1.

A wave of frequency 15 Hz travels at 24 m s^{-1} through a medium.

What is the phase difference between two points 2.0 m apart?

A There is no phase difference.

B They are out of phase by a quarter of a cycle.

C They are out of phase by half a cycle.

D They are out of phase by 0.80 of a cycle.

Ans: B

- $\lambda = 24 / 15 = 1.6$
- $n = 2 / 1.6 = 1.25$ (1 + quarter wave)
- Thus out of phase by quarter of a cycle

2.

A sound wave reduces in intensity but maintains a constant frequency as it travels through air.

Which statement is correct?

A The maximum displacement of the particles changes between one particle and the next particle.

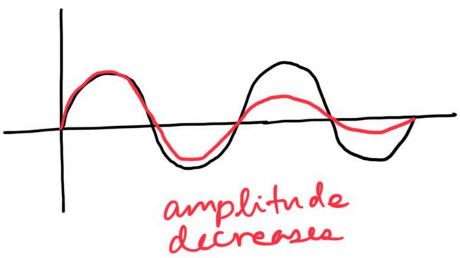
B The phase difference between adjacent particles is zero.

C The wavelength is the distance between two particles that have a phase difference of 180°.

D Two particles that have a phase difference of 360° have the same maximum displacement.

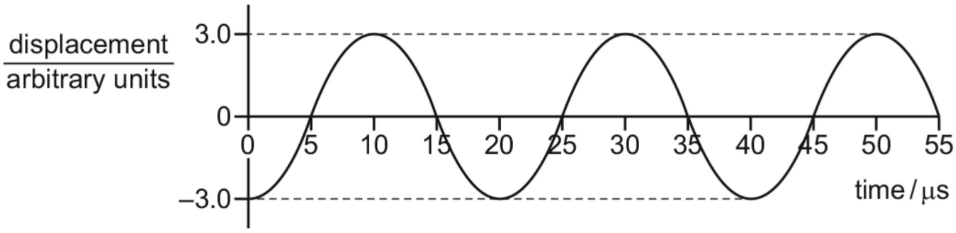
Ans: A

- Phase difference between adjacent particles is not 0 - They have to be nλ apart for phase difference to be 0!! This rules out option B
- Wavelength = distance between particles having phase difference of 360
- $I \propto A^2$ and $I \propto f^2$
- Since frequency is constant, decrease in intensity means decrease in amplitude
- This rules out option D
- Thus option A is correct



3.

The graph shows the variation with time of the displacement of an electromagnetic wave at a point.



The wave is travelling in a vacuum.

What is the amplitude and what is the wavelength of the wave?

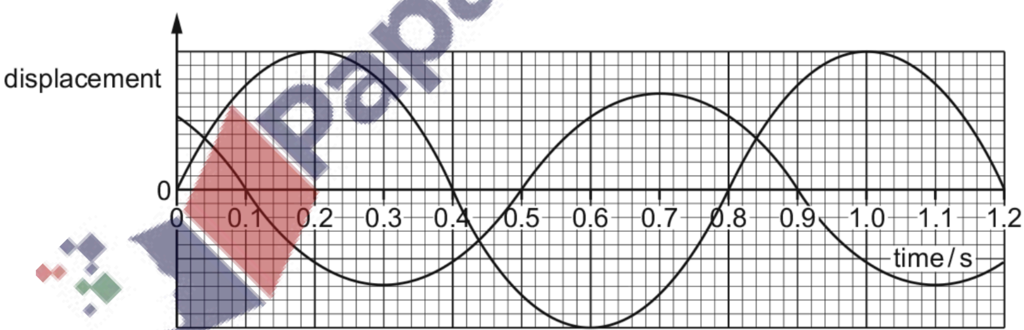
	amplitude / arbitrary units	wavelength / m
A	3.0	6000
B	6.0	6000
C	3.0	7500
D	6.0	7500

Ans: A

- Amplitude = 3
- Time period = $55 \times 10^{-6} / 2.75 = 1/50000$
- Frequency = 50000
- Wavelength = $3 \times 10^{8} / 50000 = 6000$

4.

Two progressive waves meet at a fixed point P. The variation with time of the displacement of each wave at point P is shown in the graph.

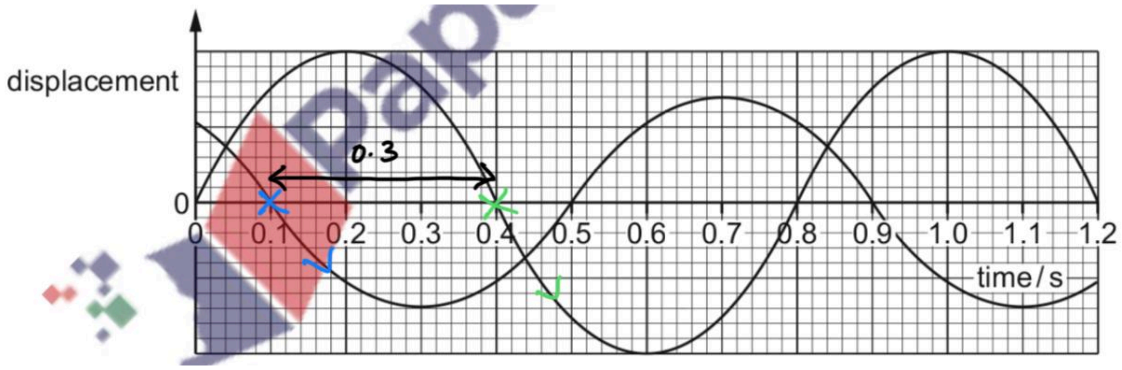


What is the phase difference between the two waves at point P?

A 45° **B** 90° **C** 135° **D** 180°

Ans: C

- Choose a reference point: same point on both waves



- Time lag = 0.3
- Time period = 0.8
- Ratio = ⅜
- Phase difference = ⅜ x 360 = 135

5.

A wave of amplitude A has an intensity I.

After passing through a certain medium, the wave has a new intensity of $\frac{I}{4}$.

What is the new amplitude of the wave?

A $2A$ **B** $\frac{A}{2}$ **C** $\frac{A}{4}$ **D** $\frac{A}{16}$

Ans: B

6.

Two progressive waves of frequency 300 Hz superpose to produce a stationary wave in which adjacent nodes are 1.5 m apart.

What is the speed of the progressive waves?

A $100\,m\,s^{-1}$ **B** $200\,m\,s^{-1}$ **C** $450\,m\,s^{-1}$ **D** $900\,m\,s^{-1}$

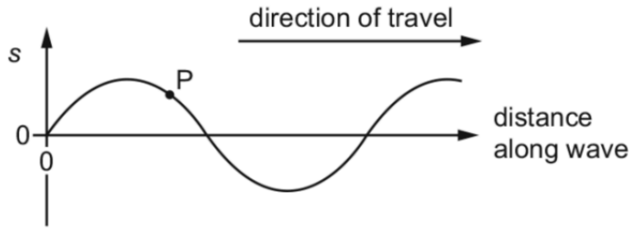
Ans: D

Adjacent nodes = ½ wavelength apart

7.

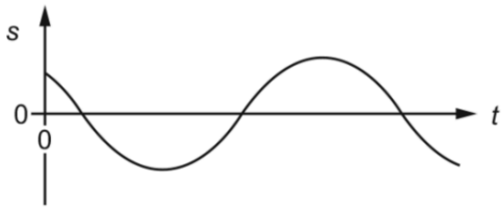
A wave moves along the surface of water.

The diagram shows the variation of displacement *s* with distance along the wave at time $t = 0$.

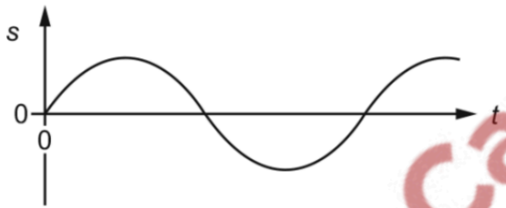


Which graph best shows the variation with time *t* of the displacement *s* of the point P on the wave?

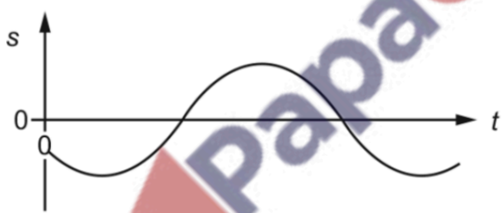
A



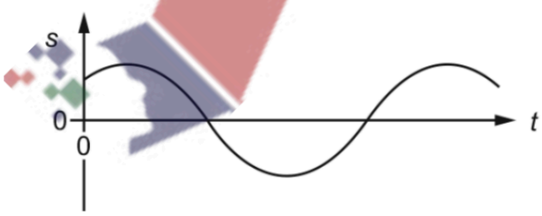
B



C



D

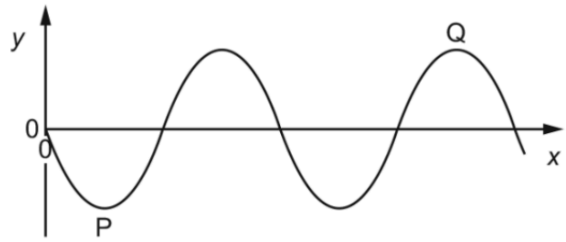


Ans: D

- First graph shows the wave at a specific point in time
- Second graph shows the wave at a specific distance along the wave
- At t=0, P is at the point shown in the given graph; this rule out B and C
- If the wave moves towards the right, the points behind P move towards P. A crest is behind P, which will move to point P with time.
- Thus the displacement should increase.

