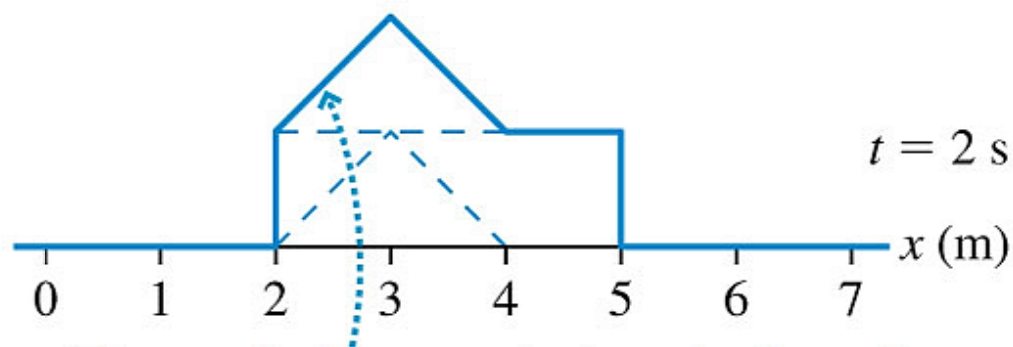
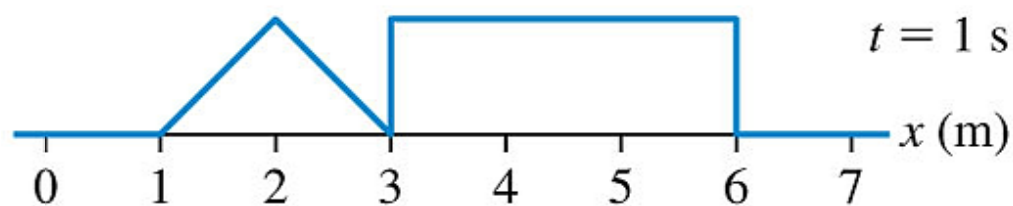
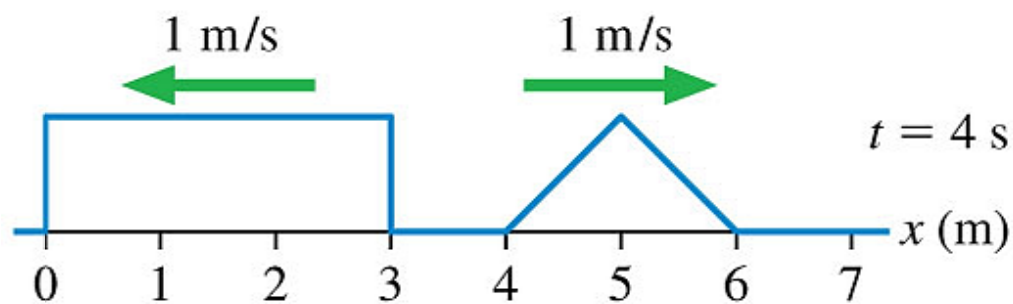
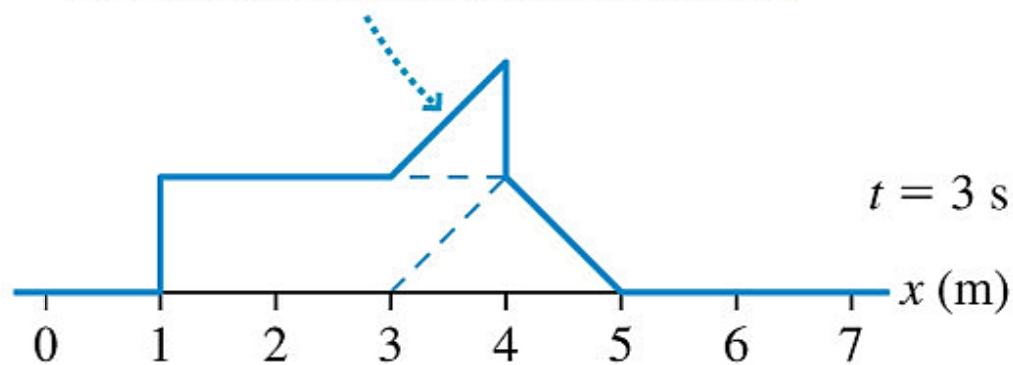


Two waves approach each other.



The net displacement is the point-by-point summation of the individual waves.

