25 Which of the following summarises the change in wave characteristics on going from infra-red to ultraviolet in the electromagnetic spectrum?

	frequency	speed (in a vacuum)
A	decreases	decreases
B	decreases	remains constant
C	increases	remains constant
D	increases	increases

26 The diagram shows a cathode-ray oscilloscope trace of a sound wave. The time-base is calibrated at $2.0\,\text{ms}\,\text{cm}^{-1}$.
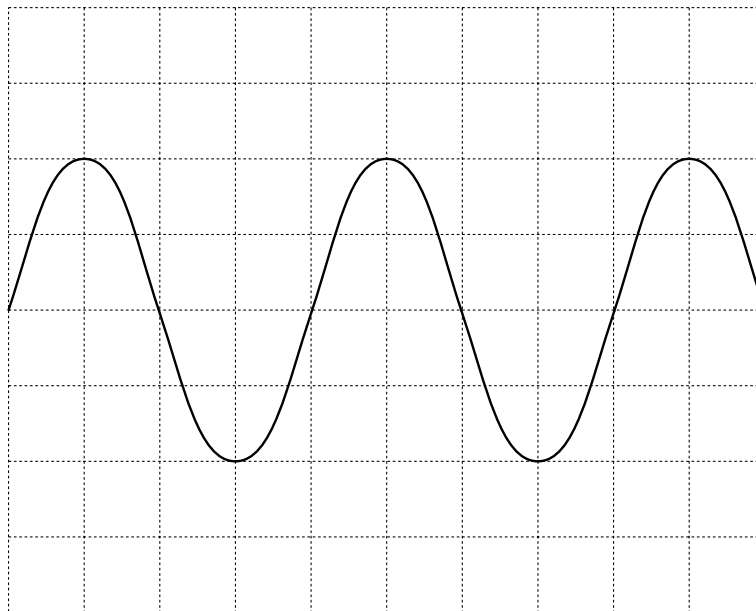
What is the frequency of the sound wave?

A   62.5 Hz   **B**   125 Hz   **C**   250 Hz   **D**   500 Hz

27 Which statement correctly relates the intensity of a sound wave to the vibrations of the molecules?

A   intensity α amplitude

B   intensity α (amplitude)^2

C   intensity α displacement

D   intensity α (displacement)^2

Waves

25 Which value is a possible wavelength for radiation in the microwave region of the electromagnetic spectrum?

A 3×10^{-2} m   **B** 3×10^{-5} m   **C** 3×10^{-8} m   **D** 3×10^{-10} m

26 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?
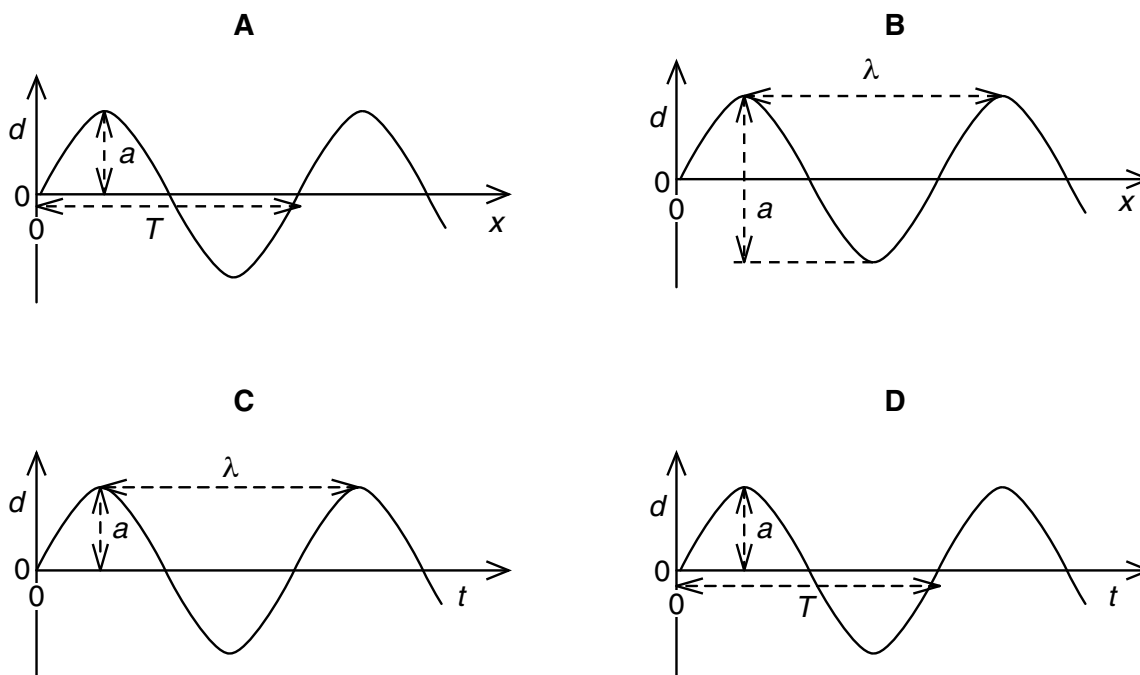
27 A wave of amplitude a has an intensity of $3.0 \, \text{W m}^{-2}$.

What is the intensity of a wave of the same frequency that has an amplitude $2a$?

A $4.2 \, \text{W m}^{-2}$ **B** $6.0 \, \text{W m}^{-2}$ **C** $9.0 \, \text{W m}^{-2}$ **D** $12 \, \text{W m}^{-2}$

23 Which of the following is true for all transverse waves?

    A   They are all electromagnetic.

    B   They can all be polarised.

    C   They can all travel through a vacuum.

    D   They all involve the oscillation of atoms.

Waves

25 Electromagnetic waves of wavelength λ and frequency f travel at speed c in a vacuum.

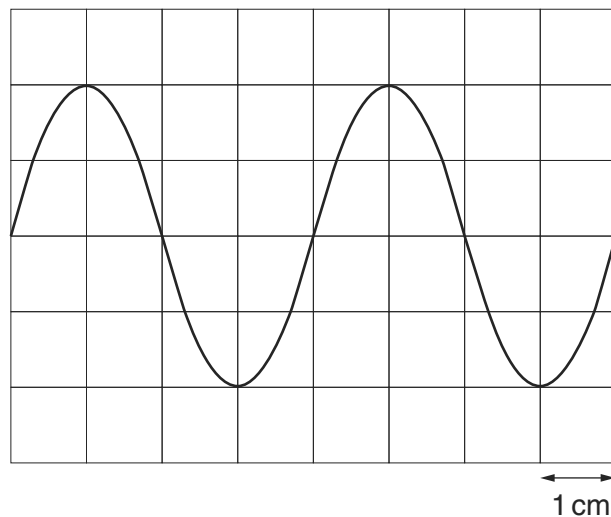Which of the following describes the wavelength and speed of electromagnetic waves of frequency $f/2$?   9702/01/M/J/03

	wavelength	speed in a vacuum
A	$\lambda/2$	$c/2$
B	$\lambda/2$	c
C	2λ	c
D	2λ	$2c$

26 A sound wave is displayed on the screen of a cathode-ray oscilloscope. The time base of the c.r.o. is set at $2.5\,\text{ms}/\text{cm}$.   9702/01/M/J/03

1 cm

What is the frequency of the sound wave?

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

27 When the light from two lamps falls on a screen, no interference pattern can be obtained.
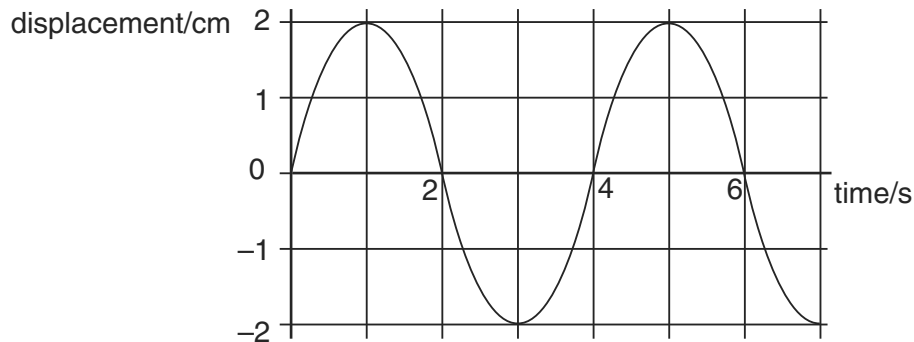
9702/01/M/J/03

Why is this?

A   The lamps are not point sources.

B   The lamps emit light of different amplitudes.

C   The light from the lamps is not coherent.

D   The light from the lamps is white.

Waves

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

Which of the following is correct?

A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B The wave has an amplitude of 2 cm and must be transverse.

C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D The wave has an amplitude of 4 cm and must be transverse.

25 Which of the following applies to a progressive transverse wave?

	transfers energy	can be polarised
A	no	no
B	no	yes
C	yes	no
D	yes	yes

**24** Which observation indicates that sound waves are longitudinal?

A Sound can be reflected from a solid surface.

B Sound cannot be polarised.

C Sound is diffracted around corners.

D Sound is refracted as it passes from hot air to cold air.

Waves

25 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.
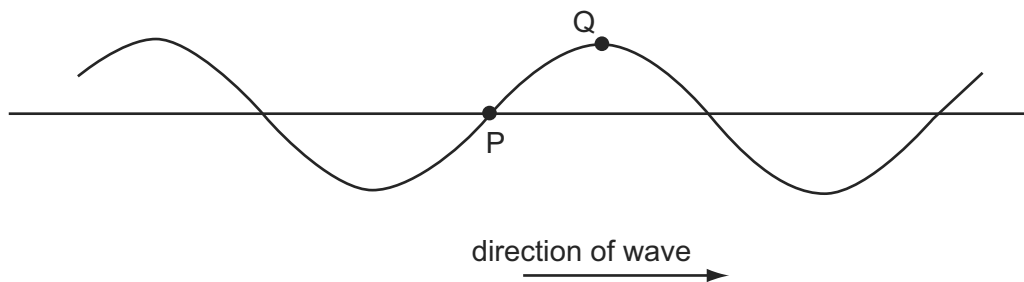
direction of wave

Which of the following 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

26 A plane wave of amplitude A is incident on a surface of area S placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is E.

The amplitude of the wave is increased to $2A$ and the area of the surface is reduced to $\frac{1}{2}S$.

How much energy per unit time reaches this smaller surface?

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

27 What is the approximate range of frequencies of infra-red radiation?

A 1×10^3 Hz to 1×10^9 Hz

B 1×10^9 Hz to 1×10^{11} Hz

C 1×10^{11} Hz to 1×10^{14} Hz

D 1×10^{14} Hz to 1×10^{17} Hz

26 A wave of amplitude 20 mm has intensity I_X. Another wave of the same frequency but of amplitude 5 mm has intensity I_Y.

What is $\dfrac{I_X}{I_Y}$?

A 2 **B** 4 **C** 16 **D** 256

Waves

24 Which of the following 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

23 What do **not** travel at the speed of light in a vacuum?

    A   electrons

    B   microwaves

    C   radio waves

    D   X-rays

24 The number of wavelengths of visible light in one metre is of the order of

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

25 A health inspector is measuring the intensity of a sound. Near a loudspeaker his meter records an intensity I. This corresponds to an amplitude A of the sound wave. At another position the meter gives an intensity reading of $2I$.

What is the corresponding sound wave amplitude?

    A $\dfrac{A}{\sqrt{2}}$ **B** $\sqrt{2}\,A$ **C** $2A$ **D** $4A$

26 A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest.

What is the nature of the sound wave in the tube?

    A   longitudinal and progressive

    B   longitudinal and stationary

    C   transverse and progressive

    D   transverse and stationary

25 The frequency of a certain wave is $500\,\text{Hz}$ and its speed is $340\,\text{m s}^{-1}$.

What is the phase difference between the motions of two points on the wave $0.17\,\text{m}$ apart?

