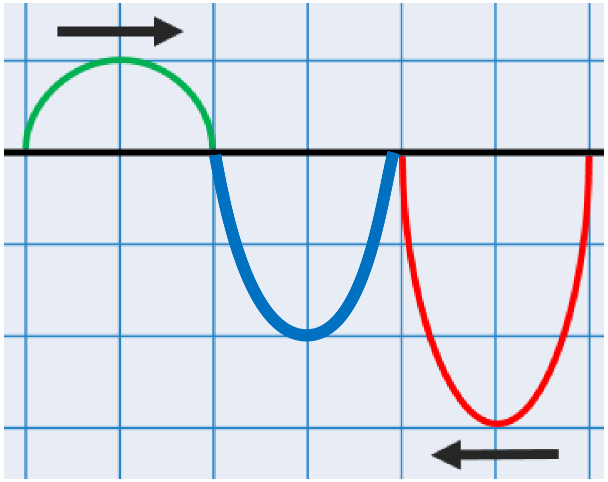
What is the resulting amplitude when these waves meet?



Destructive Interference

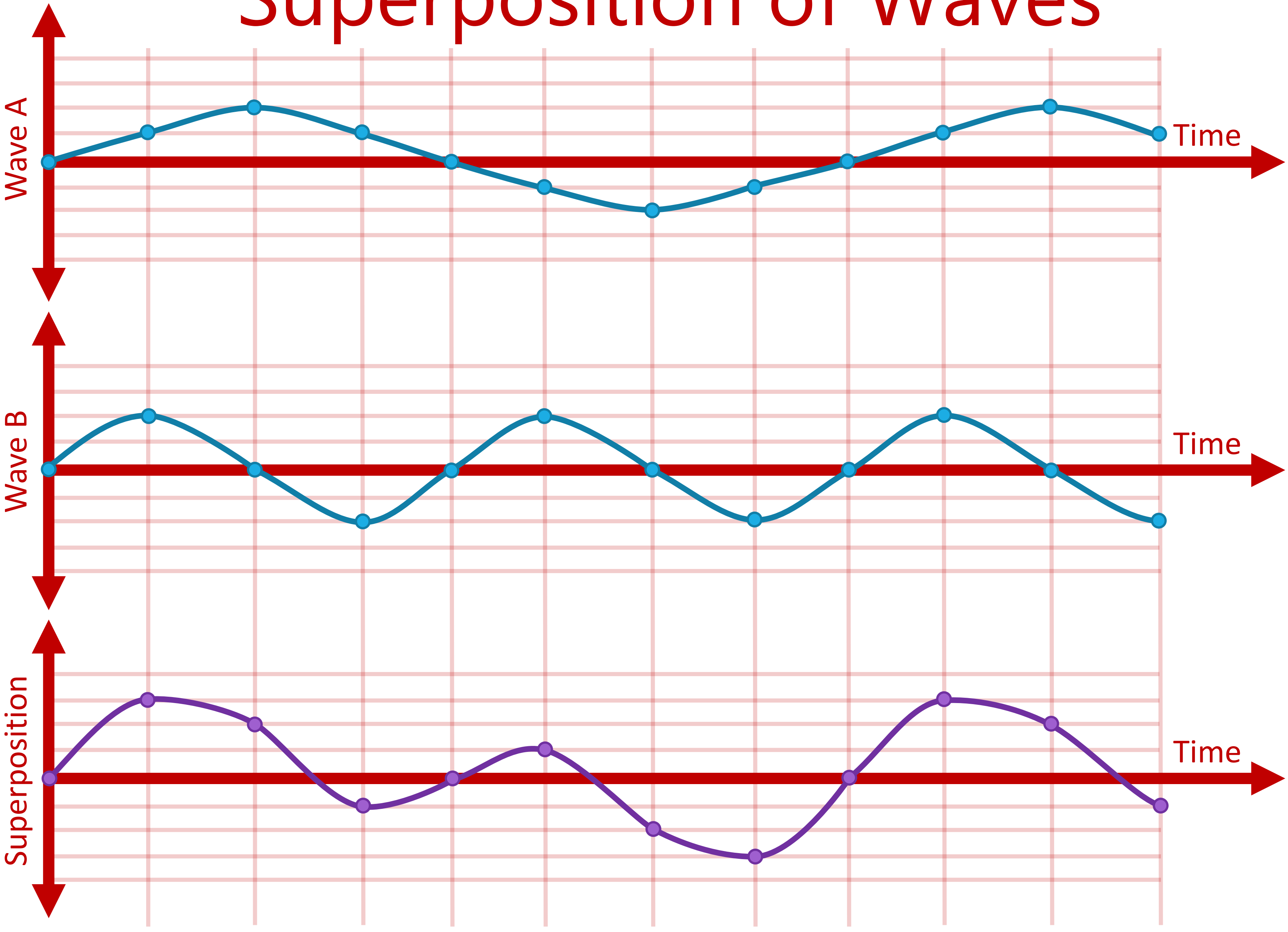






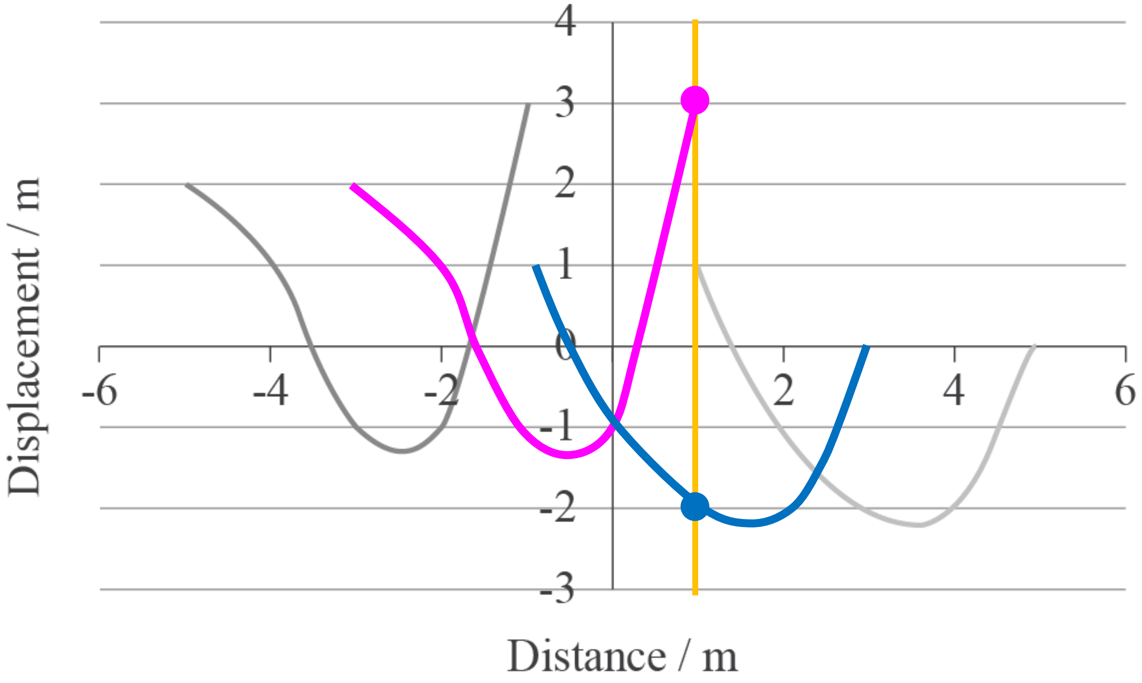
What is the resulting amplitude when these waves meet?

