Superposition

MCQ

1 To produce a stationary wave, two waves must travel in opposite directions through the same space.

Which statement about the properties of the two waves must also be true?

A The waves must have equal frequency, but a different speed and wavelength.
B The waves must have equal speed, but a different wavelength and frequency.
C The waves must have equal speed, frequency and wavelength.
D The waves must have equal wavelength, but a different speed and frequency.

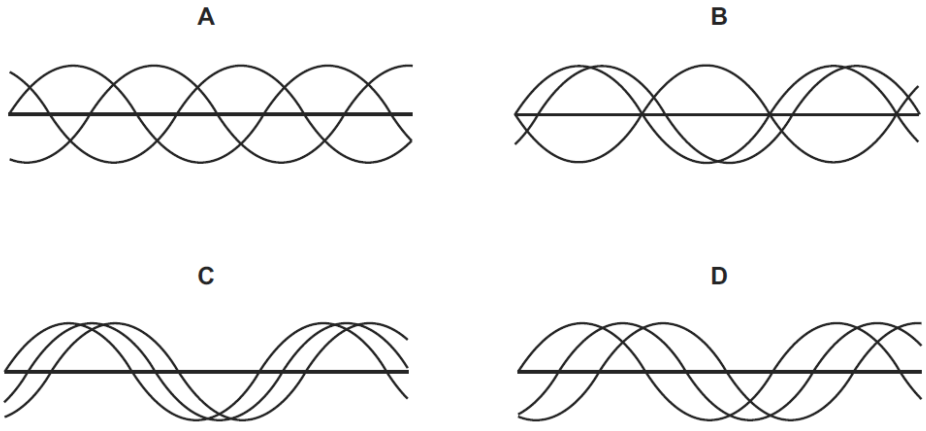
2 Where, in a standing wave, do the vibrations of the medium occur?

A Only at the nodes
B Only at the antinodes
C At all points between the nodes
D At all points between the antinodes

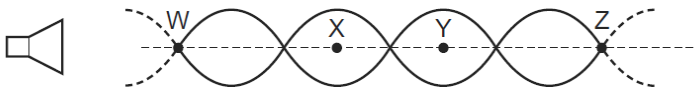
3 The three waves shown in each diagram have the same amplitude and frequency but differ in phase.

They are added together to give a resultant wave.

In which case is the resultant wave zero?



4 The diagram represents the pattern of stationary waves formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown).

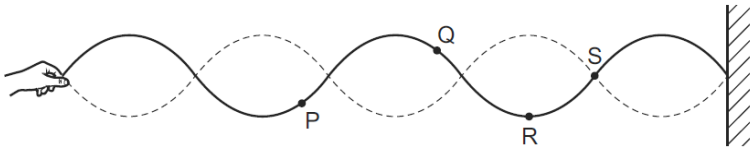


W, X, Y and Z are four points on the line through the centre of these waves.

Which statement about these stationary waves is correct?

A An antinode is formed at the surface of the metal sheet.
B A node is a quarter of a wavelength from an adjacent antinode.
C The oscillations at X are in phase with those at Y.
D The stationary waves oscillate at right angles to the line WZ.

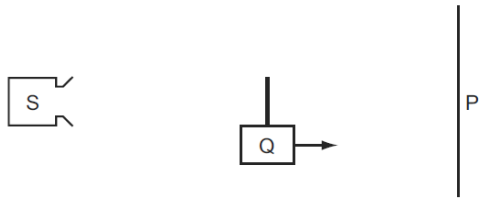
5 A stationary wave is set up on a stretched string, as shown.



Which statement about the points on the string is correct?

A Point Q vibrates with the largest amplitude.
B Points P and R vibrate in phase.
C Point S is an antinode.
D The horizontal distance between R and S is half the wavelength.

6 Source S emits microwaves with constant amplitude. The microwaves hit a metal screen P and are reflected. A stationary wave is formed between S and P. The wavelength of the microwaves is much smaller than the distance between S and P.

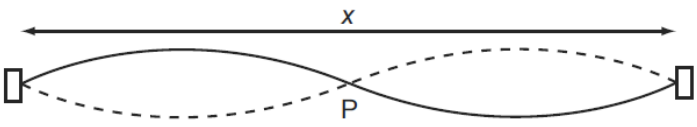


A detector Q is moved at a slow, constant speed from S to P.

What happens to the amplitude of the signal detected by Q?

