

## Waves and Superposition

(Past Year Topical Questions 2010-2015)

May/June 2010 (11)

- 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.

Which type of wave are they most likely to be?

- A radio waves  
 B microwaves  
 C infra-red waves  
 D ultraviolet waves
- 23 Using monochromatic light, interference fringes are produced on a screen placed a distance  $D$  from a pair of slits of separation  $a$ . The separation of the fringes is  $x$ .

Both  $a$  and  $D$  are now doubled.

What is the new fringe separation?

- A  $\frac{x}{2}$       B  $x$       C  $2x$       D  $4x$
- 24 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet.

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

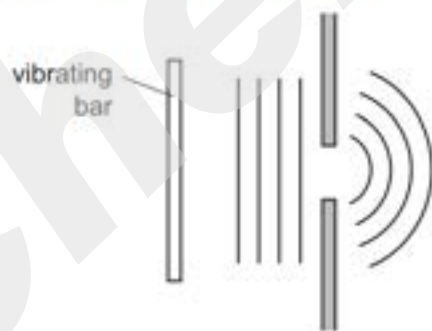


diagram 1

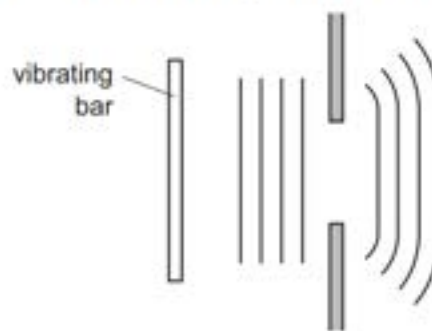


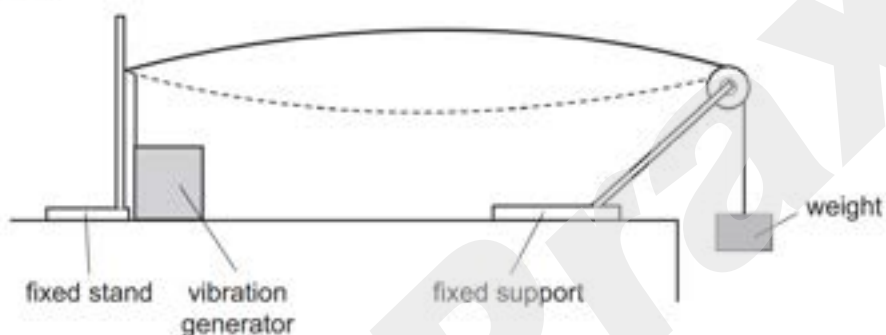
diagram 2

Which action would cause the waves in diagram 1 to be diffracted less and so produce an emergent pattern closer to that shown in diagram 2?

- A increasing the frequency of vibration of the bar
- B increasing the speed of the waves by making the water in the tank deeper
- C reducing the amplitude of vibration of the bar
- D reducing the length of the vibrating bar

May/June 2010 (12)

- 22 The diagram shows a steel wire clamped at one end and tensioned at the other by a weight hung over a pulley.



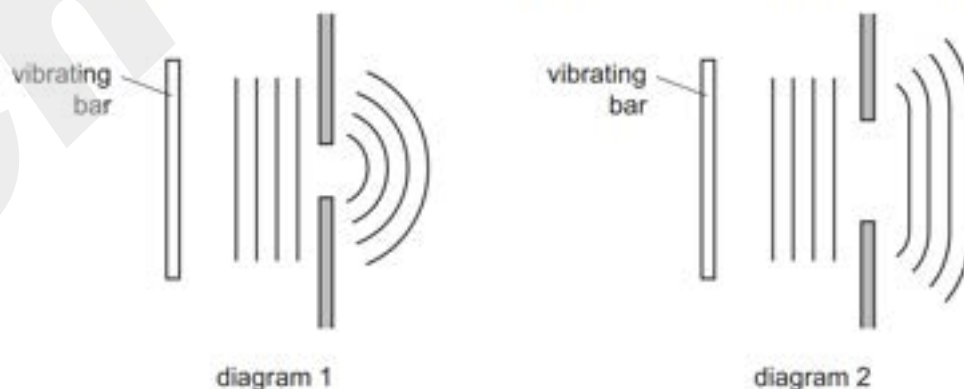
A vibration generator is attached to the wire near the clamped end. A stationary wave with one loop is produced. The frequency of the vibration generator is  $f$ .

Which frequency should be used to produce a stationary wave with two loops?

- A  $\frac{f}{4}$
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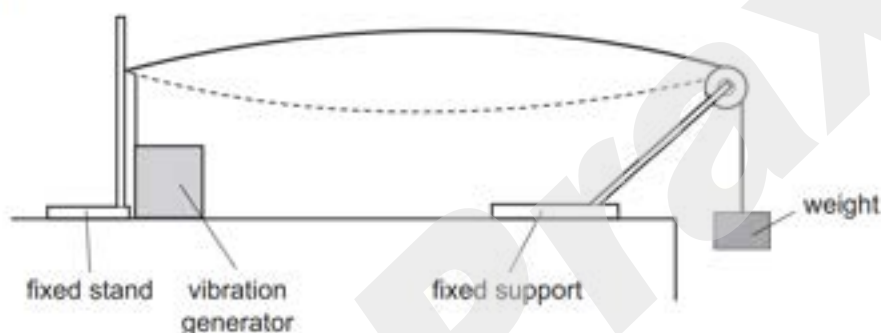
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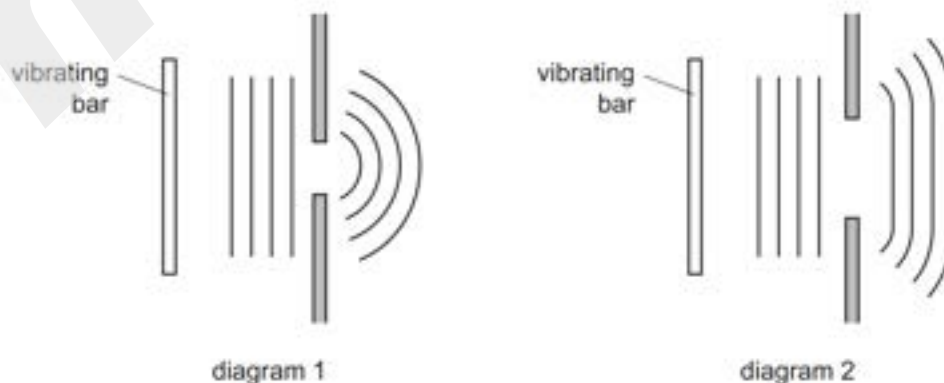
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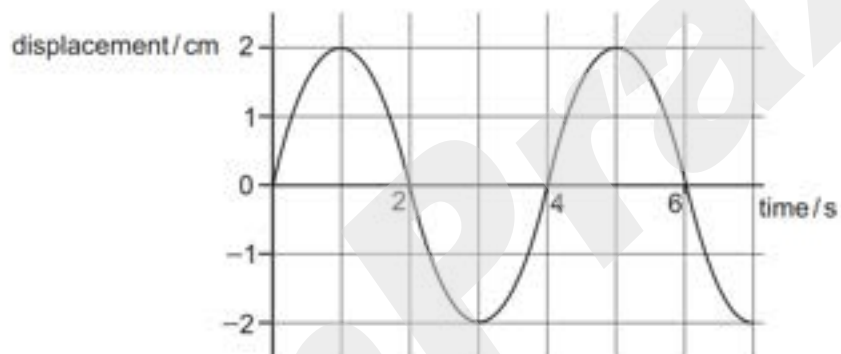


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October/November 2010 (11)

