

1. Question | 9702 Feb-March 2016 P1 V2 Q20

20 With which types of wave can the Doppler shift be observed?

- A** all types of wave
- B** light and sound waves only
- C** sound waves and water waves only
- D** sound waves only

2. Question | 9702 Feb-March 2016 P1 V2 Q21

21 A distant star is receding from the Earth with a speed of $1.40 \times 10^7 \text{ ms}^{-1}$. It emits light of frequency $4.57 \times 10^{14} \text{ Hz}$. The speed of light is $3.00 \times 10^8 \text{ ms}^{-1}$.

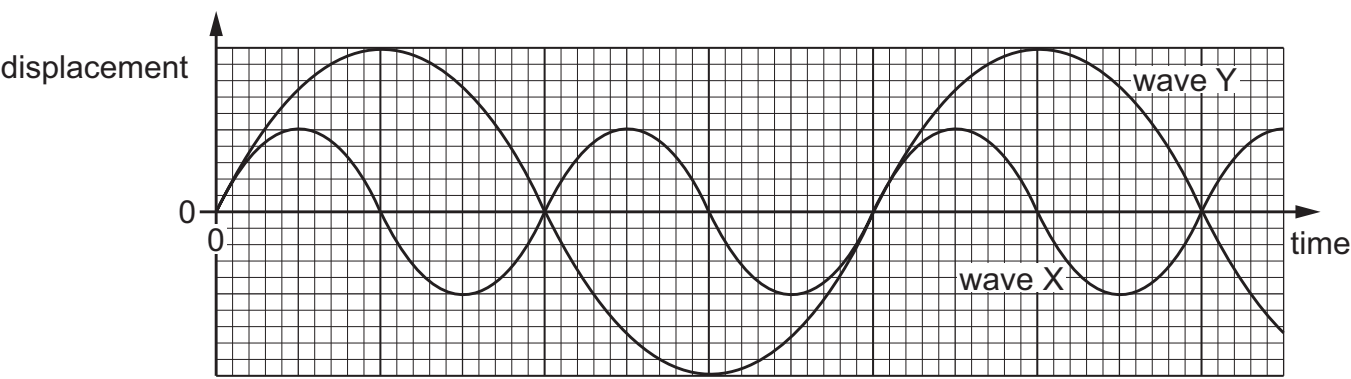
The Doppler effect formula can be used with light waves.

What will be the frequency of this light when detected on Earth?

- A** $2.04 \times 10^{13} \text{ Hz}$
- B** $4.37 \times 10^{14} \text{ Hz}$
- C** $4.57 \times 10^{14} \text{ Hz}$
- D** $4.79 \times 10^{14} \text{ Hz}$

3. Question | 9702 Feb-March 2016 P1 V2 Q22

22 The graph shows the variation with time of the displacement of two separate waves X and Y.



Wave X has frequency f and amplitude A .

What is the frequency and what is the amplitude of wave Y?

	frequency	amplitude
A	$\frac{1}{2}f$	$\frac{1}{2}A$
B	$\frac{1}{2}f$	$2A$
C	$2f$	$\frac{1}{2}A$
D	$2f$	$2A$

4. Question | 9702 Feb-March 2016 P1 V2 Q23

23 Diffraction is a term used to describe one aspect of wave behaviour.

What does diffraction make possible?

- A** the ability to hear around corners
- B** the ability to hear high frequency and low frequency sound waves
- C** the ability to hear loud and quiet sounds
- D** the ability to hear sound through a brick wall

5. Question | 9702 May-June 2016 P1 V1 Q22

22 Two sound waves have frequencies of 250 Hz and 300 Hz. The speed of sound is 340 m s^{-1} .

What is the difference between the wavelengths of the two waves?

- A** 0.23 m **B** 1.1 m **C** 1.4 m **D** 6.8 m

6. Question | 9702 May-June 2016 P1 V1 Q23

23 Which electromagnetic waves have the wavelengths of 10^{-2} m , 10^{-5} m , 10^{-10} m and 10^{-13} m ?

	10^{-2} m	10^{-5} m	10^{-10} m	10^{-13} m
A	infra-red	microwaves	visible light	X-rays
B	microwaves	infra-red	X-rays	gamma rays
C	microwaves	visible light	ultraviolet	gamma rays
D	radio waves	microwaves	ultraviolet	X-rays

7. Question | 9702 May-June 2016 P1 V1 Q25

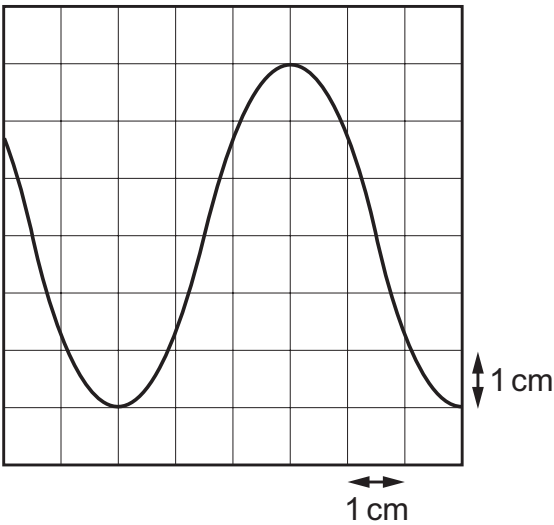
25 Continuous water waves are diffracted through a gap in a barrier in a ripple tank.

Which change will cause the diffraction of the waves to increase?

- A** increasing the frequency of the waves
B increasing the width of the gap
C reducing the wavelength of the waves
D reducing the width of the gap

8. Question | 9702 May-June 2016 P1 V2 Q22

22 A microphone connected to the Y-plates of a cathode-ray oscilloscope (c.r.o.) is placed in front of a loudspeaker. The trace on the screen of the c.r.o. is shown.



The time-base setting is 0.5 ms cm^{-1} and the Y-plate sensitivity is 0.2 mV cm^{-1} .

What is the frequency of the sound from the loudspeaker and what is the amplitude of the trace on the c.r.o.?

	frequency / Hz	amplitude / mV
A	330	0.6
B	330	1.2
C	670	0.6
D	670	1.2

9. Question | 9702 May-June 2016 P1 V2 Q23

23 A source of sound of frequency 1000 Hz moves away from a stationary observer at a speed of 30.0 ms^{-1} . The speed of sound is 330 ms^{-1} .

What is the frequency of the sound heard by the observer?

- A** 909 Hz **B** 917 Hz **C** 1090 Hz **D** 1100 Hz

10. Question | 9702 May-June 2016 P1 V2 Q24

24 Each of the principal radiations of the electromagnetic spectrum has a range of wavelengths.

Which wavelength is correctly linked to its radiation?

	wavelength /m	radiation
A	10^{-9}	gamma ray
B	10^{-5}	microwave
C	10^{-8}	ultraviolet
D	10^{-14}	X-ray

11. Question | 9702 May-June 2016 P1 V2 Q25

25 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** $4A$

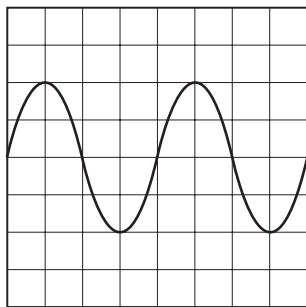
12. Question | 9702 May-June 2016 P1 V2 Q26

26 Which statement is an example of the diffraction of light?

- A** the addition of the amplitudes of two beams of light which are in phase
B the change in direction of a beam of light when passing from air into water
C the separation of a beam of white light into a spectrum of colours using a prism
D the spreading of a beam of light as it passes through a small hole

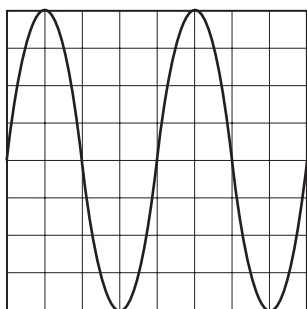
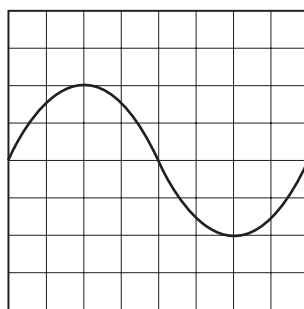
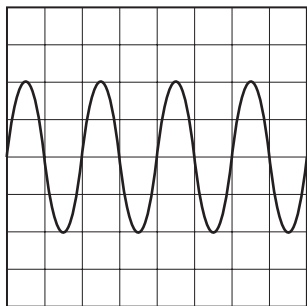
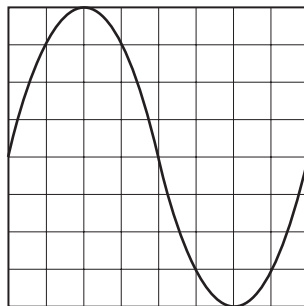
13. Question | 9702 May-June 2016 P1 V3 Q5

- 5 The following trace is seen on the screen of a cathode-ray oscilloscope.



The setting of the time-base is then changed from 10 ms cm^{-1} to 20 ms cm^{-1} and the Y-plate sensitivity remains constant.

Which trace is now seen on the screen?

A**B****C****D**

14. Question | 9702 May-June 2016 P1 V3 Q23

23 A beam of red laser light has length 1.0 m.

What is the order of magnitude of the number of wavelengths of the red light in 1.0 m?

- A** 10^4 **B** 10^6 **C** 10^8 **D** 10^{10}

15. Question | 9702 May-June 2016 P1 V3 Q24

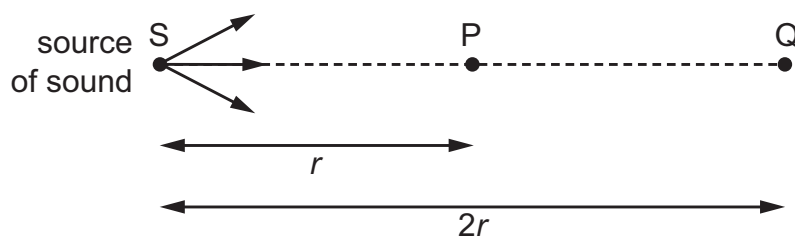
24 When a car travelling with constant velocity passes a stationary observer, the observer hears a change in the frequency of the sound emitted by the car.

Which statement is correct?

- A** The change in frequency is greater as the car moves away than as it approaches.
- B** The greater the speed of the car, the greater the change in observed frequency.
- C** The observed frequency is lower as the car moves towards the observer and higher as the car moves away from the observer.
- D** The volume of the sound heard by the observer does not change as the car approaches.

- 25** 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

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



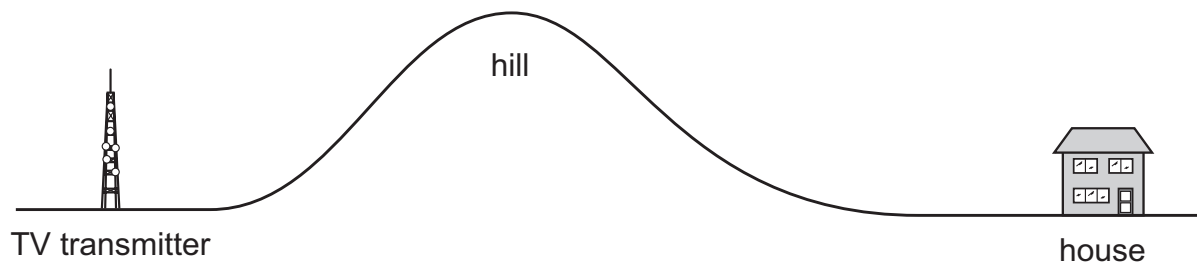
Air molecules at point P, a distance r from the source S, oscillate with amplitude $8.0\ \mu\text{m}$.

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

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

- A** $1.4\ \mu\text{m}$ **B** $2.0\ \mu\text{m}$ **C** $2.8\ \mu\text{m}$ **D** $4.0\ \mu\text{m}$

- 26** A hill separates a television (TV) transmitter from a house. The transmitter cannot be seen from the house. However, the house has good TV reception.

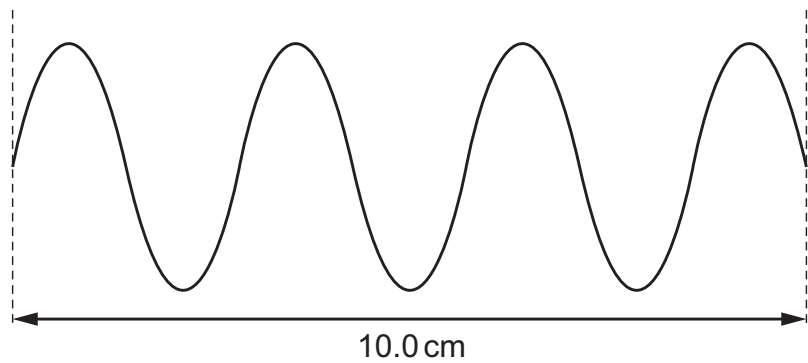


By which wave effect at the hill could the TV signal reach the house?

- A** coherence
- B** diffraction
- C** interference
- D** reflection

18. Question | 9702 Oct-Nov 2016 P1 V1 Q5

- 5 A student uses a cathode-ray oscilloscope (c.r.o.) to measure the period of a signal. She sets the time-base of the c.r.o. to 5 ms cm^{-1} and observes the trace illustrated below. The trace has a length of 10.0 cm .



What is the period of the signal?

- A $7.1 \times 10^{-6}\text{ s}$ B $1.4 \times 10^{-5}\text{ s}$ C $7.1 \times 10^{-3}\text{ s}$ D $1.4 \times 10^{-2}\text{ s}$

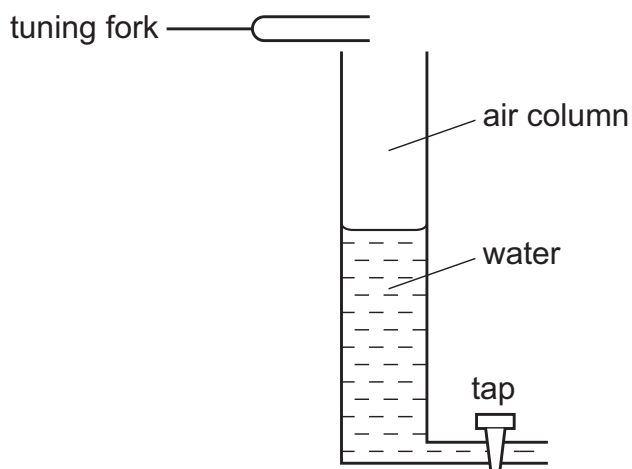
19. Question | 9702 Oct-Nov 2016 P1 V1 Q23

- 23 The table shows the wavelengths of five electromagnetic waves.

Which row correctly identifies the principal radiation for each of these wavelengths?

	10^{-14} m	10^{-10} m	10^{-6} m	10^{-2} m	10^2 m
A	gamma ray	X-ray	infra-red	microwave	radio wave
B	radio wave	microwave	infra-red	X-ray	gamma ray
C	radio wave	microwave	ultraviolet	infra-red	X-ray
D	X-ray	infra-red	ultraviolet	microwave	radio wave

- 24** The diagram shows an experiment to produce a stationary wave in an air column. A tuning fork, placed above the column, vibrates and produces a sound wave. The length of the air column can be varied by altering the volume of the water in the tube.



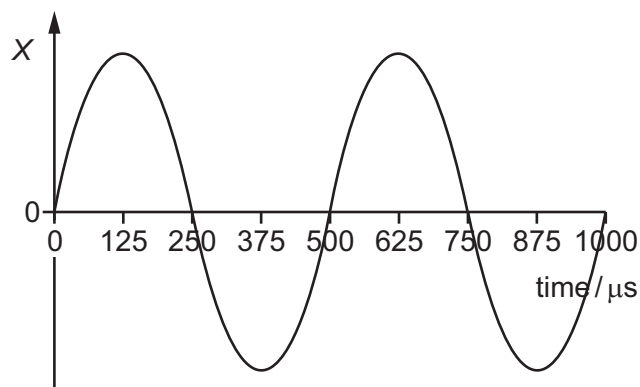
The tube is filled and then water is allowed to run out of it. The first two stationary waves occur when the air column lengths are 0.14 m and 0.42 m.

What is the wavelength of the sound wave?

- A** 0.14 m **B** 0.28 m **C** 0.42 m **D** 0.56 m

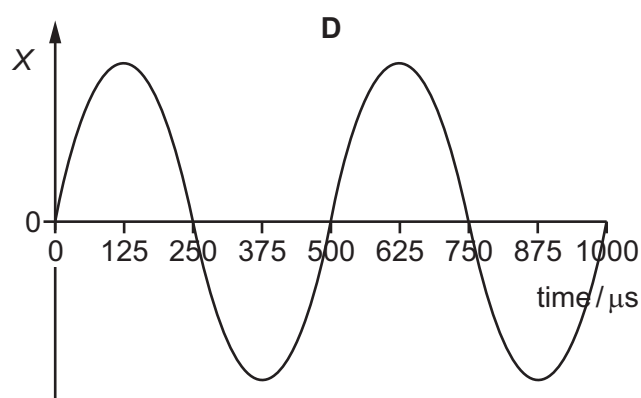
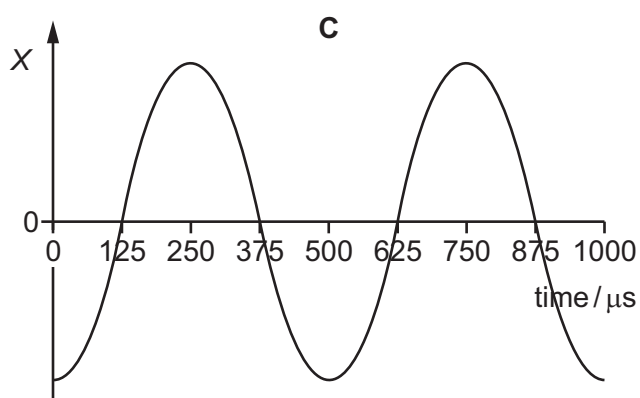
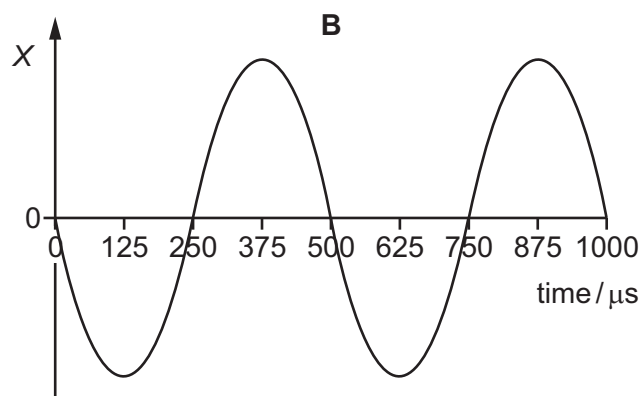
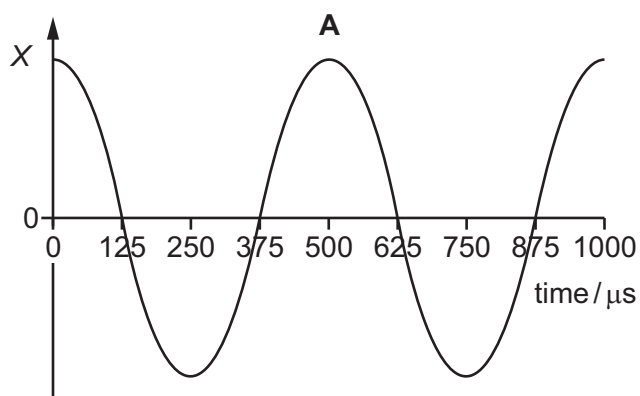
21. Question | 9702 Oct-Nov 2016 P1 V1 Q25

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



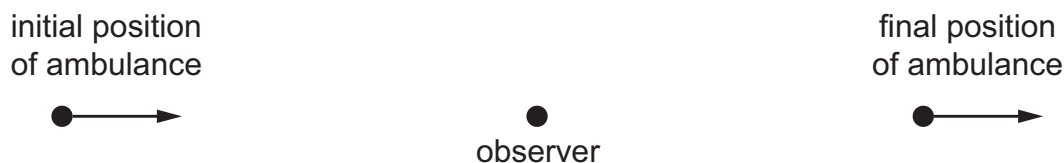
The velocity of sound in the gas is 330 m s^{-1} . All the graphs below have the same zero time as the graph above.

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?



22. Question | 9702 Oct-Nov 2016 P1 V1 Q26

- 26** The warning signal on an ambulance has a frequency of 600 Hz. The speed of sound is 330 m s^{-1} . The ambulance is travelling with a constant velocity of 25 m s^{-1} towards an observer.

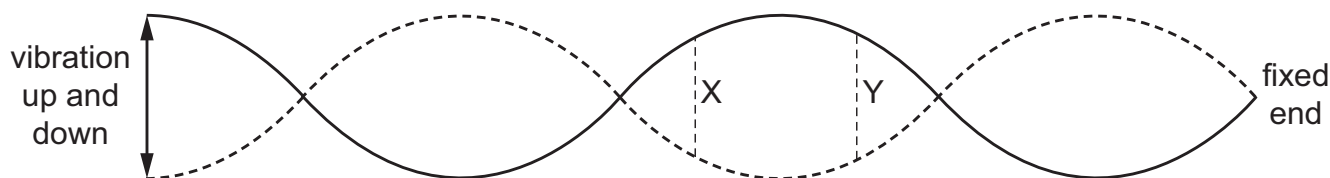


Which overall change in observed frequency takes place between the times at which the ambulance is a long way behind the observer and when it is a long way in front of the observer?

- A** 49 Hz **B** 84 Hz **C** 91 Hz **D** 98 Hz

23. Question | 9702 Oct-Nov 2016 P1 V1 Q28

- 28** The diagram shows a long rope fixed at one end. The other end is moved up and down, setting up a stationary wave.



What is the phase difference between the oscillations at X and at Y?

- A** 0 **B** 45° **C** 90° **D** 135°

24. Question | 9702 Oct-Nov 2016 P1 V2 Q23

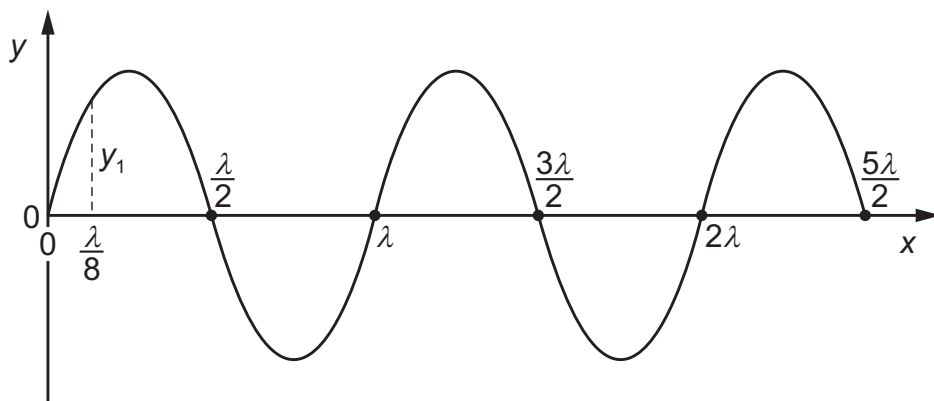
- 23** High-frequency sound waves with frequency 2.0 MHz travel with a speed of 2.0 km s^{-1} through a liquid.

What is the shortest distance between a compression and a rarefaction (expansion) in the liquid?

- A** 0.5 mm **B** 1.0 mm **C** 5.0 mm **D** 10.0 mm

25. Question | 9702 Oct-Nov 2016 P1 V2 Q24

- 24** 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 $\frac{17\lambda}{8}$

26. Question | 9702 Oct-Nov 2016 P1 V2 Q25

- 25** A man standing next to a stationary train hears sound of frequency 400Hz emitted from the train’s horn. The train then moves directly away from the man and sounds its horn when it has a speed of 50 m s^{-1} . The speed of sound is 340 m s^{-1} .
- What is the difference in frequency of the sound heard by the man on the two occasions?
- A** 51 Hz **B** 69 Hz **C** 349 Hz **D** 469 Hz

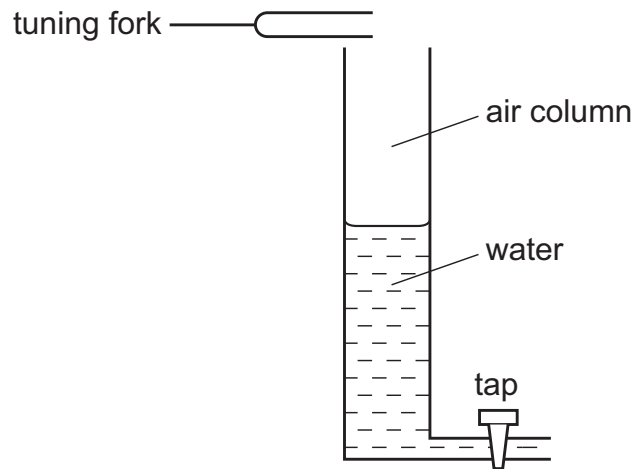
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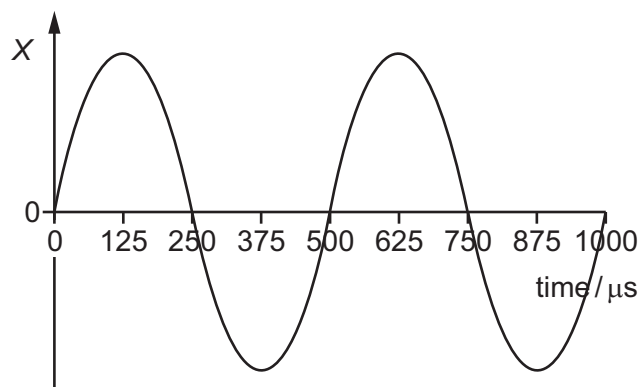
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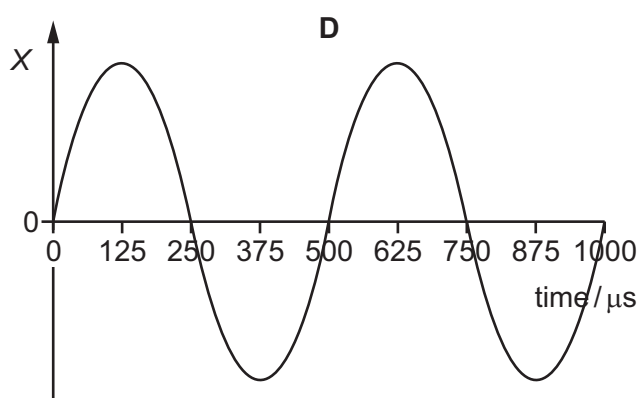
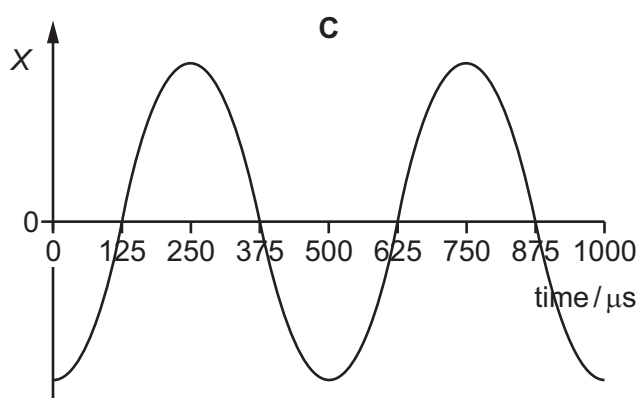
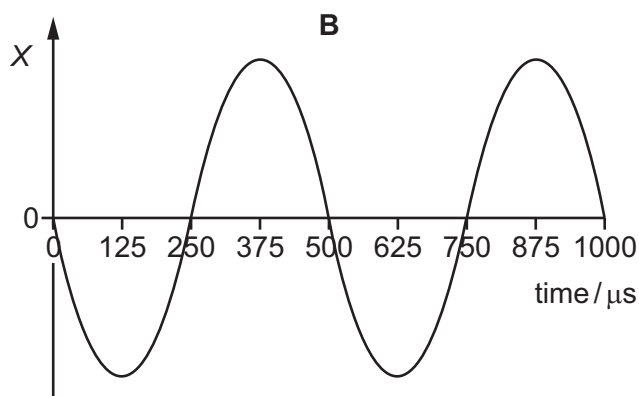
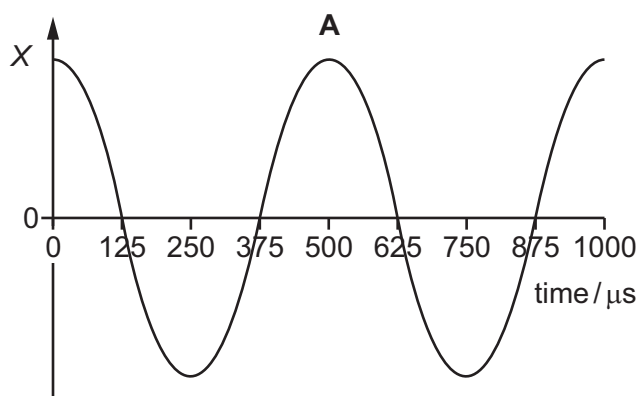
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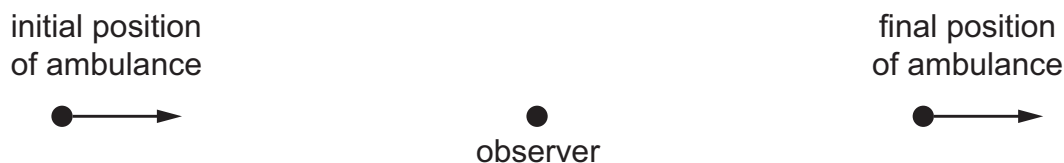
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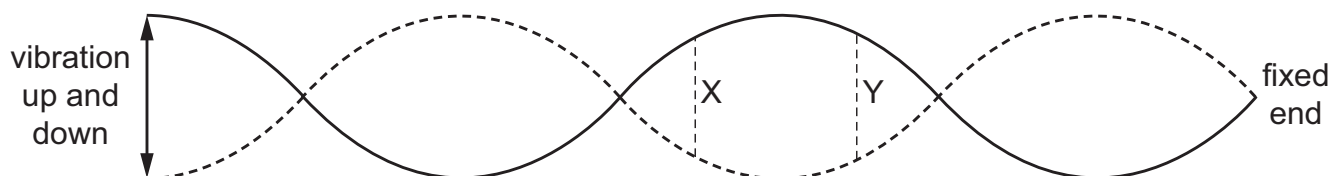


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What is the phase difference between the oscillations at X and at Y?

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32. Question | 9702 Feb-March 2017 P1 V2 Q2

- 2** What is an approximate value for the speed of sound in air?

- A** 30 m s^{-1} **B** 300 m s^{-1} **C** $30\,000 \text{ m s}^{-1}$ **D** $300\,000\,000 \text{ m s}^{-1}$

33. Question | 9702 Feb-March 2017 P1 V2 Q22

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

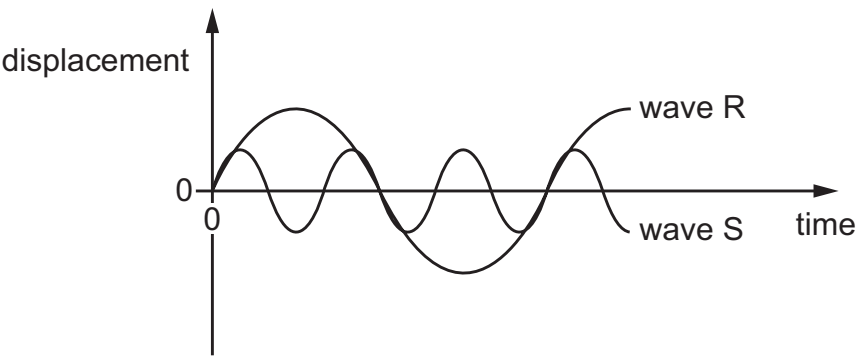
- A** amplitude $\propto$ intensity
B amplitude $\propto$ (intensity)²
C amplitude $\propto \sqrt{\text{intensity}}$
D (amplitude)² $\propto \sqrt{\text{intensity}}$

34. Question | 9702 Feb-March 2017 P1 V2 Q23

- 23** Which statement about light waves and sound waves is correct?
- A** Both light waves and sound waves show the Doppler effect.
 - B** Light waves can be diffracted but sound waves cannot be diffracted.
 - C** Sound waves are transverse waves and light waves are longitudinal waves.
 - D** Sound waves can travel in a vacuum but light waves cannot travel in a vacuum.

35. Question | 9702 Feb-March 2017 P1 V2 Q24

- 24** The diagram shows two waves R and S.



Wave R has an amplitude of 8 cm and a period of 30 ms.

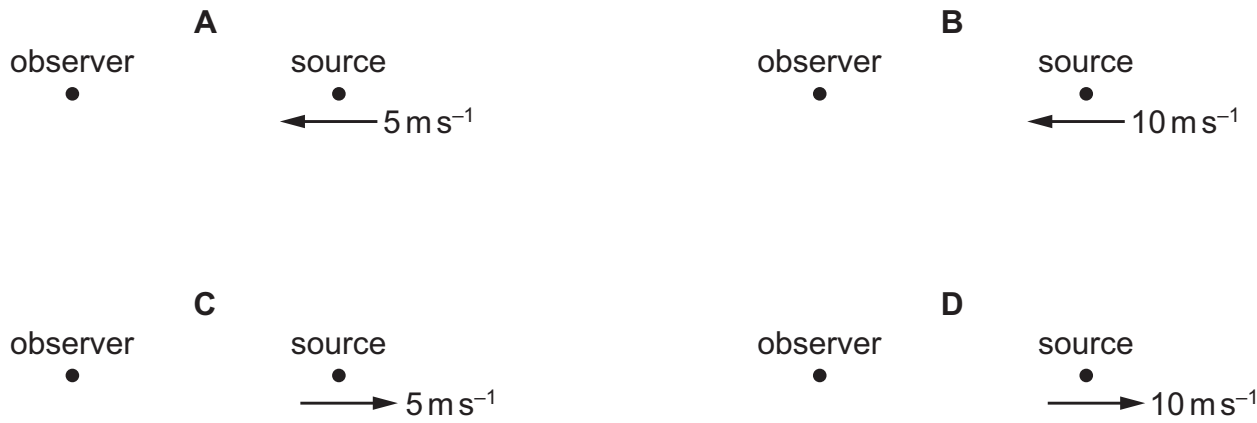
What are the amplitude and the period of wave S?

	amplitude / cm	period / ms
A	2	10
B	2	90
C	4	10
D	4	90

36. Question | 9702 Feb-March 2017 P1 V2 Q25

25 A source of sound waves is travelling as shown.

In which situation would the stationary observer detect the largest decrease in the observed frequency?



37. Question | 9702 Feb-March 2017 P1 V2 Q26

26 M and N are two electromagnetic waves.

The ratio

$$\frac{\text{wavelength of M}}{\text{wavelength of N}} = 10^5.$$

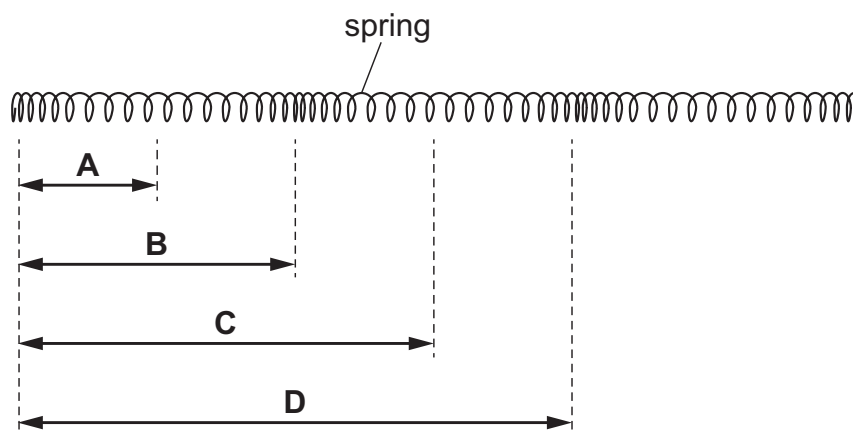
What could M and N be?

	M	N
A	microwaves	visible light
B	microwaves	γ -rays
C	γ -rays	microwaves
D	visible light	microwaves

38. Question | 9702 May-June 2017 P1 V1 Q22

22 A longitudinal wave travels through a long spring. The spring is shown at one instant.

What is the wavelength of the wave?



39. Question | 9702 May-June 2017 P1 V1 Q23

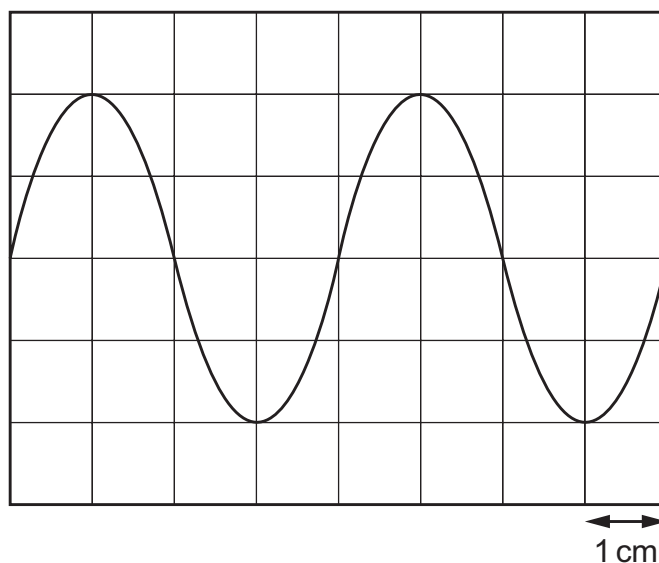
23 A sound wave has a frequency of 2500 Hz and a speed of 1500 m s^{-1} .

What is the shortest distance from a point of maximum pressure in the wave to a point of minimum pressure?

- A** 0.15 m **B** 0.30 m **C** 0.60 m **D** 1.20 m

40. Question | 9702 May-June 2017 P1 V1 Q24

- 24** A sound wave is displayed on the screen of a cathode-ray oscilloscope (c.r.o.) as shown.



The time-base of the c.r.o. is set at 2.5 ms cm^{-1} .

What is the frequency of the sound wave?

- A** 50 Hz **B** 100 Hz **C** 200 Hz **D** 400 Hz

41. Question | 9702 May-June 2017 P1 V1 Q25

- 25** A car travelling in a straight line at a speed of 30 ms^{-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 ms^{-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

42. Question | 9702 May-June 2017 P1 V1 Q26

- 26** Which list shows electromagnetic waves in order of increasing frequency?

- A** radio waves $\rightarrow$ gamma rays $\rightarrow$ ultraviolet $\rightarrow$ infra-red
B radio waves $\rightarrow$ infra-red $\rightarrow$ ultraviolet $\rightarrow$ gamma rays
C ultraviolet $\rightarrow$ gamma rays $\rightarrow$ radio waves $\rightarrow$ infra-red
D ultraviolet $\rightarrow$ infra-red $\rightarrow$ radio waves $\rightarrow$ gamma rays

43. Question | 9702 May-June 2017 P1 V2 Q22

22 The period of an electromagnetic wave is 1.0 ns.

What are the frequency and wavelength of the wave?

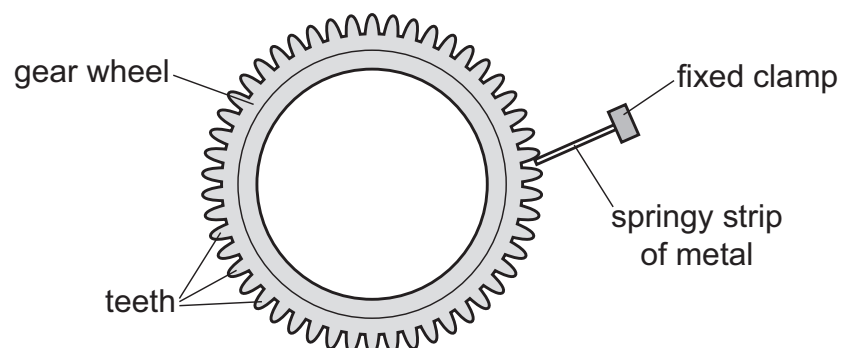
	frequency / Hz	wavelength / m
A	1.0	3.0×10^8
B	1.0×10^6	300
C	1.0×10^9	0.30
D	1.0×10^{12}	3.0×10^{-4}

44. Question | 9702 May-June 2017 P1 V2 Q23

23 Which statement about progressive longitudinal waves is **not** correct?

- A** The oscillations of the particles are parallel to the direction of travel of the wave energy.
- B** They have a series of nodes and antinodes.
- C** They need a medium through which to travel.
- D** They transfer energy.

- 24** 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

46. Question | 9702 May-June 2017 P1 V2 Q25

- 25** An ambulance travels along a straight road at a speed of 30.0 ms^{-1} . Its siren emits sound of frequency 2000 Hz . The speed of sound in the air is 340 ms^{-1} . The ambulance passes a man standing at the side of the road.

What is the frequency of the sound heard by the man as the ambulance moves towards him and as the ambulance moves away from him?

	frequency heard as ambulance moves towards man / Hz	frequency heard as ambulance moves away from man / Hz
A	1820	2180
B	1840	2190
C	2180	1820
D	2190	1840

47. Question | 9702 May-June 2017 P1 V2 Q26

- 26** Three different electromagnetic waves P, Q and R have the frequencies shown.

	frequency / Hz
P	3×10^{10}
Q	3×10^{13}
R	6×10^{14}

Which row identifies P, Q and R?

	P	Q	R
A	infra-red	visible	ultraviolet
B	microwave	infra-red	visible
C	ultraviolet	X-ray	gamma ray
D	visible	ultraviolet	X-ray

48. Question | 9702 May-June 2017 P1 V2 Q28

- 28** A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

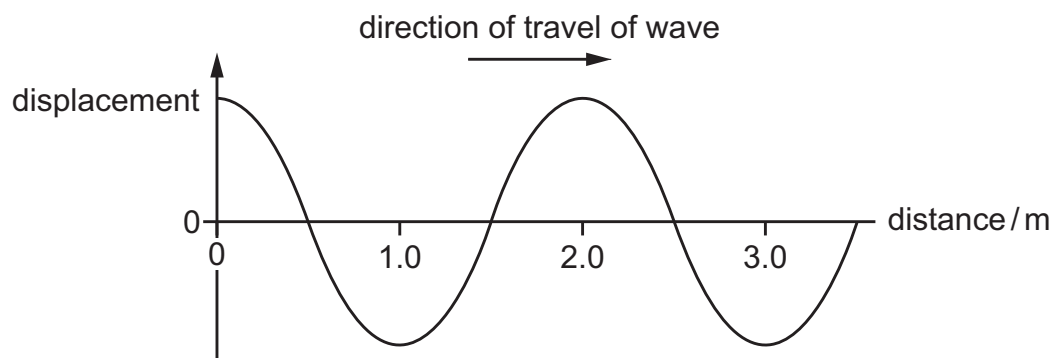
What is the total number of intensity maxima from the grating?