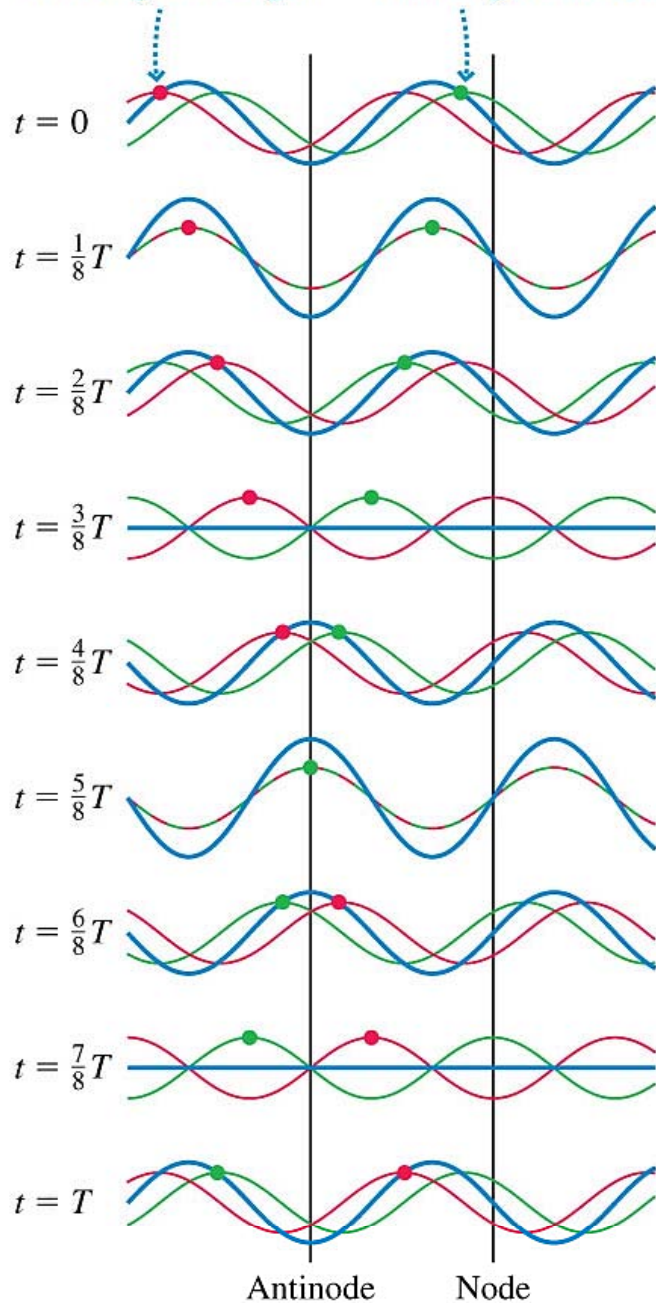


Both waves emerge unchanged.

(a) A string is carrying two waves moving in opposite directions.



(b) The red wave is traveling to the right. The green wave is traveling to the left.



The blue wave is the superposition of the red and green waves.

At this time the waves exactly overlap and the superposition has a maximum amplitude.

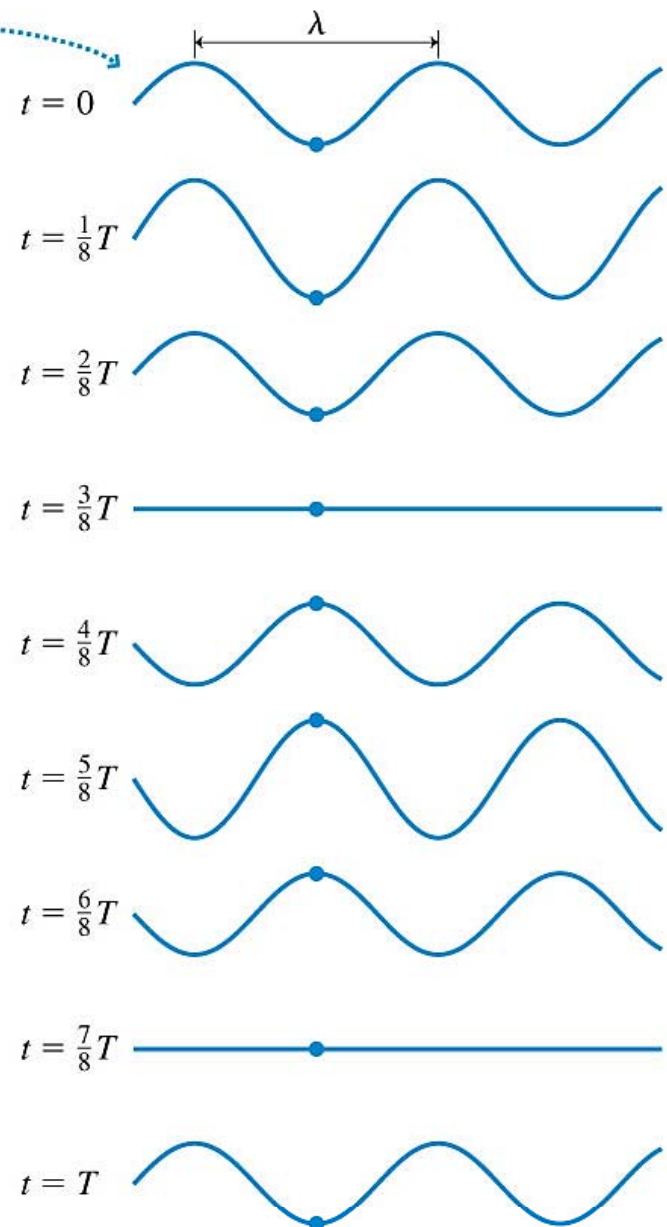
At this time a crest of the red wave meets a trough of the green wave. The waves cancel.