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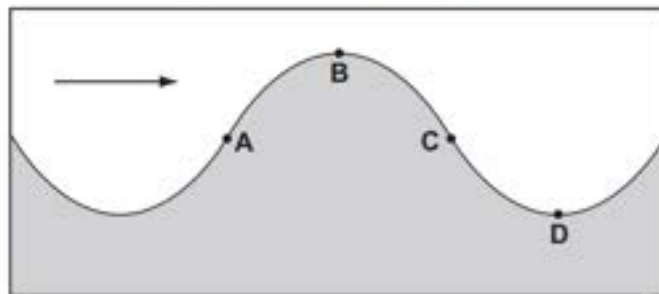


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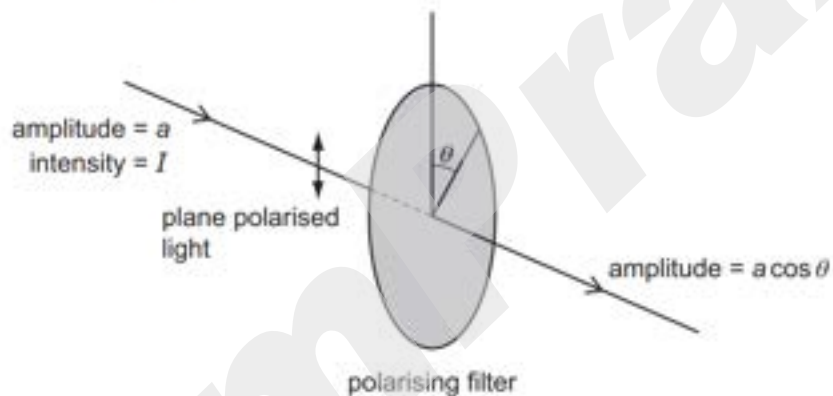
- A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.
- B The wave has an amplitude of 2 cm and must be transverse.
- C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.
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- 24 The diagram 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?



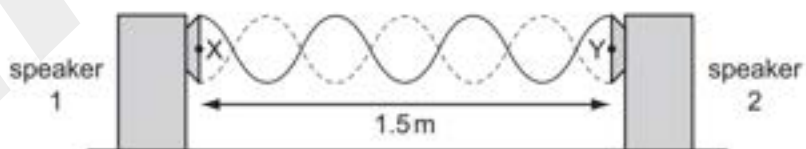
- 25 When plane-polarised light of amplitude  $a$  is passed through a polarising filter as shown, the amplitude of the light emerging is  $a \cos \theta$ .



The intensity of the initial beam is  $I$ .

What is the intensity of the emerging light when  $\theta$  is  $60.0^\circ$ ?

- A  $0.250I$       B  $0.500I$       C  $0.750I$       D  $0.866I$
- 26 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.



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

What is the wavelength of the sound?

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

27 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

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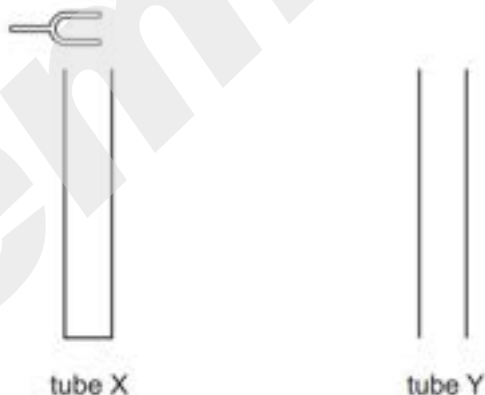
Which amplitude is necessary for the intensity to be doubled to  $2I$ ?

- A  $A^2$
- B  $\sqrt{A}$
- C  $\sqrt{2}A$
- D  $2A$

24 Which value is a possible wavelength for radiation in the ultra-violet region of the electromagnetic spectrum?

- A  $3 \times 10^{-2}$  m
- B  $3 \times 10^{-6}$  m
- C  $3 \times 10^{-8}$  m
- D  $3 \times 10^{-10}$  m

25 The diagram shows two tubes.



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

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

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

- A a fork of frequency  $\frac{f}{2}$
- B a fork of frequency  $\frac{2f}{3}$
- C a fork of frequency  $\frac{3f}{2}$
- D a fork of frequency  $2f$

- 26 A microwave transmitter emits waves towards a metal plate. The waves strike the plate and are reflected back along their original path.



A microwave detector is moved along the line PT.

Points P, Q, R, S and T are the positions where minima of intensity are observed. These points are found to be 15 mm apart.

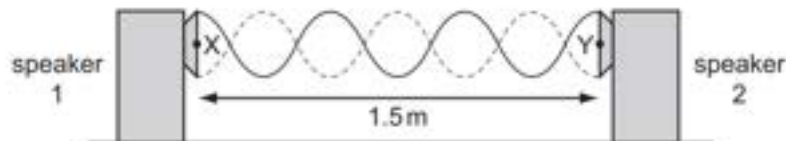
What is the frequency of the microwaves?

- A 5.0 GHz      B 6.7 GHz      C 10 GHz      D 20 GHz
- 27 A double slit experiment, using light of wavelength 600 nm, results in fringes being produced on a screen. The fringe separation is found to be 1.0 mm.
- When the distance between the double slits and the viewing screen is increased by 2.0 m, the fringe separation increases to 3.0 mm.
- What is the separation of the double slits producing the fringes?
- A 0.4 mm      B 0.6 mm      C 0.9 mm      D 1.2 mm



October/November 2010 (13)

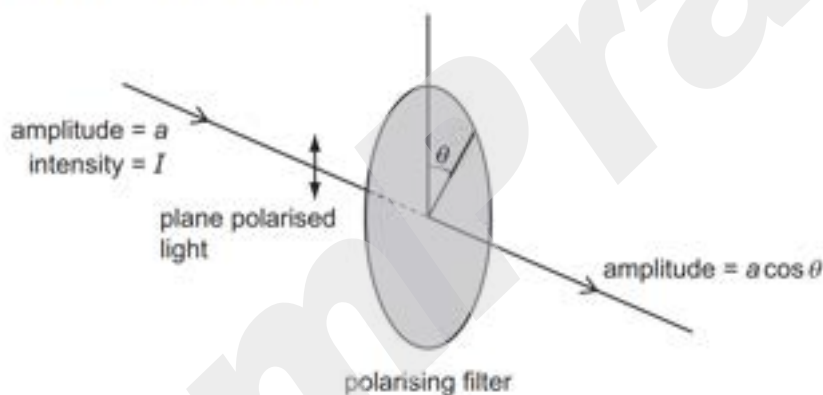
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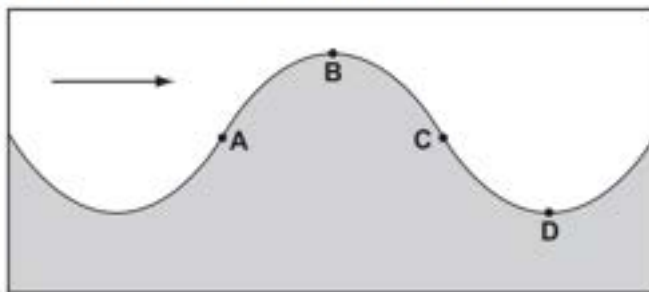
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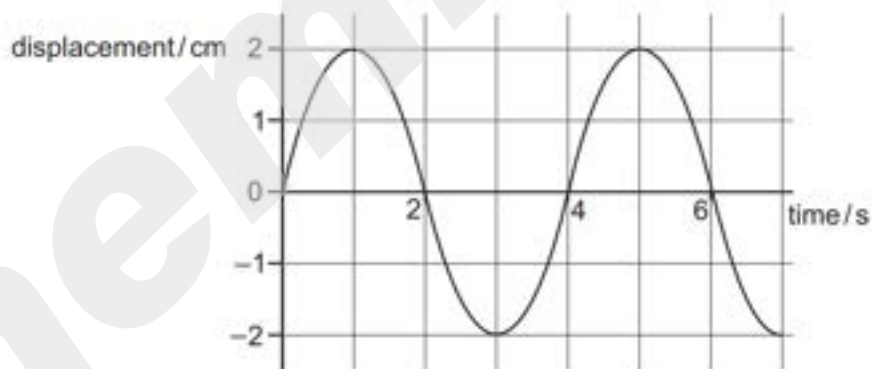
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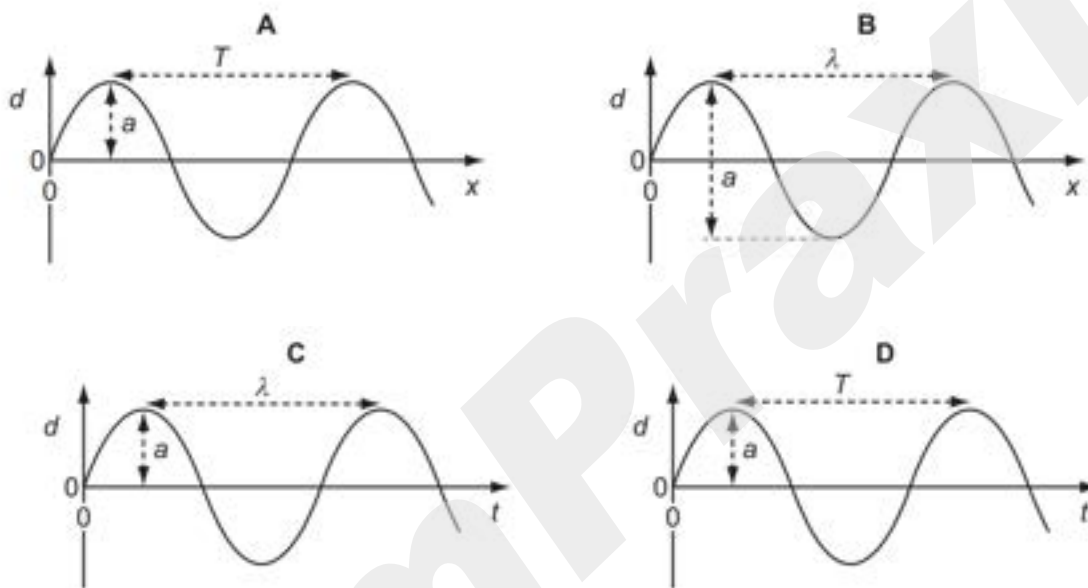
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The labels on the graphs are intended to show the wavelength  $\lambda$ , the period  $T$  and the amplitude  $a$  of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?



