1. 9702/12/F/M/16 Q20

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. 9702/12/F/M/16 Q21

A distant star is receding from the Earth with a speed of $1.40 \times 10^7 \, \text{m s}^{-1}$. It emits light of frequency $4.57 \times 10^{14} \, \text{Hz}$. The speed of light is $3.00 \times 10^8 \, \text{m s}^{-1}$.
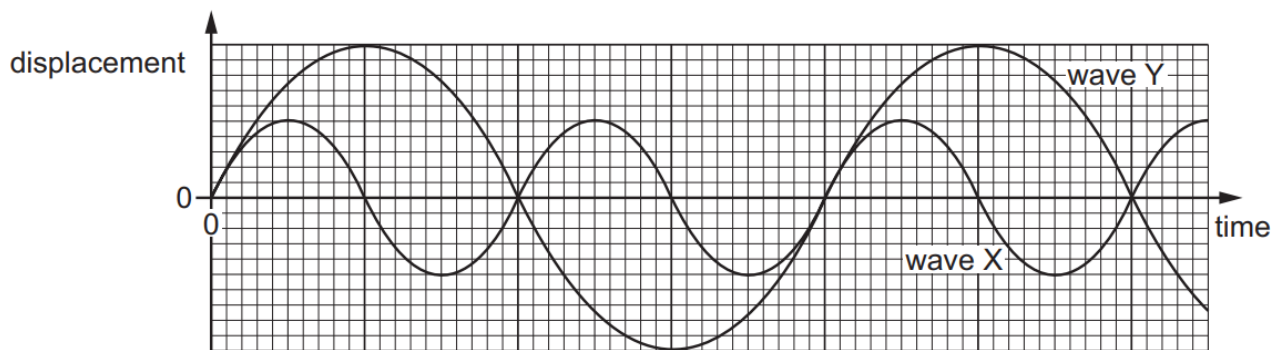
The Doppler effect formula can be used with light waves.

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. 9702/12/F/M/16 Q22

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	$2f$	$2A$

Exam Buddy

4. 9702/11/M/J/16 Q22

   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

5. 9702/11/M/J/16 Q23

   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

6. 9702/11/M/J/16 Q24

   Which statement concerning a stationary wave is correct?

   A All the particles between two successive nodes oscillate in phase.

   B The amplitude of the stationary wave is equal to the amplitude of one of the waves creating it.

   C The wavelength of the stationary wave is equal to the separation of two adjacent nodes.

   D There is no displacement of a particle at an antinode at any time.

7. 9702/12/M/J/16 Q22

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.

1 cm

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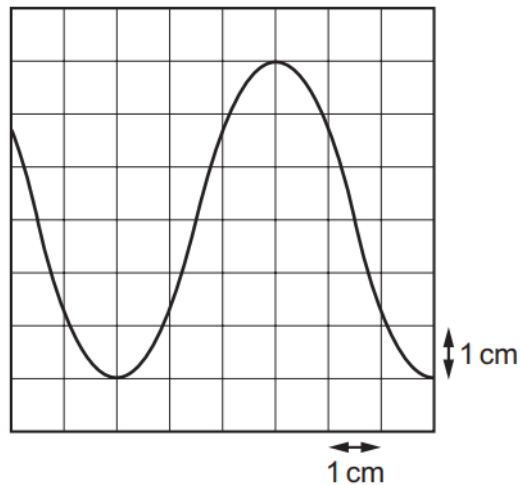
The time-base setting is $0.5\,ms\,cm^{-1}$ and the Y-plate sensitivity is $0.2\,mV\,cm^{-1}$.

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

8. 9702/12/M/J/16 Q23

A source of sound of frequency 1000 Hz moves away from a stationary observer at a speed of $30.0\,m\,s^{-1}$. The speed of sound is $330\,m\,s^{-1}$.

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

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

9. 9702/12/M/J/16 Q24

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

10. 9702/13/M/J/16 Q23

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}

11. 9702/13/M/J/16 Q24

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.

12. 9702/13/M/J/16 Q25

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

$$I \propto \frac{1}{x^2}.$$
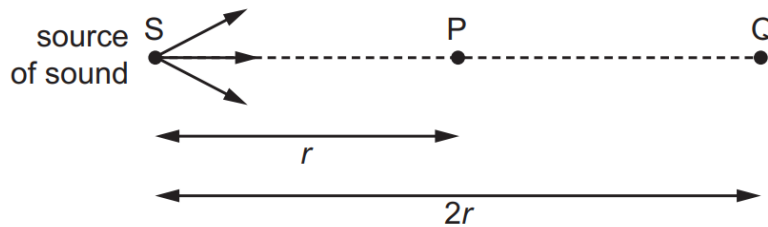
Air molecules at point P, a distance r from the source S, oscillate with amplitude 8.0 μm.

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

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

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

13. 9702/11/O/N/16 Q23

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

14. 9702/11/O/N/16 Q24

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.

tuning fork

air column

water

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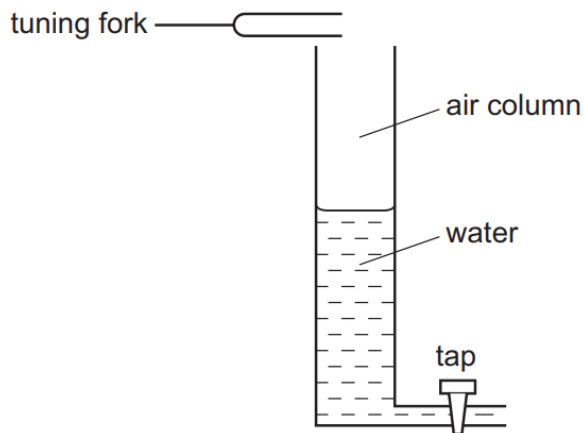
The tube is filled and then water is allowed to run out of it. The first two stationary waves occur when the air column lengths are 0.14 m and 0.42 m.

What is the wavelength of the sound wave?

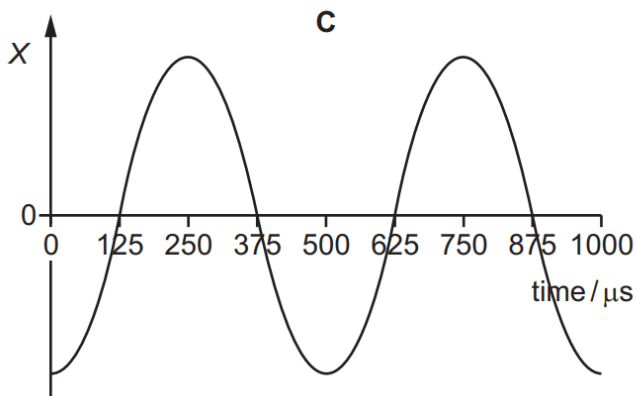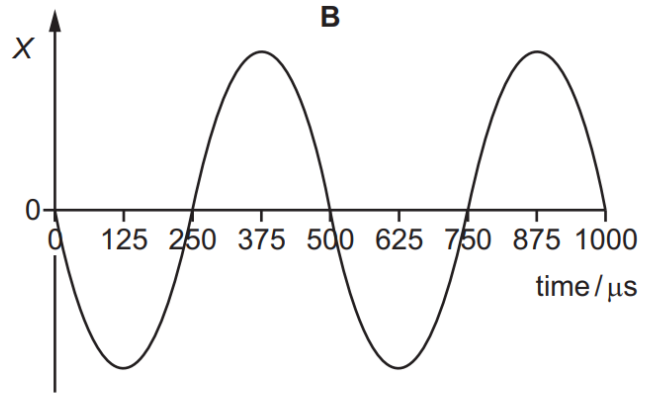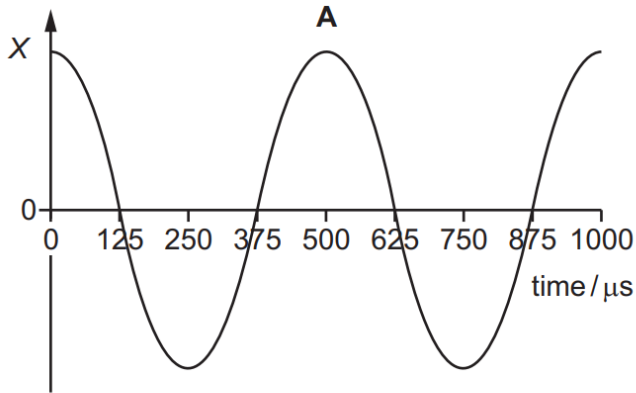**A** 0.14 m **B** 0.28 m **C** 0.42 m **D** 0.56 m

15. 9702/11/O/N/16 Q25

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

X

0

0   125 250 375 500 625 750 875 1000

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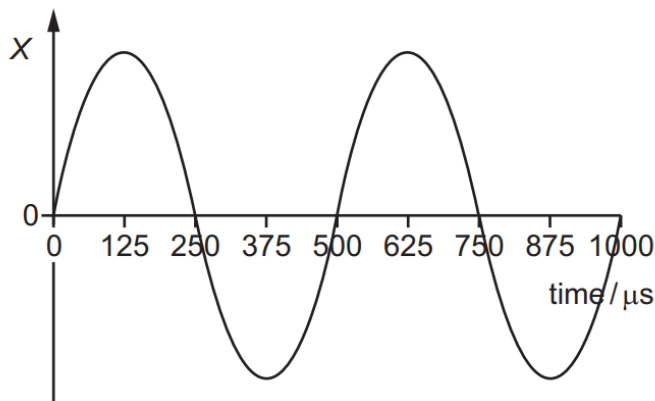
The velocity of sound in the gas is $330\,\mathrm{m\,s^{-1}}$. All the graphs below have the same zero time as the graph above.

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?

A

x

0

0   125   250   375   500   625   750   875   1000

time / μs

B

x

0

0   125   250   375   500   625   750   875   1000

time / μs

C

x

0

0   125   250   375   500   625   750   875   1000

time / μs

D

x

0

0   125   250   375   500   625   750   875   1000

time / μs

16. 9702/11/O/N/16 Q26

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.

initial position
of ambulance
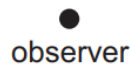
●——▶

final position
of ambulance

●——▶

●
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

Exam Buddy

17. 9702/12/O/N/16 Q23

High-frequency sound waves with frequency 2.0 MHz travel with a speed of $2.0\,km\,s^{-1}$ through a liquid.
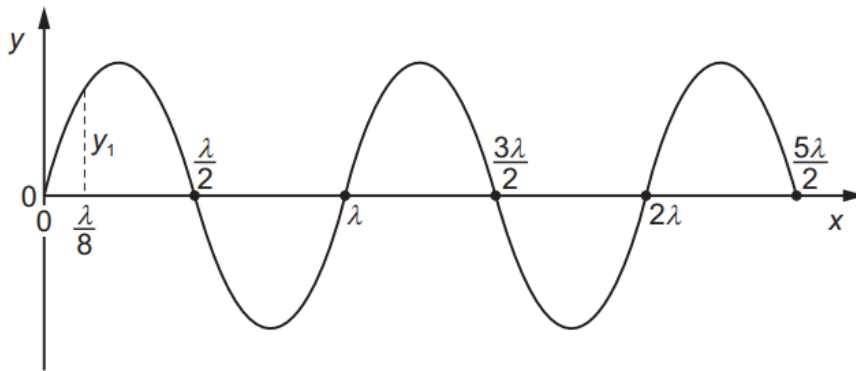
What is the shortest distance between a compression and a rarefaction (expansion) in the liquid?

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

18. 9702/12/O/N/16 Q24

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 $x = \dfrac{\lambda}{8}$ is y_1.

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

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

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

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

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

19. 9702/12/O/N/16 Q25

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 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

20. 9702/12/F/M/17 Q22

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)$^2 \propto \sqrt{\text{intensity}}$

21. 9702/12/F/M/17 Q23

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.

22. 9702/12/F/M/17 Q24

The diagram shows two waves R and S.
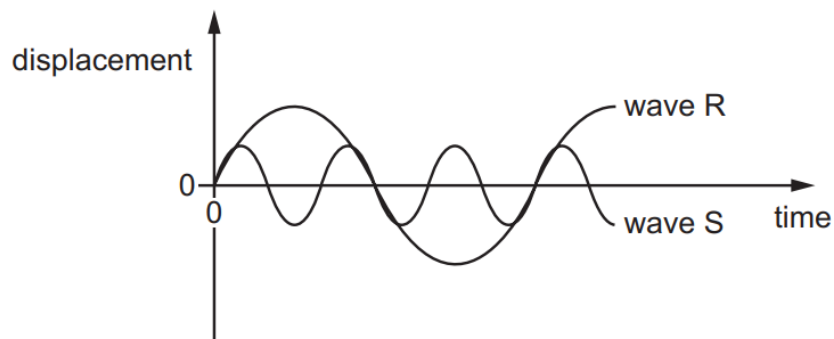
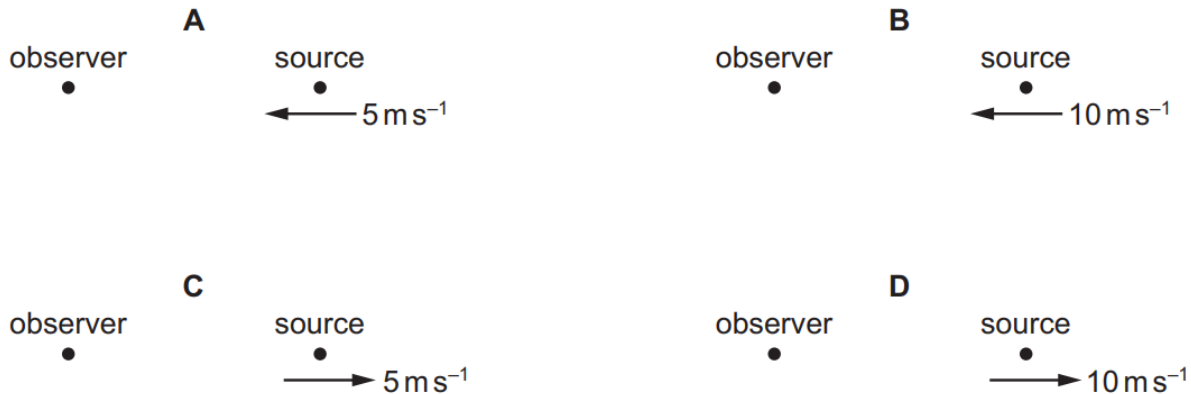Wave R has an amplitude of 8 cm and a period of 30 ms.

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

Exam Buddy

23. 9702/12/F/M/17 Q25

A source of sound waves is travelling as shown.

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

A

observer   source

  •   •

          ← 5 m s⁻¹

B

observer   source

  •   •

          ← 10 m s⁻¹

C

observer   source

  •   •

          → 5 m s⁻¹

D

observer   source

  •   •

          → 10 m s⁻¹

24. 9702/12/F/M/17 Q26

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

25. 9702/11/M/J/17 Q23

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

26. 9702/11/M/J/17 Q24.