    A $\dfrac{\pi}{4}$ rad   **B** $\dfrac{\pi}{2}$ rad   **C** $\dfrac{3\pi}{4}$ rad   **D** π rad

Waves

22 Polarisation is a phenomenon associated with a certain type of wave.
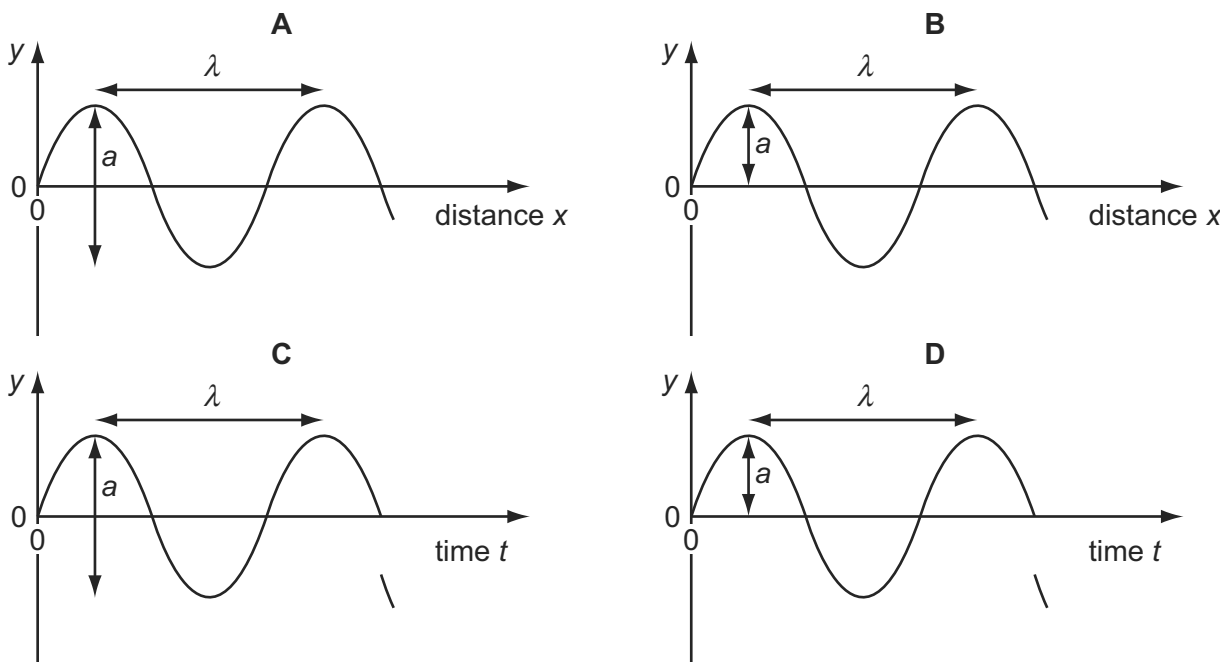
Which condition **must** be fulfilled if a wave is to be polarised?

   A   It must be a light wave.

   B   It must be a longitudinal wave.

   C   It must be a radio wave.

   D   It must be a transverse wave.

23 A sound wave has displacement *y* at distance *x* from its source at time *t*.

Which graph correctly shows the amplitude *a* and the wavelength λ of the wave?

23 Which phenomenon is associated with transverse waves but **not** longitudinal waves?

   A   polarisation

   B   reflection

   C   refraction

   D   superposition

23 The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as 10^x Hz.

What is the value of *x*?

   A   13   **B**   15   **C**   17   **D**   19

Waves

24 The intensity of a progressive wave is proportional to the square of the amplitude of the wave. It is also proportional to the square of the frequency.   9702/01/O/N/05

The variation with time t of displacement x of particles in a medium, when two progressive waves P and Q pass separately through the medium, are shown on the graphs.
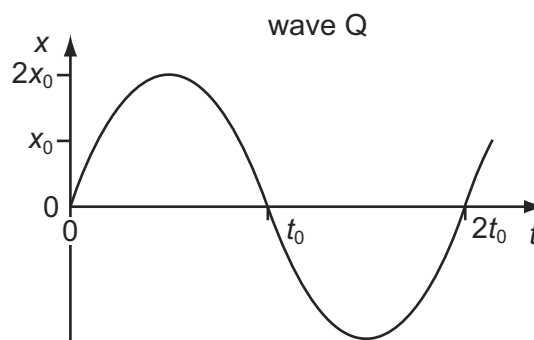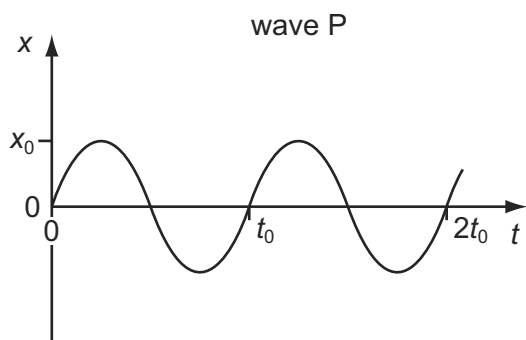
The intensity of wave P is I_0.

What is the intensity of wave Q?

A $\frac{1}{2}I_0$ **B** I_0 **C** $8\,I_0$ **D** $16\,I_0$

25 A sound wave of frequency 150 Hz travels in water at a speed of 1500 m s^{-1}. It then travels through the surface of the water and into air, where its speed is 300 m s^{-1}.   9702/01/O/N/05

Which line in the table gives the correct values for the wavelengths of the sound in water and in air?

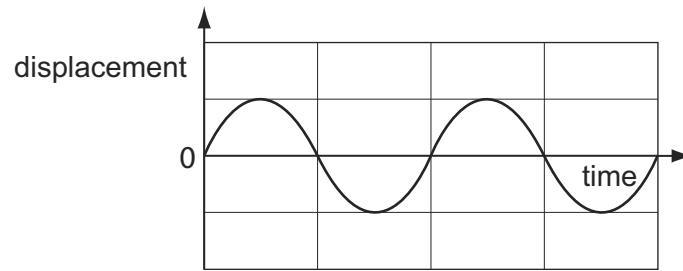|	wavelength in water / m	wavelength in air / m
A	0.10	0.10
B	0.10	0.50
C	10	2.0
D	10	50

24 A wave motion is described by the oscillation of particles.   9702/01/O/N/06

What is the name given to the number of complete oscillations of a particle in one second?

A amplitude

B frequency

C wavelength

D wave speed

Waves

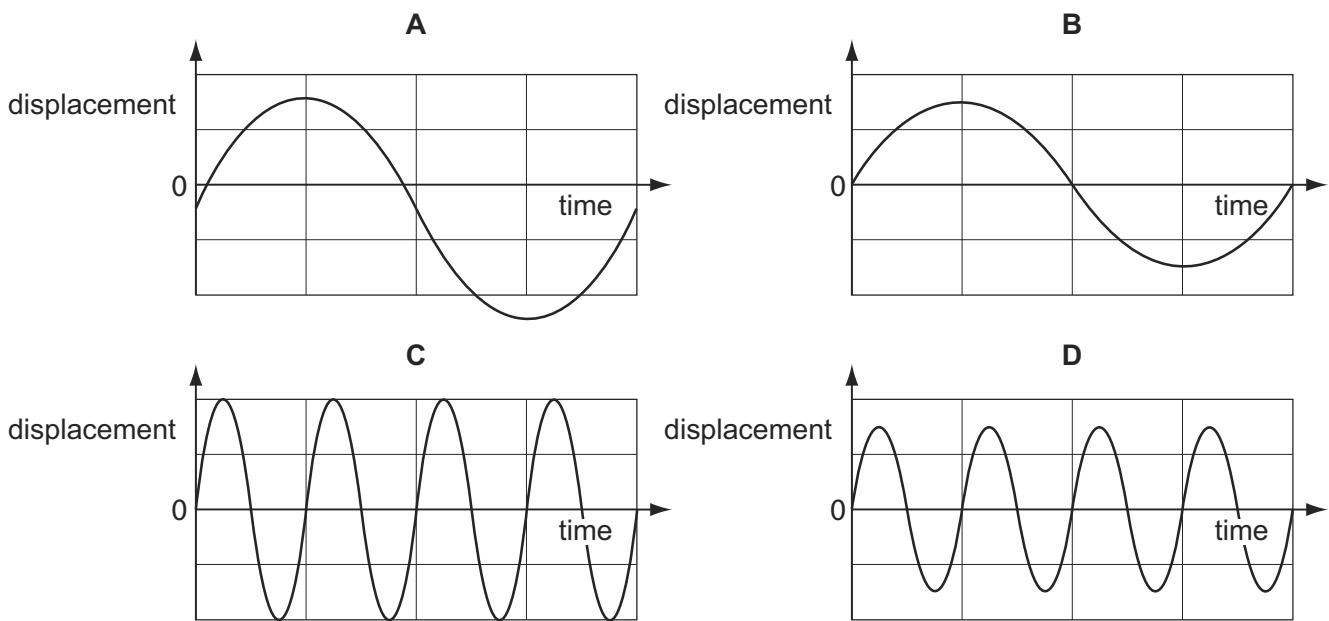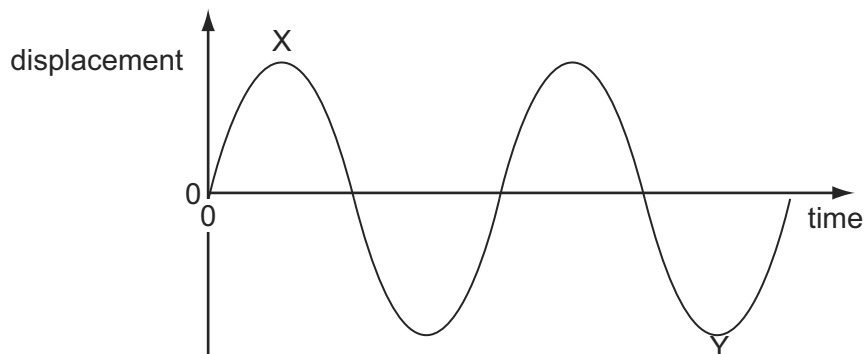**24** A displacement-time graph is shown for a particular wave.

A second wave of similar type has twice the intensity and half the frequency.

When drawn on the same axes, what would the second wave look like?

A

B

C

D

25 A displacement-time graph for a transverse wave is shown in the diagram.

The phase difference between X and Y can be expressed as $n\pi$.

What is the value of n?

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

Waves

26 Continuous water waves are diffracted through a gap in a barrier in a ripple tank.   9702/01/O/N/06

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

A   increasing the frequency of the waves

B   increasing the width of the gap

C   reducing the wavelength of the waves

D   reducing the width of the gap

21 Which of the following types of wave can be polarised?   9702/01/M/J/07

A   a longitudinal progressive wave

B   a longitudinal stationary wave

C   a transverse stationary wave

D   a transverse sound wave

22 Sound wave X has intensity 10^{12} times greater than that of sound wave Y.   9702/01/M/J/07

By how much is the amplitude of X greater than the amplitude of Y?

A 10^6 times

B 3.16×10^6 times

C 5×10^{11} times

D 10^{12} times

23 The graph shows the shape at a particular instant of part of a transverse wave travelling along a string.   9702/01/M/J/07
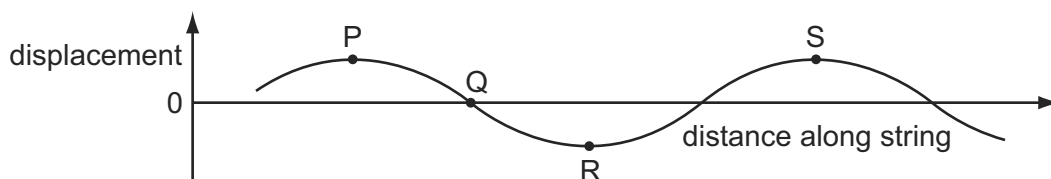
Which statement about the motion of points in the string is correct?

A   The speed at point P is a maximum.

B   The displacement at point Q is always zero.

C   The energy at point R is entirely kinetic.

D   The acceleration at point S is a maximum.

Waves

24 The diagram illustrates part of the electromagnetic spectrum.   9702/01/M/J/07

| high frequencies | 1 | | visible | 2 | | low frequencies |

Which labels are correct for the regions marked 1 and 2?