- A** 6 **B** 7 **C** 8 **D** 9

21 Which statement about electromagnetic waves in a vacuum is correct?

- A** Amplitude is inversely proportional to velocity.
- B** Frequency is inversely proportional to wavelength.
- C** Intensity is proportional to amplitude.
- D** Velocity is proportional to wavelength.

- 22** A transverse wave travels along a rope. The graph shows the variation of the displacement of the particles in the rope with distance along it at a particular instant.

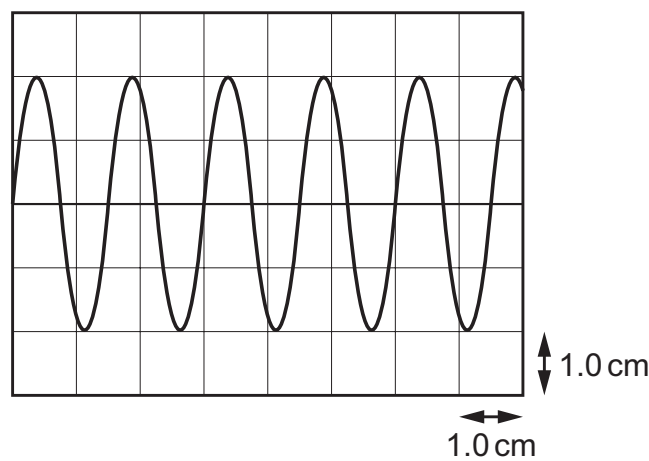


At which distance along the rope do the particles have maximum upwards velocity?

- A** 0.5 m **B** 1.0 m **C** 1.5 m **D** 2.0 m

51. Question | 9702 May-June 2017 P1 V3 Q23

23 A trace is shown on the screen of a cathode-ray oscilloscope (c.r.o.).



The time-base setting is 2.5 ms cm^{-1} and the Y-gain is 2.0 V cm^{-1} .

What is the frequency and the amplitude of the waveform displayed by the c.r.o.?

	frequency /Hz	amplitude /V
A	0.00375	4.0
B	0.00375	8.0
C	267	4.0
D	267	8.0

52. Question | 9702 May-June 2017 P1 V3 Q24

24 A high-speed train approaches a stationary observer at a speed of 80 ms^{-1} . The train's horn emits a sound of frequency 250 Hz.

The speed of sound is 340 m s^{-1} .

What is the observed frequency of the sound from the horn?

- A** 190 Hz **B** 200 Hz **C** 310 Hz **D** 330 Hz

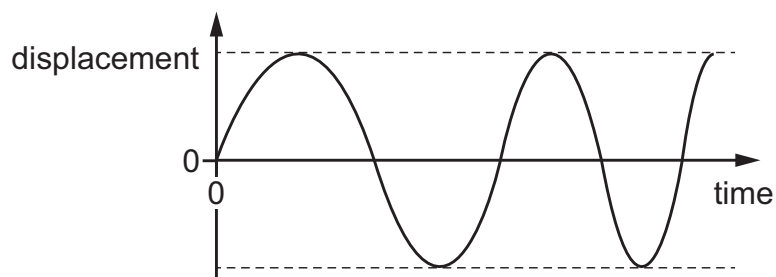
53. Question | 9702 May-June 2017 P1 V3 Q25

25 Which row shows a correct frequency in Hz for each of the four principal radiations?

	X-rays	ultraviolet	microwaves	infra-red
A	10^{10}	10^{14}	10^{18}	10^{15}
B	10^{14}	10^{18}	10^{15}	10^{10}
C	10^{15}	10^{10}	10^{14}	10^{18}
D	10^{18}	10^{15}	10^{10}	10^{14}

54. Question | 9702 Oct-Nov 2017 P1 V1 Q22

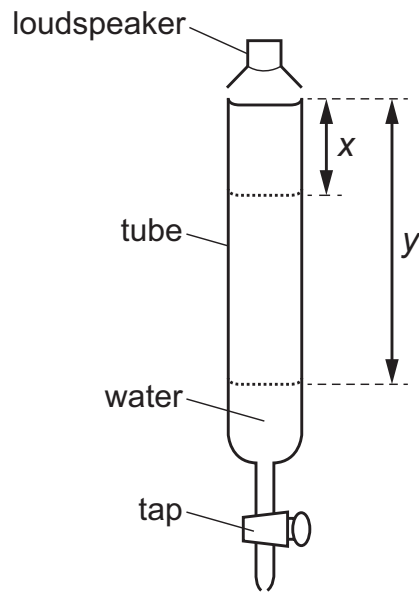
22 The displacement-time graph for a layer of air in the path of a sound wave is shown.



Which wave quantity is increasing?

- A** amplitude
- B** frequency
- C** period
- D** wavelength

23 A loudspeaker emits a sound wave into a tube initially full of water.



A tap at the bottom of the tube is opened so that water slowly leaves the tube. For some lengths of the air column in the tube, the sound heard is much louder.

The first loud sound is heard when the air column in the tube has length x .

The next time that a loud sound is heard is when the air column in the tube has length y .

What is the wavelength of the sound wave from the loudspeaker?

- A** $2x$ **B** $4y$ **C** $2(y - x)$ **D** $4(y - x)$

56. Question | 9702 Oct-Nov 2017 P1 V1 Q24

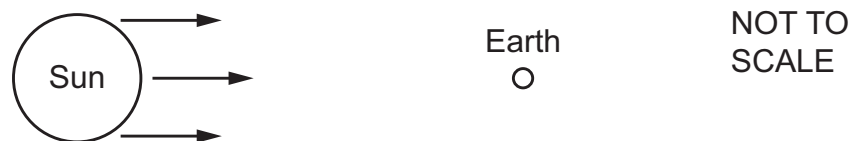
- 24** Diffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest when the wavelength and the obstruction are similar in size.

For waves travelling through air, what is the combination of wave and obstruction that could best demonstrate diffraction?

- A** microwaves passing a steel post
- B** radio waves passing a copper wire
- C** sound waves passing a human hair
- D** visible light waves passing a gate post

57. Question | 9702 Oct-Nov 2017 P1 V1 Q25

- 25** 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.

58. Question | 9702 Oct-Nov 2017 P1 V1 Q26

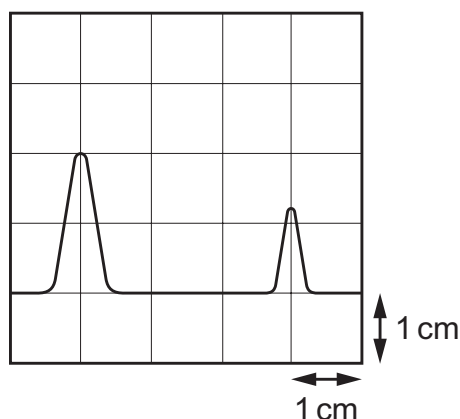
26 What is the order of magnitude of the frequencies of electromagnetic waves in the visible spectrum?

- A** 10^{10} Hz **B** 10^{12} Hz **C** 10^{14} Hz **D** 10^{16} Hz

59. Question | 9702 Oct-Nov 2017 P1 V2 Q5

5 A transmitter emits a pulse of electromagnetic waves towards a reflector. The pulse is reflected and returns to the transmitter.

A detector is located at the transmitter. The emitted pulse and the reflected pulse are displayed on a cathode-ray oscilloscope (c.r.o.) as shown.

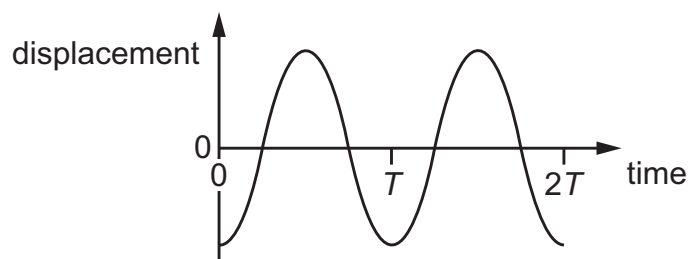


The pulse takes $6.3 \mu\text{s}$ to travel from the transmitter to the reflector.

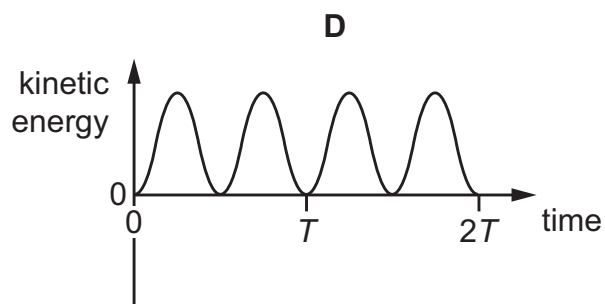
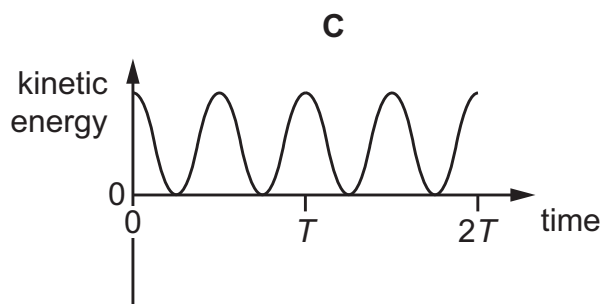
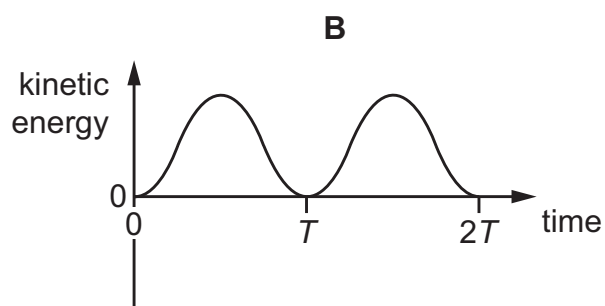
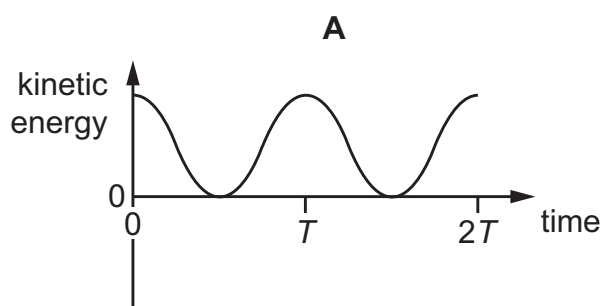
What is the time-base setting of the c.r.o.?

- A** $2.1 \mu\text{s cm}^{-1}$ **B** $3.2 \mu\text{s cm}^{-1}$ **C** $4.2 \mu\text{s cm}^{-1}$ **D** $6.3 \mu\text{s cm}^{-1}$

- 22** 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?



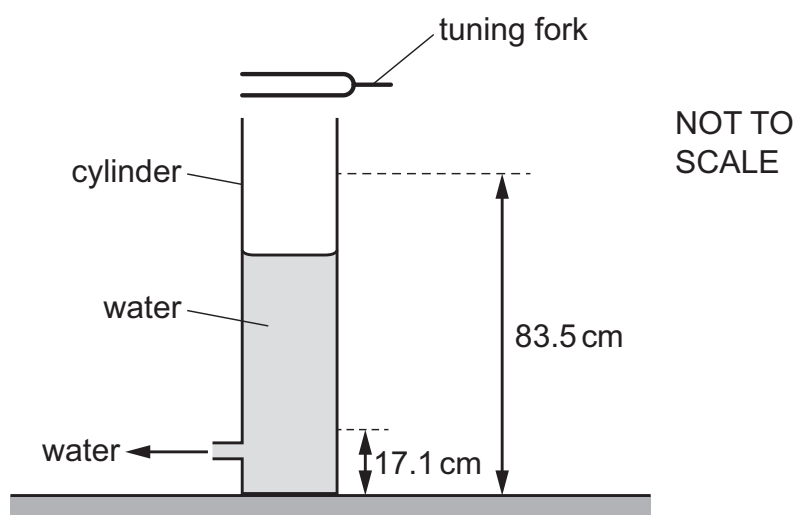
61. Question | 9702 Oct-Nov 2017 P1 V2 Q23

23 Which wave is a longitudinal wave?

- A** a light wave travelling through air
- B** a radio wave from a broadcasting station
- C** a ripple on the surface of water
- D** a sound wave travelling through air

62. Question | 9702 Oct-Nov 2017 P1 V2 Q24

24 A vibrating tuning fork is held above a glass cylinder filled to the top with water. The water level is steadily lowered. A loud sound is first heard when the water level is 83.5 cm above the bench. The next loud sound is heard when the water level is 17.1 cm above the bench.



The speed of sound in air is 340 m s^{-1} .

What is the frequency of the tuning fork?

- A** 128 Hz
- B** 256 Hz
- C** 384 Hz
- D** 512 Hz

63. Question | 9702 Oct-Nov 2017 P1 V2 Q25

- 25** A train that is moving in a straight line along a railway track has a whistle that continuously emits sound of frequency f .

A woman standing by the side of the track hears sound of frequency $0.85f$.

The speed of sound in the air is 340 m s^{-1} .

What is the velocity of the train?

- A** 51 m s^{-1} away from the woman
- B** 51 m s^{-1} towards the woman
- C** 60 m s^{-1} away from the woman
- D** 60 m s^{-1} towards the woman

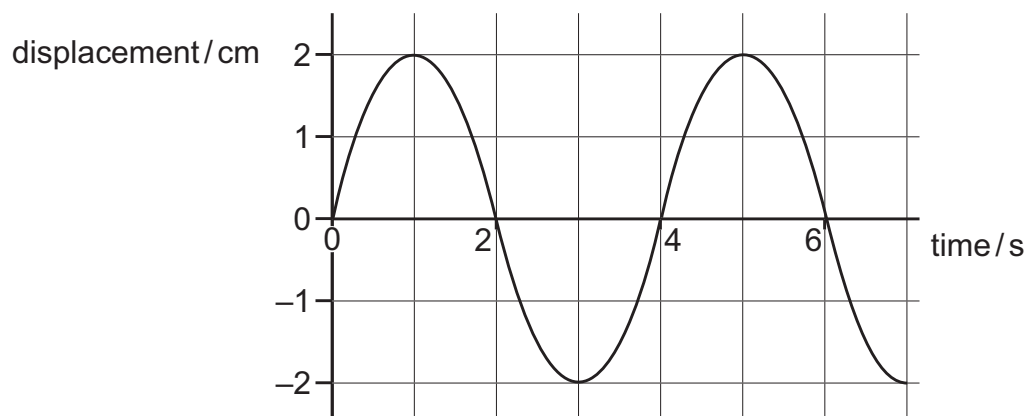
64. Question | 9702 Oct-Nov 2017 P1 V2 Q26

- 26** Orange light in a vacuum has a wavelength of 600 nm .

What is the frequency of this light?

- A** 180 Hz **B** $5.0 \times 10^5 \text{ Hz}$ **C** $1.8 \times 10^{11} \text{ Hz}$ **D** $5.0 \times 10^{14} \text{ Hz}$

22 The graph shows how the displacement of a particle in a wave varies with time.

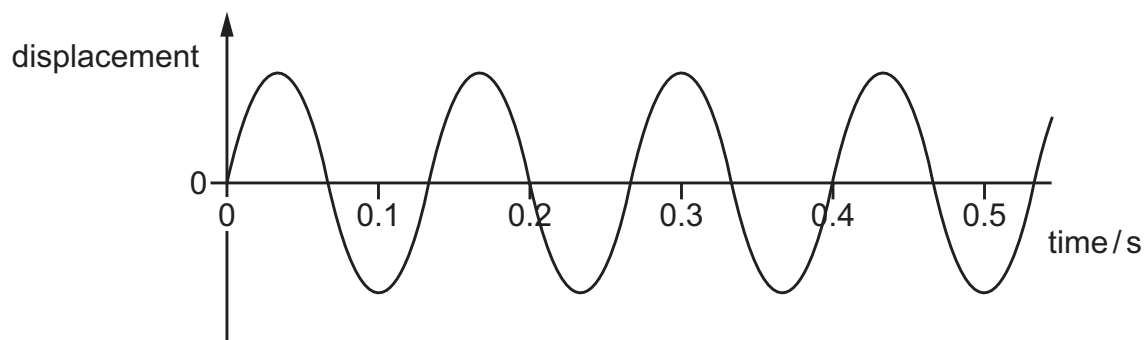


Which statement is correct?

- A** The wave has a period of 2 s and could be either transverse or longitudinal.
- B** The wave has a period of 2 s and must be transverse.
- C** The wave has a period of 4 s and could be either transverse or longitudinal.
- D** The wave has a period of 4 s and must be transverse.

23 A wave travels along a coiled spring.

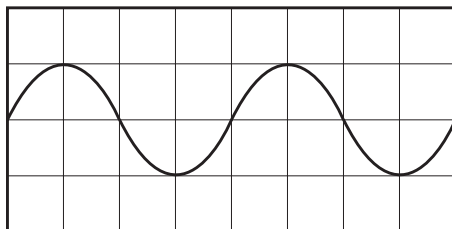
The graph shows the variation with time of the displacement of a point on the spring.



What is the frequency of the wave?

- A** 0.13 Hz **B** 0.20 Hz **C** 5.0 Hz **D** 7.5 Hz

24 An electrical signal is displayed on a cathode-ray oscilloscope (c.r.o.).



The time-base setting is 50 ms div^{-1} .

The Y-gain setting is 2 V div^{-1} .

What is the amplitude of the signal?

A 2 V

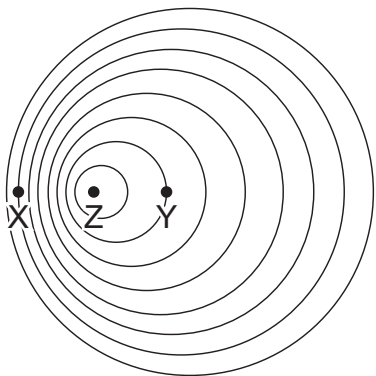
B 4 V

C 5 V

D 10 V

68. Question | 9702 Oct-Nov 2017 P1 V3 Q25

25 A source of sound of frequency F at point Z is moving at a steady speed. The pattern of the emitted wavefronts is shown.



Which row describes the frequencies of the sound heard by stationary observers at X and Y?

	frequency heard at X	frequency heard at Y
A	$<F$	$<F$
B	$<F$	$>F$
C	$>F$	$<F$
D	$>F$	$>F$

69. Question | 9702 Oct-Nov 2017 P1 V3 Q26

26 A car travelling at a steady speed in a straight line passes close to a stationary observer. The observer measures the frequency of the sound from the engine.

As the car approaches, the observed frequency is 220 Hz. When the car moves away, the observed frequency is 180 Hz.

The speed of sound in air is 340 m s^{-1} .

What is the speed of the car?

- A** 8.5 m s^{-1} **B** 31 m s^{-1} **C** 34 m s^{-1} **D** 38 m s^{-1}

70. Question | 9702 Oct-Nov 2017 P1 V3 Q27

27 Which frequency of electromagnetic radiation could be ultraviolet?

- A** $1.0 \times 10^6 \text{ Hz}$
- B** $1.0 \times 10^9 \text{ Hz}$
- C** $1.0 \times 10^{12} \text{ Hz}$
- D** $1.0 \times 10^{15} \text{ Hz}$

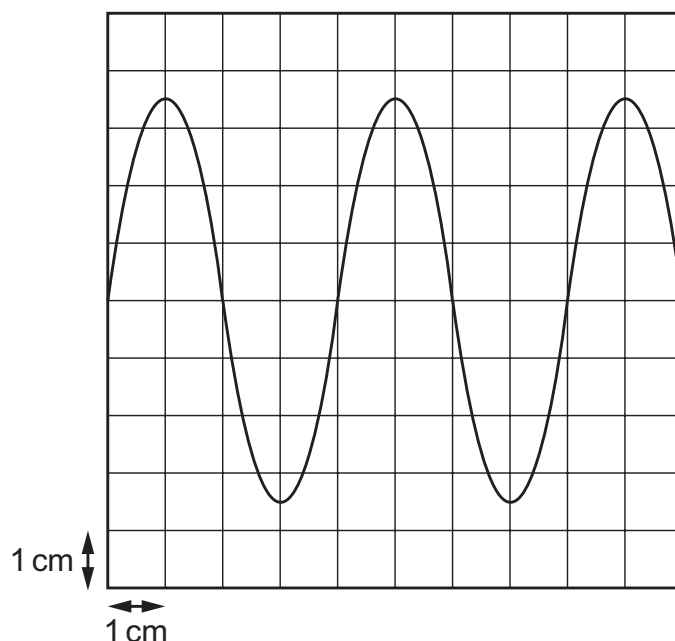
71. Question | 9702 Oct-Nov 2017 P1 V3 Q28

28 An electromagnetic wave travels in a straight line through a vacuum. The wave has a frequency of 6.0 THz.

What is the number of wavelengths in a distance of 1.0 m along the wave?

- A** 5.0×10^{-5} **B** 2.0×10^1 **C** 2.0×10^4 **D** 5.0×10^7

- 6** A cathode-ray oscilloscope (c.r.o.) is connected to an alternating voltage. The following trace is produced on the screen.

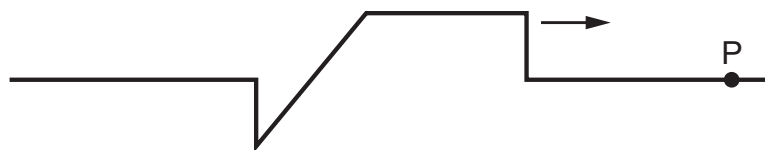


The oscilloscope time-base setting is 0.5 ms cm^{-1} and the Y-plate sensitivity is 2 V cm^{-1} .

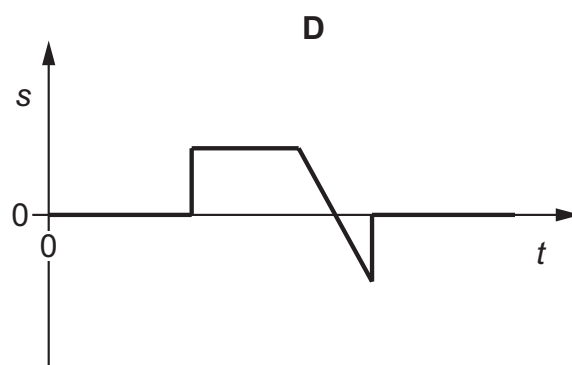
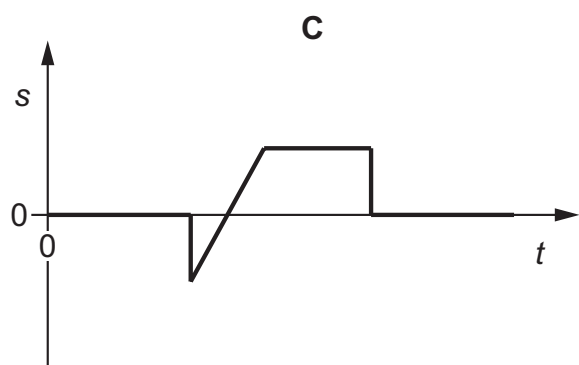
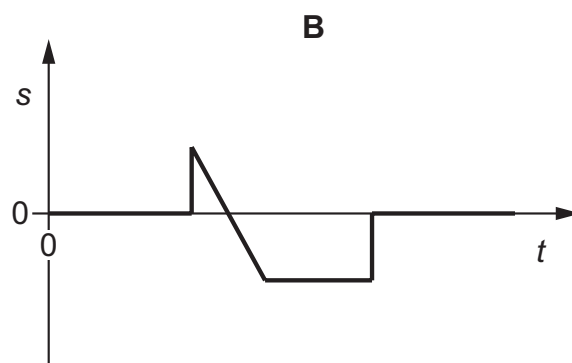
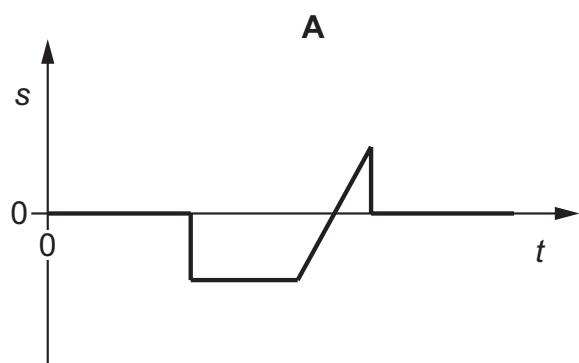
Which statement about the alternating voltage is correct?

- A** The amplitude is 3.5 cm.
- B** The frequency is 0.5 kHz.
- C** The period is 1 ms.
- D** The wavelength is 4 cm.

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

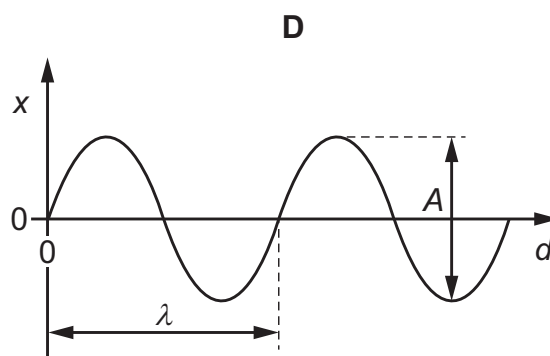
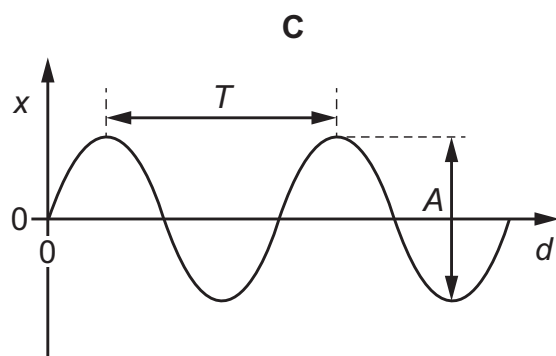
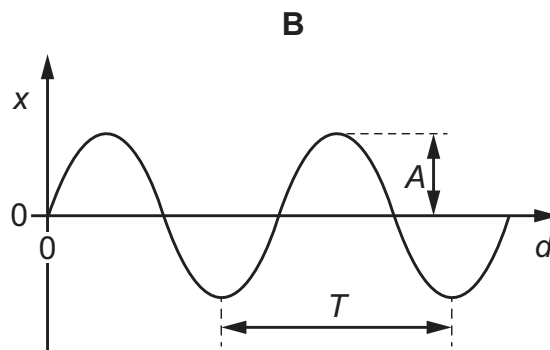
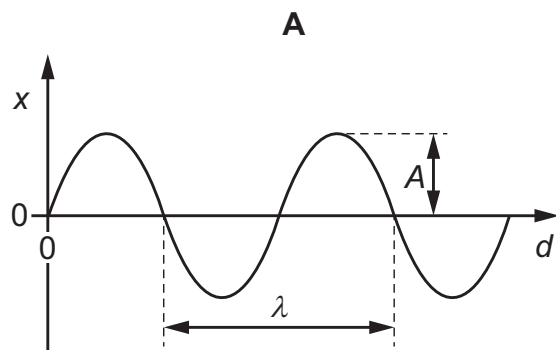


Which diagram shows the variation with time t of the displacement s of the particle P in the rope?



- 22** A wave has period T , wavelength λ and amplitude A . The wave is shown on a graph of displacement x against distance d .

Which graph is correctly labelled?



- 23** The table lists possible orders of magnitude of the wavelengths of some of the principal radiations of the electromagnetic spectrum.

Which row shows the correct orders of magnitude of the wavelengths?

	wavelength / m			
	microwaves	infra-red	ultraviolet	X-rays
A	10^{-6}	10^{-10}	10^{-12}	10^{-14}
B	10^{-4}	10^{-8}	10^{-10}	10^{-12}
C	10^{-2}	10^{-6}	10^{-8}	10^{-10}
D	10^2	10^{-4}	10^{-6}	10^{-8}

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

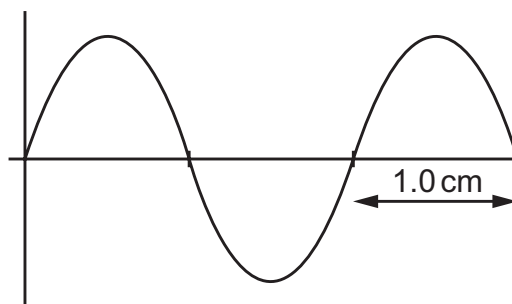
The vehicle moves directly towards the observer at constant speed. The observer detects microwaves of frequency F_0 .

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_0 .
- B** The observed frequency will fall, then remain steady then rise to a higher frequency than F_0 .
- C** The observed frequency will rise, then remain steady then fall to a lower frequency than F_0 .
- D** The observed frequency will rise, then remain steady then return to the frequency F_0 .

25 The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.



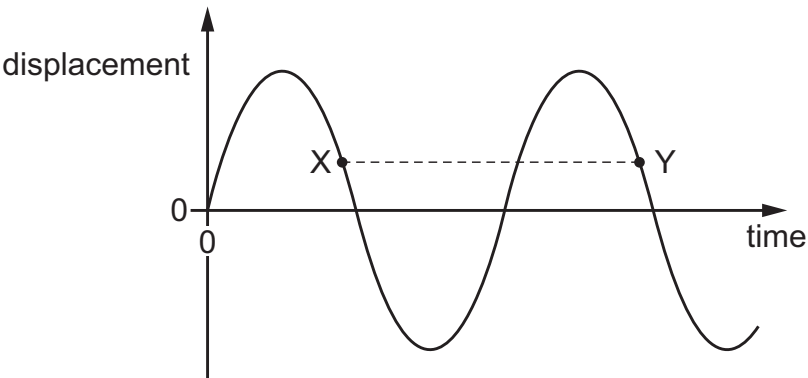
The time base setting is $0.20 \mu\text{s cm}^{-1}$.

Which statement is correct?

- A** The frequency of the wave is 2.5 MHz and it lies in the microwave region of the electromagnetic spectrum.
- B** The frequency of the wave is 2.5 MHz and it lies in the radio-wave region of the electromagnetic spectrum.
- C** The frequency of the wave is 5.0 MHz and it lies in the microwave region of the electromagnetic spectrum.
- D** The frequency of the wave is 5.0 MHz and it lies in the radio-wave region of the electromagnetic spectrum.

20 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

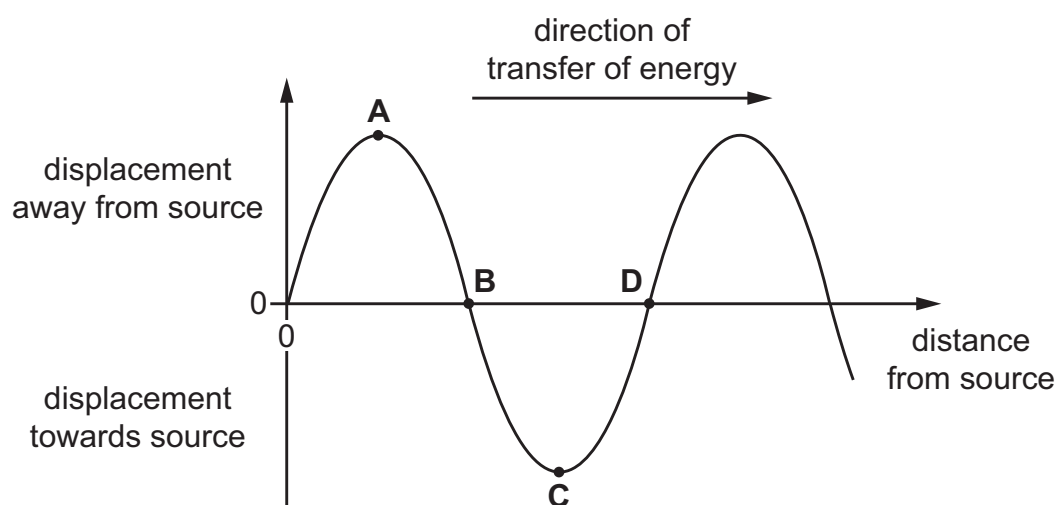
21 Which region of the electromagnetic spectrum includes waves with a frequency of 10^7 MHz?

- A** infra-red waves
- B** radio waves
- C** ultraviolet waves
- D** X-rays

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.

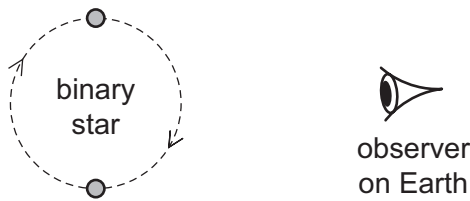
Which point on the graph is the centre of a compression?



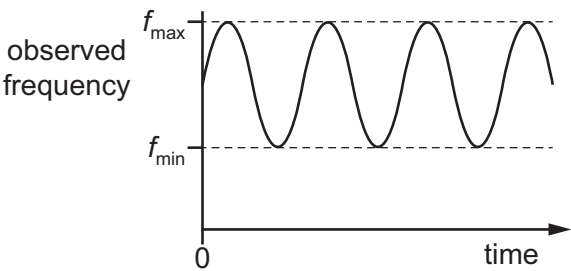
- 23** What can be deduced from a table of wavelengths of the waves in the electromagnetic spectrum?
- A** Green light has a shorter wavelength than X-rays.
 - B** Red light has a shorter wavelength than green light.
 - C** The wavelength range for radio waves is less than that for infra-red waves.
 - D** The wavelength range for X-rays is less than that for radio waves.

82. Question | 9702 May-June 2018 P1 V1 Q24

24 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.



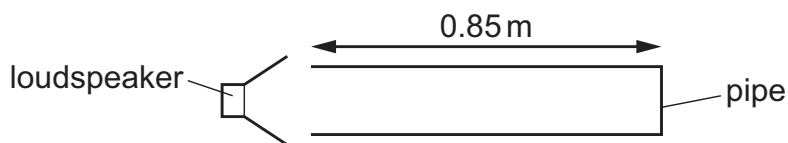
The rate of rotation of the binary star increases.

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

83. Question | 9702 May-June 2018 P1 V1 Q27

- 27** A pipe, closed at one end, has a loudspeaker at the open end. A stationary sound wave is formed in the air within the pipe with an antinode at the open end of the pipe.



The length of the pipe is 0.85 m.

The speed of sound in air is 340 m s^{-1} .

Which frequency of sound from the loudspeaker would **not** produce a stationary wave?

- A** 100 Hz **B** 200 Hz **C** 300 Hz **D** 500 Hz

84. Question | 9702 May-June 2018 P1 V2 Q22

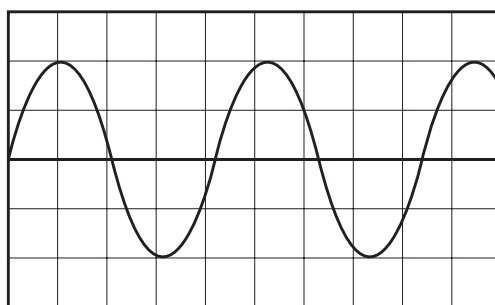
- 22** Two lasers emit light in a vacuum. One laser emits red light and the other emits green light.

Which property of the two laser beams **must** be different?

- A** amplitude
B frequency
C intensity
D speed

85. Question | 9702 May-June 2018 P1 V2 Q23

- 23** The diagram shows the screen of a cathode-ray oscilloscope (c.r.o.) displaying a wave.



The time-base of the c.r.o. is set at 10 ms/division .

What is the frequency of the wave?

- A** 0.24 Hz **B** 4.2 Hz **C** 12 Hz **D** 24 Hz

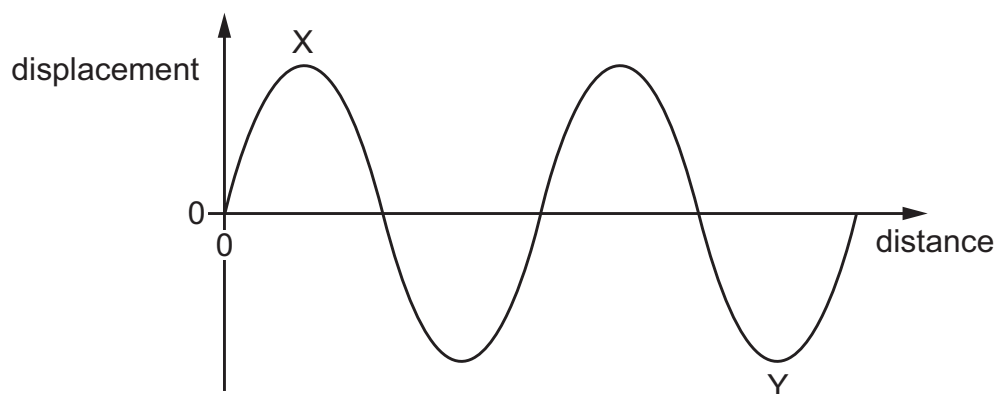
86. Question | 9702 May-June 2018 P1 V2 Q25

- 25** Which region of the electromagnetic spectrum has waves of wavelength 1000 times smaller than the wavelength of visible light?
- A** infra-red
 - B** microwaves
 - C** ultraviolet
 - D** X-rays

87. Question | 9702 May-June 2018 P1 V2 Q27

- 27** An astronomer observes the light from a star that is moving away from the Earth.
- For the observed light, what has been increased due to the star's motion?
- A** amplitude
 - B** frequency
 - C** speed
 - D** wavelength

20 The displacement-distance graph for a transverse progressive wave is shown.



The phase difference between points X and Y can be expressed as $(180n)^\circ$.

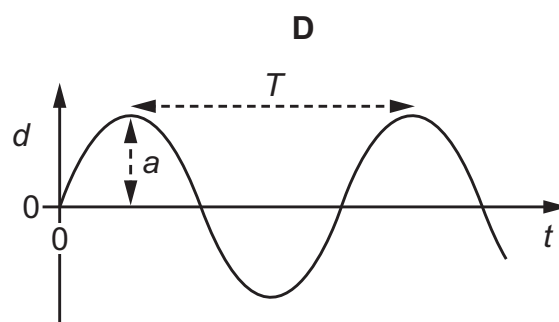
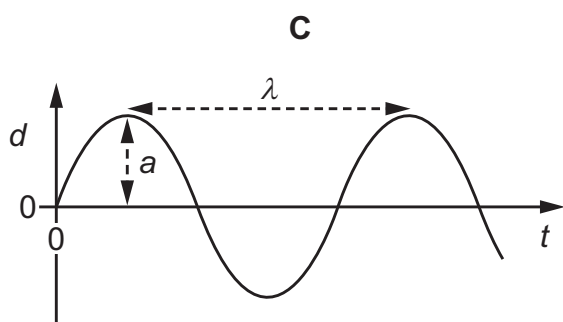
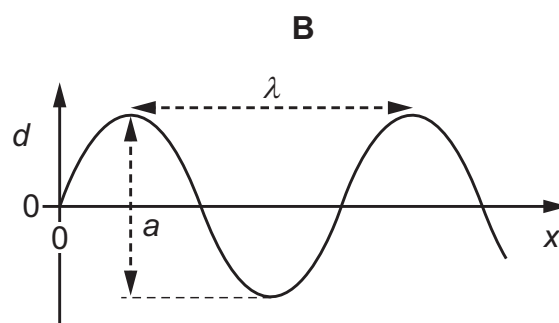
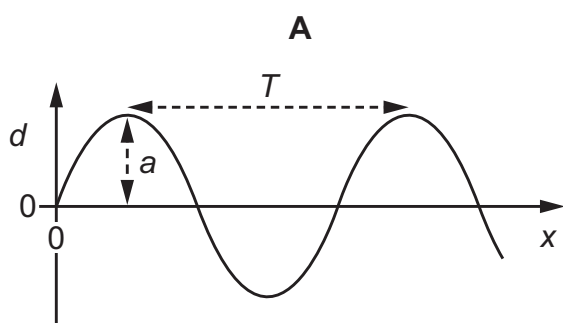
What is the value of n ?

- A** 1.5 **B** 2.5 **C** 3.0 **D** 6.0

- 21** The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x .

The labels on the graphs are intended to show the wavelength λ , the period T and the amplitude a of the wave, but only one graph is correctly labelled.

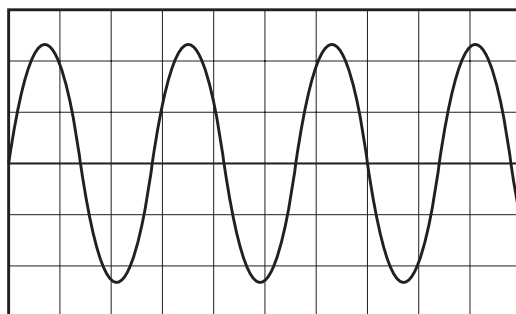
Which graph is correctly labelled?



90. Question | 9702 May-June 2018 P1 V3 Q22

22 A cathode-ray oscilloscope (c.r.o.) is used to determine the frequency of a sound wave.

The diagram shows the waveform on the screen.



The time-base setting is 5.0 ms/div .

What is the frequency of the sound wave?

- A** 57 Hz **B** 71 Hz **C** 114 Hz **D** 143 Hz

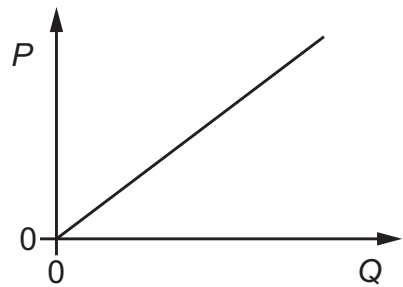
91. Question | 9702 May-June 2018 P1 V3 Q23

23 A police car travels at a velocity of 30.0 ms^{-1} directly towards a stationary observer. The horn of the car emits sound of frequency 2000 Hz . The speed of sound is 340 ms^{-1} .

What is the frequency of the sound heard by the observer?

- A** 1840 Hz **B** 2000 Hz **C** 2180 Hz **D** 2190 Hz

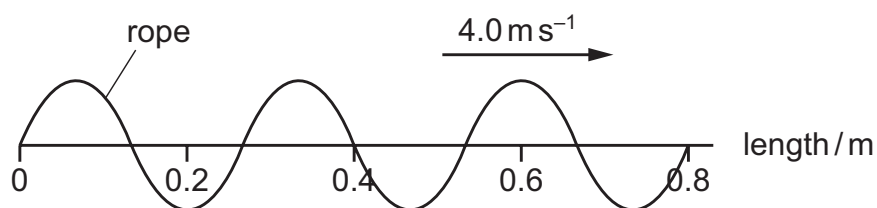
21 The graph shows the variation of a quantity P with a quantity Q for a sound wave travelling in air.