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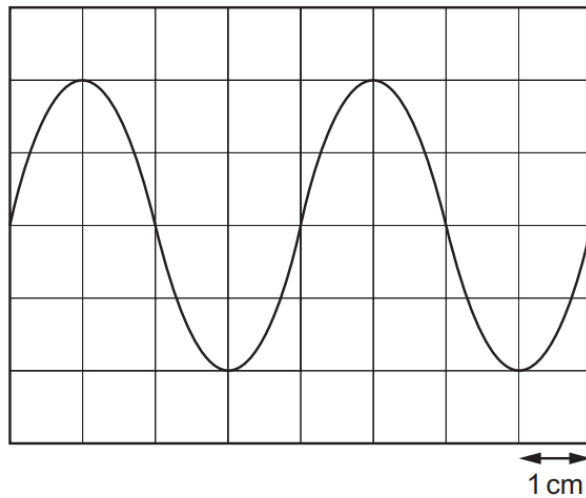
1 cm

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

27. 9702/11/M/J/17 Q25

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

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

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

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

28. 9702/11/M/J/17 Q26

Which list shows electromagnetic waves in order of increasing frequency?

A   radio waves → gamma rays → ultraviolet → infra-red

B   radio waves → infra-red → ultraviolet → gamma rays

C   ultraviolet → gamma rays → radio waves → infra-red

D   ultraviolet → infra-red → radio waves → gamma rays

29. 9702/12/M/J/17 Q22

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}

30. 9702/12/M/J/17 Q23

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.

31. 9702/12/M/J/17 Q24

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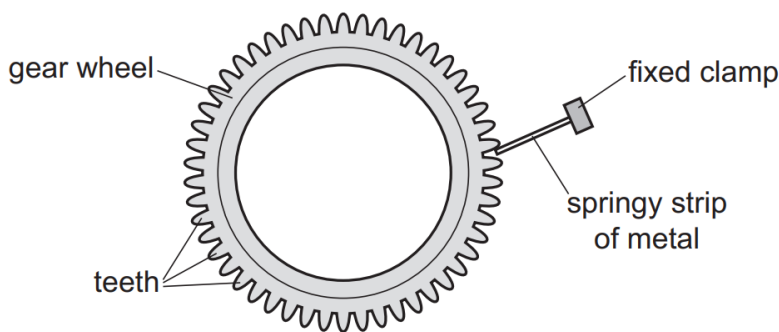
The speed of sound in air is $330 \, \text{m s}^{-1}$.

What is the wavelength of the emitted sound?

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

32. 9702/12/M/J/17 Q25

An ambulance travels along a straight road at a speed of $30.0\,\text{ms}^{-1}$. Its siren emits sound of frequency 2000 Hz. The speed of sound in the air is $340\,\text{ms}^{-1}$. 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

33. 9702/12/M/J/17 Q26

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

34. 9702/13/M/J/17 Q21

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.

35. 9702/13/M/J/17 Q22

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.

direction of travel of wave
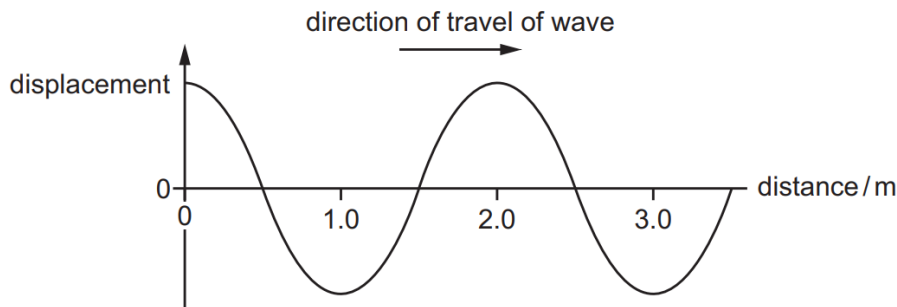
At which distance along the rope do the particles have maximum upwards velocity?

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

36. 9702/13/M/J/17 Q23

A trace is shown on the screen of a cathode-ray oscilloscope (c.r.o.).
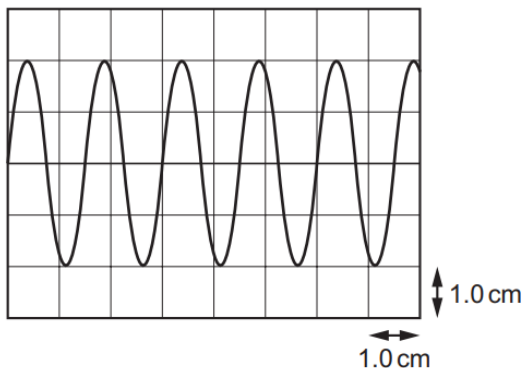
The time-base setting is $2.5\,\text{ms}\,\text{cm}^{-1}$ and the Y-gain is $2.0\,\text{V}\,\text{cm}^{-1}$.

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

Exam Buddy

37. 9702/13/M/J/17 Q24

A high-speed train approaches a stationary observer at a speed of $80\,m\,s^{-1}$. 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** $330\,Hz$

38. 9702/13/M/J/17 Q25

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}

39. 9702/11/O/N/17 Q22

The displacement-time graph for a layer of air in the path of a sound wave is shown.
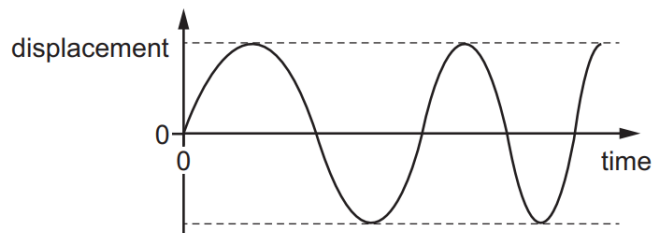
Which wave quantity is increasing?

A amplitude

B frequency

C period

D wavelength

40. 9702/11/O/N/17 Q25

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.
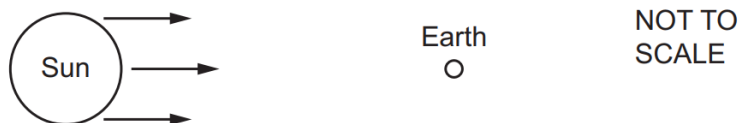
What could be the explanation for this Doppler effect?

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.

41. 9702/11/O/N/17 Q26

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

A $10^{10}\,\text{Hz}$ **B** $10^{12}\,\text{Hz}$ **C** $10^{14}\,\text{Hz}$ **D** $10^{16}\,\text{Hz}$

42. 9702/12/O/N/17 Q22

When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown.
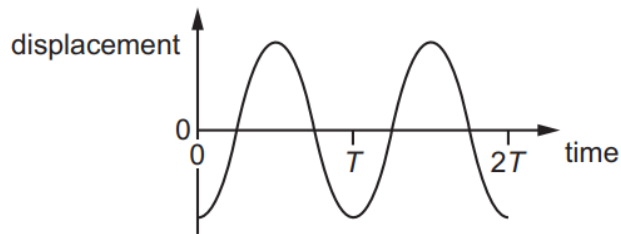
Which graph best shows how the kinetic energy of the air particle varies with time?

A

B

C

D
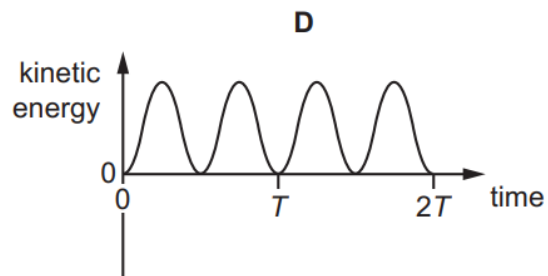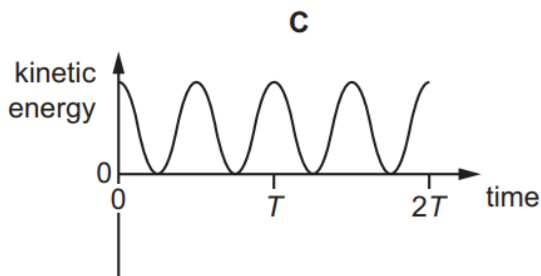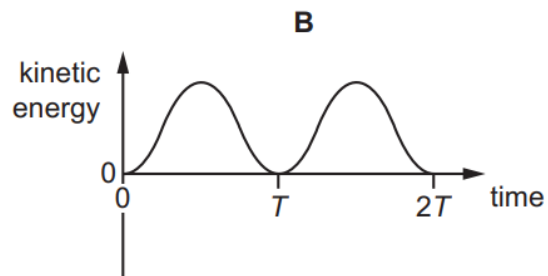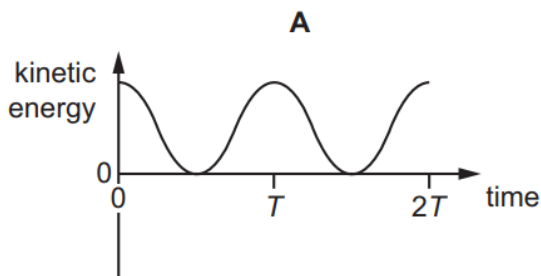
43. 9702/12/O/N/17 Q23

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

44. 9702/12/O/N/17 Q25

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 0.85*f*.

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

What is the velocity of the train?

A $51 \, \text{m s}^{-1}$ away from the woman

B $51 \, \text{m s}^{-1}$ towards the woman

C $60 \, \text{m s}^{-1}$ away from the woman

D $60 \, \text{m s}^{-1}$ towards the woman

45. 9702/12/O/N/17 Q26

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** $5.0 \times 10^{14} \, \text{Hz}$

46. 9702/13/O/N/17 Q22

The graph shows how the displacement of a particle in a wave varies with time.
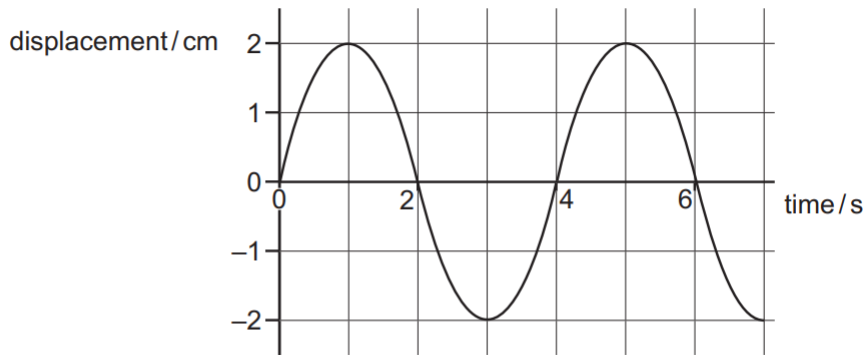
Which statement is correct?

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.

47. 9702/13/O/N/17 Q23

A wave travels along a coiled spring.

The graph shows the variation with time of the displacement of a point on the spring.
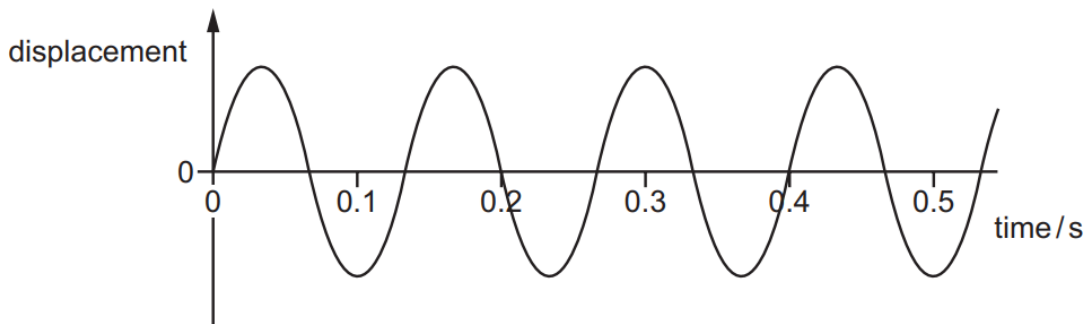
What is the frequency of the wave?

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

48. 9702/13/O/N/17 Q24

An electrical signal is displayed on a cathode-ray oscilloscope (c.r.o.).
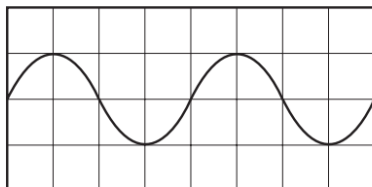
The time-base setting is $50\,\text{ms div}^{-1}$.

The Y-gain setting is $2\,\text{V div}^{-1}$.

What is the amplitude of the signal?

A 2 V   **B** 4 V   **C** 5 V   **D** 10 V

49. 9702/13/O/N/17 Q25

A source of sound of frequency F at point Z is moving at a steady speed. The pattern of the emitted wavefronts is shown.
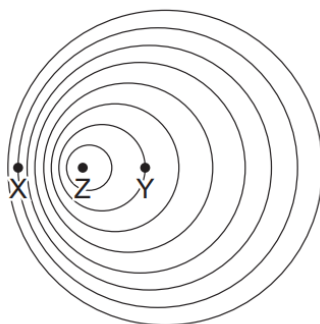
Which row describes the frequencies of the sound heard by stationary observers at X and Y?

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

50. 9702/13/O/N/17 Q26

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}

51. 9702/13/O/N/17 Q27

Which frequency of electromagnetic radiation could be ultraviolet?