- 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.

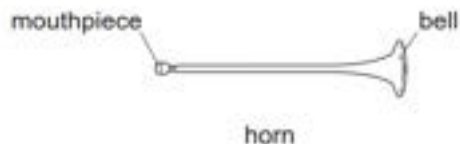
- 24 A source of sound of constant power  $P$  is situated in an open space. The intensity  $I$  of sound at distance  $r$  from this source is given by

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

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

- A  $a \propto \frac{1}{r}$
- B  $a \propto \frac{1}{r^2}$
- C  $a \propto r$
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- 25 The basic principle of note production in a horn is to set up a stationary wave in an air column.



For the lowest note produced by a horn, a node is formed at the mouthpiece and the antinode is formed at the bell. The frequency of this note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

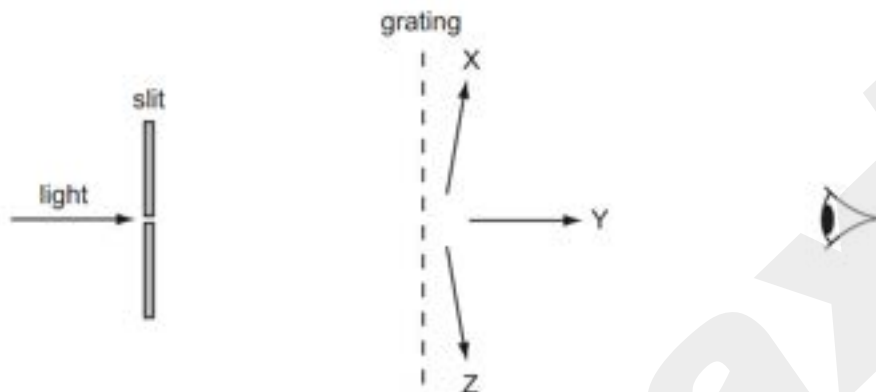
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<b>B</b>	150	225
<b>C</b>	150	300
<b>D</b>	225	375

- 26 Which electromagnetic wave phenomenon is needed to explain the spectrum produced when white light falls on a diffraction grating?
- A** coherence
  - B** interference
  - C** polarisation
  - D** refraction



- 27 A diffraction grating with 500 lines per mm is used to observe diffraction of monochromatic light of wavelength 600 nm.

The light is passed through a narrow slit and the grating is placed so that its lines are parallel to the slit. Light passes through the slit and then the grating.



An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

How many images of the slit does he see?

- A 3                      B 4                      C 6                      D 7

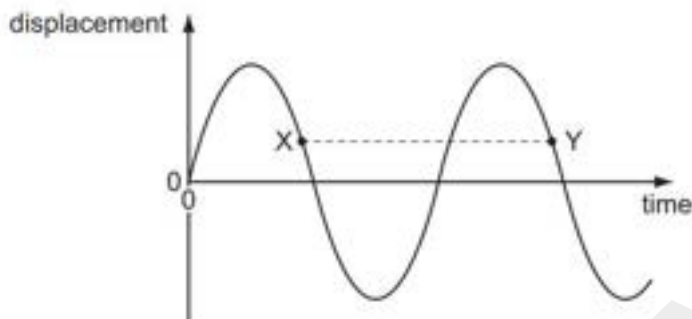
May/June 2011 (12)

- 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

26 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
<b>A</b>	time period	amplitudes
<b>B</b>	time period	displacements
<b>C</b>	wavelength	amplitudes
<b>D</b>	wavelength	displacements

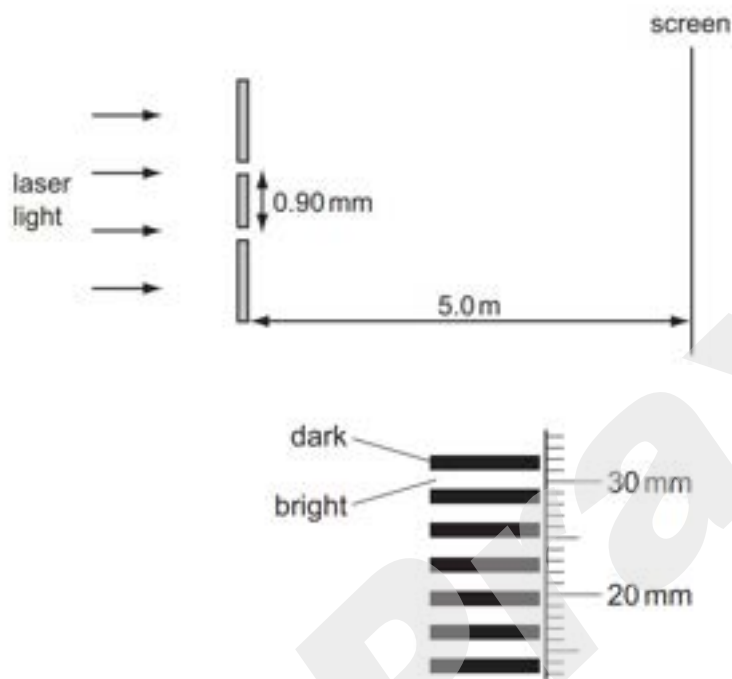
27 If a wave can be polarised, it **must** be

- A** a longitudinal wave.
- B** an electromagnetic wave.
- C** a sound wave.
- D** a transverse wave.

28 In which situation does diffraction occur?

- A** A wave bounces back from a surface.
- B** A wave passes from one medium into another.
- C** A wave passes through an aperture.
- D** Waves from two identical sources are superposed.

- 29 The diagrams show the arrangement of apparatus for a Young's slits experiment and also part of the pattern formed on the screen with a ruler placed next to it.