A Decreases steadily
B Increases and decreases regularly
C Increases steadily
D Remains constant

7 The diagram represents a stationary wave on a stretched string.



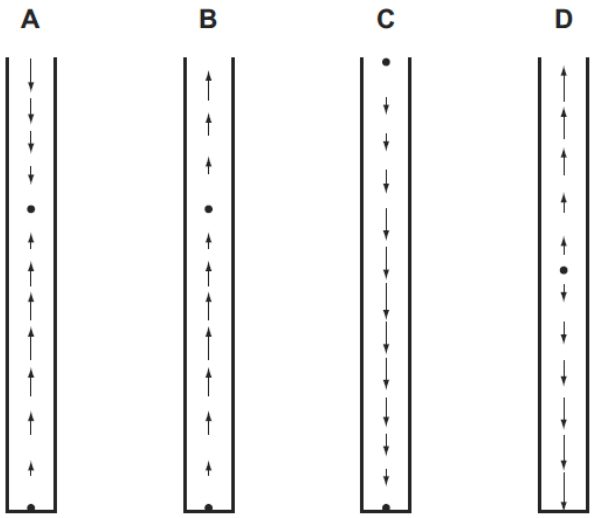
What is represented by point P and by the length *x*?

	point P	***length x***
A	antinode	one wavelength
B	antinode	two wavelengths
C	node	one wavelength
D	node	two wavelengths

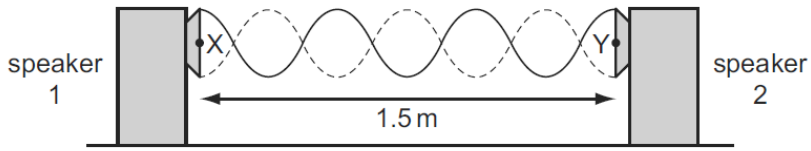
8 A stationary longitudinal wave is set up in a pipe.

In the diagrams below, the length of each arrow represents the amplitude of the motion of the air molecules, and the arrow head shows the direction of motion at a particular instant.

Which diagram shows a stationary wave in which there are two nodes and two antinodes?



9 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.

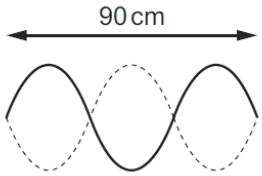


When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

A 0.21 m **B** 0.25 m **C** 0.43 m **D** 0.50 m

10 The diagram shows a stationary wave on a string at two instants of maximum vertical displacement.

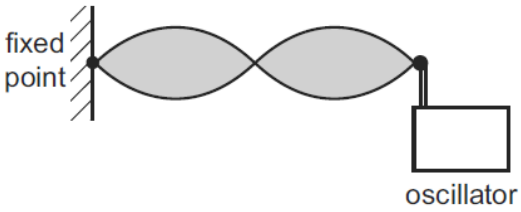


The frequency of the wave is 12 Hz.

What is the speed of the wave?

A 3.6 m s^{-1} **B** 7.2 m s^{-1} **C** 360 m s^{-1} **D** 720 m s^{-1}

11 The speed of a transverse wave on a stretched string can be changed by adjusting the tension of the string. A stationary wave pattern is set up on a stretched string using an oscillator set at a frequency of 650 Hz.



How must the wave be changed to maintain the same stationary wave pattern if the applied frequency is increased to 750 Hz?

A Decrease the speed of the wave on the string.
B Decrease the wavelength of the wave on the string.
C Increase the speed of the wave on the string.
D Increase the wavelength of the wave on the string.

12 T is a microwave transmitter placed at a fixed distance from a flat reflecting surface S.

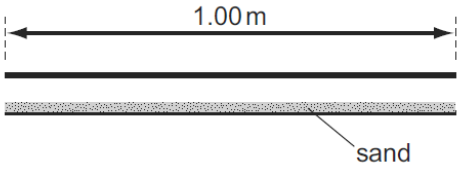
A small microwave receiver is moved steadily from T towards S and receives signals of alternate maxima and minima of intensity.

The distance between successive maxima is 15 mm.

What is the frequency of the microwaves?

A 1.0×10^7 Hz **B** 2.0×10^7 Hz **C** 1.0×10^{10} Hz **D** 2.0×10^{10} Hz

13 The diagram shows an air-filled pipe open at both ends. The length of the pipe is 1.00 m and the lower surface of the inside of the pipe is covered with a layer of fine sand.



When a source of sound of a single frequency is put near one end of the pipe, the air in the pipe is found to resonate and a pattern in the sand shows that a standing wave containing three nodes is formed within the pipe.

