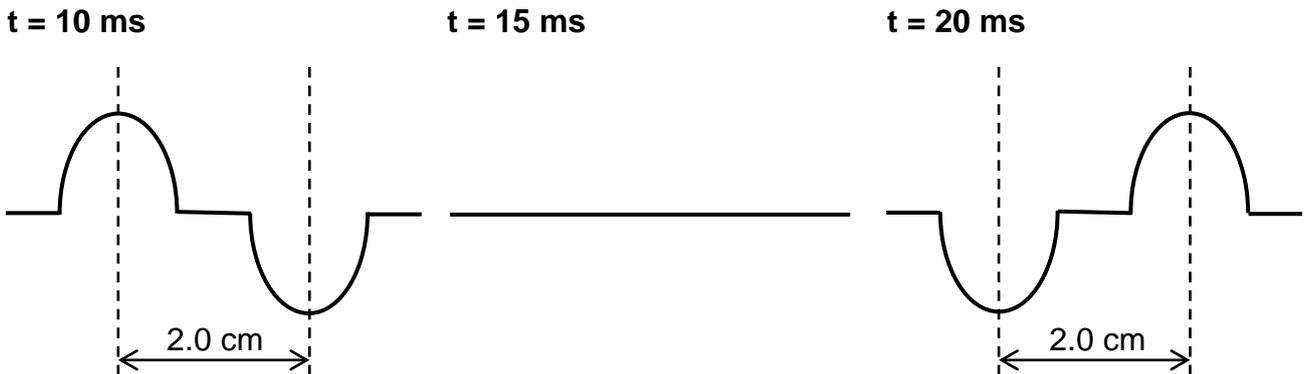




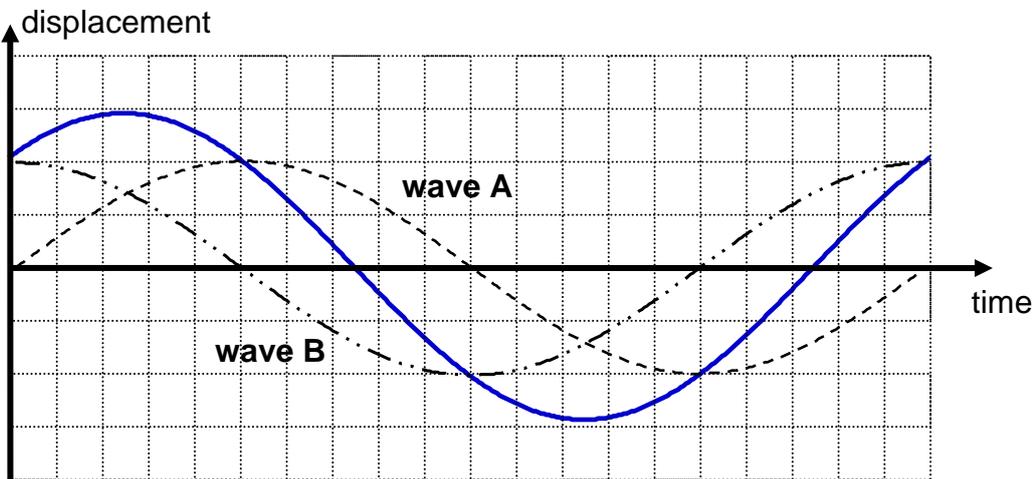
2020 Sec 4 AP1 Superposition  
Answers to Examples