8.

The graph shows the variation of displacement *y* with distance *x* along a progressive wave at one instant in time.



What is the phase difference between points P and Q on the wave?

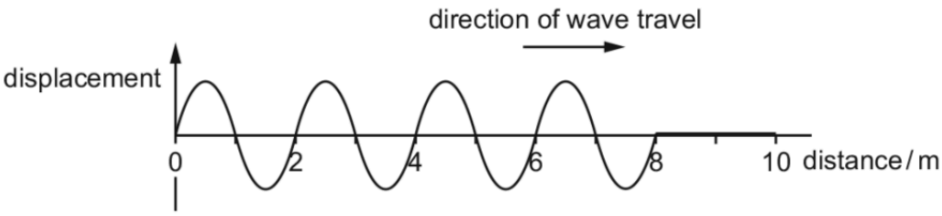
A 90° **B** 270° **C** 540° **D** 630°

Ans: C

- Between P and Q = 1.5 wavelength
- 1.5 x 360 = 540

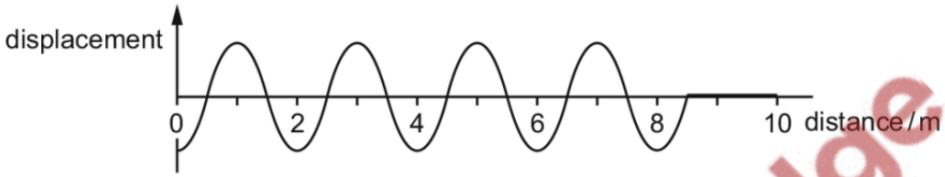
9.

A transverse wave is travelling along a rope. The frequency of the wave is 2.0 Hz. The graph shows the variation with distance of the displacement of the wave at time t = 0.

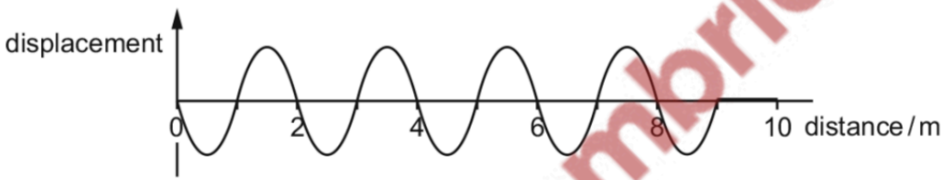


Which diagram shows the position of the wave at time t = 0.5 s?

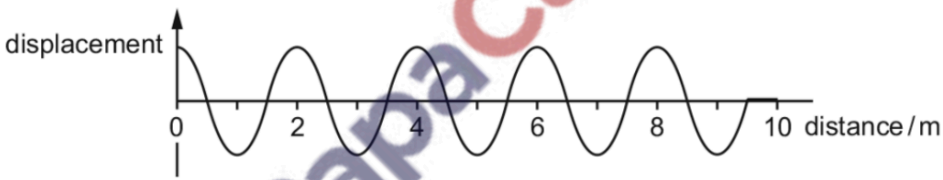
A



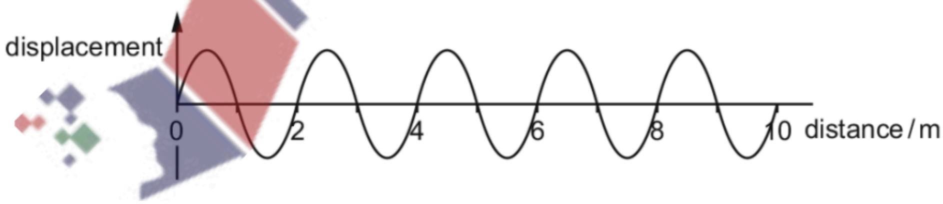
B



C



D



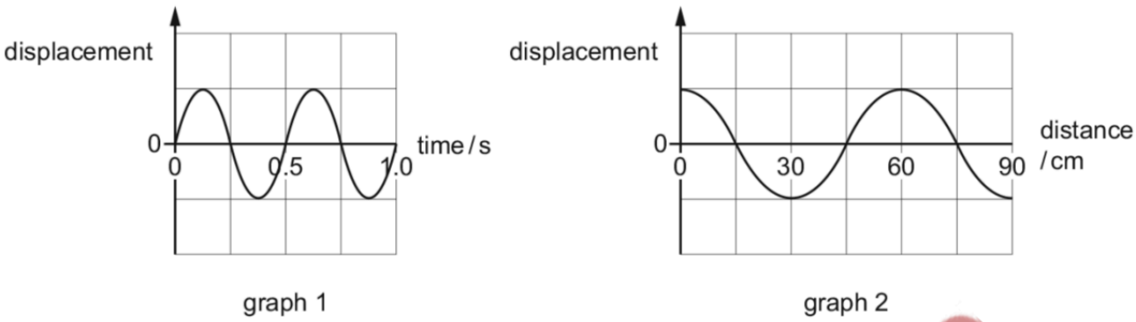
Ans: D

- Find the speed at which the wave is moving: v = fλ = 2 x 2 = 4 m/s
- 4m/s velocity = each 1 second, the wave shape moves 4m to the right.
- Distance travelled by wave in 0.5s = 0.5 x 4 = 2m
- Thus the wave should end at 10m

10.

The two graphs represent the same wave.

Graph 1 shows the variation with time of the displacement at a particular distance. Graph 2 shows the variation with distance of the displacement at one instant.



What is the speed of the wave?

A 22.5 $cm\,s^{-1}$ **B** 30.0 $cm\,s^{-1}$ **C** 90.0 $cm\,s^{-1}$ **D** 120 $cm\,s^{-1}$

Ans: D

11.

A source of sound of constant power P is situated in an open space. The intensity I of sound at distance r from this source is given by

$$I = \frac{P}{4\pi r^2}.$$

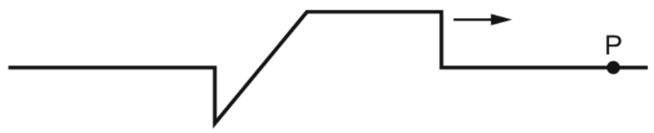
How does the amplitude ***a*** of the vibrating air molecules vary with the distance r from the source?

A $a \propto \frac{1}{r}$ **B** $a \propto \frac{1}{r^2}$ **C** $a \propto r$ **D** $a \propto r^2$

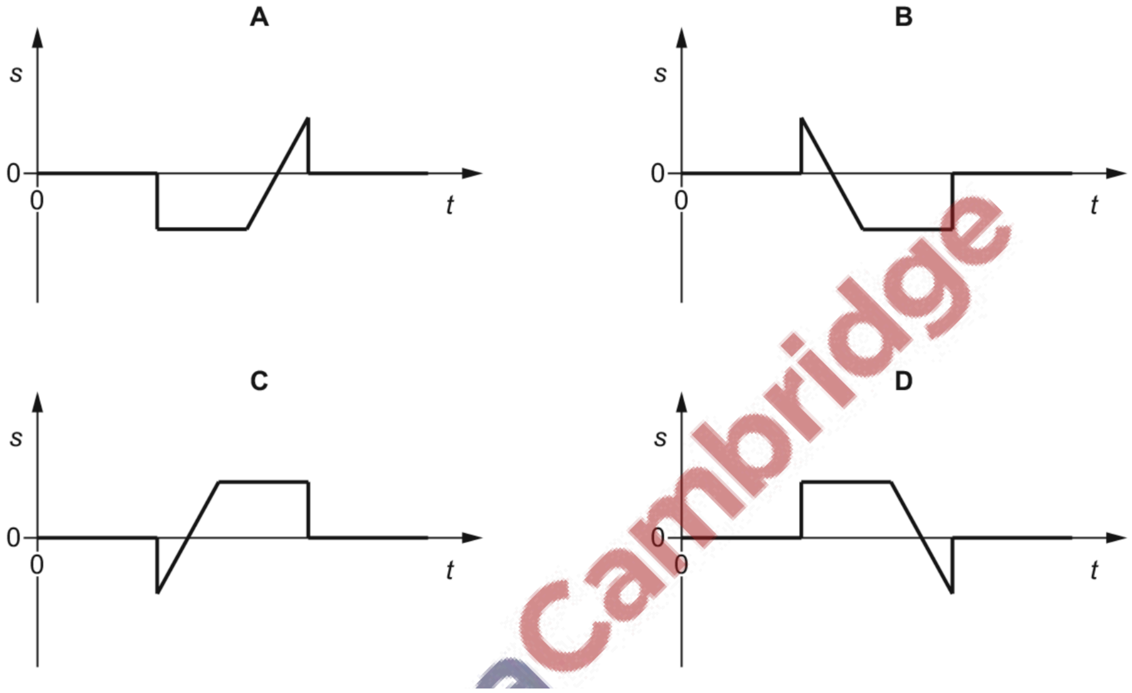
Ans: A

12.