Superposition of Waves



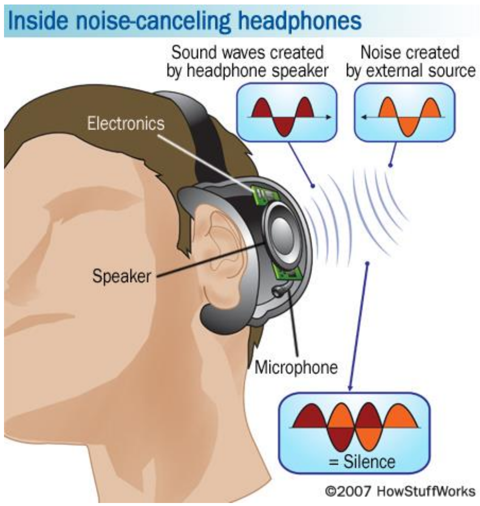
IB Sample Question

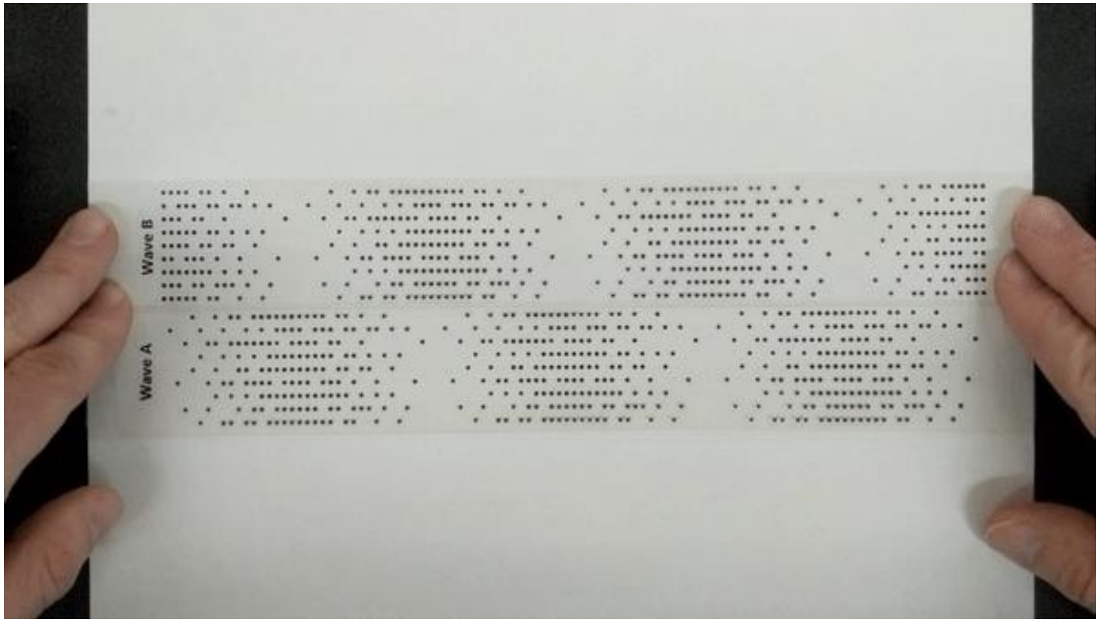
Both the waves below are moving at 0.5 m s^{-1} towards each other. What is the displacement at a distance of 1 m, after 4 s has passed?



$(+3) + (-2) = \mathbf{+1}$

Noise Canceling Headphones



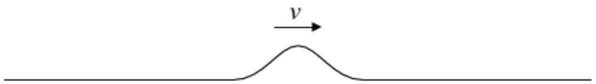


IB Sample Question

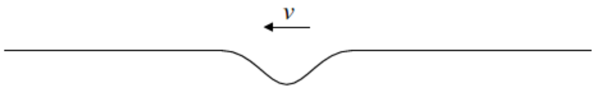
15. Two wave pulses travel along a string towards each other. The diagram shows their positions at a moment in time.

Which of the following shows a possible configuration of the pulses at a later time?

A.