	1	2
A	infrared	X-rays
B	microwaves	X-rays
C	ultraviolet	microwaves
D	X-rays	infrared

21 What is the relationship between the intensity I and the amplitude a of a wave?   9702/01/O/N/07

A $\dfrac{I}{a}$ = constant

B $\dfrac{I}{a^2}$ = constant

C $I a$ = constant

D $I a^2$ = constant

23 The graph represents a sinusoidal wave in the sea, travelling at a speed of $8.0\ \mathrm{m\ s^{-1}}$, at one instant of time. The maximum speed of the oscillating particles in the wave is $2\pi a f$, where a is the amplitude and f is the frequency.   9702/01/O/N/07
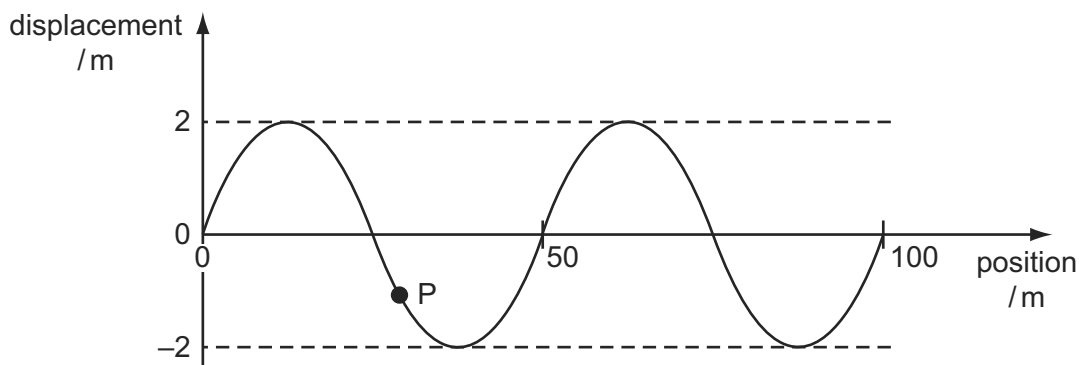
An object P of mass $2.0 \times 10^{-3}\ \mathrm{kg}$ floats on the surface.

What is the maximum kinetic energy of P due to the wave? Assume that its motion is vertical.

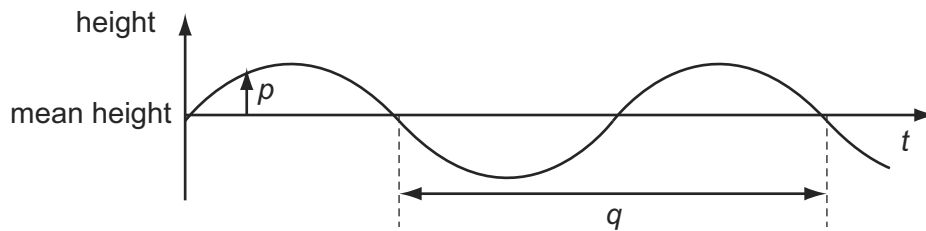**A** 0.026 mJ   **B** 4.0 mJ   **C** 39 mJ   **D** 64 mJ

Waves

22 An electromagnetic wave has a frequency of 10^8 Hz.

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

A infra-red

B radio

C ultraviolet

D visible

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

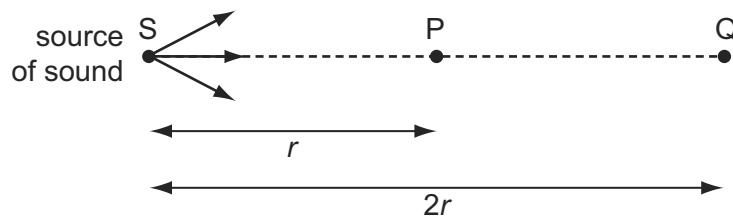What are p and q?

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

26 The intensity I of a sound at a point P is inversely proportional to the square of the distance x of P from the source of the sound. That is

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

Air molecules at P, a distance r from 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

Waves

x

27 Sound waves, emitted by a small loudspeaker, are reflected by a wall.
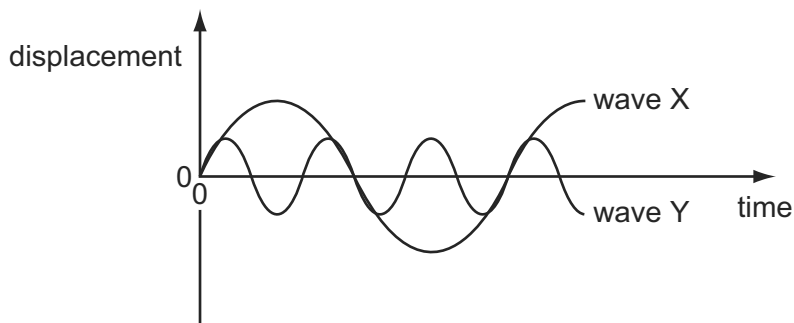
The frequency f of the waves is adjusted until a stationary wave is formed with the antinode nearest the wall at a distance x from the wall.

Which expression gives f in terms of x and the speed of sound c?

A $f = \dfrac{4c}{x}$ **B** $f = \dfrac{2c}{x}$ **C** $f = \dfrac{c}{2x}$ **D** $f = \dfrac{c}{4x}$

24 The diagram shows two waves X and Y.

Wave X has amplitude 8 cm and frequency 100 Hz.

What are the amplitude and frequency of wave Y?

	amplitude/cm	frequency/Hz
A	2	33
B	2	300
C	4	33
D	4	300

25 Light can exhibit all of the properties listed.

Which property can sound **not** exhibit?

A interference

B polarisation

C refraction

D total internal reflection

22 The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as 10^x Hz.
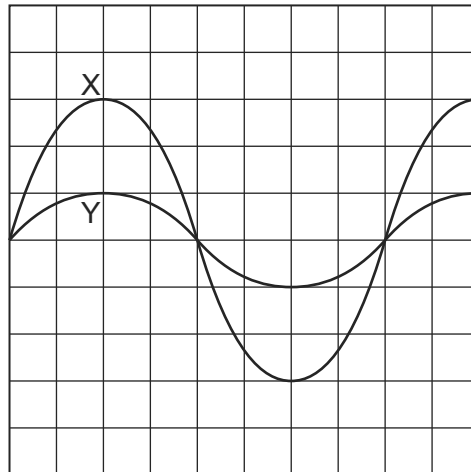
What is the value of x?

A 13 **B** 15 **C** 17 **D** 19

Waves

26 The diagram represents the screen of a cathode-ray oscilloscope displaying two sound waves labelled X and Y.

What is the ratio $\dfrac{\text{intensity of sound wave X}}{\text{intensity of sound wave Y}}$?

A $\dfrac{9}{1}$ **B** $\dfrac{3}{1}$ **C** $\dfrac{\sqrt{3}}{1}$ **D** $\dfrac{1}{1}$

23 Which wave properties change when light passes from air into glass?

A colour and speed

B frequency and wavelength

C speed and wavelength

D wavelength and colour

24 The light from two lasers passes through 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 plane of polarisation

D speed

23 The amplitude of a wave is A and its intensity is I.

Which amplitude is necessary for the intensity to be doubled to $2I$?

A A^2 **B** $\sqrt{A}$ **C** $\sqrt{2}\,A$ **D** $2A$

Waves

23 The light from two lasers passes through a vacuum. One laser emits red light and the other emits green light.   9702/12/O/N/09

Which property of the two laser beams must be different?

A   amplitude

B   frequency

C   plane of polarisation

D   speed

22 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m.   9702/11/M/J/10

Which type of wave are they most likely to be?

A   radio waves

B   microwaves

C   infra-red waves

D   ultraviolet waves

23 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m.   9702/13/M/J/10

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24 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m.   9702/12/M/J/10

Which type of wave are they most likely to be?

A   radio waves

B   microwaves

C   infra-red waves

D   ultraviolet waves

24 Which value is a possible wavelength for radiation in the ultra-violet region of the electromagnetic spectrum?   9702/12/O/N/10

A 3×10^{-2} m   **B** 3×10^{-5} m   **C** 3×10^{-8} m   **D** 3×10^{-10} m

Waves

23 The graph shows how the displacement of a particle in a wave varies with time.   9702/11/O/N/10
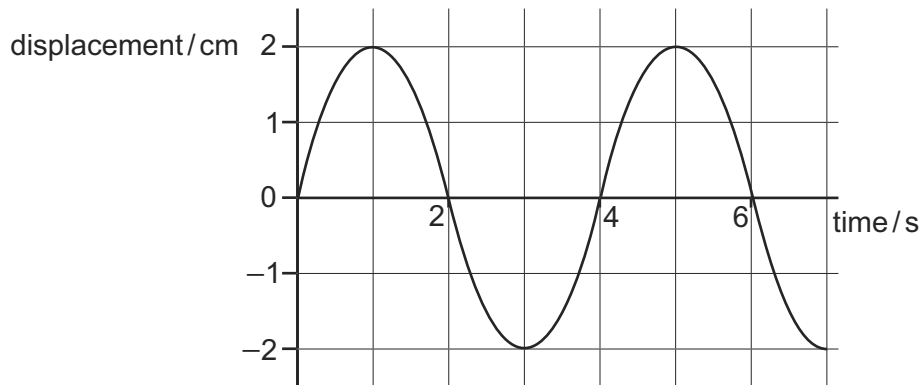

Which statement is correct?

A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B The wave has an amplitude of 2 cm and must be transverse.

C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D The wave has an amplitude of 4 cm and must be transverse.

24 The diagram shows a vertical cross-section through a water wave moving from left to right.

9702/11/O/N/10

At which point is the water moving upwards with maximum speed?
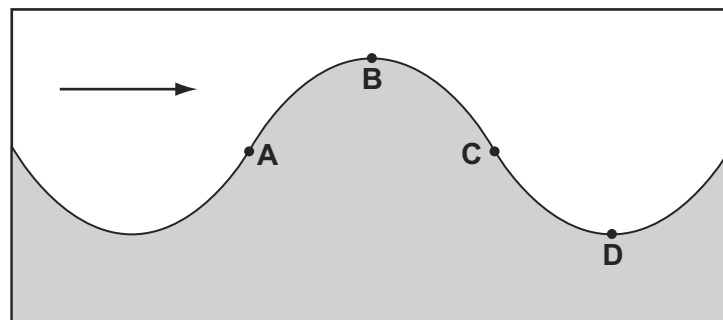
26 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.

9702/11/O/N/10
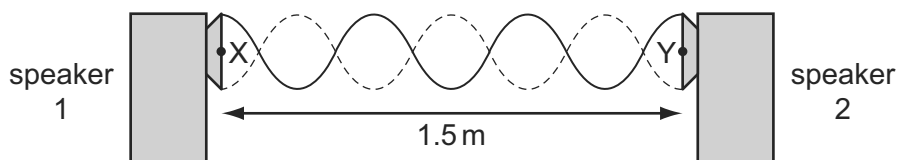
When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

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

Waves

25 When plane-polarised light of amplitude *a* is passed through a polarising filter as shown, the amplitude of the light emerging is $a\cos\theta$.

amplitude = *a*
intensity = *I*

plane polarised
light

θ

amplitude = $a\cos\theta$

polarising filter
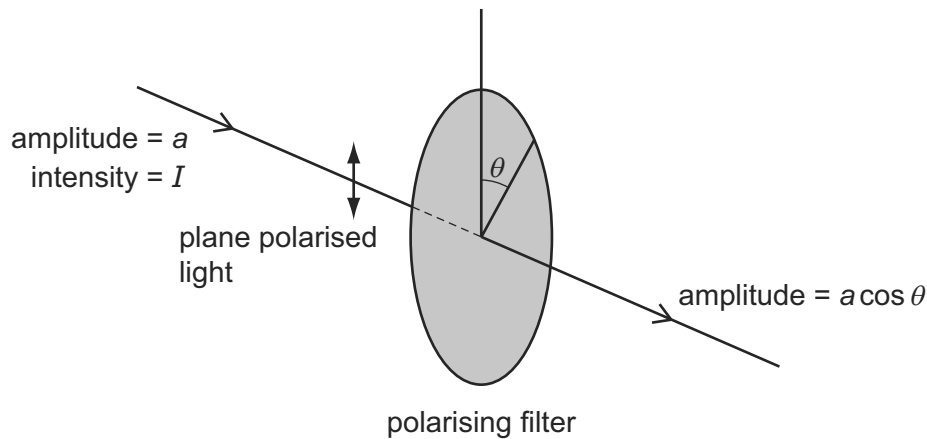
The intensity of the initial beam is *I*.

What is the intensity of the emerging light when θ is 60.0°?