A wave pulse moves along a stretched rope in the direction shown.



Which diagram shows the variation with time *t* of the displacement *s* of the particle P in the rope?

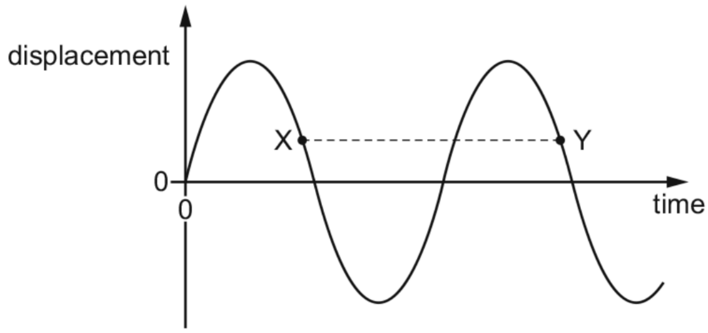


Ans: D

13.

A transverse progressive wave is set up on a string.

The graph shows the variation with time of displacement for a point on this string.



The separation XY on the graph represents the ……1…… of the wave.

X and Y have equal ……2…… .

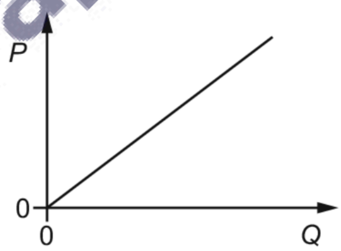
Which words correctly complete gaps 1 and 2?

	1	2
A	time period	amplitudes
B	time period	displacements
C	wavelength	amplitudes
D	wavelength	displacements

Ans: B

14.

The graph shows the variation of a quantity *P* with a quantity *Q* for a sound wave travelling in air.



What could *P* and *Q* be?

	P	*Q*
A	amplitude	intensity
B	frequency	wavelength
C	speed	frequency
D	wavelength	period

Ans: D
Amplitude & intensity will have exponential curve - rules out A
Frequency and wavelength are inversely proportional - rule out B
Speed of sound in air is ALWAYS the same - rules out C

15.

A progressive wave on a wire has a frequency of 10 Hz. Two points on the wire, separated by a distance of 0.25 m, have a phase difference of 22.5°.

What is the maximum speed of the wave?

A $2.5\,\text{m s}^{-1}$ **B** $10\,\text{m s}^{-1}$ **C** $20\,\text{m s}^{-1}$ **D** $40\,\text{m s}^{-1}$

Ans: D

$$\frac{0.25}{\lambda} = \frac{22.5}{360} \Rightarrow \lambda = 4\text{m}$$

$$v = 4 \times 10 = 40 \text{ m/s}$$

16.

What is the relationship between the amplitude of a wave and its intensity?

A amplitude $\propto$ intensity

B amplitude $\propto$ (intensity)^2

C amplitude $\propto \sqrt{\text{intensity}}$

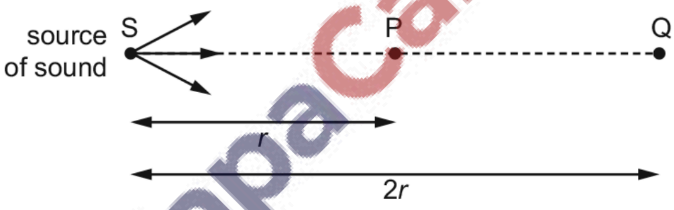
D (amplitude)$^2 \propto \sqrt{\text{intensity}}$

Ans: C

17.

The intensity I of sound is inversely proportional to the square of the distance x from the source of the sound. This can be represented as

$$I \propto \frac{1}{x^2}.$$



Air molecules at point P, a distance r from the source S, oscillate with amplitude 8.0 µm.

Point Q is situated a distance $2r$ from S.

What is the amplitude of oscillation of air molecules at Q?

A 1.4 µm **B** 2.0 µm **C** 2.8 µm **D** 4.0 µm

Ans: D

- The equation given is for intensity
- You need to find amplitude!!

$$I \propto \frac{1}{x^2}$$

$$I \propto A^2$$

$$\Rightarrow A^2 \propto \frac{1}{x^2}$$

$$\Rightarrow A \propto \frac{1}{x}$$

$$8 = \frac{k}{r} \Rightarrow k = 8r$$

$$A = \frac{k}{2r} = \frac{8r}{2r} = 4$$

NOTE: longitudinal waves cannot travel through vacuum, but can travel through air.

18.

A transverse wave is moving along a rope. Two points X and Y on the rope are a quarter of a wavelength apart from each other.

Which statement is **not** possible for the two points X and Y at any instant?

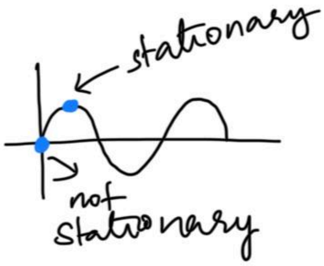
A They are both stationary.

B They are displaced in opposite directions from their equilibrium position.

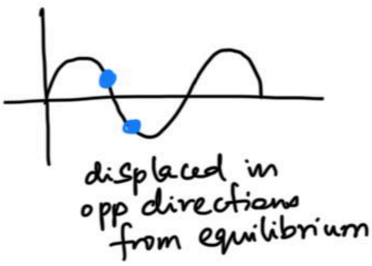
C They are moving in opposite directions.

D They both have displacements of the same magnitude from their equilibrium positions.

Ans: A

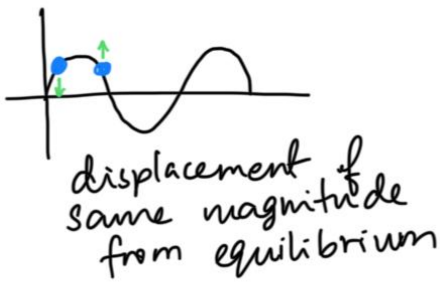


both cannot be stationary



B is possible

C is possible



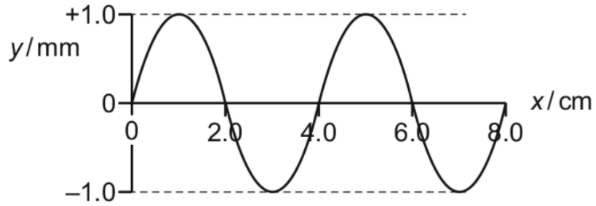
D is possible

19.

A transverse wave in a medium has the waveform shown, where

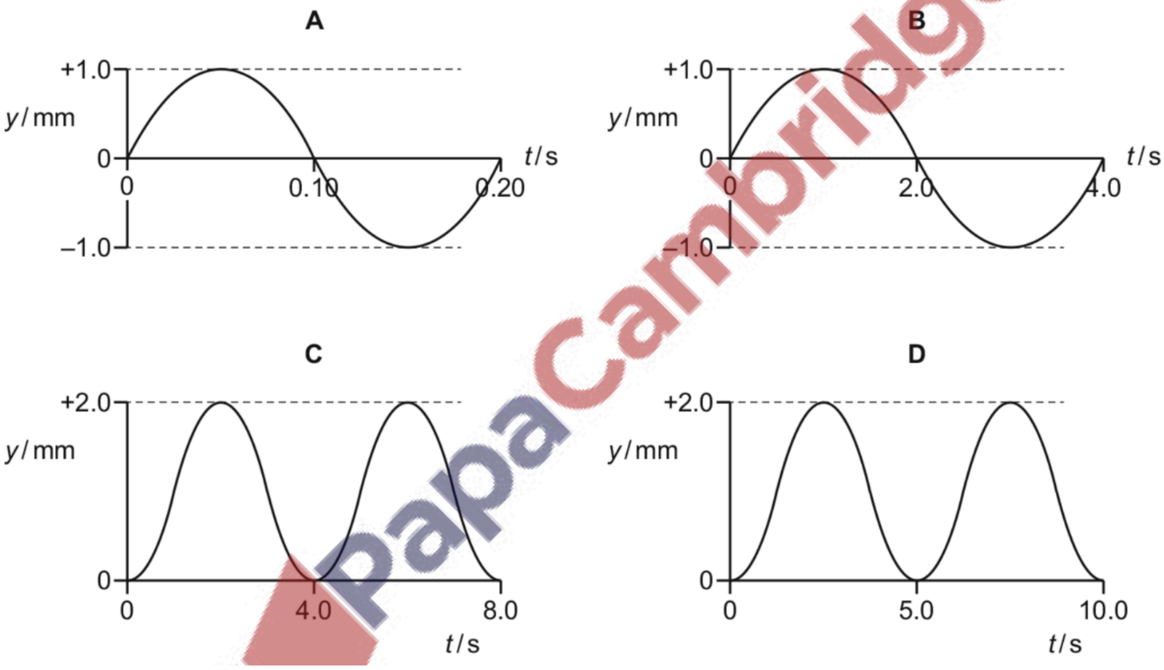
y = vertical displacement and x = horizontal distance.

The speed of the wave is $20.0\,\text{cm}\,\text{s}^{-1}$.



A particle of the medium oscillates vertically.