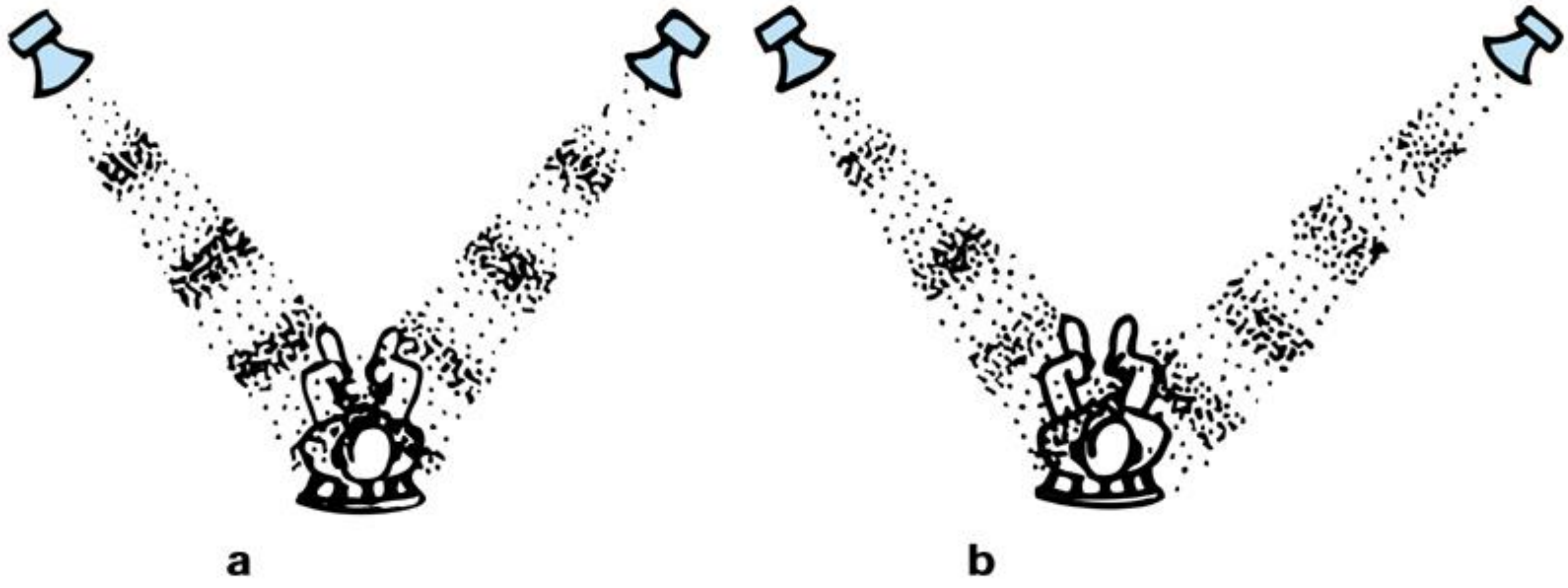
B.



C.

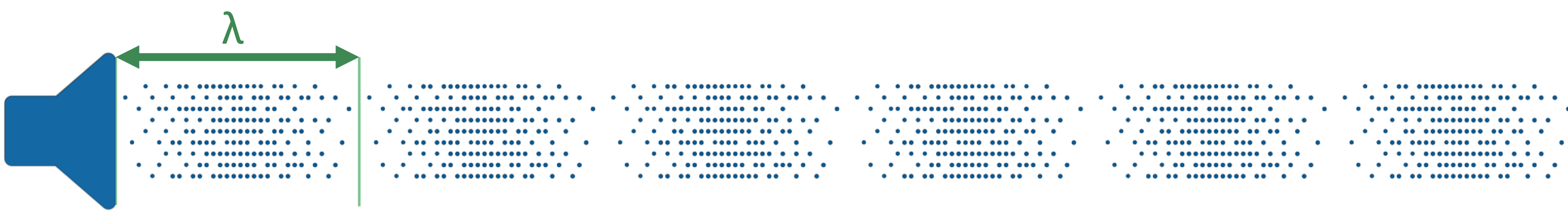
D.

