MULTIPLE CHOICE QUESTIONS

5. A pipe of fixed length is closed at one end. What is $\frac{\text{third harmonic frequency of pipe}}{\text{first harmonic frequency of pipe}}$?

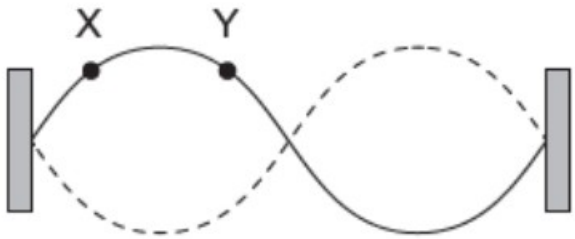
A. $\frac{1}{5}$

B. $\frac{1}{3}$

C. 3

D. 5

7. The diagram shows a second harmonic standing wave on a string fixed at both ends.



What is the phase difference, in rad, between the particle at X and the particle at Y?

A. 0

B. $\frac{\pi}{4}$

C. $\frac{\pi}{2}$

D. $\frac{3\pi}{4}$

The wavelength of a standing (stationary) wave is equal to

A. the distance between adjacent nodes.

B. twice the distance between adjacent nodes.

C. half the distance between adjacent nodes.

D. the distance between a node and an adjacent antinode.

18. The frequency of the first harmonic standing wave in a pipe that is open at both ends is 200 Hz. What is the frequency of the first harmonic in a pipe of the same length that is open at one end and closed at the other?

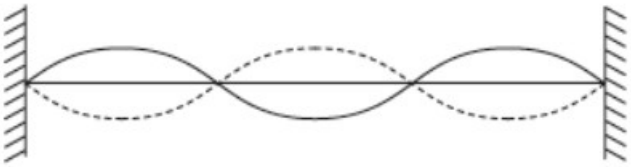
A. 50 Hz

B. 75 Hz

C. 100 Hz

D. 400 Hz

A standing (stationary) wave is set up on a string at a particular frequency as shown.



How many nodes will be on the string if the frequency is doubled but nothing else is changed?

A. 2

B. 3

C. 7

D. 8

A standing sound wave is set up inside a narrow glass tube which has both ends open. The first harmonic frequency of the standing wave is 500Hz.

What is the frequency of the sound wave if the length of the tube is halved and one end is closed?

A. 250 Hz

B. 500 Hz

C. 1000 Hz

D. 2000 Hz

A standing wave is established in air in a pipe with one closed and one open end.

The air molecules near X are

A. always at the centre of a compression.

B. always at the centre of a rarefaction.

C. sometimes at the centre of a compression and sometimes at the centre of a rarefaction.

D. never at the centre of a compression or a rarefaction.

The lowest frequency emitted by an organ pipe that is open at both ends is *f*. What is the lowest frequency emitted by an organ pipe of the same length that is closed at one end?

A. $\frac{f}{4}$

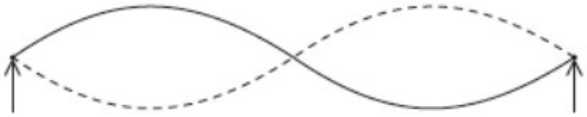
B. $\frac{f}{2}$

C. $2f$

D. $4f$

Which of the following is a correct comparison between standing waves and travelling waves?

	Standing waves	Travelling waves
A.	wave amplitude is constant at all points along the wave	wave amplitude depends upon the position along the wave
B.	energy is always transferred	energy is not transferred
C.	the wavelength is twice the distance between consecutive nodes	the wavelength is the distance between consecutive crests
D.	phase varies continuously along the wave	phase is constant between consecutive crests



Which expression, where n is an integer, gives the frequencies of harmonics that have a node at the centre of the string?

A. $\frac{n+1}{2}f$

B. nf

C. $2nf$

D. $(2n + 1)f$

The air in a pipe, of length l and open at both ends, vibrates with a fundamental frequency f. What is the fundamental frequency of a pipe of length $1.5l$ and closed at one end?

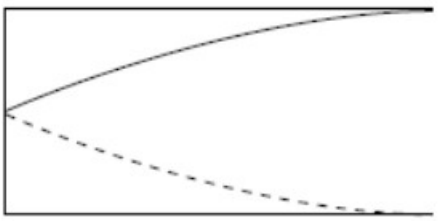
A. $\frac{f}{3}$

B. $\frac{2f}{3}$

C. $\frac{3f}{2}$

D. $3f$

A standing wave of frequency f is established in air in a pipe open at one end, as shown.