A 0.250 *I* **B** 0.500 *I* **C** 0.750 *I* **D** 0.866 *I*

24 When plane-polarised light of amplitude *a* is passed through a polarising filter as shown, the amplitude of the light emerging is $a\cos\theta$.

amplitude = *a*
intensity = *I*

plane polarised
light

θ

amplitude = $a\cos\theta$

polarising filter
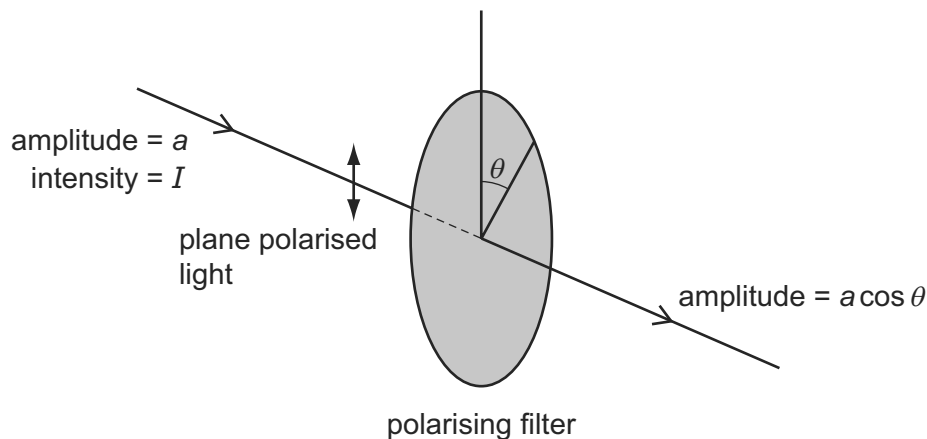
The intensity of the initial beam is *I*.

What is the intensity of the emerging light when θ is 60.0°?

A 0.250 *I* **B** 0.500 *I* **C** 0.750 *I* **D** 0.866 *I*

26 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m?

A infra-red

B microwave

C ultraviolet

D X-ray

Waves

25 The diagram shows a vertical cross-section through a water wave moving from left to right.
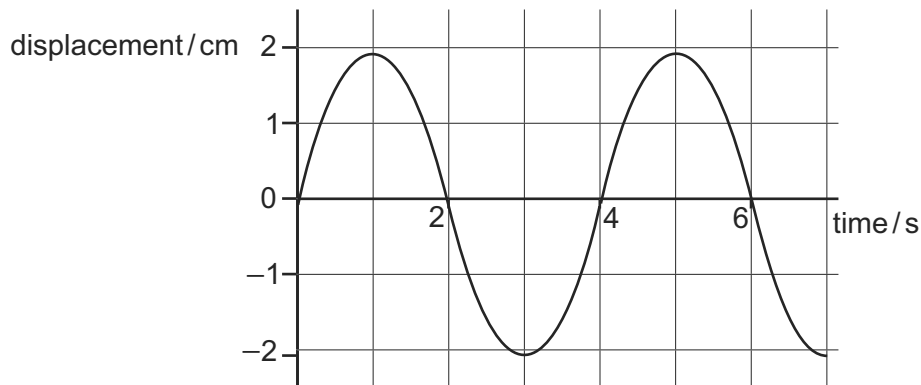
At which point is the water moving upwards with maximum speed?

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

Which statement is correct?

A   The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B   The wave has an amplitude of 2 cm and must be transverse.

C   The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D   The wave has an amplitude of 4 cm and must be transverse.

23 Which statement about sound waves in air at constant temperature is correct?

A   Amplitude is inversely proportional to velocity.

B   Frequency is inversely proportional to wavelength.

C   Velocity is proportional to wavelength.

D   Wavelength is proportional to amplitude.

**25** In which order of magnitude are the frequencies of electromagnetic waves in the visible spectrum?

A 10^{12} Hz   **B** 10^{13} Hz   **C** 10^{14} Hz   **D** 10^{15} Hz

Waves

22 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*. 9702/11/M/J/11

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?
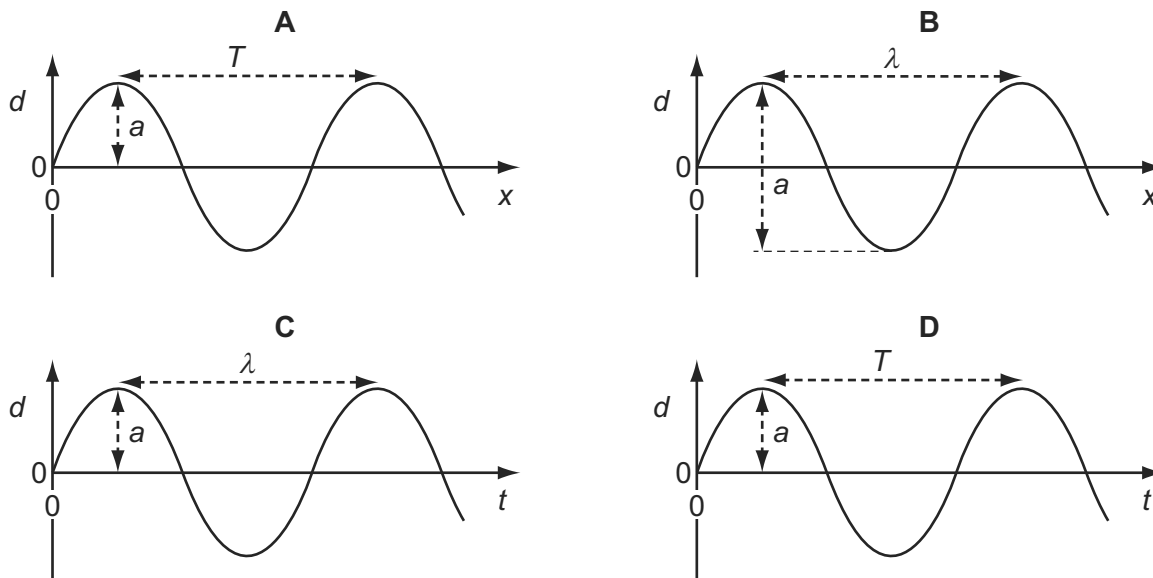
24 A source of sound of constant power *P* is situated in an open space. The intensity *I* of sound at distance *r* from this source is given by 9702/11/M/J/11

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

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** $a \propto r^2$

27 P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q. 9702/11/O/N/11
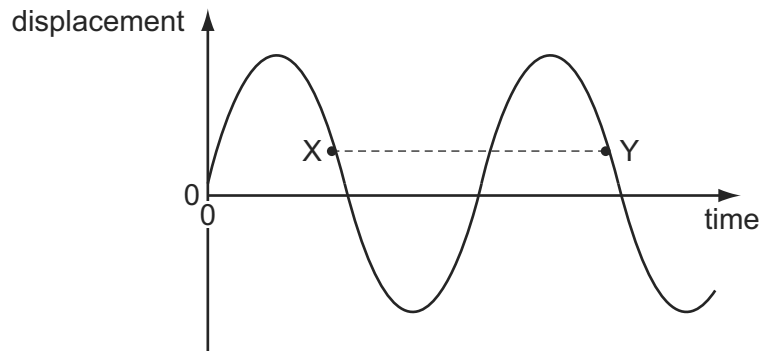
Which row is correct?

	wavelength emitted by P/m	wavelength emitted by Q/m
A	5×10^{-5}	5×10^{-8}
B	5×10^{-5}	5×10^{-10}
C	5×10^{-7}	5×10^{-8}
D	5×10^{-7}	5×10^{-10}

Waves

26 A transverse progressive wave is set up on a string.   9702/12/M/J/11

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

27 If a wave can be polarised, it **must** be   9702/12/M/J/11

A   a longitudinal wave.

B   an electromagnetic wave.

C   a sound wave.

D   a transverse wave.

22 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   9702/13/M/J/11

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

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** $a \propto r^2$

Waves

23 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.
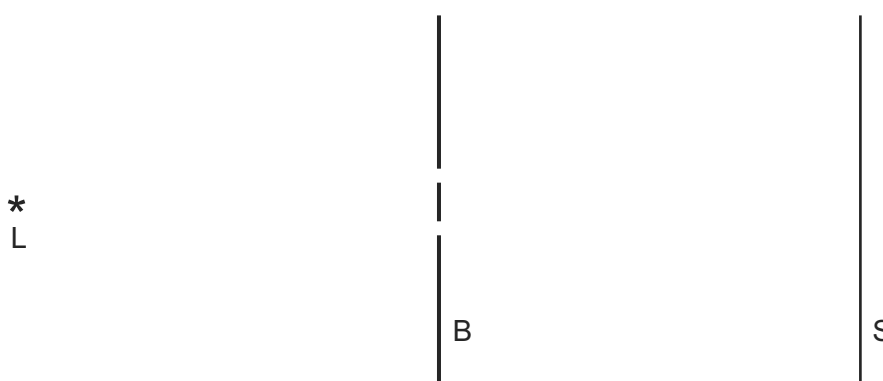
9702/13/M/J/11

Which graph is correctly labelled?
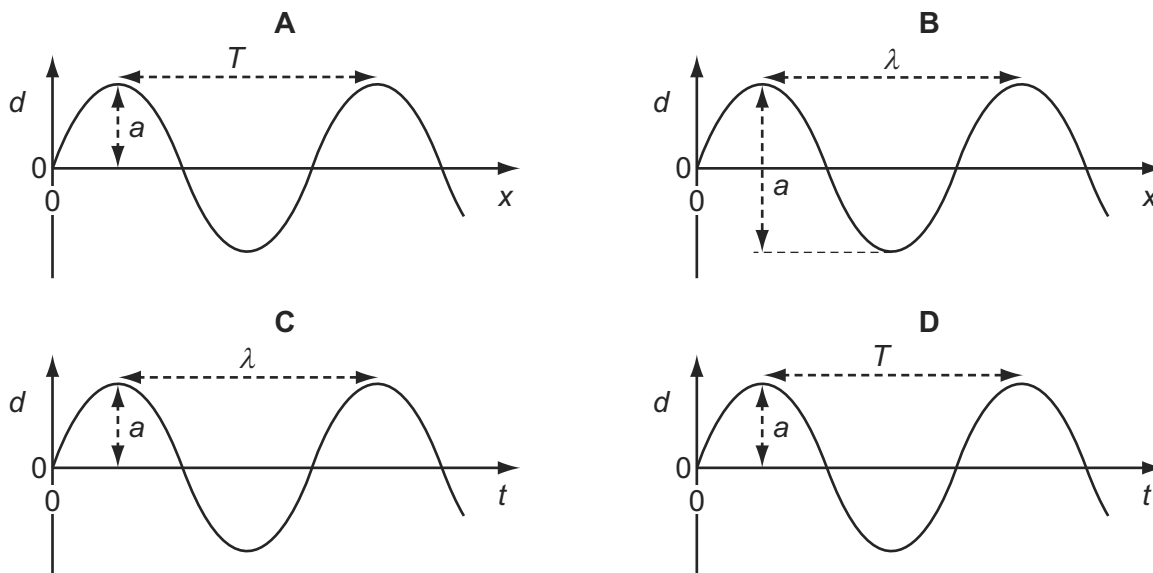
28 The diagram shows a view from above of a double slit interference demonstration.   9702/11/O/N/11

L is a monochromatic light source with a vertical filament. B is a barrier with two narrow vertical slits and S is a screen upon which interference fringes form.

The intensity is I at a point on the screen where the centre of the fringe pattern forms.

What is the intensity, at the same point, when one of the slits is covered up?

A $\dfrac{I}{\sqrt{2}}$ **B** $\dfrac{I}{2}$ **C** $\dfrac{I}{2\sqrt{2}}$ **D** $\dfrac{I}{4}$

Waves

24 A wave that can be polarised must be

    A longitudinal.

    B progressive.

    C stationary.