What could P and Q be?

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

- 22** A vibration generator produces a progressive wave on a rope. The diagram shows the rope at one instant. The wave travels at a speed of 4.0 m s^{-1} .

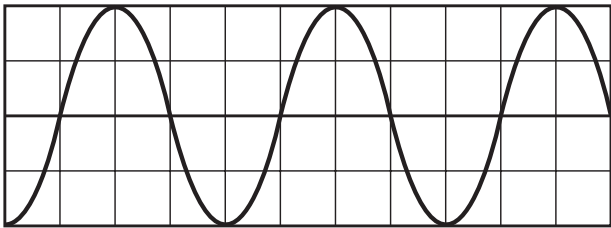


What are the wavelength and the frequency of the wave?

	wavelength /m	frequency /Hz
A	0.13	15
B	0.13	30
C	0.27	15
D	0.27	30

94. Question | 9702 Oct-Nov 2018 P1 V1 Q23

23 The diagram shows the waveform of a signal displayed on a cathode-ray oscilloscope.



The time-base is set at 5.0 ms per division.

The Y-gain is set at 5.0 mV per division.

What are the amplitude and the frequency of the signal?

	amplitude / mV	frequency / Hz
A	10	50
B	10	100
C	20	50
D	20	100

95. Question | 9702 Oct-Nov 2018 P1 V1 Q24

24 A jet aircraft travels at a speed of $0.8v$ where v is the speed of sound. The aircraft approaches a stationary observer. The frequency of sound emitted by the aircraft is 100 Hz.

Which frequency does the observer hear?

- A** 56 Hz **B** 180 Hz **C** 400 Hz **D** 500 Hz

96. Question | 9702 Oct-Nov 2018 P1 V1 Q25

25 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

97. Question | 9702 Oct-Nov 2018 P1 V1 Q26

26 What may be used to produce stationary waves?

- A** blowing air over the top of an empty bottle
- B** making a loud sound near a mountain
- C** passing monochromatic light through a double slit
- D** passing water waves through a narrow slit

98. Question | 9702 Oct-Nov 2018 P1 V2 Q22

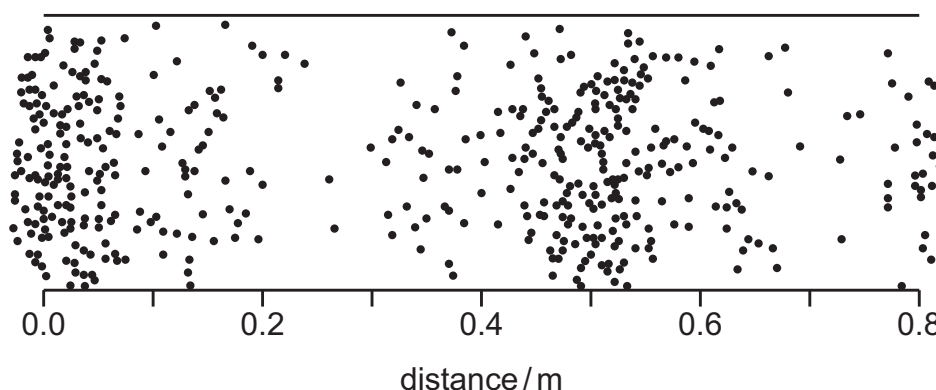
22 A progressive wave on a wire has a frequency of 10 Hz. Two points on the wire, separated by a distance of 0.25 m, have a phase difference of 22.5° .

What is the maximum speed of the wave?

- A** 2.5 ms^{-1} **B** 10 ms^{-1} **C** 20 ms^{-1} **D** 40 ms^{-1}

99. Question | 9702 Oct-Nov 2018 P1 V2 Q23

23 When a guitar string is plucked, it causes a longitudinal sound wave in the air, as shown.



The speed of sound in the air is 340 ms^{-1} .

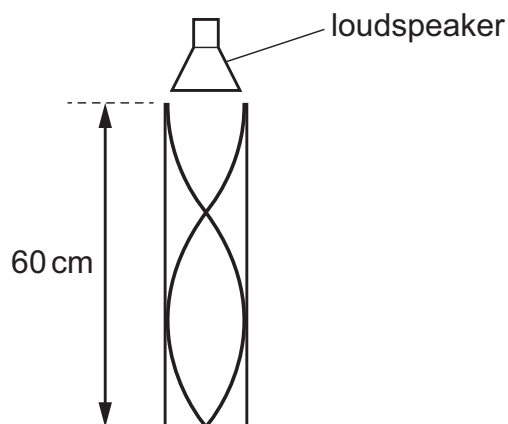
What is the approximate frequency of the sound wave shown?

- A** 430 Hz **B** 680 Hz **C** 1100 Hz **D** 1400 Hz

100. Question | 9702 Oct-Nov 2018 P1 V2 Q24

- 24** The sound from a loudspeaker placed above a tube causes resonance of the air in the tube.

A stationary wave is formed with two nodes and two antinodes as shown.



The speed of sound in the air is 340 m s^{-1} .

What is the frequency of the sound?

- A** 430 Hz **B** 570 Hz **C** 850 Hz **D** 1700 Hz

101. Question | 9702 Oct-Nov 2018 P1 V2 Q25

- 25** A police car has a two-tone siren emitting sound of frequencies of 700 Hz and 1000 Hz.

The police car is travelling at a speed of 40.0 m s^{-1} towards a stationary observer. The speed of sound in the air is 340 m s^{-1} .

What is the difference between the two frequencies of the sound that is heard by the observer?

- A** 268 Hz **B** 300 Hz **C** 335 Hz **D** 340 Hz

102. Question | 9702 Oct-Nov 2018 P1 V2 Q26

- 26** A surveyor's device emits a pulse of light. The light is reflected from a wall 150 m away.

What is the time taken for the pulse to travel from the device to the wall and then back to the device?

- A** 0.05 ns **B** 0.10 ns **C** 0.50 μs **D** 1.0 μs

28 What happens when waves pass through a gap equal to their wavelength?

- A** There is diffraction and the wavelength decreases.
- B** There is diffraction and the wavelength stays the same.
- C** There is no diffraction and the wavelength decreases.
- D** There is no diffraction and the wavelength stays the same.

104. Question | 9702 Oct-Nov 2018 P1 V3 Q21

21 A progressive sound wave in air has amplitude x_0 and intensity I .

The amplitude of the wave increases to $3x_0$.

What is the new intensity of the wave?

A $\frac{I}{9}$

B $\frac{I}{3}$

C $3I$

D $9I$

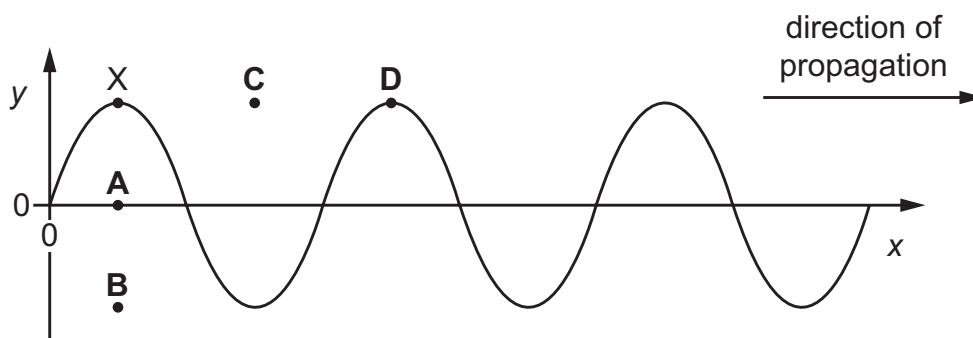
105. Question | 9702 Oct-Nov 2018 P1 V3 Q22

- 22** 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.

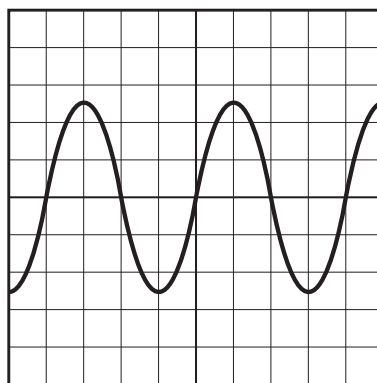
A point X on the rope is marked. The diagram shows the original position of X and four new positions.

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



106. Question | 9702 Oct-Nov 2018 P1 V3 Q23

- 23** A sound wave is detected by a microphone. The output from the microphone is connected to the Y-input of a cathode-ray oscilloscope (c.r.o.). The trace on the c.r.o. is shown.



The time-base is set at 0.20 ms per division.

What is the frequency of the sound wave?

- A** 1000 Hz **B** 1250 Hz **C** 2000 Hz **D** 2500 Hz

107. Question | 9702 Oct-Nov 2018 P1 V3 Q24

- 24** A bat flies directly towards a fixed ultrasound detector at a speed of 25.0 m s^{-1} emitting pulses of ultrasound of frequency 40.0 kHz .

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

Which frequency does the ultrasound detector record?

- A** 37.0 kHz **B** 37.2 kHz **C** 43.0 kHz **D** 43.3 kHz

108. Question | 9702 Oct-Nov 2018 P1 V3 Q25

- 25** An electromagnetic wave has a wavelength of $1.0 \times 10^{-7} \text{ m}$.

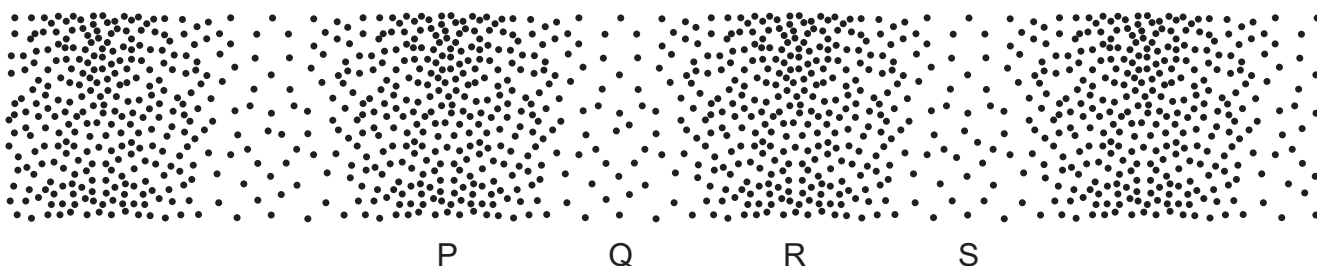
To which region of the electromagnetic spectrum does this wave belong?

- A** infra-red
B ultraviolet
C visible
D X-ray

109. Question | 9702 Feb-March 2019 P1 V2 Q22

- 22** A sound wave passes through air.

The diagram shows the positions of the molecules of the air at one instant.



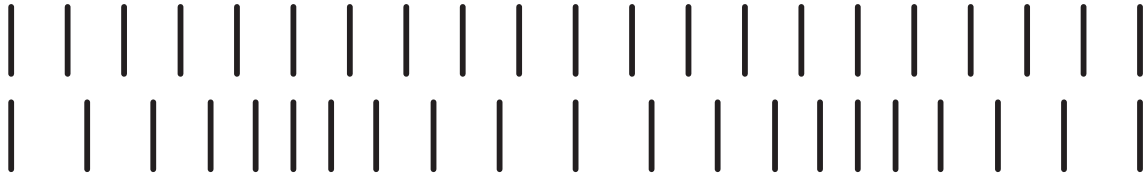
Which distance is equal to the wavelength of the wave?

- A** PQ **B** PS **C** QR **D** QS

110. Question | 9702 Feb-March 2019 P1 V2 Q23

23 The top row of bars represents a set of particles inside the Earth and at rest.

The lower row represents the same particles at one instant as a longitudinal wave passes from left to right through the Earth.



What should be measured to determine the amplitude of the oscillations of the particles in the lower row as the wave passes?

- A** half the maximum displacement of the particles from their position at rest
- B** half the maximum distance apart of the particles
- C** the maximum displacement of the particles from their position at rest
- D** the maximum distance apart of the particles

111. Question | 9702 Feb-March 2019 P1 V2 Q24

24 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** $7f_1$

112. Question | 9702 Feb-March 2019 P1 V2 Q25

- 25** A buzzer emitting sound of frequency 846 Hz is attached to a string and rotated in a horizontal circle. The linear speed of the buzzer is 25.0 m s^{-1} .



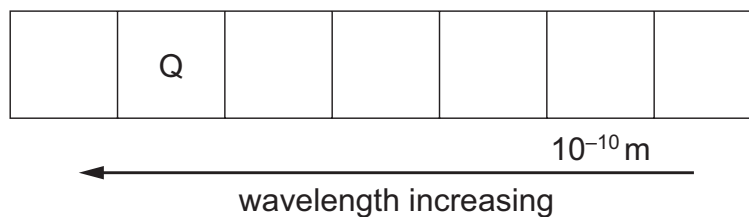
The speed of sound is 340 m s^{-1} .

What is the maximum frequency heard by the observer?

- A** 783 Hz **B** 788 Hz **C** 908 Hz **D** 913 Hz

113. Question | 9702 Feb-March 2019 P1 V2 Q26

- 26** The diagram shows the principal regions of the electromagnetic spectrum, with some details labelled. The diagram is not to scale.

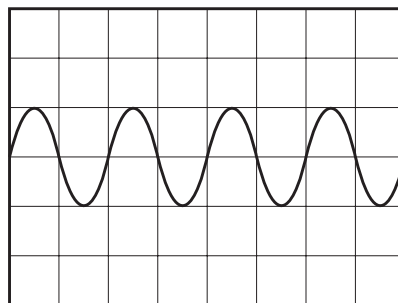


What is a typical order of magnitude of the wavelength of the radiation in region Q?

- A** 10^{-7} m **B** 10^{-5} m **C** 10^{-2} m **D** 10^0 m

114. Question | 9702 May-June 2019 P1 V1 Q4

- 4** A whale produces sound waves of frequency 5 Hz. The waves are detected by a microphone and displayed on an oscilloscope.



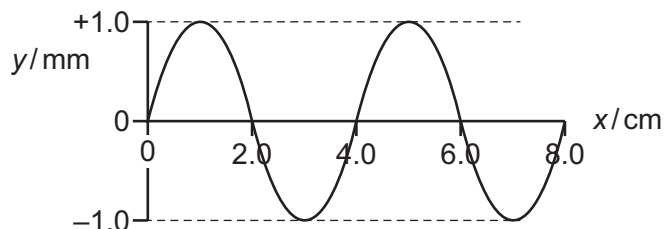
What is the time-base setting on the oscilloscope?

- A** 0.1 ms div^{-1} **B** 1 ms div^{-1} **C** 10 ms div^{-1} **D** 100 ms div^{-1}

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

y = vertical displacement and x = horizontal distance.

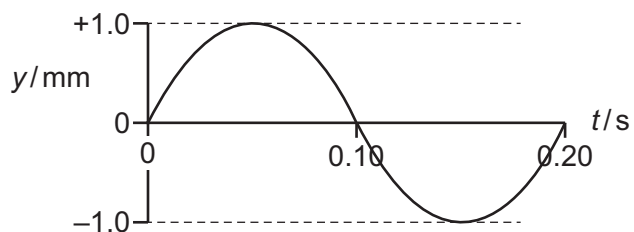
The speed of the wave is 20.0 cm s^{-1} .



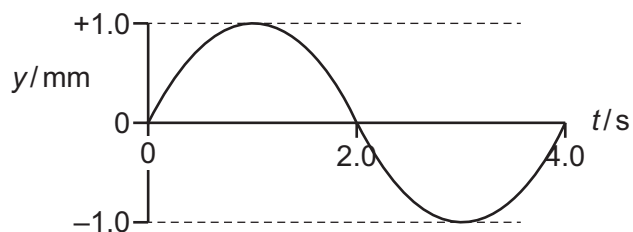
A particle of the medium oscillates vertically.

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

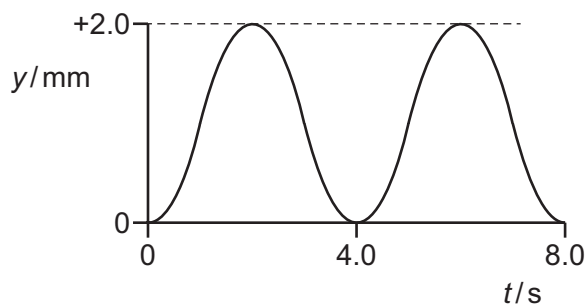
A



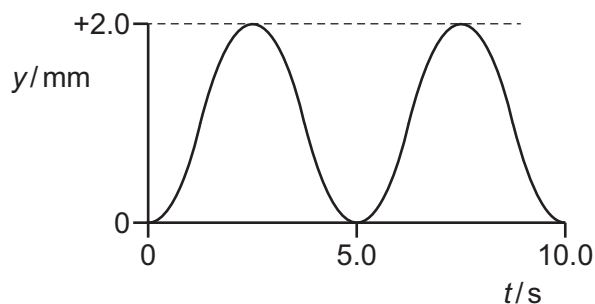
B



C



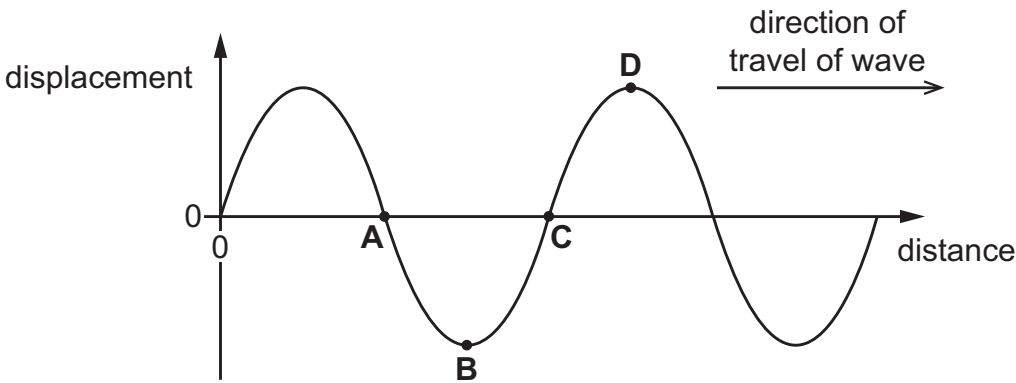
D



116. Question | 9702 May-June 2019 P1 V1 Q23

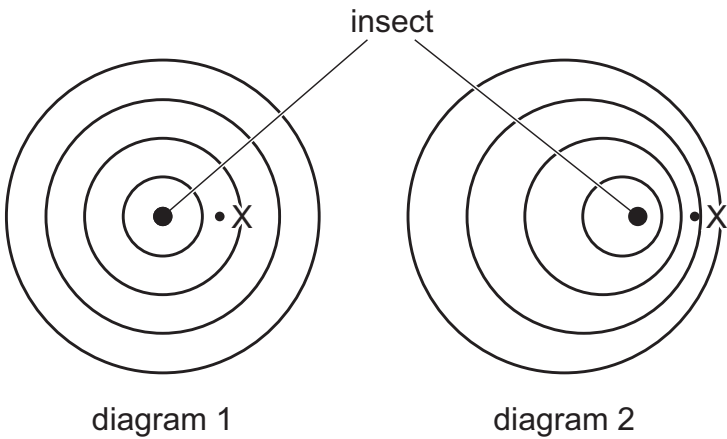
23 The graph shows the variation of the displacement of particles with distance along a transverse wave at an instant in time. The wave is moving to the right.

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



117. Question | 9702 May-June 2019 P1 V1 Q25

25 A stationary insect on the surface of water creates circular waves with its legs, as shown in diagram 1. The insect begins to travel to the right as shown in diagram 2.



Which row describes the change to the waves at X caused by the movement of the insect?

	frequency	wave speed
A	decreases	increases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

118. Question | 9702 May-June 2019 P1 V1 Q26

26 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.

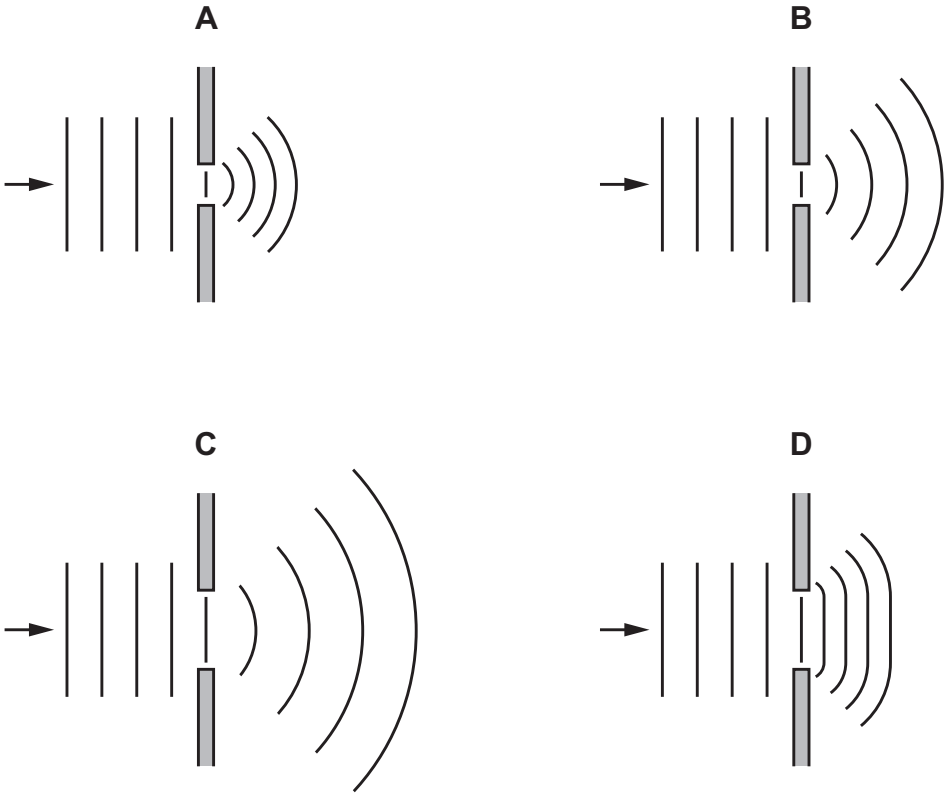
What is a possible value of v ?

	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

119. Question | 9702 May-June 2019 P1 V1 Q28

28 The diagrams show the diffraction of water waves in a ripple tank as they pass through a gap between two barriers.

Which diagram is correct?



120. Question | 9702 May-June 2019 P1 V2 Q23

- 23** The diagram illustrates the position of particles in a progressive sound wave at one instant in time.



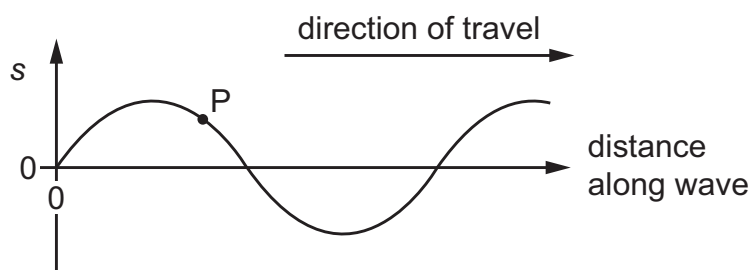
The speed of the wave is v . P and Q are two points in the wave a distance L apart.

What is an expression for the frequency of the wave?

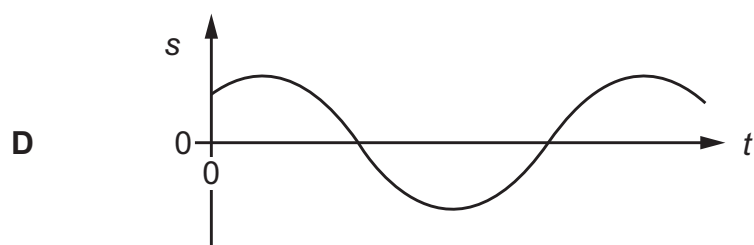
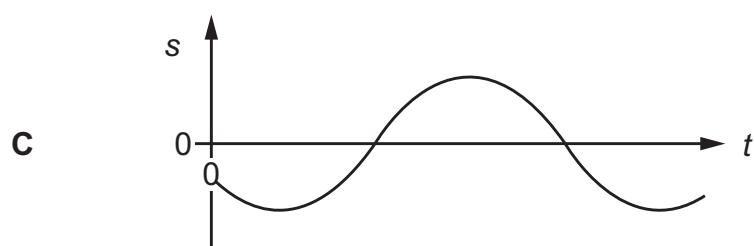
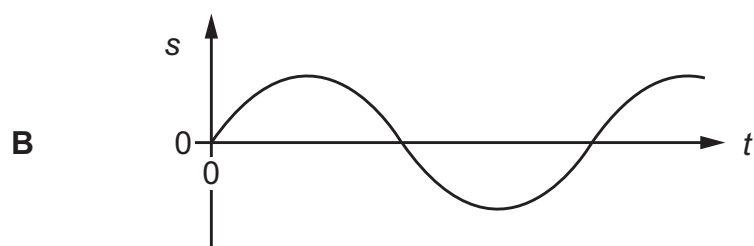
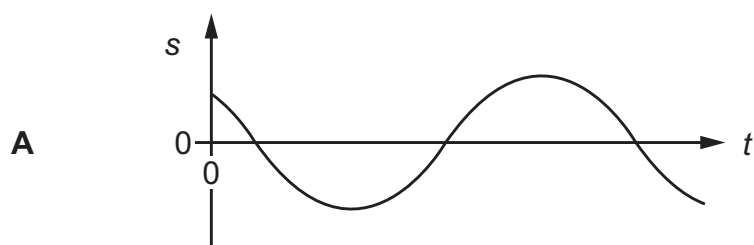
- A** $\frac{v}{2L}$ **B** $\frac{v}{L}$ **C** $\frac{2v}{L}$ **D** $\frac{L}{v}$

24 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?



122. Question | 9702 May-June 2019 P1 V2 Q25

- 25** In an experiment to determine the wavelength of sound in air, a stationary wave is set up in an air column.

The distance between a node and an adjacent antinode is L .

What is the wavelength of the sound?

- A** $\frac{1}{2}L$ **B** L **C** $2L$ **D** $4L$

123. Question | 9702 May-June 2019 P1 V2 Q26

- 26** In one of the first experiments to demonstrate the Doppler effect, a train was filled with trumpeters all playing a note of frequency 440 Hz. The difference in observed frequency of the note as the train directly approached a stationary observer was 22 Hz. The speed of sound was 340 m s^{-1} .

At which speed was the train moving?

- A** 15.4 m s^{-1} **B** 16.2 m s^{-1} **C** 17.0 m s^{-1} **D** 17.9 m s^{-1}

124. Question | 9702 May-June 2019 P1 V2 Q27

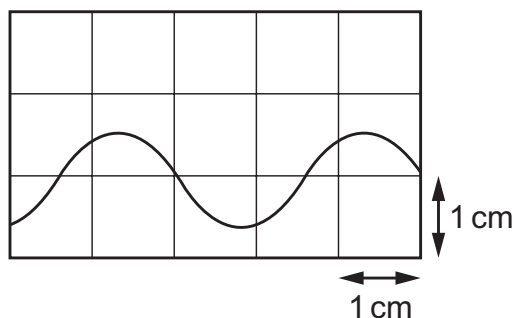
- 27** The electromagnetic spectrum consists of waves with different wavelengths.

Which row correctly identifies regions of the electromagnetic spectrum?

	10^{-10} m	10^{-8} m	10^{-5} m	10^{-2} m
A	microwaves	X-rays	ultraviolet	infrared
B	infrared	microwaves	X-rays	ultraviolet
C	microwaves	infrared	ultraviolet	X-rays
D	X-rays	ultraviolet	infrared	microwaves

125. Question | 9702 May-June 2019 P1 V2 Q28

- 28** A cathode-ray oscilloscope (CRO) is used to display the trace from a sound wave. The time-base is set at $5\mu\text{s mm}^{-1}$.

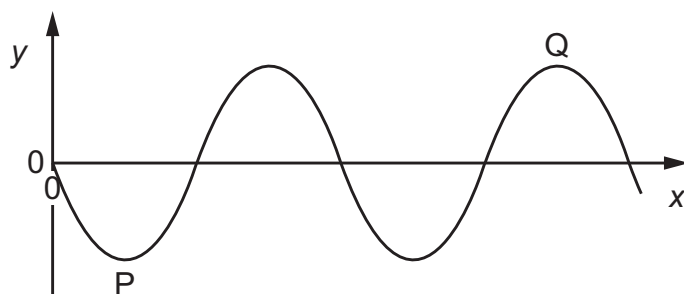


What is the frequency of the sound wave?

- A** 6.7 Hz **B** 67 Hz **C** 6.7 kHz **D** 67 kHz

126. Question | 9702 May-June 2019 P1 V3 Q21

- 21** 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°

127. Question | 9702 May-June 2019 P1 V3 Q22

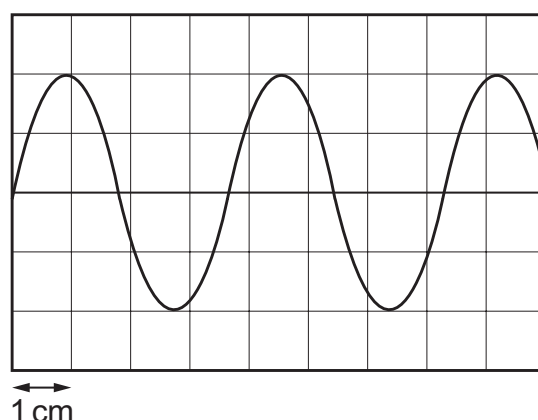
- 22** Wave-power generators take advantage of the energy that is transferred by the motion of waves across the surface of the oceans. The energy of a wave depends on its amplitude.

What is the correct definition of amplitude?

- A** the average amount of energy possessed by a wave
- B** the difference in displacement between a peak and a trough
- C** the maximum displacement of a point on the wave from equilibrium
- D** the number of oscillations of a wave that occur per second

128. Question | 9702 May-June 2019 P1 V3 Q23

- 23** A sound wave of frequency 270 Hz is recorded by a cathode-ray oscilloscope (CRO). The waveform on the CRO is shown.



What is the time-base setting on the CRO?

- A** 0.1 ms cm^{-1}
- B** 1 ms cm^{-1}
- C** 10 ms cm^{-1}
- D** 100 ms cm^{-1}

129. Question | 9702 May-June 2019 P1 V3 Q24

- 24** A motor boat vibrates in the water so that it produces water waves of frequency 0.20 Hz . The speed of these waves in the water is 20 ms^{-1} . The motor boat moves with a speed of 5.0 ms^{-1} directly towards a stationary sailing boat.

The Doppler effect equation for sound waves also applies to water waves.

What is the frequency with which the waves hit the stationary sailing boat?

- A** 0.15 Hz
- B** 0.16 Hz
- C** 0.25 Hz
- D** 0.27 Hz

130. Question | 9702 May-June 2019 P1 V3 Q25

25 Infrared laser light is used for the transmission of data along optic fibres.

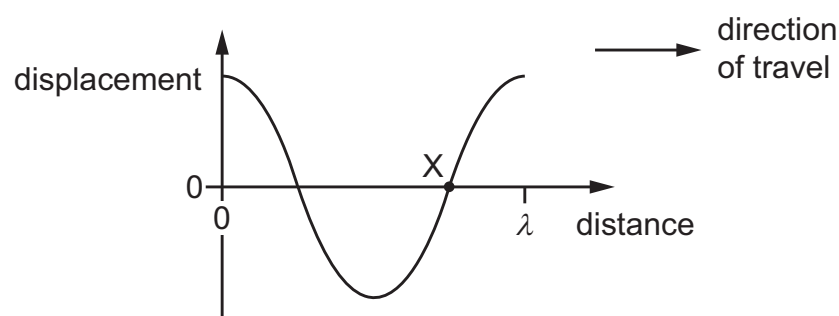
What is a typical wavelength of infrared radiation?

- A** $5 \times 10^{-5} \text{ m}$ **B** $5 \times 10^{-7} \text{ m}$ **C** $2 \times 10^{-9} \text{ m}$ **D** $2 \times 10^{-11} \text{ m}$

131. Question | 9702 Oct-Nov 2019 P1 V1 Q21

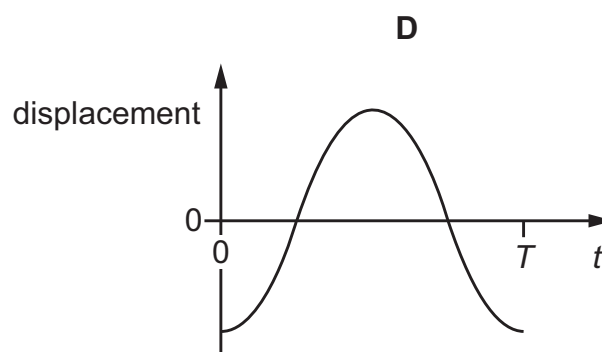
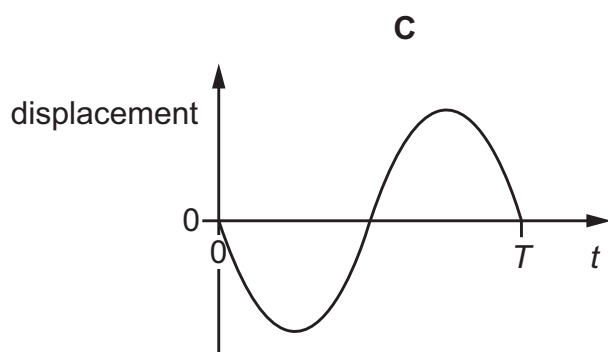
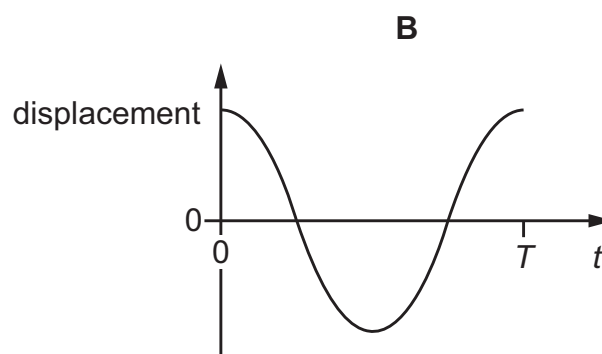
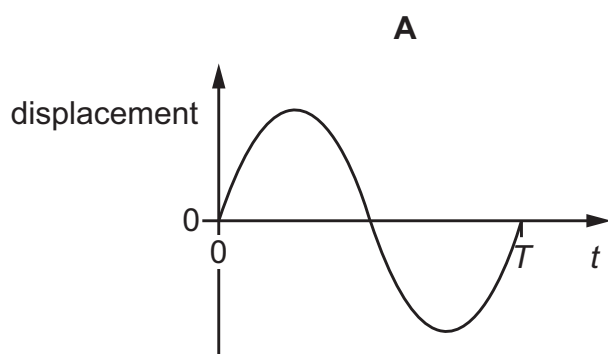
21 A transverse wave on a rope has wavelength λ and period T .

The graph shows the variation of the displacement of the particles of the rope with distance in the direction of travel of the wave at time $t = 0$.



A particle X is labelled.

Which graph shows the variation of the displacement of particle X with time t ?



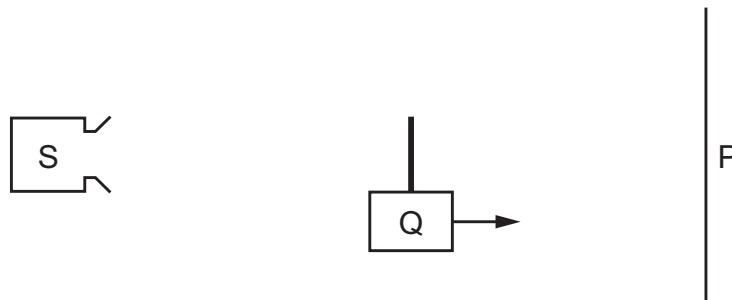
132. Question | 9702 Oct-Nov 2019 P1 V1 Q22

22 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.

133. Question | 9702 Oct-Nov 2019 P1 V1 Q23

23 Source S emits microwaves with a 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

134. Question | 9702 Oct-Nov 2019 P1 V1 Q24

- 24** The siren of a moving police car emits a sound wave with a frequency of 440 Hz. A stationary observer hears sound of frequency 494 Hz. The speed of sound in the air is 340 m s^{-1} .

What could be the speed and the direction of movement of the car?

- A** 37 m s^{-1} directly towards the observer
- B** 37 m s^{-1} directly away from the observer
- C** 42 m s^{-1} directly towards the observer
- D** 42 m s^{-1} directly away from the observer

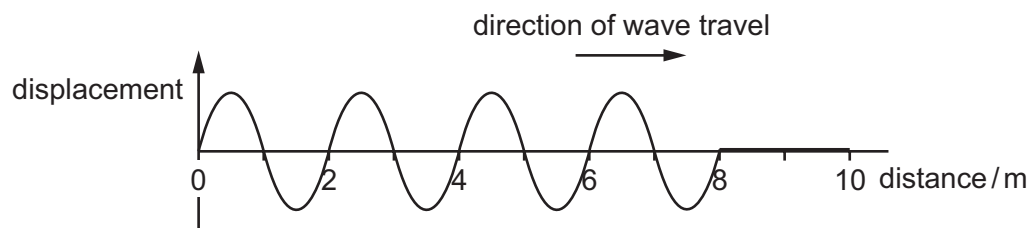
135. Question | 9702 Oct-Nov 2019 P1 V1 Q25

- 25** An electromagnetic wave has a wavelength of 138 pm in a vacuum.

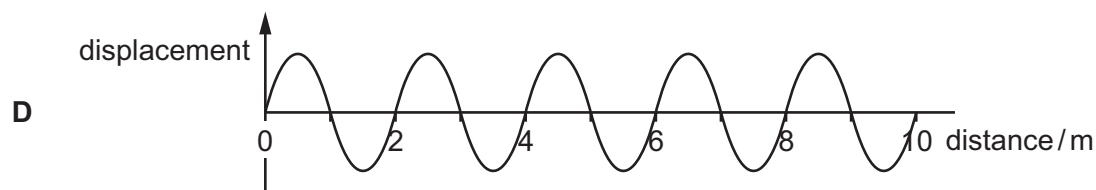
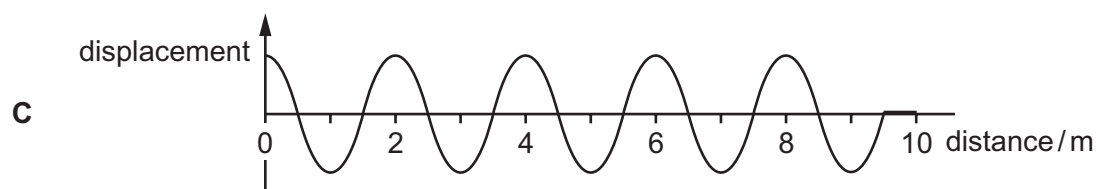
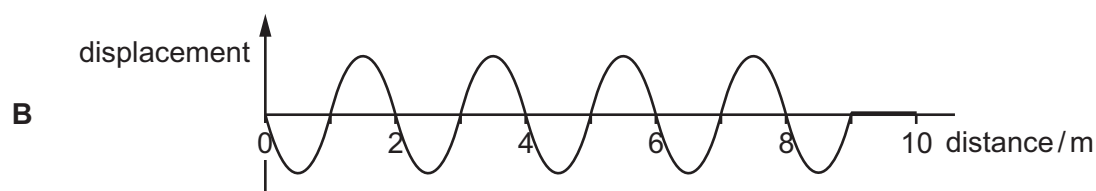
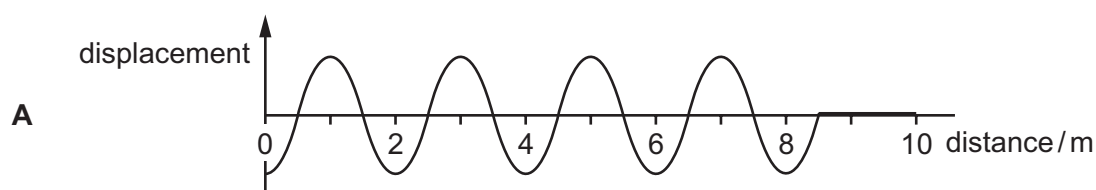
To which region of the electromagnetic spectrum does this wave belong?

- A** radio wave
- B** microwave
- C** visible light
- D** X-ray

- 20** 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 $t = 0$.

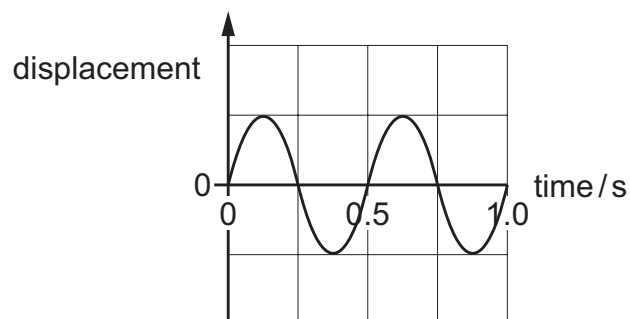


Which diagram shows the position of the wave at time $t = 0.5\text{ s}$?

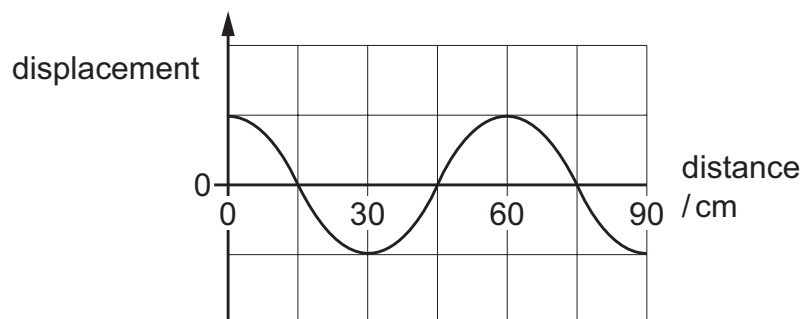


21 The two graphs represent the same wave.

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.



graph 1

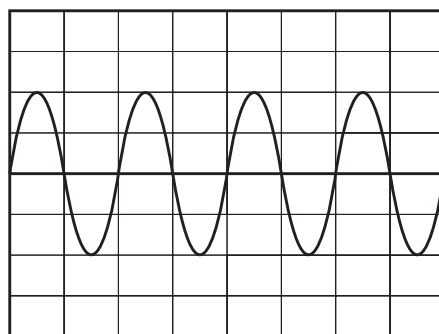


graph 2

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}

22 A microphone is connected to a cathode-ray oscilloscope (CRO). When a tuning fork is struck and then held next to the microphone, the following waveform is shown on the display of the CRO.