Which of the following is the frequency of the next highest harmonic?

A. $\frac{f}{3}$

B. $\frac{f}{2}$

C. $2f$

D. $3f$

The diagrams show four different organ pipes drawn to scale. Standing waves in the fundamental (first harmonic) mode are set up inside each pipe.

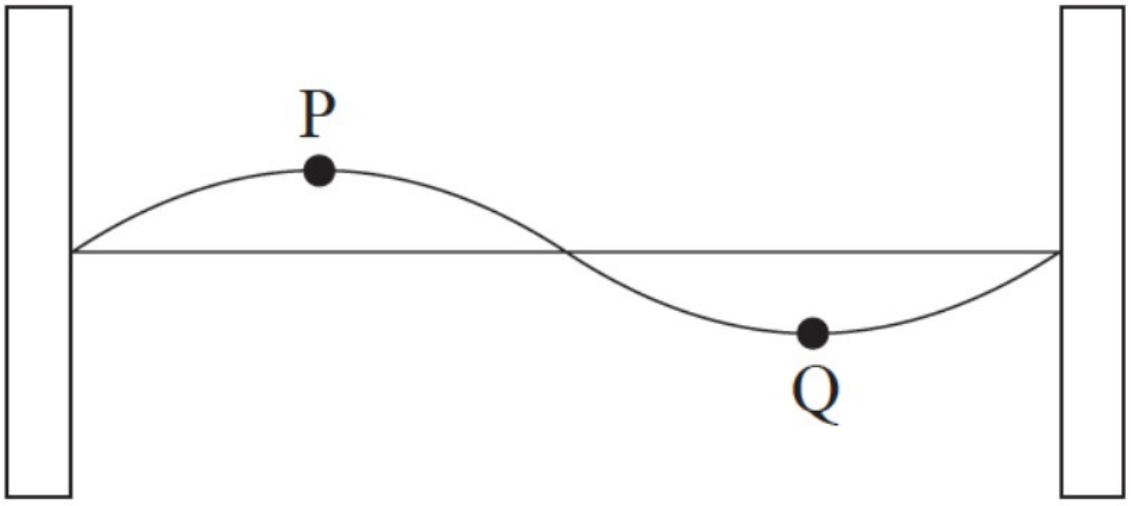
Which pipe produces a fundamental note with the lowest frequency?

A.

B.

C.

D.



What is the phase difference in radians between point P and point Q on the string?

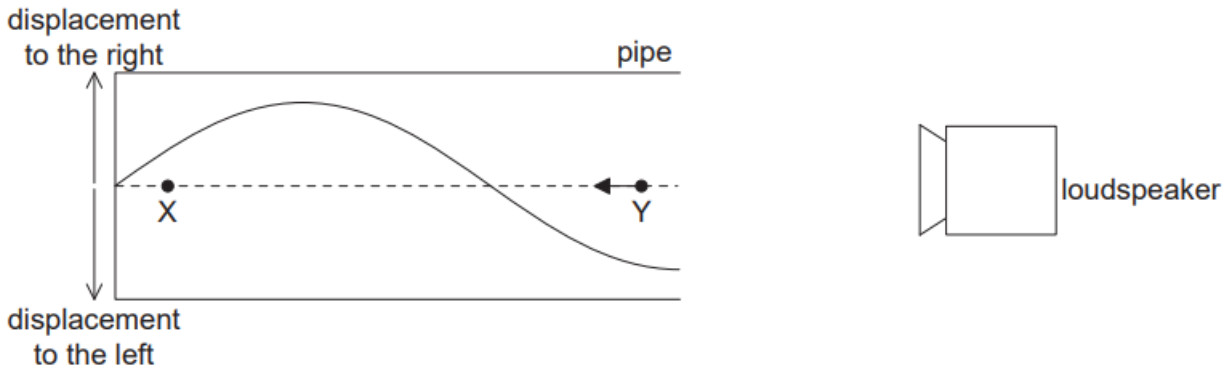
A. zero

B. $\frac{\pi}{2}$

C. π

D. 2π

3. (a) A loudspeaker emits sound towards the open end of a pipe. The other end is closed. A standing wave is formed in the pipe. The diagram represents the displacement of molecules of air in the pipe at an instant of time.