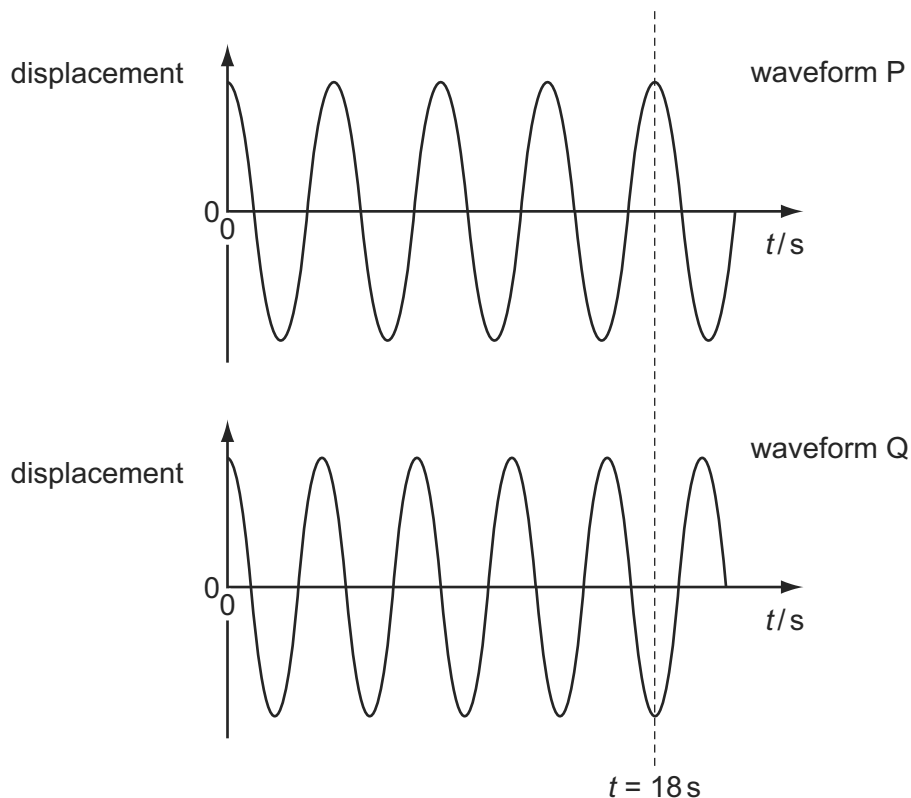   **D** transverse.

25 Which statement about electromagnetic radiation is correct?

    A Waves of wavelength 5×10^{-9} m are high-energy gamma rays.

    B Waves of wavelength 3×10^{-8} m are ultra-violet waves.

    C Waves of wavelength 5×10^{-7} m are infra-red waves.

    D Waves of wavelength 9×10^{-7} m are light waves.

26 The diagram shows two sinusoidal waveforms.

At time $t = 0$ the waves are in phase. At the dotted line, $t = 18$ s.

At which time is the phase difference between the two oscillations ⅛ of a cycle?

    A 4.0 s   **B** 4.5 s   **C** 8.0 s   **D** 9.0 s

Waves

27 The diagram shows a view from above of a double slit interference demonstration. 9702/13/O/N/11

L is a monochromatic light source with a vertical filament. B is a barrier with two narrow vertical slits and S is a screen upon which interference fringes form.

```
                                    |                    |
                                    |                    |
                                    |                    |
                                    |                    |
                                    |                    |
        *                           |                    |
        L                           |                    |
                                    |                    |
                                    B                    S
```
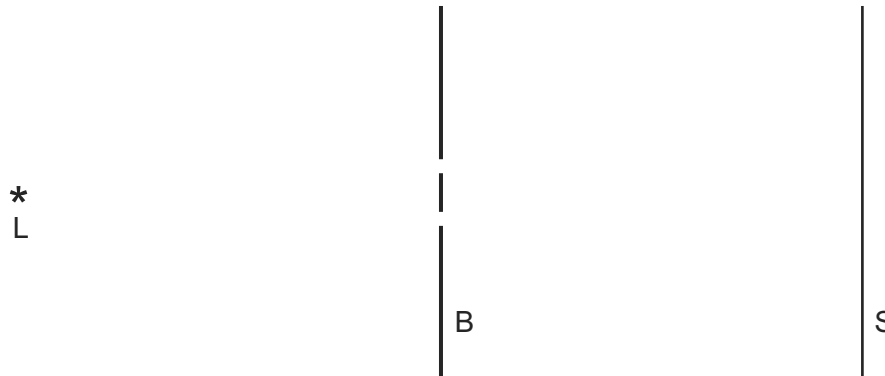
The intensity is I at a point on the screen where the centre of the fringe pattern forms.

What is the intensity, at the same point, when one of the slits is covered up?

A $\dfrac{I}{\sqrt{2}}$ **B** $\dfrac{I}{2}$ **C** $\dfrac{I}{2\sqrt{2}}$ **D** $\dfrac{I}{4}$

28 P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q. 9702/13/O/N/11

Which row is correct?

	wavelength emitted by P / m	wavelength emitted by Q / m
A	5×10^{-5}	5×10^{-8}
B	5×10^{-5}	5×10^{-10}
C	5×10^{-7}	5×10^{-8}
D	5×10^{-7}	5×10^{-10}

28 Which observation indicates that sound waves are longitudinal? 9702/11/M/J/12

A Sound can be reflected from a solid surface.

B Sound cannot be polarised.

C Sound is diffracted around corners.

D Sound is refracted as it passes from hot air to cold air.

Waves

26 Two waves E and G are shown. The waves have the same speed.
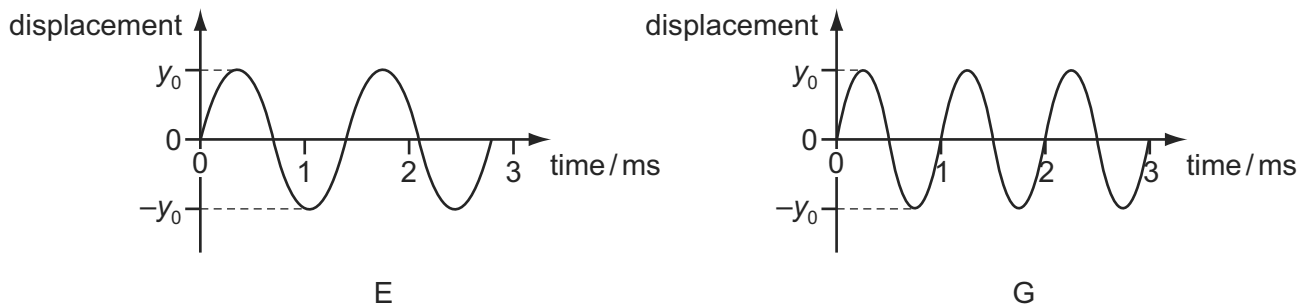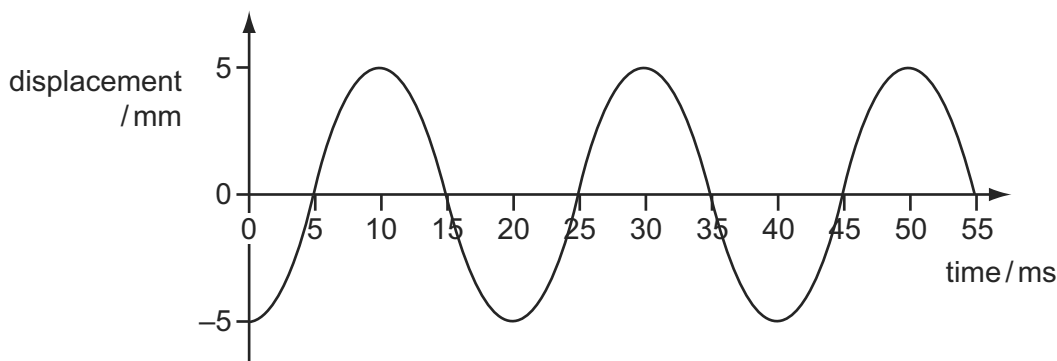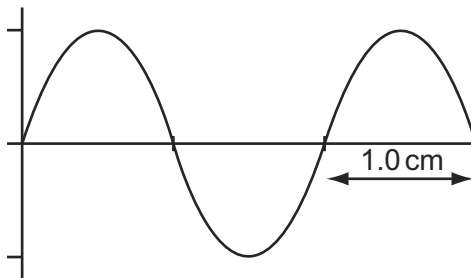

Which statement is correct?

A Wave E has a greater amplitude than wave G.

B Wave E has a greater intensity than wave G.

C Wave E has a smaller frequency than wave G.

D Wave E has a smaller wavelength than wave G.

27 The diagram shows a displacement-time graph for a progressive wave.

What are the amplitude and frequency of the wave?

	amplitude / mm	frequency / Hz
A	5	40
B	5	50
C	10	40
D	10	50

26 A surveyor's device emits a laser pulse.

What is the time taken for the pulse to travel from the device to a wall 150 m away, where it is reflected, and then return to the device?

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

Waves

27 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}

28 X and Y are two points on the surface of water in a ripple tank. A source of waves of constant frequency begins to generate waves which then travel past X and Y, causing them to oscillate.
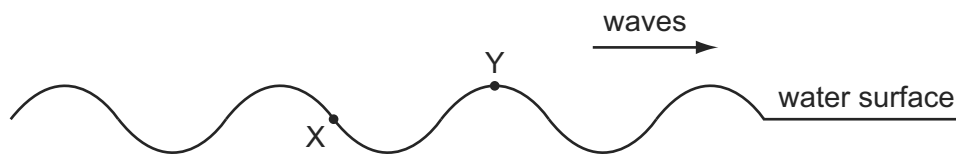
What is the phase difference between X and Y?

A   45°   **B**   135°   **C**   180°   **D**   270°

26 The diagram shows a displacement-time graph for a progressive wave.
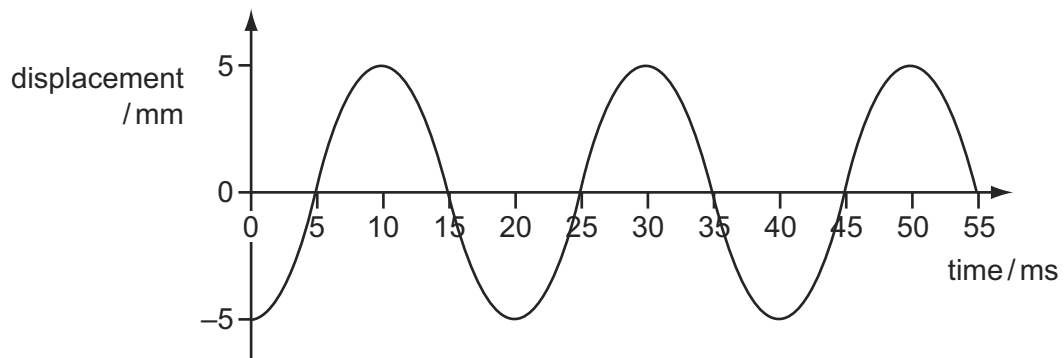
What are the amplitude and frequency of the wave?

	amplitude / mm	frequency / Hz
A	5	40
B	5	50
C	10	40
D	10	50

Waves

27 Two waves E and G are shown. The waves have the same speed. 9702/13/M/J/12
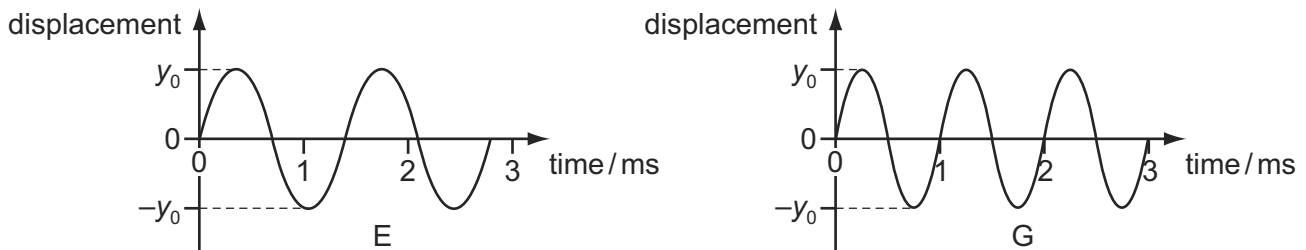
Which statement is correct?

A Wave E has a greater amplitude than wave G.

B Wave E has a greater intensity than wave G.

C Wave E has a smaller frequency than wave G.

D Wave E has a smaller wavelength than wave G.

29 Which observation indicates that sound waves are longitudinal? 9702/13/M/J/12

A Sound can be reflected from a solid surface.

B Sound cannot be polarised.

C Sound is diffracted around corners.

D Sound is refracted as it passes from hot air to cold air.

31 The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave. 9702/12/O/N/12

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 radio wave region of the electromagnetic spectrum.

**B** The frequency of the wave is 2.5 MHz and it lies in the microwave region of the electromagnetic spectrum.

C The frequency of the wave is 5.0 MHz and it lies in the radio wave region of the electromagnetic spectrum.

