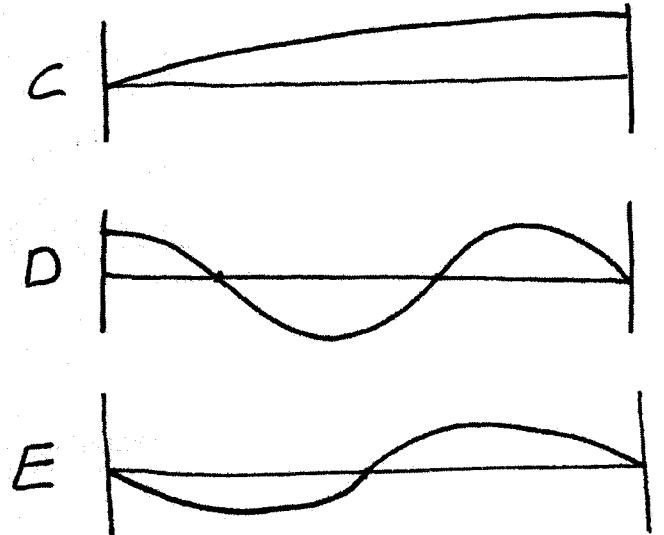
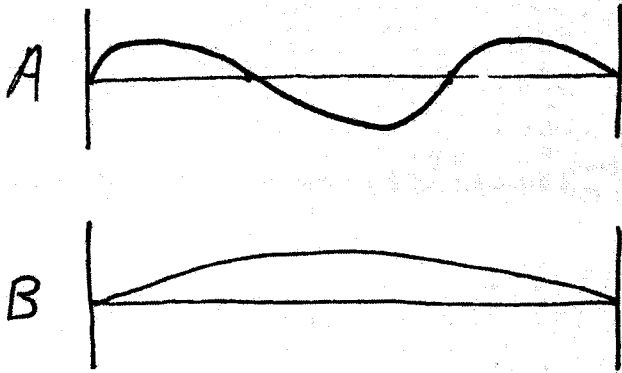


Use these images to answer the following problems.



1. In image A, if the speed of the waves is 200 m/s and the length of the string is 1.2 m, what is the frequency f of the oscillation?

- A) 500 Hz
- B) 160 Hz
- C) 167 Hz
- D) 250 Hz

$$L = 1.2 \text{ m}$$

$$\lambda = \frac{2}{3} L = 0.8 \text{ m}$$

$$F = \frac{v}{\lambda} = \frac{200 \text{ m/s}}{0.8 \text{ m}} = 250 \text{ Hz}$$

2. Which sketch represents the wave in a pipe with the left side open?

- A) A
- B) B
- C) C
- D) D
- E) E

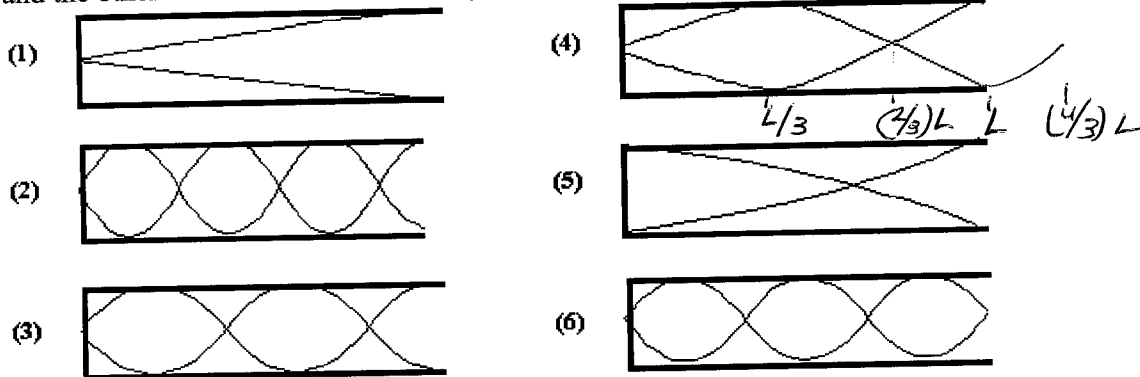
Open side has a maximum.