The superposition again reaches a maximum amplitude.

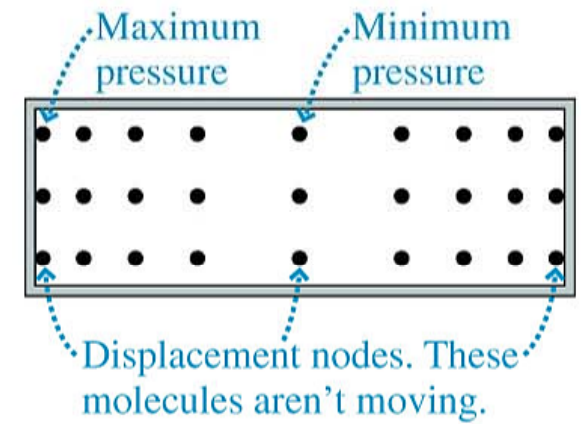
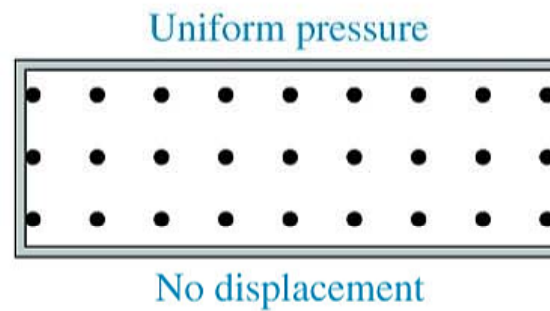
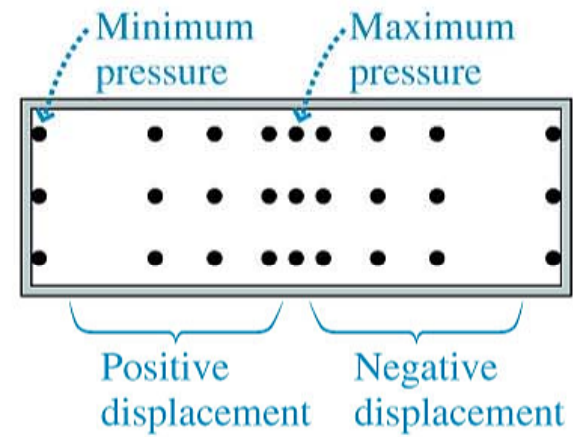
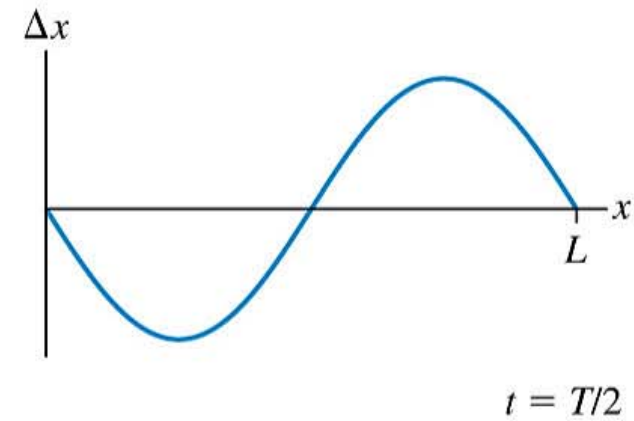
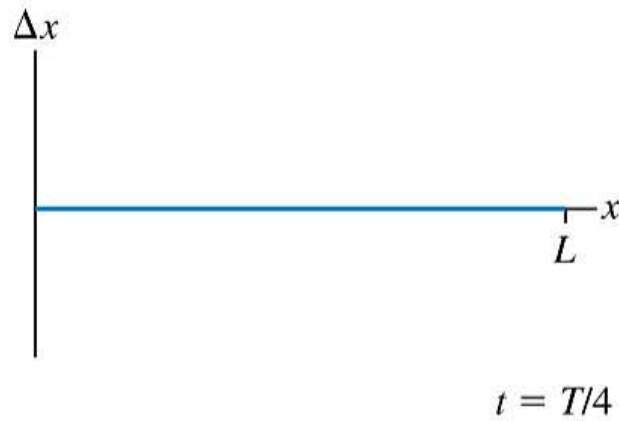
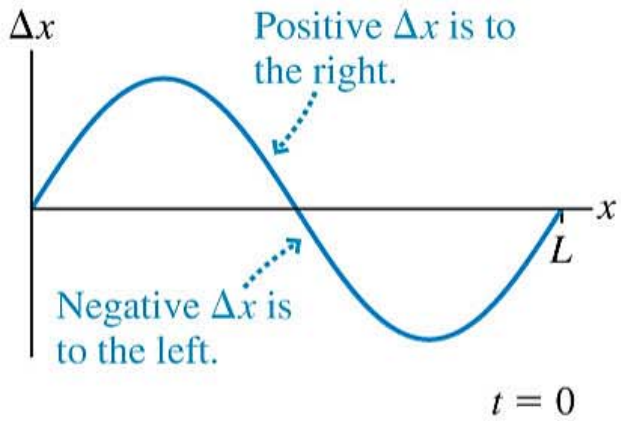
The waves again overlap and cancel.