D The frequency of the wave is 5.0 MHz and it lies in the microwave region of the electromagnetic spectrum.

Waves

26 The diagram shows a graph of displacement against time for a sound wave.

displacement

0

time
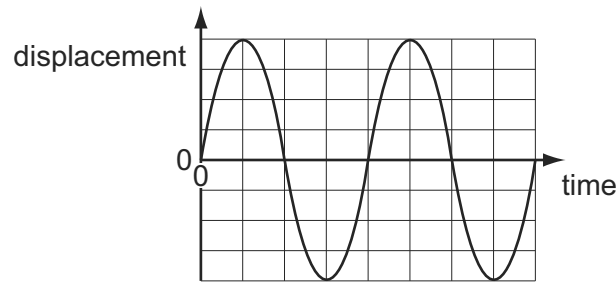
The intensity of the sound is halved.

Which graph shows the displacement of this sound wave?

A

displacement

0

time

B

displacement

0

time

C

displacement

0

time

D

displacement

0

time
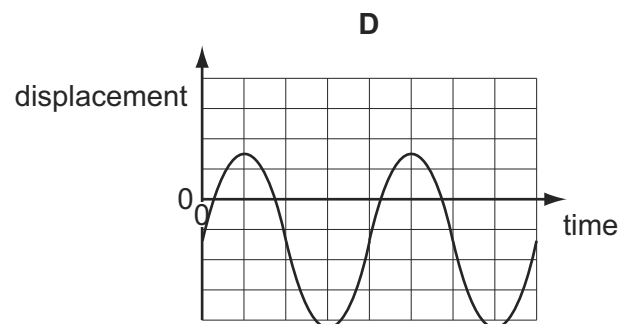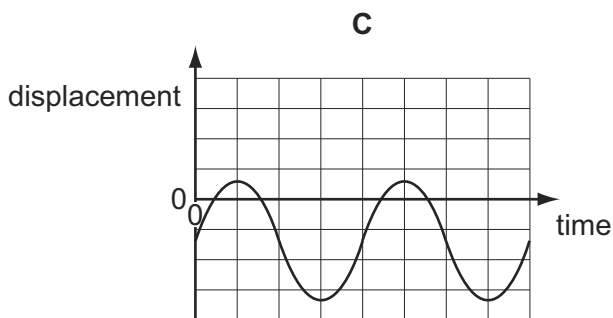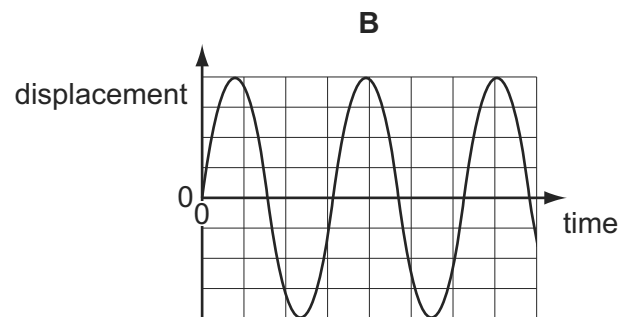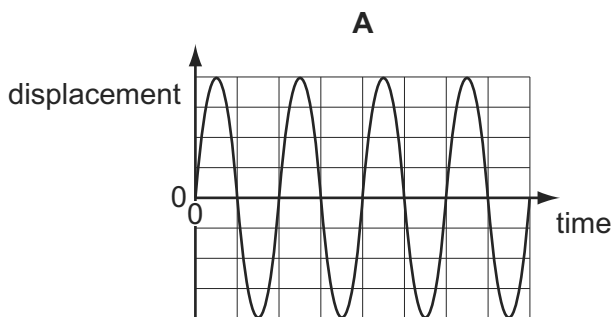
27 What do **not** travel at the speed of light in a vacuum?

A electrons

B microwaves

C radio waves

D X-rays

29 A health inspector is measuring the intensity of a sound. Near a loudspeaker, his meter records an intensity I. This corresponds to an amplitude A of the sound wave. At another position, the meter gives an intensity reading of $2I$.

What is the corresponding amplitude of the sound wave?

A $\dfrac{A}{\sqrt{2}}$ **B** $\sqrt{2}A$ **C** $2A$ **D** $4A$

Waves

28 Diffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest when the wavelength and the obstruction are similar in size. 9702/13/O/N/12

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

A microwaves passing a steel post

B radio waves passing a copper wire

C sound waves passing a human hair

D visible light waves passing a gate post

25 A wave has a speed of $340\,\text{m s}^{-1}$ and a period of $0.28\,\text{ms}$. 9702/11/M/J/13

What is its wavelength?

A $0.095\,\text{m}$ **B** $95\,\text{m}$ **C** $1.2 \times 10^{3}\,\text{m}$ **D** $1.2 \times 10^{6}\,\text{m}$

26 Which line in the table summarises the change in wave characteristics on going from infra-red to ultraviolet in the electromagnetic spectrum? 9702/11/M/J/13

	frequency	speed in a vacuum
A	decreases	decreases
B	decreases	remains constant
C	increases	remains constant
D	increases	increases

24 A light wave of amplitude A is incident normally on a surface of area S. The power per unit area reaching the surface is P. 9702/11/M/J/13

The amplitude of the light wave is increased to $2A$. The light is then focussed on to a smaller area $\frac{1}{3}S$.

What is the power per unit area on this smaller area?

A $36P$

B $18P$

C $12P$

D $6P$

Waves

24 The order of magnitude of the frequency of the shortest wavelength of visible light waves can be expressed as 10^x Hz.
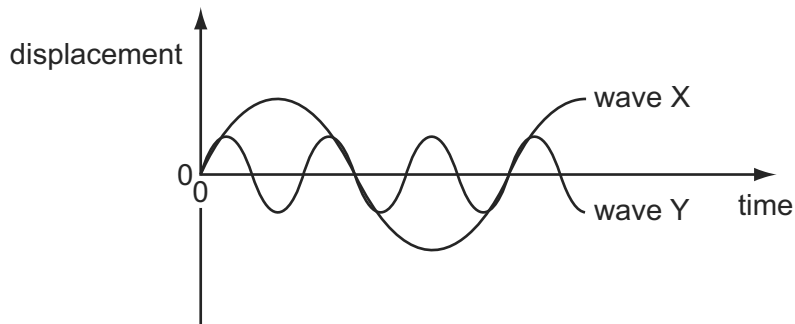
What is the value of *x*?

A 12   **B** 13   **C** 14   **D** 15

25 The diagram shows two waves X and Y.

Wave X has amplitude 8 cm and frequency 100 Hz.

What are the amplitude and the frequency of wave Y?

	amplitude / cm	frequency / Hz
A	2	33
B	2	300
C	4	33
D	4	300

26 What is correct for all transverse waves?

A They are all electromagnetic.

B They can all be polarised.

C They can all travel through a vacuum.

D They all involve the oscillation of atoms.

22 Which statement about different types of electromagnetic wave is correct?

A The frequency of infra-red waves is less than the frequency of blue light.

B The frequency of radio waves is greater than the frequency of gamma rays.

C The wavelength of red light is less than the wavelength of ultraviolet waves.

D The wavelength of X-rays is greater than the wavelength of microwaves.

Waves

24 Electromagnetic waves of wavelength λ and frequency f travel at speed c in a vacuum.

What describes the wavelength and speed of electromagnetic waves of frequency $f/2$?

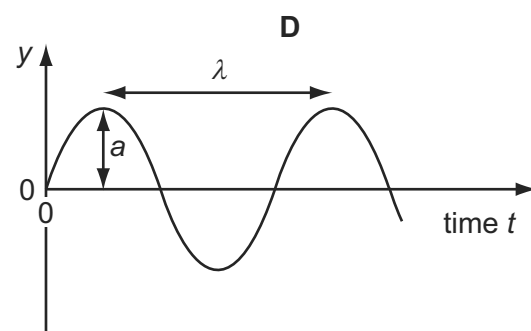|	wavelength	speed in a vacuum
A	$\lambda/2$	$c/2$
B	$\lambda/2$	c
C	2λ	c
D	2λ	$2c$

23 Orange light has a wavelength of 600 nm.

What is the frequency of this light?

A　180 GHz　　　　**B**　180 Hz　　　　**C**　500 THz　　　　**D**　500 kHz

26 A sound wave has displacement y at distance x from its source at time t.

Which graph correctly shows the amplitude a and the wavelength λ of the wave?

Waves
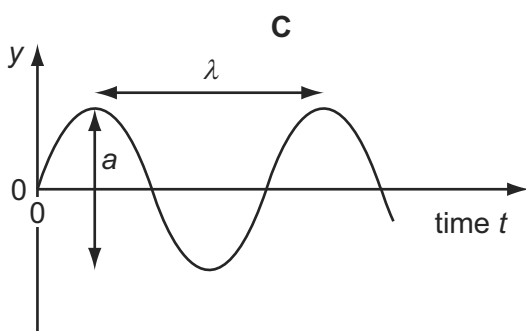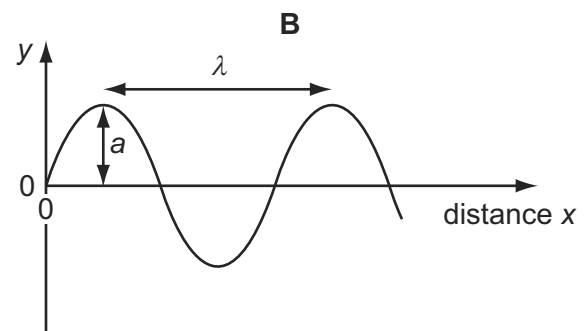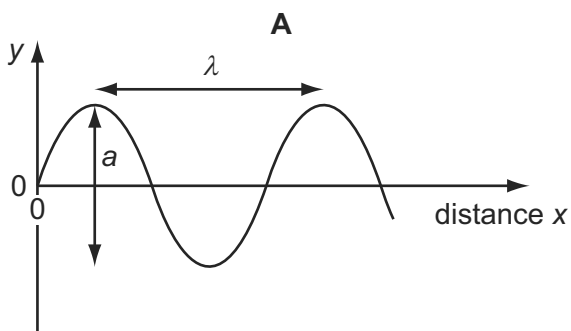
25 When the liquid crystal display of a calculator is observed through a polarising film, the display changes as the film is rotated. 9702/13/M/J/13

Which property describes the radiation from the calculator display?

A unpolarised

B a longitudinal wave

C a transverse wave

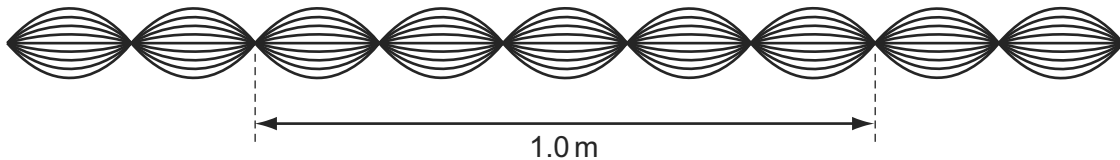**D** a wave with a 3 cm wavelength

4 A wave has a frequency of 5 GHz. 9702/11/M/J/13

What is the period of the wave?

A 20 000 μs

B 20 ns

C 2 ns

D 200 ps

25 The diagram shows a sketch of a wave pattern, over a short period of time. 9702/11/O/N/13

1.0 m

Which description of this wave is correct?

A The wave is longitudinal, has a wavelength of 20 cm and is stationary.

B The wave is transverse, has a wavelength of 20 cm and is stationary.

C The wave is transverse, has a wavelength of 40 cm and is progressive.

D The wave is transverse, has a wavelength of 40 cm and is stationary.

26 Which statement about a light wave and a sound wave is correct? 9702/11/O/N/13

A Both can be polarised.

B Both can travel through free space.

C Both have a frequency inversely proportional to their wavelength.

D Both have an intensity proportional to their amplitude.