3. In image B, if the wavelength is $\lambda = 6 \text{ m}$, what is the length of the string?

- A) 2 m
- B) 3 m
- C) 6 m
- D) 9 m
- E) 12 m

$$\lambda = 2L \rightarrow L = 3 \text{ m}$$

The figures show standing waves of sound in six organ pipes of the same length. Each pipe has one end open and the other end closed. *Note: some of the figures show situations that are not possible.*



4. Which figures *do not* illustrate possible resonant situations?

- A) 1 and 4
- B) 2 and 3
- C) 4 and 5
- D) 5 and 6
- E) 4, 5, and 6

(5) should have a node on the left
 (6) should have a max on the right

5. Which one of the pipes emits sound with the lowest frequency?

- A) 1
- B) 2
- C) 3
- D) 4
- E) 6

Low $f = \text{High } \lambda = \text{Long}$

6. Which one of the pipes emits sound with the highest frequency?

- A) 1
- B) 2
- C) 3
- D) 4
- E) 6

High $f = \text{Low } \lambda = \text{Short}$

7. Which one of the pipes is resonating in its *third* harmonic?

- A) 1
- B) 2
- C) 3
- D) 4
- E) 6

Fundamental $\lambda = 4L$ (1)
 Third Harmonic $\lambda = \frac{4}{3}L$ (4)

8. If the length of the pipes is 0.500 m, what is the frequency of the sound emitted from pipe 3? The speed of sound is 343 m/s.

- A) 172 Hz
- B) 344 Hz
- C) 429 Hz
- D) 515 Hz
- E) 858 Hz

$$\lambda = \frac{4}{3}L = 0.667 \text{ m}$$

$$f = \frac{v}{\lambda} = \frac{343 \text{ m/s}}{0.4 \text{ m}} = 857.5 \text{ Hz}$$

9. A 4.00-m long string, clamped at both ends, vibrates at 2.00×10^2 Hz. If the string resonates in six segments, what is the speed of transverse waves on the string?

- A) 100 m/s
- B) 133 m/s
- C) 267 m/s
- D) 328 m/s
- E) 400 m/s

6 segments $\frac{L}{3} = \lambda = \frac{4.00}{3} \text{ m} = 1.33 \text{ m}$

$$v = f\lambda = (200 \text{ Hz})(1.33 \text{ m}) = 266 \text{ m/s}$$

10. A rope of length L is clamped at both ends. Which one of the following is not a possible wavelength for standing waves on this rope?

- A) $L/2$
- B) $2L/3$
- C) L
- D) $2L$
- E) $4L$

Fundamental $\lambda = 2L$

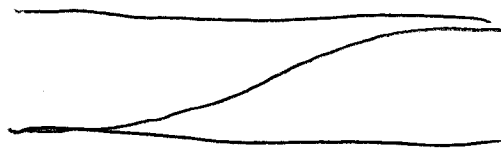
Other $\lambda_n = \frac{2L}{n} = 2L, \frac{2L}{2} = L, \frac{2L}{3}, \frac{2L}{4} = \frac{L}{2}, \dots$

$\lambda = 4L$ would be $n = 1/2$, not allowed.

11. Determine the shortest length of pipe, open at both ends, which will resonate at 256 Hz. The speed of sound is 343 m/s.

- A) 0.330 m
- B) 0.670 m
- C) 0.990 m
- D) 1.32 m
- E) 1.67 m

Open at both ends



$$\lambda = 2L$$

$$f = 256 \text{ Hz}$$

$$v = 343 \text{ m/s}$$

$$\lambda = \frac{v}{f} = 1.34 \text{ m}$$

$$L = \frac{\lambda}{2} = 0.670 \text{ m}$$