Interference from Multiple Sources



Constructive Destructive

1D Sound Interference



Path Difference = 2.5λ

0λ	0.5λ	1λ	1.5λ	2λ	2.5λ	
✓		✓		✓		Constructive
	✓		✓		✓	Destructive

Path Difference = $n\lambda$

Path Difference = $(n + \frac{1}{2})\lambda$

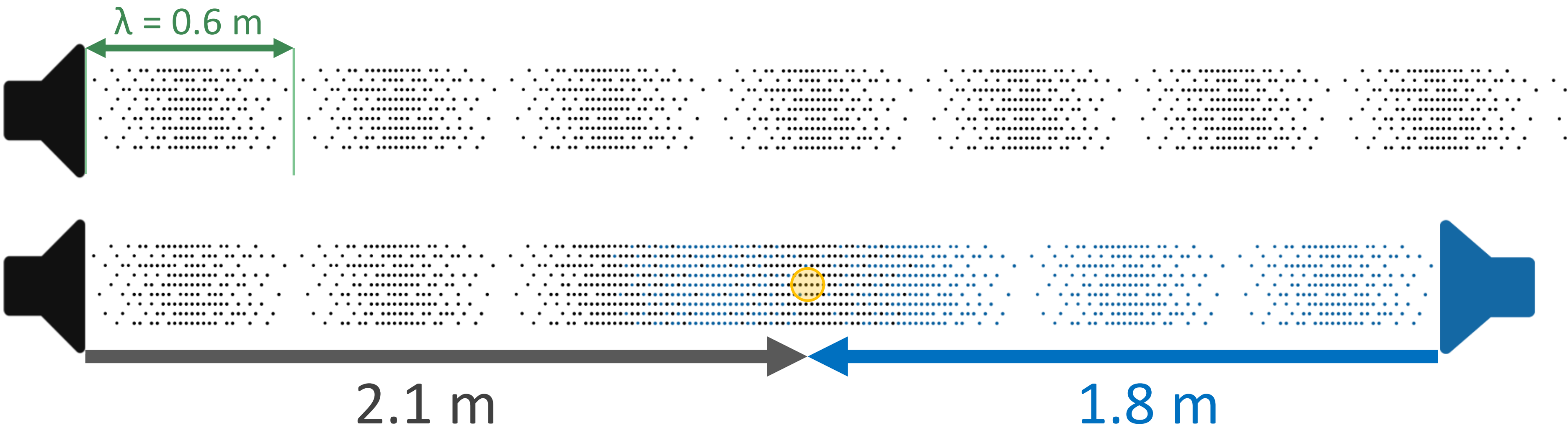
*n is any integer

These are known as "**coherent waves**" because they have the same frequency and a constant phase difference

IB Physics Data Booklet

Sub-topic 4.1 – Oscillations	Sub-topic 4.4 – Wave behaviour
$T = \frac{1}{f}$	$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$ $s = \frac{\lambda D}{d}$ Constructive interference: path difference $= n\lambda$ Destructive interference: path difference $= (n + \frac{1}{2})\lambda$
Sub-topic 4.2 – Travelling waves	
$c = f\lambda$	
Sub-topic 4.3 – Wave characteristics	
$I \propto A^2$ $I \propto x^{-2}$ $I = I_0 cos^2\,\theta$	