Which graph of vertical displacement y against time t best represents the motion of this particle?

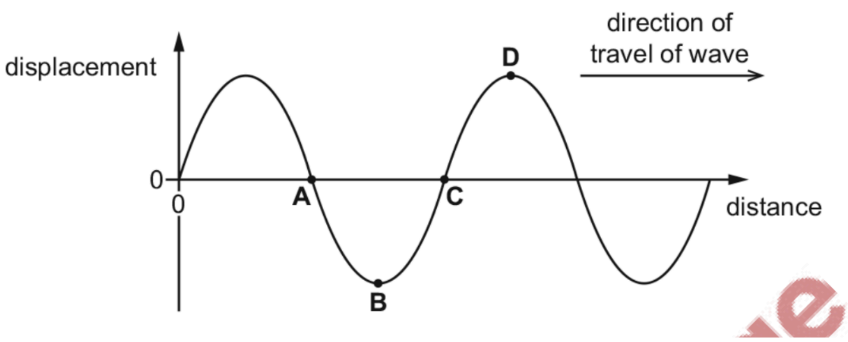


Ans: A

20.

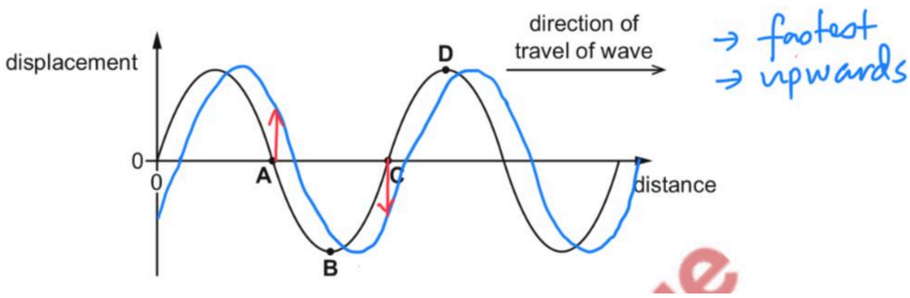
The graph shows the variation of the displacement of particles with distance along a transverse wave at an instant in time. The wave is moving to the right.

Which position along the wave corresponds to a point where particles in the wave are travelling the fastest upwards?



Ans: A

- To determine which point is going up/down, draw the next screenshot of the wave
- Since question asks for which particle travels fastest, a particle at equilibrium is required, because this is where it has highest velocity: rules out B and D.
- A moves up and C moves down
- Thus A



21.

Which statement about all types of transverse waves is correct?

A They all have the same speed.

B They all have vibrations that are parallel to the direction of propagation of energy.

C They can all form stationary waves.

D They can all travel through a vacuum.

Ans: C

- Option D is wrong since mechanical waves need a medium; eg. Water waves, earthquake/seismic waves, waves that travel down a rope.

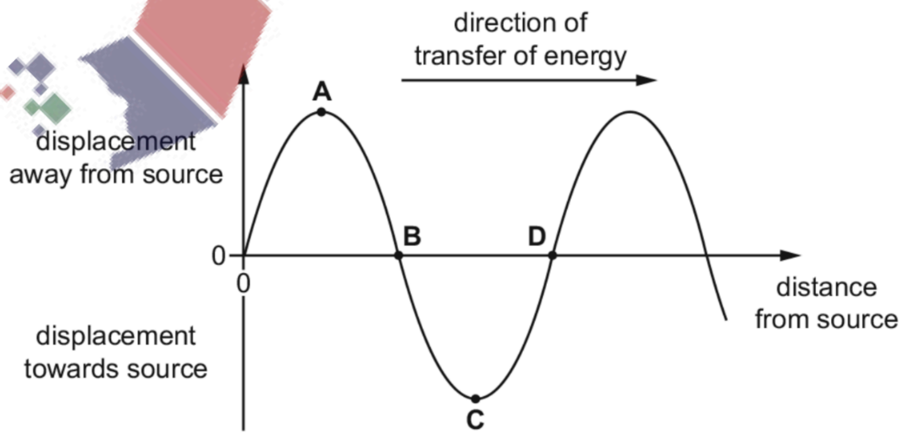
NOTE: all transwervse waves can form stationary waves.

22.

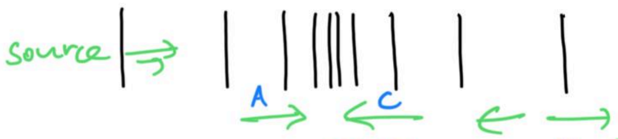
A longitudinal wave has vibrations parallel to the direction of transfer of energy by the wave.

The wave can be represented on a graph showing the variation of the displacement of the particles with distance from the source.

Which point on the graph is the centre of a compression?



Ans: B



compression rarefaction

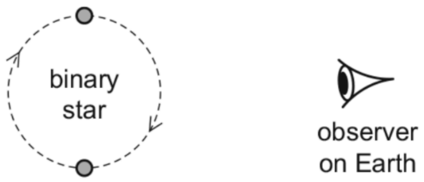
at A: disp away from source

at C: disp towards source

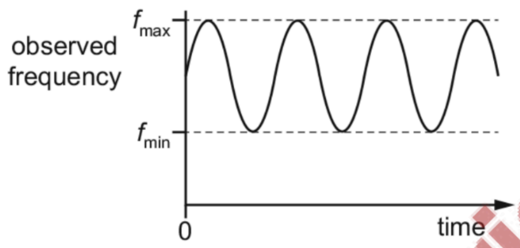
B is at the centre

23.

A binary star consists of two stars rotating around a common centre. Light from one of the stars is observed on the Earth.



The observed frequency of the light varies between a minimum frequency f_{min} and a maximum frequency f_{max}, as shown.



The rate of rotation of the binary star increases.

What is the change to f_{max} and the change to f_{min}?

	f_{max}	f_{min}
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Ans: C

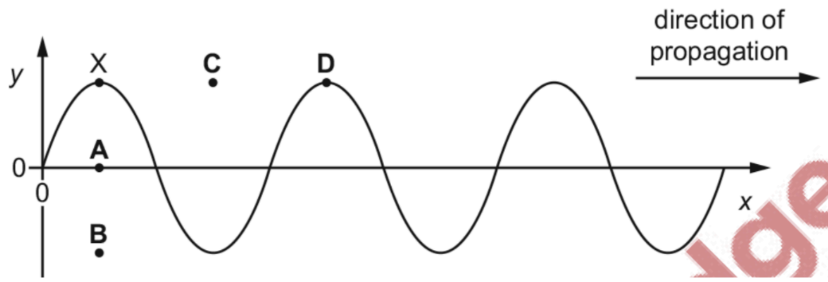
24.

The variation with distance x of the displacement y of a transverse wave on a rope is shown at time $t = 0$.

The wave has a frequency of 0.5 Hz.

A point X on the rope is marked. The diagram shows the original position of X and four new positions.

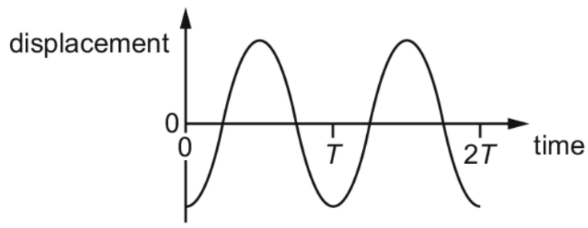
What is the position of X at time $t = 1$ s?



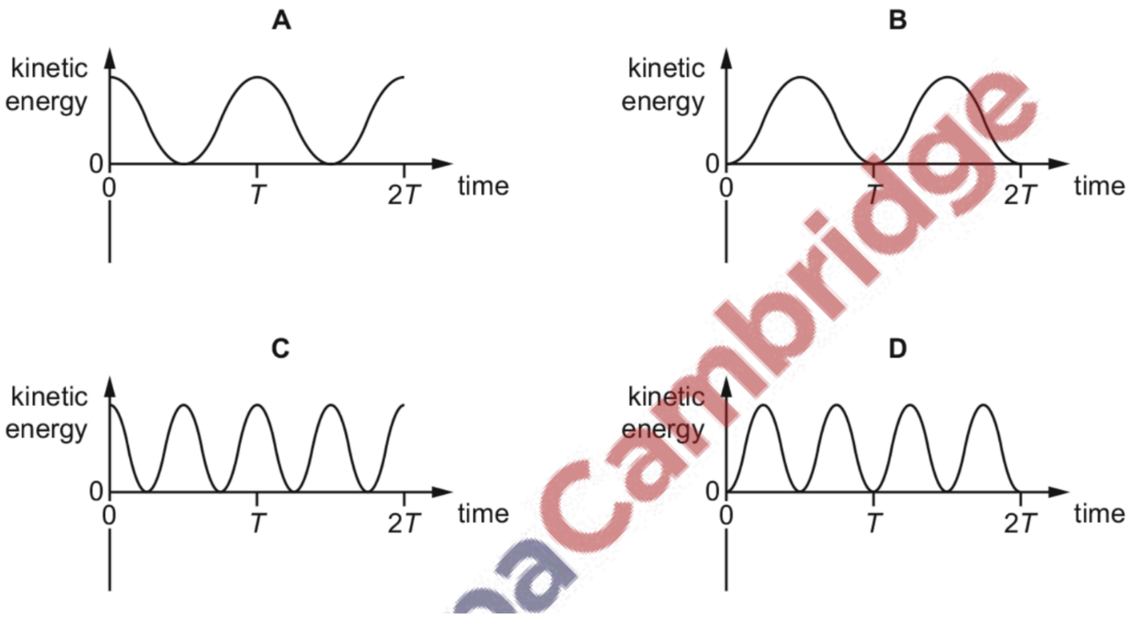
Ans: B

25.