What is the wavelength of the light?

- A  $4.8 \times 10^{-7} \text{ m}$     B  $5.4 \times 10^{-7} \text{ m}$     C  $3.2 \times 10^{-6} \text{ m}$     D  $3.4 \times 10^{-6} \text{ m}$

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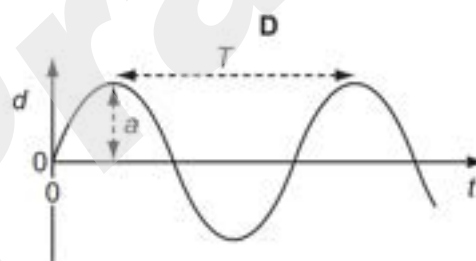
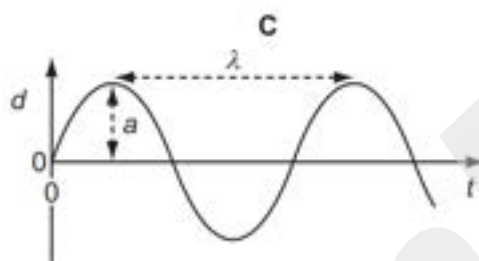
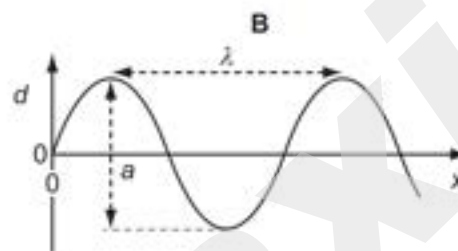
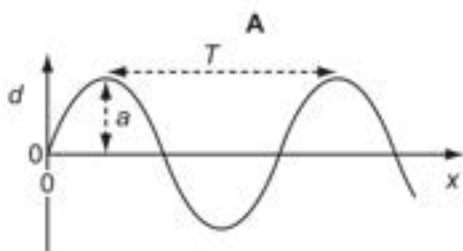
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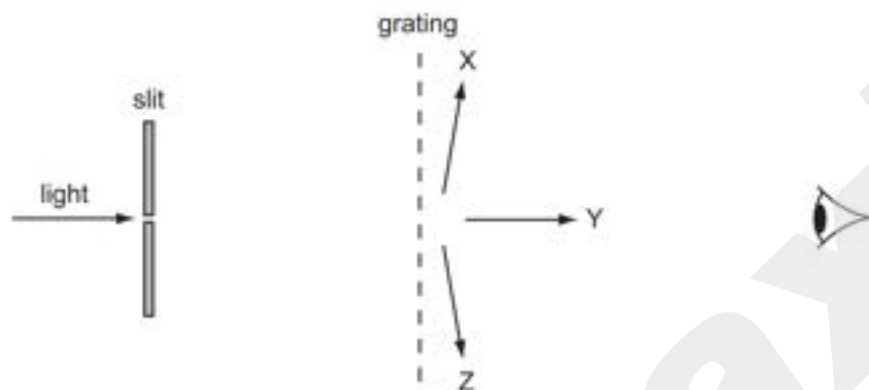
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D	225	375

October/November 2011 (11)

- 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.

Which row is correct?

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

- 28 The diagram shows a view from above of a double slit interference demonstration.

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.

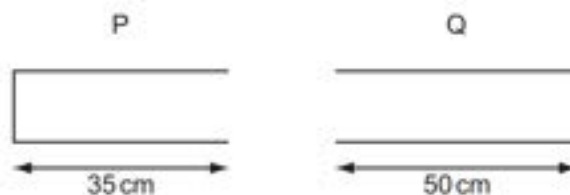


The intensity is  $I$  at a point on the screen where the centre of the fringe pattern forms.

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

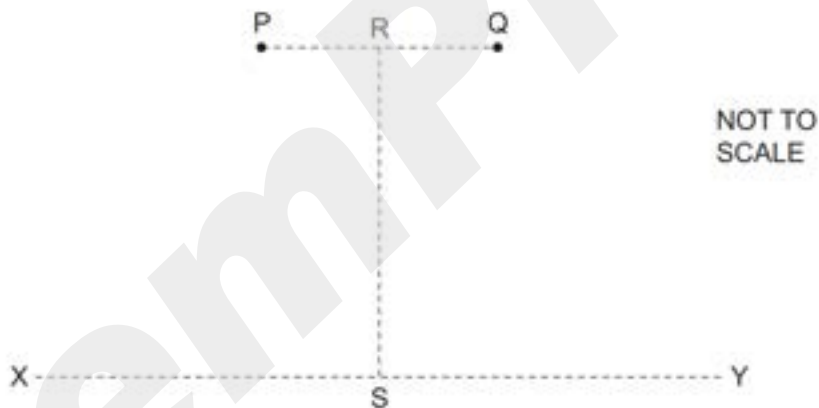
- A  $\frac{I}{\sqrt{2}}$       B  $\frac{I}{2}$       C  $\frac{I}{2\sqrt{2}}$       D  $\frac{I}{4}$

- 29 Travelling waves of wavelength 20 cm are created in the air columns in a closed pipe P and an open pipe Q. The lengths of the pipes are shown.



In which pipe or pipes are stationary waves formed?

- A P and Q  
 B P only  
 C Q only  
 D neither P nor Q
- 30 Coherent waves are produced at P and at Q and travel outwards in all directions. The line RS is halfway between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ.



Along which line, or lines, is an interference pattern observed?

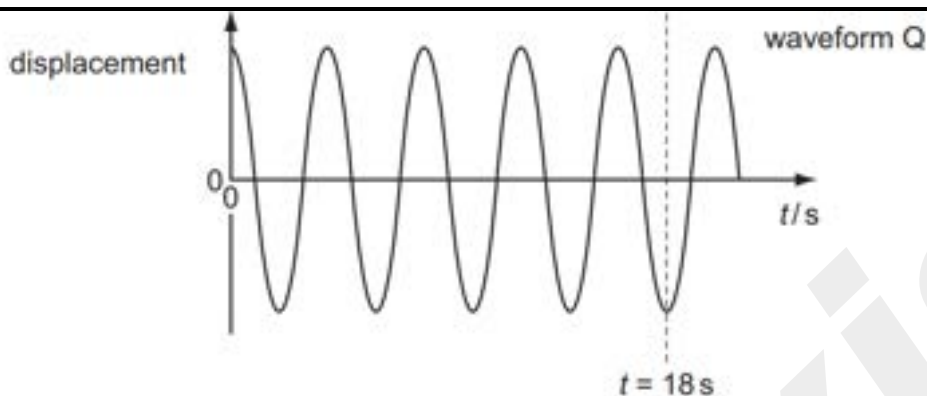
- A both RS and XY  
 B RS only  
 C XY only  
 D neither RS nor XY

October/November 2011 (12)

- 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  $5 \times 10^{-9}$  m are high-energy gamma rays.
  - B Waves of wavelength  $3 \times 10^{-8}$  m are ultra-violet waves.
  - C Waves of wavelength  $5 \times 10^{-7}$  m are infra-red waves.
  - D Waves of wavelength  $9 \times 10^{-7}$  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  $\frac{1}{8}$  of a cycle?

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

- 27 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

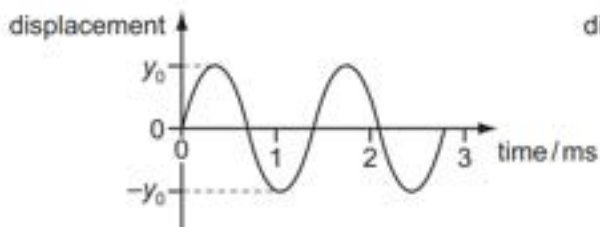
- 28 Two light sources produce visible interference fringes only in certain circumstances.

Which condition enables visible interference fringes to be formed?