Waves

30 When plane-polarised light of amplitude A is passed through a polarising filter as shown, the amplitude of the light emerging is $A\cos\theta$.

amplitude A
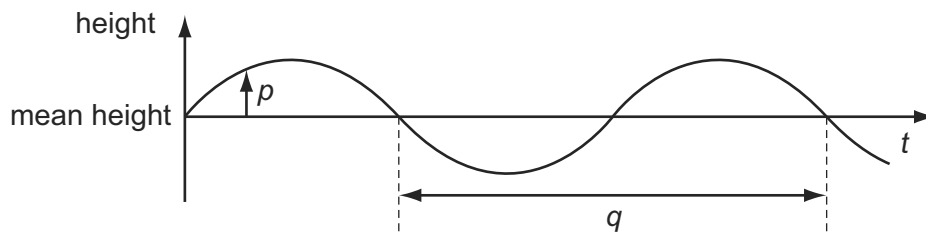intensity I

plane-polarised light

θ

amplitude $A\cos\theta$

polarising filter
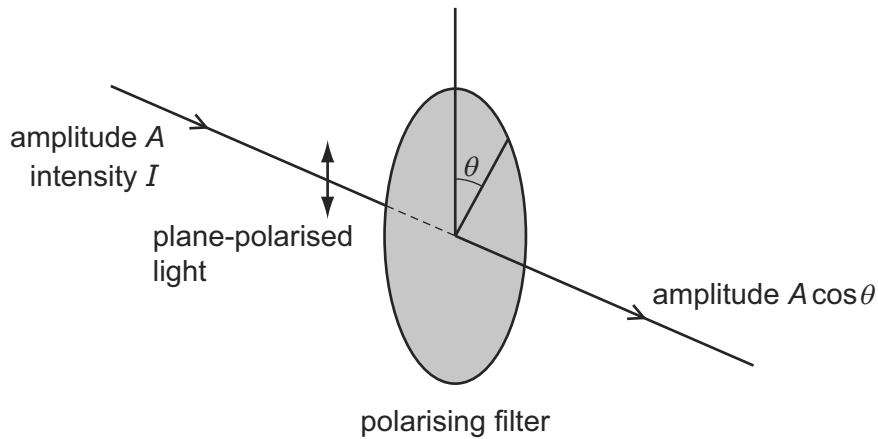
The intensity of the initial beam is I.

What is the intensity of the emerging light when θ is 60.0°?

A $0.250\,I$ **B** $0.500\,I$ **C** $0.750\,I$ **D** $0.866\,I$

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

height

mean height

p

q

t

What are p and q?

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

Waves

24 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m.

Which type of wave are they most likely to be?

A radio waves

B microwaves

C infra-red waves

D ultraviolet waves

25 A cathode-ray oscilloscope (c.r.o.) displays a waveform corresponding to a sound wave.

In order to determine the frequency of the sound wave, which part of the displayed waveform must be measured and which c.r.o. setting must be known?

	on-screen measurement	c.r.o. setting
A	amplitude	time-base
B	amplitude	Y-gain
C	wavelength	time-base
D	wavelength	Y-gain

22 Which statement about longitudinal waves is correct?

A Longitudinal waves include radio waves travelling through air.

B Particles in a longitudinal wave vibrate at right-angles to the direction of transfer of wave energy.

C Some types of longitudinal wave can be polarised.

D Stationary waves can be produced by the superposition of longitudinal waves.

23 The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as 10^x Hz.

What is the value of x?

A 13 **B** 15 **C** 17 **D** 19

Waves
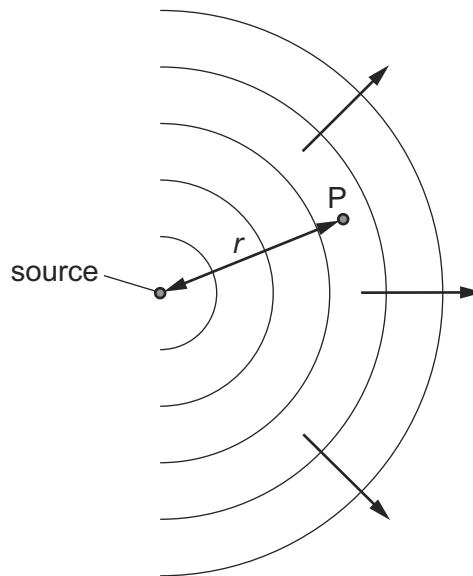
26 What is the approximate range of frequencies of infra-red radiation?

A 1×10^3 Hz   to 1×10^9 Hz

B 1×10^9 Hz   to 1×10^{11} Hz

C 1×10^{11} Hz   to 1×10^{14} Hz

D 1×10^{14} Hz   to 1×10^{17} Hz

27 A small source emits spherical waves.

The wave intensity I at any point P, a distance r from the source, is inversely proportional to r^2.

What is the relationship between the wave amplitude a and the distance r?

A $a^2 \propto \dfrac{1}{r}$ **B** $a \propto \dfrac{1}{r}$ **C** $a \propto \dfrac{1}{r^2}$ **D** $a \propto \dfrac{1}{r^4}$

24 The speed v of waves in deep water is given by the equation $\quad v^2 = \dfrac{g\lambda}{2\pi}$

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 $\dfrac{1}{\lambda}$

Waves

23 A sound wave consists of a series of moving pressure variations from the normal, constant air pressure.

The graph shows these pressure variations for two waves at one instant in time.
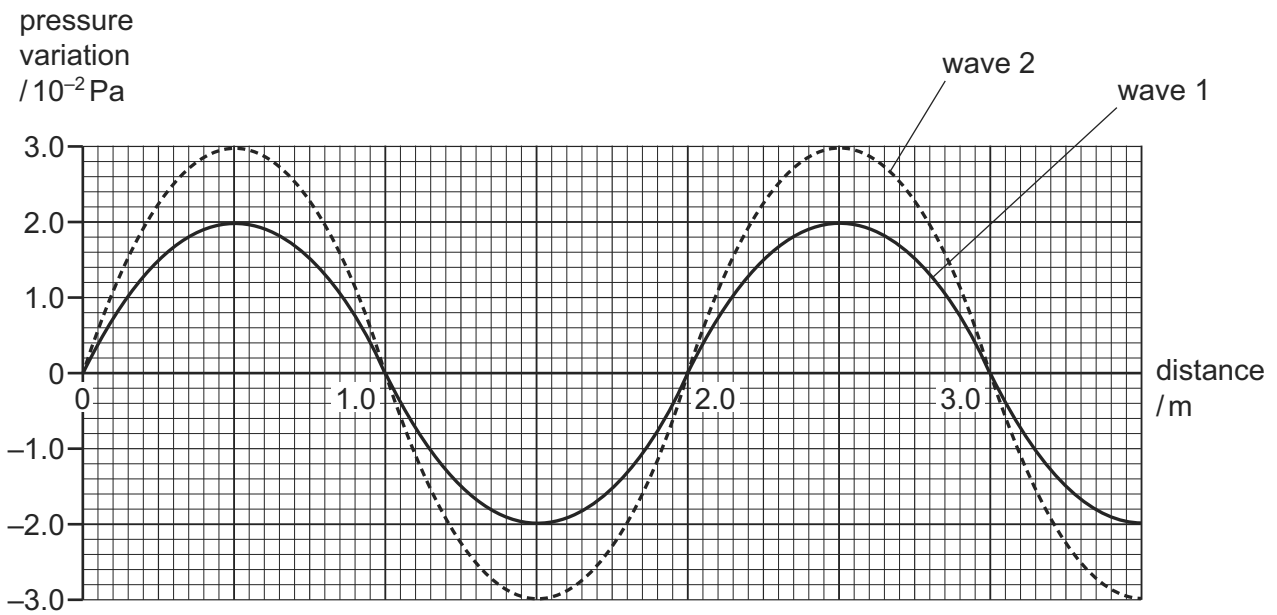
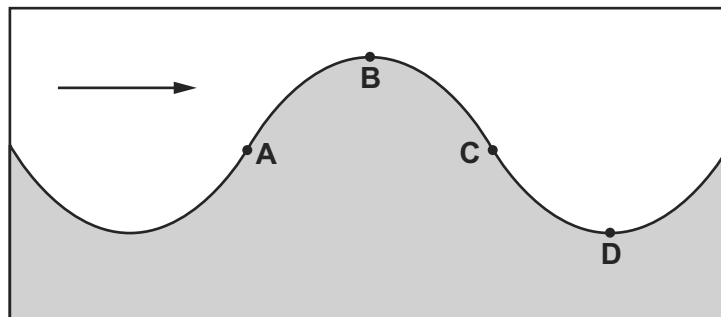Wave 1 has an intensity of $1.6 \times 10^{-6}\,\mathrm{W\,m^{-2}}$.

What is the intensity of wave 2?

A $2.4 \times 10^{-6}\,\mathrm{W\,m^{-2}}$

B $3.0 \times 10^{-6}\,\mathrm{W\,m^{-2}}$

C $3.6 \times 10^{-6}\,\mathrm{W\,m^{-2}}$

D $4.5 \times 10^{-6}\,\mathrm{W\,m^{-2}}$

24 The diagram shows a vertical cross-section through a water wave moving from left to right.

At which point is the water moving upwards with maximum speed?

Waves

22 What, to two significant figures, are the period, the frequency and the amplitude of the wave represented by the graph?
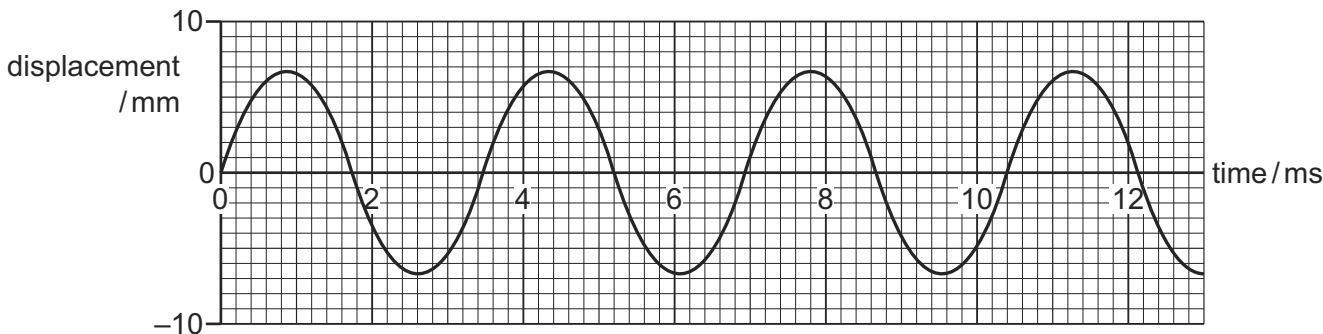
	period /s	frequency /Hz	amplitude /m
A	0.0027	370	0.0067
B	0.0031	320	0.013
C	0.0035	290	0.0067
D	0.0042	240	0.013

26 Which statement about waves is correct?

A All electromagnetic waves travel at the same speed in a vacuum.

B Longitudinal waves can be polarised.

C The amplitude of a wave is directly proportional to the energy transferred by the wave.

D The frequency of infra-red light is greater than the frequency of ultra-violet light.

24 Which statement describes a situation when polarisation could **not** occur?

A Light waves are reflected.

B Light waves are scattered.

C Microwaves pass through a metal grid.

D Sound waves pass through a metal grid.

25 A stationary sound wave is produced in a tube.

Which statement describes the wave speed?

A It is the distance between two adjacent nodes divided by the period of the wave.

B It is the speed at which energy is transferred from one antinode to an adjacent antinode.

C It is the speed of a particle at an antinode.

D It is the speed of one of the progressive waves that are producing the stationary wave.

Waves

27 The variation with distance x of the intensity I along a stationary sound wave in air is shown by the following graph.

9702/13/O/N/14
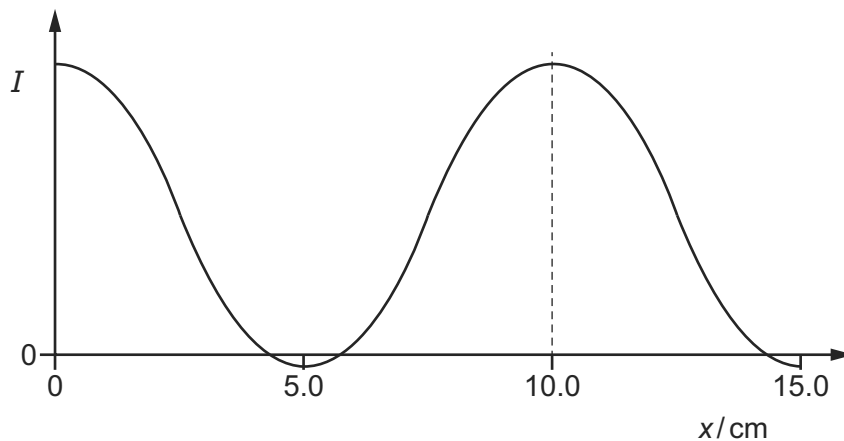
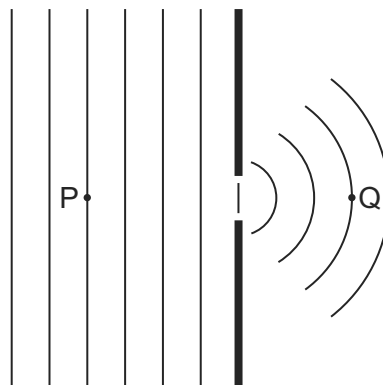The speed of sound in air is $340 \, \text{m s}^{-1}$.