At this time the superposition has the form it had at $t = 0$.

(c) The superposition is a standing wave with the same wavelength as the original waves.

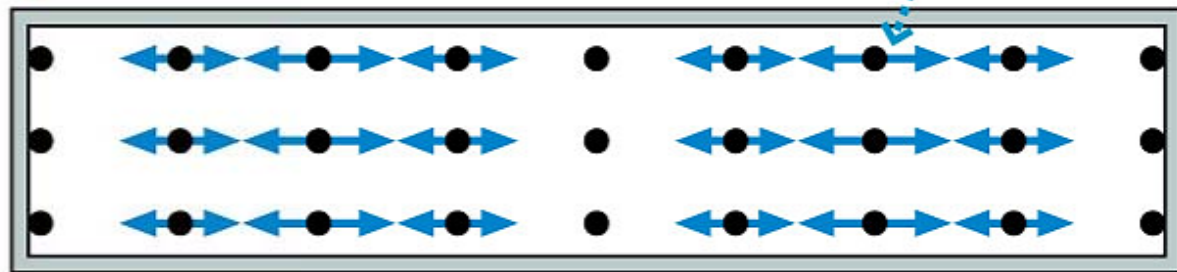




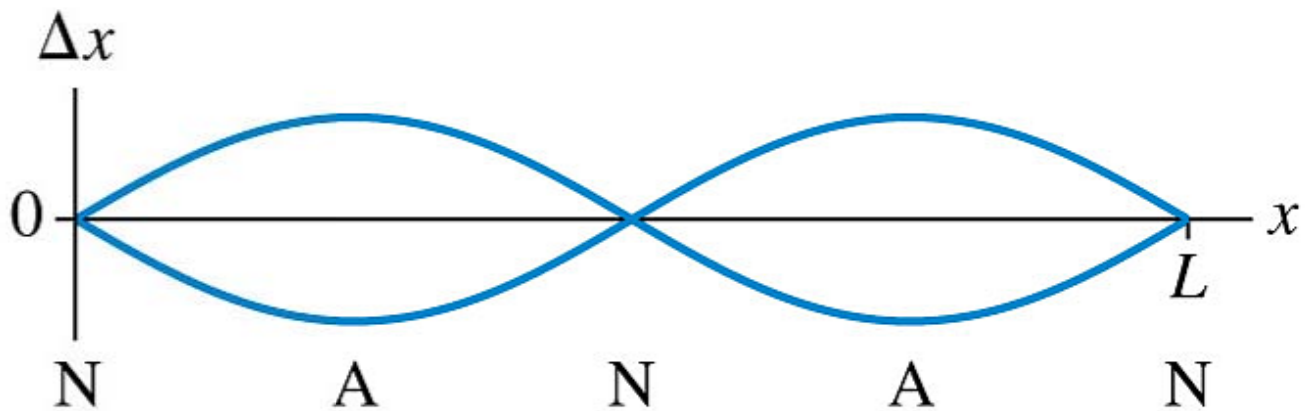


The closed end is a displacement node and a pressure antinode.

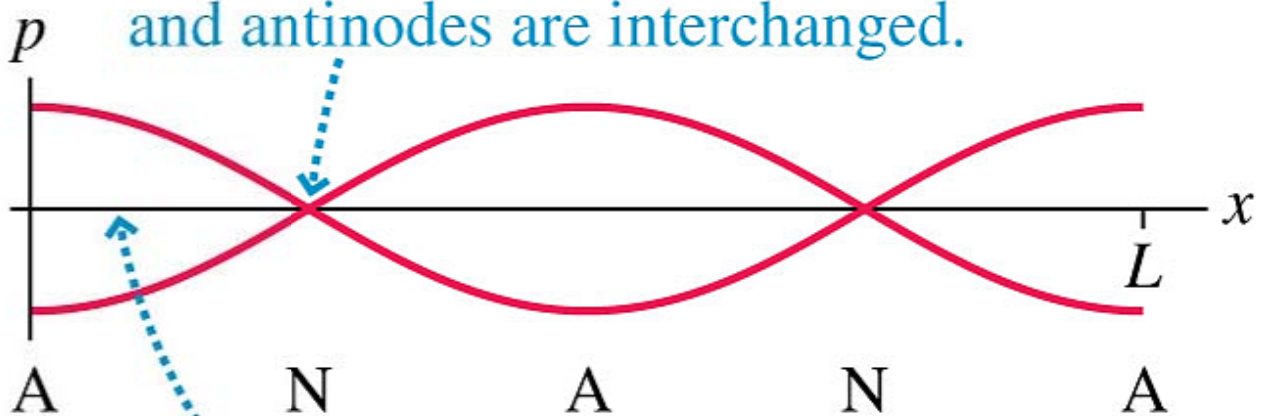
Air molecules undergo longitudinal oscillations. This is a displacement antinode and a pressure node.