Finding a Minimum



Path Difference = 2.1 – 1.8 = 0.3 m

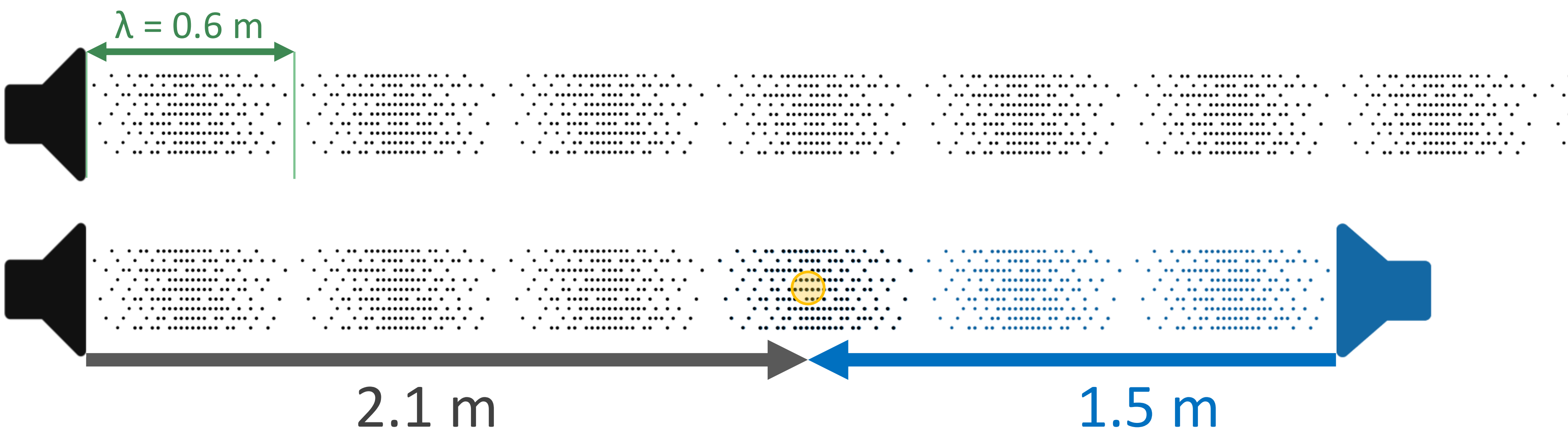
Path Difference = (   ) × λ

0.3 m = (0.5) × 0.6 m

Constructive | Path Difference = $n\lambda$

Destructive | Path Difference = $(n + \frac{1}{2})\lambda$

Finding a Maximum



Path Difference = 2.1 – 1.5 = 0.6 m

Path Difference = (   ) × λ

0.6 m = (1) × 0.6 m

Constructive | Path Difference = $n\lambda$

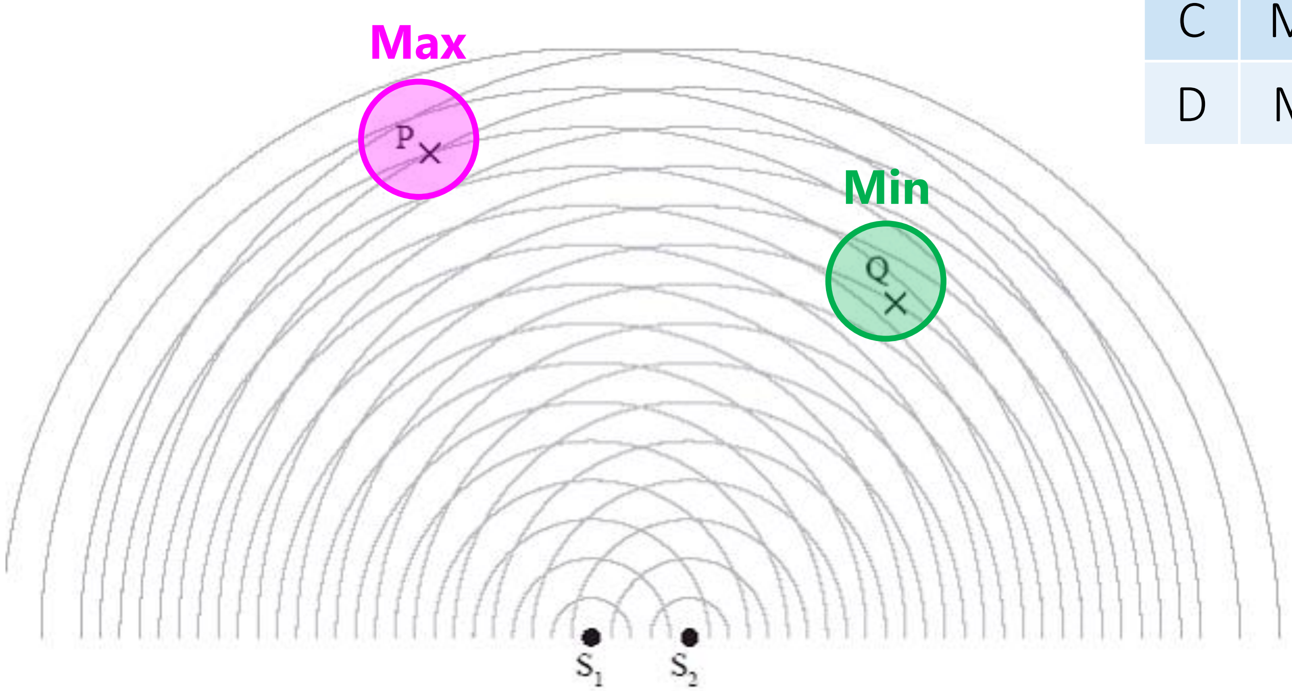
Destructive | Path Difference = $(n + \frac{1}{2})\lambda$

Try This

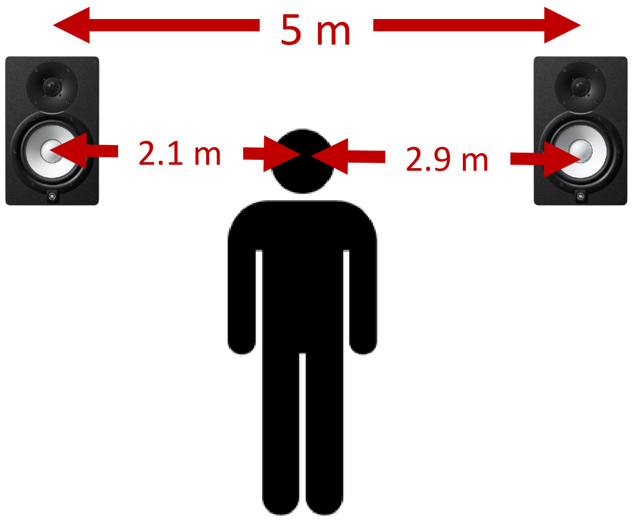
Two coherent point sources S_1 and S_2 emit spherical waves.