The time-base setting on the CRO is 2.00 ms per division.

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

- A** 63 Hz **B** 170 Hz **C** 250 Hz **D** 500 Hz

139. Question | 9702 Oct-Nov 2019 P1 V2 Q23

- 23** A loudspeaker emitting a constant frequency of 2000 Hz is swung in a horizontal circle with a speed of 15.0 ms^{-1} .

A stationary observer is level with the loudspeaker and situated a long distance from the loudspeaker. The observer hears a sound of varying frequency. The maximum frequency heard is 2097 Hz .

What is the speed of the sound in the air?

- A** 294 ms^{-1} **B** 309 ms^{-1} **C** 324 ms^{-1} **D** 330 ms^{-1}

140. Question | 9702 Oct-Nov 2019 P1 V2 Q24

- 24** Two electromagnetic waves have wavelengths of $5.0 \times 10^{-7}\text{ m}$ and $5.0 \times 10^{-2}\text{ m}$.

Which row identifies the regions of the electromagnetic spectrum to which the waves belong?

	wavelength $5.0 \times 10^{-7}\text{ m}$	wavelength $5.0 \times 10^{-2}\text{ m}$
A	ultraviolet	infrared
B	visible	microwave
C	ultraviolet	microwave
D	visible	infrared

141. Question | 9702 Oct-Nov 2019 P1 V2 Q26

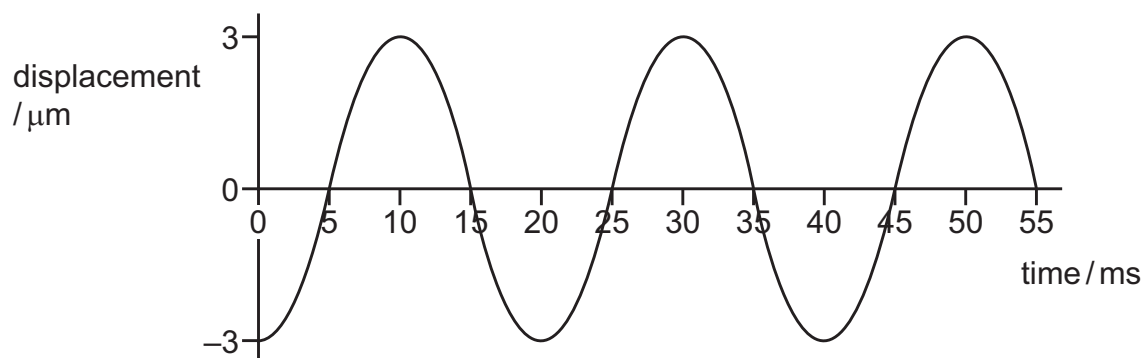
- 26** Which statement about a light wave and a sound wave is correct?
- A** Both can travel through free space.
 - B** Both have a frequency inversely proportional to their wavelength.
 - C** Both have an intensity proportional to their amplitude.
 - D** Both have oscillations perpendicular to the direction of energy transfer.

142. Question | 9702 Oct-Nov 2019 P1 V3 Q21

- 21** Which statement about light waves and sound waves is **not** correct?
- A** Light waves and sound waves can both demonstrate the Doppler effect.
 - B** Light waves are transverse waves and sound waves are longitudinal waves.
 - C** Light waves can be diffracted but sound waves cannot.
 - D** Light waves can travel in a vacuum but sound waves cannot.

143. Question | 9702 Oct-Nov 2019 P1 V3 Q22

22 The graph represents a sound wave.

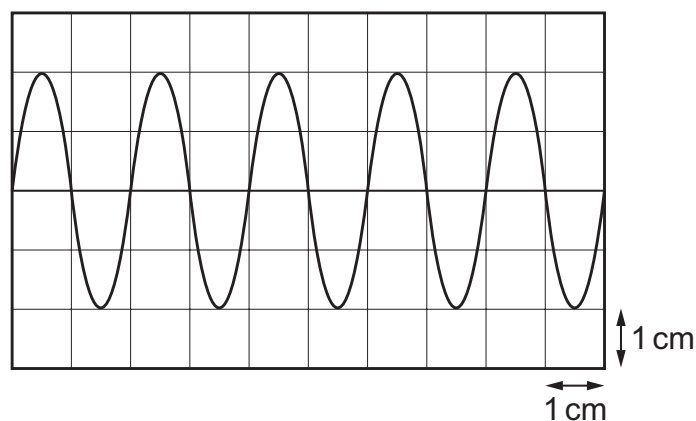


Which statement is correct?

- A** The wave is longitudinal and has a period of 25 ms.
- B** The wave is longitudinal and has a frequency of 50 Hz.
- C** The wave is transverse and has an amplitude of $3\ \mu\text{m}$.
- D** The wave is transverse and has a wavelength of 20 ms.

144. Question | 9702 Oct-Nov 2019 P1 V3 Q23

23 A cathode-ray oscilloscope (CRO) is used to display a wave of frequency $5.0\ \text{kHz}$. The display is shown.



What is the time-base setting of the CRO?

- A** $10\ \mu\text{s cm}^{-1}$
- B** $100\ \mu\text{s cm}^{-1}$
- C** $10\ \text{ms cm}^{-1}$
- D** $100\ \text{ms cm}^{-1}$

- 24** A siren emits sound of frequency 1000 Hz. The siren moves at 20 m s^{-1} towards an observer who is standing still.

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

Which expression would correctly give the frequency heard by the observer?

A $\frac{1000 \times 330}{330 + 20}$

B $\frac{1000 \times 330}{330 - 20}$

C $\frac{1000 (330 + 20)}{330}$

D $\frac{1000 (330 - 20)}{330}$

- 25** 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

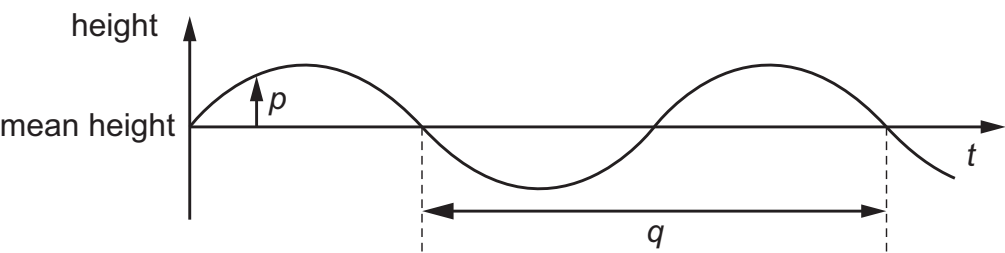
$$I = \frac{P}{4\pi r^2}.$$

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** $a \propto r^2$

147. Question | 9702 Oct-Nov 2019 P1 V3 Q27

27 The graph shows how the height of the water surface at a point in a harbour varies with time t as waves pass the point.

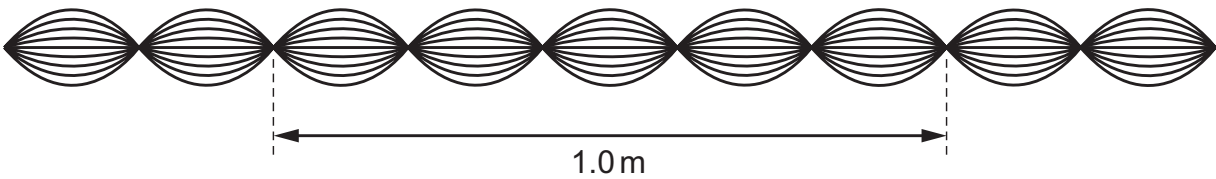


What are p and q ?

	p	q
A	displacement	period
B	displacement	wavelength
C	amplitude	period
D	amplitude	wavelength

148. Question | 9702 Oct-Nov 2019 P1 V3 Q28

28 The diagram shows a sketch of a wave pattern over a short period of time.



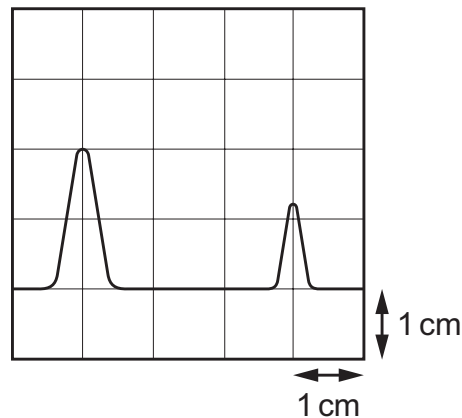
Which description of this wave is correct?

- A The wave is longitudinal, has a wavelength of 20 cm and is stationary.
- B The wave is transverse, has a wavelength of 20 cm and is stationary.
- C The wave is transverse, has a wavelength of 40 cm and is progressive.
- D The wave is transverse, has a wavelength of 40 cm and is stationary.

149. Question | 9702 Feb-March 2020 P1 V2 Q4

- 4** A transmitter emits a pulse of electromagnetic waves towards a reflector. The pulse is reflected and returns to the transmitter.

A detector is located at the transmitter. The emitted pulse and the reflected pulse are displayed on a cathode-ray oscilloscope (CRO) as shown.



The pulse takes $6.3 \mu\text{s}$ to travel from the transmitter to the reflector.

What is the time-base setting of the CRO?

- A** $2.1 \mu\text{s cm}^{-1}$ **B** $3.2 \mu\text{s cm}^{-1}$ **C** $4.2 \mu\text{s cm}^{-1}$ **D** $6.3 \mu\text{s cm}^{-1}$

150. Question | 9702 Feb-March 2020 P1 V2 Q21

- 21** 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.

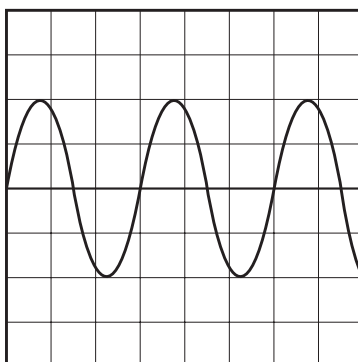
151. Question | 9702 Feb-March 2020 P1 V2 Q22

22 Which row describes a longitudinal wave and a medium through which it can travel?

	direction of oscillation of the medium compared with the direction of propagation of wave energy	medium
A	parallel	air
B	parallel	vacuum
C	perpendicular	air
D	perpendicular	vacuum

152. Question | 9702 Feb-March 2020 P1 V2 Q23

23 A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.



The time-base setting is 0.50 ms per division.

What is the frequency of the sound wave?

- A** 500 Hz **B** 670 Hz **C** 1000 Hz **D** 1300 Hz

153. Question | 9702 Feb-March 2020 P1 V2 Q24

- 24** An observer is situated at the top of a tall tower. An aeroplane emitting sound at a frequency of 1000 Hz approaches the observer at a speed of 165 m s^{-1} .

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

What is the frequency of the sound received by the observer?

- A** 330 Hz **B** 667 Hz **C** 1000 Hz **D** 2000 Hz

154. Question | 9702 Feb-March 2020 P1 V2 Q25

- 25** What is the order of magnitude of the wavelengths of microwaves and X-rays?

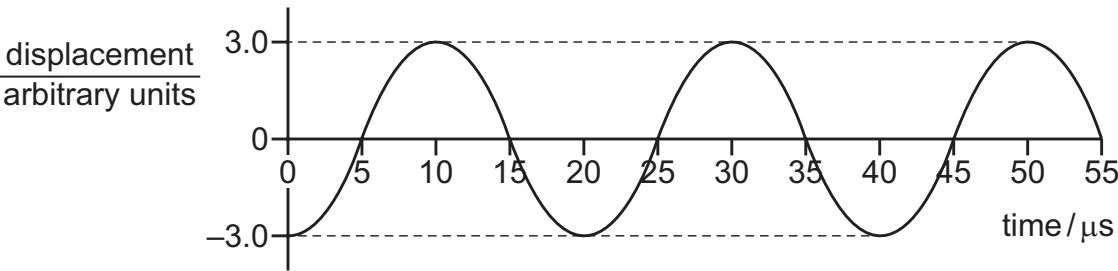
	wavelength of microwaves / m	wavelength of X-rays / m
A	10^{-6}	10^3
B	10^{-2}	10^3
C	10^{-6}	10^{-10}
D	10^{-2}	10^{-10}

155. Question | 9702 May-June 2020 P1 V1 Q22

- 22** 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.

156. Question | 9702 May-June 2020 P1 V1 Q23

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



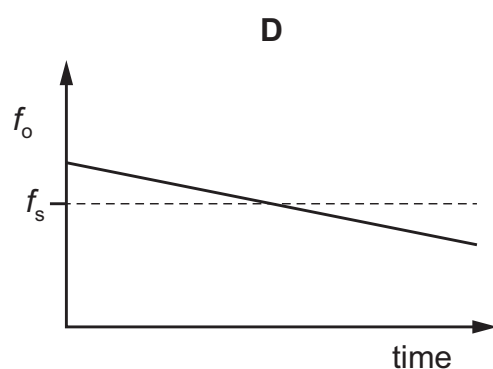
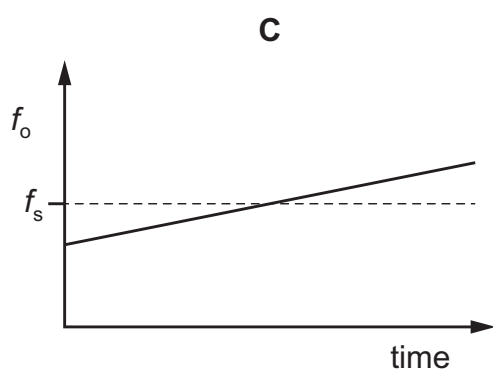
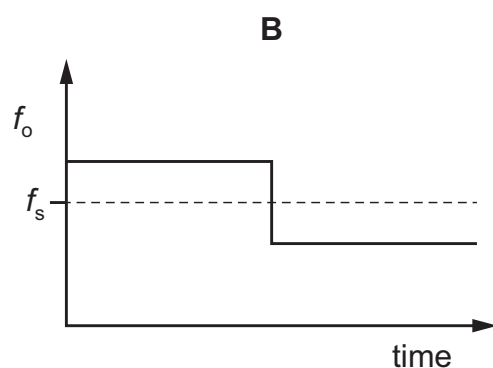
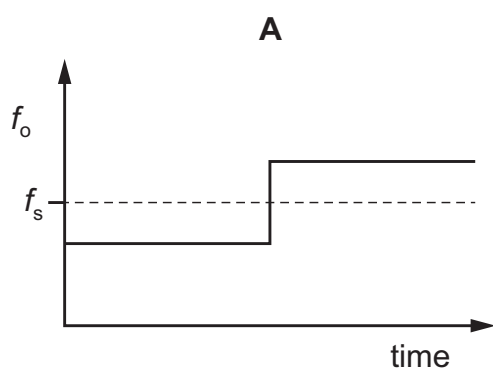
The wave is travelling in a vacuum.

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

- 25** 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?



158. Question | 9702 May-June 2020 P1 V1 Q26

- 26** What are the names of the electromagnetic waves that have wavelengths in a vacuum of 100 pm and of 100 μm ?

	wavelength 100 pm	wavelength 100 μm
A	γ -rays	infrared
B	γ -rays	red light
C	X-rays	infrared
D	X-rays	red light

159. Question | 9702 May-June 2020 P1 V1 Q28

- 28** Which statement **must** be true for diffraction to occur when a wave passes through a gap?

- A** The wave is able to travel in a vacuum.
- B** The wave is progressive.
- C** The wave has a large amplitude.
- D** The wave has a long wavelength.

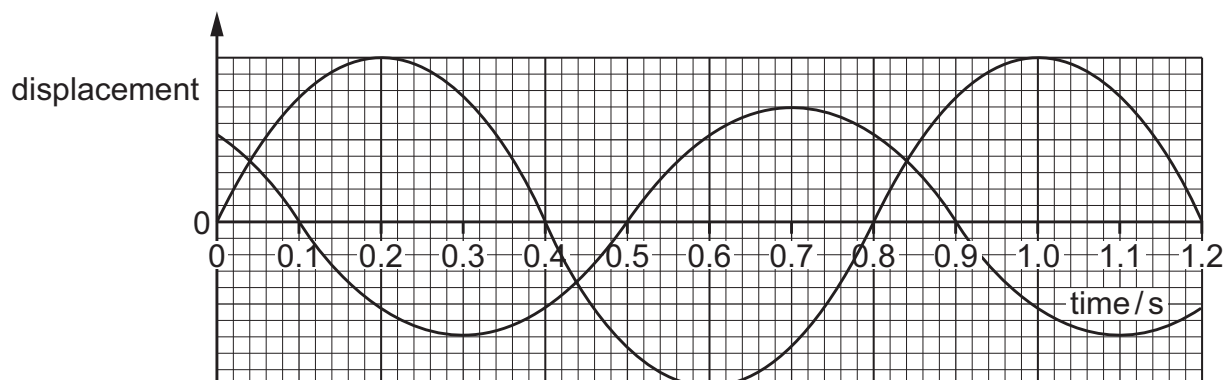
160. Question | 9702 May-June 2020 P1 V2 Q21

- 21** 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.

- 22** 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.

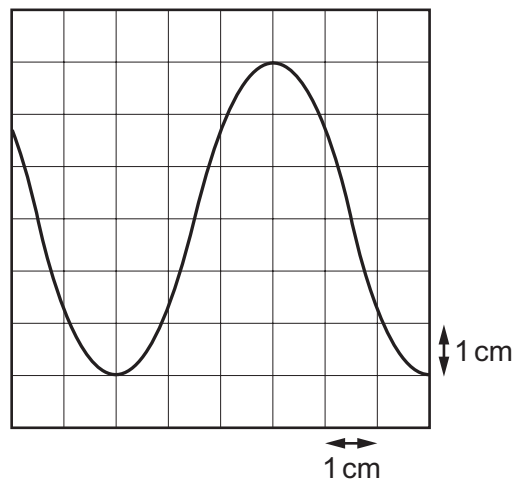


What is the phase difference between the two waves at point P?

- A** 45° **B** 90° **C** 135° **D** 180°

162. Question | 9702 May-June 2020 P1 V2 Q23

23 A microphone connected to the Y-plates of a cathode-ray oscilloscope (CRO) is placed in front of a loudspeaker. The trace on the screen of the CRO is shown.



The time-base setting is 0.5 ms cm^{-1} and the Y-plate sensitivity is 0.2 mV cm^{-1} .

What is the frequency of the sound from the loudspeaker and what is the amplitude of the trace on the CRO?

	frequency / Hz	amplitude / mV
A	330	0.6
B	330	1.2
C	670	0.6
D	670	1.2

- 25** 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

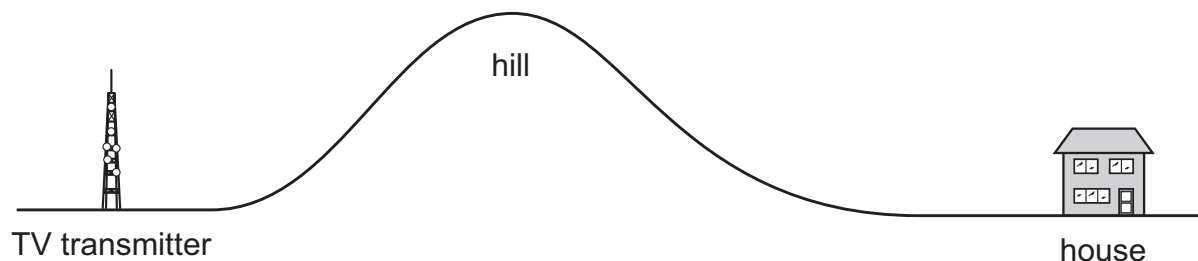
- 26** The table shows the wavelengths of five electromagnetic waves.

Which row correctly identifies the principal radiation for each of these wavelengths?

	10^{-14} m	10^{-10} m	10^{-6} m	10^{-2} m	10^2 m
A	gamma-ray	X-ray	infrared	microwave	radio wave
B	radio wave	microwave	infrared	X-ray	gamma-ray
C	radio wave	microwave	ultraviolet	infrared	X-ray
D	X-ray	infrared	ultraviolet	microwave	radio wave

165. Question | 9702 May-June 2020 P1 V2 Q28

- 28** A hill separates a television (TV) transmitter from a house. The transmitter cannot be seen from the house. However, the house has good TV reception.



By which wave effect at the hill could the TV signal reach the house?

- A** coherence
- B** diffraction
- C** interference
- D** reflection

166. Question | 9702 May-June 2020 P1 V3 Q22

- 22** A wave of amplitude A has an intensity I .

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

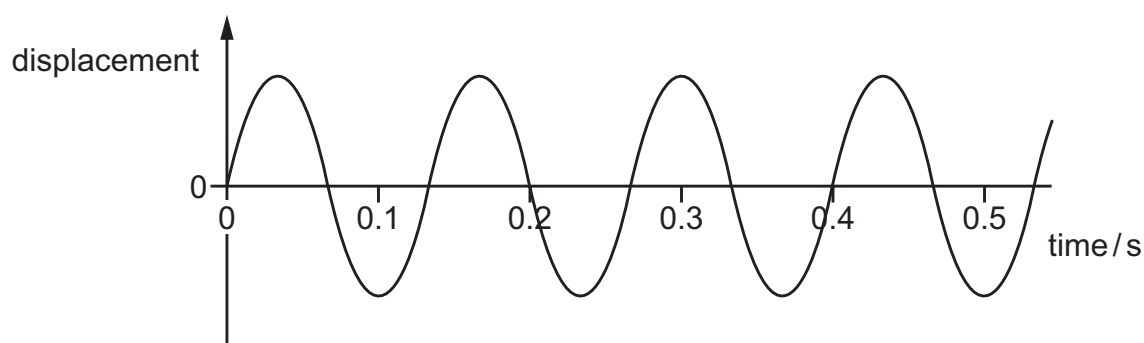
What is the new amplitude of the wave?

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

167. Question | 9702 May-June 2020 P1 V3 Q23

23 A wave travels along a coiled spring.

The graph shows the variation with time of the displacement of a point on the spring.



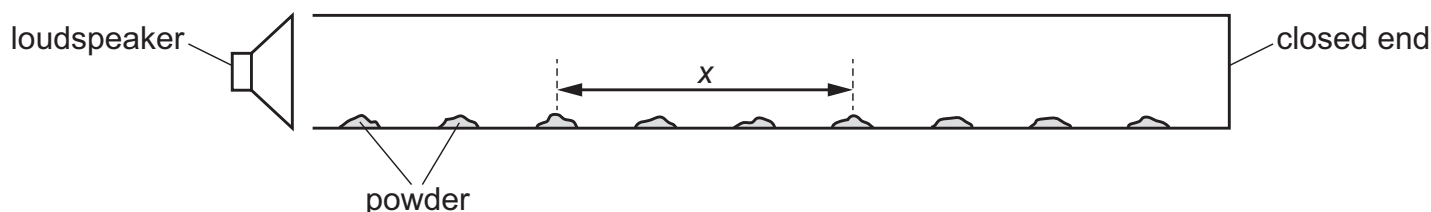
What is the frequency of the wave?

- A** 0.13 Hz **B** 0.20 Hz **C** 5.0 Hz **D** 7.5 Hz

168. Question | 9702 May-June 2020 P1 V3 Q24

24 A loudspeaker is set up at the open end of a closed tube containing powder.

When the loudspeaker produces sound of frequency 1200 Hz, a stationary wave is produced in the tube. The powder gathers at the nodes of the stationary wave as shown.



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

What is the value of distance x ?

- A** 28 cm **B** 42 cm **C** 84 cm **D** 112 cm

25 A stationary source S emits a sound wave of frequency f .

The source now moves away from a stationary observer.

Which statement is correct?

- A** The frequency of the source S and the observed frequency are now both higher than f .
- B** The frequency of the source S and the observed frequency are now both lower than f .
- C** The frequency of the source S is now lower than f .
- D** The observed frequency is now lower than f .

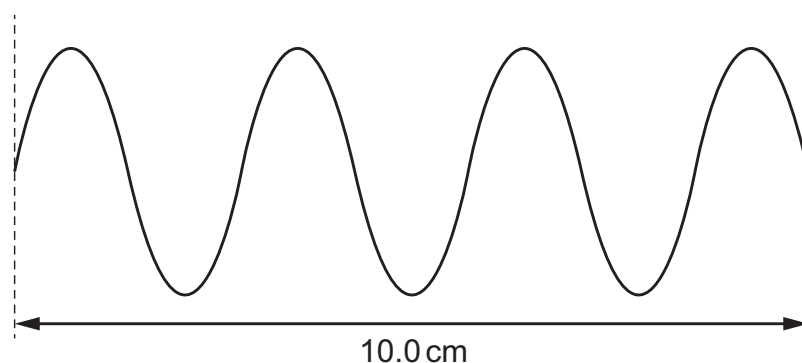
26 The table lists possible wavelengths of four different electromagnetic waves.

Which row is correct?

	type of wave	approximate wavelength / m
A	infrared	10^{-5}
B	radio	10^{-3}
C	ultraviolet	10^{-12}
D	X-rays	10^{-7}

171. Question | 9702 Oct-Nov 2020 P1 V1 Q4

- 4 A student uses a cathode-ray oscilloscope (CRO) to measure the period of a signal. She sets the time-base of the CRO to 5 ms cm^{-1} and observes the trace illustrated below. The trace has a length of 10.0 cm .



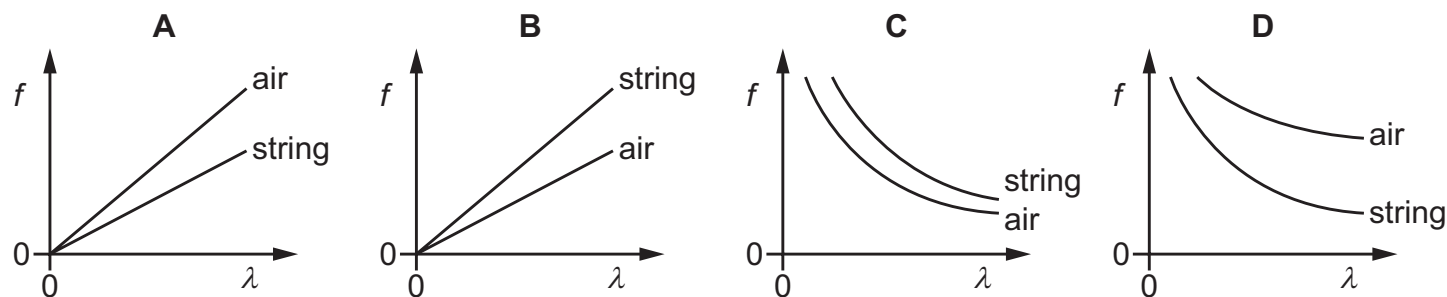
What is the period of the signal?

- A** $7.1 \times 10^{-6} \text{ s}$ **B** $1.4 \times 10^{-5} \text{ s}$ **C** $7.1 \times 10^{-3} \text{ s}$ **D** $1.4 \times 10^{-2} \text{ s}$

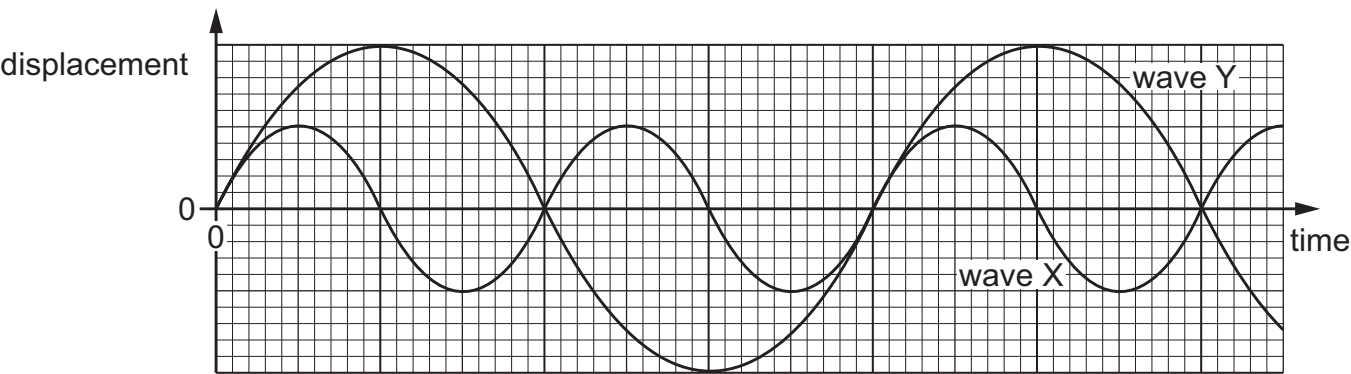
172. Question | 9702 Oct-Nov 2020 P1 V1 Q21

- 21 A guitar string vibrates to create a sound. The speed of the wave in the guitar string is always 440 m s^{-1} . The vibrating string creates a sound wave that moves in the air with a speed of 330 m s^{-1} .

Which graph shows the variation of frequency f with the wavelength λ for the waves in the string and in the air?



22 The graph shows the variation with time of displacement for two different waves X and Y.



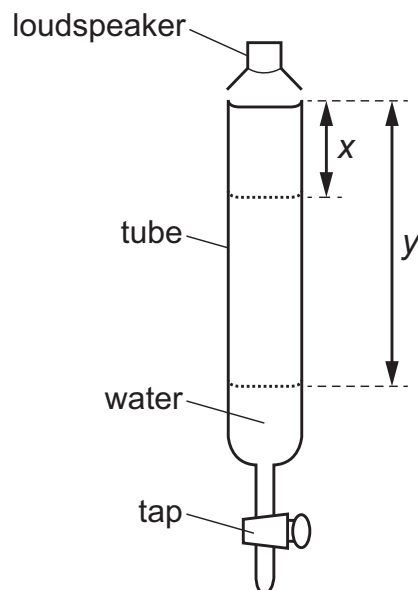
Wave X has frequency f and amplitude A .

What is the frequency and what is the amplitude of wave Y?

	frequency	amplitude
A	$\frac{1}{2}f$	$\frac{1}{2}A$
B	$\frac{1}{2}f$	$2A$
C	$2f$	$\frac{1}{2}A$
D	$2f$	$2A$

174. Question | 9702 Oct-Nov 2020 P1 V1 Q23

- 23** A loudspeaker emits a sound wave into a tube initially full of water.



A tap at the bottom of the tube is opened so that water slowly leaves the tube. For some lengths of the air column in the tube, the sound heard is much louder.

The first loud sound is heard when the air column in the tube has length x .

The next time that a loud sound is heard is when the air column in the tube has length y .

What is the wavelength of the sound wave from the loudspeaker?

- A** $2x$ **B** $4y$ **C** $2(y - x)$ **D** $4(y - x)$

175. Question | 9702 Oct-Nov 2020 P1 V1 Q24

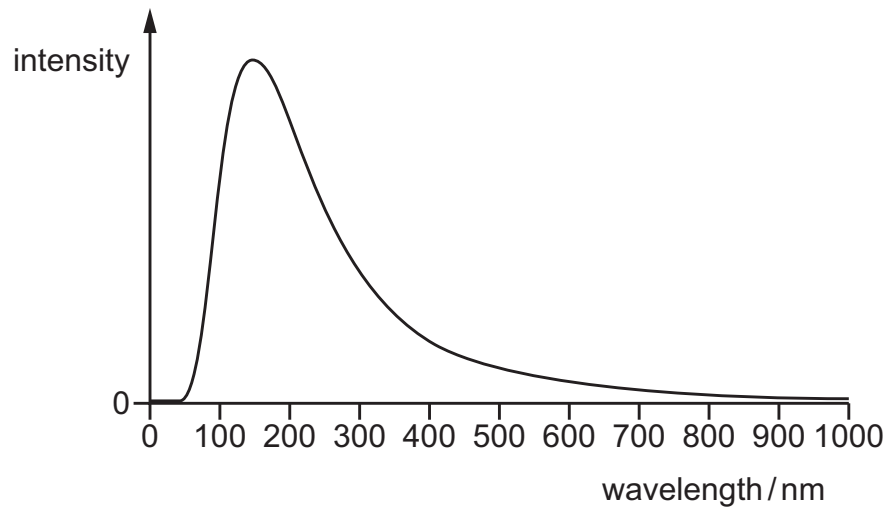
- 24** A source of sound of frequency 1000 Hz directly approaches a stationary observer. The observer measures the frequency of the received sound to be 1500 Hz. The speed of sound in still air is 330 m s^{-1} .

What is the speed of the source of sound?

- A** 110 m s^{-1} **B** 165 m s^{-1} **C** 220 m s^{-1} **D** 330 m s^{-1}

176. Question | 9702 Oct-Nov 2020 P1 V1 Q25

- 25** The graph shows how the intensity of electromagnetic radiation emitted from a distant star varies with wavelength.



In which region of the electromagnetic spectrum is the radiation of greatest intensity?

- A** infrared
- B** visible light
- C** ultraviolet
- D** X-ray

177. Question | 9702 Oct-Nov 2020 P1 V1 Q27

- 27** Which waves would best demonstrate diffraction through a doorway?

- A** sound waves
- B** ultraviolet waves
- C** visible light waves
- D** X-rays

22 The speed v of waves in deep water is given by the equation

$$v^2 = \frac{g\lambda}{2\pi}$$

where λ is the wavelength of the waves and g is the acceleration of free fall.

A student measures the wavelength λ and the frequency f of a number of these waves.

Which graph should he plot to give a straight line through the origin?

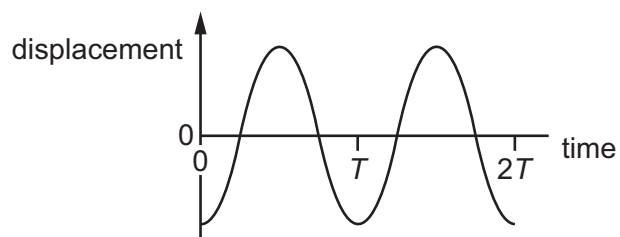
A f^2 against λ

B f against λ^2

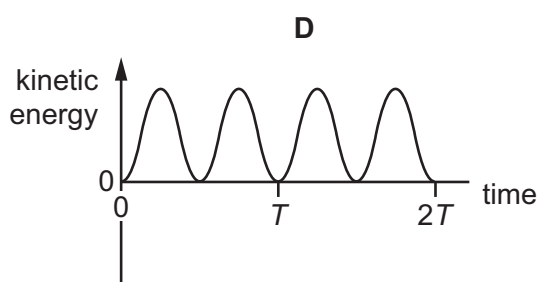
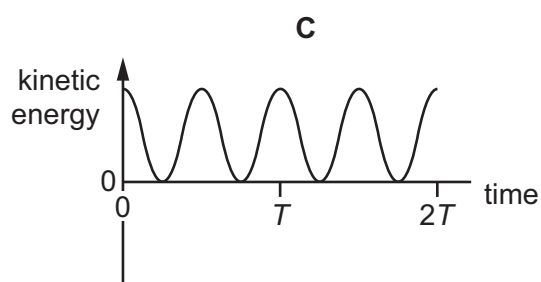
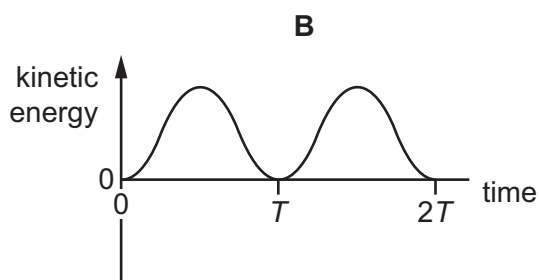
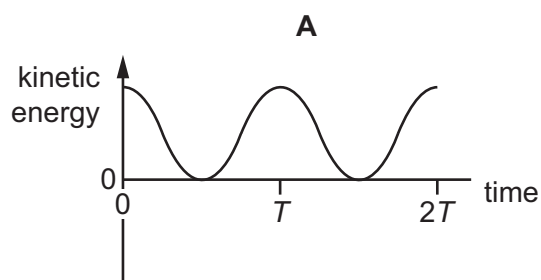
C f against $\frac{1}{\lambda}$

D f^2 against $\frac{1}{\lambda}$

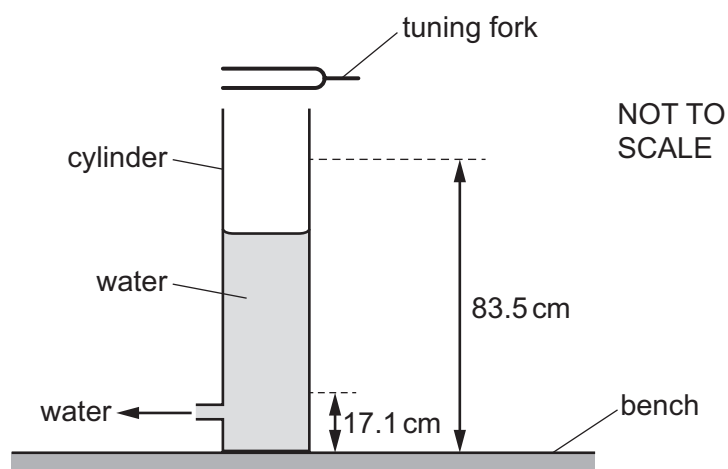
- 23** When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown.



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



- 24** A vibrating tuning fork is held above a glass cylinder filled to the top with water. The water level is steadily lowered. A loud sound is first heard when the water level is 83.5 cm above the bench. The next loud sound is heard when the water level is 17.1 cm above the bench.

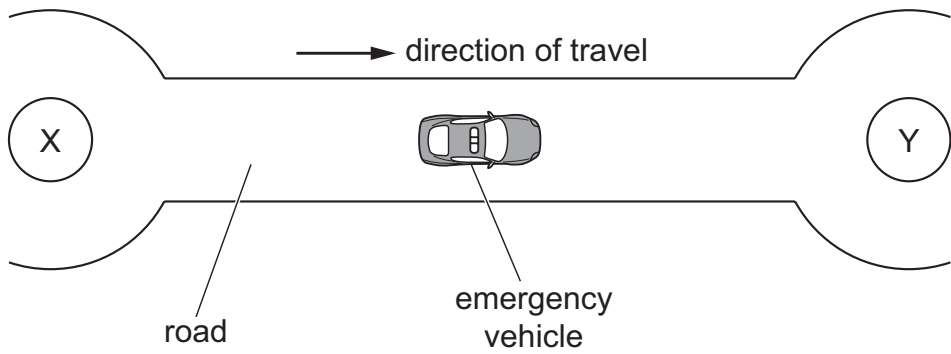


The speed of sound in air is 340 m s^{-1} .

What is the frequency of the tuning fork?

- A** 128 Hz **B** 256 Hz **C** 384 Hz **D** 512 Hz

25 An emergency vehicle sounds its siren as it accelerates along a straight road between two points X and Y, as shown in the diagram.



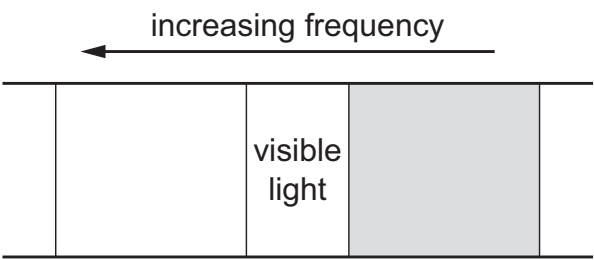
The frequency of the sound emitted by the siren is 750 Hz.

A person stands at X and another person stands at Y.

What describes the sounds heard by the people at X and at Y as the vehicle accelerates?

	sound heard by person at X	sound heard by person at Y
A	higher than 750 Hz, increasing in frequency	lower than 750 Hz, decreasing in frequency
B	higher than 750 Hz, decreasing in frequency	lower than 750 Hz, increasing in frequency
C	lower than 750 Hz, decreasing in frequency	higher than 750 Hz, increasing in frequency
D	lower than 750 Hz, increasing in frequency	higher than 750 Hz, decreasing in frequency

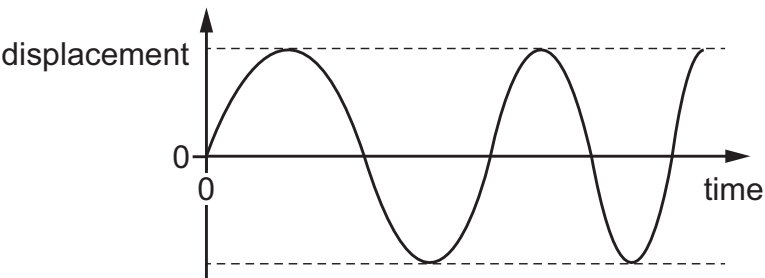
26 Part of the electromagnetic spectrum is shown.



What is the name of the shaded region and what is the order of magnitude of a wavelength of a wave from this region?

	name	wavelength / m
A	infrared	10^{-5}
B	infrared	10^{-8}
C	ultraviolet	10^{-5}
D	ultraviolet	10^{-8}

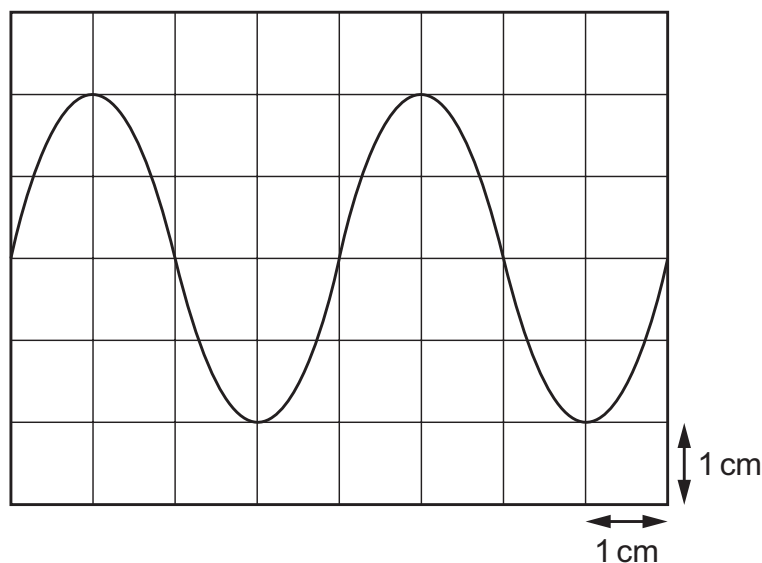
23 The displacement–time graph for an air particle in the path of a sound wave is shown.



Which property of the sound wave must be increasing?

- A amplitude
- B frequency
- C period
- D speed

- 24** A sound wave is displayed on the screen of a cathode-ray oscilloscope (CRO) as shown.



The time-base of the CRO is set at 2.5 ms cm^{-1} .

What is the frequency of the sound wave?

- A** 50 Hz **B** 100 Hz **C** 200 Hz **D** 400 Hz

- 25** The horn of a train emits sound of frequency f_1 . While the horn is sounding, the train moves directly towards a stationary person. The speed of the train is $0.20v$, where v is the speed of sound.