What is the frequency of the sound wave?

A 1700 Hz   **B** 2270 Hz   **C** 3400 Hz   **D** 6800 Hz

**28** Plane wavefronts in a ripple tank pass through a gap as shown.

9702/13/O/N/14

Which property of the wave will be different at Q compared with P?

A velocity

B frequency

C amplitude

D wavelength

22 Which statement about electromagnetic radiation is correct?

9702/11/O/N/14

A Waves of wavelength $5 \times 10^{-9} \, \text{m}$ are high-energy gamma rays.

B Waves of wavelength $3 \times 10^{-8} \, \text{m}$ are ultra-violet waves.

C Waves of wavelength $5 \times 10^{-7} \, \text{m}$ are infra-red waves.

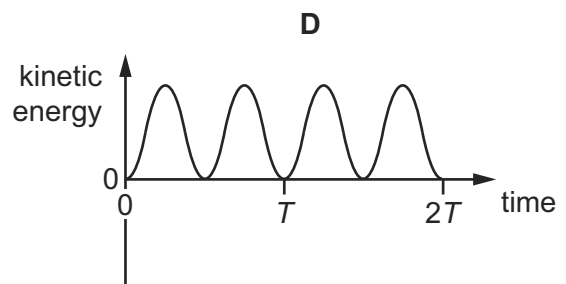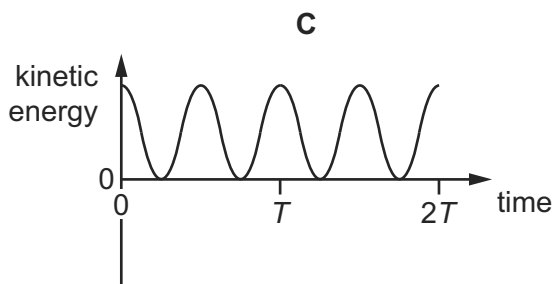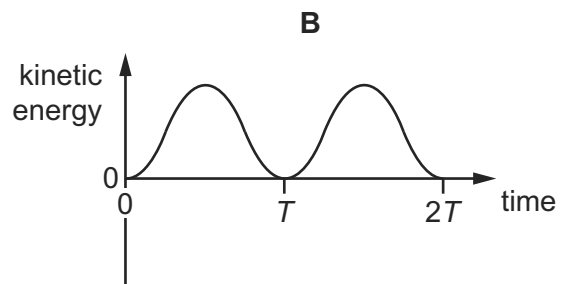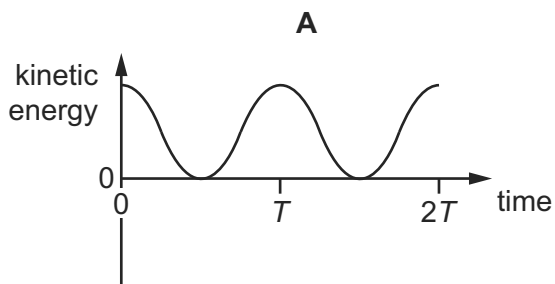**D** Waves of wavelength $9 \times 10^{-7} \, \text{m}$ are light waves.

Waves

23 When sound travels through air, the air particles vibrate. A graph of displacement against time for a single air particle is shown. 9702/11/O/N/14
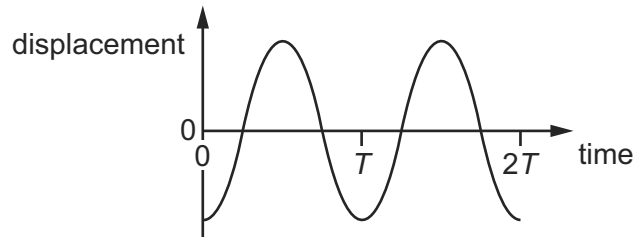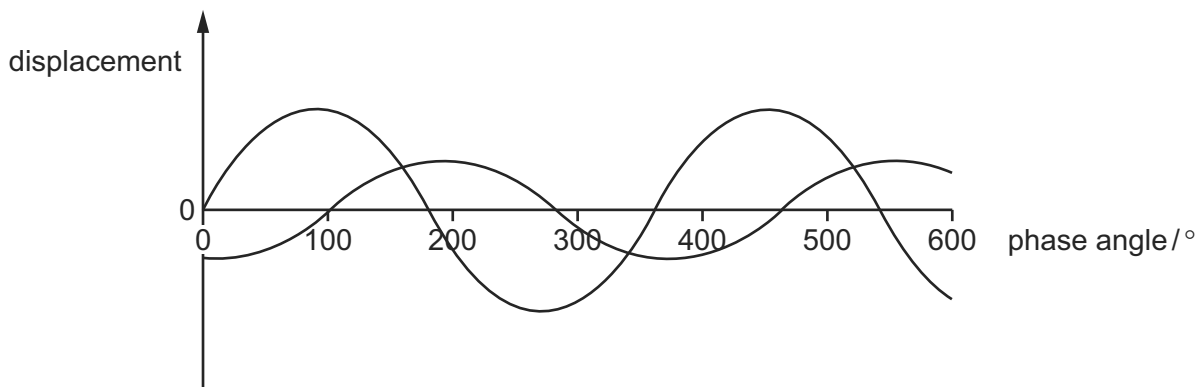

Which graph best shows how the kinetic energy of the air particle varies with time?

A

B

C

D

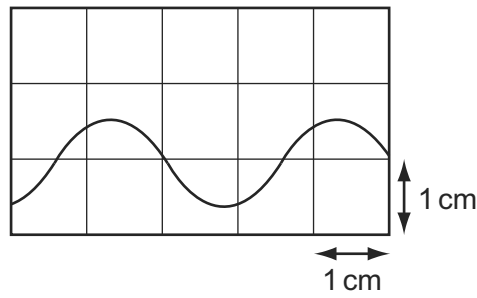**24** Two light waves of the same frequency are represented by the diagram. 9702/12/M/J/15

What could be the phase difference between the two waves?

A 150° **B** 220° **C** 260° **D** 330°

Waves

25 A cathode-ray oscilloscope (c.r.o.) is used to display the trace from a sound wave. The time-base is set at $5\,\mu s\,mm^{-1}$.
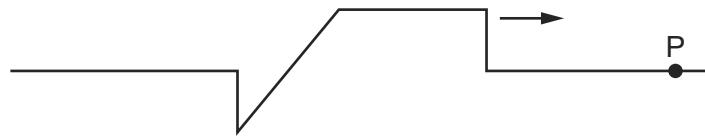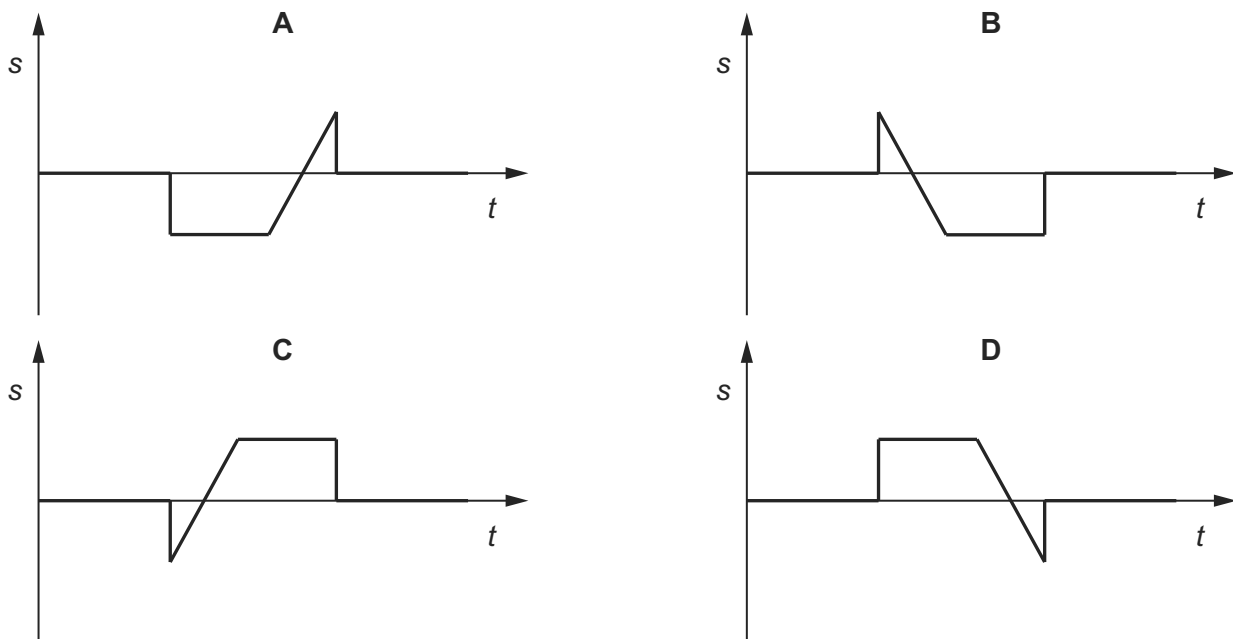
9702/13/M/J/15

What is the frequency of the sound wave?

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

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

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

25 A sound wave has a speed of $330\,m\,s^{-1}$ and a frequency of 50 Hz.

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What is a possible distance between two points on the wave that have a phase difference of 60°?

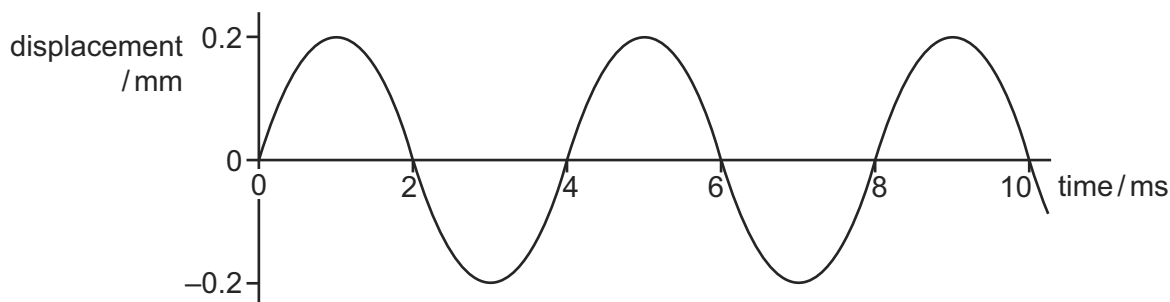**A** 0.03 m   **B** 1.1 m   **C** 2.2 m   **D** 6.6 m

Waves

28 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m?

   A   infra-red

   B   microwave

   C   ultraviolet

   D   X-ray

24 A sound wave moves with a speed of $320\,\mathrm{m\,s^{-1}}$ through air. The variation with time of the displacement of an air particle due to this wave is shown in the graph.

Which statement about the sound wave is correct?

   A   The frequency of the wave is 500 Hz.

   B   The graph shows that sound is a transverse wave.

   C   The intensity of the wave will be doubled if its amplitude is increased to 0.4 mm.

   D   The wavelength of the sound wave is 1.28 m.

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

What is the phase difference between two points 2 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 0.8 of a cycle.

26 A wave of amplitude a has an intensity of $3.0\,\mathrm{W\,m^{-2}}$.

What is the intensity of a wave of the same frequency that has an amplitude $2a$?

   A $4.2\,\mathrm{W\,m^{-2}}$ **B** $6.0\,\mathrm{W\,m^{-2}}$ **C** $9.0\,\mathrm{W\,m^{-2}}$ **D** $12\,\mathrm{W\,m^{-2}}$

Waves

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

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

A gamma ray

B X-ray

C visible light

D infra-red

Waves