Which of the following best describes the intensity of the waves at P and Q?

	P	Q
A	Maximum	Minimum
B	Minimum	Maximum
C	Maximum	Maximum
D	Minimum	Minimum



Try this #1



Two speakers are separated by a distance of 5 meters, if they emit a coherent sound signal of 850 Hz. If the speed of sound is 340 m s^{-1}, is this person in a maximum or minimum location?

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{340}{850} = 0.4\,m$$

Path Difference

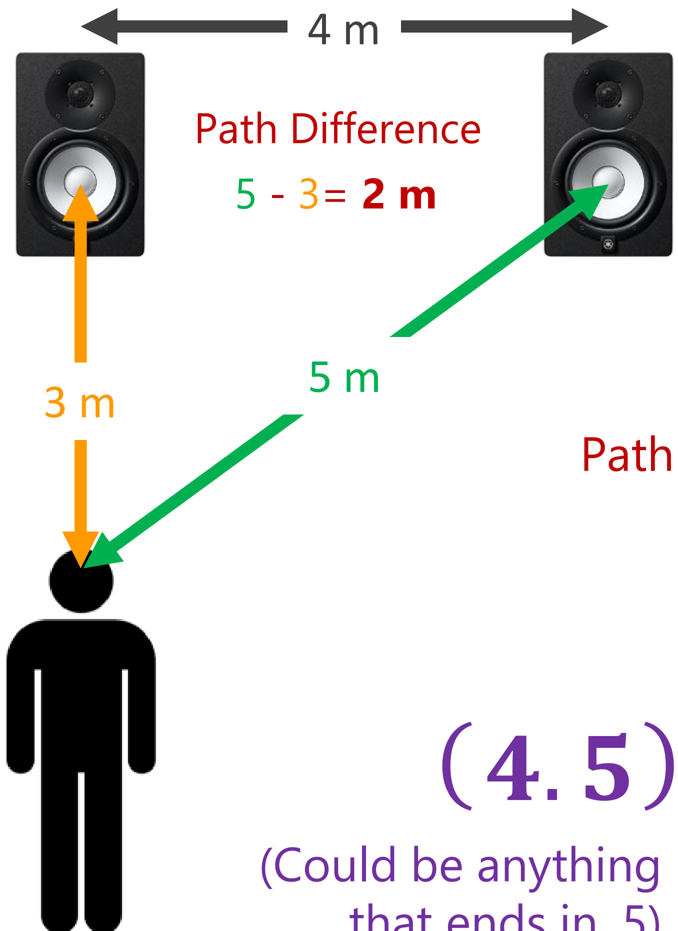
2.9 – 2.1 = **0.8 m**

Path Difference = (___) × λ

$$\frac{0.8}{0.4} = \mathbf{2}$$

Maximum because result is a perfect integer

Try This #2



If these speakers are playing a note with a frequency of 680 Hz, is this person standing at a maximum or minimum spot? Assume a speed of sound of 340 m s^{-2}

$$\lambda = \frac{v}{f} = \frac{340}{680} = 0.5\ m$$

Path Diff. = (   ) × λ

$$\frac{2}{0.5} = 4$$

Maximum because result is a perfect integer

What frequency would result in the opposite effect?

$$(4.5) = \frac{2\ \text{m}}{\lambda}$$

(Could be anything that ends in .5)

$$\lambda = 0.44\ \text{m}$$

$$f = \frac{v}{\lambda} = \frac{340}{0.44} = \mathbf{773\ Hz}$$

Lesson Takeaways

- ❑ I can qualitatively and quantitatively interpret cases of constructive and destructive interference
- ❑ I can add up two waves with superposition to create a new waveform
- ❑ I can use wavelength and source distance to identify maxima and minima for interference