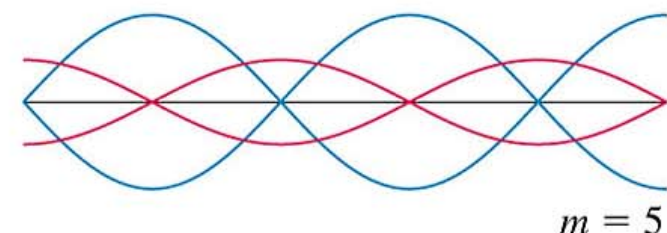
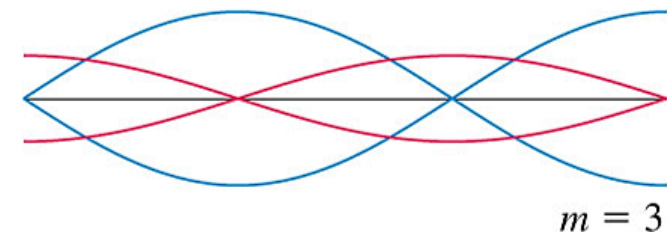
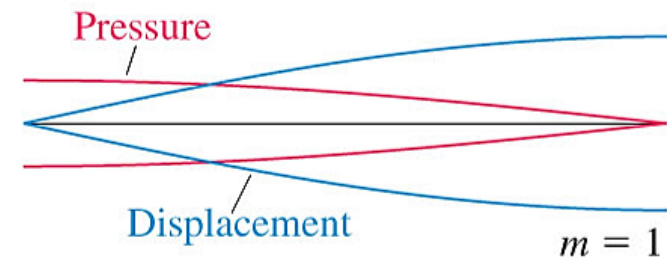
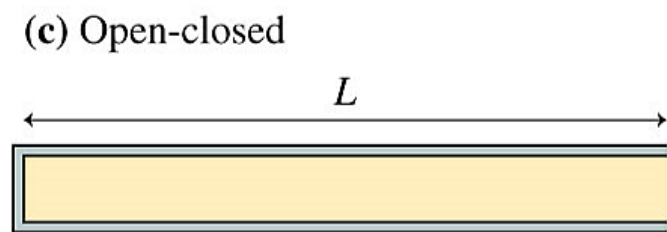
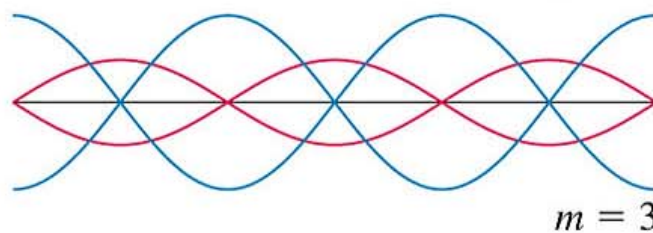
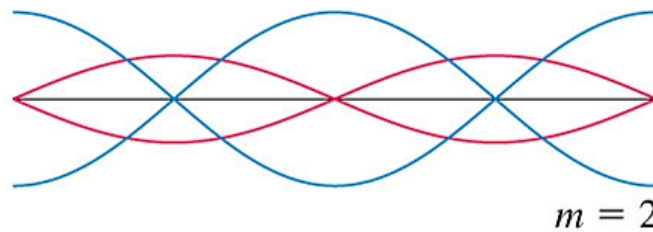
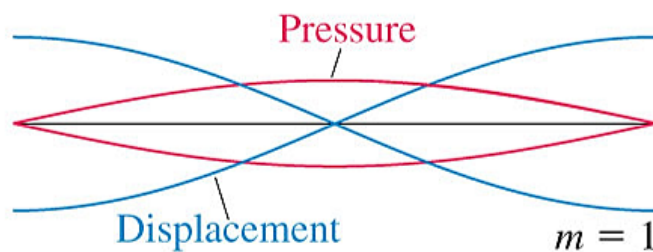
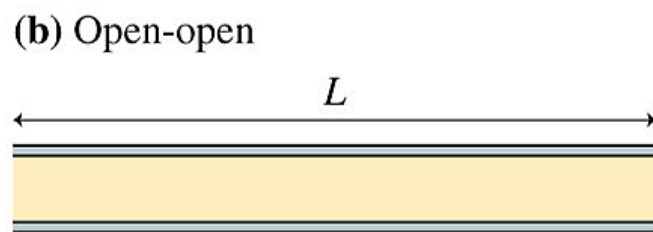
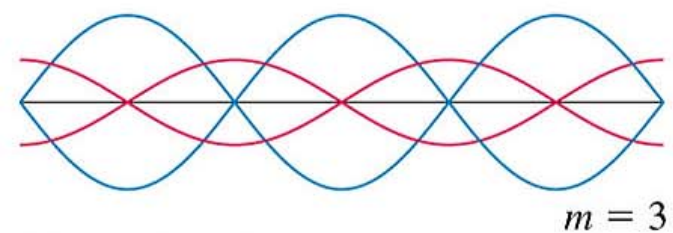
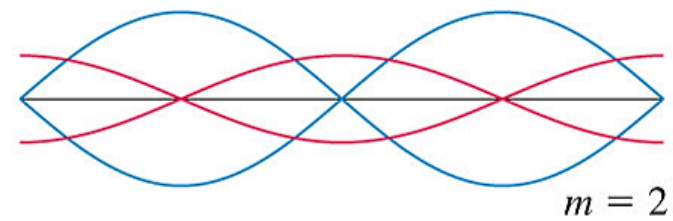
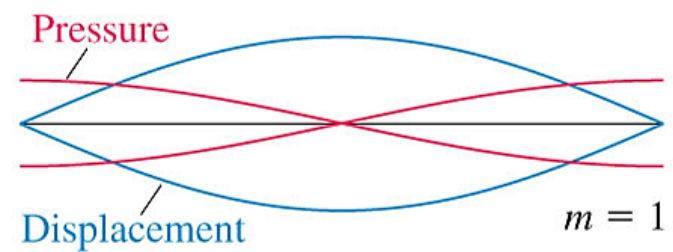
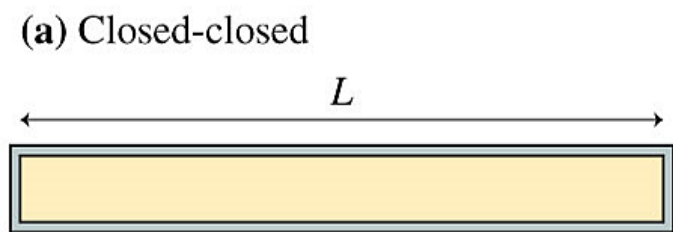
L