The frequency of the sound heard by the person is f_2 .

What is the ratio $\frac{f_1}{f_2}$?

- A** $\frac{0.80}{1}$ **B** $\frac{1}{1.2}$ **C** $\frac{1.2}{1}$ **D** $\frac{1}{0.80}$

- 26** Two satellites in orbit around the Earth are at a constant distance of 100 km apart from each other.

Satellite X transmits a microwave pulse towards satellite Y. The pulse takes time T to reach Y.

Satellite Y then transmits a pulse of visible light towards satellite X.

What is the time taken for the pulse of light to reach X?

- A** $10^{-5} T$ **B** $10^{-3} T$ **C** $10^{-2} T$ **D** T

187. Question | 9702 Feb-March 2021 P1 V2 Q21

21 A progressive radio wave in a vacuum has a frequency of 75 MHz.

What is the phase difference between two points on the wave that are 50 cm apart from each other?

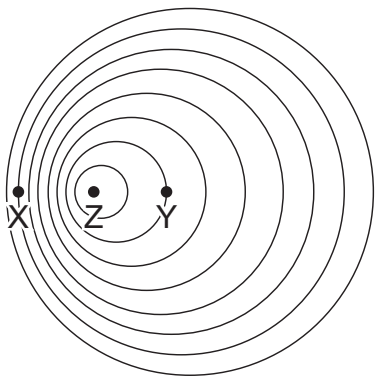
- A** 23° **B** 45° **C** 90° **D** 180°

188. Question | 9702 Feb-March 2021 P1 V2 Q22

22 Which statement is correct for longitudinal waves but **not** correct for transverse waves?

- A** They can form stationary waves.
- B** They can only travel through a medium.
- C** They can transfer energy in the direction of travel.
- D** They consist of peaks and troughs.

24 A source of sound of frequency F at point Z is moving at a steady speed. The pattern of the emitted wavefronts is shown.



Which row describes the frequencies of the sound heard by stationary observers at X and Y?

	frequency heard at X	frequency heard at Y
A	$<F$	$<F$
B	$<F$	$>F$
C	$>F$	$<F$
D	$>F$	$>F$

25 What is **not** a possible value for the wavelength of the named electromagnetic waves when it is travelling in a vacuum?

	electromagnetic wave	wavelength / m
A	γ -rays	3×10^{-13}
B	X-rays	3×10^{-10}
C	infrared	3×10^{-6}
D	microwaves	3×10^{-5}

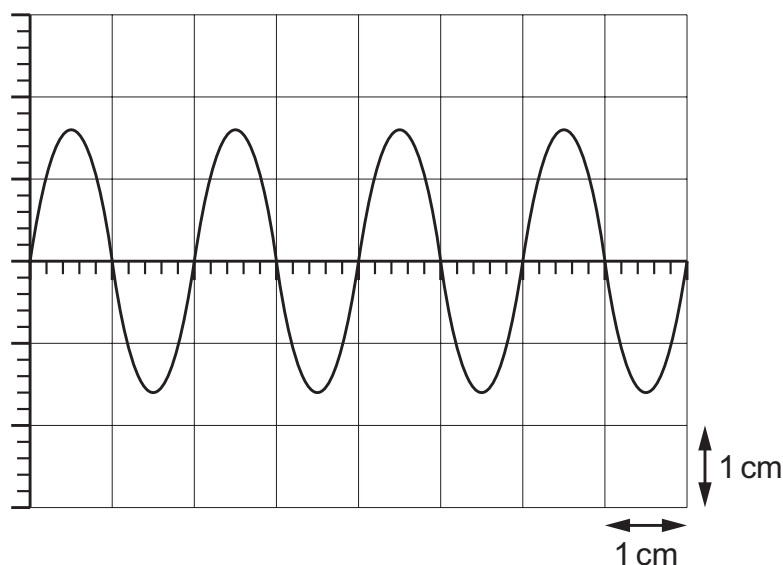
- 27** A water wave is diffracted as it passes through a gap between two barriers in a ripple tank. The wave is observed to 'spread out' as it moves through the gap.

Which two factors both affect the amount of diffraction observed?

- A** the amplitude and frequency of the incident wave
- B** the amplitude of the incident wave and the width of the gap
- C** the wavelength and amplitude of the incident wave
- D** the wavelength of the incident wave and the width of the gap

192. Question | 9702 May-June 2021 P1 V1 Q4

- 4** A signal of frequency 25 Hz is displayed on the screen of a cathode-ray oscilloscope.



What is the time-base setting?

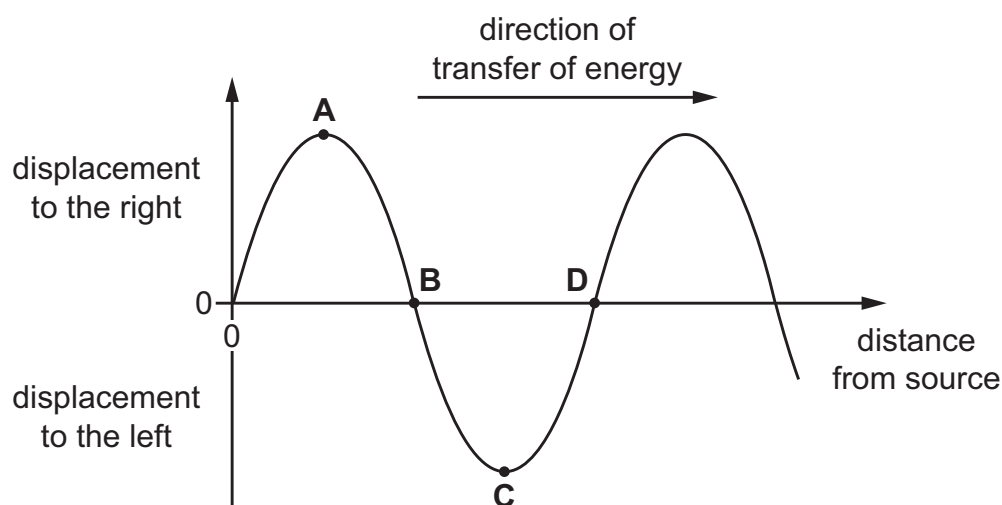
- A** 10 ms cm^{-1} **B** 20 ms cm^{-1} **C** 25 ms cm^{-1} **D** 40 ms cm^{-1}

193. Question | 9702 May-June 2021 P1 V1 Q22

- 22** A longitudinal wave travelling from left to right has vibrations parallel to the direction of transfer of energy by the wave.

The wave can be represented on a graph showing the variation with distance of the displacement of the particles from their equilibrium positions at one instant.

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



194. Question | 9702 May-June 2021 P1 V1 Q23

23 A stationary wave is formed from two identical sound waves.

A microphone is placed at a position of maximum loudness. It is then moved along the stationary wave from this first position of maximum loudness to the fourth position of maximum loudness. The microphone moves a distance of 12 cm.

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

What is the frequency of the sound waves?

- A** 4100 Hz **B** 5500 Hz **C** 8300 Hz **D** 11 000 Hz

195. Question | 9702 May-June 2021 P1 V1 Q24

24 An ambulance has a siren that emits sound of a constant frequency. The ambulance is moving directly towards a stationary observer.

The ambulance decelerates as it is approaching the observer and then accelerates after it has passed the observer.

How does the frequency of the sound heard by the observer change as the ambulance is approaching and as it is moving away from the observer?

	approaching observer	moving away from observer
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

25 Microwaves in a vacuum travel at speed X and have wavelength of order of magnitude Y .

What are the speed and a possible order of magnitude of wavelength of X-rays in a vacuum?

	speed	wavelength
A	X	$10^{-8} Y$
B	X	$10^{-4} Y$
C	$10^4 X$	Y
D	$10^8 X$	Y

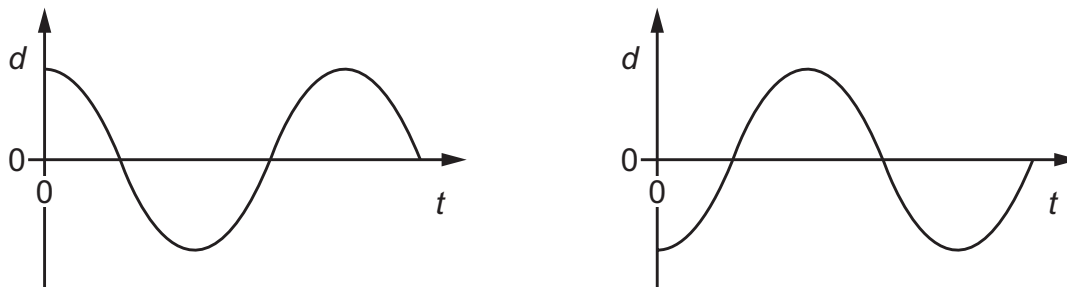
21 Two lasers emit light in a vacuum. One laser emits red light and the other emits green light.

Which property of the light from the two lasers **must** be different?

- A** amplitude
- B** frequency
- C** intensity
- D** speed

198. Question | 9702 May-June 2021 P1 V2 Q22

- 22** Two particles in a progressive wave are a distance 10 cm apart. The two graphs show the variation with time t of the displacement d of the two particles.



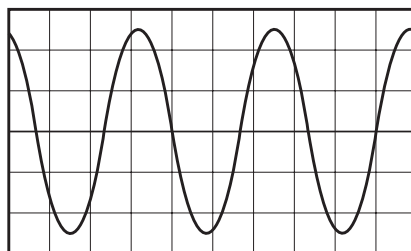
What could be represented by the two graphs?

- A** particles in a longitudinal wave with a compression and the nearest rarefaction separated by 10 cm
- B** particles in a longitudinal wave with a compression and the nearest rarefaction separated by 20 cm
- C** particles in a transverse wave with a peak and the nearest trough separated by 20 cm
- D** particles in a transverse wave with two adjacent peaks separated by 10 cm

199. Question | 9702 May-June 2021 P1 V2 Q23

- 23** A sound wave is detected by a microphone that is connected to a cathode-ray oscilloscope (CRO).

The screen of the CRO displays a waveform, as shown.



The time-base is set to $20 \mu\text{s div}^{-1}$.

What is the frequency of the sound wave?

- A** 15 Hz
- B** 15 000 Hz
- C** 20 000 Hz
- D** 30 000 Hz

200. Question | 9702 May-June 2021 P1 V2 Q24

- 24** A person stands at the side of a straight railway track. A train moves towards the person and emits sound from its whistle. The person hears a sound of frequency 1690 Hz as the train approaches him.

The person then hears sound of frequency 1500 Hz as the train moves away from him. The speed of sound in air is 340 m s^{-1} .

What is the speed of the train?

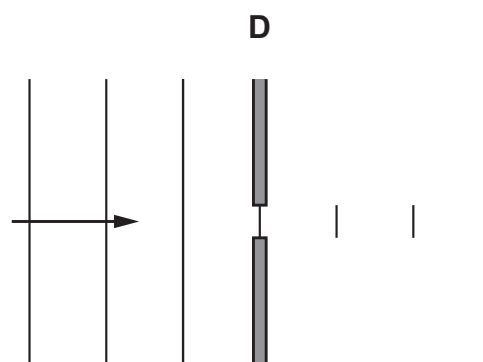
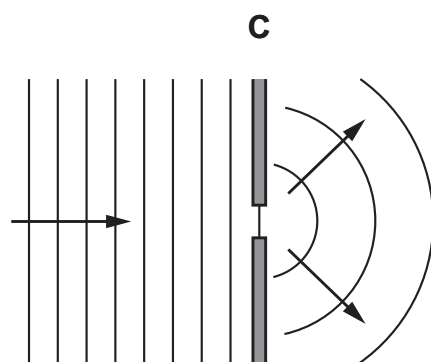
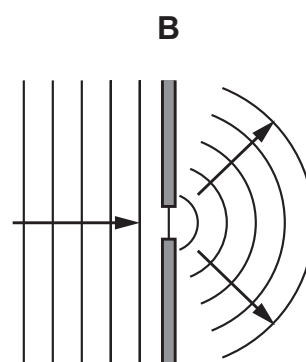
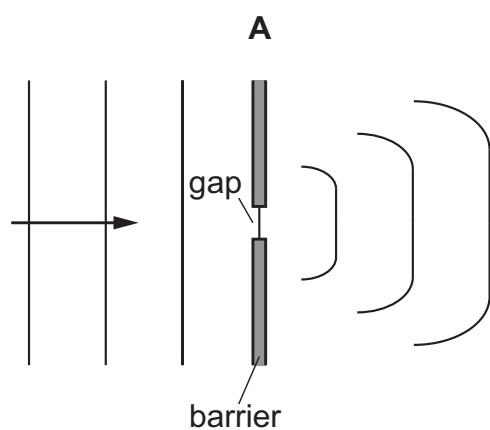
- A** 20 m s^{-1} **B** 38 m s^{-1} **C** 41 m s^{-1} **D** 43 m s^{-1}

201. Question | 9702 May-June 2021 P1 V2 Q25

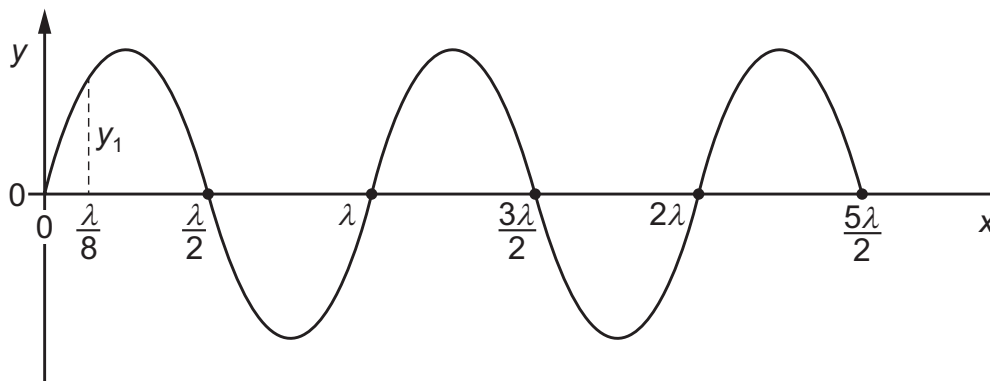
- 25** Which list shows electromagnetic waves in order of decreasing frequency?

- A** gamma-rays → infrared → ultraviolet → radio waves
B gamma-rays → ultraviolet → infrared → radio waves
C radio waves → infrared → ultraviolet → gamma-rays
D radio waves → ultraviolet → infrared → gamma-rays

27 Which diagram best shows how water waves diffract when they pass through a gap in a barrier?



- 22** 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 wave has displacement $+y_1$ at distance $x = \frac{\lambda}{8}$.

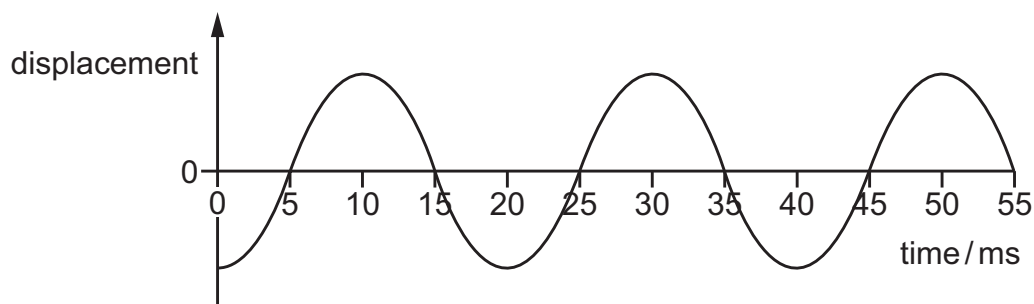


What are the next two values of x where the displacement y is again equal to $+y_1$?

- 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 $\frac{17\lambda}{8}$

204. Question | 9702 May-June 2021 P1 V3 Q23

- 23** The graph shows the variation with time of the displacement of an air particle as a progressive sound wave passes through the air. The speed of sound in air is 330 ms^{-1} .

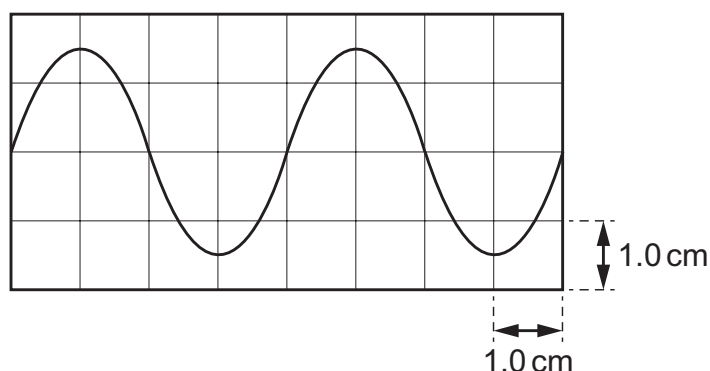


What is the wavelength of the wave?

- A** 6.6 m **B** 8.3 m **C** 20 m **D** 25 m

205. Question | 9702 May-June 2021 P1 V3 Q24

- 24** A microphone is connected to a cathode-ray oscilloscope (CRO). A sound wave of constant frequency is detected by the microphone. The screen of the CRO is shown.



The time-base is set at 1.0 ms cm^{-1} .

What is the frequency of the sound wave?

- A** 250 Hz **B** 500 Hz **C** 670 Hz **D** 4000 Hz

206. Question | 9702 May-June 2021 P1 V3 Q25

- 25** A train's whistle is emitting sound of frequency 500 Hz as the train moves with a speed of 20 m s^{-1} along a straight track. The train moves directly towards a stationary observer standing next to the track and then passes the observer.

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

What is the difference between the frequencies of the sound heard by the observer before and after the train has passed the observer?

- A** 29 Hz **B** 32 Hz **C** 40 Hz **D** 61 Hz

207. Question | 9702 May-June 2021 P1 V3 Q26

- 26** Gamma-rays, microwaves, visible light and X-rays are four regions of the electromagnetic spectrum.

Which list shows these four regions in order of increasing wavelength?

- A** microwaves $\rightarrow$ visible light $\rightarrow$ X-rays $\rightarrow$ gamma-rays
B gamma-rays $\rightarrow$ X-rays $\rightarrow$ visible light $\rightarrow$ microwaves
C X-rays $\rightarrow$ gamma-rays $\rightarrow$ microwaves $\rightarrow$ visible light
D microwaves $\rightarrow$ visible light $\rightarrow$ gamma-rays $\rightarrow$ X-rays

208. Question | 9702 May-June 2021 P1 V3 Q28

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

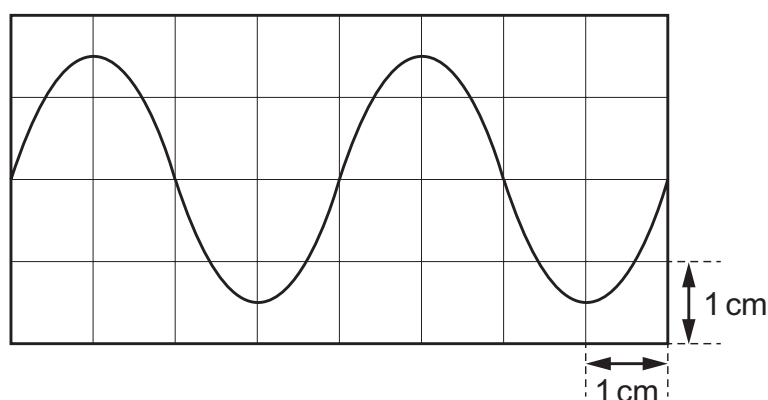
Which size of architectural features in a large concert hall would best diffract sound waves of frequency 0.44 kHz?

- A** 1.3 mm **B** 750 mm **C** 7.5 m **D** 17 m

209. Question | 9702 Oct-Nov 2021 P1 V1 Q4

- 4** A cathode-ray oscilloscope (CRO) is used to display a sound wave of frequency 2000 Hz.

The display of the CRO is shown.



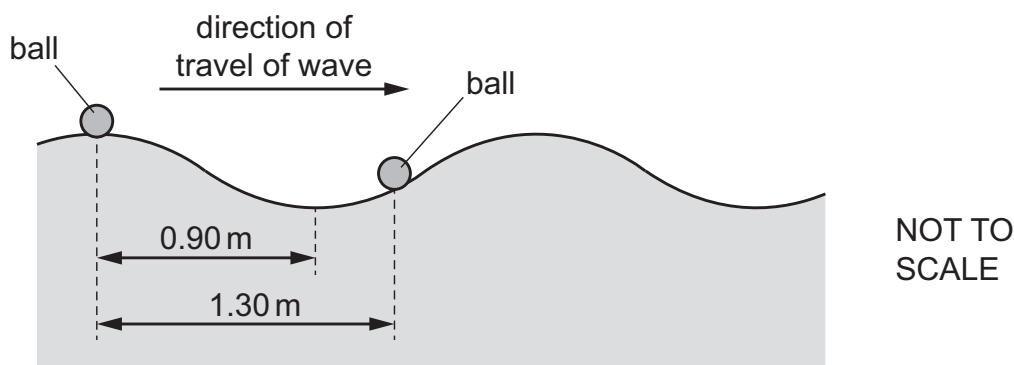
What is the time-base setting on the CRO?

- A** $125 \mu\text{s cm}^{-1}$ **B** $250 \mu\text{s cm}^{-1}$ **C** $500 \mu\text{s cm}^{-1}$ **D** $1000 \mu\text{s cm}^{-1}$

210. Question | 9702 Oct-Nov 2021 P1 V1 Q21

- 21** Two balls float on the surface of the sea. The balls are separated by a distance of 1.30 m.

A wave travels on the surface of the sea so that the balls move vertically up and down.



The distance between a crest and an adjacent trough of the wave is 0.90 m.

What is the phase difference between the two balls?

- A** 55° **B** 110° **C** 160° **D** 260°

211. Question | 9702 Oct-Nov 2021 P1 V1 Q22

22 Which statement about transverse or longitudinal waves is **not** correct?

- A** Longitudinal waves can be used to demonstrate diffraction.
- B** Longitudinal waves can travel in a vacuum.
- C** Transverse waves can form stationary waves.
- D** Transverse waves can transfer energy.

212. Question | 9702 Oct-Nov 2021 P1 V1 Q24

24 With which waves can the Doppler effect be observed?

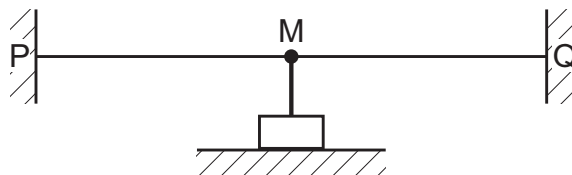
- A** all waves including sound and light
- B** light waves only
- C** sound and light waves only
- D** sound waves only

213. Question | 9702 Oct-Nov 2021 P1 V1 Q25

25 Which radiation could consist of waves of wavelength 0.5 nm?

- A** γ -rays
- B** ultraviolet
- C** visible light
- D** X-rays

- 26** A string is fixed between point P and an oscillator M. Another string is fixed between M and point Q. M is midway between P and Q.



The frequency of the oscillator is adjusted until a stationary wave is formed on both strings. The speed of the wave between P and M is twice the speed of the wave between M and Q.

Which diagram could represent the stationary wave pattern?

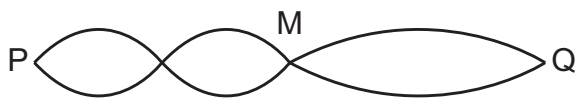
A



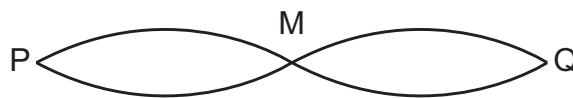
B



C



D



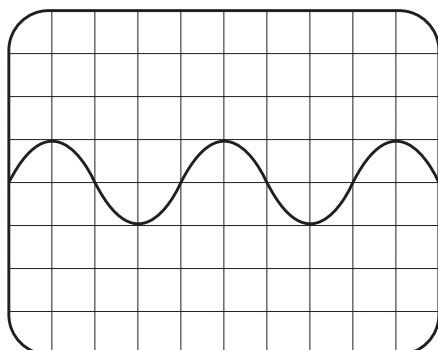
27 A water wave in a ripple tank is diffracted as it passes through a gap in a barrier.

Which two factors affect the angle of diffraction of the wave?

- A** the amplitude and frequency of the incident wave
- B** the amplitude of the incident wave and the width of the gap
- C** the wavelength and amplitude of the incident wave
- D** the wavelength of the incident wave and the width of the gap

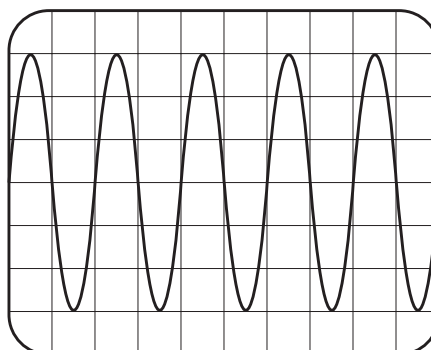
- 4 Four cathode-ray oscilloscope (CRO) screens each display a waveform. The screen and the time-base setting of each CRO is shown.

1



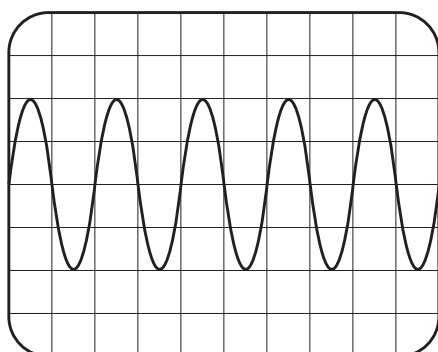
time-base setting: 0.02 s/div

2



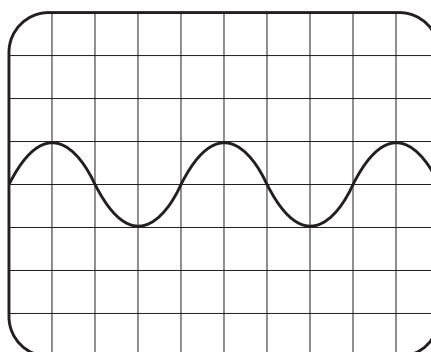
time-base setting: 0.04 s/div

3



time-base setting: 0.01 s/div

4



time-base setting: 0.08 s/div

Which screens show waveforms of the same frequency?

- A** 1 and 2 **B** 1 and 3 **C** 1 and 4 **D** 2 and 3

23 The table contains descriptions and examples of waves.

Which row is correct?

	description of wave	example
A	oscillations are parallel to the direction of energy transfer	gamma-rays
B	oscillations are parallel to the direction of energy transfer	ultraviolet waves
C	oscillations are perpendicular to the direction of energy transfer	sound waves
D	oscillations are perpendicular to the direction of energy transfer	X-rays

25 A train travels in a straight line at a constant speed of 30 m s^{-1} . The train's horn continuously emits sound of frequency 2400 Hz.

A stationary observer stands next to the train track. The train approaches the stationary observer, passes him and then moves away.

The speed of sound is 340 m s^{-1} .

What is the maximum difference in the frequencies of the sound heard by the stationary observer?

- A** 190 Hz **B** 230 Hz **C** 430 Hz **D** 460 Hz

219. Question | 9702 Oct-Nov 2021 P1 V2 Q26

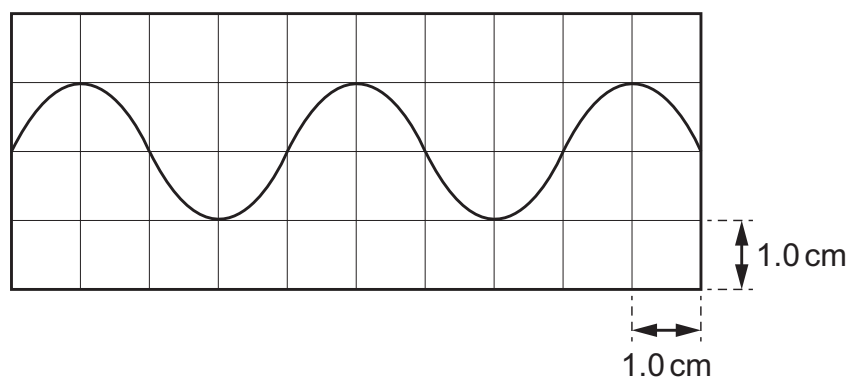
26 Electromagnetic waves of frequency 30 THz are in a vacuum.

In which region of the electromagnetic spectrum are the waves?

- A** infrared
- B** microwave
- C** ultraviolet
- D** visible light

220. Question | 9702 Oct-Nov 2021 P1 V3 Q4

4 The output of a signal generator is connected to a cathode-ray oscilloscope (CRO). A trace is shown on the screen.



The time-base of the CRO is set at 2.00 ms cm^{-1} .

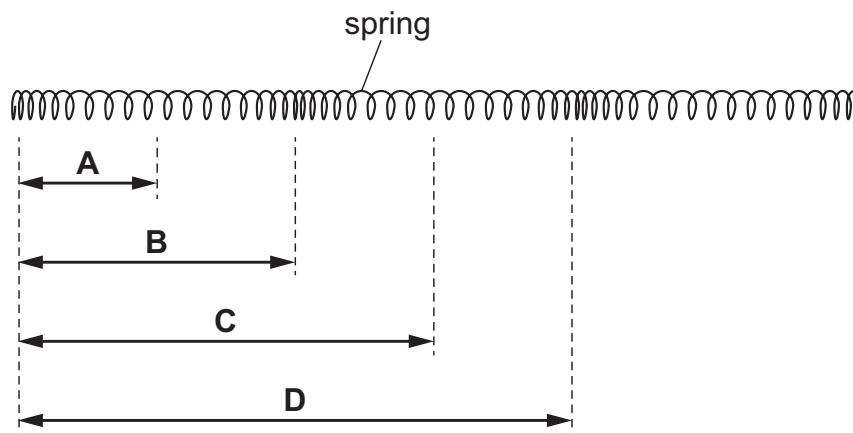
What is the frequency of the signal?

- A** 50 Hz
- B** 125 Hz
- C** 250 Hz
- D** 500 Hz

221. Question | 9702 Oct-Nov 2021 P1 V3 Q22

22 A longitudinal wave travels through a long spring. The spring is shown at one instant.

What is the wavelength of the wave?



222. Question | 9702 Oct-Nov 2021 P1 V3 Q23

23 Which statement about waves is correct?

- A** Both longitudinal and transverse waves can travel through a vacuum.
- B** Both longitudinal and transverse waves transfer matter.
- C** Longitudinal progressive waves consist of alternate nodes and antinodes.
- D** The particles of a transverse wave vibrate perpendicular to the direction of energy propagation.

223. Question | 9702 Oct-Nov 2021 P1 V3 Q24

24 A stationary sound wave is formed in a pipe that is closed at one end and open at the other end. The wave has two antinodes. One of these antinodes is at the open end of the pipe.

The length of the pipe is 0.600 m. The speed of sound in the air column in the pipe is 340 m s^{-1} .

What is the frequency of the sound wave?

- A** 425 Hz **B** 850 Hz **C** 1130 Hz **D** 2270 Hz

224. Question | 9702 Oct-Nov 2021 P1 V3 Q25

25 A train travels at constant speed along a straight track. The train's horn emits sound of frequency 500 Hz.

A person standing by the side of the track hears sound of frequency 450 Hz.

The speed of sound in air is 340 m s^{-1} .

What is the speed of the train and in which direction is it travelling relative to the person?

	speed / ms ⁻¹	direction
A	34	away from the person
B	34	towards the person
C	38	away from the person
D	38	towards the person

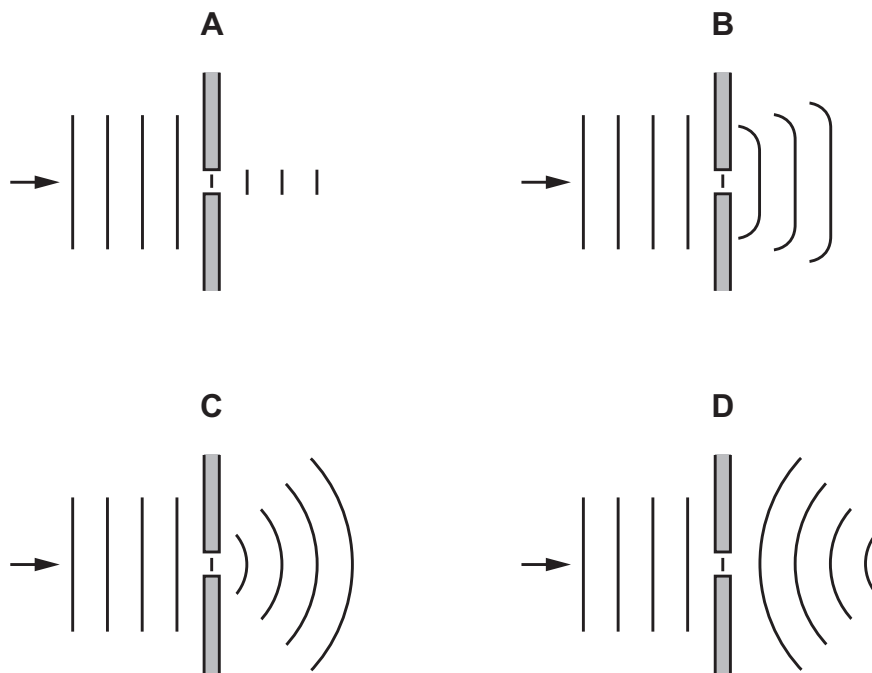
225. Question | 9702 Oct-Nov 2021 P1 V3 Q26

26 A smooth surface has bumps on the surface that are smaller than the wavelength of visible light.

What is the approximate maximum size of the largest bumps on the surface?

A 20 nm **B** 350 nm **C** 720 nm **D** 5.0 μm

28 Which diagram shows the diffraction of water waves in a ripple tank?



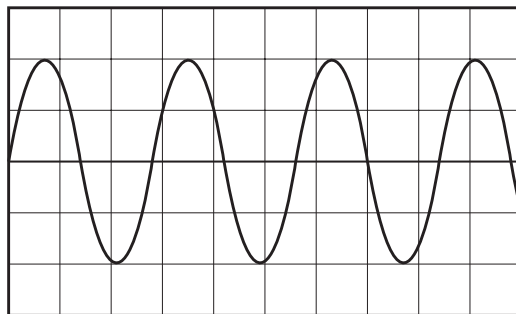
20 Which statement about progressive waves is correct?

- 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.

228. Question | 9702 Feb-March 2022 P1 V2 Q21

- 21** A cathode-ray oscilloscope (CRO) is used to determine the frequency of a sound wave.

The diagram shows the waveform on the screen.



The time-base setting is 5.0 ms div^{-1} .

What is the best estimate of the frequency of the sound wave?

- A** 50 Hz **B** 71 Hz **C** 100 Hz **D** 143 Hz

229. Question | 9702 Feb-March 2022 P1 V2 Q22

- 22** The warning signal on an ambulance has a frequency of 600 Hz. The speed of sound is 330 m s^{-1} . The ambulance is travelling with a constant velocity of 25 m s^{-1} towards an observer. The ambulance passes, and then moves away from the observer with no change in velocity.

initial position
of ambulance



observer



final position
of ambulance



Which overall change in observed frequency takes place between the times at which the ambulance is a long way behind the observer and when it is a long way in front of the observer?

- A** 49 Hz **B** 84 Hz **C** 91 Hz **D** 98 Hz

230. Question | 9702 Feb-March 2022 P1 V2 Q23

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

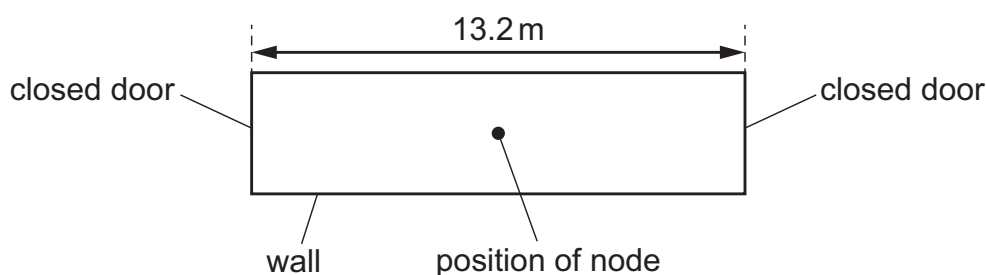
The pulses travel the same distance to reach Mars. Assume that the pulses travel in a vacuum for the full duration of their journey.

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

231. Question | 9702 Feb-March 2022 P1 V2 Q25

- 25** A corridor is 13.2m long and has closed doors that reflect sound at both ends. The speed of sound in the air in the corridor is 330 m s^{-1} .



What is the lowest frequency of sound that could create a stationary wave in the corridor with a node halfway along it?

- A** 0.040 Hz
- B** 13 Hz
- C** 25 Hz
- D** 50 Hz

232. Question | 9702 Feb-March 2022 P1 V2 Q26

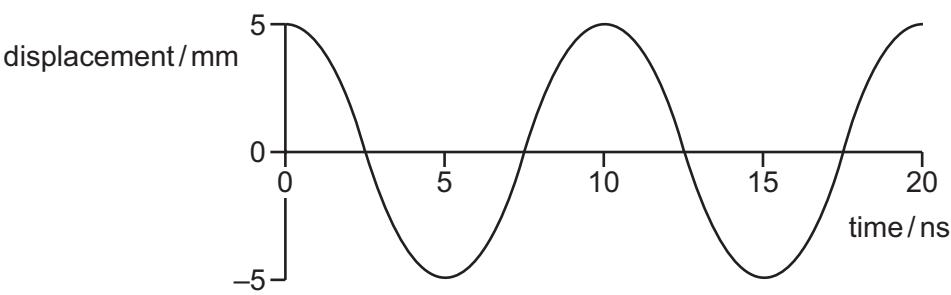
- 26** Water waves of wavelength λ are formed in a ripple tank. The waves are diffracted as they pass through a narrow gap of width d (d is greater than λ).

Which gap width and which wavelength will cause the largest decrease in the amount of diffraction?

	gap width	wavelength
A	$\frac{1}{2}d$	$\frac{1}{2}\lambda$
B	$\frac{1}{2}d$	2λ
C	$2d$	$\frac{1}{2}\lambda$
D	$2d$	2λ

233. Question | 9702 May-June 2022 P1 V1 Q21

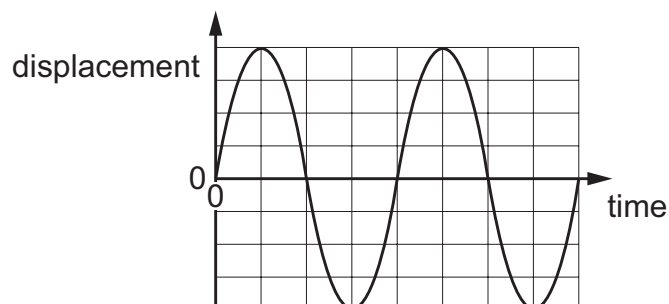
21 The graph shows the variation with time of the displacement of a particle as a progressive wave passes.



What are the frequency and the amplitude of the wave?

	frequency / MHz	amplitude / mm
A	100	5
B	200	5
C	100	10
D	200	10

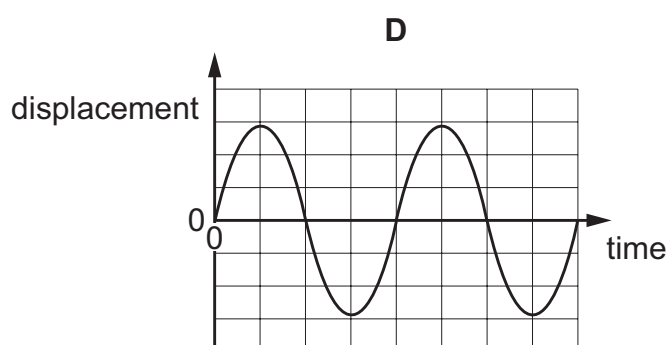
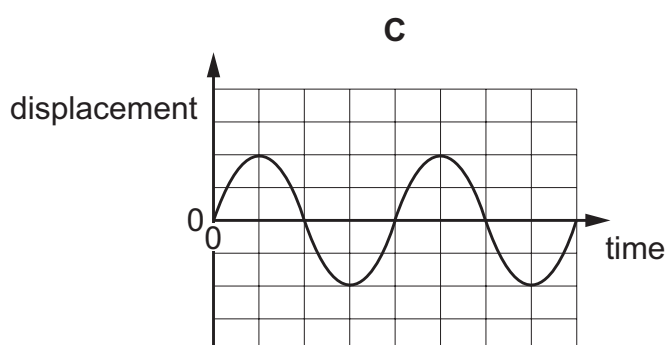
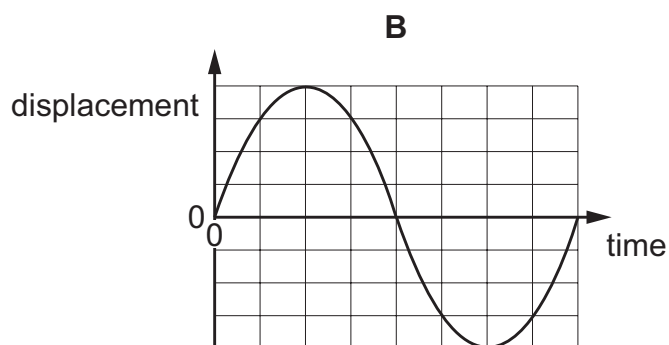
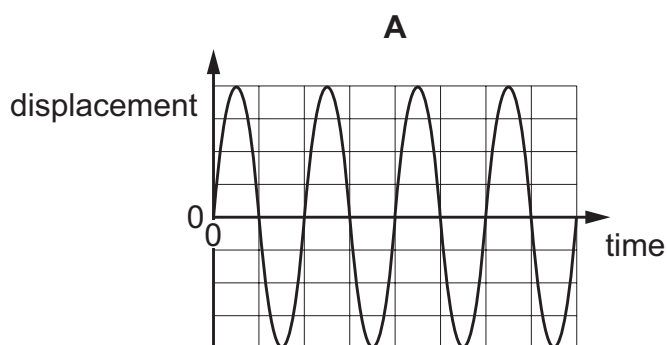
- 22** The graph shows the variation of the displacement of an air particle with time as a sound wave passes through air.



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?



235. Question | 9702 May-June 2022 P1 V1 Q23

23 Which statement is correct?

- A** Gases cannot transmit longitudinal waves.
- B** Longitudinal sound waves cannot form stationary waves.
- C** Solids can transmit both transverse and longitudinal waves.
- D** Transverse waves cannot pass through a vacuum.

236. Question | 9702 May-June 2022 P1 V1 Q24

24 A car is travelling at a constant velocity directly towards a man standing in the middle of the road.

The driver sounds the car's horn as a warning. The horn emits a sound wave of constant frequency.