**Example 1**

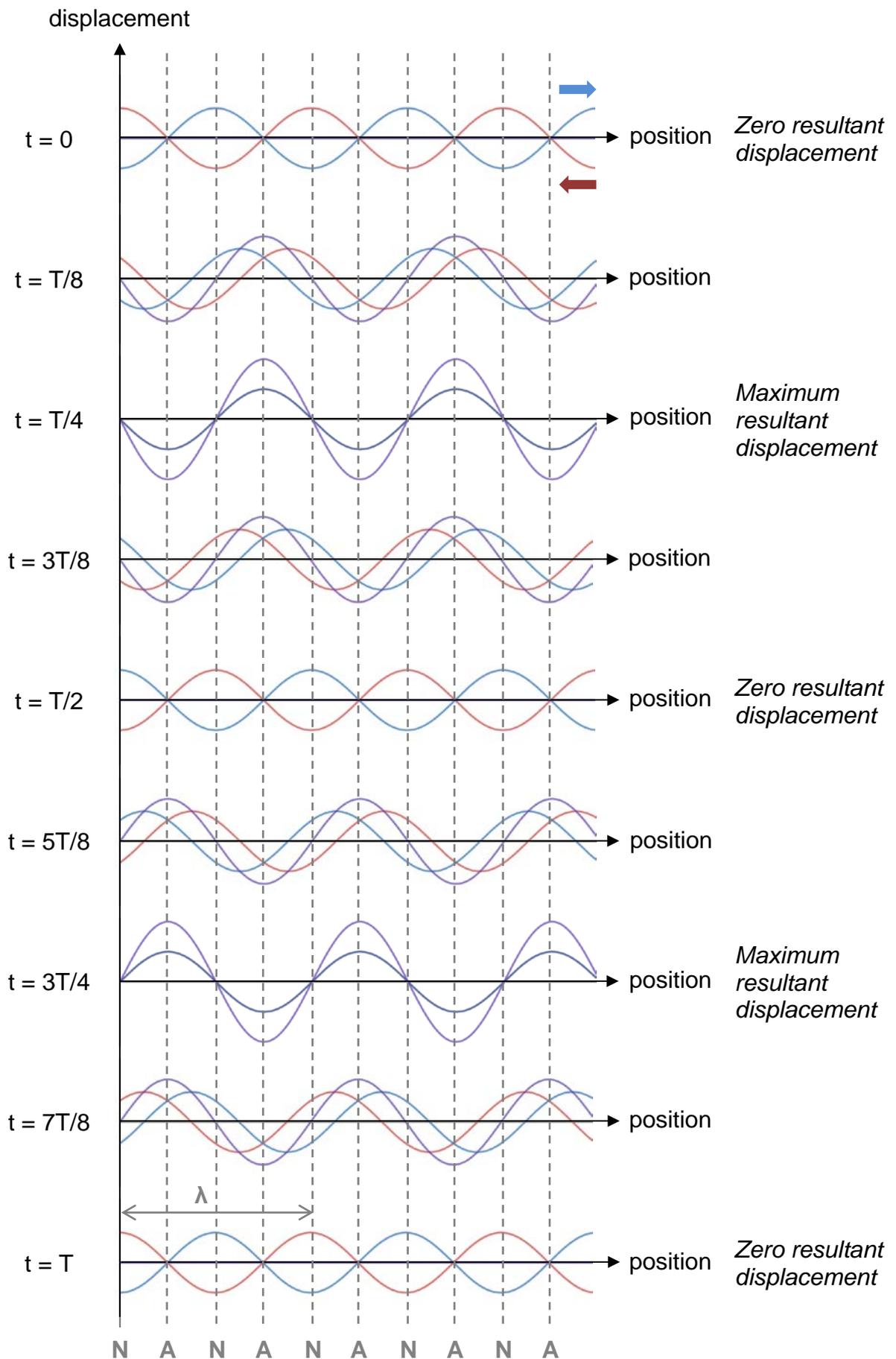
$$\begin{aligned} \text{distance travelled by one pulse in } 5.0 \text{ ms} &= v t \\ &= (2.0)(5.0 / 1000) \\ &= 0.010 \text{ m} \\ &= 1.0 \text{ cm} \end{aligned}$$

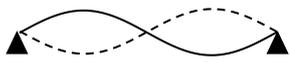


**Example 2**



### Example 3

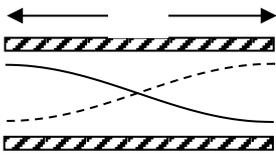
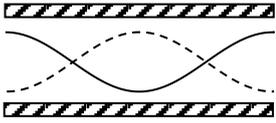
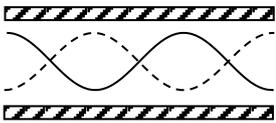


Harmonic Series	Mode of Vibration	Wavelength	Frequency
First harmonic (Fundamental mode)		$\lambda_1 = 2L$	$f_1 = \frac{v}{2L}$
Second harmonic (First overtone)		$\lambda_2 = L$	$f_2 = \frac{v}{L} = 2f_1$
Third harmonic (Second overtone)		$\lambda_3 = \frac{2L}{3}$	$f_3 = \frac{3v}{2L} = 3f_1$
n-th harmonic (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 =  $\lambda / 2$   
 $\lambda = 0.40 \times 2$   
 $= 0.80 \text{ m}$

$v = f \lambda$   
 $f = v / \lambda$   
 $= 300 / 0.80$   
 $= 380 \text{ Hz (2 sf)}$

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

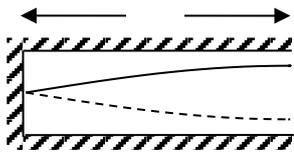
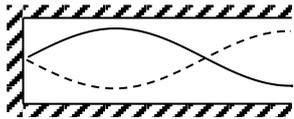
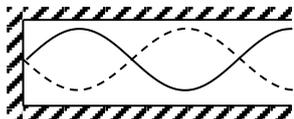
$$2\lambda = 2.5$$

$$\lambda = 1.25 \text{ m}$$

$$v = f\lambda$$

$$= 260 (1.25)$$

$$= 330 \text{ m s}^{-1} (2 \text{ sf})$$

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:  $\lambda / 4 = 17.0$   
 $\lambda = 68.0 \text{ cm}$

(b) No change in frequency, velocity or wavelength

Third harmonic:  $l = 0.75 \lambda$   
 $= 0.75 (68.0)$   
 $= 51.0 \text{ cm}$