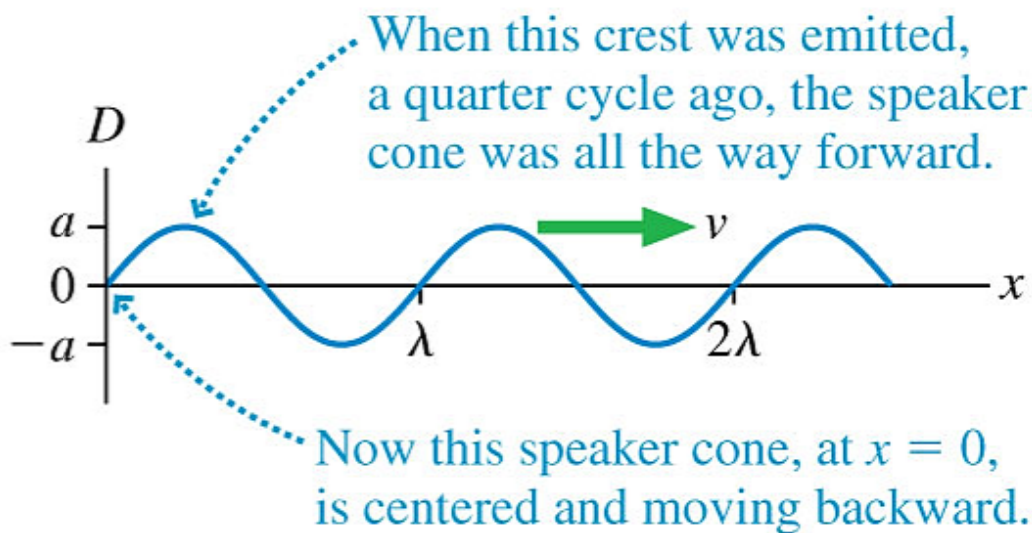
The displacement and pressure nodes and antinodes are interchanged.