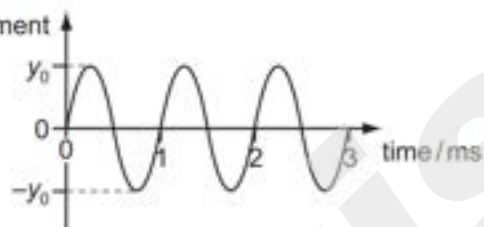
- A** using a white light source  
**B** using incoherent sources  
**C** using one light source which is polarised at right angles to light from the other source  
**D** using sources from which the light does not overlap

May/June 2012 (11)

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



E

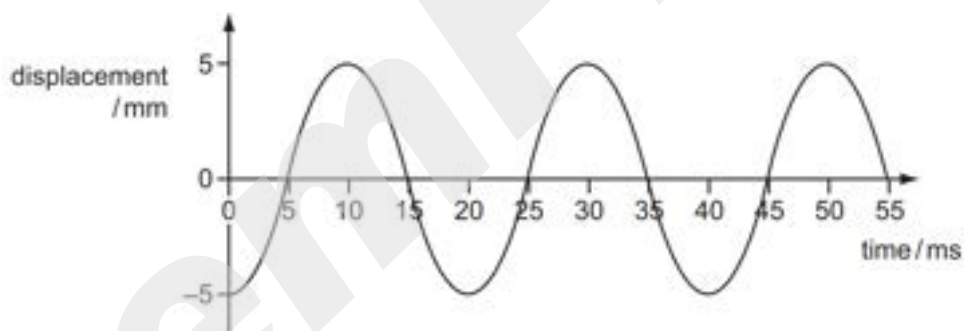


G

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

28 Which observation indicates that sound waves are longitudinal?

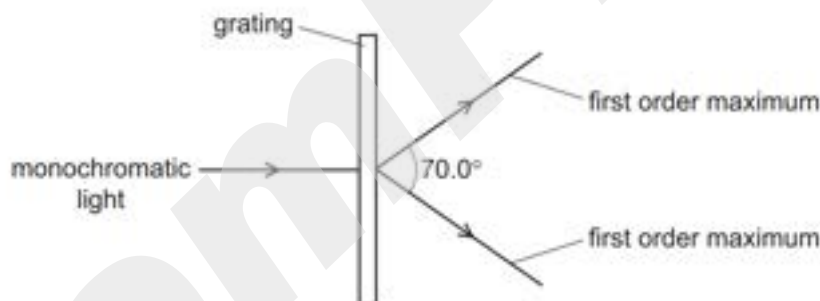
- A Sound can be reflected from a solid surface.
- B Sound cannot be polarised.
- C Sound is diffracted around corners.
- D Sound is refracted as it passes from hot air to cold air.

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

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

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

30 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram.



The spacing of the slits in the grating is  $1.00 \times 10^{-6}$  m. The angle between the first order diffraction maxima is  $70.0^\circ$ .

What is the wavelength of the light?

- A 287 nm
- B 470 nm
- C 574 nm
- D 940 nm

May/June 2012 (12)

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?

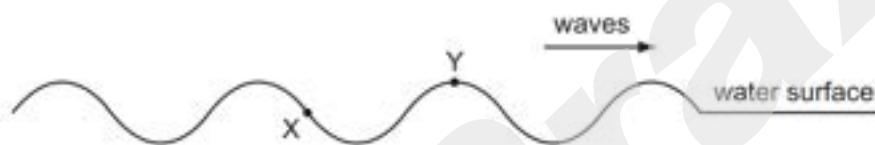
- A 0.05 ns
- B 0.10 ns
- C  $0.50 \mu\text{s}$
- D  $1.0 \mu\text{s}$

- 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	$3.0 \times 10^8$
B	$1.0 \times 10^6$	300
C	$1.0 \times 10^9$	0.30
D	$1.0 \times 10^{12}$	$3.0 \times 10^{-4}$

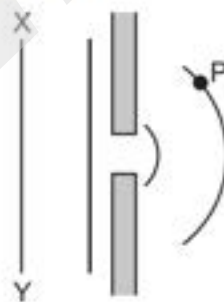
- 28 X and Y are two points on the surface of water in a ripple tank. A source of waves of constant frequency begins to generate waves which then travel past X and Y, causing them to oscillate.



What is the phase difference between X and Y?

- A  $45^\circ$       B  $135^\circ$       C  $180^\circ$       D  $270^\circ$
- 29 A monochromatic plane wave of speed  $c$  and wavelength  $\lambda$  is diffracted at a small aperture.

The diagram illustrates successive wavefronts.



After what time will some portion of the wavefront XY reach point P?

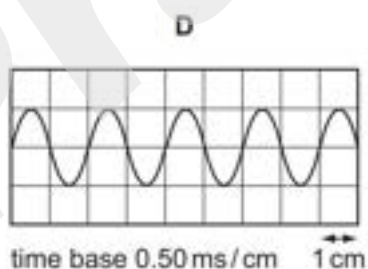
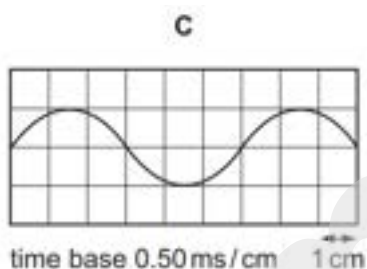
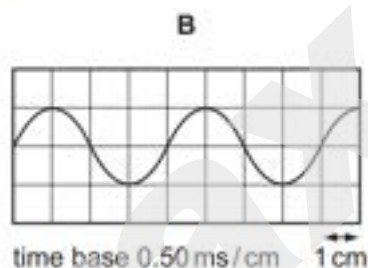
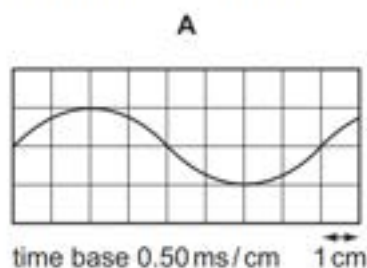
- A  $\frac{3\lambda}{2c}$       B  $\frac{2\lambda}{c}$       C  $\frac{3\lambda}{c}$       D  $\frac{4\lambda}{c}$

**30** A standing sound wave is set up between a loudspeaker and a wall.

A microphone is connected to a cathode-ray oscilloscope (c.r.o.) and is moved along a line directly between the loudspeaker and the wall. The amplitude of the trace on the c.r.o. rises to a maximum at a position X, falls to a minimum and then rises once again to a maximum at a position Y.

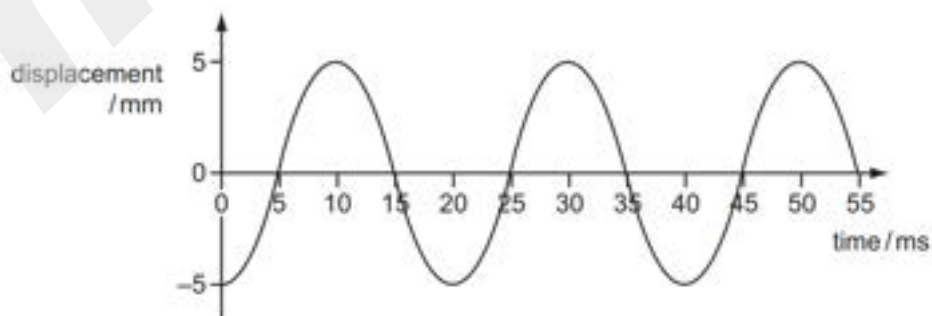
The distance between X and Y is 33 cm. The speed of sound in air is  $330 \text{ m s}^{-1}$ .

Which diagram represents the c.r.o. trace of the sound received at X?



May/June 2012 (13)

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



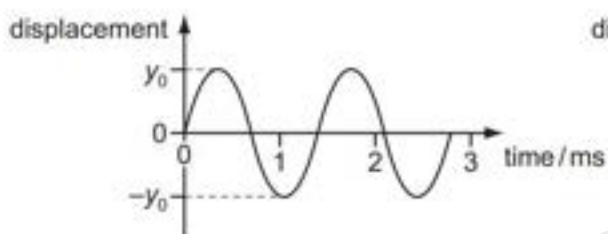
What are the amplitude and frequency of the wave?