A 1.0×10^6 Hz

B 1.0×10^9 Hz

C 1.0×10^{12} Hz

D 1.0×10^{15} Hz

52. 9702/13/O/N/17 Q28

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

53. 9702/12/F/M/18 Q21

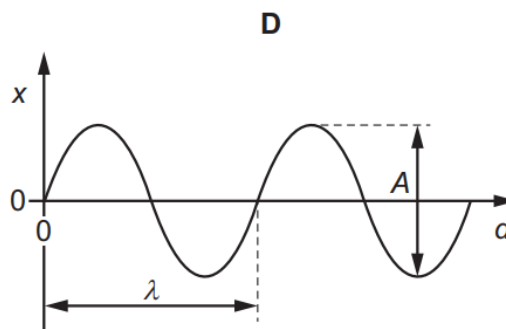A wave pulse moves along a stretched rope in the direction shown.
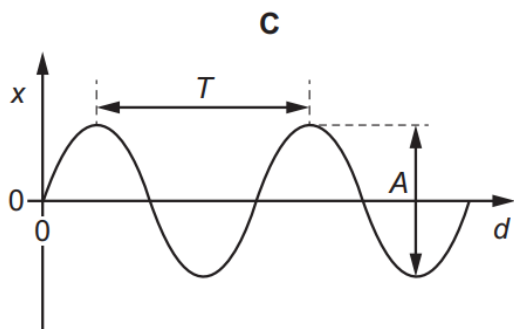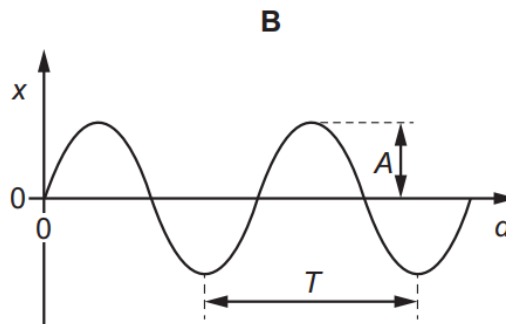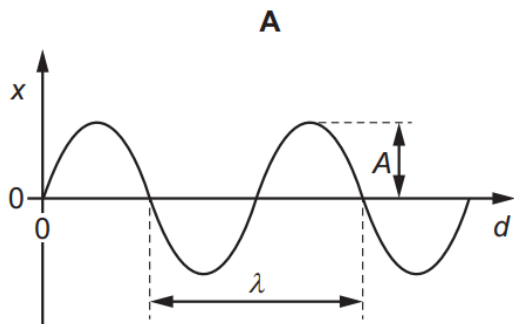
Which diagram shows the variation with time *t* of the displacement *s* of the particle P in the rope?

A

B

C

D
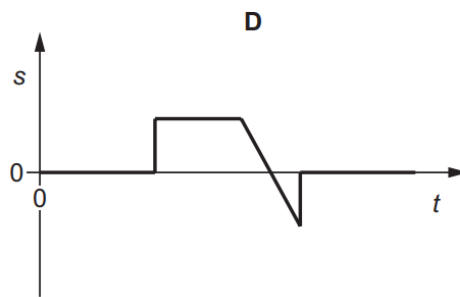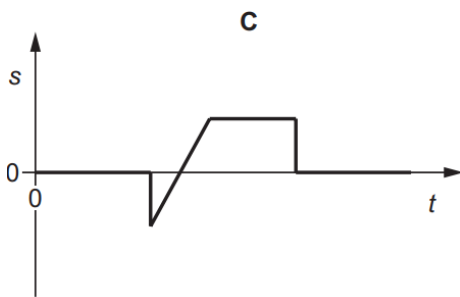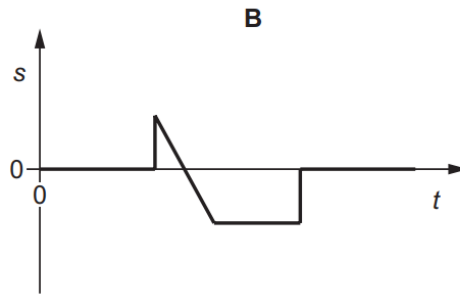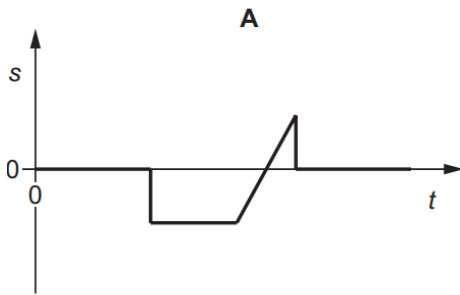
54. 9702/12/F/M/18 Q22

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?

55. 9702/12/F/M/18 Q23

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}

56. 9702/12/F/M/18 Q24

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

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

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

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

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

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

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

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

57. 9702/12/F/M/18 Q25

The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.
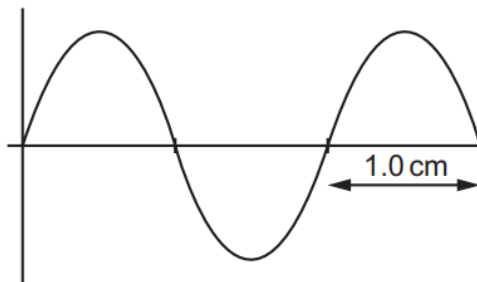
The time base setting is $0.20\,\mu s\,cm^{-1}$.

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.

58. 9702/11/M/J/18 Q20

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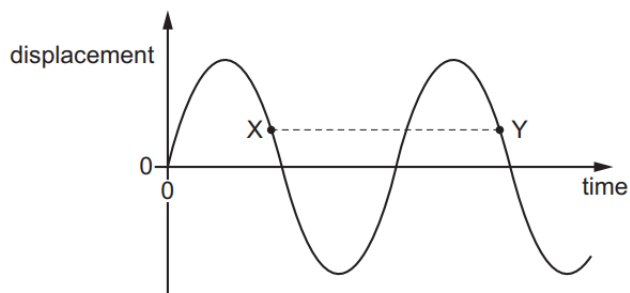
The separation XY on the graph represents the ......1...... of the wave.

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

59. 9702/11/M/J/18 Q21

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

60. 9702/11/M/J/18 Q22

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?
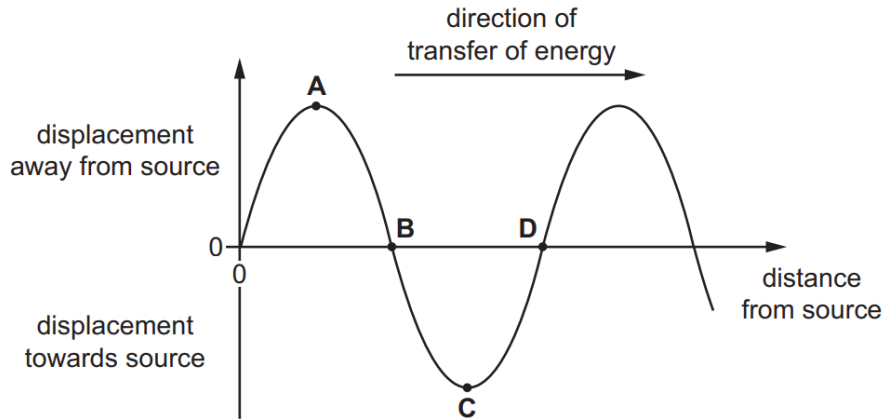
61. 9702/11/M/J/18 Q23

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.

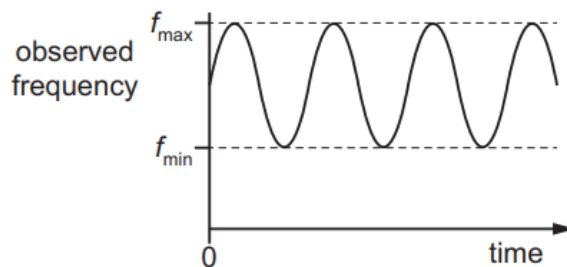D   The wavelength range for X-rays is less than that for radio waves.

62. 9702/11/M/J/18 Q24

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

63. 9702/12/M/J/18 Q22

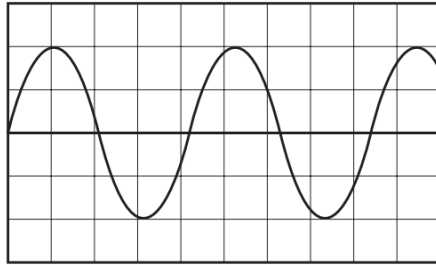Two lasers emit light in a vacuum. One laser emits red light and the other emits green light.

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

A   amplitude

B   frequency

C   intensity

D   speed

64. 9702/12/M/J/18 Q23

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

65. 9702/12/M/J/18 Q25

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

66. 9702/12/M/J/18 Q27

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

67. 9702/13/M/J/18 Q20

The displacement-distance graph for a transverse progressive wave is shown.
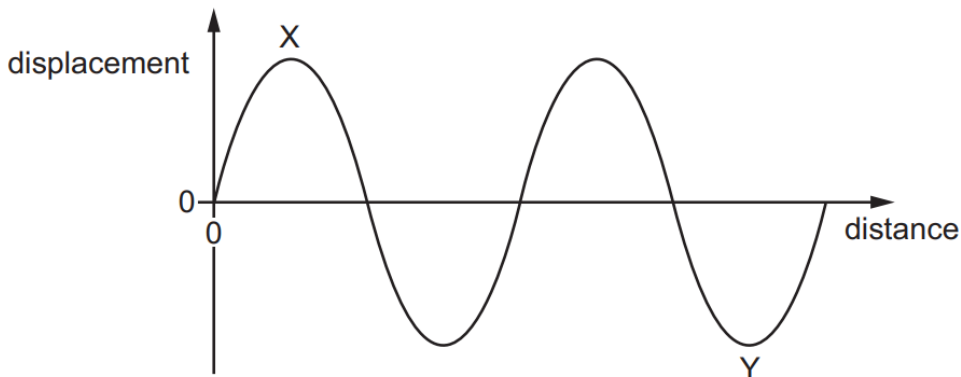
The phase difference between points X and Y can be expressed as $(180\,n)°$.

What is the value of n?

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

68. 9702/13/M/J/18 Q21

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.
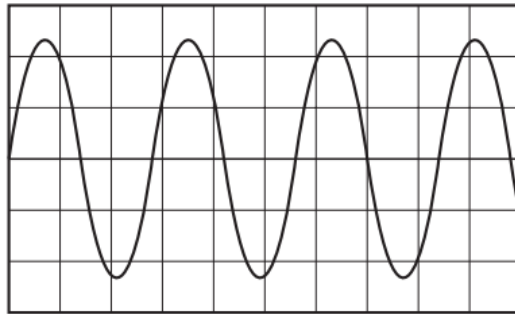
Which graph is correctly labelled?
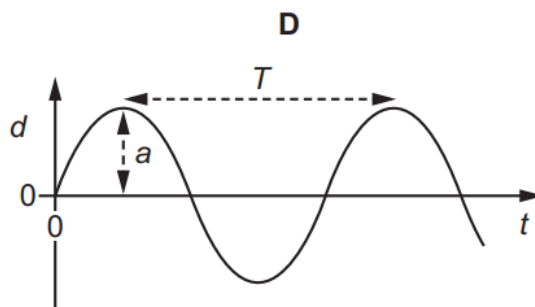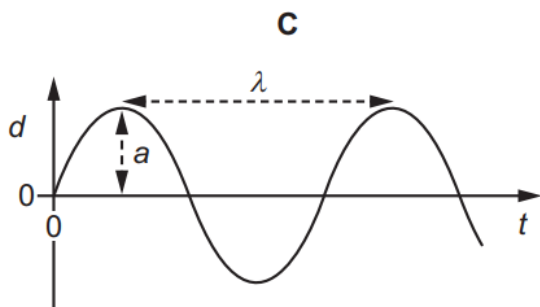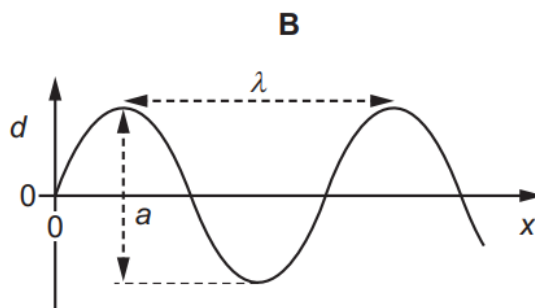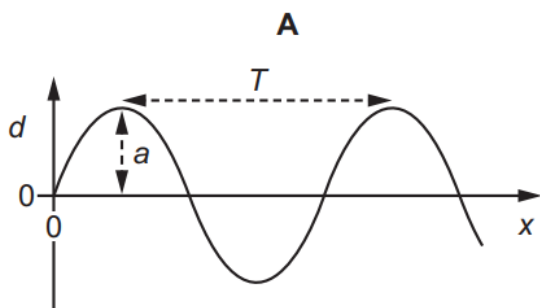
69. 9702/13/M/J/18 Q22

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

70. 9702/13/M/J/18 Q23

A police car travels at a velocity of $30.0\,\text{m s}^{-1}$ directly towards a stationary observer. The horn of the car emits sound of frequency 2000 Hz. The speed of sound is $340\,\text{m s}^{-1}$.

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

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

71. 9702/11/O/N/18 Q21

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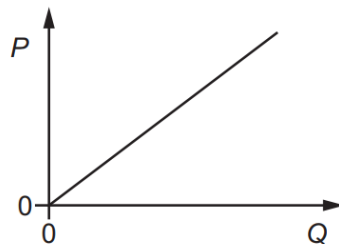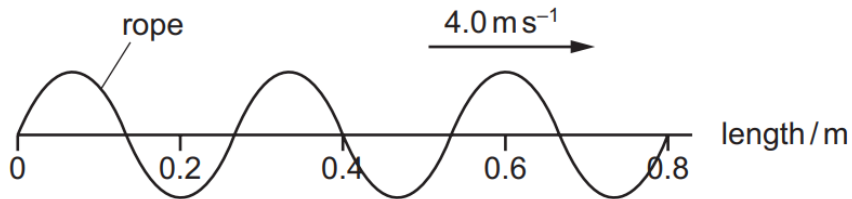

What could *P* and *Q* be?

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

72. 9702/11/O/N/18 Q22

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 $4.0\,ms^{-1}$.
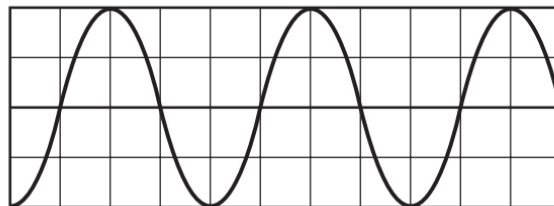

What are the wavelength and the frequency of the wave?

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

73. 9702/11/O/N/18 Q23

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

74. 9702/11/O/N/18 Q24

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

75. 9702/11/O/N/18 Q25

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
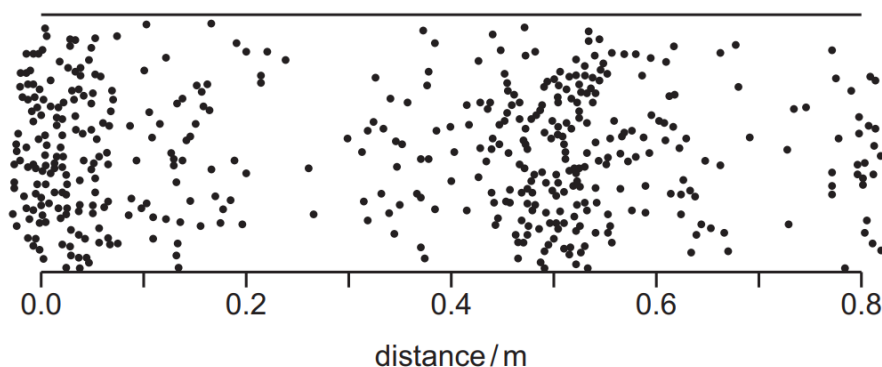
D X-ray telescope

76. 9702/12/O/N/18 Q22

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 m s^{-1} **B** 10 m s^{-1} **C** 20 m s^{-1} **D** 40 m s^{-1}

77. 9702/12/O/N/18 Q23

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

distance / m

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

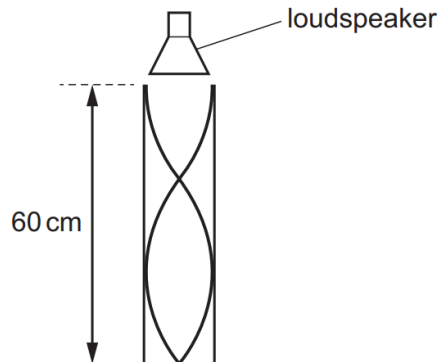What is the approximate frequency of the sound wave shown?