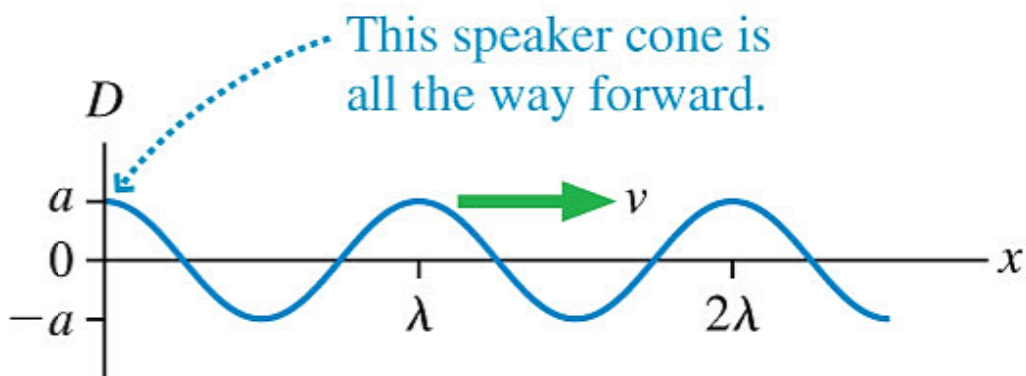
The pressure is oscillating around atmospheric pressure p_{atmos} .



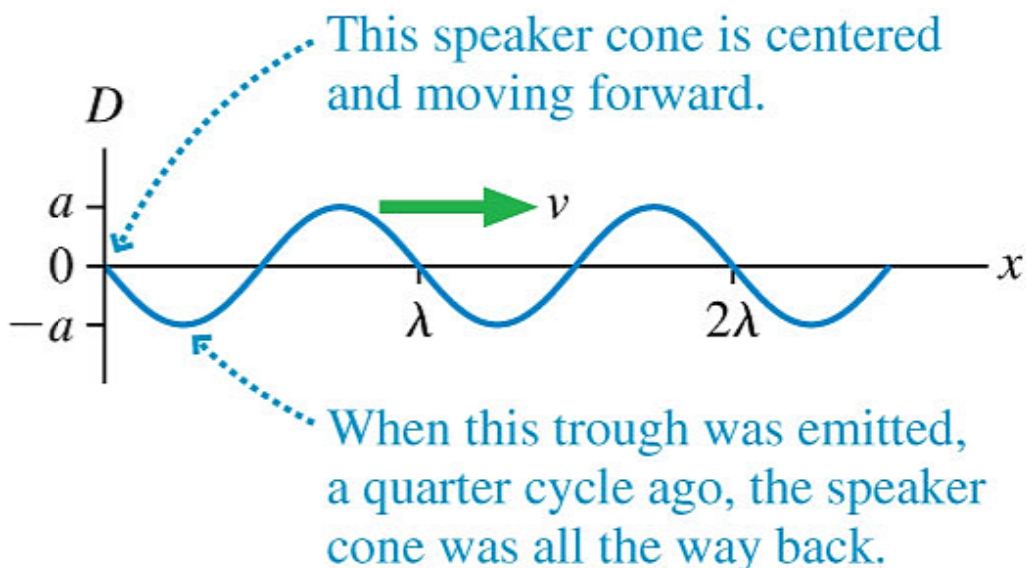
(a) Snapshot graph at $t = 0$ for $\phi_0 = 0$ rad