What are the amplitude and frequency of the wave?

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

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



E

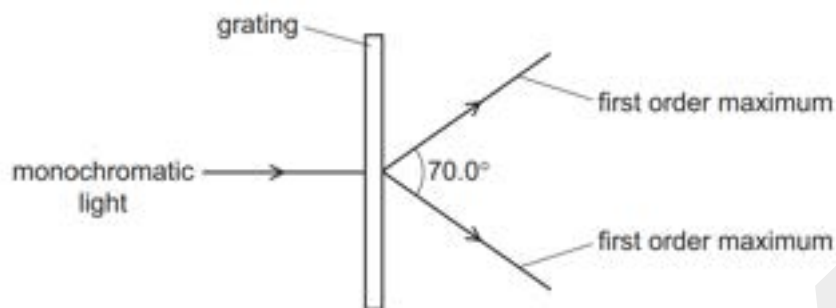


G

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.

- 28 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram.



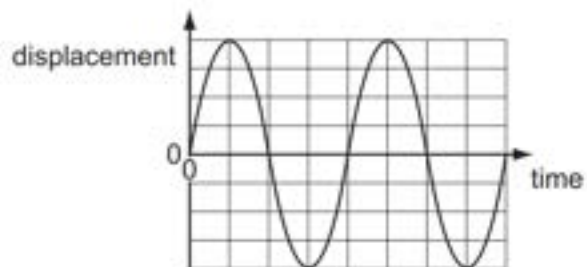
The spacing of the slits in the grating is  $1.00 \times 10^{-6}$  m. The angle between the first order diffraction maxima is  $70.0^\circ$ .

What is the wavelength of the light?

- A 287 nm      B 470 nm      C 574 nm      D 940 nm
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- 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.
- 30 To produce a stationary wave, two waves must travel in opposite directions through the same space.
- Which statement about the properties of the two waves must also be true?
- A The waves must have equal frequency, but a different speed and wavelength.  
 B The waves must have equal speed, but a different wavelength and frequency.  
 C The waves must have equal speed, frequency and wavelength.  
 D The waves must have equal wavelength, but a different speed and frequency.

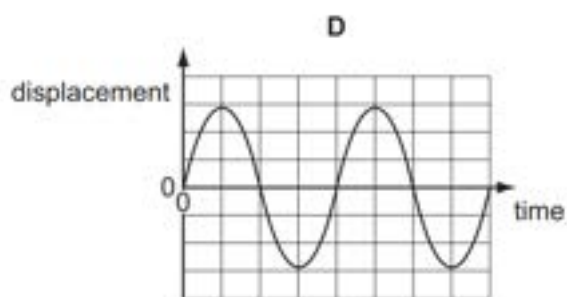
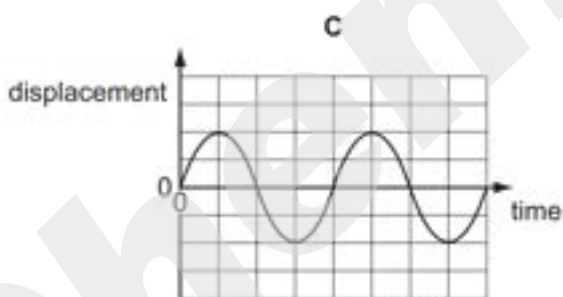
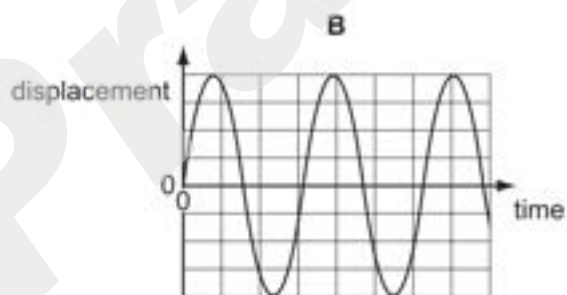
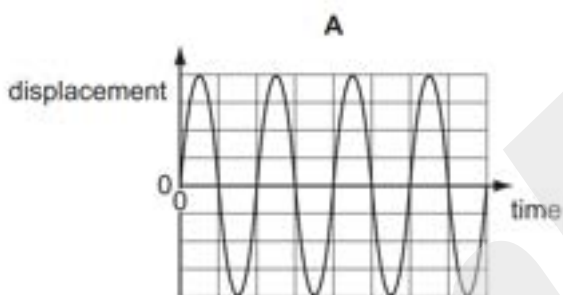
October/November 2012 (11)

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



The intensity of the sound is halved.

Which graph shows the displacement of this sound wave?



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

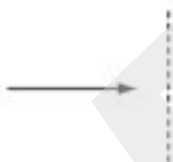
- A electrons
- B microwaves
- C radio waves
- D X-rays

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

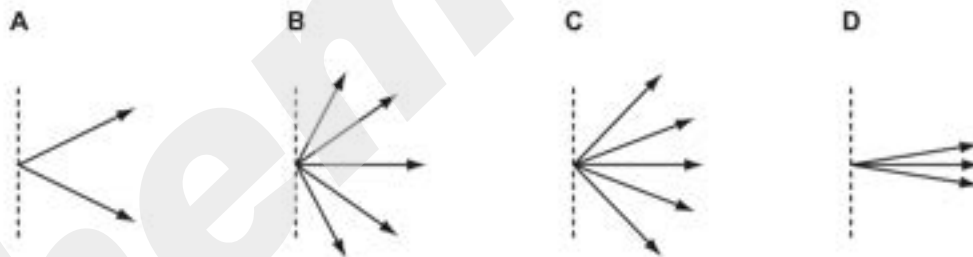
What is the lowest frequency of sound produced by a pipe of length 10m?  
(The speed of sound in the pipe is  $320 \text{ m s}^{-1}$ .)

- A 4 Hz
- B 8 Hz
- C 16 Hz
- D 32 Hz

29 Monochromatic light is directed at a diffraction grating as shown.

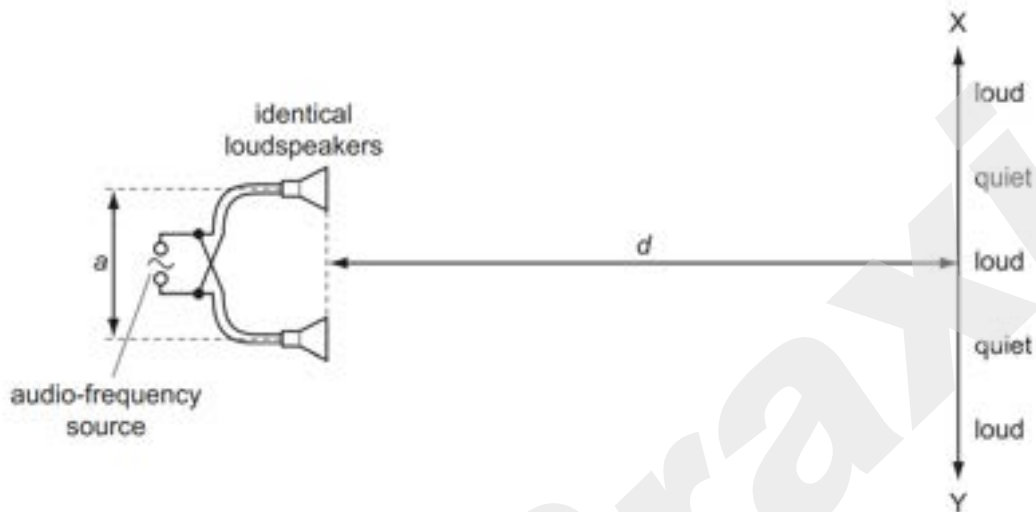


Which diagram shows all the possible directions of the light, after passing through the grating, that give maximum intensity?