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

78. 9702/12/O/N/18 Q24

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 $340\,\text{m}\,\text{s}^{-1}$.

What is the frequency of the sound?

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

79. 9702/12/O/N/18 Q25

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 $40.0\,\text{m}\,\text{s}^{-1}$ towards a stationary observer. The speed of sound in the air is $340\,\text{m}\,\text{s}^{-1}$.

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

80. 9702/12/O/N/18 Q26

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

81. 9702/13/O/N/18 Q21

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?

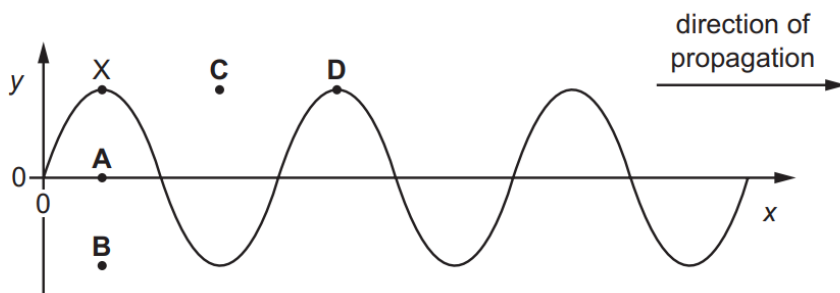A $\dfrac{I}{9}$ B $\dfrac{I}{3}$ C $3I$ D $9I$

82. 9702/13/O/N/18 Q22

The variation with distance x of the displacement y of a transverse wave on a rope is shown at time $t = 0$.
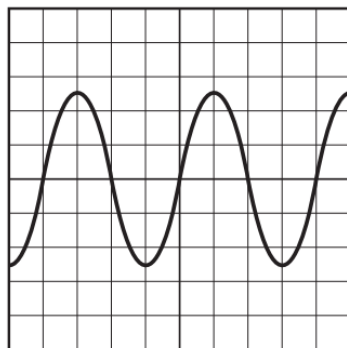
The wave has a frequency of 0.5 Hz.

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?

83. 9702/13/O/N/18 Q23

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

84. 9702/13/O/N/18 Q24

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

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

Which frequency does the ultrasound detector record?

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

85. 9702/13/O/N/18 Q25

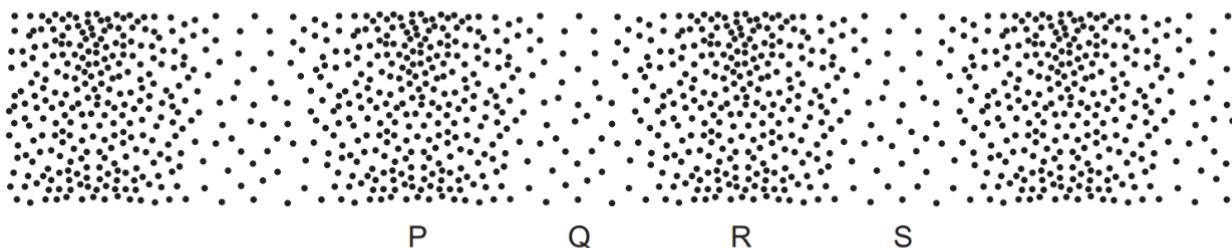An electromagnetic wave has a wavelength of $1.0 \times 10^{-7}\,\mathrm{m}$.

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

A   infra-red

B   ultraviolet

C   visible

D   X-ray

86. 9702/12/F/M/19 Q22

A sound wave passes through air.

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

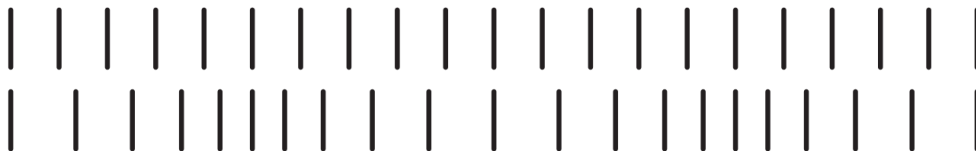Which distance is equal to the wavelength of the wave?

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

87. 9702/12/F/M/19 Q23

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

88. 9702/12/F/M/19 Q25

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 $25.0\,\text{m s}^{-1}$.
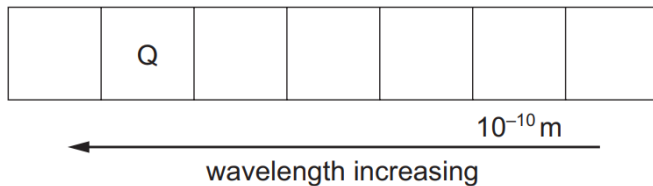

observer   buzzer
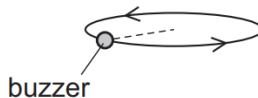
The speed of sound is $340\,\text{m s}^{-1}$.

What is the maximum frequency heard by the observer?

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

89. 9702/12/F/M/19 Q26

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

10^{-10} m

wavelength increasing

What is a typical order of magnitude of the wavelength of the radiation in region Q?
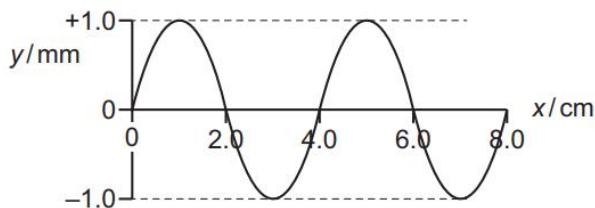
A 10^{-7} m **B** 10^{-5} m **C** 10^{-2} m **D** 10^{0} m

90. 9702/11/M/J/19 Q22
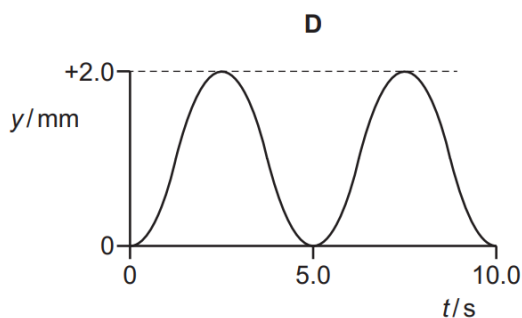
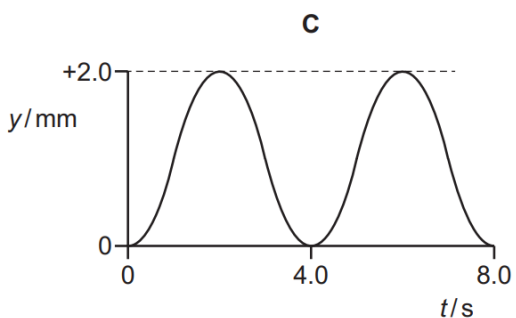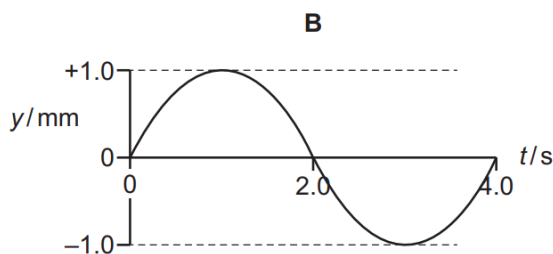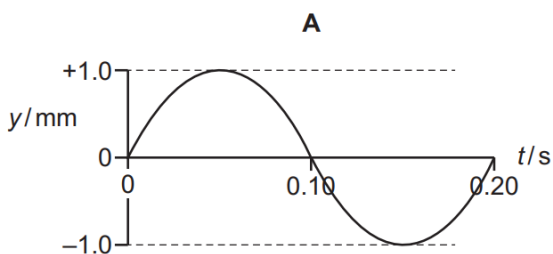A transverse wave in a medium has the waveform shown, where

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?
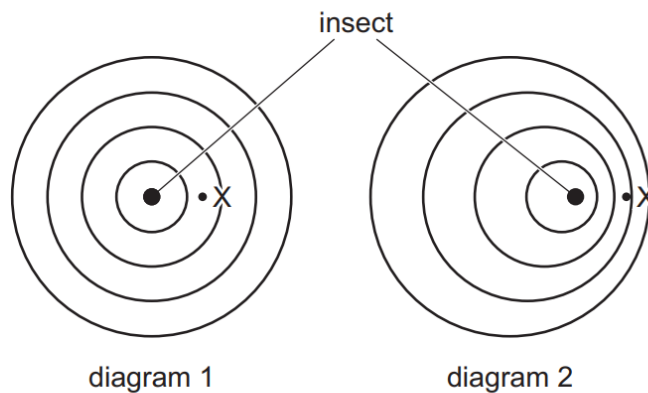
91. 9702/11/M/J/19 Q23

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?
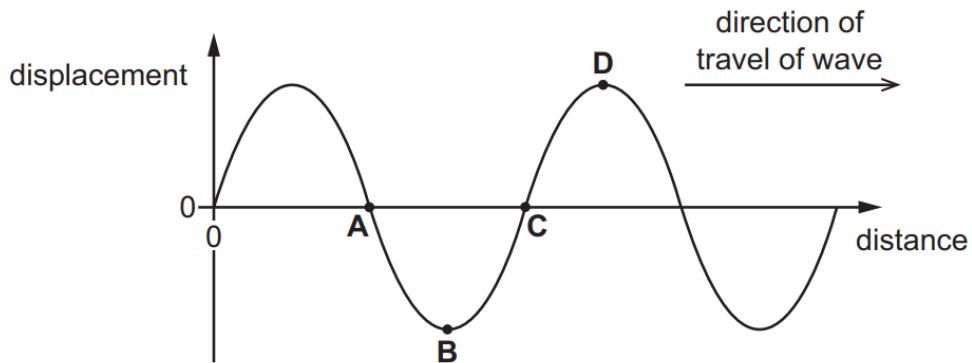
92. 9702/11/M/J/19 Q25

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.

diagram 1   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

Exam Buddy

93. 9702/11/M/J/19 Q26

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

94. 9702/11/M/J/19 Q27

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

What is the speed of the progressive waves?

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

95. 9702/12/M/J/19 Q23

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

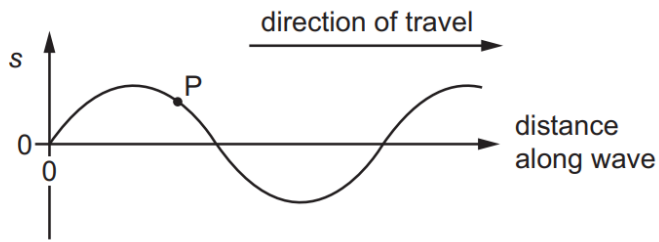The speed of the wave is v. P and Q are two points in the wave a distance L apart.

What is an expression for the frequency of the wave?

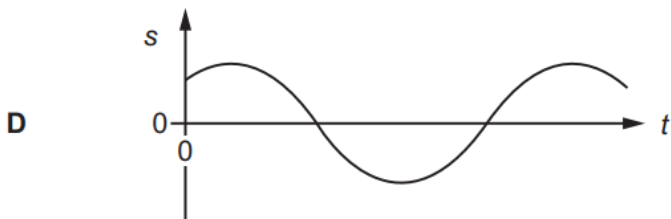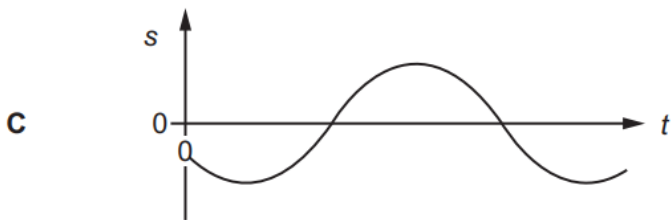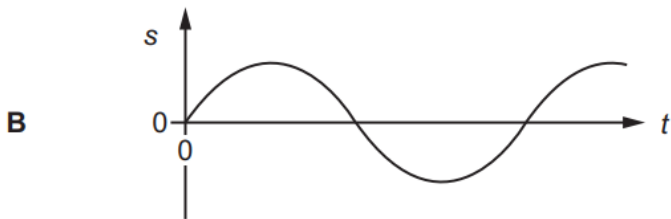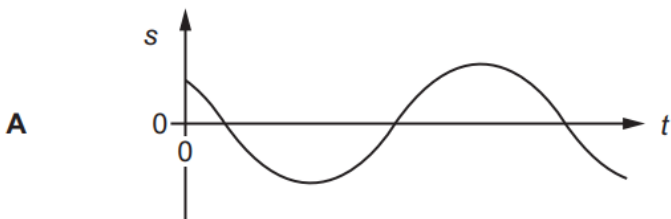**A** $\dfrac{v}{2L}$ **B** $\dfrac{v}{L}$ **C** $\dfrac{2v}{L}$ **D** $\dfrac{L}{v}$

96. 9702/12/M/J/19 Q24

A wave moves along the surface of water.

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

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

A

B

C

D

97. 9702/12/M/J/19 Q26

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}

98. 9702/12/M/J/19 Q27

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

99. 9702/12/M/J/19 Q28

A cathode-ray oscilloscope (CRO) is used to display the trace from a sound wave. The time-base is set at 5 μs mm^{-1}.
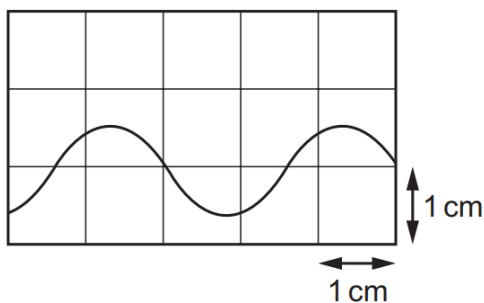
What is the frequency of the sound wave?