(i) Outline how the standing wave is formed. [1]

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X and Y represent the equilibrium positions of two air molecules in the pipe. The arrow represents the velocity of the molecule at Y.

(ii) Draw an arrow on the diagram to represent the direction of motion of the molecule at X. [1]

(iii) Label a position N that is a node of the standing wave. [1]

(iv) The speed of sound is 340 m s^{-1} and the length of the pipe is 0.30 m. Calculate, in Hz, the frequency of the sound. [2]

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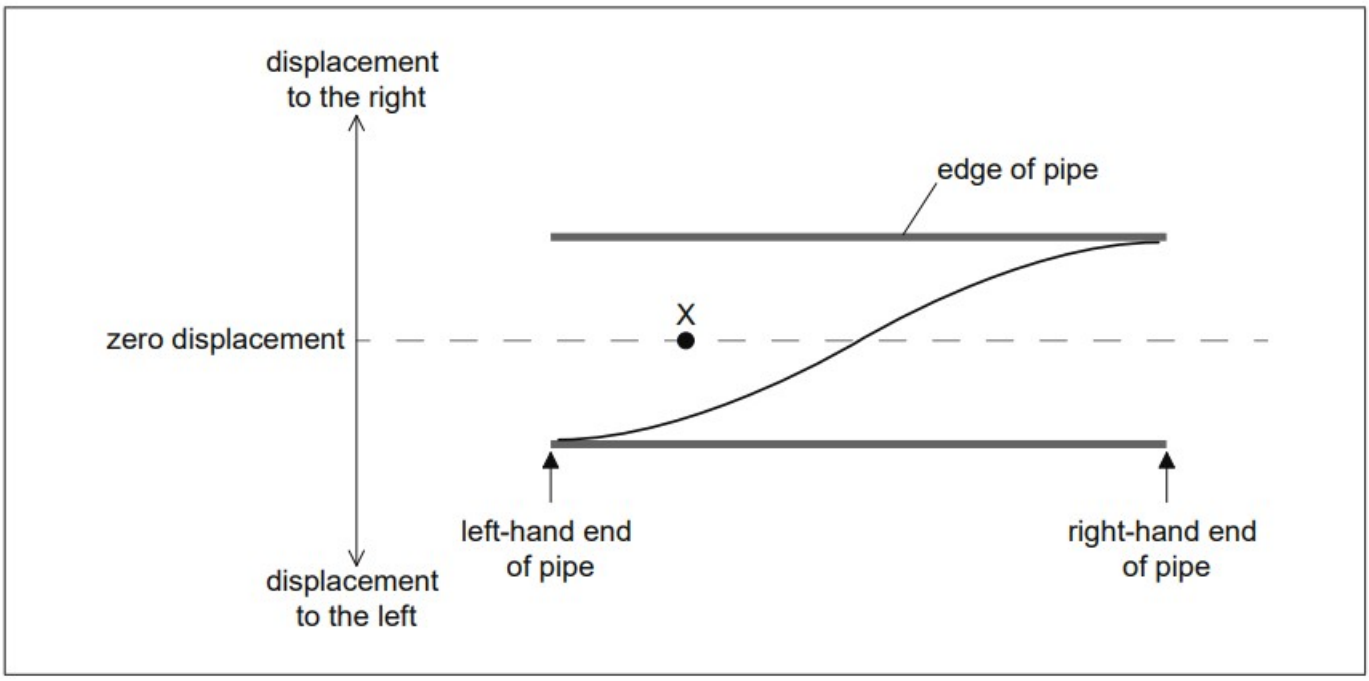
4. A pipe is open at both ends. A first-harmonic standing wave is set up in the pipe. The diagram shows the variation of displacement of air molecules in the pipe with distance along the pipe at time $t = 0$. The frequency of the first harmonic is f.



(a) (i) Sketch, on the diagram, the variation of displacement of the air molecules with distance along the pipe when $t = \frac{3}{4f}$. [1]

(ii) An air molecule is situated at point X in the pipe at $t = 0$. Describe the motion of this air molecule during one complete cycle of the standing wave beginning from $t = 0$. [2]

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(b) The speed of sound c for longitudinal waves in air is given by

$$c = \sqrt{\frac{K}{\rho}}$$

where ρ is the density of the air and K is a constant.