October/November 2012 (12)

- 28 The diagram shows two identical loudspeakers driven in phase by a common audio-frequency source.



When a student moves along line  $XY$ , she notices that there are variations in the loudness of the sound. The regions in which the sound is heard are alternately loud and quiet as indicated on the diagram.

How may the distance between loud regions be reduced?

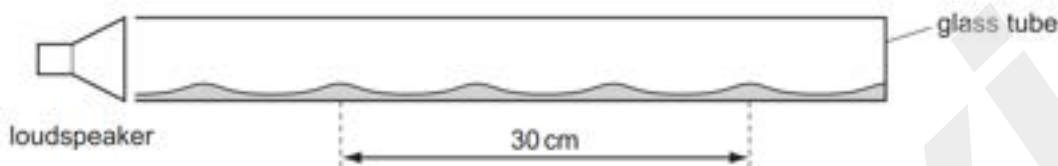
- A decreasing the distance  $a$  between the speakers
- B increasing distance  $d$
- C increasing the frequency of the audio-frequency source
- D increasing the power output from the audio-frequency source



- 29 A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube.

The frequency of the sound is varied and, at one frequency, a stationary wave is formed inside the tube so that the dust forms small heaps.

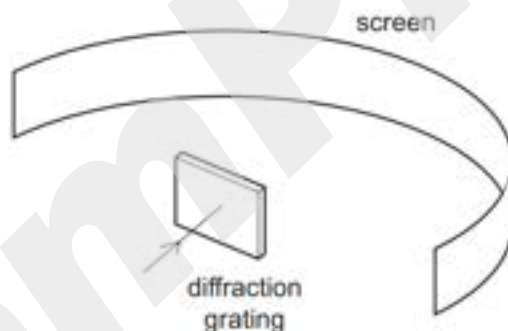
The distance between four heaps of dust is 30 cm.



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

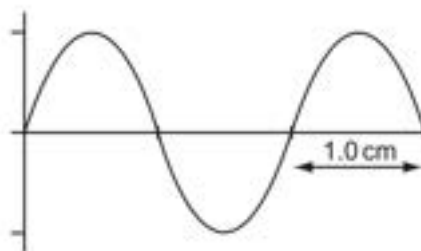
What is the frequency of the sound emitted by the loudspeaker?

- A 1650 Hz      B 2200 Hz      C 3300 Hz      D 6600 Hz
- 30 Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima on a screen.



What is the greatest number of maxima that can be observed?

- A 4      B 5      C 8      D 9
- 31 The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.



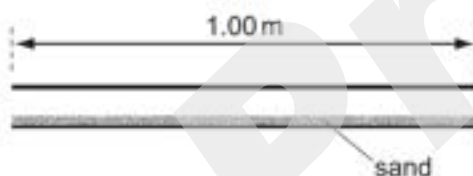
The time base setting is  $0.20 \mu\text{s cm}^{-1}$ .

Which statement is correct?

- A The frequency of the wave is 2.5 MHz and it lies in the 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.

October/November 2012 (13)

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



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

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

What is the frequency of the sound?

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

27 A stationary sound wave is formed in a measuring cylinder by blowing across the top, as shown.



Which statement is correct?

- A The fundamental frequency of the stationary wave decreases when some water is added to the cylinder.
  - B The stationary wave in the cylinder is caused by the superposition of two waves moving in opposite directions.
  - C The stationary wave in the cylinder is polarised.
  - D The stationary wave will have an antinode at the bottom of the cylinder.
- 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.

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

May/June 2013 (11)

- 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  $P$ .

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  $6P$
- 25 A wave has a speed of  $340 \text{ m s}^{-1}$  and a period of  $0.28 \text{ ms}$ .  
 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?

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

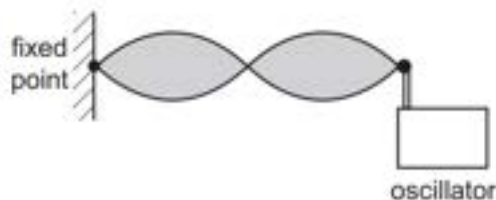
- 27 Light of wavelength  $600 \text{ nm}$  is incident on a pair of slits. Fringes with a spacing of  $4.0 \text{ mm}$  are formed on a screen.

What will be the fringe spacing when the wavelength of the light is changed to  $400 \text{ nm}$  and the separation of the slits is doubled?

- A  $1.3 \text{ mm}$   
 B  $3.0 \text{ mm}$   
 C  $5.3 \text{ mm}$   
 D  $12 \text{ mm}$



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



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

- A Decrease the speed of the wave on the string.  
 B Decrease the wavelength of the wave on the string.  
 C Increase the speed of the wave on the string.  
 D Increase the wavelength of the wave on the string.
- 29 Noise reduction headphones actively produce their own sound waves in order to cancel out external sound waves.

A microphone in the headphones receives waves of one frequency. A loudspeaker in the headphones then produces a wave of that frequency but of a different phase.

What is the phase difference between the external sound wave and the wave produced by the loudspeaker in the headphones?

- A  $90^\circ$       B  $180^\circ$       C  $270^\circ$       D  $360^\circ$

May/June 2013 (12)

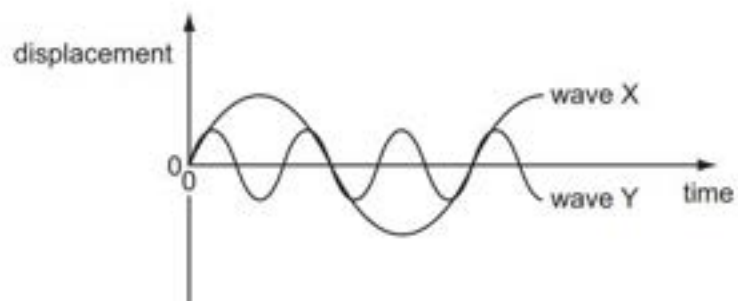
- 24 The order of magnitude of the frequency of the shortest wavelength of visible light waves can be expressed as  $10^x$  Hz.

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.

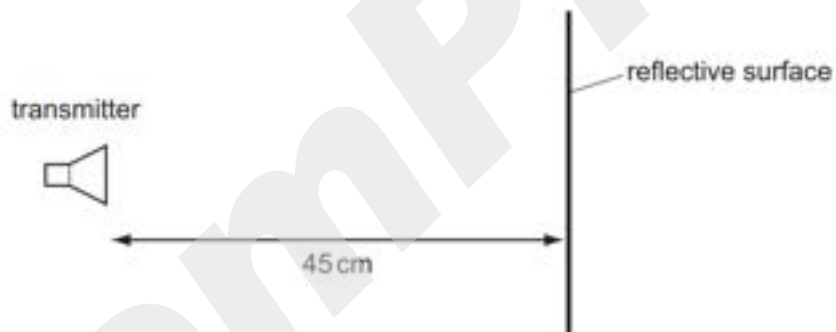
What are the amplitude and the frequency of wave Y?

	amplitude / cm	frequency / Hz
<b>A</b>	2	33
<b>B</b>	2	300
<b>C</b>	4	33
<b>D</b>	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.

**27** A transmitter of electromagnetic waves is placed 45 cm from a reflective surface.



The emitted waves have a frequency of 1.00 GHz. A stationary wave is produced with a node at the transmitter and a node at the surface.

How many antinodes are in the space between the transmitter and the surface?

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

- 28 A teacher sets up the apparatus shown to demonstrate a two-slit interference pattern on the screen.



Which change to the apparatus will increase the fringe spacing?