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

100. 9702/13/M/J/19 Q21

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°

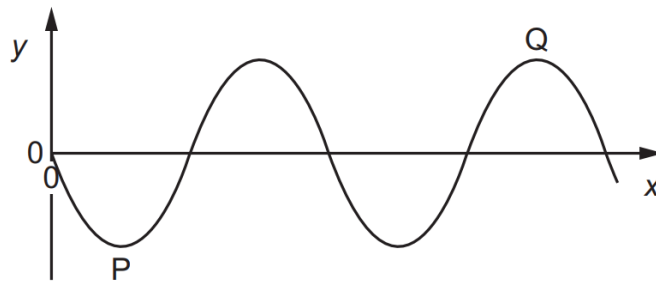**101.** 9702/13/M/J/19 Q22

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

102. 9702/13/M/J/19 Q23

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

1 cm
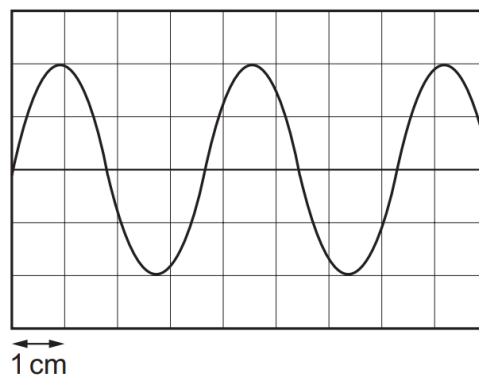
What is the time-base setting on the CRO?

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

Exam Buddy

103. 9702/13/M/J/19 Q24

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 m s^{-1}. The motor boat moves with a speed of 5.0 m s^{-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

104. 9702/13/M/J/19 Q25

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

What is a typical wavelength of infrared radiation?

A 5×10^{-5} m   **B** 5×10^{-7} m   **C** 2×10^{-9} m   **D** 2×10^{-11} m

105. 9702/11/O/N/19 Q21

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 $t = 0$.
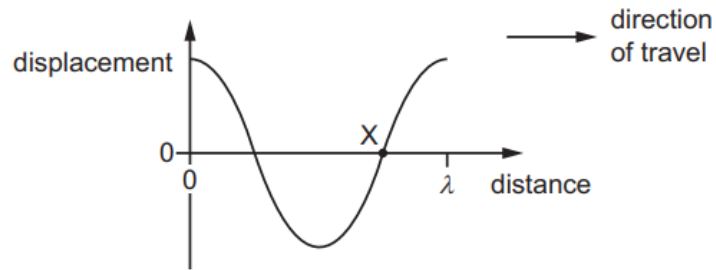
A particle X is labelled.

Which graph shows the variation of the displacement of particle X with time t?
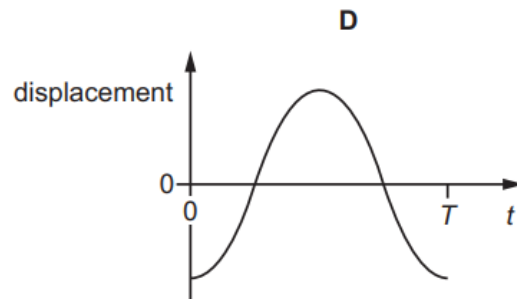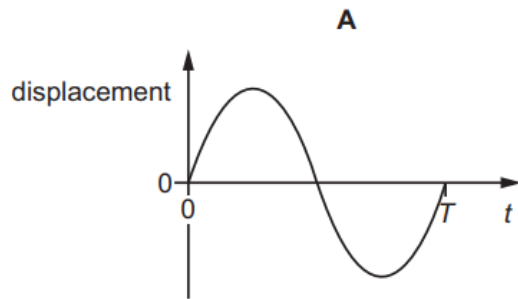
106.   9702/11/O/N/19 Q22

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.

107.   9702/11/O/N/19 Q24

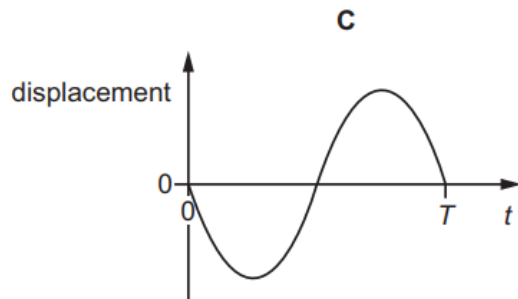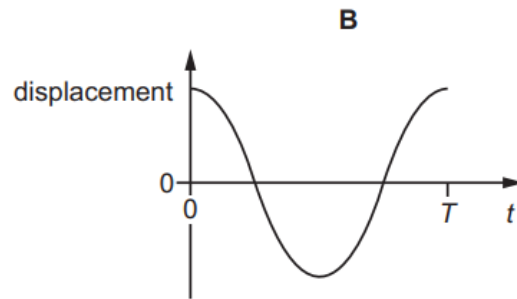The siren of a moving police car emits a sound wave with a frequency of 440 Hz. A stationary observer hears sound of frequency 494 Hz. The speed of sound in the air is 340 m s^{-1}.

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

108.   9702/11/O/N/19 Q25

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

109.   9702/12/O/N/19 Q20

A transverse wave is travelling along a rope. The frequency of the wave is 2.0 Hz. The graph shows the variation with distance of the displacement of the wave at time $t = 0$.
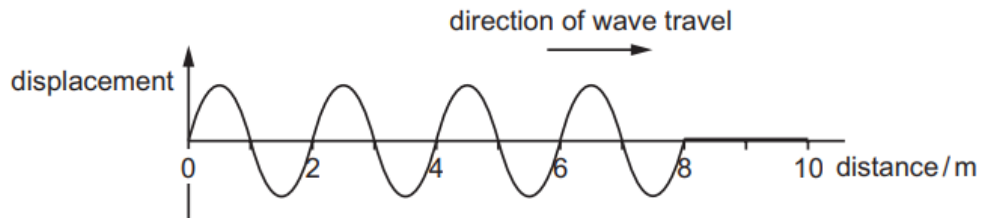
Which diagram shows the position of the wave at time $t = 0.5$ s?
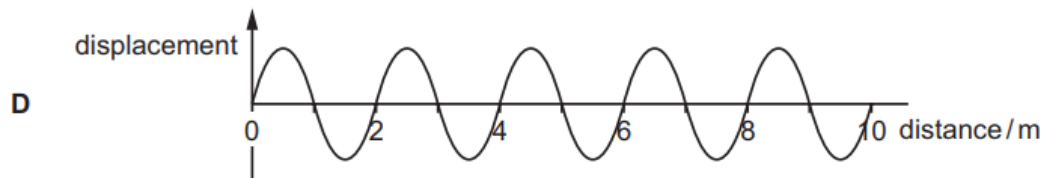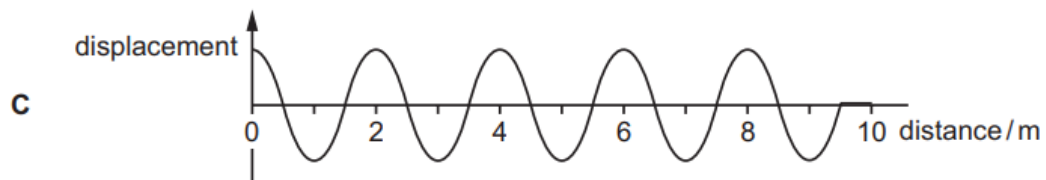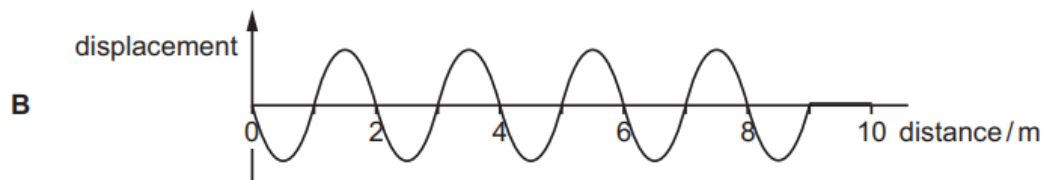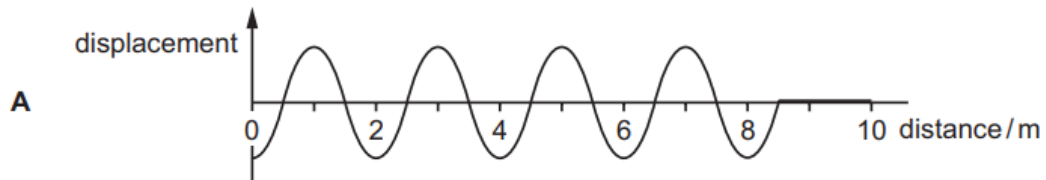
110. 9702/12/O/N/19 Q21

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.
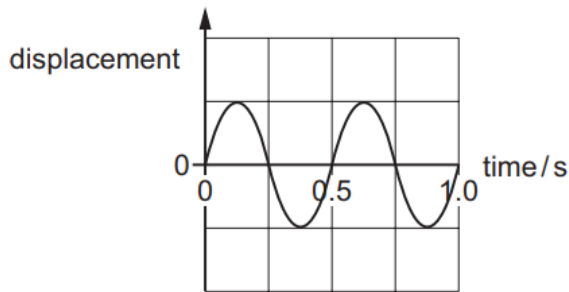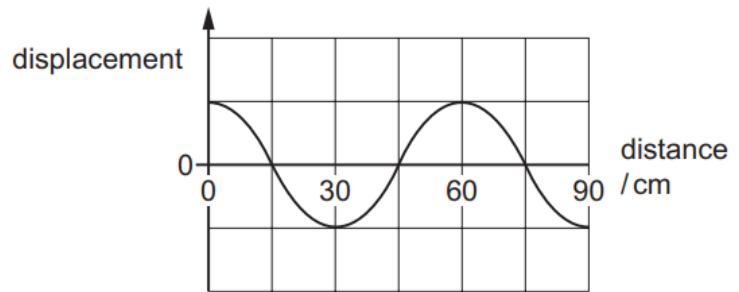
graph 1   graph 2

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}

111. 9702/12/O/N/19 Q22

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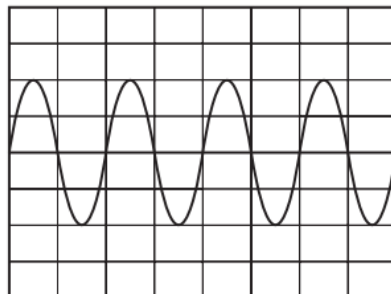
The time-base setting on the CRO is 2.00 ms per division.

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

112. 9702/12/O/N/19 Q23

A loudspeaker emitting a constant frequency of 2000 Hz is swung in a horizontal circle with a speed of $15.0\,\text{m}\,\text{s}^{-1}$.

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 $294\,\text{m}\,\text{s}^{-1}$ **B** $309\,\text{m}\,\text{s}^{-1}$ **C** $324\,\text{m}\,\text{s}^{-1}$ **D** $330\,\text{m}\,\text{s}^{-1}$

113. 9702/12/O/N/19 Q24

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

114. 9702/13/O/N/19 Q21

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.

115.   9702/13/O/N/19 Q22

The graph represents a sound wave.
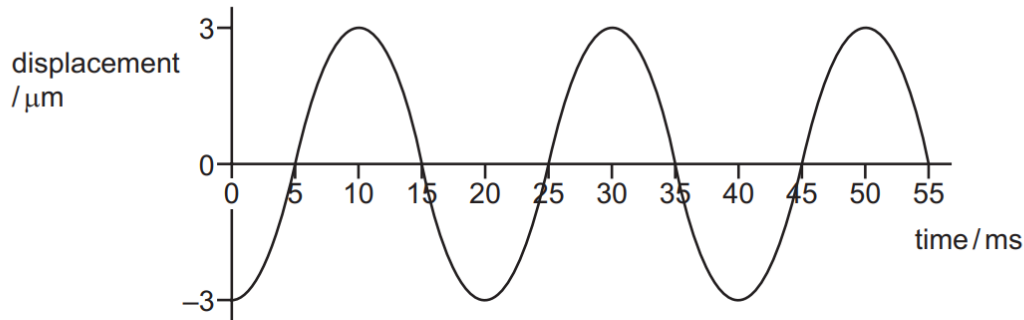
Which statement is correct?

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 μm.

D   The wave is transverse and has a wavelength of 20 ms.

116.   9702/13/O/N/19 Q23

A cathode-ray oscilloscope (CRO) is used to display a wave of frequency 5.0 kHz. The display is shown.
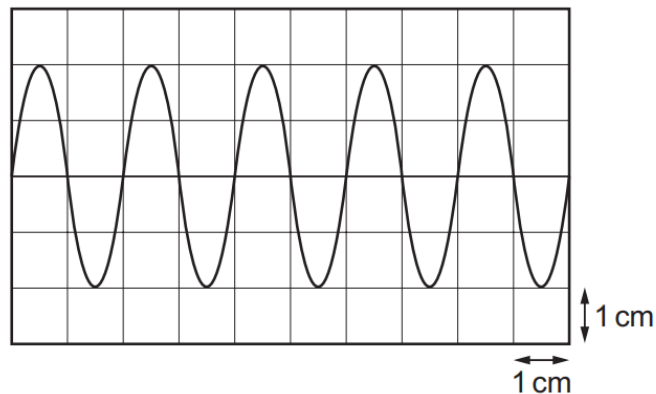
What is the time-base setting of the CRO?

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

Exam**Buddy**

117. 9702/13/O/N/19 Q24

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 $\dfrac{1000 \times 330}{330 + 20}$

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

C $\dfrac{1000\,(330 + 20)}{330}$

D $\dfrac{1000\,(330 - 20)}{330}$

118. 9702/13/O/N/19 Q25

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

119. 9702/12/F/M/20 Q21

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.

Exam Buddy

120.   9702/12/F/M/20 Q22

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

121.   9702/12/F/M/20 Q23

A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.
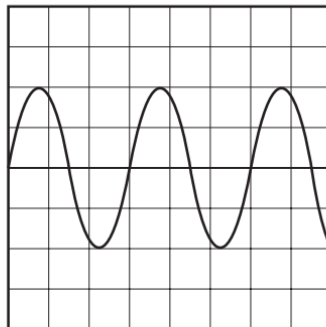
The time-base setting is 0.50 ms per division.

What is the frequency of the sound wave?

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

122.   9702/12/F/M/20 Q24

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

123. 9702/12/F/M/20 Q25

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}

124. 9702/11/M/J/20 Q22

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.

125. 9702/11/M/J/20 Q23

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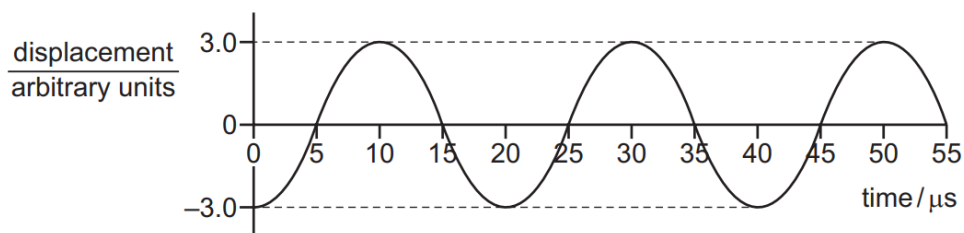
The wave is travelling in a vacuum.