When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown.



Which graph best shows how the kinetic energy of the air particle varies with time?



Ans: D

26.

A stationary wave is set up on a stretched string.

The diagram shows the string at two instants of time when it has maximum displacement.

The oscillations of point P on the string have amplitude A.

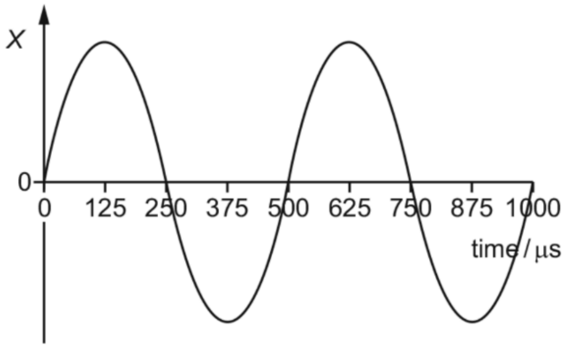
What is the distance moved by P from the position shown in the diagram after half a time period of the wave?

A 0 **B** A **C** $2A$ **D** $4A$

Ans: C

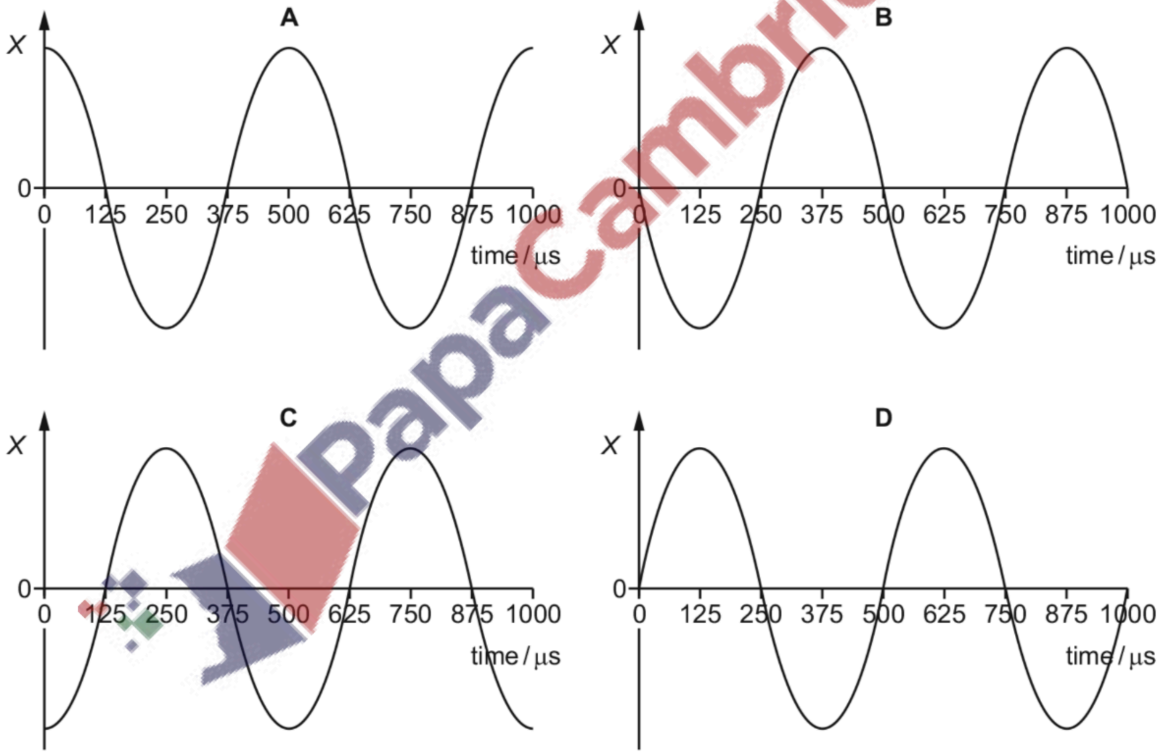
27.

The graph shows the variation with time of the displacement X of a gas molecule as a continuous sound wave passes through a gas.



The velocity of sound in the gas is 330 m s^{-1}. All the graphs below have the same zero time as the graph above.

What is the displacement-time graph for a molecule that is a distance of 0.165 m further away from the source of the sound?

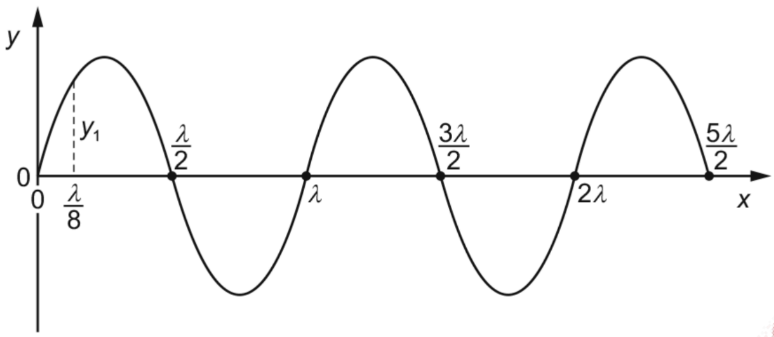


Ans: D

Wavelength is calculated as 0.165m

28.

A transverse progressive wave of wavelength λ is set up on a stretched string. The graph shows the variation of displacement y with distance x at a particular instant of time. The displacement where distance $x = \frac{\lambda}{8}$ is y_1.



What are the next two values of x where the displacement y is again equal to y_1?

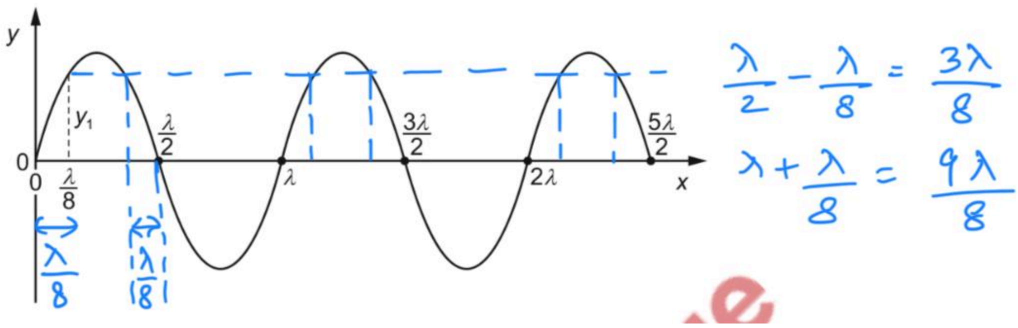
A $\frac{3\lambda}{8}$ and $\frac{5\lambda}{8}$

B $\frac{3\lambda}{8}$ and $\frac{9\lambda}{8}$

C $\frac{5\lambda}{8}$ and $\frac{9\lambda}{8}$

D $\frac{9\lambda}{8}$ and $\frac{17\lambda}{8}$

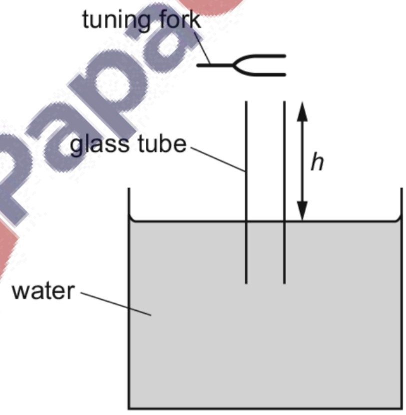
Ans: B



29.

A long glass tube is almost completely immersed in a large tank of water. A tuning fork is struck and held just above the open end of the tube as it is slowly raised.

A louder sound is first heard when the height h of the end of the tube above the water is 18.8 cm. A louder sound is next heard when h is 56.4 cm. The speed of sound in air is $330\,m\,s^{-1}$.

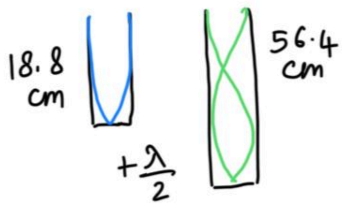


What is the frequency of the sound produced by the tuning fork?

A 220 Hz **B** 440 Hz **C** 660 Hz **D** 880 Hz

Ans: B

1st harmonic $h = 18.8$ cm
2nd harmonic $h = 56.4$ cm



$56.4 - 18.8 = \frac{\lambda}{2} = 37.6$

$\lambda = 37.6 \times 2 = 75.2$

$f = 330/(75.2 \times 10^{-2}) = 438.8$

30.