The frequency of the sound heard by the man is different from the frequency of the sound emitted by the horn.

Which statement is correct?

- A** The frequency of the sound emitted by the horn is greater than the frequency of the sound heard by the man.
- B** The frequency of the sound heard by the man depends on the distance between the car and the man.
- C** The sound waves continually accelerate as they move from the horn to the man.
- D** The wavelength of the sound heard by the man is less than the wavelength of the sound emitted by the horn.

237. Question | 9702 May-June 2022 P1 V1 Q25

25 Which statement about electromagnetic waves is correct?

- A** A wave of wavelength $5.0 \times 10^{-6} \text{ m}$ is invisible to the human eye.
- B** They can all travel at different speeds in free space.
- C** They cannot be polarised.
- D** They consist of vibrating atoms.

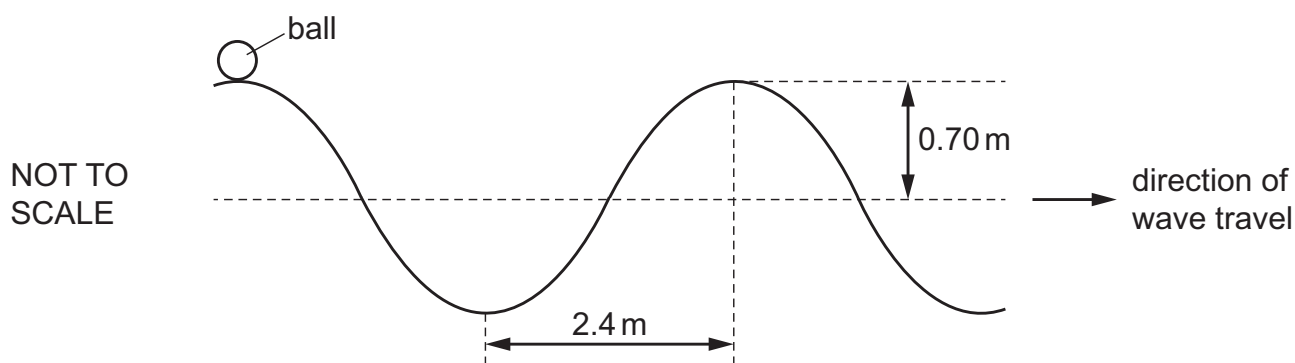
238. Question | 9702 May-June 2022 P1 V2 Q21

21 Which statement is correct for **all** types of progressive wave?

- A** The distance from a peak to the next trough is equal to a wavelength.
- B** They can be demonstrated in ripple tanks.
- C** They consist of vibrating atoms.
- D** They transfer energy from one position to another.

239. Question | 9702 May-June 2022 P1 V2 Q22

22 A transverse water wave is moving along the surface of some water. This causes a ball to move vertically without moving horizontally as it floats upon the surface. At one instant, the ball is at the position shown.



The wave has a frequency of 0.20 Hz and an amplitude of 0.70 m. The distance between a trough and an adjacent peak is 2.4 m.

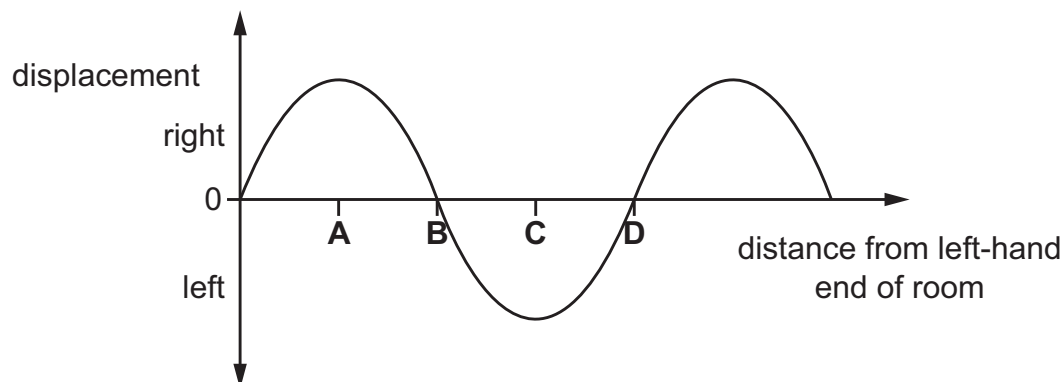
What is the distance travelled by the ball in a time of 20 s?

- A** 5.6 m
- B** 9.6 m
- C** 11.2 m
- D** 19.2 m

240. Question | 9702 May-June 2022 P1 V2 Q23

- 23** A sound wave travels from left to right across a room. The variation with distance across the room of the displacement of the air molecules at one instant is shown.

At which distance will the air pressure be lowest?



241. Question | 9702 May-June 2022 P1 V2 Q24

- 24** A source emits a sound wave of a single frequency. The Doppler effect causes a different frequency of sound to be heard by a stationary observer.

What is a requirement for the Doppler effect to occur?

- A** a source that is moving as it produces the sound wave
- B** a source that produces a polarised sound wave
- C** a source that produces a sound wave of changing amplitude
- D** a source that produces a sound wave of changing frequency

242. Question | 9702 May-June 2022 P1 V2 Q25

- 25** An electromagnetic wave in free space has a frequency of 2.5×10^{14} Hz.

Which region of the electromagnetic spectrum includes this frequency?

- A** infrared
- B** microwave
- C** ultraviolet
- D** X-ray

243. Question | 9702 May-June 2022 P1 V2 Q26

- 26** Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° .

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

- A** zero **B** 2.5 W m^{-2} **C** 2.9 W m^{-2} **D** 6.0 W m^{-2}

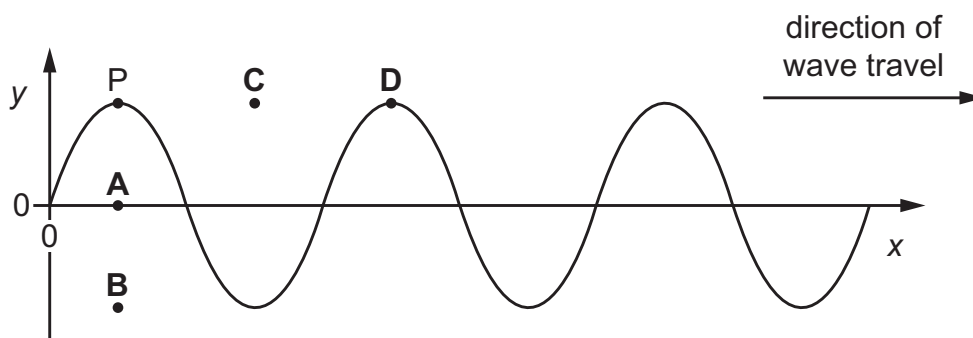
244. Question | 9702 May-June 2022 P1 V3 Q22

- 22** 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 P on the rope is marked. The diagram shows the original position of P and four new positions.

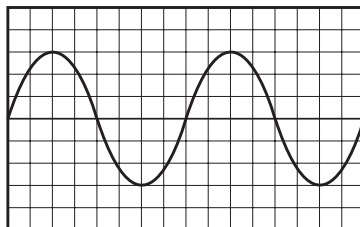
What is the position of P at time $t = 1 \text{ s}$?



245. Question | 9702 May-June 2022 P1 V3 Q23

- 23** A cathode-ray oscilloscope (CRO) is connected to a microphone which detects sound of constant frequency.

The trace on the screen of the CRO is shown.



Which property of the sound wave is measured using **only** information from the CRO?

- A** amplitude
- B** period
- C** speed
- D** wavelength

246. Question | 9702 May-June 2022 P1 V3 Q24

- 24** A transverse wave and a longitudinal wave both travel in the same direction down a long stretched spring.

Which statement is **not** correct for these two forms of wave?

- A** The displacement measurements for the particles of the two waves are made at right angles to each other.
- B** The energy transferred by the two waves is in the same direction.
- C** The velocities of the two waves are in the same direction.
- D** The wavelength measurements for the two waves are made at right angles to each other.

247. Question | 9702 May-June 2022 P1 V3 Q25

- 25** A man standing next to a stationary train hears sound of frequency 400 Hz emitted from the train's horn. The train then moves directly away from the man and sounds its horn when it has a speed of 50 m s^{-1} . The speed of sound in the air is 340 m s^{-1} .

What is the difference in frequency of the sound heard by the man on the two occasions?

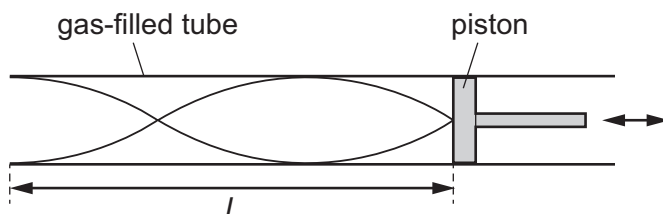
- A** 51 Hz
- B** 69 Hz
- C** 350 Hz
- D** 470 Hz

- 26** Which list of regions of the electromagnetic spectrum is in order of increasing wavelength from left to right?
- A** gamma-ray → ultraviolet → infrared
 - B** infrared → microwave → ultraviolet
 - C** microwave → X-ray → infrared
 - D** X-ray → ultraviolet → gamma-ray

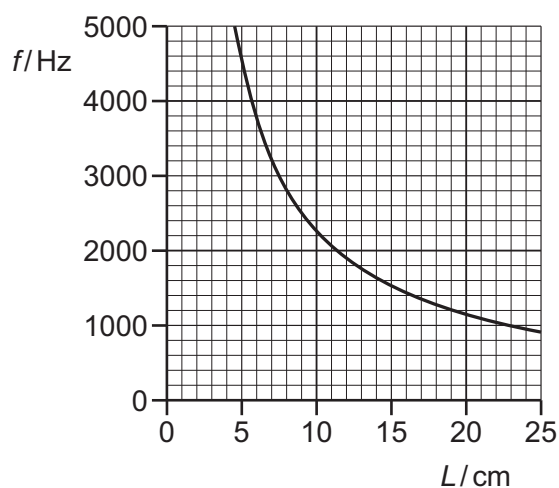
249. Question | 9702 May-June 2022 P1 V3 Q28

- 28** A stationary sound wave is formed in a gas-filled tube of length L , which is closed at one end by a piston. The length of the tube can be altered by moving the piston.

The length of the tube and the frequency of the sound are varied so that the stationary wave always has two antinodes and two nodes, as shown.



The graph shows the variation of the frequency f of the stationary sound wave with the length L of the tube.



What is the speed of sound in the gas in the tube?

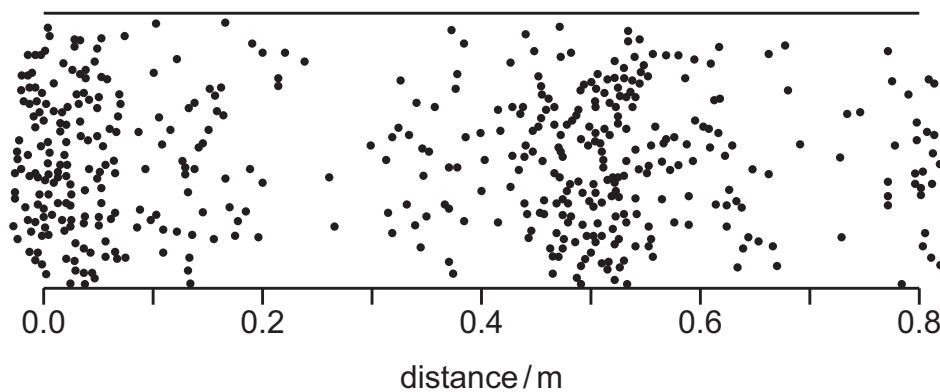
- A** 150 ms^{-1} **B** 230 ms^{-1} **C** 300 ms^{-1} **D** 340 ms^{-1}

- 21** A signal generator, amplifier and loudspeaker are used to produce different sound waves in the air of a room. The relationships between the properties of these waves are investigated.

Which relationship is **not** correct?

- A** Amplitude is proportional to wavelength.
- B** Frequency is inversely proportional to wavelength.
- C** Intensity is proportional to amplitude squared at a given frequency.
- D** Period is equal to the reciprocal of frequency.

22 When a guitar string is plucked, it causes a longitudinal sound wave in the air, as shown.



The speed of sound in the air is 340 m s^{-1} .

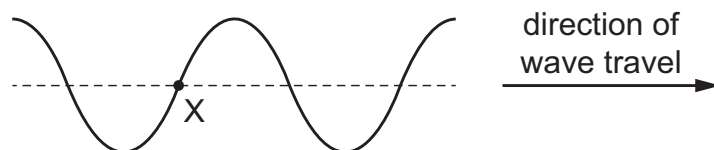
What is the approximate frequency of the sound wave shown?

- A** 430 Hz **B** 680 Hz **C** 1100 Hz **D** 1400 Hz

252. Question | 9702 Oct-Nov 2022 P1 V1 Q23

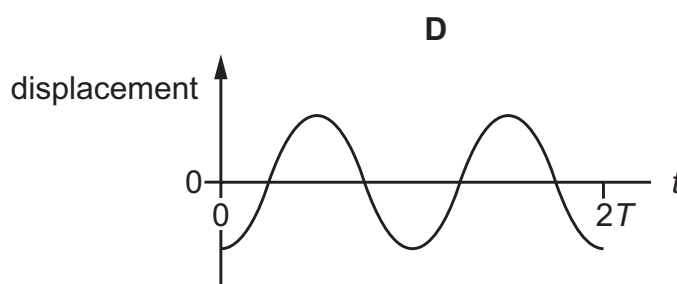
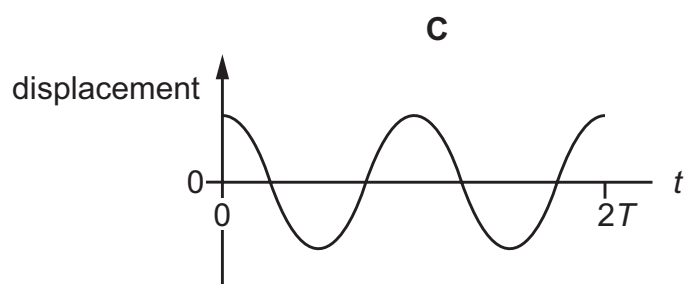
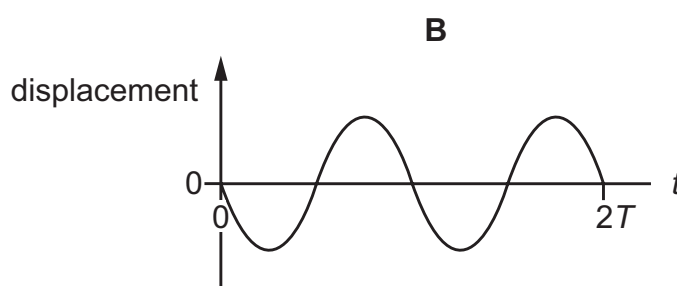
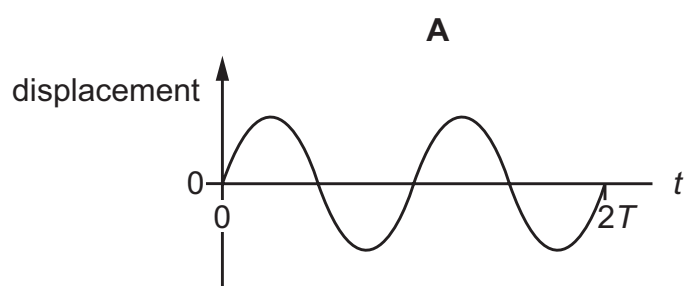
23 A transverse wave travels along a rope. The diagram shows the rope at time $t = 0$.

The wave is travelling from left to right. The period of the wave is T .



One particle of the rope is labelled X.

Which graph shows the variation with time of the displacement of particle X between $t = 0$ and $t = 2T$?



253. Question | 9702 Oct-Nov 2022 P1 V1 Q24

24 A jet aircraft travels at a speed of $0.80v$, where v is the speed of sound. The aircraft directly approaches a stationary observer. The frequency of sound emitted by the aircraft is 100 Hz.

Which frequency does the observer hear?

- A** 56 Hz **B** 180 Hz **C** 400 Hz **D** 500 Hz

254. Question | 9702 Oct-Nov 2022 P1 V1 Q25

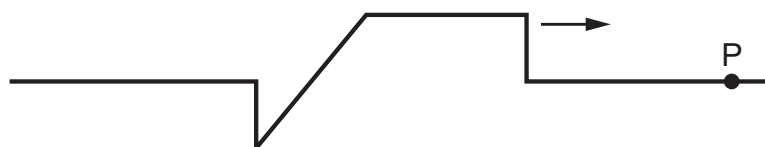
25 A telescope detects and analyses some electromagnetic radiation of wavelength 2 cm.

Which type of telescope is it?

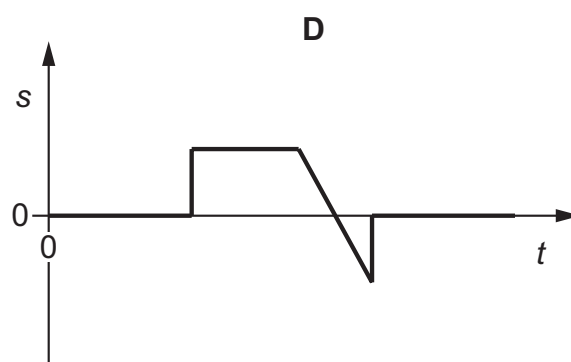
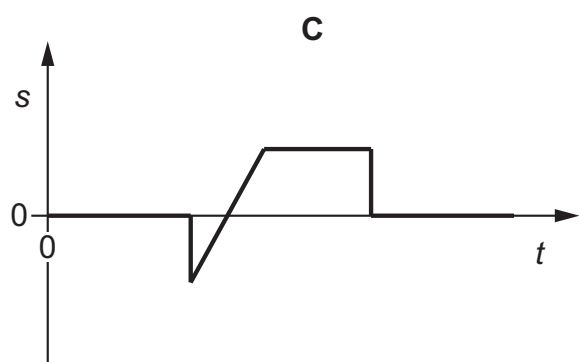
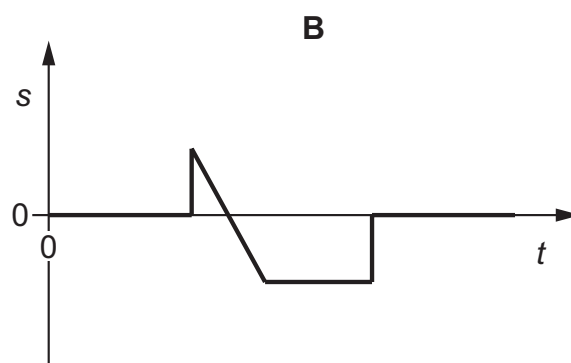
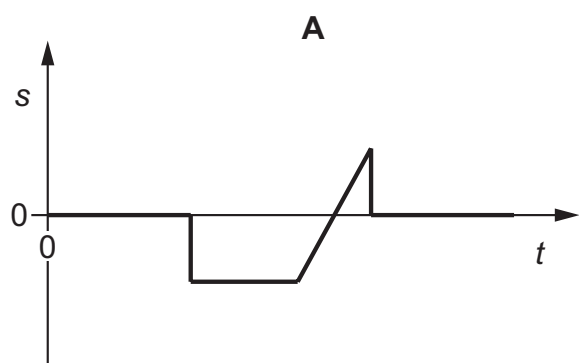
- A** microwave telescope
- B** optical telescope
- C** radio telescope
- D** X-ray telescope

255. Question | 9702 Oct-Nov 2022 P1 V2 Q22

22 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?



256. Question | 9702 Oct-Nov 2022 P1 V2 Q23

- 23** Which statement about progressive transverse and longitudinal waves is correct?
- A** Particles in a transverse wave have fixed equilibrium positions but those in longitudinal waves do not.
 - B** Transverse waves can be polarised but longitudinal waves cannot.
 - C** Transverse waves transfer energy but longitudinal waves do not.
 - D** Two-source interference can be demonstrated with transverse waves but not with longitudinal waves.

257. Question | 9702 Oct-Nov 2022 P1 V2 Q24

- 24** A miniature loudspeaker, initially at rest, falls vertically from a window in a high building. When the speaker has fallen a distance of 10.0 m, it emits a very short pulse of sound of constant frequency 256 Hz in all directions. The pulse of sound, travelling at a speed of 330 m s^{-1} , is heard by a person leaning out of the window.

Air resistance is negligible.

What is the frequency of the pulse of sound heard by the person?

- A** 246 Hz **B** 249 Hz **C** 267 Hz **D** 313 Hz

25 Two electromagnetic waves have wavelengths of $5.0 \times 10^{-7} \text{ m}$ and $5.0 \times 10^{-2} \text{ m}$ in a vacuum.

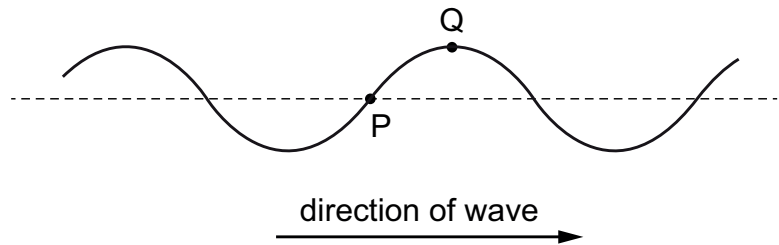
Which row identifies the regions of the electromagnetic spectrum to which the waves belong?

	wavelength $5.0 \times 10^{-7} \text{ m}$	wavelength $5.0 \times 10^{-2} \text{ m}$
A	ultraviolet	infrared
B	visible	microwave
C	ultraviolet	microwave
D	visible	infrared

259. Question | 9702 Oct-Nov 2022 P1 V3 Q21

21 The diagram shows a transverse wave on a rope. The wave is travelling from left to right.

At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.



Which row describes the direction of motion, if any, of the points P and Q at this instant?

	point P	point Q
A	downwards	stationary
B	stationary	downwards
C	stationary	upwards
D	upwards	stationary

260. Question | 9702 Oct-Nov 2022 P1 V3 Q22

22 The period of an electromagnetic wave in a vacuum is 1.0 ns.

What are the frequency and wavelength of the wave?

	frequency / Hz	wavelength / m
A	1.0	3.0×10^8
B	1.0×10^6	300
C	1.0×10^9	0.30
D	1.0×10^{12}	3.0×10^{-4}

261. Question | 9702 Oct-Nov 2022 P1 V3 Q23

- 23** An observer is standing on a railway platform. A train passes the observer at constant speed while emitting sound of constant frequency f from its whistle.

What does the observer hear?

- A** sound of a decreasing frequency as the train approaches and of an increasing frequency as it moves away
- B** sound of a higher frequency than f as the train approaches and of a lower frequency than f as the train moves away
- C** sound of a lower frequency than f as the train approaches and of a higher frequency than f as the train moves away
- D** sound of an increasing frequency as the train approaches and as it moves away

262. Question | 9702 Oct-Nov 2022 P1 V3 Q24

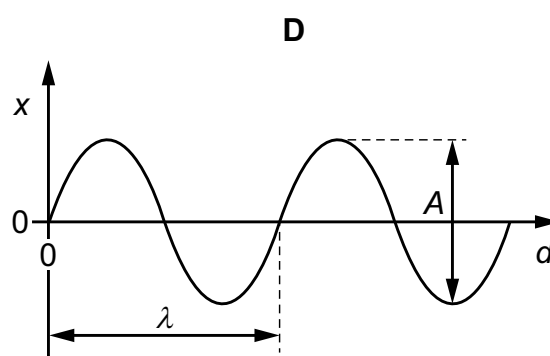
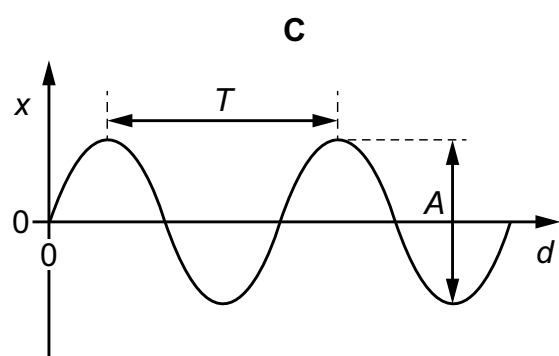
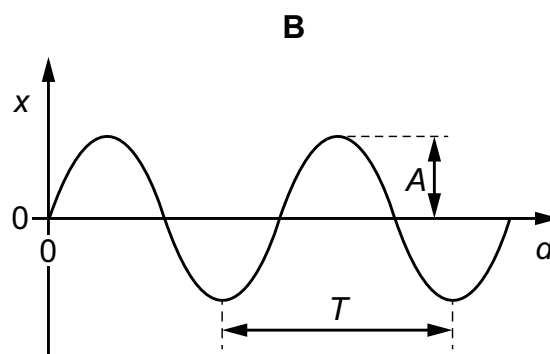
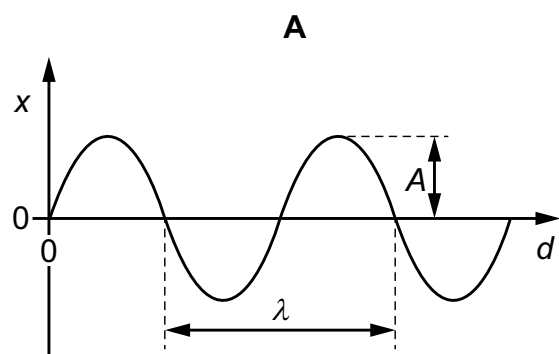
- 24** Which microorganisms have a length that is equal to the wavelength in free space of an electromagnetic wave that is visible to the human eye?

- A** algae of length $0.5\ \mu\text{m}$
- B** bacteria of length $5.0\ \mu\text{m}$
- C** fungi of length $50\ \mu\text{m}$
- D** protozoa of length $100\ \mu\text{m}$

263. Question | 9702 Specimen 2022 P1 Q21

- 21** A wave has period T , wavelength λ and amplitude A . The wave is shown on a graph of displacement x against distance d .

Which graph is correctly labelled?



264. Question | 9702 Specimen 2022 P1 Q22

- 22** A vehicle emits sound of a constant frequency. A stationary observer hears the sound.

The vehicle moves directly towards the observer at constant speed. The observer hears sound of frequency f_o .

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

What is the variation in the frequency of the sound that is heard 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 .

265. Question | 9702 Specimen 2022 P1 Q23

- 23** A car travelling in a straight line at a speed of 30 ms^{-1} passes near a stationary observer while sounding its horn. The frequency of sound emitted by the horn is 400 Hz .

The speed of sound in air is 336 ms^{-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

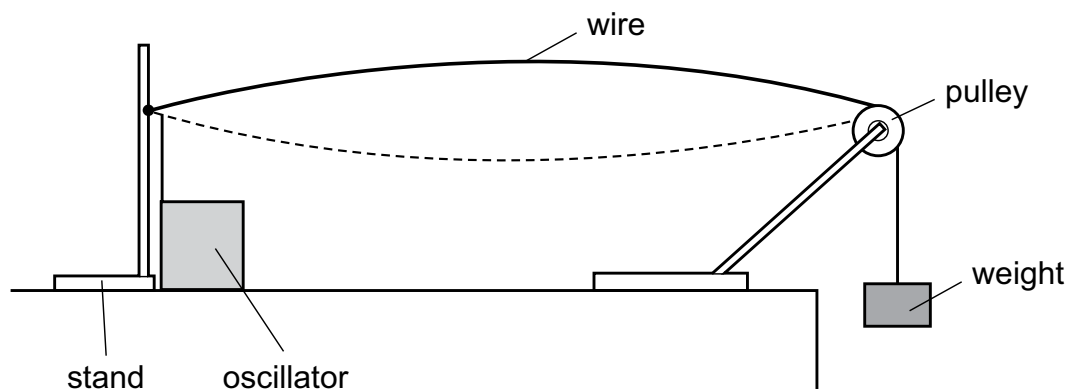
266. Question | 9702 Specimen 2022 P1 Q24

- 24** Which list shows electromagnetic waves in order of increasing frequency?

- A** radio waves $\rightarrow$ gamma-rays $\rightarrow$ ultraviolet $\rightarrow$ infrared
B radio waves $\rightarrow$ infrared $\rightarrow$ ultraviolet $\rightarrow$ gamma-rays
C ultraviolet $\rightarrow$ gamma-rays $\rightarrow$ radio waves $\rightarrow$ infrared
D ultraviolet $\rightarrow$ infrared $\rightarrow$ radio waves $\rightarrow$ gamma-rays

267. Question | 9702 Specimen 2022 P1 Q25

- 25** The diagram shows a steel wire fixed at one end. The other end is attached to a weight hanging over a pulley.



An oscillator is attached to the wire near the fixed end. A stationary wave with one loop is produced. The frequency of the oscillator is f .

Which frequency of the oscillator produces a stationary wave with two loops?

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

268. Question | 9702 Specimen 2022 P1 Q26

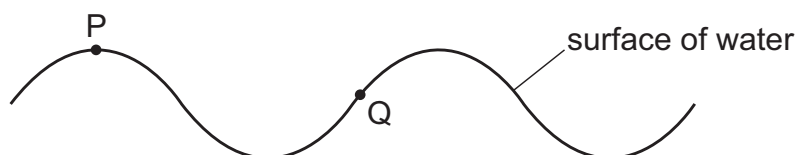
26 Which statement gives a condition that enables diffraction to occur?

- A** A source of waves moves towards a stationary observer.
- B** A wave is partially blocked by an obstacle.
- C** Two coherent waves are superposed.
- D** Two waves are travelling through the same part of a medium in opposite directions.

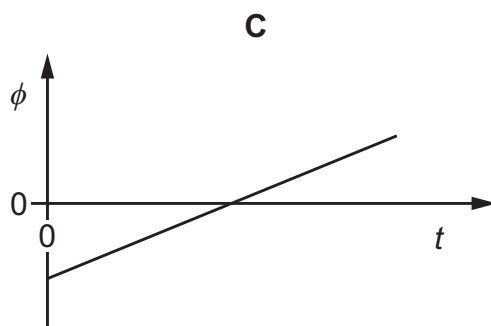
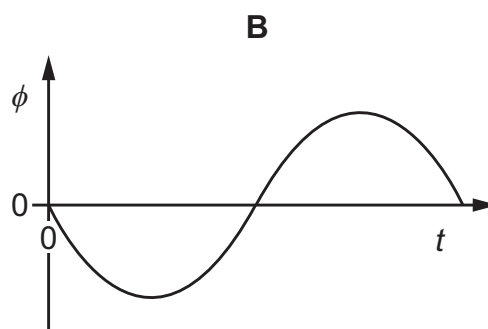
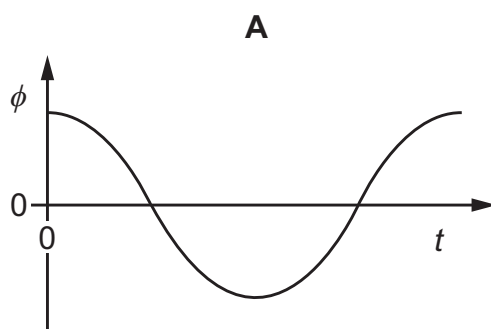
269. Question | 9702 Feb-March 2023 P1 V2 Q20

20 In a progressive water wave, two particles, P and Q, on the surface of the water, are a fixed horizontal distance apart. P and Q oscillate vertically.

At time $t = 0$, the wave is as shown.



Which graph best represents the variation with time t of the phase difference ϕ between the oscillation of the water particle P and the oscillation of the water particle Q?



270. Question | 9702 Feb-March 2023 P1 V2 Q21

21 Which statement about longitudinal waves and transverse waves is **not** correct?

- A** Both waves can be polarised.
- B** Both waves can form stationary waves.
- C** Both waves can transfer energy as progressive waves.
- D** Both waves obey the equation $v = f\lambda$.

271. Question | 9702 Feb-March 2023 P1 V2 Q22

22 An observer hears a sound wave emitted from a moving source.

The observed frequency is less than the frequency of sound emitted from the source.

What could be the reason for this?

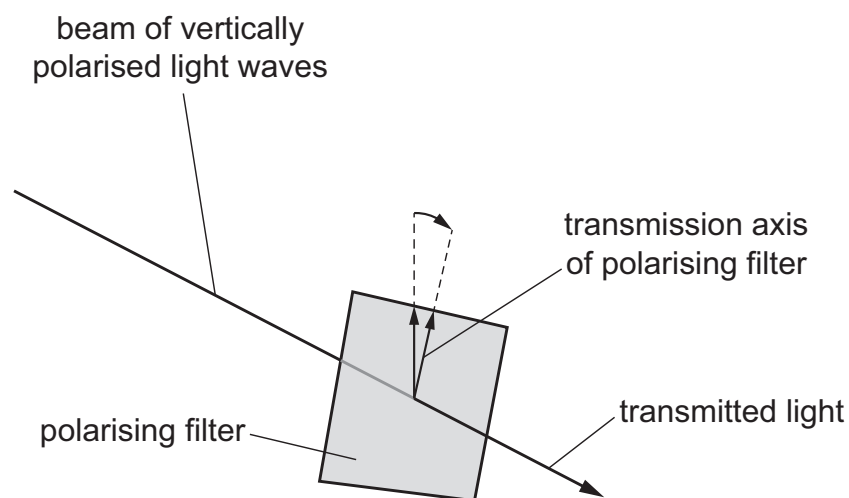
- A** The source is moving away from the observer.
- B** The source is moving towards the observer.
- C** The speed of the sound wave in air decreases due to the movement of the source.
- D** The speed of the sound wave in air increases due to the movement of the source.

272. Question | 9702 Feb-March 2023 P1 V2 Q23

23 What is the approximate range of frequencies of electromagnetic radiation visible to the human eye?

- A** (430–750) kHz
- B** (430–750) MHz
- C** (430–750) GHz
- D** (430–750) THz

- 24** 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.

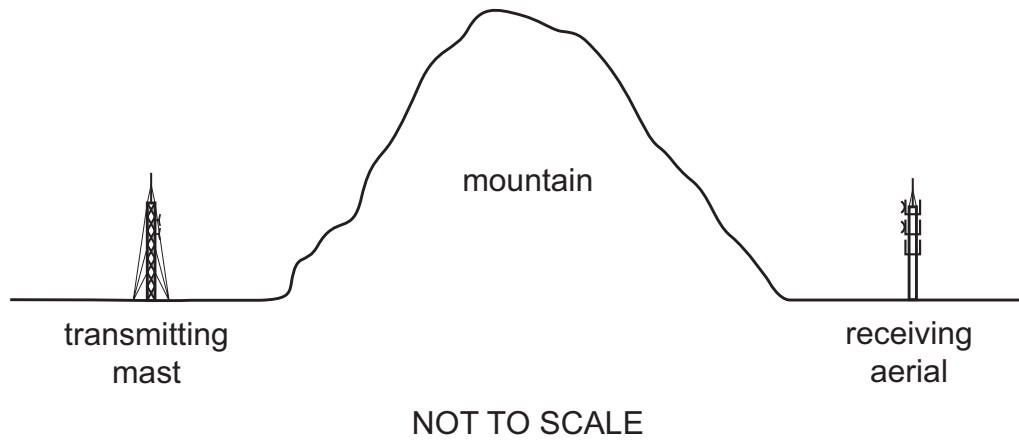


The filter is first rotated clockwise by an angle of 30° so that the transmitted light waves have intensity I_{30} . The filter is then rotated clockwise by a further angle of 30° .

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** $0.87 I_{30}$

- 27** A transmitting mast sends out microwaves of wavelength 1.5 cm and radio waves of wavelength 1.5 km.

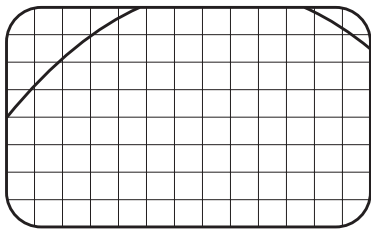


A receiving aerial behind a mountain can detect the radio waves but not the microwaves.

What is the reason for this?

- A** The radio waves are coherent but the microwaves are not.
- B** The radio waves are diffracted around the mountain but the microwaves are not.
- C** The radio waves are reflected by the mountain but the microwaves are not.
- D** The radio waves travel at the speed of light but the microwaves do not.

20 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.

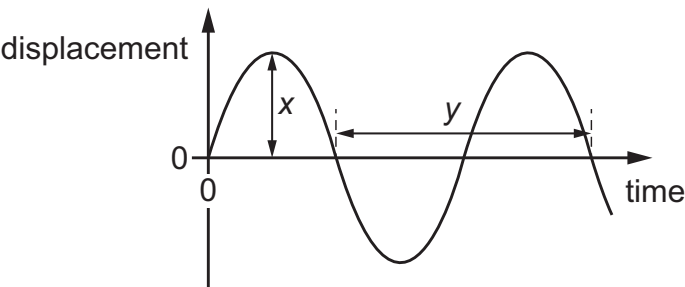


The student is expecting a sinusoidal waveform to be shown on the screen.

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

21 The graph shows the variation with time of the displacement of a particle in a progressive wave.



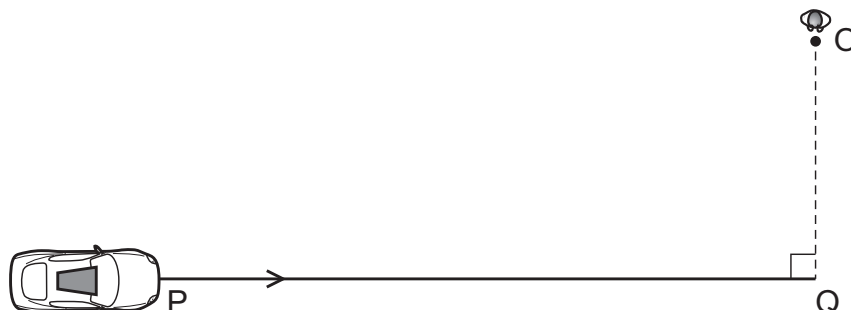
Two measurements, x and y , are labelled on the graph.

What do x and y represent?

	x	y
A	amplitude	period
B	frequency	period
C	amplitude	wavelength
D	frequency	wavelength

22 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

23 Some sources of electromagnetic waves in free space are listed.

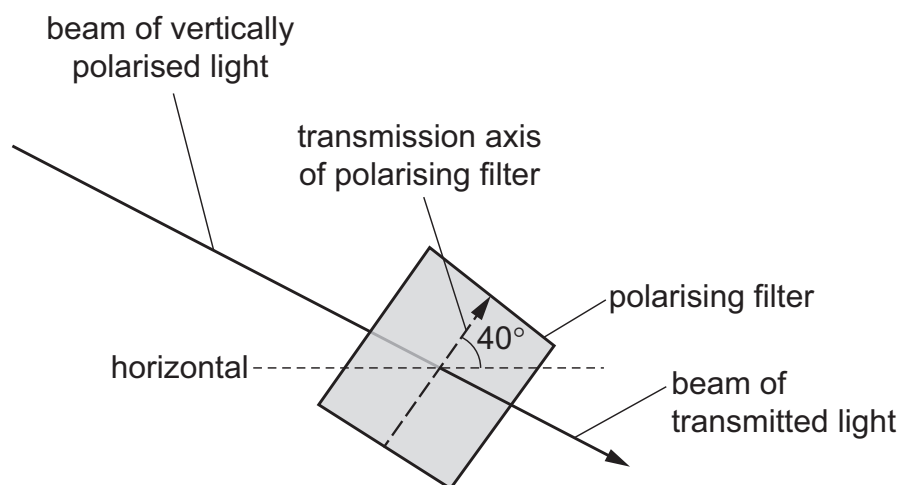
- 1 a radio wave transmitter
- 2 a source of X-rays
- 3 a 30 mm wavelength radar transmitter
- 4 a light-emitting diode that emits red light

Which list gives the sources in order of increasing wavelength, from left to right, of the waves emitted by the sources?

- A** 1 → 3 → 4 → 2
- B** 2 → 4 → 1 → 3
- C** 2 → 4 → 3 → 1
- D** 3 → 1 → 4 → 2

279. Question | 9702 May-June 2023 P1 V1 Q24

- 24** 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.

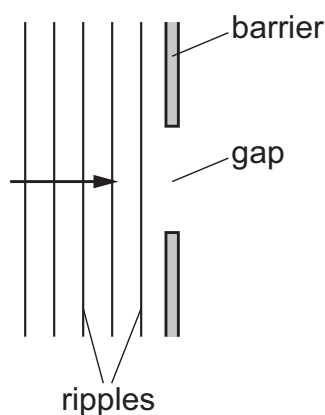


What is the ratio $\frac{\text{amplitude of transmitted beam}}{\text{amplitude of incident beam}}$?

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

280. Question | 9702 May-June 2023 P1 V1 Q27

- 27** A ripple tank and a barrier with a single gap are used to demonstrate the diffraction of surface ripples on water. Initially, the wavelength of the ripples is five times smaller than the gap in the barrier.



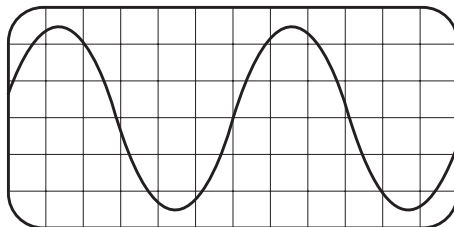
Which change increases the amount of diffraction observed?

- A** double the amplitude of the ripples
B double the width of the gap
C halve the frequency of the ripples
D halve the wavelength of the ripples

281. Question | 9702 May-June 2023 P1 V2 Q20

- 20** A microphone detects a sound wave. The microphone is connected to a cathode-ray oscilloscope (CRO).

The shape of the trace on the screen of the CRO is shown.



Which property of the sound wave can be determined by using only the measurement of a horizontal distance on the screen and the value of a control setting of the CRO?

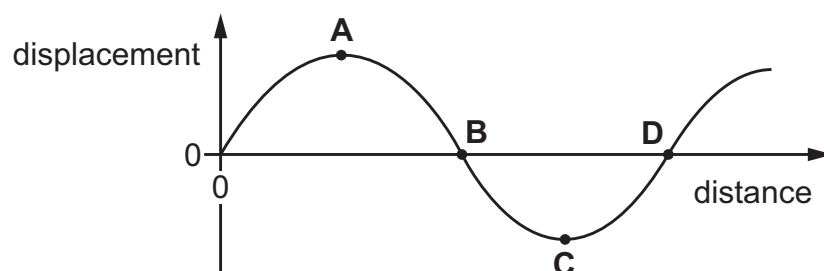
- A** amplitude
- B** frequency
- C** speed
- D** wavelength

282. Question | 9702 May-June 2023 P1 V2 Q21

- 21** A longitudinal wave is travelling from left to right. The graph shows the variation of the displacement of the particles with distance along the wave at one instant in time.