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

126. 9702/11/M/J/20 Q25

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?

A

B

C

D
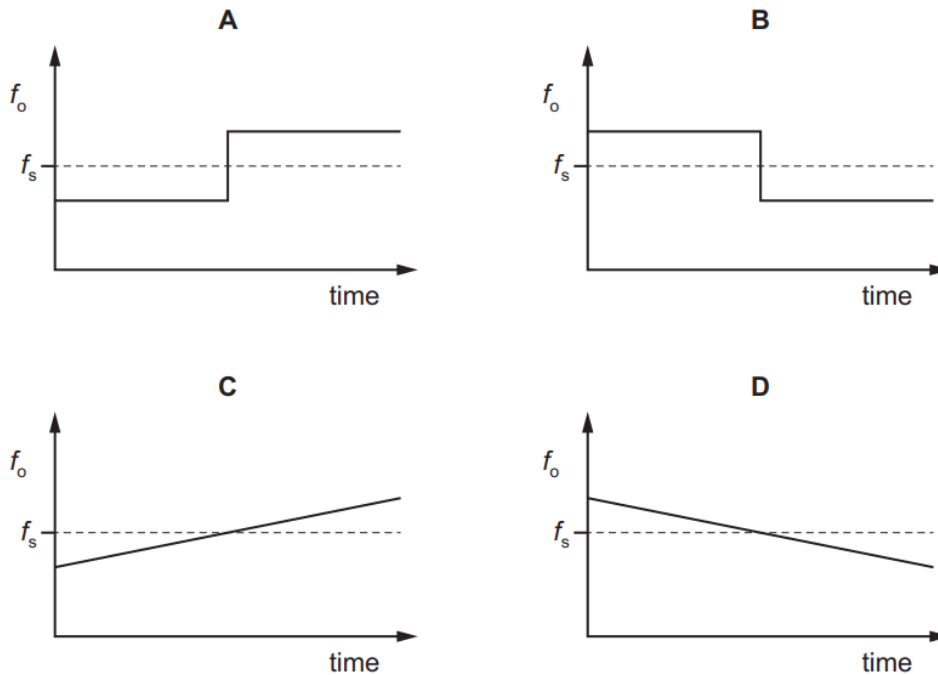
127. 9702/11/M/J/20 Q26

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

128. 9702/12/M/J/20 Q21

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.

129. 9702/12/M/J/20 Q22

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°

130. 9702/12/M/J/20Q23

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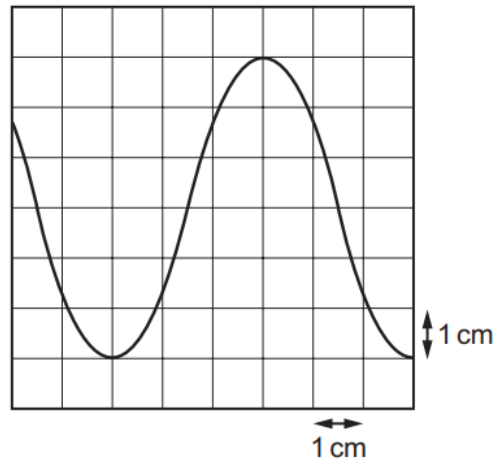
	frequency /Hz	amplitude /mV
A	330	0.6
B	330	1.2
C	670	0.6
D	670	1.2

131. 9702/12/M/J/20 Q26

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

132. 9702/13/M/J/20 Q22

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** $\frac{A}{16}$

133. 9702/13/M/J/20 Q23

A wave travels along a coiled spring.

The graph shows the variation with time of the displacement of a point on the spring.
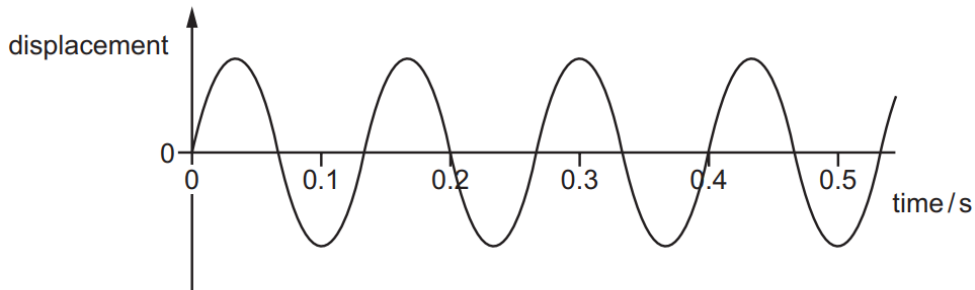
What is the frequency of the wave?

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

134. 9702/13/M/J/20 Q26

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}

135. 9702/11/O/N/20 Q21

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

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

136. 9702/11/O/N/20 Q22

The graph shows the variation with time of displacement for two different waves X and Y.
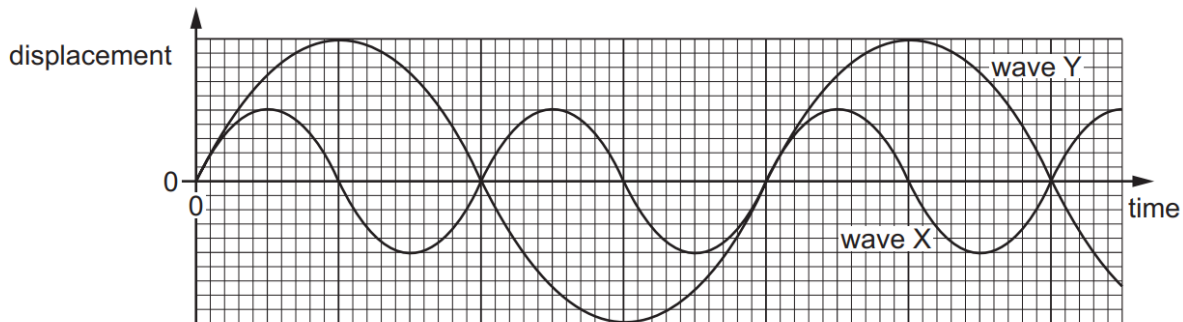
Wave X has frequency f and amplitude A.

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	$2f$	$2A$

137. 9702/11/O/N/20 Q24

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}

138. 9702/11/O/N/20 Q25

The graph shows how the intensity of electromagnetic radiation emitted from a distant star varies with wavelength.
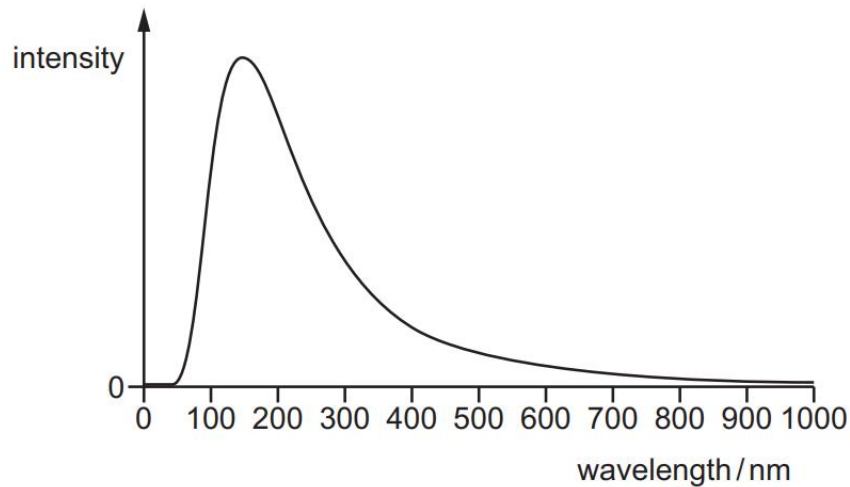
In which region of the electromagnetic spectrum is the radiation of greatest intensity?

A infrared

B visible light

C ultraviolet

D X-ray

139. 9702/12/O/N/20 Q22

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 $\dfrac{1}{\lambda}$

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

140. 9702/12/O/N/20 Q23

When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown.
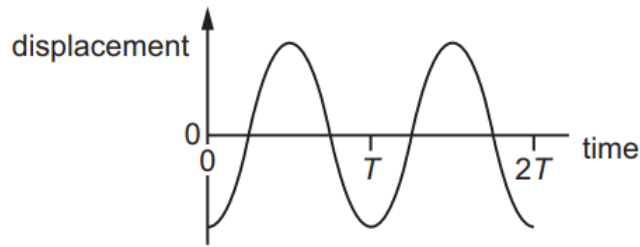
Which graph shows how the kinetic energy of the air particle varies with time?
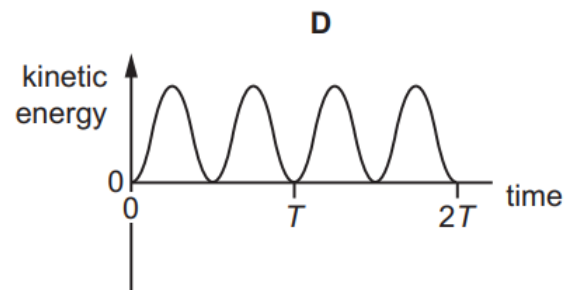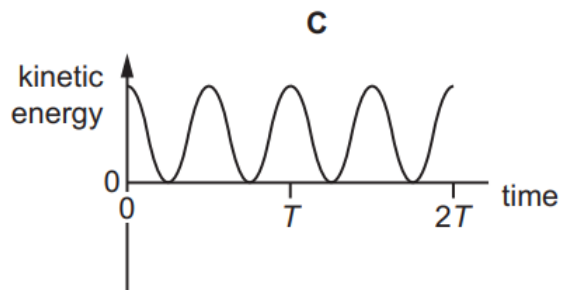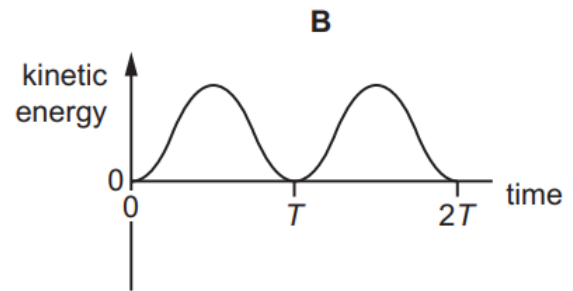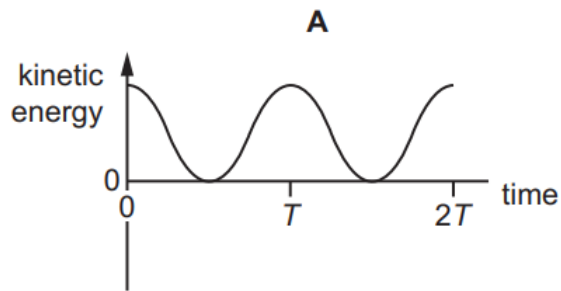
141.   9702/12/O/N/20 Q25

An emergency vehicle sounds its siren as it accelerates along a straight road between two points X and Y, as shown in the diagram.
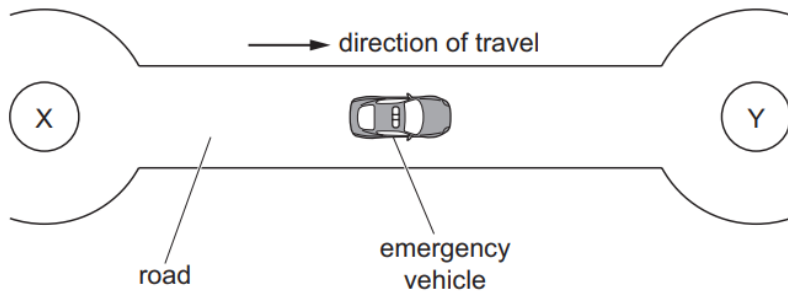
The frequency of the sound emitted by the siren is 750 Hz.

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

142.   9702/12/O/N/20 Q26

Part of the electromagnetic spectrum is shown.
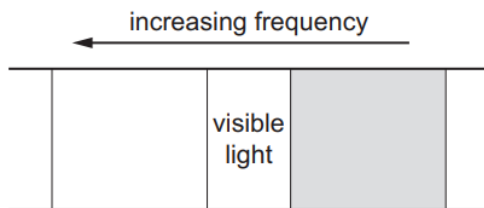
What is the name of the shaded region and what is the order of magnitude of a wavelength of a wave from this region?

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

Exam Buddy

143. 9702/13/O/N/20 Q22

Two waves X and Y have the same frequency. The amplitude of X is $1.5A_0$ and the amplitude of Y is $2.5A_0$. The waves meet at a point and superpose to form a resultant wave.

For the resultant wave, what is the ratio $\dfrac{\text{maximum possible intensity}}{\text{minimum possible intensity}}$?

A   1.7　　　　　**B**   2.8　　　　　**C**   4.0　　　　　**D**   16

144. 9702/13/O/N/20 Q23

The displacement–time graph for an air particle in the path of a sound wave is shown.
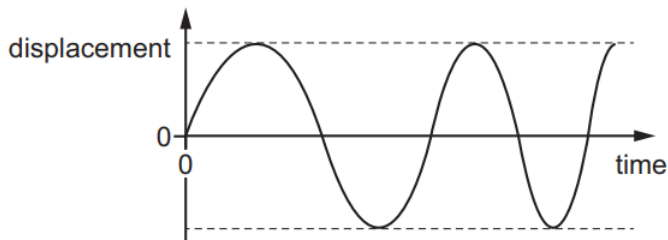
Which property of the sound wave must be increasing?

A   amplitude

B   frequency

C   period

D   speed

145. 9702/13/O/N/20 Q24

A sound wave is displayed on the screen of a cathode-ray oscilloscope (CRO) as shown.
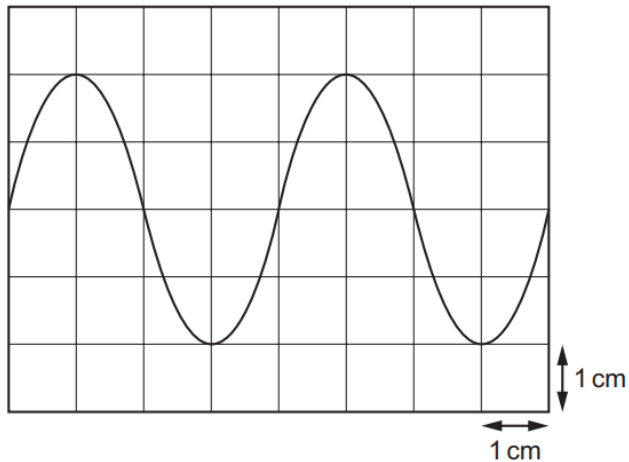
The time-base of the CRO is set at $2.5\,\text{ms}\,\text{cm}^{-1}$.