The speed of sound in air is 330 m s^{-1}.

What is the frequency of the sound?

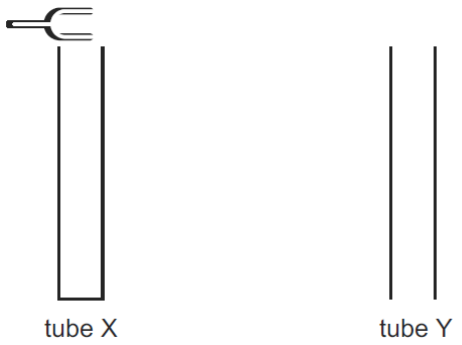
A 330 Hz **B** 495 Hz **C** 990 Hz **D** 1320 Hz

14 A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other.

What is the lowest frequency of sound produced by a pipe of length 10 m?
(The speed of sound in the pipe is 320 m s^{-1}.)

A 4.0 Hz **B** 8.0 Hz **C** 16 Hz **D** 32 Hz

15 The diagram shows two tubes.



The tubes are identical except tube X is closed at its lower end while tube Y is open at its lower end. Both tubes have open upper ends.

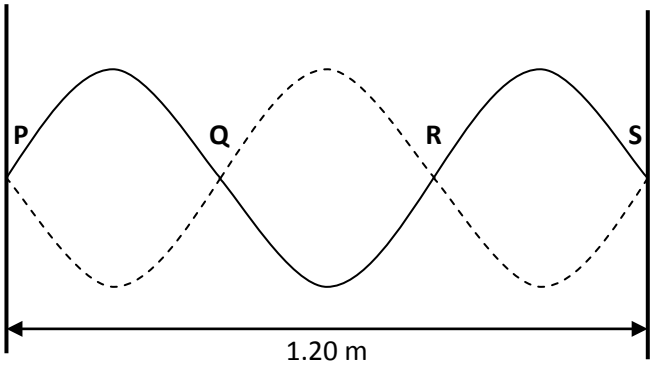
A tuning fork placed above tube X causes resonance of the air at frequency *f*. No resonance is found at any **lower** frequency than *f* with tube X.

Which tuning fork will produce resonance when placed just above tube Y?

A A fork of frequency $f / 2$
B A fork of frequency $2f / 3$
C A fork of frequency $3f / 2$
D A fork of frequency $2f$

Structured Questions

16 The diagram represents a stationary wave on a stretched string. The continuous line shows the position of the string at a particular instant when the displacement is a maximum.



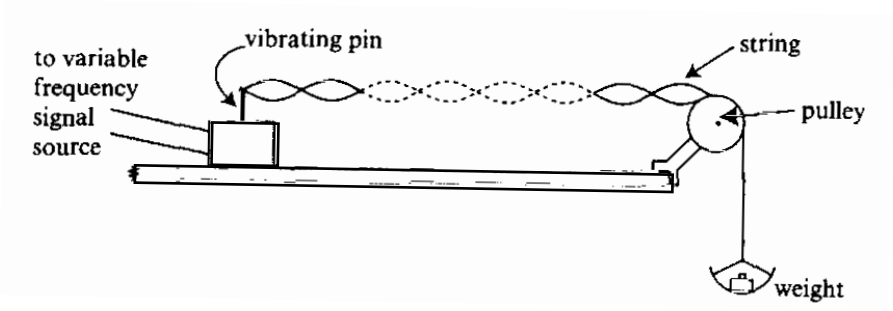
P and S are the fixed ends of the string. Q and R are the positions of the nodes. The speed of the waves on the string is 200 m s^{-1}.

(a) Calculate the wavelength of the waves on the string.

(b) Calculate the frequency of the vibration.

(c) Draw the position of the string 3.0 ms later than the position shown. Explain how you arrive at your answer.

17 The apparatus was used to demonstrate a transverse standing wave on a string.



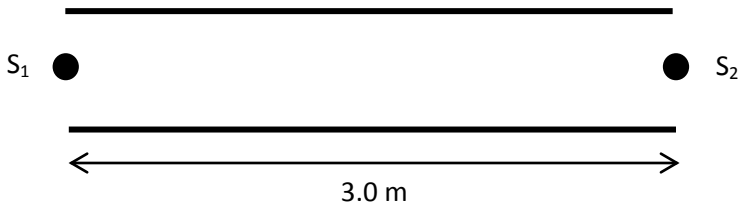
Both the weight and the distance between the pin and the pulley were kept constant. At 480 Hz, there was a standing wave pattern and each loop was 10.0 cm long. At a higher frequency, there were two more loops than at 480 Hz and each loop was 8.0 cm long.

