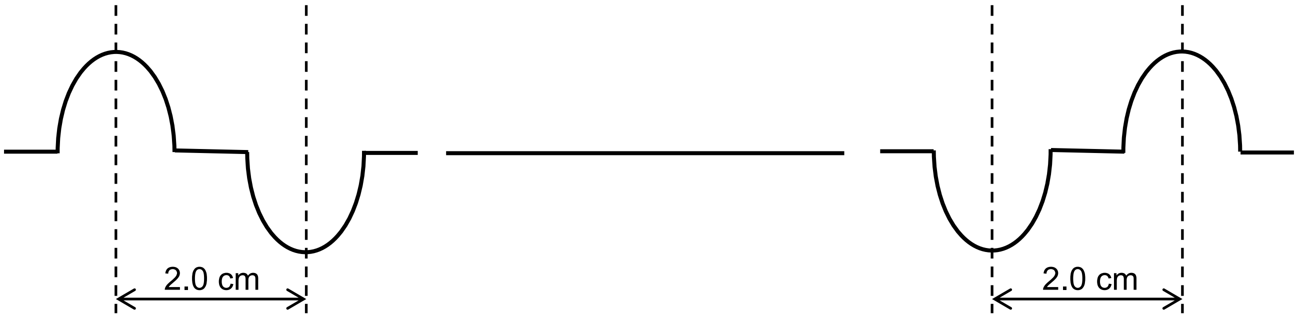
2025 Sec 4 AP1 Superposition

Answers to Examples

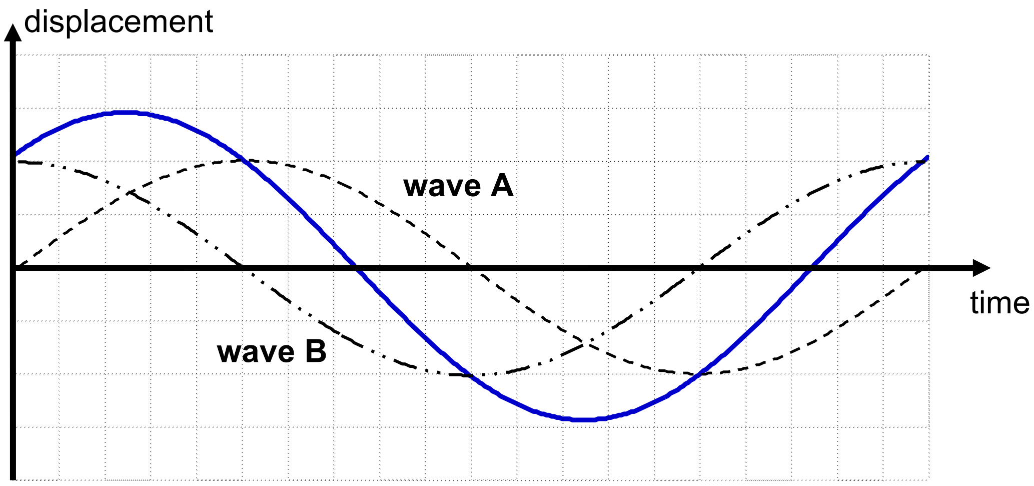
Example 1

distance travelled by one pulse in 5.0 ms = v t
= (2.0)(5.0 / 1000)
= 0.010 m
= 1.0 cm