What is the frequency of the sound wave?

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

146. 9702/13/O/N/20 Q25

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 $\dfrac{f_1}{f_2}$?

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

147. 9702/13/O/N/20 Q26

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

148. 9702/12/F/M/21 Q21

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** $180°$

149. 9702/12/F/M/21 Q22

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.

150. 9702/12/F/M/21 Q24

A source of sound of frequency F at point Z is moving at a steady speed. The pattern of the emitted wavefronts is shown.
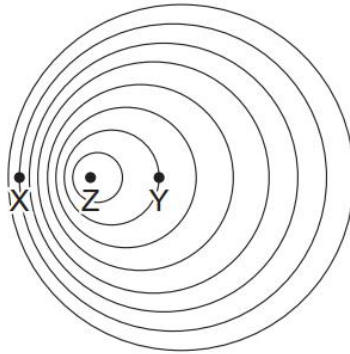
Which row describes the frequencies of the sound heard by stationary observers at X and Y?

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

151. 9702/12/F/M/21 Q25

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}

152.   9702/11/M/J/21 Q21

Two identical waves are produced by sources at points P and Q. The waves travel along different paths to reach point R, as shown.
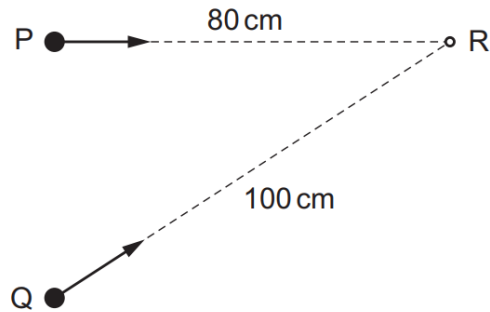
Both waves have a wavelength of 6.0 cm. The waves are in phase at point R.

What is the phase difference between the waves as they leave points P and Q?

A   0°   **B**   60°   **C**   90°   **D**   120°

153.   9702/11/M/J/21 Q22

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?

154. 9702/11/M/J/21 Q23

A stationary wave is formed from two identical sound waves.

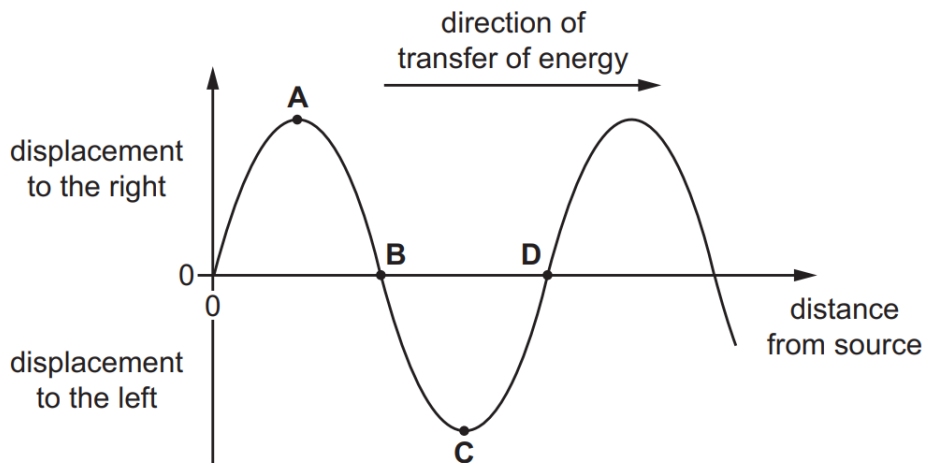A microphone is placed at a position of maximum loudness. It is then moved along the stationary wave from this first position of maximum loudness to the fourth position of maximum loudness. The microphone moves a distance of 12 cm.

The speed of sound is $330\,\mathrm{m\,s^{-1}}$.

What is the frequency of the sound waves?

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

155. 9702/11/M/J/21 Q24

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

156. 9702/11/M/J/21 Q25

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

157. 9702/12/M/J/21 Q21

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

158. 9702/12/M/J/21 Q22

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.
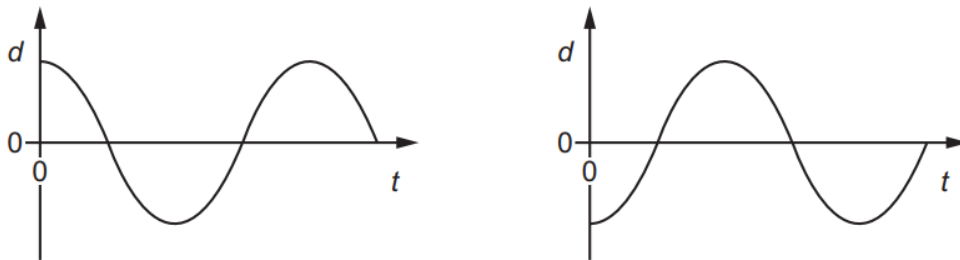
What could be represented by the two graphs?

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

159. 9702/12/M/J/21 Q23

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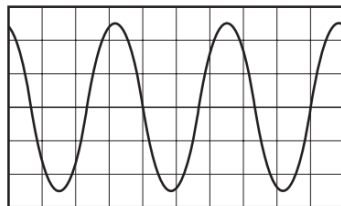
The time-base is set to $20\,\mu s\,div^{-1}$.

What is the frequency of the sound wave?

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

160. 9702/12/M/J/21 Q24

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 $340\,\text{m}\,\text{s}^{-1}$.

What is the speed of the train?

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

161. 9702/12/M/J/21 Q25

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

162. 9702/13/M/J/21 Q22

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 $x = \dfrac{\lambda}{8}$.
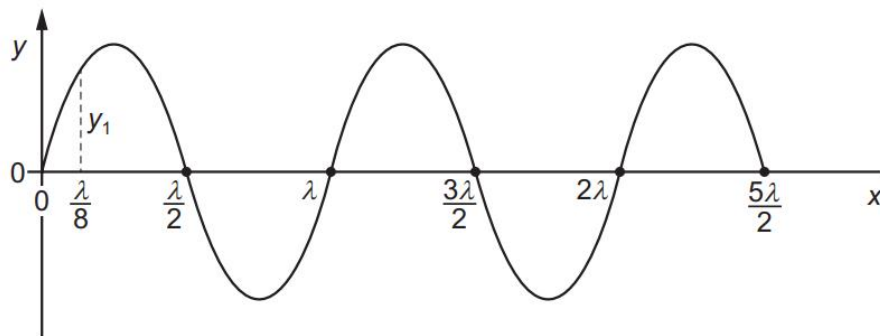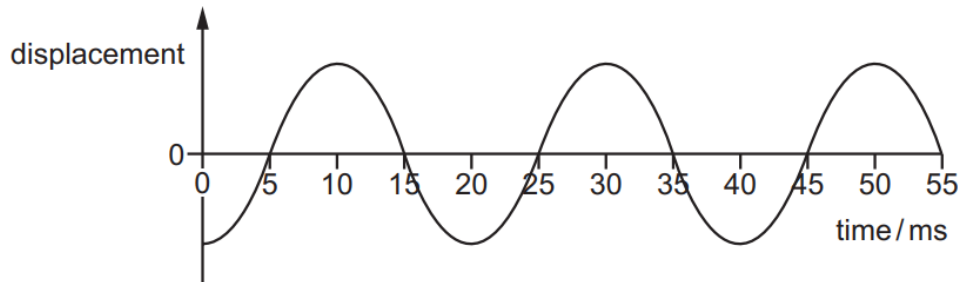

What are the next two values of x where the displacement y is again equal to $+y_1$?

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

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

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

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

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163. 9702/13/M/J/21 Q23

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 $330\,\text{m s}^{-1}$.
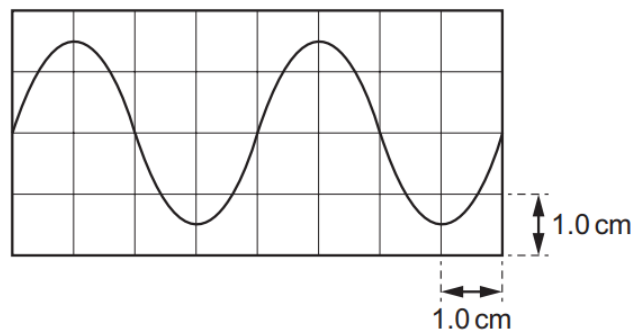

What is the wavelength of the wave?

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

164. 9702/13/M/J/21 Q24

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 $1.0\,\text{ms cm}^{-1}$.

What is the frequency of the sound wave?

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

165. 9702/13/M/J/21 Q25

A train's whistle is emitting sound of frequency 500 Hz as the train moves with a speed of $20\,\text{m s}^{-1}$ 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 $330\,\text{m s}^{-1}$.

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

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166. 9702/13/M/J/21 Q26

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 → visible light → X-rays → gamma-rays

B gamma-rays → X-rays → visible light → microwaves

C X-rays → gamma-rays → microwaves → visible light

D microwaves → visible light → gamma-rays → X-rays

167. 9702/11/O/N/21 Q21

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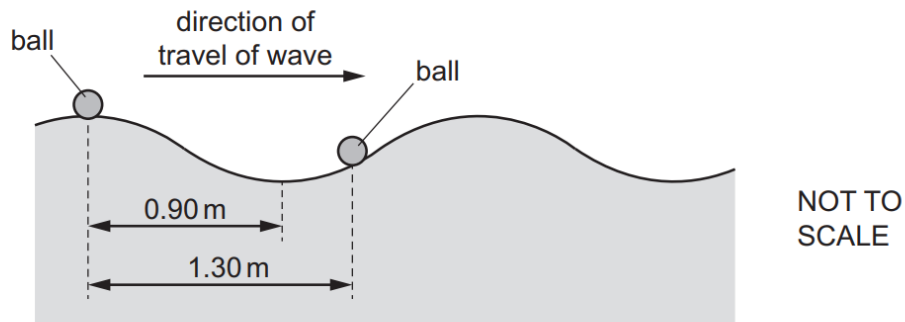
The distance between a crest and an adjacent trough of the wave is 0.90 m.

What is the phase difference between the two balls?

A 55° B 110° C 160° D 260°

168. 9702/11/O/N/21 Q22

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.

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169. 9702/11/O/N/21 Q24

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

170. 9702/11/O/N/21 Q25

Which radiation could consist of waves of wavelength 0.5 nm?

A γ-rays

B ultraviolet

C visible light

D X-rays

171. 9702/12/O/N/21 Q23

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

172. 9702/12/O/N/21 Q25

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

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173.   9702/12/0/N/21Q26

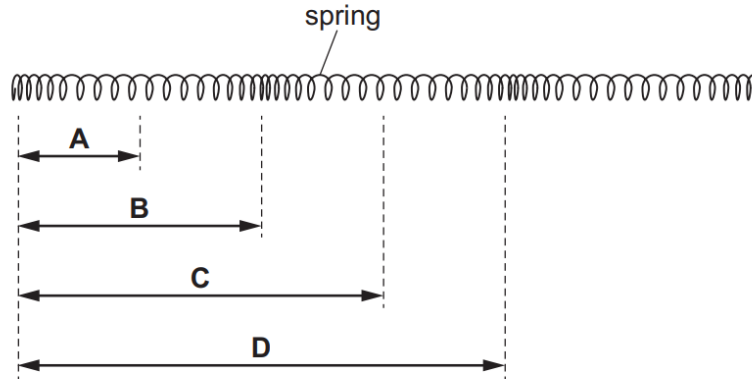Electromagnetic waves of frequency 30 THz are in a vacuum.

In which region of the electromagnetic spectrum are the waves?

A   infrared

B   microwave

C   ultraviolet

D   visible light

174.   9702/13/0/N/21 Q22

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

What is the wavelength of the wave?

spring

175.   9702/13/0/N/21 Q23

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.

176.   9702/13/0/N/21 Q24

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 ms^{-1}.

What is the frequency of the sound wave?

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

177. 9702/13/O/N/21 Q25

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 $340 \, ms^{-1}$.

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

178. 9702/13/O/N/21 Q26

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
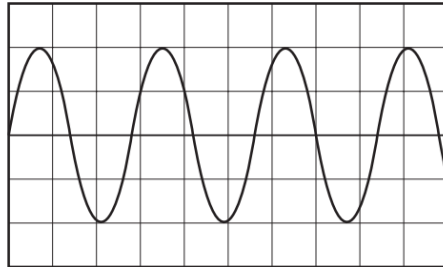
179. 9702/12/F/M/22 Q20

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.

180. 9702/12/F/M/22 Q21

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 $5.0\,\text{ms div}^{-1}$.

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

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

181. 9702/12/F/M/22 Q22

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

initial position
of ambulance

final position
of ambulance

●——→

●

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

182. 9702/12/F/M/22 Q23

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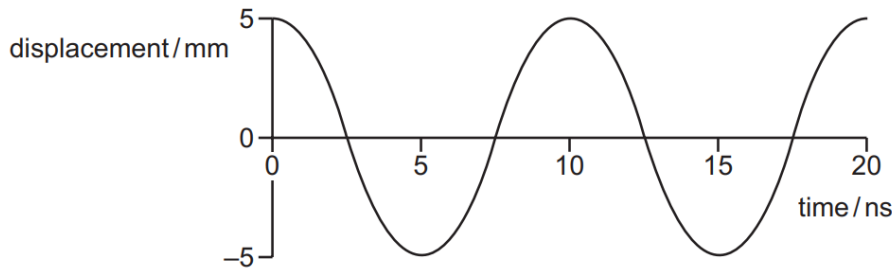
In which order would these pulses of light arrive at Mars?

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

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183. 9702/11/M/J/22 Q21

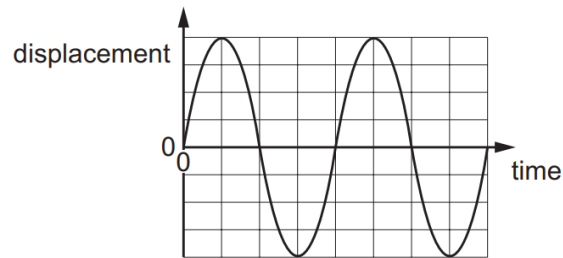The graph shows the variation with time of the displacement of a particle as a progressive wave passes.

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

184. 9702/11/M/J/22 Q22

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

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

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

Which graph shows the displacement of the air particle?