A straight tube is closed at one end and has a loudspeaker positioned at the open end. The frequency of the loudspeaker is initially very low and is increased slowly. A series of loudness maxima are heard. The stationary wave which gives the first maximum has a node at the closed end and an antinode at the open end. The frequency of the loudspeaker is f_1 when the first maximum is heard.

What is the frequency of the loudspeaker when the fourth maximum is heard?

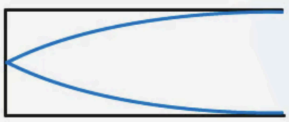
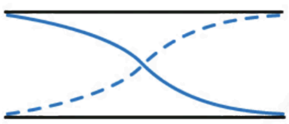
A $\frac{7f_1}{4}$ **B** $2f_1$ **C** $4f_1$ **D** $7f_1$

$f = \frac{nv}{4L} \Rightarrow f_1 = \frac{1v}{4L}$

$n = 1, 3, 5, 7$ ∴ at 4th maxima, $n = 7$

$f = \frac{7v}{4L} = 7f_1$

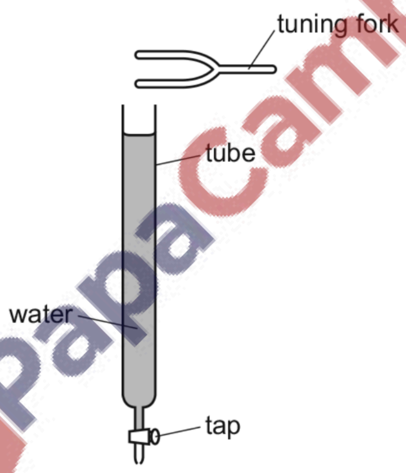
NOTE:

Air column fundamental wave	Length L / m	Resonant frequencies f / Hz	Value of n
	$L = \frac{n\lambda}{2}$	$f = \frac{nv}{2L}$	n = 1, 2, 3
	$L = \frac{n\lambda}{4}$	$f = \frac{nv}{4L}$	n = odd
	$L = \frac{n\lambda}{2}$	$f = \frac{nv}{2L}$	n = 1, 2, 3...

31.

A long tube, filled with water, has a tap fitted at its base, as shown.

A tuning fork is sounded above the tube and the water is allowed to run gradually out of the tube.



A louder sound is heard at intervals as the water runs out of the tube. The change in water level between louder sounds is 32 cm.

What is the wavelength of the sound in the tube?

A 16 cm **B** 32 cm **C** 64 cm **D** 128 cm

Ans: C

- $\lambda/2 = 32$
- $\lambda = 32 \times 2 = 64$

32.

The diagram shows apparatus for the measurement of the frequency of a sound wave.

Sound of the unknown frequency is reflected back from a metal plate. A microphone placed at a distance *D* from the metal plate detects the sound intensity. A minimum intensity is detected with *D* = 12.0 cm. The plate is moved further away from the microphone until the next minimum is detected with *D* = 15.0 cm.

The speed of sound in air is 336 m s^{-1}.

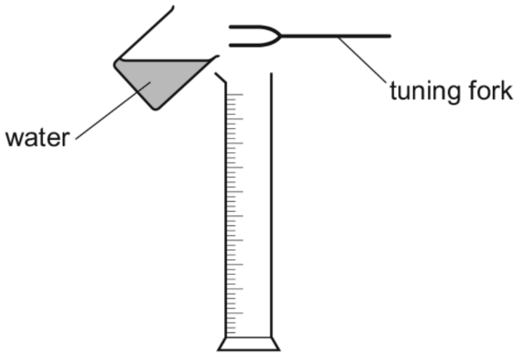
What is the frequency of the sound?

A 56 Hz **B** 112 Hz **C** 5600 Hz **D** 11 200 Hz

Ans: C

33.

A vibrating tuning fork is held over a measuring cylinder, as shown.



Water is then gradually poured into the measuring cylinder. A much louder sound is first heard when the water level is 2.9 cm above the base of the measuring cylinder. A second much louder sound is heard when the water level reaches a height of 67.3 cm above the base.

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

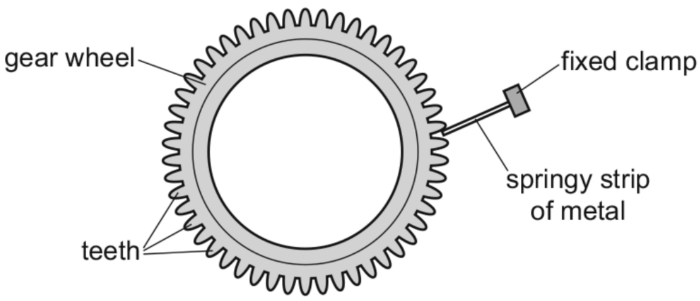
What is the frequency of the tuning fork?

A 128 Hz **B** 256 Hz **C** 512 Hz **D** 1024 Hz

Ans: B

34.

A bicycle gear wheel is a disc with 50 'teeth' equally spaced around its edge, as shown. The gear wheel is rotated 10 times each second. A springy strip of metal is vibrated by the rotating 'teeth'. The metal strip produces a sound of frequency that is equal to the frequency of vibration of the strip.



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

What is the wavelength of the emitted sound?

A 0.66 m **B** 1.5 m **C** 6.6 m **D** 500 m

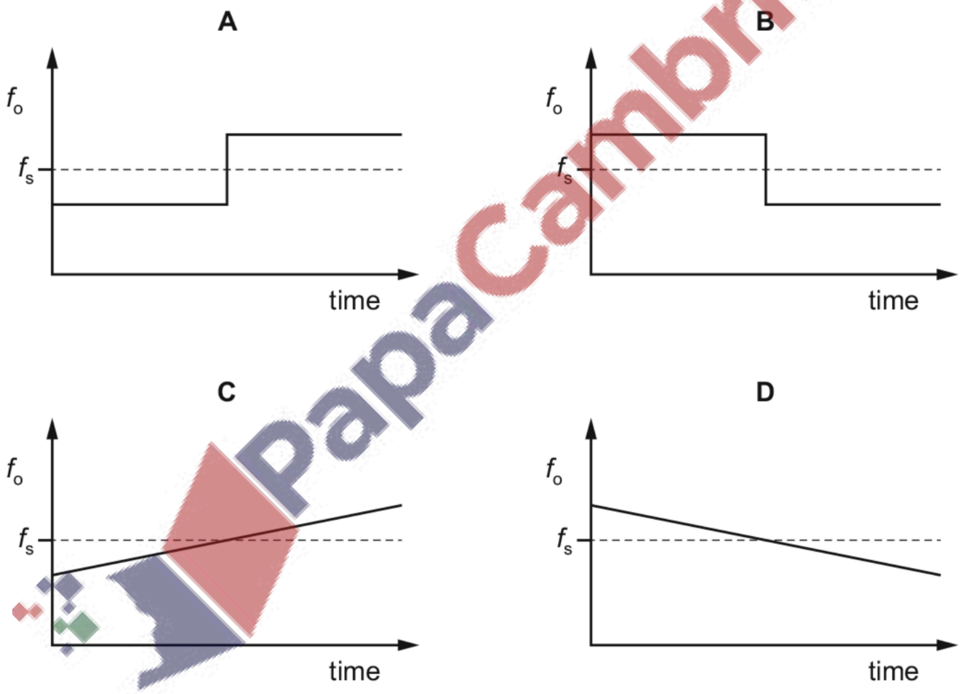
Ans: A

- 1 complete rotation = 50 teeth.
- If rotated 10 times each sec, 50 x 10 (500) teeth pass the strip in 1 second.
- Frequency = 500Hz
- 330/500 = 0.66m

35.

A source emitting sound of a single frequency f_s travels at constant speed directly towards an observer. The source then passes the observer and continues to move directly away from the observer. The velocity of the source remains constant.

Which graph represents the variation with time of the frequency f_o of the sound heard by the observer?



Ans: B

- When it comes towards observer, higher frequency is heard
- When it moves away from observer, lower frequency is heard
- The frequency should be constant in both sections, because the speed of motion is constant

36.

A stationary person measures the speed and wavelength of the sound from a horn on a stationary vehicle. The person then repeats the measurements when the vehicle is approaching at a constant speed.

Which row describes the measured wavelength and the measured speed of the sound wave from the moving vehicle when compared with the sound wave from the stationary vehicle?

	wavelength of the sound wave	speed of the sound wave
A	longer	greater
B	shorter	greater
C	longer	same
D	shorter	same

Ans: D

37.

A toy motorboat moving with constant velocity v vibrates up and down on the surface of a pond. This causes the boat to act as a source of circular water waves of frequency 2.0 Hz. The speed of the waves is $1.5\,m\,s^{-1}$.

A man, standing at the edge of the pond, observes that the waves from the boat approach him with a frequency of 3.0 Hz.

The formula for Doppler effect calculations with sound waves may also be used for water waves.

What is a possible value of v?

	speed / $m\,s^{-1}$	direction
A	0.50	directly away from the man
B	0.50	directly towards the man
C	0.75	directly away from the man
D	0.75	directly towards the man

Ans: B

38.

A vehicle carries a microwave transmitter that emits microwaves of a constant frequency. A stationary observer has a microwave receiver.

The vehicle moves directly towards the observer at constant speed. The observer detects microwaves of frequency F_o.