(a) Sketch three stationary patterns which could be formed on the string in the diagram above.

(b) Calculate the speed of the waves along the string.

(c) Determine the number of loops that would be created at 480 Hz.

18 Two sources of sound waves S_1 and S_2 are placed at a distance 3.0 m apart at either end of a narrow pipe. Both sources are emitting waves of wavelength 1.2 m and of similar amplitudes. By drawing on the figure, show how the amplitude of the resultant wave will vary along the line S_1S_2.



19 A long tube, fitted with a tap, is filled with water. A tuning fork is sounded above the top of the tube as the water is allowed to run out of the tube as shown in the figures below.

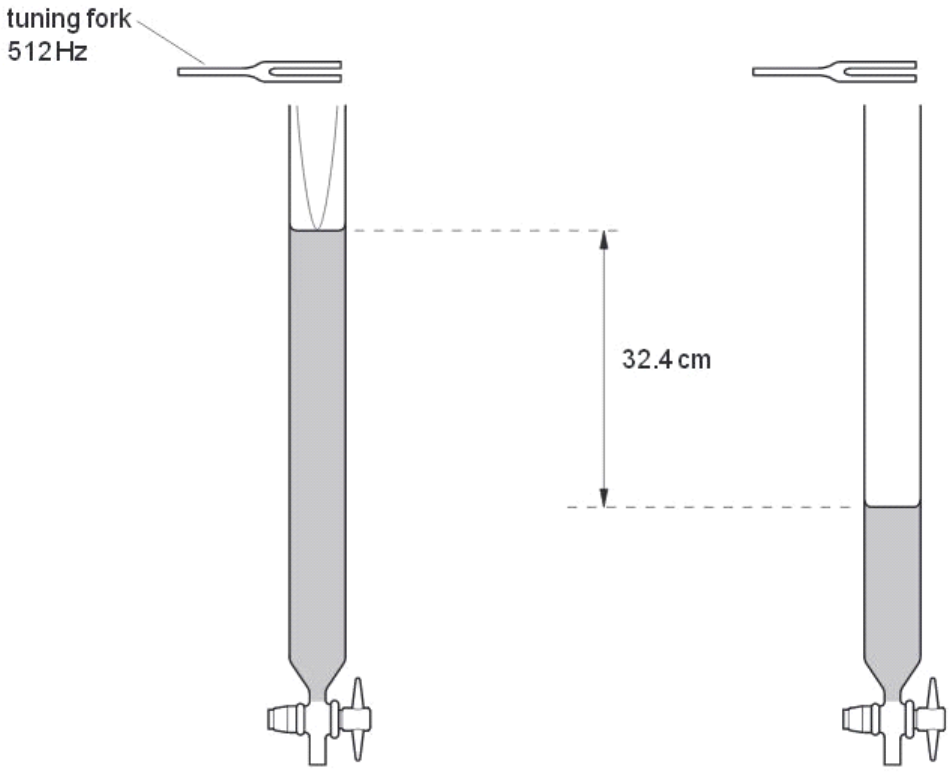


Fig. 19.1 **Fig. 19.2**

A loud sound is first heard when the water level is shown in Fig. 19.1, and then again when the water level is as shown in Fig. 19.2

Fig. 19.1 illustrates the stationary wave produced in the tube.

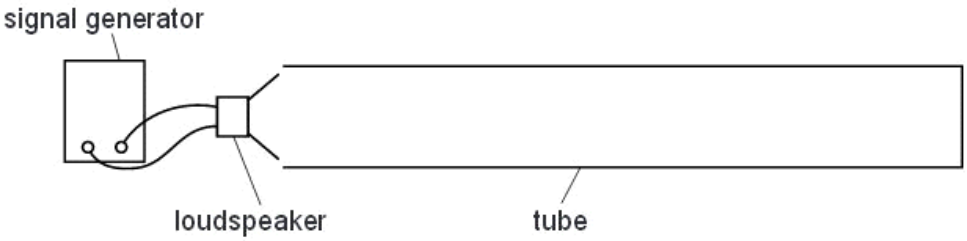
(a) On Fig. 19.2,

(i) sketch the form of the stationary wave set up in the tube,

(ii) mark, with the letter N, the positions of any nodes of the stationary wave.