A student measures f to be 120 Hz when the length of the pipe is 1.4 m. The density of the air in the pipe is 1.3 kg m^{-3}. Determine, in kg m^{-1} s^{-2}, the value of K for air. [3]

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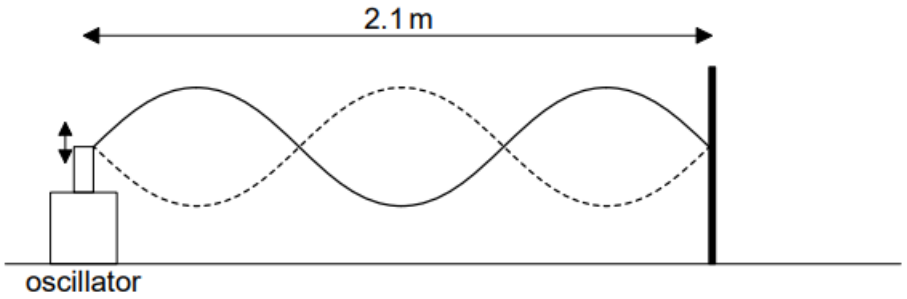
(c) One end of a string is attached to an oscillator and the other is fixed to a wall. When the frequency of the oscillator is 360 Hz the standing wave shown is formed on the string.



Point X (not shown) is a point on the string at a distance of 10 cm from the oscillator.

(i) State the number of all other points on the string that have the same amplitude and phase as X. [1]

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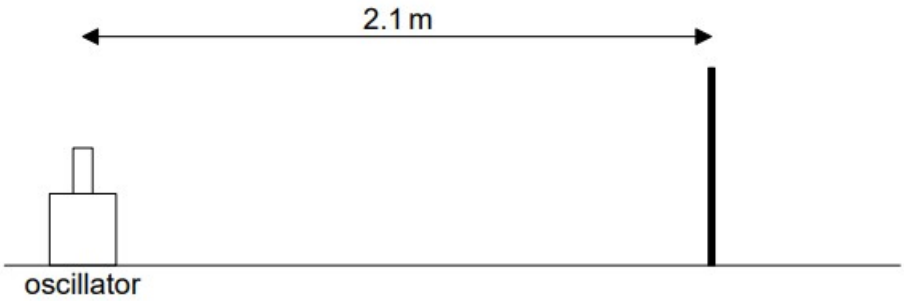
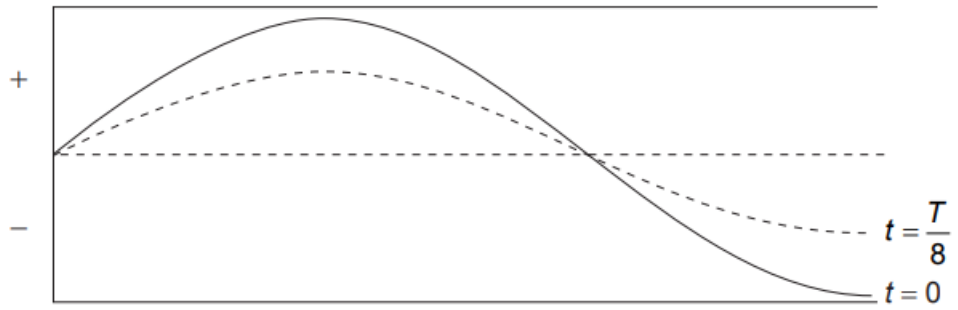
(ii) The frequency of the oscillator is reduced to 120 Hz. On the diagram, draw the standing wave that will be formed on the string. [1]



(d) A standing sound wave is established in a tube that is closed at one end and open at the other end. The period of the wave is T. The diagram represents the standing wave at $t = 0$ and at $t = \frac{T}{8}$. The wavelength of the wave is 1.20 m. Positive displacements mean displacements to the right.



(i) Calculate the length of the tube. [1]

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(ii) A particle in the tube has its equilibrium position at the open end of the tube. State and explain the direction of the velocity of this particle at time $t = \frac{T}{8}$ [2]

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(iii) Draw on the diagram the standing wave at time $t = \frac{T}{4}$ [1]