Displacements to the right are positive; displacements to the left are negative.

Which labelled point represents a compression?



283. Question | 9702 May-June 2023 P1 V2 Q22

22 A source X emits a sound wave of constant frequency f .

The wave is subsequently received at a stationary detector Y.

The frequency of the wave that is detected by Y is less than f .

What could be the reason for this?

- A** Between X and Y, the wave undergoes diffraction.
- B** Between X and Y, the wave undergoes reflection.
- C** X is moving away from Y.
- D** X is moving towards Y.

284. Question | 9702 May-June 2023 P1 V2 Q23

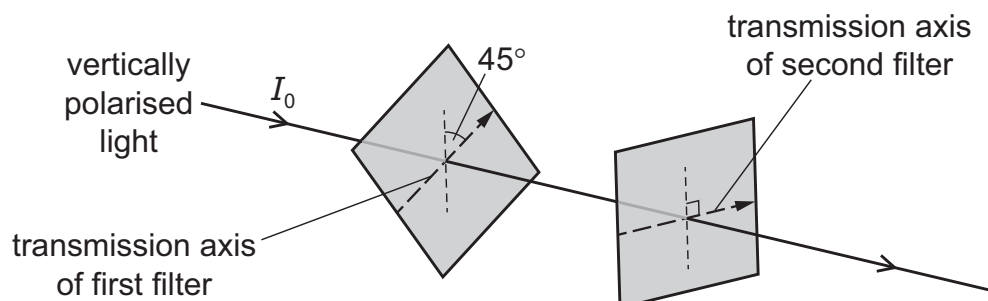
23 A beam of visible light is in a vacuum.

What could be the frequency of the light?

- A** $5.0 \times 10^5 \text{ Hz}$ **B** $5.0 \times 10^8 \text{ Hz}$ **C** $5.0 \times 10^{11} \text{ Hz}$ **D** $5.0 \times 10^{14} \text{ Hz}$

24 A vertically polarised beam of light of intensity I_0 is incident normally on a polarising filter.

The transmission axis of the filter is at 45° to the vertical. The beam of light transmitted by this filter is then incident normally on a second filter. The transmission axis of the second filter is horizontal.



What is the intensity of the beam of light after transmission through the second filter?

A 0

B $\frac{1}{4} I_0$

C $\frac{1}{2} I_0$

D I_0

- 27** A continuous progressive water wave in a ripple tank passes through a gap in a barrier and diffracts.

The width of the gap is greater than the wavelength of the wave.

Which change causes the wave to spread over a larger angle as it passes through the gap?

- A** a small decrease in the wavelength of the wave
- B** a small decrease in the width of the gap
- C** a small increase in the frequency of the wave
- D** a small increase in the height of the barrier

20 A progressive wave of frequency 1.5 kHz travels in a medium at a speed of 340 m s^{-1} .

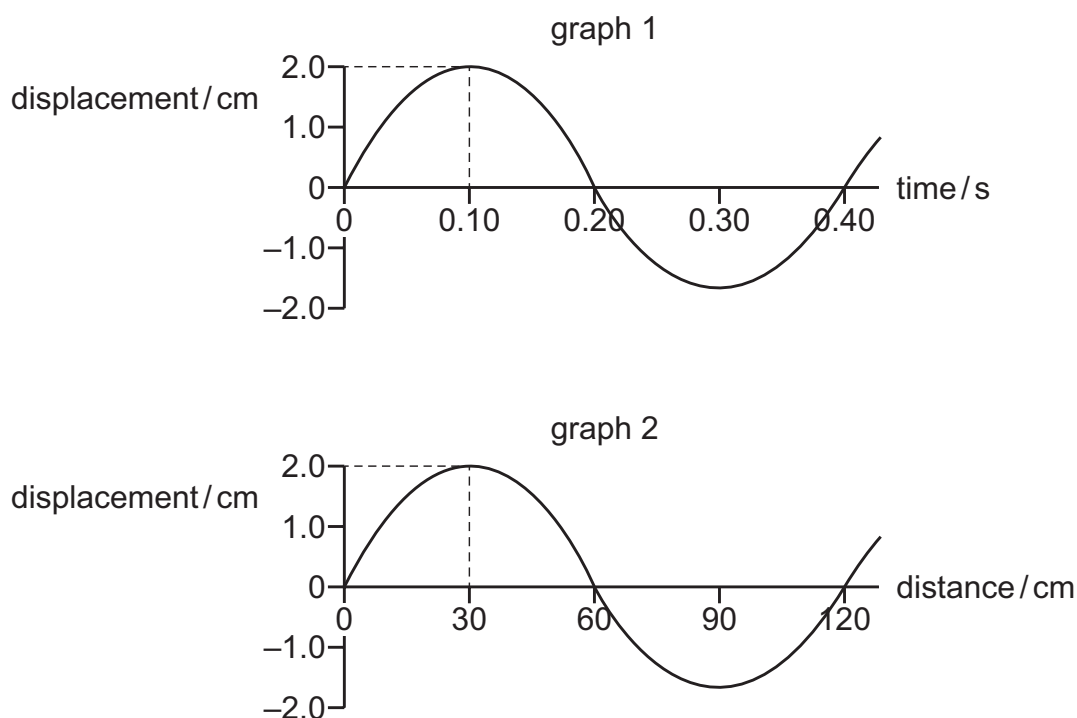
What is the minimum distance between two points on the wave that have a phase difference of 70° ?

- A** 4.4 cm **B** 8.8 cm **C** 18 cm **D** 23 cm

288. Question | 9702 May-June 2023 P1 V3 Q21

- 21** Graph 1 shows the variation with time of displacement at a fixed distance along a progressive wave.

Graph 2 represents the same wave and shows the variation with distance of displacement at an instant in time.



What is the speed of the wave?

- A** 5.0 cm s^{-1} **B** 48 cm s^{-1} **C** 150 cm s^{-1} **D** 300 cm s^{-1}

289. Question | 9702 May-June 2023 P1 V3 Q22

- 22** A vehicle moves with constant velocity along a road directly towards an observer. The observed frequency of the sound from the vehicle changes as the vehicle moves past the observer.

Which phenomenon explains the change in frequency?

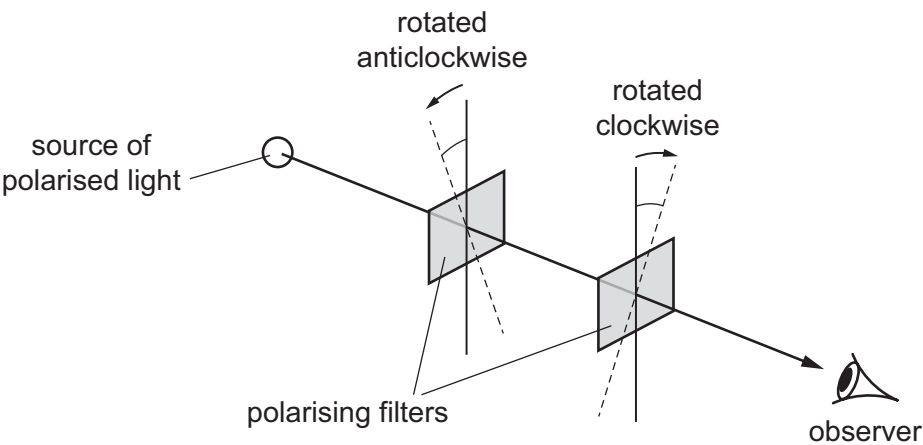
- A** diffraction
B interference
C polarisation
D the Doppler effect

23 An electromagnetic wave has a wavelength of 2.1 cm in a vacuum.

Which region of the electromagnetic spectrum contains this wave?

- A** infrared
- B** microwave
- C** radio wave
- D** visible light

24 A source of plane polarised light is observed through two polarising filters.

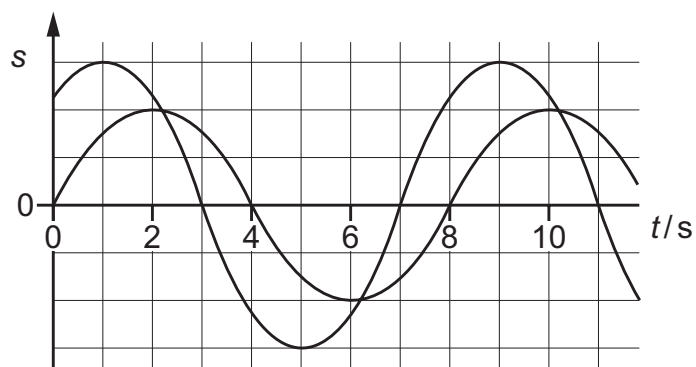


The filters are positioned so that the source appears at its brightest. One of the filters is then rotated clockwise and the other filter is rotated anticlockwise through the same angle.

How does the source appear when both filters have been rotated 90° and 180° from their initial positions?

	90°	180°
A	brightest	brightest
B	brightest	darkest
C	darkest	brightest
D	darkest	darkest

- 20** Two waves pass through a point P. The graph shows the variation with time t of the displacement s of the two waves at point P.



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

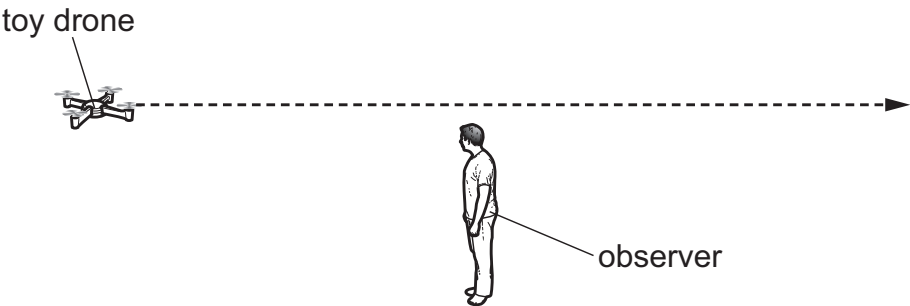
- A** 0° **B** 45° **C** 90° **D** 180°

21 Which row is correct for both progressive transverse waves and progressive longitudinal waves?

	transverse waves	longitudinal waves
A	contain compressions and rarefactions	some can travel in a vacuum
B	can be polarised	contain compressions and rarefactions
C	vibrations are perpendicular to the direction of travel of the wave energy	can be polarised
D	some can travel in a vacuum	vibrations are perpendicular to the direction of travel of the wave energy

22 A toy drone emits a sound of constant frequency 800 Hz. The speed of the sound in the air is 330 m s^{-1} .

The drone moves along a straight path directly towards an observer and then continues in a straight line directly away from the observer. The speed of the drone is constant.



What is the velocity of the drone when the frequency of the sound heard by the observer is 850 Hz?

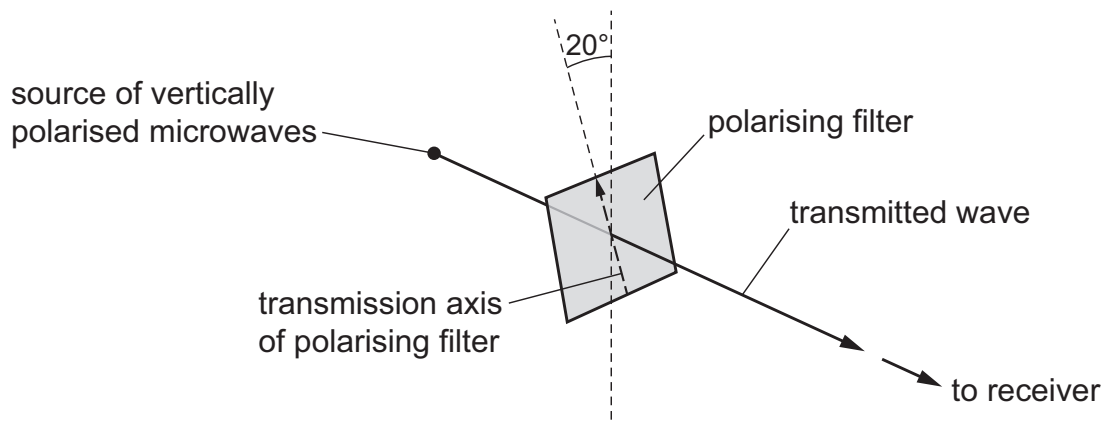
	magnitude of velocity / m s^{-1}	direction of velocity
A	19	away from the observer
B	21	away from the observer
C	19	towards the observer
D	21	towards the observer

- 23** Which statement about electromagnetic waves in a vacuum is correct?
- A** Infrared waves have shorter wavelengths than visible light waves.
 - B** Microwaves have longer wavelengths than radio waves.
 - C** Ultraviolet waves have higher frequencies than visible light waves.
 - D** γ -rays have lower frequencies than X-rays.

296. Question | 9702 Oct-Nov 2023 P1 V1 Q24

- 24** Vertically polarised microwaves are emitted from a source. The microwaves are detected by a receiver that is connected to a cathode-ray oscilloscope (CRO). The waveform displayed on the screen of the CRO has an amplitude of 2.6 cm.

A metal wire grid that acts as a polarising filter is now placed between the source and the receiver. The filter is orientated so that the plane of polarisation of the transmitted wave is at an angle of 20° to the vertical.



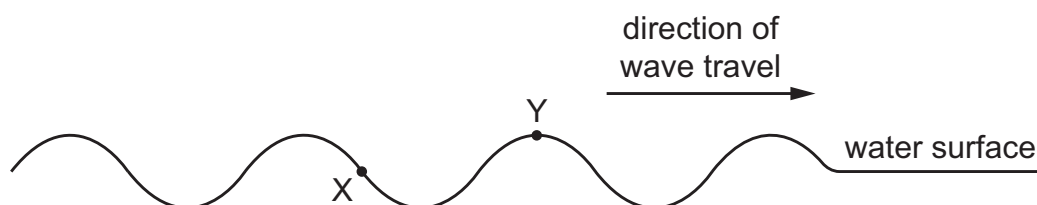
The distance between the source and receiver is unchanged. The settings on the CRO are also unchanged.

What is now the amplitude of the waveform displayed on the screen of the CRO?

- A** 0.30 cm **B** 0.89 cm **C** 2.3 cm **D** 2.4 cm

297. Question | 9702 Oct-Nov 2023 P1 V2 Q20

- 20** X and Y are two points on the surface of water in a ripple tank. A source of constant frequency generates a wave which travels past X and Y, causing them to oscillate vertically.

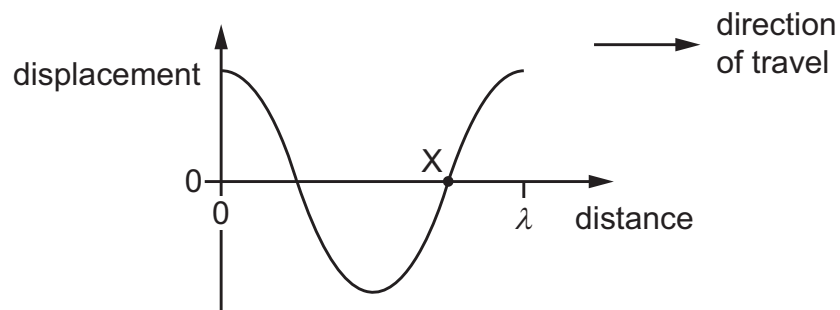


What is the phase difference between X and Y?

- A** 45° **B** 135° **C** 180° **D** 270°

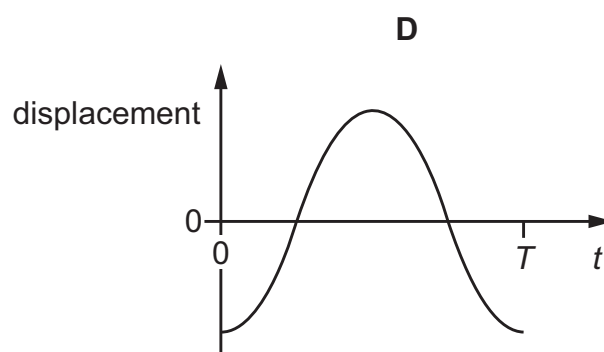
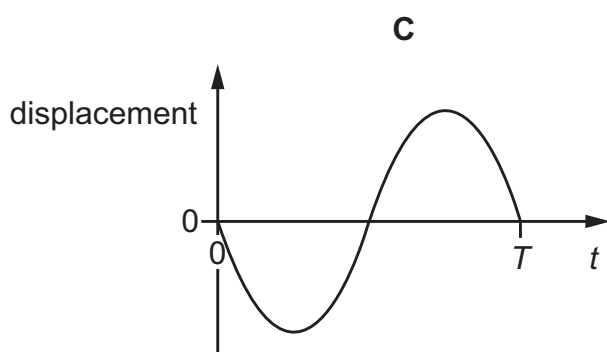
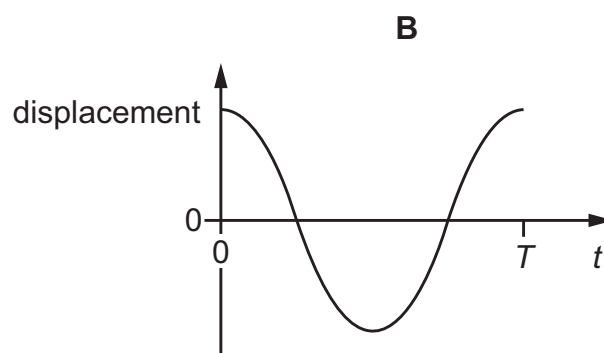
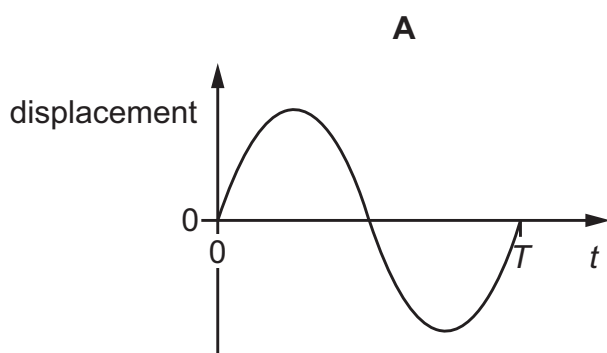
21 A transverse wave on a rope has wavelength λ and period T .

The graph shows the variation of the displacement of the particles of the rope with distance in the direction of travel of the wave at time $t = 0$.



A particle X is labelled.

Which graph shows the variation of the displacement of particle X with time t ?



299. Question | 9702 Oct-Nov 2023 P1 V2 Q22

- 22** A source of sound waves is moving at a constant speed directly towards a stationary observer.
- The sound waves have a speed of 340 ms^{-1} and a frequency of 480 Hz . The observer hears sound waves of frequency 650 Hz .
- What is the speed of the source?
- A** 89 ms^{-1} **B** 120 ms^{-1} **C** 250 ms^{-1} **D** 340 ms^{-1}

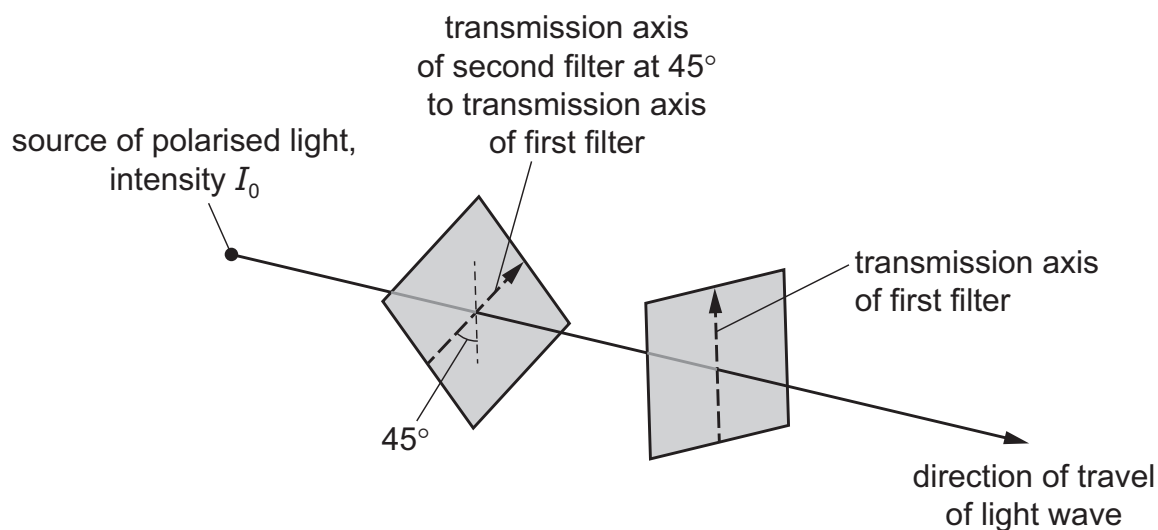
300. Question | 9702 Oct-Nov 2023 P1 V2 Q23

- 23** A student is investigating two electromagnetic waves, X and Y, in a vacuum.
- Wave X has a wavelength of $5.2 \times 10^{-7}\text{ m}$. Wave Y has a frequency of 9.4 GHz .
- Which principal regions of the electromagnetic spectrum contain waves X and Y?

	X	Y
A	radio wave	ultraviolet
B	ultraviolet	visible
C	visible	microwave
D	microwave	radio wave

- 24** A plane polarised light wave of intensity I_0 is incident normally on a polarising filter. The initial intensity of the transmitted wave is 0.

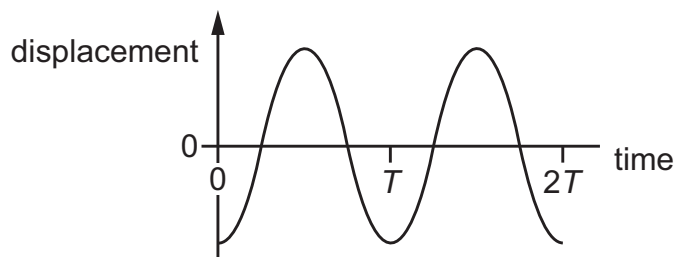
A second polarising filter is then inserted between the source and the first filter. Its transmission axis is at 45° to the transmission axis of the first filter, as shown.



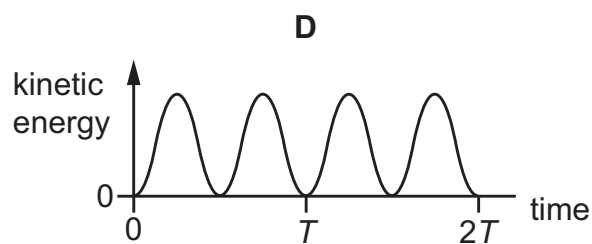
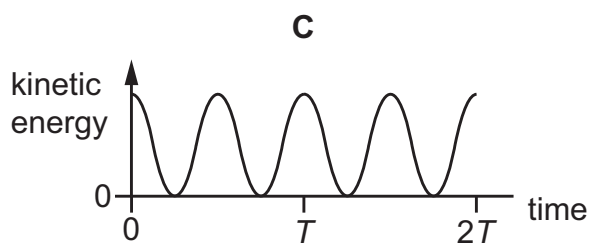
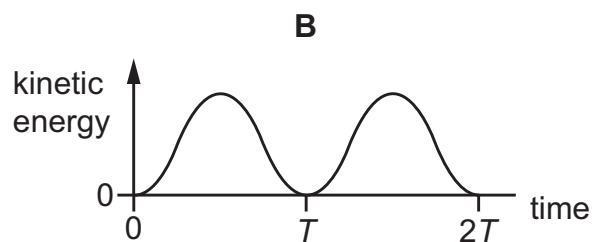
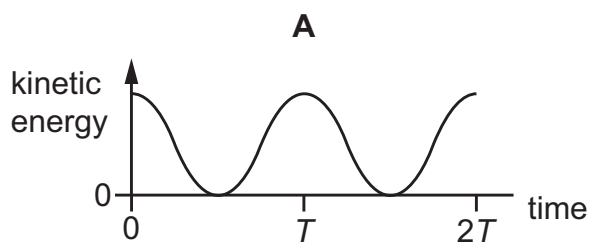
What is the intensity of the transmitted wave from the filter combination?

- A** 0 **B** $\frac{I_0}{8}$ **C** $\frac{I_0}{4}$ **D** $\frac{I_0}{2}$

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



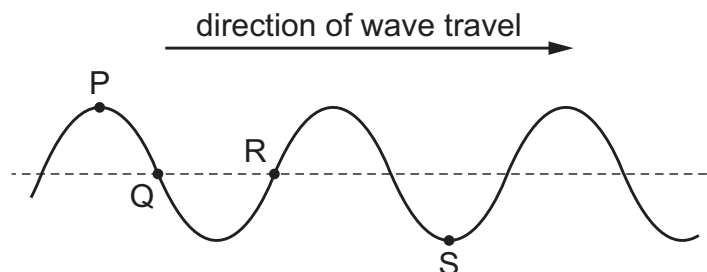
Which graph shows how the kinetic energy of the air particle varies with time?



303. Question | 9702 Oct-Nov 2023 P1 V3 Q21

21 A wave travels on the surface of water. P, Q, R and S are four particles of water on the surface.

The diagram shows the positions of the particles at one instant. The direction of travel of the wave is from left to right.



Which two particles are about to move upwards?

- A** P and R **B** P and S **C** R and S **D** Q and S

304. Question | 9702 Oct-Nov 2023 P1 V3 Q22

22 A loudspeaker emits sound of frequency f_s . The loudspeaker is attached to a car that moves with increasing speed directly towards a stationary observer.

Which statement describes the frequency of the sound heard by the observer?

- A** a frequency greater than f_s and increasing
B a frequency greater than f_s but decreasing
C a frequency less than f_s and decreasing
D a frequency less than f_s but increasing

305. Question | 9702 Oct-Nov 2023 P1 V3 Q23

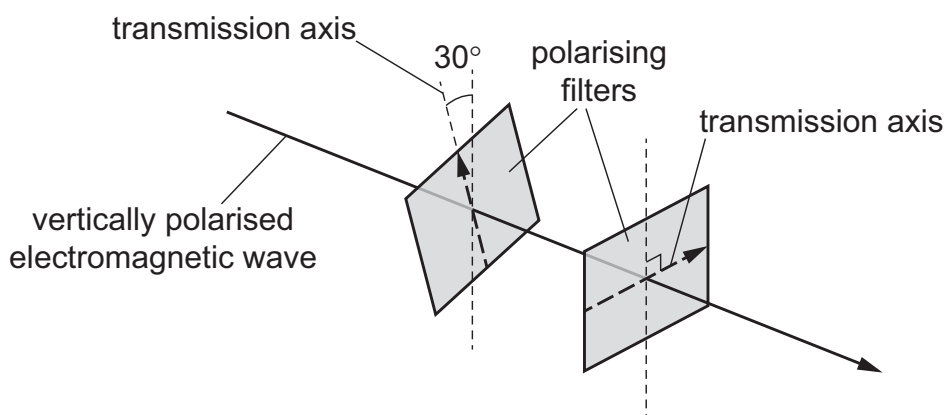
23 Which statement about electromagnetic waves in a vacuum is correct?

- A** Amplitude is inversely proportional to velocity.
- B** Frequency is inversely proportional to wavelength.
- C** Intensity is proportional to amplitude.
- D** Velocity is proportional to wavelength.

306. Question | 9702 Oct-Nov 2023 P1 V3 Q24

24 A vertically polarised electromagnetic wave of intensity I_0 is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 30° to the vertical.

The transmitted wave from the first filter is then incident normally on a second polarising filter. The transmission axis of this filter is at an angle of 90° to the vertical.



What is the intensity of the wave after passing through the second filter?

- A** 0
- B** $0.063 I_0$
- C** $0.19 I_0$
- D** $0.56 I_0$

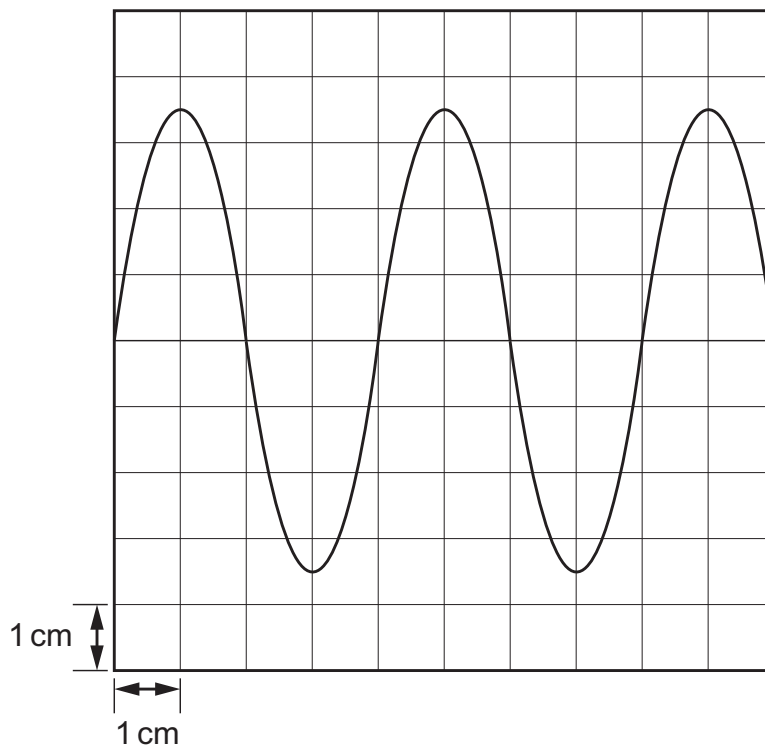
24 The range of frequencies of sound waves emitted by blue whales is 10 Hz to 40 Hz.

The speed of sound in seawater is approximately 1.5 km s^{-1} .

What is the approximate range of wavelengths of the sound waves emitted by blue whales?

- A** 6.7 mm to 27 mm
- B** 3.8 cm to 15 cm
- C** 6.7 m to 27 m
- D** 38 m to 150 m

- 25** A sound wave is detected by a microphone and displayed on the screen of a cathode-ray oscilloscope (CRO).



The frequency of the wave is 2.5 kHz.

What is the setting on the time-base of the CRO?

- A** 0.1 ms cm^{-1} **B** 0.4 ms cm^{-1} **C** 0.1 s cm^{-1} **D** 0.4 s cm^{-1}

- 26** A source of sound waves with constant frequency moves towards a stationary observer.

The observer compares the sound waves arriving at the observer's position with the waves emitted by the source of sound.

What is detected by the observer?

- A** a decreased frequency of the sound waves
B no change in frequency of the sound waves
C a decreased wavelength of the sound waves
D no change in wavelength of the sound waves

310. Question | 9702 Feb-March 2024 P1 V2 Q27

27 Which type of waves **cannot** be polarised?

- A** radio waves
- B** sound waves
- C** ultraviolet waves
- D** X-rays

311. Question | 9702 Feb-March 2024 P1 V2 Q28

28 A beam of light with power P has an area of cross-section A .

The amplitude of the light waves in the beam is X .

The beam of light is then changed to one with the same frequency but with an increased amplitude of $4X$ and an area of cross-section reduced to $\frac{A}{3}$.

What is the power of the new beam?

- A** $1.3P$ **B** $5.3P$ **C** $12P$ **D** $48P$

312. Question | 9702 May-June 2024 P1 V1 Q19

- 19** A plane wave of amplitude A is incident on a surface of area S placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is E .

The amplitude of the wave is increased to $2A$ and the area of the surface is reduced to $\frac{1}{2}S$.

How much energy per unit time reaches this smaller surface?

- A** $4E$ **B** $2E$ **C** E **D** $\frac{1}{2}E$

313. Question | 9702 May-June 2024 P1 V1 Q24

24 A plane polarised wave has amplitude A . The wave is incident normally on a polarising filter.

The transmission axis of the filter is at angle θ to the plane of polarisation of the incident wave.

What is the amplitude of the wave that emerges from the filter?

- A** $A \cos \theta$ **B** $A \cos^2 \theta$ **C** $A^2 \cos \theta$ **D** $A^2 \cos^2 \theta$

314. Question | 9702 May-June 2024 P1 V1 Q25

25 An electromagnetic wave is travelling through a vacuum.

What could be the wavelength and period of the electromagnetic wave?

	wavelength	period
A	$1.2 \times 10^{-10} \text{ Tm}$	2.5 Ms
B	1.2 pm	$2.5 \times 10^{11} \text{ Gs}$
C	$1.2 \times 10^2 \text{ pm}$	$4.0 \times 10^{-10} \text{ ns}$
D	$1.2 \times 10^3 \text{ }\mu\text{m}$	4.0 ns

315. Question | 9702 May-June 2024 P1 V1 Q27

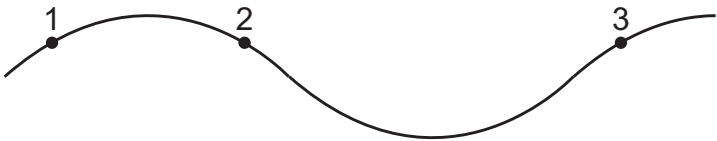
27 The siren of a moving police car emits a sound wave with a frequency of 440 Hz. A stationary observer hears sound of frequency 494 Hz. The speed of sound in the air is 340 m s^{-1} .

What could be the speed and the direction of movement of the car?

- A** 37 m s^{-1} directly away from the observer
B 37 m s^{-1} directly towards the observer
C 42 m s^{-1} directly away from the observer
D 42 m s^{-1} directly towards the observer

316. Question | 9702 May-June 2024 P1 V1 Q28

28 The diagram shows the shape at one instant in time of part of a stretched string as a wave travels along it from left to right.



What are the directions of the velocities of the points 1, 2 and 3 on the string at this instant in time?

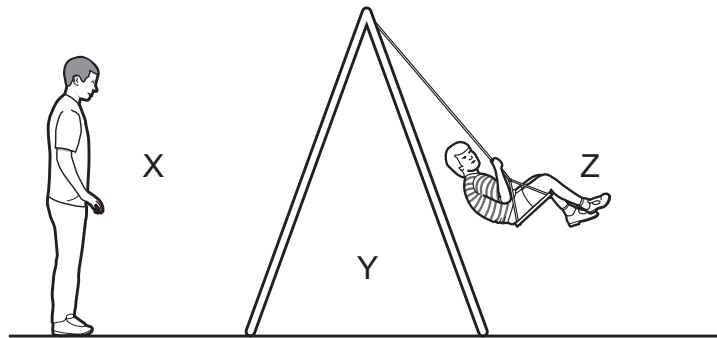
	point 1	point 2	point 3
A	→	→	→
B	→	←	→
C	↑	↓	↑
D	↓	↑	↓

317. Question | 9702 May-June 2024 P1 V1 Q29

29 Which wave **cannot** be a longitudinal wave?

- A** a diffracted wave
- B** a polarised wave
- C** a reflected wave
- D** a stationary wave

21 A man stands stationary in front of a swing. A child sits and swings.



The child blows a whistle that emits a sound at a constant frequency.

The man observes the frequency of the sound when the swing is at positions X, Y and Z.

When will the man hear the highest frequency?

- A** when the swing is at X
- B** when the swing is at Y and moving away from the man
- C** when the swing is at Y and moving towards the man
- D** when the swing is at Z

319. Question | 9702 May-June 2024 P1 V2 Q22

- 22** A loudspeaker is playing music in a room. The door to the room is open and has a width of 0.80 m.

Sound waves of many different frequencies pass through the doorway and diffract. The speed of sound in air is 340 m s^{-1} .

Which frequency of sound wave diffracts the most as it passes through the doorway?

- A** $2.4 \times 10^{-3} \text{ Hz}$
- B** $8.0 \times 10^{-1} \text{ Hz}$
- C** $2.7 \times 10^2 \text{ Hz}$
- D** $4.3 \times 10^2 \text{ Hz}$

320. Question | 9702 May-June 2024 P1 V2 Q24

- 24** Polarisation is associated with certain waves.

Which waves **cannot** be polarised?

- A** radio waves from a transmitter
- B** sound waves from a moving source
- C** ultraviolet rays from the Sun
- D** X-rays from an X-ray emitter

321. Question | 9702 May-June 2024 P1 V2 Q25

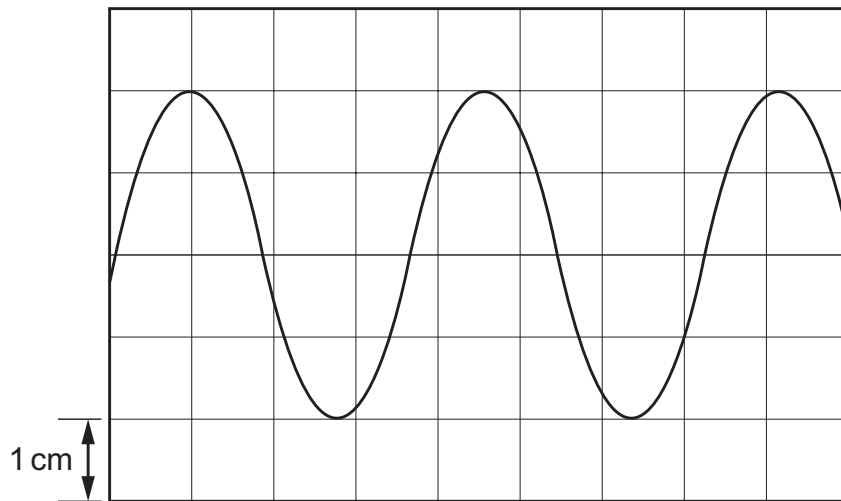
- 25** A guitar string is plucked.

Which statement describes the resulting waves?

- A** Longitudinal waves on the string cause longitudinal waves in the air.
- B** Longitudinal waves on the string cause transverse waves in the air.
- C** Transverse waves on the string cause longitudinal waves in the air.
- D** Transverse waves on the string cause transverse waves in the air.

322. Question | 9702 May-June 2024 P1 V3 Q22

- 22** The diagram shows a representation of a wave on the screen of an oscilloscope.



The y-gain is set to 3.5 mV cm^{-1} .

What is the amplitude of the wave?

- A** 0.57 mV **B** 3.5 mV **C** 7.0 mV **D** 14 mV

323. Question | 9702 May-June 2024 P1 V3 Q23

- 23** A transverse progressive wave on a string has a wavelength of 12 cm and an amplitude of 1.5 cm. The speed of the wave on the string is 48 cm s^{-1} .

What is the distance travelled by a point on the string in a time of 2.0 s?

- A** 12 cm **B** 24 cm **C** 48 cm **D** 96 cm

324. Question | 9702 May-June 2024 P1 V3 Q24

- 24** An ambulance siren emits a sound with a single frequency f .

The ambulance travels towards, passes close to, and then travels away from a stationary observer.

Which statement describes the frequency of the sound detected by the observer as the ambulance **passes** the observer?

- A** equal to f and decreasing
B equal to f and increasing
C greater than f and constant
D less than f and constant

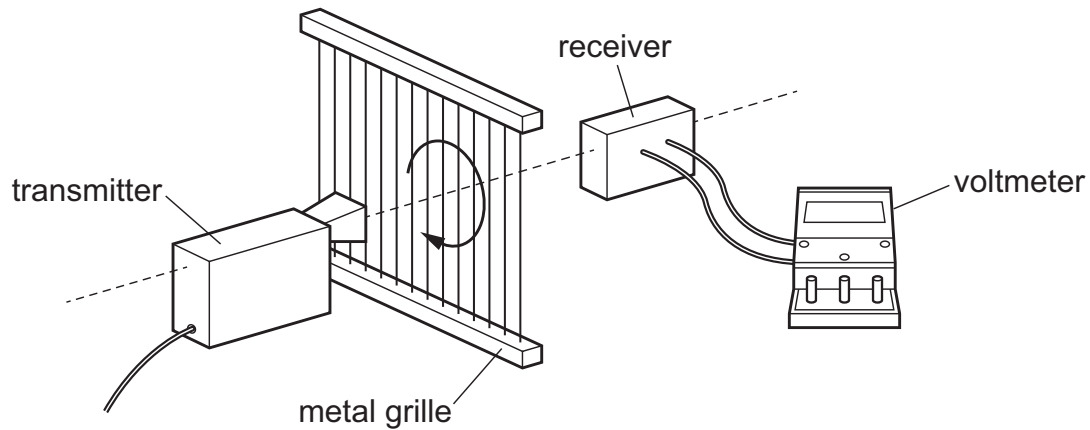
25 An electromagnetic wave has a wavelength of 138 pm in a vacuum.

To which region of the electromagnetic spectrum does this wave belong?

- A** radio wave
- B** microwave
- C** visible light
- D** X-ray

- 26** A student investigates the polarisation of microwaves. The microwaves from the transmitter are vertically polarised. A metal grille acts as a polarising filter when placed between the microwave transmitter and the receiver. The reading on the voltmeter is proportional to the intensity of microwaves transmitted through the grille.

When the transmission axis of the grille is vertical, the voltmeter reads 3.50 V.



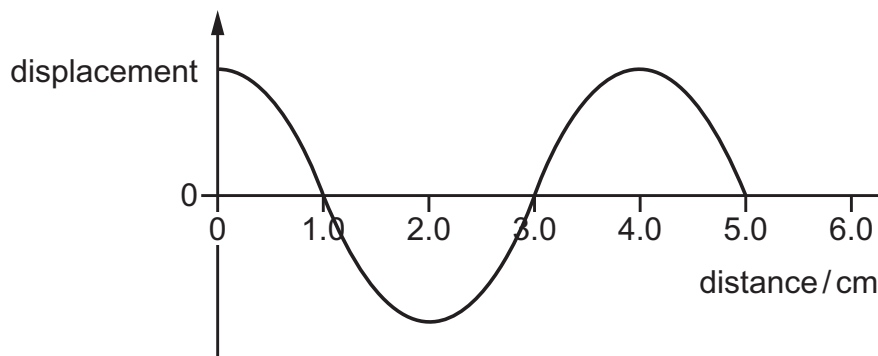
The grille is then rotated through an angle θ . The voltmeter now reads 2.20 V.

What is θ ?

- A** 37.5° **B** 39.0° **C** 51.0° **D** 52.5°

327. Question | 9702 Oct-Nov 2024 P1 V1 Q24

- 24** The graph shows the variation of the displacement with distance for a progressive wave at one instant in time.



The period of the wave is 91 ms.

What can be determined about the wave?

- A** It has a velocity of 0.44 m s^{-1} and a frequency of 11 Hz.
- B** It has a velocity of 0.55 m s^{-1} and a wavelength of 5.0 cm.
- C** It is longitudinal and has a frequency of 11 Hz.
- D** It is transverse and has a wavelength of 4.0 cm.

328. Question | 9702 Oct-Nov 2024 P1 V1 Q25

- 25** Which group of electromagnetic waves is arranged in order from shortest wavelength to longest wavelength?