The vehicle then accelerates, still moving towards the observer, travels at higher steady speed for a time and then decelerates until it stops.

What is the variation in the frequency of the microwaves that are detected by the observer?

A The observed frequency will fall, then remain steady then return to the frequency F_o.

B The observed frequency will fall, then remain steady then rise to a higher frequency than F_o.

C The observed frequency will rise, then remain steady then fall to a lower frequency than F_o.

D The observed frequency will rise, then remain steady then return to the frequency F_o.

Ans: C

39.

A car travelling in a straight line at a speed of $30\,m\,s^{-1}$ passes near a stationary observer while sounding its horn. The true frequency of sound from the horn is 400 Hz.

The speed of sound in air is $336\,m\,s^{-1}$.

What is the change in the frequency of the sound heard by the observer as the car passes?

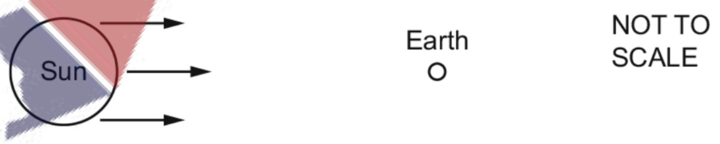
A 39 Hz **B** 66 Hz **C** 72 Hz **D** 78 Hz

Ans: C

Find the frequency while approaching and then while moving away.

40.

Light of a particular wavelength λ_s is emitted from the Sun. At any instant, a band of wavelengths ranging from less than λ_s to more than λ_s is observed on the Earth. This is caused by the Doppler effect.



What could be the explanation for this Doppler effect?

A The Sun is moving at right-angles to a line joining the Sun and the Earth.

B The Sun is moving away from the Earth.

C The Sun is moving towards the Earth.

D The Sun is rotating.

Ans: D

41.

A telescope detects and analyses some electromagnetic radiation of wavelength 2 cm.

Which type of telescope is it?

A microwave telescope

B optical telescope

C radio telescope

D X-ray telescope

Ans: A

42.

What is a typical value of the wavelength of a microwave travelling in a vacuum?

A 3 000 000 pm

B 30 nm

C 30 000 μm

D 3000 mm

Ans: C

43.

An electromagnetic wave has a wavelength that is numerically of the same order of magnitude as the diameter of a nucleus.

In which region of the electromagnetic spectrum does the wave occur?

A gamma ray

B X-ray

C visible light

D infra-red

Ans: A

44.

Which statement about progressive waves is correct?

A They are always transverse waves.

B They can exist in solids but not liquids.

C They decrease in frequency as their speed increases.

D They transfer energy away from their source.

Ans: D

45.

Brief pulses of red, blue and green light are emitted from the Sun at the same time.

The pulses travel the same distance to reach Mars. Assume that the pulses travel in a vacuum for the full duration of their journey.

In which order would these pulses of light arrive at Mars?

A all arrive at the same time

B blue first, then green, then red

C red first, then blue, then green

D red first, then green, then blue

Ans: A

All have the same speed, so arrive at the same time!!

46.

Two coherent progressive waves from different sources meet at a point.

Which condition **must** be satisfied for there to be zero resultant amplitude at the point where the waves meet?

A The two waves must be emitted from their sources with the same intensity.

B The two waves must be in phase with each other at the point.

C The two waves must be travelling in opposite directions.

D The two waves must have the same amplitude at the point.

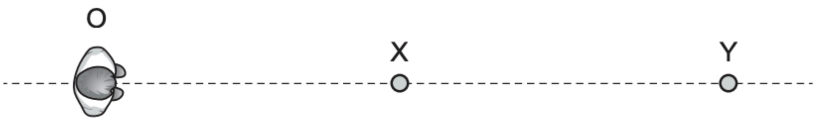
Ans: D

Amplitude doesn't mean positive or negative, it just means maximum displacement! This has to be equal in order for displacement to cancel out.

47.

Two loudspeakers X and Y emit sound waves that are in phase and of wavelength 0.75 m.

An observer O is able to stand anywhere on a straight line that passes through X and Y, as shown. The observer stands at a point where the sound waves from X and Y meet in phase.



What could be the distances OY and XY?

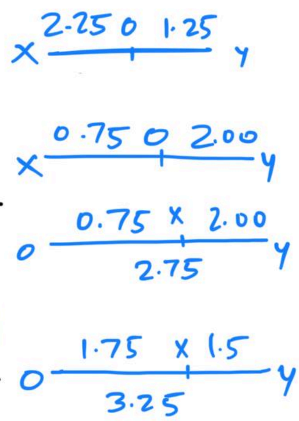
	distance OY / m	distance XY / m
A	1.25	3.50
B	2.00	2.75
C	2.75	2.00
D	3.25	1.50

Ans: D

The waves should be in the same phase when they reach O.

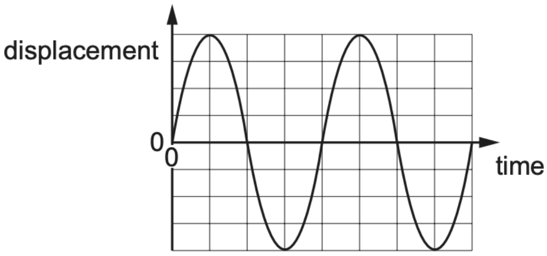
OX	no. of λ of X	OY	no. of λ of Y
2.25	3	1.25	$1\frac{2}{3}$
0.75	1	2.00	$2\frac{2}{3}$
0.75	1	2.75	$3\frac{2}{3}$
1.75	$2\frac{1}{3}$	3.25	$4\frac{1}{3}$

waves in phase



48.

22 The graph shows the variation of the displacement of an air particle with time as a sound wave passes through air.

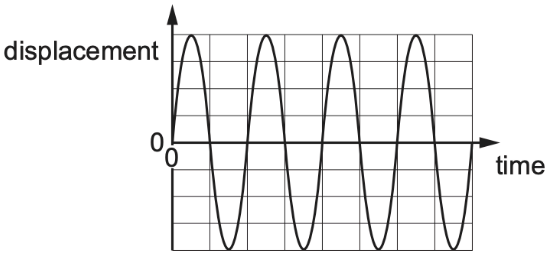


The intensity of the sound is halved while the frequency remains constant.

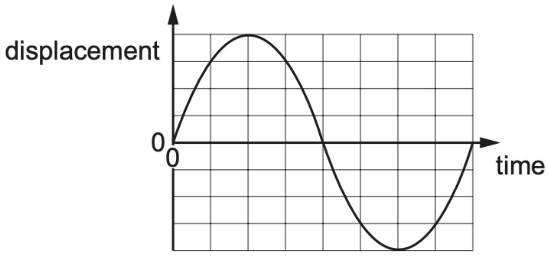
The four graphs below are drawn to the same scale as the graph above.

Which graph shows the displacement of the air particle?

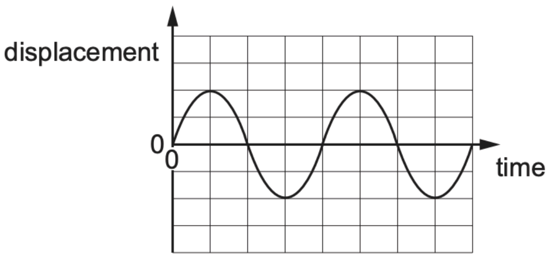
A



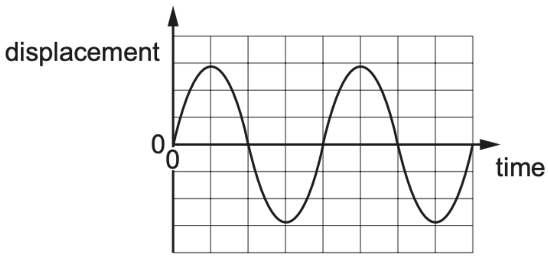
B



C



D



Ans: D

$$I \propto A^2$$

$$I = kA^2 \Rightarrow k = \frac{I}{A^2}$$

$$\frac{I}{2} = k(x)^2 = \frac{I}{A^2}(x)^2$$

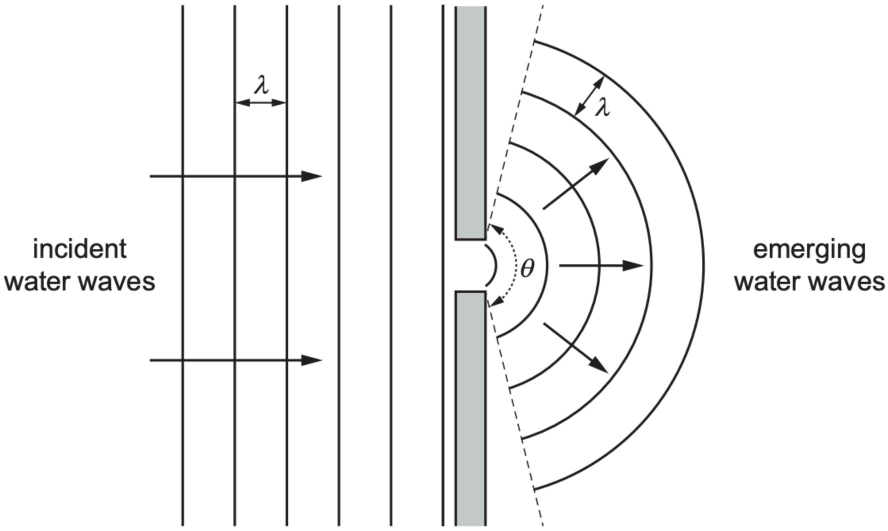
$$\Rightarrow \frac{1}{2} = \frac{x^2}{A^2} \Rightarrow x = \sqrt{\frac{A^2}{2}} = A\sqrt{\frac{1}{2}}$$

$$= 0.7A$$

D matches 0.7A

49.