(b) Snapshot graph at $t = 0$ for $\phi_0 = \pi/2$ rad

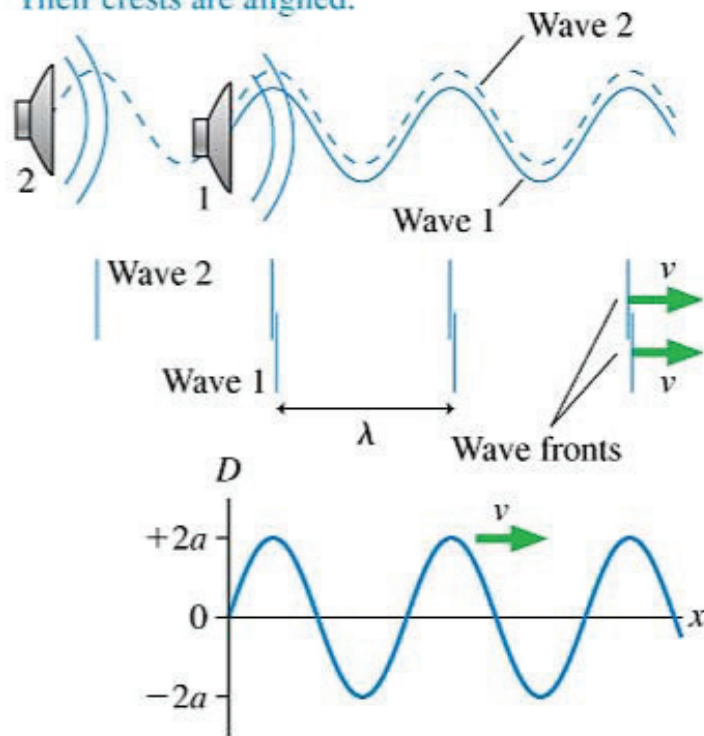


(c) Snapshot graph at $t = 0$ for $\phi_0 = \pi$ rad



(a) Constructive interference

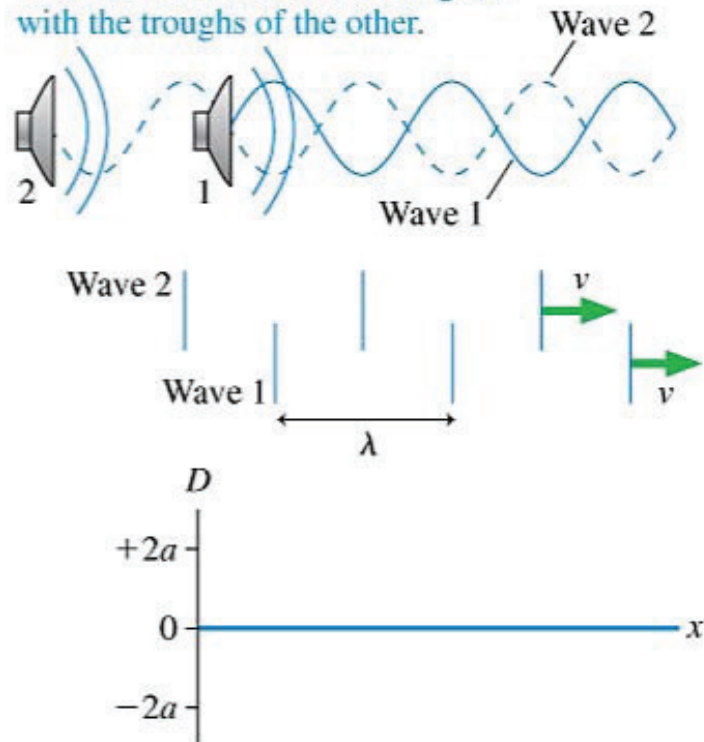
These two waves are in phase.
Their crests are aligned.



Their superposition produces a traveling wave moving to the right with amplitude $2a$. This is maximum constructive interference.

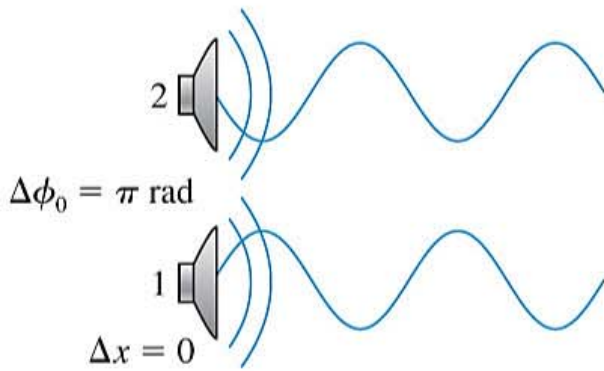
(b) Destructive interference

These two waves are out of phase.
The crests of one wave are aligned with the troughs of the other.

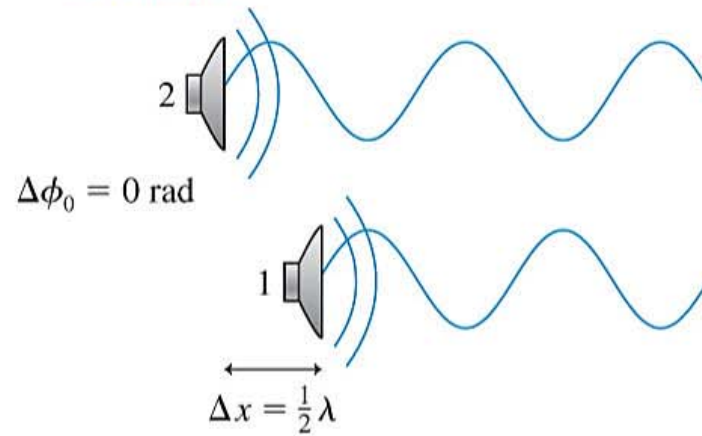


Their superposition produces a wave with zero amplitude. This is perfect destructive interference.

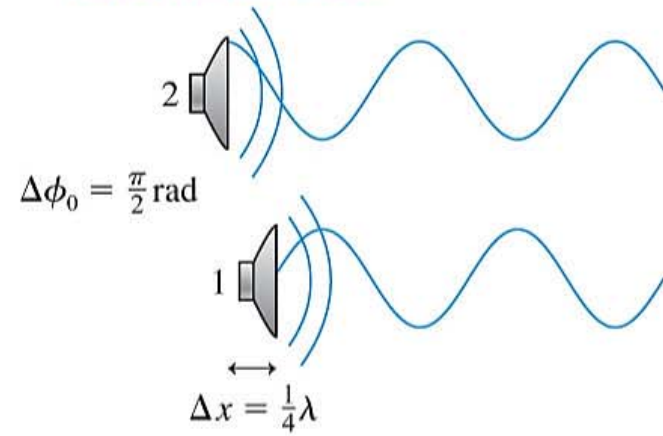
(a) The sources are out of phase.



(b) Identical sources are separated by half a wavelength.



(c) The sources are both separated and partially out of phase.



(a) The sources are out of phase.