- A** radio waves $\rightarrow$ visible light $\rightarrow$ gamma rays
- B** visible light $\rightarrow$ microwaves $\rightarrow$ infrared
- C** visible light $\rightarrow$ ultraviolet $\rightarrow$ X-rays
- D** X-rays $\rightarrow$ infrared $\rightarrow$ microwaves

329. Question | 9702 Oct-Nov 2024 P1 V1 Q26

- 26** A wave has a frequency of 5 GHz.

What is the period of the wave?

- A** 200 ps
- B** 2 ns
- C** 20 ns
- D** 20 000 μs

29 Radio waves can be polarised, but sound waves **cannot** be polarised.

Which statement gives the reason for this?

- A** Radio waves are generally of a higher frequency than sound waves.
- B** Radio waves are transverse waves, but sound waves are longitudinal waves.
- C** Radio waves can travel through a vacuum, but sound waves **cannot** travel through a vacuum.
- D** Radio waves travel at a much higher speed than sound waves.

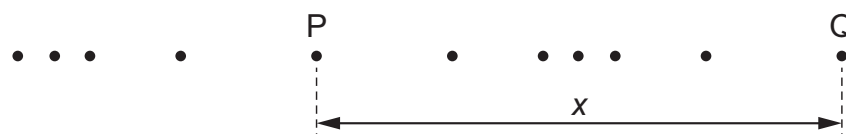
331. Question | 9702 Oct-Nov 2024 P1 V2 Q23

- 23** A horizontal beam of vertically polarised light of amplitude A is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 50° to the vertical.

What is the amplitude of the light in the beam after it has passed through the filter?

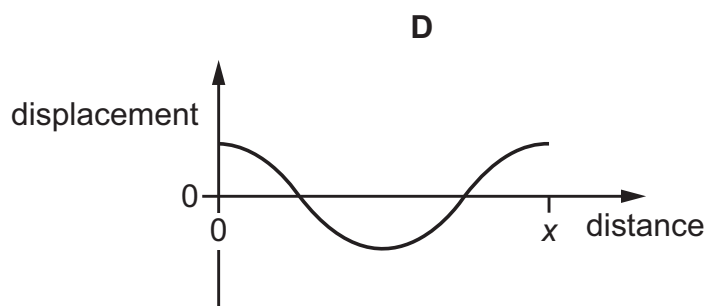
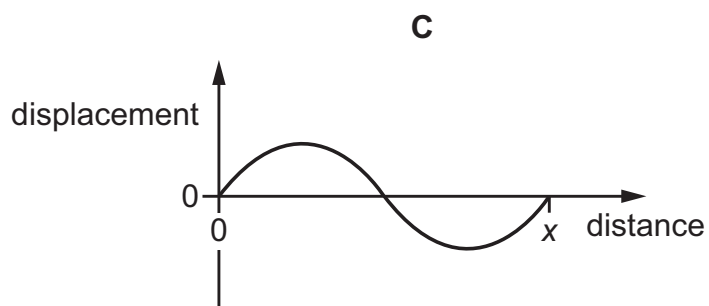
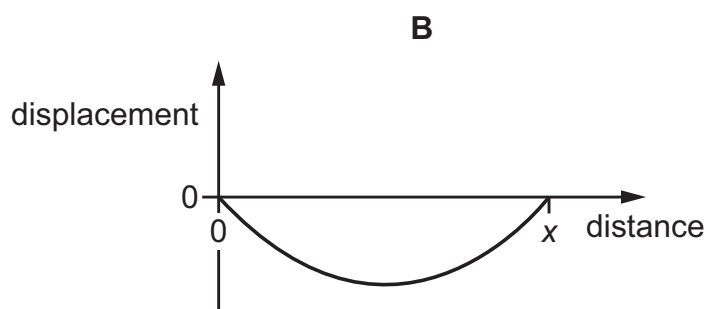
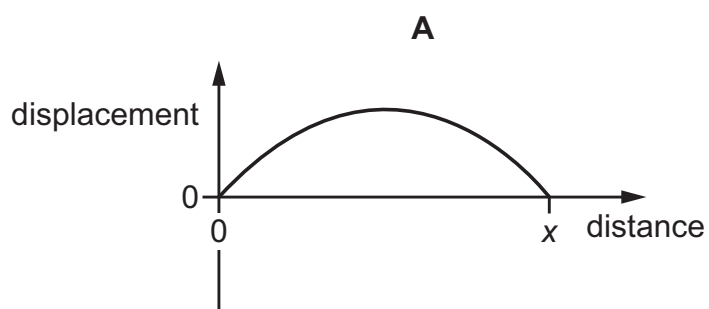
- A** $0.17A$ **B** $0.41A$ **C** $0.64A$ **D** $0.80A$

- 24** A progressive longitudinal sound wave moves through air. The diagram shows the positions of the air particles along part of the wave at one instant.



Point Q is a distance x from point P.

Which graph shows the variation of the displacement of the air particles with distance from P along the wave?



333. Question | 9702 Oct-Nov 2024 P1 V2 Q25

25 An electromagnetic wave in free space has a frequency of 3.0×10^{16} Hz.

Which row gives the principal region of this wave and an example of an electromagnetic wave with a lower frequency?

	principal region	wave with lower frequency
A	infrared	visible light
B	infrared	X-rays
C	ultraviolet	visible light
D	ultraviolet	X-rays

334. Question | 9702 Oct-Nov 2024 P1 V2 Q26

26 A source of sound emits waves of a constant frequency. The source moves at a constant speed in a straight line relative to a stationary observer.

Which velocity of the source gives the smallest observed frequency?

	speed / ms ⁻¹	direction
A	5	away from observer
B	10	away from observer
C	15	towards observer
D	20	towards observer

335. Question | 9702 Oct-Nov 2024 P1 V2 Q27

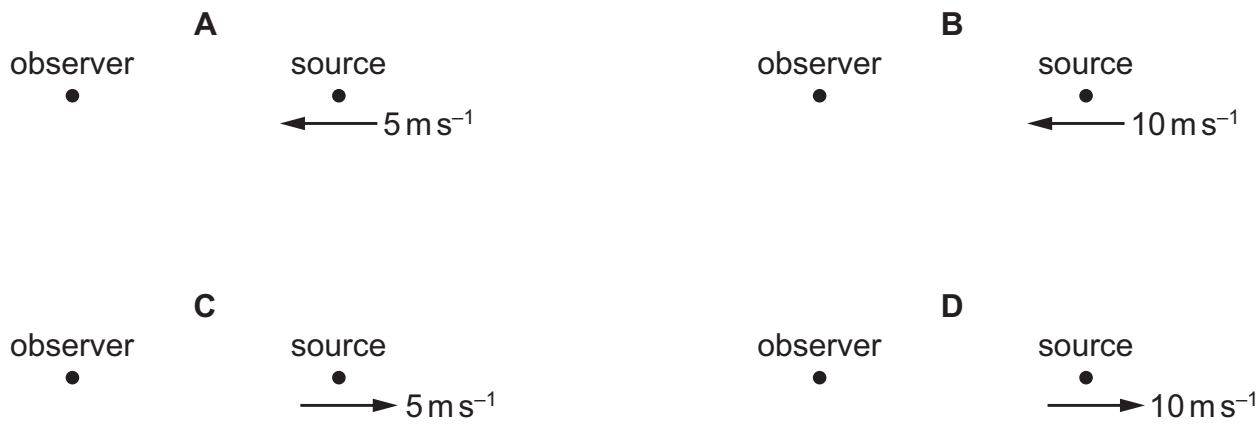
27 What could describe the time-base of a cathode-ray oscilloscope (CRO)?

- A** the frequency per division on the screen
- B** the number of divisions on the screen per unit frequency
- C** the number of divisions on the screen per unit time
- D** the time per division on the screen

336. Question | 9702 Oct-Nov 2024 P1 V3 Q24

24 A source of sound waves of constant frequency is travelling as shown.

In which situation would the stationary observer detect a sound with the lowest frequency?



337. Question | 9702 Oct-Nov 2024 P1 V3 Q25

25 Each of the principal radiations of the electromagnetic spectrum has a range of wavelengths.

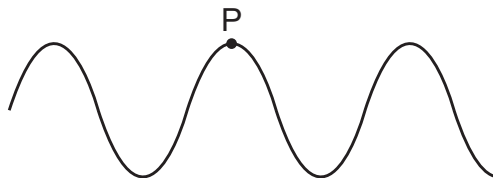
Which wavelength is correctly linked to its radiation?

	wavelength / m	radiation
A	10^{-9}	gamma ray
B	10^{-5}	microwave
C	10^{-8}	ultraviolet
D	10^{-14}	X-ray

338. Question | 9702 Oct-Nov 2024 P1 V3 Q26

- 26** A transverse water wave has a frequency of 15 Hz, a wavelength of 0.12 m and an amplitude of 4.0 mm.

P is a water particle that is initially at the peak of the wave, as shown.



What is the total vertical distance travelled by P in a time of 0.5 s?

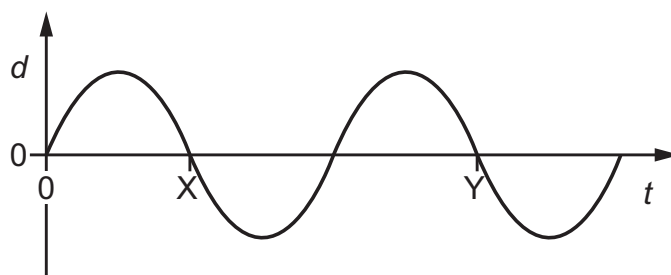
- A** 30 mm **B** 60 mm **C** 120 mm **D** 900 mm

339. Question | 9702 Oct-Nov 2024 P1 V3 Q27

- 27** A wave is formed on a string.

A student plots a graph of the variation of displacement d with time t for a point on the string.

The student marks two points, X and Y, on the graph.



Which property of the wave is represented by the distance along the horizontal axis between X and Y?

- A** amplitude
B frequency
C period
D wavelength

22 Which row correctly identifies the properties of all electromagnetic waves?

	transverse wave	longitudinal wave	can travel in free space
A	✓	✗	✓
B	✓	✗	✗
C	✗	✓	✓
D	✗	✓	✗

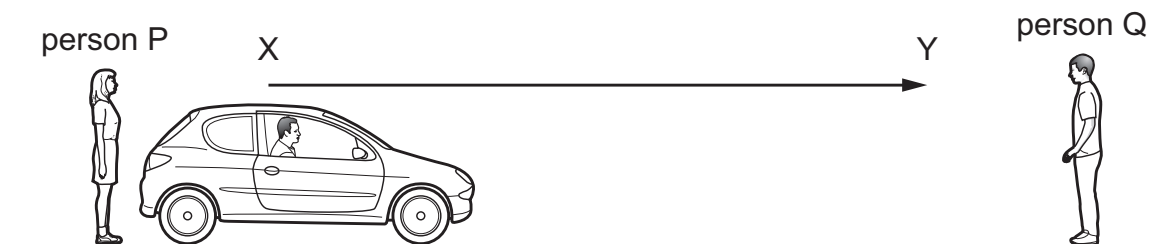
key
✓ = property of an electromagnetic wave
✗ = **not** a property of an electromagnetic wave

23 What is the approximate range of wavelengths in free space for infrared radiation?

- A** 100 nm to 400 nm
- B** 300 μm to 30 cm
- C** 400 nm to 700 nm
- D** 800 nm to 1000 μm

342. Question | 9702 Feb-March 2025 P1 V2 Q24

- 24** The diagram shows a car travelling at a constant speed in a straight line between person P and person Q from point X to point Y.



The car sounds its horn continuously as it travels. The horn emits sound of constant frequency.

Which statements about what person P and person Q hear during the motion of the car are correct?

- 1 Person P hears a sound of increasing frequency.
- 2 Person Q hears a sound of decreasing frequency.
- 3 Person Q always hears a sound of higher frequency than person P.

- A** 1, 2 and 3
B 1 and 2 only
C 3 only
D none of them

343. Question | 9702 Feb-March 2025 P1 V2 Q25

- 25** A progressive wave of frequency 300 Hz is travelling with a speed of 600 m s^{-1} .

What is the phase difference between two points on the wave that are a distance of 0.50 m apart?

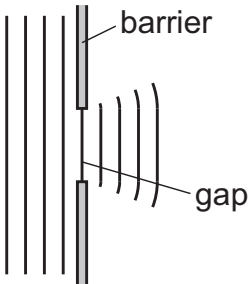
- A** 45° **B** 90° **C** 180° **D** 360°

344. Question | 9702 Feb-March 2025 P1 V2 Q26

- 26** A polarised beam of light with intensity I is incident normally on a polarising filter.
- The transmitted light has intensity I .
- The filter is rotated about the normal axis through an angle θ .
- The transmitted light has intensity $0.75I$.
- What is the angle θ ?
- A** 30° **B** 42° **C** 49° **D** 60°

345. Question | 9702 Feb-March 2025 P1 V2 Q28

- 28** The diagram shows a water wave in a shallow tank. The wave is diffracted through a gap in a barrier and spreads. The wavelength of the wave is much smaller than the width of the gap.



The wavelength of the wave and the width of the gap are both changed by a small amount.

Which combination of changes **must** increase the amount of spreading due to diffraction?

	wavelength	width of gap
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

346. Question | 9702 May-June 2025 P1 V1 Q24

- 24** An aircraft produces a sound at a frequency of 30.0 Hz.

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

The aircraft is directly in front of the stationary observer and travels in a straight line towards or away from the observer.

The observer hears the sound from the aircraft at a frequency of 20.0 Hz.

What is the speed and direction of the aircraft?

	speed / m s^{-1}	direction
A	110	away from observer
B	110	towards observer
C	165	away from observer
D	165	towards observer

347. Question | 9702 May-June 2025 P1 V1 Q25

- 25** Which statement about longitudinal and transverse wave motion for a progressive wave is correct?

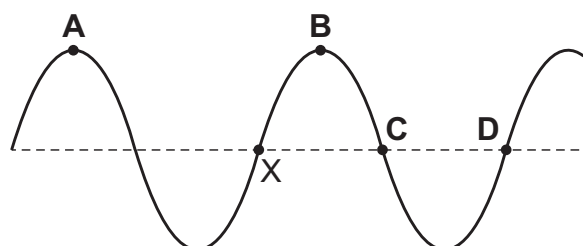
- A** All transverse and longitudinal waves require a medium for propagation.
- B** All transverse waves travel at the same speed, but longitudinal waves can travel at different speeds.
- C** In both transverse waves and longitudinal waves, a particle with zero displacement has a maximum speed.
- D** In a longitudinal wave there is a net movement of particles in the direction of travel of the wave, but there is no net movement of particles in a transverse wave.

348. Question | 9702 May-June 2025 P1 V1 Q26

- 26** The diagram shows a progressive transverse wave on a stretched string at one instant in time.

One point on the string is labelled X.

Which point on the string is 270° out of phase with X?



9702 Physics Paper 1 - Waves

Topical questions | 384 questions

349. Question | 9702 May-June 2025 P1 V1 Q27

27 Which wavelength of electromagnetic radiation in free space could be green light?

- A** $4.9 \times 10^{-9} \text{ m}$ **B** $6.6 \times 10^{-9} \text{ m}$ **C** $5.5 \times 10^{-7} \text{ m}$ **D** $8.6 \times 10^{-7} \text{ m}$

350. Question | 9702 May-June 2025 P1 V1 Q28

28 Which group contains only waves that can be polarised?

- A** infrared waves, radio waves, sound waves
B visible light waves, microwaves, radio waves
C visible light waves, radio waves, sound waves
D microwaves, visible light waves, sound waves

351. Question | 9702 May-June 2025 P1 V2 Q5

5 Radio waves can be used to measure the distance between Earth and the planet Jupiter.

A pulse of radio waves is emitted from the surface of Earth. The pulse reflects from the surface of Jupiter and is detected again on Earth.

The time between emitting and receiving the pulse is 3960 s.

What is the distance between Earth and Jupiter?

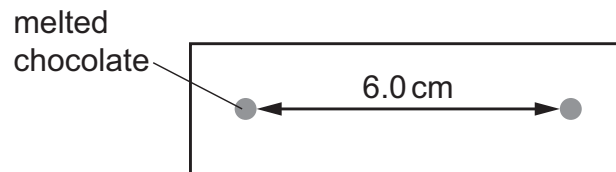
- A** $5.94 \times 10^8 \text{ km}$
B $1.19 \times 10^9 \text{ km}$
C $5.94 \times 10^{11} \text{ km}$
D $1.19 \times 10^{12} \text{ km}$

- 24** A teacher removes the turntable from a microwave oven and places a bar of chocolate in the oven. She then switches the oven on for a short time.

A stationary wave is formed in the oven.

When the chocolate is removed, the teacher observes that there are two small sections of melted chocolate 6.0 cm apart with unmelted chocolate in between.

Each section of melted chocolate is located at an antinode.



Assume that the speed of the microwaves is $3.0 \times 10^8 \text{ m s}^{-1}$.

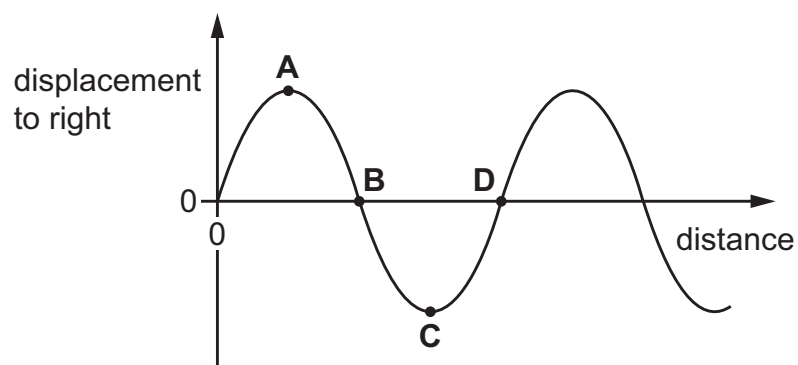
What is the frequency of the microwaves emitted by the oven?

- A** 25 MHz **B** 50 MHz **C** 2.5 GHz **D** 5.0 GHz

25 A sound wave travels from the left to the right.

The graph shows the variation of the displacement to the right of particles in the sound wave with distance, at one instant.

Which letter represents the centre of a compression?



354. Question | 9702 May-June 2025 P1 V2 Q26

- 26** A buzzer emitting sound of frequency 846 Hz is attached to a string and rotated in a horizontal circle. The linear speed of the buzzer is 25.0 m s^{-1} .



The speed of sound is 340 m s^{-1} .

What is the maximum frequency heard by the observer?

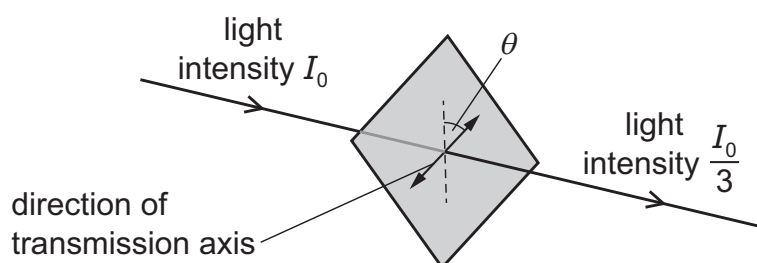
- A** 783 Hz **B** 788 Hz **C** 908 Hz **D** 913 Hz

355. Question | 9702 May-June 2025 P1 V2 Q27

- 27** Vertically polarised light of intensity I_0 is incident normally on a polarising filter.

The transmission axis of the filter is at an angle θ to the plane of polarisation of the light.

The intensity of the light after passing through the filter is $\frac{I_0}{3}$.



What is θ ?

- A** 8.4° **B** 55° **C** 71° **D** 84°

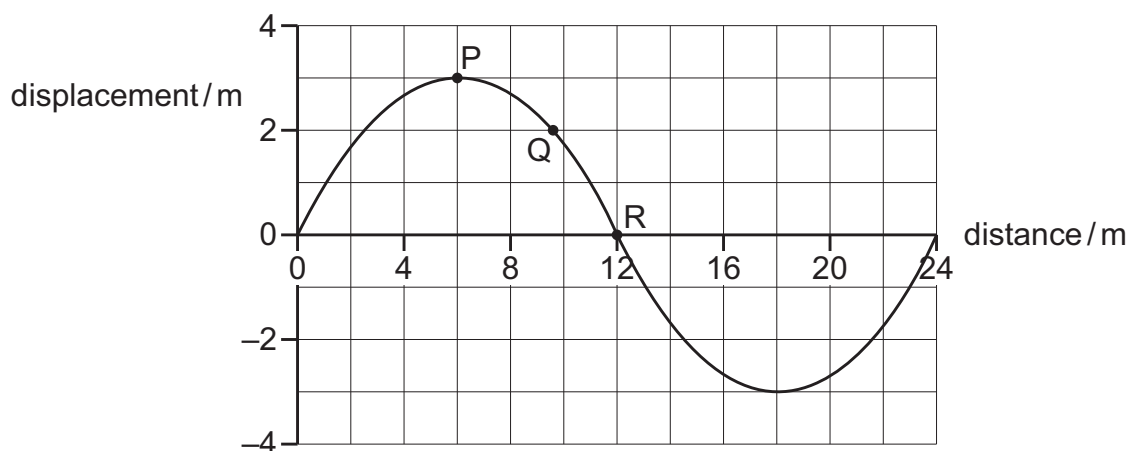
356. Question | 9702 May-June 2025 P1 V2 Q28

28 Which statement compares the behaviour of transverse and longitudinal waves?

- A** Only longitudinal waves can be diffracted.
- B** Only longitudinal waves can travel in free space.
- C** Only transverse waves can be coherent.
- D** Only transverse waves can be polarised.

357. Question | 9702 May-June 2025 P1 V3 Q24

24 The graph shows the variation with distance along the wave of the displacement of water particles at a particular instant in time for a transverse water wave.



P, Q and R show the positions of three water particles in the wave.

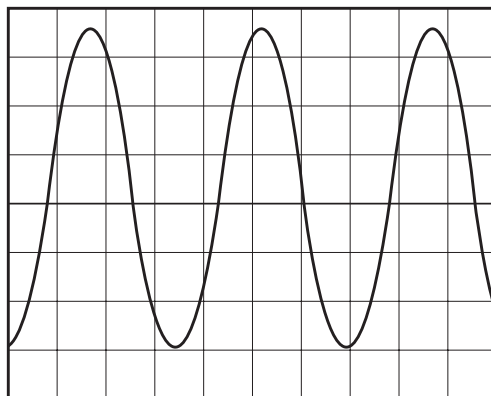
Which particle has the greatest speed at the instant shown?

- A** all have the same speed
- B** particle P
- C** particle Q
- D** particle R

25 Which phenomenon is only associated with transverse waves?

- A** diffraction
- B** interference
- C** polarisation
- D** reflection

26 A wave is displayed on an oscilloscope.



The oscilloscope settings are:

time-base: $300 \mu\text{s div}^{-1}$

y-gain: $40 \mu\text{V div}^{-1}$.

What is the frequency of the wave?

- A** 130 Hz **B** 950 Hz **C** 1100 Hz **D** 7100 Hz

27 An electromagnetic wave travelling in free space is **not** visible to the human eye.

What is a possible wavelength of the wave?

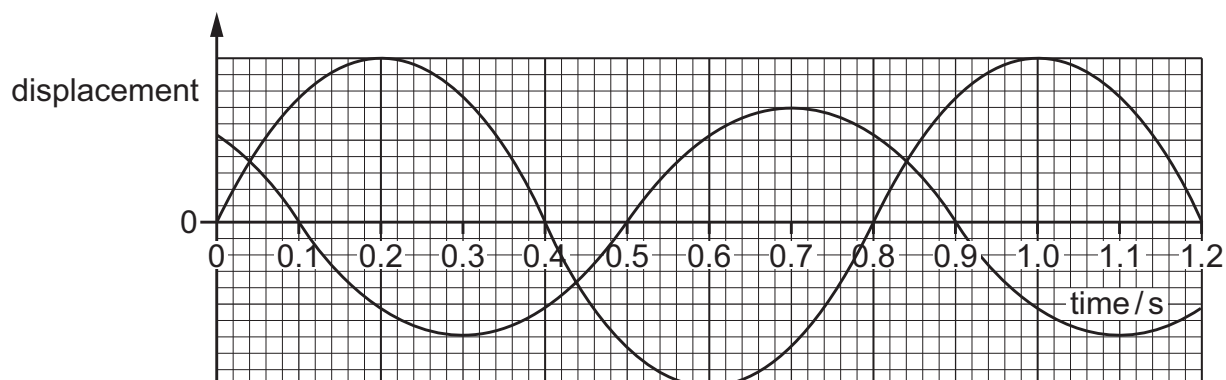
A $4.5 \times 10^{-10} \text{ km}$

B $6.2 \times 10^{-7} \text{ m}$

C $5.4 \times 10^{-6} \text{ cm}$

D $4.2 \times 10^{-4} \text{ mm}$

- 19** 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.



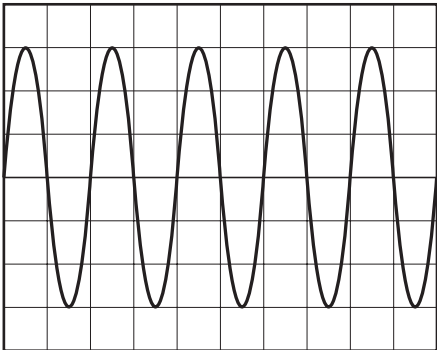
What is the phase difference between the two waves at point P?

- A** 45° **B** 90° **C** 135° **D** 180°

362. Question | 9702 May-June 2025 P1 V4 Q20

20 A microphone is connected to a cathode-ray oscilloscope (CRO). The diagram shows the waveform on the display of the CRO when the microphone detects a sound.

The y -gain is set to 1 V div^{-1} . The time-base is set to 2.0 ms div^{-1} .



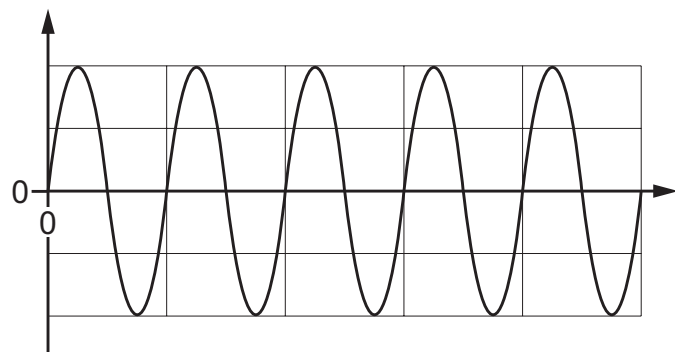
Which row gives the amplitude and frequency of the waveform?

	amplitude / V	frequency / Hz
A	3	125
B	3	250
C	6	125
D	6	250

363. Question | 9702 May-June 2025 P1 V4 Q21

21 A progressive longitudinal wave is travelling horizontally from left to right.

A graphical representation of the wave at one instant in time is shown.



Which row could give the correct labels for the x -axis and y -axis of this graph?

	x -axis	y -axis
A	distance	displacement of particles to the right
B	distance	displacement of particles upwards
C	time	displacement of particles to the right
D	time	displacement of particles upwards

364. Question | 9702 May-June 2025 P1 V4 Q22

22 A vehicle is moving with a speed of 30.0 m s^{-1} directly towards a stationary observer. The horn of the vehicle emits sound of frequency 440 Hz . The speed of sound in air is 340 m s^{-1} .

What is the frequency of the sound heard by the observer?

- A** 401 Hz **B** 404 Hz **C** 479 Hz **D** 483 Hz

23 Which row could describe electromagnetic waves?

	type of wave	speed in free space
A	longitudinal	faster for shorter wavelengths
B	longitudinal	the same for all wavelengths
C	transverse	faster for shorter wavelengths
D	transverse	the same for all wavelengths

24 A horizontal beam of light is incident normally on a polarising filter. The incident light is vertically polarised and has an intensity of 24 W m^{-2} . The direction of the transmission axis of the filter is at an angle of 30° to the vertical.

What is the intensity of the light in the transmitted beam?

- A** 18 W m^{-2} **B** 21 W m^{-2} **C** 28 W m^{-2} **D** 32 W m^{-2}

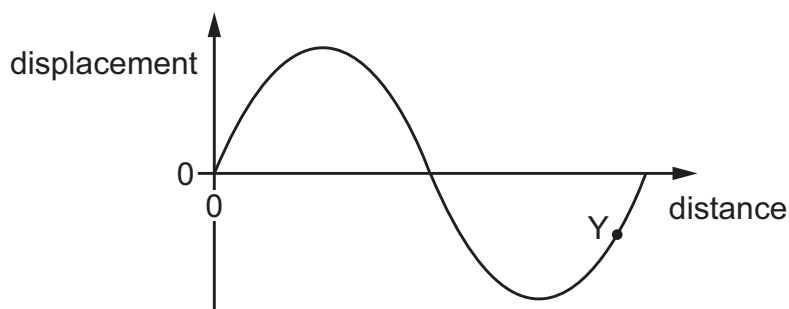
24 Which row is correct for sound waves?

	can travel in a vacuum	can be polarised	can diffract through a gap
A	no	no	yes
B	yes	no	no
C	no	yes	no
D	no	yes	yes

368. Question | 9702 Oct-Nov 2025 P1 V1 Q25

- 25** A source emits a progressive sound wave in the horizontal direction. The wave travels away from the source in a direction towards the right.

The graph shows the variation of the displacement of the particles from their equilibrium positions with distance from the source at a particular instant in time. Displacements to the right of the equilibrium positions are shown as positive.



Position Y represents the displacement of a particle in the sound wave at a particular distance from the source at this instant.

Which statement about the motion of this particle is correct?

- A** The particle is moving away from the source.
- B** The particle is moving towards the source.
- C** The particle is moving upwards.
- D** The particle is moving downwards.

369. Question | 9702 Oct-Nov 2025 P1 V1 Q26

- 26** Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° .

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

- A** zero
- B** 2.5 W m^{-2}
- C** 2.9 W m^{-2}
- D** 6.0 W m^{-2}

370. Question | 9702 Oct-Nov 2025 P1 V1 Q27

27 A dolphin is swimming at a speed of 16.0 ms^{-1} directly towards a stationary underwater microphone.

The dolphin emits a sound of frequency 122 kHz . The speed of sound in water is 1480 ms^{-1} .

What is the frequency of sound detected by the microphone?

- A** 1300 Hz **B** 1330 Hz **C** 121 kHz **D** 123 kHz

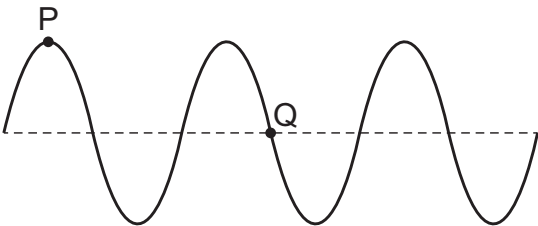
371. Question | 9702 Oct-Nov 2025 P1 V2 Q24

24 Which row describes a progressive longitudinal wave?

	transfers energy in a direction parallel to the oscillations	requires a medium to travel through	always travels at the same speed
A	false	false	true
B	false	true	true
C	true	false	false
D	true	true	false

372. Question | 9702 Oct-Nov 2025 P1 V2 Q25

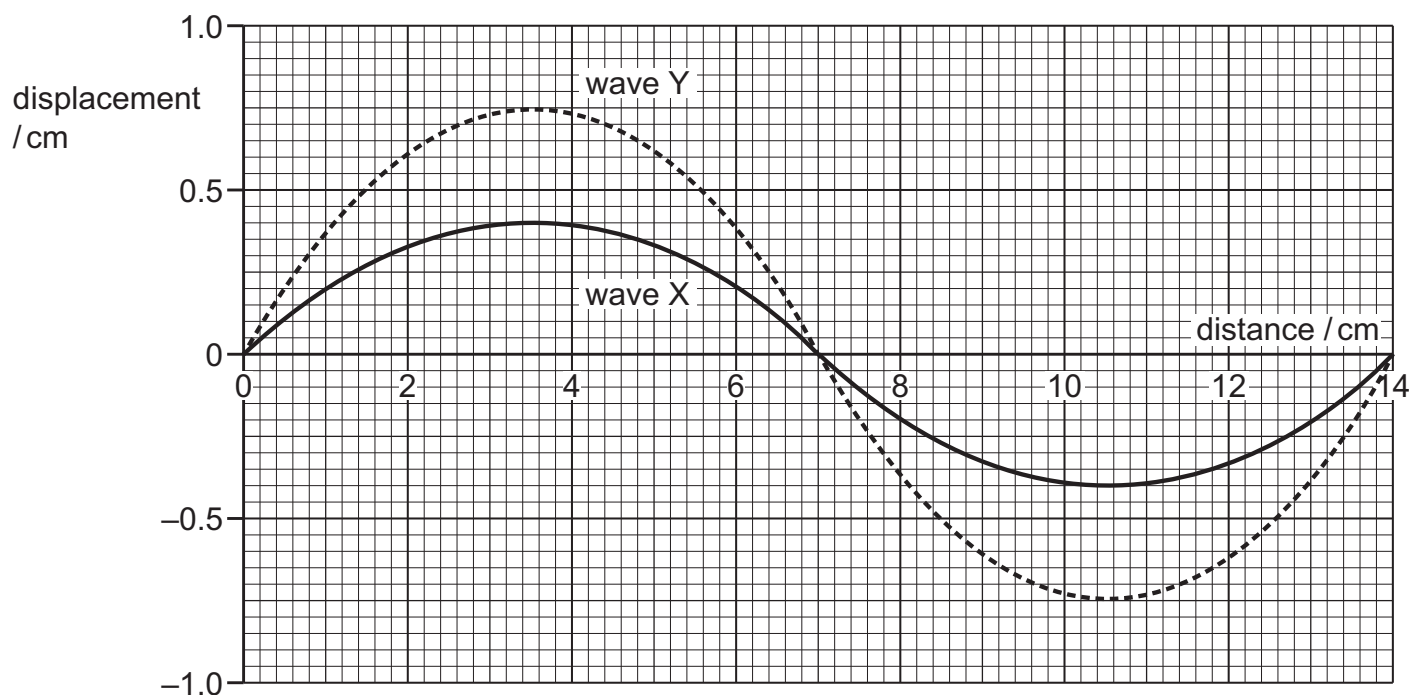
25 What is the phase difference between points P and Q on the progressive wave shown in the diagram?



- A** 180° **B** 450° **C** 540° **D** 720°

373. Question | 9702 Oct-Nov 2025 P1 V2 Q26

- 26** The graph shows the variation of displacement with distance for two progressive waves X and Y of the same type in the same medium.



The intensity of wave X is I .

What is the intensity of wave Y?

- A** $0.28I$ **B** $0.53I$ **C** $1.9I$ **D** $3.5I$

374. Question | 9702 Oct-Nov 2025 P1 V2 Q27

- 27** A moving source emits sound of frequency 1200 Hz.

A stationary observer hears sound of frequency 960 Hz. The speed of the sound is 340 m s^{-1} .

What could be the velocity of the source?

- A** 68 m s^{-1} directly away from the observer
B 68 m s^{-1} directly towards the observer
C 85 m s^{-1} directly away from the observer
D 85 m s^{-1} directly towards the observer

375. Question | 9702 Oct-Nov 2025 P1 V2 Q28

28 A light wave passes through a single slit and a diffraction pattern forms.

What happens to the frequency and the speed of the wave when it is diffracted?

	frequency	speed
A	decreases	increases
B	increases	decreases
C	no change	decreases
D	no change	no change

376. Question | 9702 Oct-Nov 2025 P1 V3 Q24

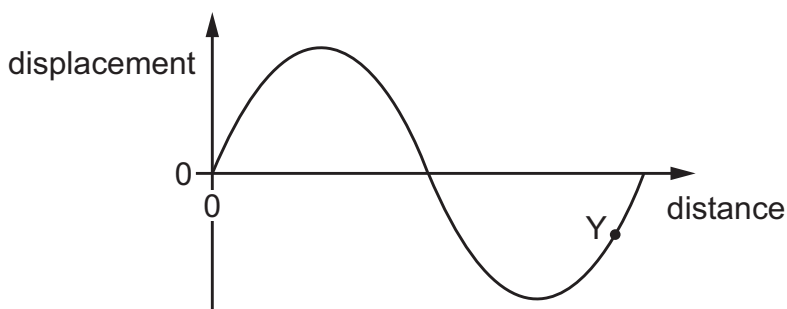
24 Which row is correct for sound waves?

	can travel in a vacuum	can be polarised	can diffract through a gap
A	no	no	yes
B	yes	no	no
C	no	yes	no
D	no	yes	yes

377. Question | 9702 Oct-Nov 2025 P1 V3 Q25

- 25** A source emits a progressive sound wave in the horizontal direction. The wave travels away from the source in a direction towards the right.

The graph shows the variation of the displacement of the particles from their equilibrium positions with distance from the source at a particular instant in time. Displacements to the right of the equilibrium positions are shown as positive.



Position Y represents the displacement of a particle in the sound wave at a particular distance from the source at this instant.

Which statement about the motion of this particle is correct?

- A** The particle is moving away from the source.
- B** The particle is moving towards the source.
- C** The particle is moving upwards.
- D** The particle is moving downwards.

378. Question | 9702 Oct-Nov 2025 P1 V3 Q26

- 26** Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° .

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

- A** zero
- B** 2.5 W m^{-2}
- C** 2.9 W m^{-2}
- D** 6.0 W m^{-2}

379. Question | 9702 Oct-Nov 2025 P1 V3 Q27

- 27** A dolphin is swimming at a speed of 16.0 m s^{-1} directly towards a stationary underwater microphone.

The dolphin emits a sound of frequency 122 kHz . The speed of sound in water is 1480 m s^{-1} .

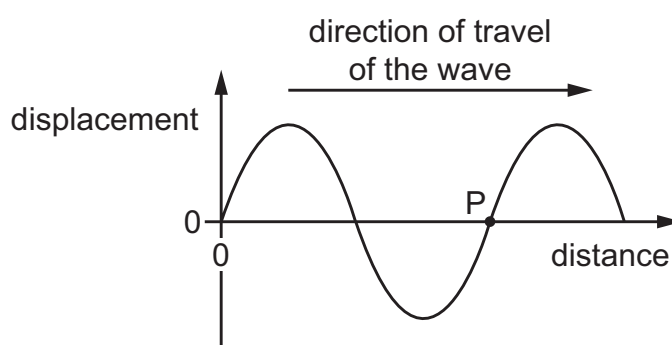
What is the frequency of sound detected by the microphone?

- A** 1300 Hz **B** 1330 Hz **C** 121 kHz **D** 123 kHz

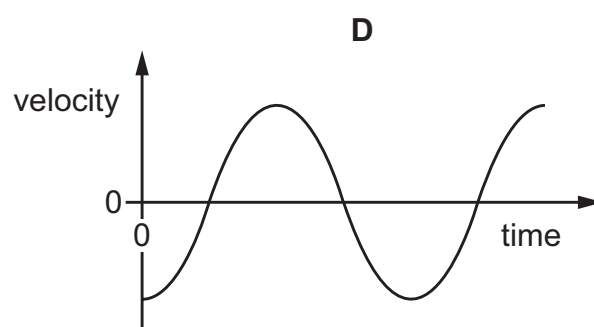
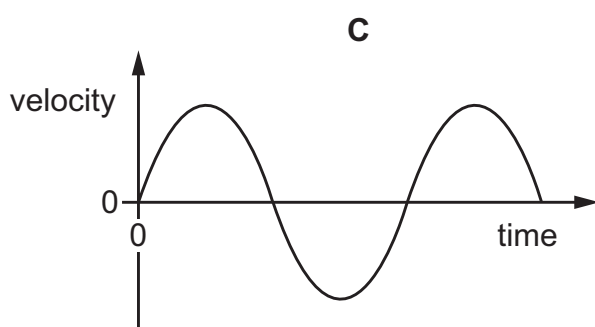
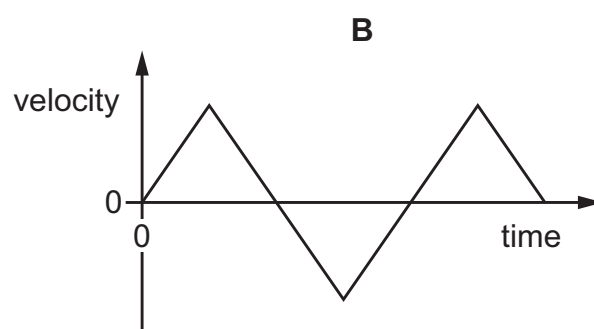
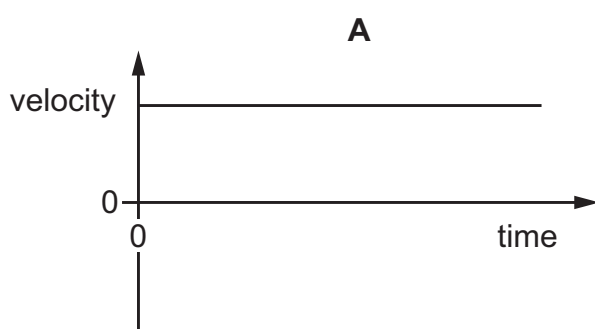
380. Question | 9702 Oct-Nov 2025 P1 V4 Q24

- 24** A transverse progressive wave travels along a string.

The graph shows the variation with distance of the displacement of the string at time $t = 0$.



Which graph represents the variation with time of the velocity of point P on the string?



381. Question | 9702 Oct-Nov 2025 P1 V4 Q25

25 Which statement about electromagnetic waves is correct?

- A** A wave of wavelength $5.0 \times 10^{-6} \text{ m}$ is invisible to the human eye.
- B** They can all travel at different speeds in free space.
- C** They **cannot** be polarised.
- D** They consist of vibrating atoms.

382. Question | 9702 Oct-Nov 2025 P1 V4 Q26

26 For a progressive transverse wave, what describes the term diffraction?

- A** the change in observed frequency of a wave due to a movement of the wave source
- B** the spreading of a wave as it passes through a gap or around an obstacle
- C** when oscillations of a wave are confined to one plane
- D** the resultant displacement of two waves is equal to the sum of the displacements of the individual waves when the waves meet

383. Question | 9702 Oct-Nov 2025 P1 V4 Q27

27 An aircraft flies at a velocity v_s directly away from a stationary observer.

The aircraft emits a sound of constant frequency.

The speed of sound in air is v .

The frequency of the sound heard by the observer on the ground is 500 Hz.

The speed of the aircraft is increased so that it flies away from the observer at a greater velocity.

The observer now hears a sound of frequency 250 Hz.

Which expression gives the new velocity of the aircraft?

- A** $2(v + v_s)$ **B** $\frac{v + v_s}{2}$ **C** $2v_s + v$ **D** $2v_s - v$

28 What may be observed with light waves but **not** with sound waves?

- A** diffraction
- B** interference
- C** polarisation
- D** reflection