A

displacement

0

time

B

displacement

0

time

C

displacement

0

time

D

displacement

0

time
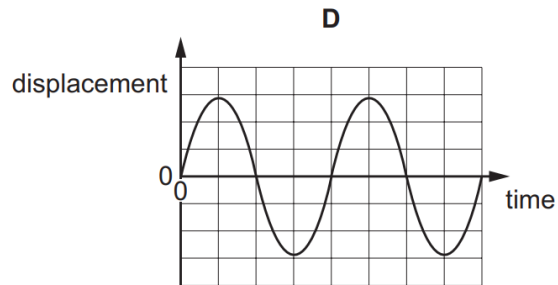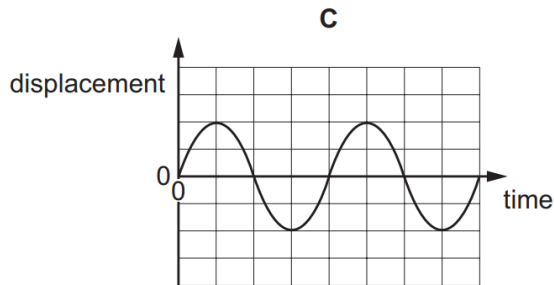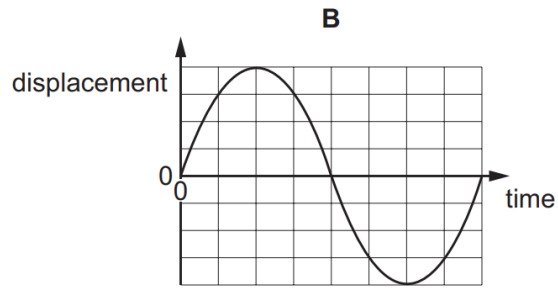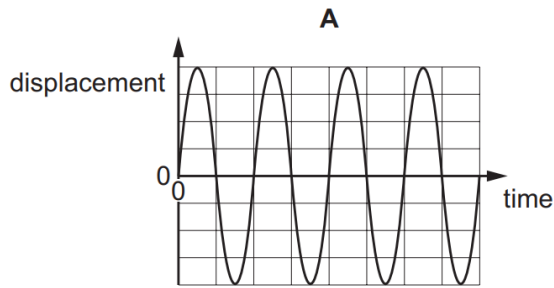
185. 9702/11/M/J/22 Q23

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.

186. 9702/11/M/J/22 Q24

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.

187.   9702/11/M/J/22 Q25

Which statement about electromagnetic waves is correct?

A   A wave of wavelength 5.0×10^{-6} 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.

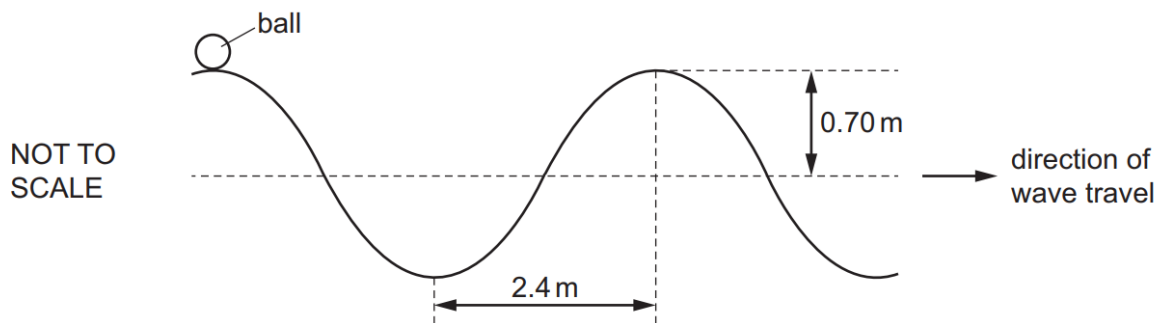**188.**   9702/12/M/J/22 Q21

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.

189.   9702/12/M/J/22 Q22

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

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190. 9702/12/M/J/22 Q23

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?
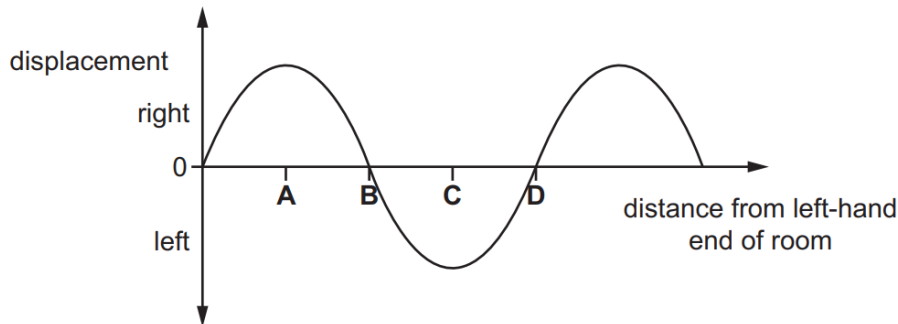
191. 9702/12/M/J/22 Q24

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

192. 9702/12/M/J/22 Q25

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

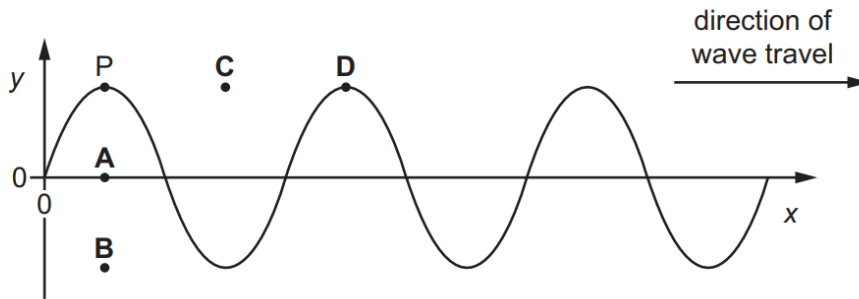**B**   microwave

C   ultraviolet

D   X-ray

193. 9702/13/M/J/22 Q22

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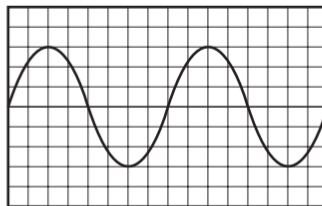
What is the position of P at time $t = 1$ s?

194. 9702/13/M/J/22 Q23

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

195. 9702/13/M/J/22 Q24

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.

196. 9702/13/M/J/22 Q25

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 $50\,\text{m s}^{-1}$. The speed of sound in the air is $340\,\text{m s}^{-1}$.

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

197. 9702/13/M/J/22 Q26

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
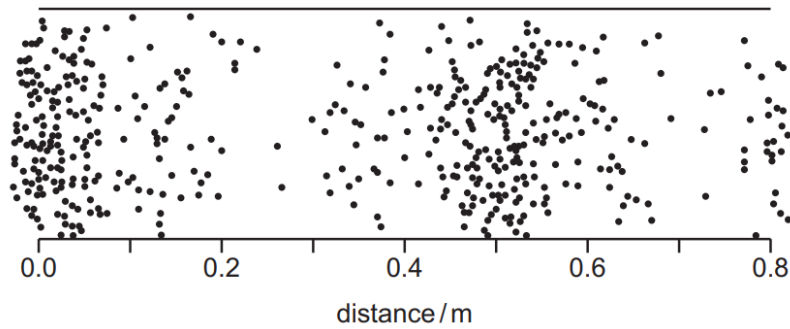
198. 9702/11/O/N/22 Q21

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.

199. 9702/11/O/N/22 Q22

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 $340\,\mathrm{m\,s^{-1}}$.
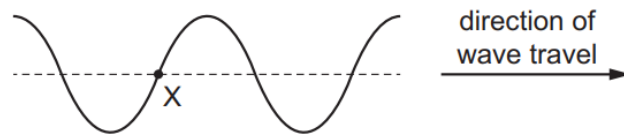
What is the approximate frequency of the sound wave shown?

A 430 Hz   **B** 680 Hz   **C** 1100 Hz   **D** 1400 Hz
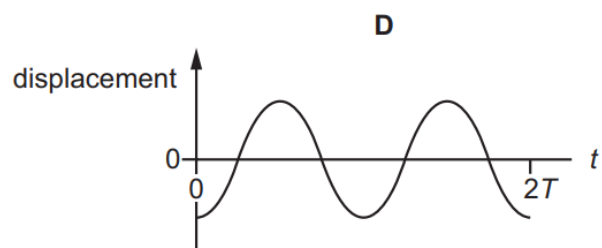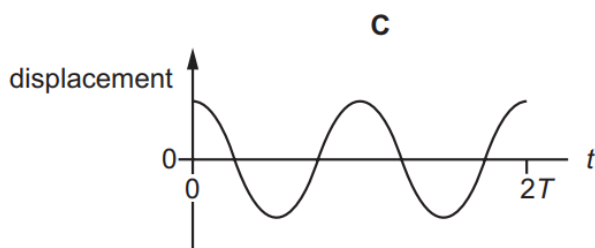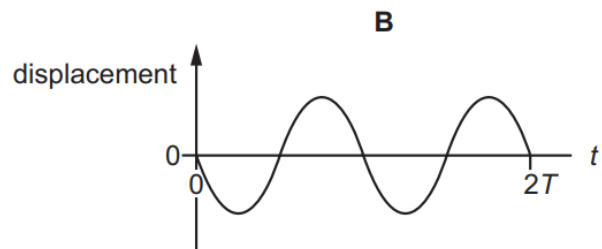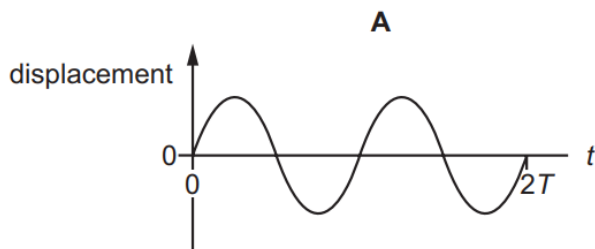
200. 9702/11/O/N/22 Q23

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.

direction of wave travel

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 $t = 2T$?

A

displacement

B

displacement

C

displacement

D

displacement

201. 9702/11/O/N/22 Q24

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
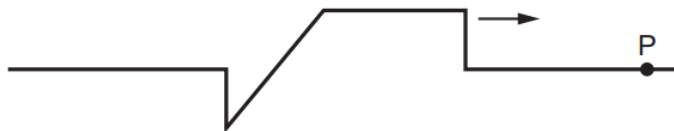
202. 9702/11/O/N/22 Q25

A telescope detects and analyses some electromagnetic radiation of wavelength 2 cm.
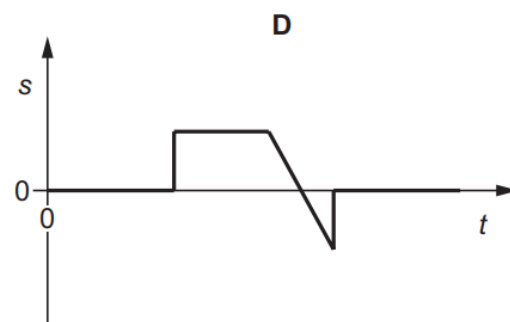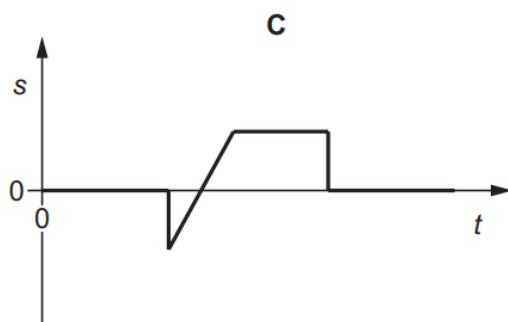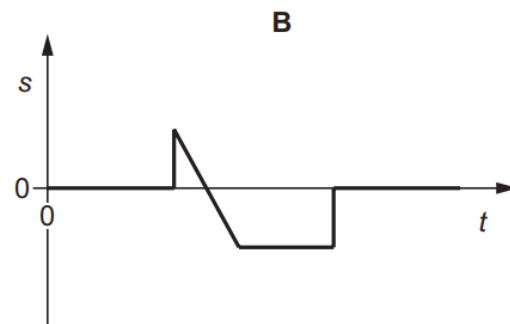
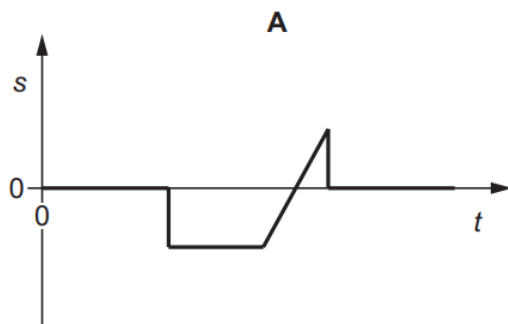Which type of telescope is it?

A microwave telescope

B optical telescope

C radio telescope

D X-ray telescope

203. 9702/12/O/N/22 Q22

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?

204. 9702/12/O/N/22 Q23

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.

205. 9702/12/O/N/22 Q24

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

206. 9702/12/O/N/22 Q25

Two electromagnetic waves have wavelengths of 5.0×10^{-7} m and 5.0×10^{-2} m in a vacuum.

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

	wavelength 5.0×10^{-7} m	wavelength 5.0×10^{-2} m
A	ultraviolet	infrared
B	visible	microwave
C	ultraviolet	microwave
D	visible	infrared

207. 9702/12/O/N/22 Q26

The wavelength of sound in air may be determined by using stationary waves.

In one experiment, a loudspeaker produces a sound wave of constant frequency which is reflected directly back along its original path by a metal plate approximately 1 m away. A microphone connected to a cathode-ray oscilloscope (CRO) is moved between the loudspeaker and plate to identify regions of high sound intensity ('loud' spots) and low sound intensity ('quiet' spots).

The wavelength of the sound is determined using the **least** possible number of measured quantities.

Which row shows the quantities that are needed?

	frequency of sound	mean separation of 'quiet' spots	speed of sound in air	
A	✓	✓	✗	key
B	✓	✗	✓	✓ = needed
C	✓	✗	✗	✗ = not needed
D	✗	✓	✗	

208. 9702/13/O/N/22 Q21

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.
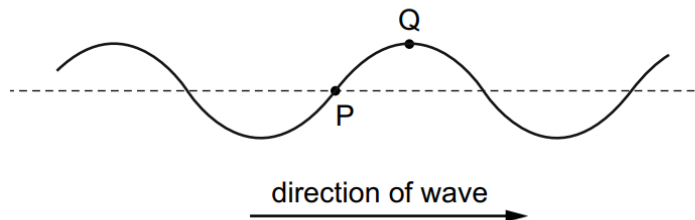
direction of wave

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

209. 9702/13/O/N/22 Q22

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}

210. 9702/13/O/N/22 Q23

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

211. 9702/13/O/N/22 Q24

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 $0.5\,\mu m$

B   bacteria of length $5.0\,\mu m$

C   fungi of length $50\,\mu m$

D   protozoa of length $100\,\mu m$

Exam Buddy