Water waves of wavelength λ are incident normally on an obstacle with a narrow gap. The width of the gap is equal to λ. The waves from the gap emerge over an angle θ, as shown.



The gap is slowly widened.

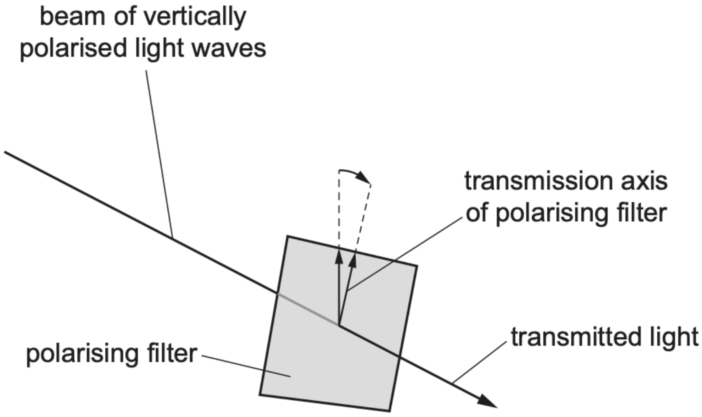
Which changes, if any, occur to θ and to the wavelength of the emerging waves?

	θ	wavelength
A	decreases	remains the same
B	increases	remains the same
C	remains the same	decreases
D	remains the same	increases

Ans: A

50.

A beam of vertically polarised light is incident normally on a polarising filter. The filter can be rotated so that it is always in a plane perpendicular to the beam. The transmission axis of the filter is initially vertical.



The filter is first rotated clockwise by an angle of 30° so that the transmitted light waves have intensity I_{30}.The filter is then rotated clockwise by a further angle of 30°.

What is the new intensity of the transmitted light waves?

A $0.25\,I_{30}$ **B** $0.33\,I_{30}$ **C** $0.75\,I_{30}$ **D** $0.87\,I_{30}$

Ans: B

$$I_{30} = I_0 \cos^2 30 = \frac{3}{4} I_0$$

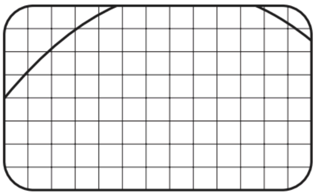
$$I_{60} = I_0 \cos^2 60 = \frac{1}{4} I_0$$

$$\frac{1}{4} \div \frac{3}{4} = \frac{1}{3} I_{30}$$

NOTE: transmitted intensity eq: $I = I_0\cos^2\theta$!!

51.

In an experiment, a student uses a microphone and a cathode-ray oscilloscope (CRO) to analyse a sound wave. The diagram shows the trace on the screen of the CRO.



The student is expecting a sinusoidal waveform to be shown on the screen.

Which changes should the student make to the time-base and the *y*-gain of the CRO so that the screen shows a continuous trace for one complete cycle of the waveform?

	time-base	*y*-gain
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

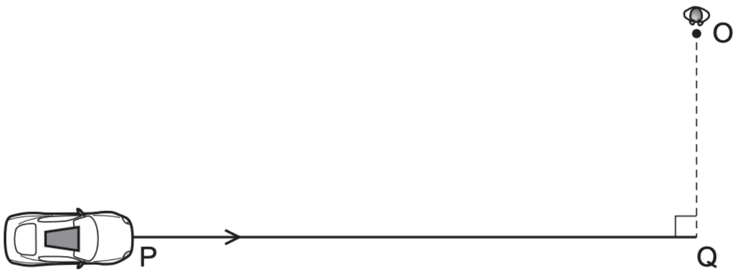
Ans: D

- y-gain = how much voltage each box represents = V/div
- time-base = how much time each box represents = s/div
- Both have to be increased for the entire sine wave to fit.
- If each box represents more quantity, less number of boxes are required.

52.

A car travels at a constant speed along a straight line PQ.

A loudspeaker attached to the car emits sound of constant frequency *f*. A stationary observer is at point O.



What does the observer hear as the car moves from P towards Q?

A a frequency less than *f* that decreases as the car moves from P towards Q

B a frequency less than *f* that increases as the car moves from P towards Q

C a frequency more than *f* that decreases as the car moves from P towards Q

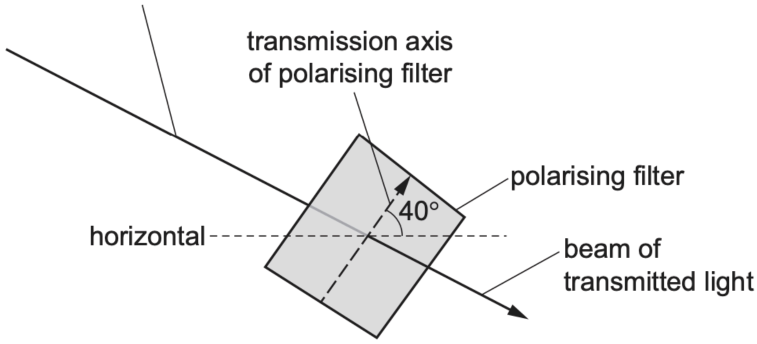
D a frequency more than *f* that increases as the car moves from P towards Q

Ans: C

- The car is moving towards the observer, so observer hears a frequency more than f – rule out A and B.
- If the observer was standing at Q, the higher observed frequency would be constant.
- Since the observer is standing further away at O, this observed higher frequency is not constant.
- When the car reaches Q, it is no longer moving towards the observer. It starts to move away. Thus the observed frequency is lower than f.
- To go from higher than f to lower than f, the frequency must decrease.
- Thus, frequency decreases as the car moves from P to Q.
- Also, relative velocity decreases as it moves from P to Q.

53.

A vertically polarised beam of light is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 40° to the horizontal.



What is the ratio $\dfrac{\text{amplitude of transmitted beam}}{\text{amplitude of incident beam}}$?

A 0.41 **B** 0.59 **C** 0.64 **D** 0.77

Ans: C

- It's vertically polarised, so find angle from vertical, which is 50!!

$$I \propto A^2 \Rightarrow I = kA^2$$

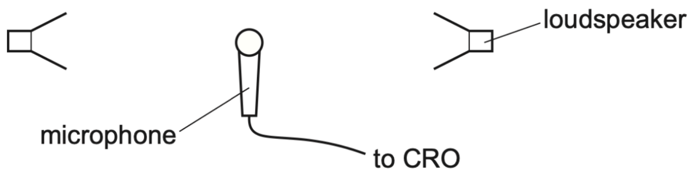
$$\Rightarrow A = \sqrt{\frac{I}{k}}$$

$$\therefore \text{ratio} = \frac{\sqrt{I\cos^2 50}}{\sqrt{I}}$$

$$= 0.64$$

54.

Two loudspeakers are connected to the same signal generator. The signal generator produces a single frequency. The loudspeakers face each other so that a stationary sound wave is set up in the region between the loudspeakers.



A microphone is connected to a cathode-ray oscilloscope (CRO) and positioned between the two loudspeakers.

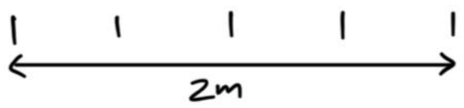
The microphone is moved along a line joining the two loudspeakers.

The signal on the CRO shows 5 maximum amplitudes as the microphone moves. The microphone moves a distance of 2.0 m from the position that gives the first maximum to the position that gives the fifth maximum.

What is the wavelength of the sound wave?

A 0.40 m **B** 0.50 m **C** 0.80 m **D** 1.0 m

Ans: D



max occurs at antinode
d btwn 2 antinodes = $\frac{1}{2}\lambda$
$\therefore \frac{2}{4} = \frac{1}{2}\lambda \Rightarrow \lambda = 1m$

55.

Three statements about two progressive waves are listed.

1 The waves have the same frequency.

2 The waves have the same amplitude.

3 The waves are emitted with a constant phase difference.

Which statements **must** be correct for the two waves to be coherent?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Ans: C

56.

Waves P and Q have the same amplitude. The waves meet in phase at point X and interfere to give a resultant wave with intensity I.

The amplitude of wave P is doubled.

What is the new intensity of the resultant wave at X, in terms of I?

A $0.44I$ **B** $1.5I$ **C** $2.3I$ **D** $3.0I$

Ans: C

- Initially both have amplitude of 1, so resultant amplitude at X = 2. I = 2^2 = 4
- When amplitude of P is doubled, resultant amplitude at X = 1+2 = 3. I = 3^2 = 9
- 9/4 = 2.25 = 2.3