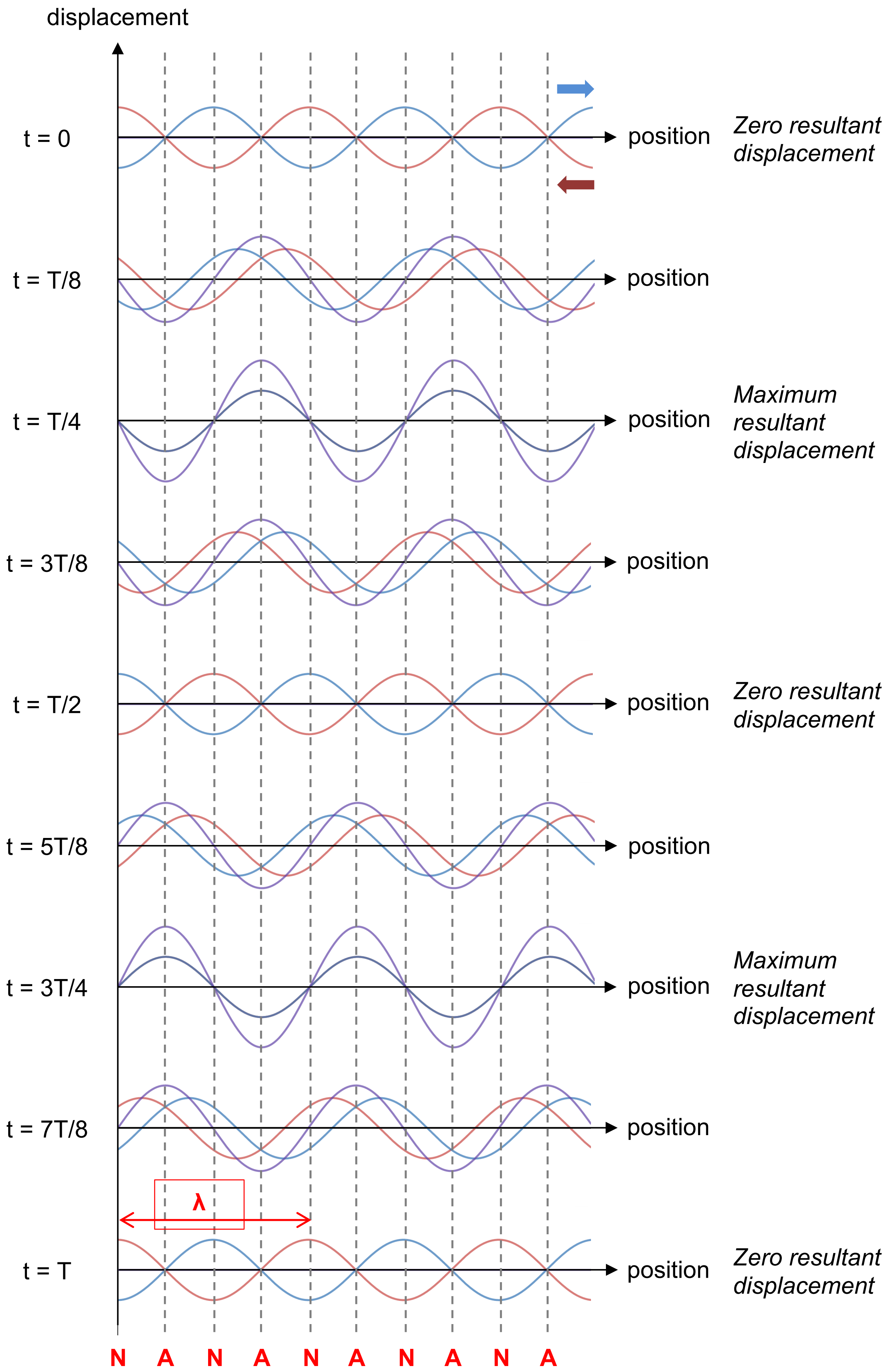
t = 10 ms **t = 15 ms** **t = 20 ms**

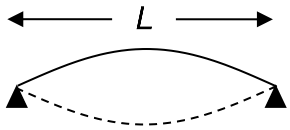
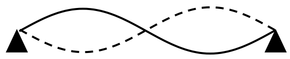


Example 2



Example 3


displacement
t = 0
position
Zero resultant displacement
t = T/8
position
t = T/4
position
Maximum resultant displacement
t = 3T/8
position
t = T/2
position
Zero resultant displacement
t = 5T/8
position
t = 3T/4
position
Maximum resultant displacement
t = 7T/8
position
λ
t = T
position
Zero resultant displacement
N A N A N A N A N A

Harmonic Series	Mode of Vibration	Wavelength	Frequency
First harmonic (Fundamental mode)		$\lambda_1 = 2L$	$f_1 = \frac{v}{2L}$
Second harmonic (First overtone)		$\lambda_2 = L$	$f_2 = \frac{v}{L} = 2f_1$
Third harmonic (Second overtone)		$\lambda_3 = \frac{2L}{3}$	$f_3 = \frac{3v}{2L} = 3f_1$
n-th harmonic (n−1-th overtone)	All harmonics are possible	$\lambda_n = \frac{2L}{n}$	$f_n = \frac{nv}{2L} = nf_1$

Example 4

Distance between consecutive nodes = $\lambda / 2$

$\lambda = 0.40 \times 2$

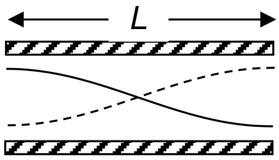
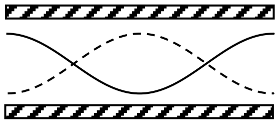
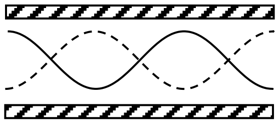
$= 0.80$ m

$v = f\lambda$

$f = v / \lambda$

$= 300 / 0.80$

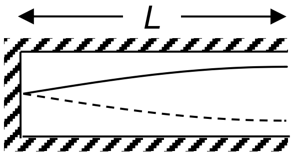
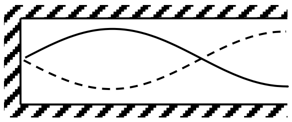
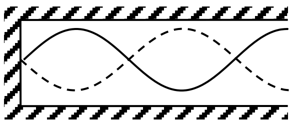
$= 380$ Hz (2 sf)

Harmonic Series	Mode of Vibration	Wavelength	Frequency
First harmonic (Fundamental mode)		$\lambda_1 = 2L$	$f_1 = \frac{v}{2L}$
Second harmonic (First overtone)		$\lambda_2 = L$	$f_2 = \frac{v}{L} = 2f_1$
Third harmonic (Second overtone)		$\lambda_3 = \frac{2L}{3}$	$f_3 = \frac{3v}{2L} = 3f_1$
n-th harmonic (n−1-th overtone)	All harmonics are possible	$\lambda_n = \frac{2L}{n}$	$f_n = \frac{nv}{2L} = nf_1$

Example 5

2 λ = 2.5
λ = 1.25 m

v = f λ
= 260 (1.25)
= 330 m s^{-1} (2 sf)

Harmonic Series	Mode of Vibration	Wavelength	Frequency
First harmonic (Fundamental mode)		$\lambda_1 = 4L$	$f_1 = \frac{v}{4L}$
Second harmonic	-	-	-
Third harmonic (First overtone)		$\lambda_3 = \frac{4L}{3}$	$f_3 = \frac{3v}{4L} = 3f_1$
Fourth harmonic	-	-	-
Fifth harmonic (Second overtone)		$\lambda_5 = \frac{4L}{5}$	$f_5 = \frac{5v}{4L} = 5f_1$
n-th harmonic ($\frac{n-1}{2}$-th overtone)	Only odd-numbered harmonics are possible	$\lambda_n = \frac{4L}{n}$	$f_n = \frac{nv}{4L} = nf_1$

Example 6

(a) First harmonic: λ / 4 = 17.0
λ = 68.0 cm

(b) No change in frequency, velocity or wavelength

Third harmonic: *l* = 0.75 λ
= 0.75 (68.0)
= 51.0 cm