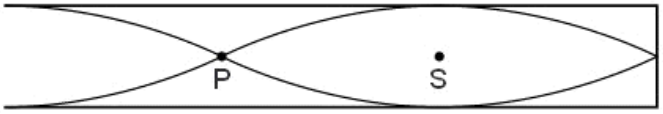
(b) The frequency of the fork is 512 Hz and the difference in the height of the water level for the two positions where a loud sound is heard is 32.4 cm. Calculate the speed of sound in the tube.

20 The figure below shows an arrangement for producing stationary waves in a tube that is closed at one end.



(a) Explain how waves from the loudspeaker produce stationary waves in the tube.

(b) One of the stationary waves that may be formed in the tube is represented in the figure below.



(i) Describe the motion of the air particles in the tube at

1. point P,

2. point S.

(ii) The speed of sound in the tube is 330 m s^{-1} and the frequency of the waves from the loudspeaker is 880 Hz. Calculate the length of the tube.

Answers

MCQ

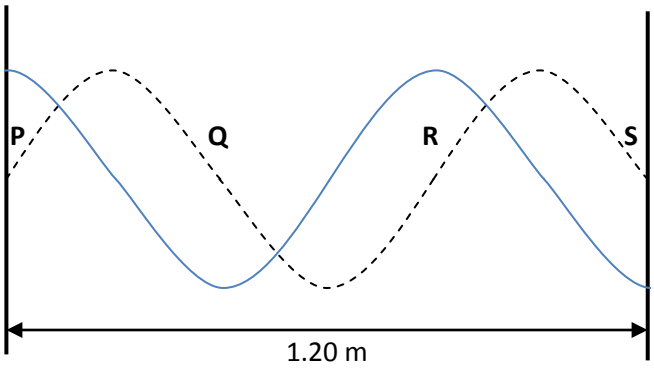
CCABB BCADB CCBBD

Structured Questions

16 (a) 0.80 m

(b) 250 Hz

(c)



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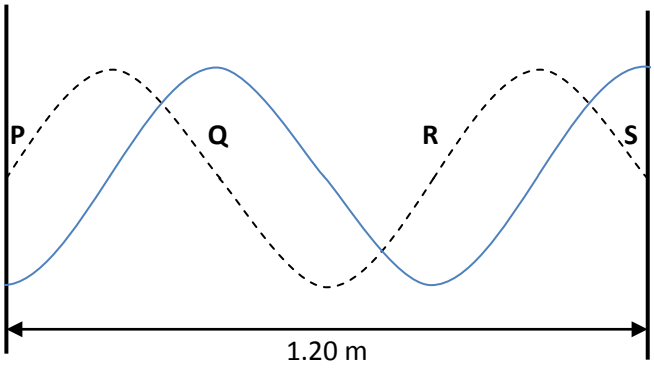
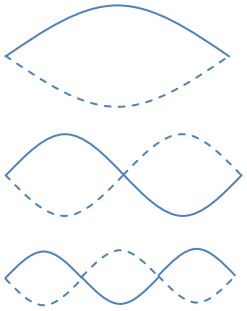


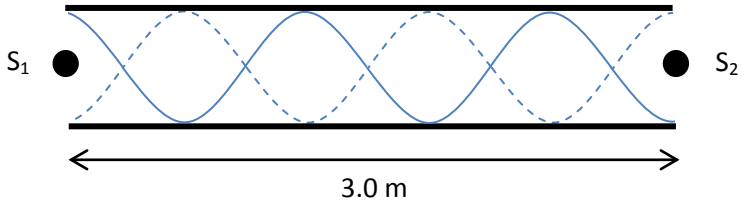
17 (a)



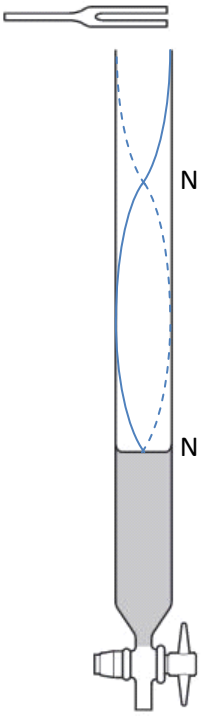
(b) 96 m s^{-1}

(c) 8 loops

18



19 (a)



(b) 332 m s^{-1}

20 (a) waves reflect at closed end
incident and reflected waves are in opposite directions, but have the same amplitude and frequency/wavelength
stationary waves formed if tube length equivalent to $\lambda / 4$, $3 \lambda / 4$, …

(b) (i) 1. stationary
2. vibrating back and forward with maximum amplitude
(ii) 0.28 m