- A decreasing the distance  $p$
  - B decreasing the distance  $q$
  - C decreasing the distance  $r$
  - D decreasing the wavelength of the light
- 29 Monochromatic light of wavelength  $5.30 \times 10^{-7} \text{ m}$  is incident normally on a diffraction grating. The first order maximum is observed at an angle of  $15.4^\circ$  to the direction of the incident light.
- What is the angle between the first and second order diffraction maxima?
- A  $7.6^\circ$
  - B  $15.4^\circ$
  - C  $16.7^\circ$
  - D  $32.0^\circ$

May/June 2013 (13)

- 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.
- 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

24 Electromagnetic waves of wavelength  $\lambda$  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	$2\lambda$	$c$
D	$2\lambda$	$2c$

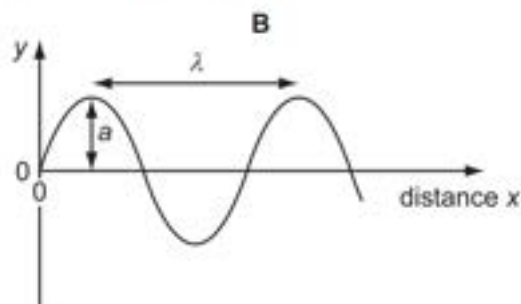
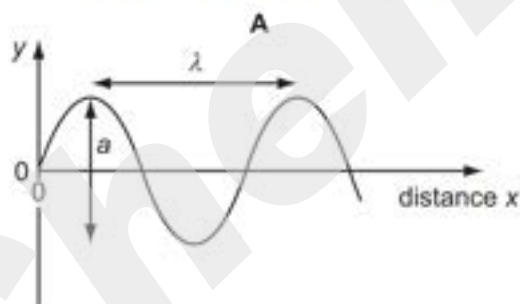
25 When the liquid crystal display of a calculator is observed through a polarising film, the display changes as the film is rotated.

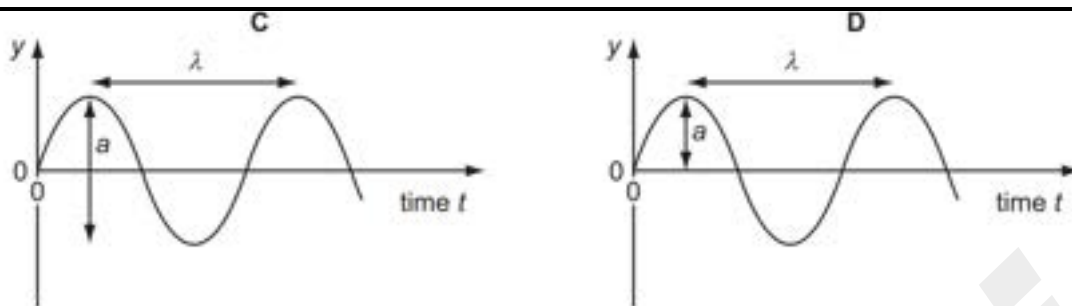
Which property describes the radiation from the calculator display?

- A unpolarised
- B a longitudinal wave
- C a transverse wave
- D a wave with a 3 cm wavelength

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  $\lambda$  of the wave?



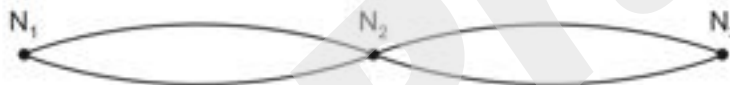


- 27 A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

What is the total number of transmitted maxima?

- A 3                      B 4                      C 6                      D 7

- 28 The diagram shows a standing wave on a string. The standing wave has three nodes  $N_1$ ,  $N_2$  and  $N_3$ .



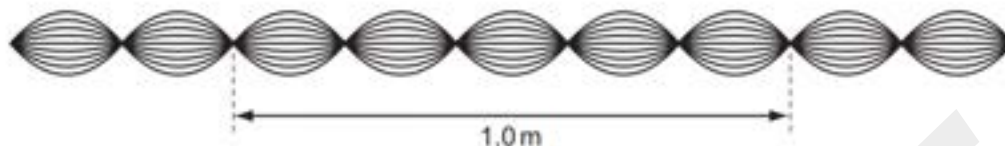
Which statement is correct?

- A All points on the string vibrate in phase.  
 B All points on the string vibrate with the same amplitude.  
 C Points equidistant from  $N_2$  vibrate with the same frequency and in phase.  
 D Points equidistant from  $N_2$  vibrate with the same frequency and the same amplitude.



October/November 2013 (11) & October/November 2013 (12)

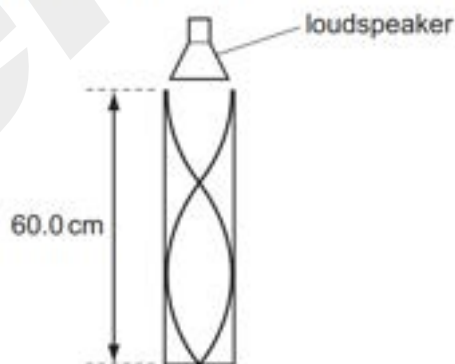
- 25 The diagram shows a sketch of a wave pattern, over a short period of time.



Which description of this wave is correct?

- A The wave is longitudinal, has a wavelength of 20 cm and is stationary.
  - B The wave is transverse, has a wavelength of 20 cm and is stationary.
  - C The wave is transverse, has a wavelength of 40 cm and is progressive.
  - D The wave is transverse, has a wavelength of 40 cm and is stationary.
- 26 Which statement about a light wave and a sound wave is correct?
- 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.
- 27 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.

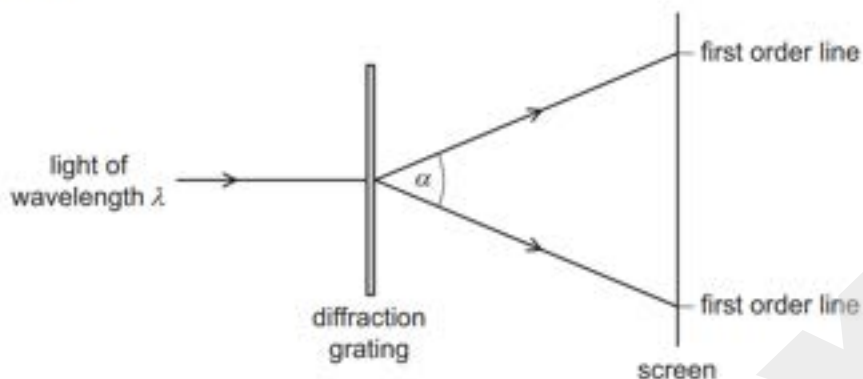


The speed of sound in air is  $330 \text{ m s}^{-1}$ .

What is the frequency of the sound?

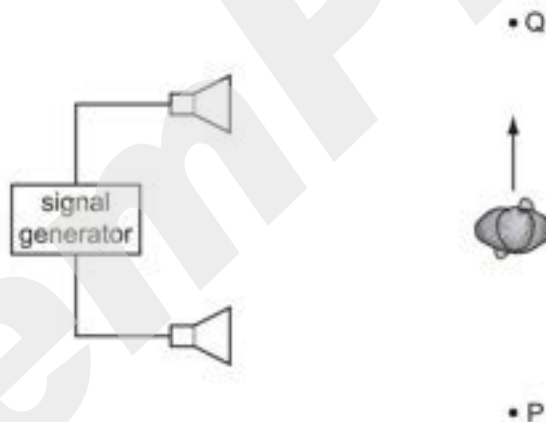
- A 413 Hz
- B 550 Hz
- C 830 Hz
- D 1650 Hz

- 28 Light of wavelength  $\lambda$  passes through a diffraction grating with slit spacing  $d$ . A series of lines is observed on a screen.



What is the angle  $\alpha$  between the two first order lines?

- A  $\sin^{-1}\left(\frac{\lambda}{2d}\right)$     B  $\sin^{-1}\left(\frac{\lambda}{d}\right)$     C  $2\sin^{-1}\left(\frac{\lambda}{2d}\right)$     D  $2\sin^{-1}\left(\frac{\lambda}{d}\right)$
- 29 A student connects two loudspeakers to a signal generator.

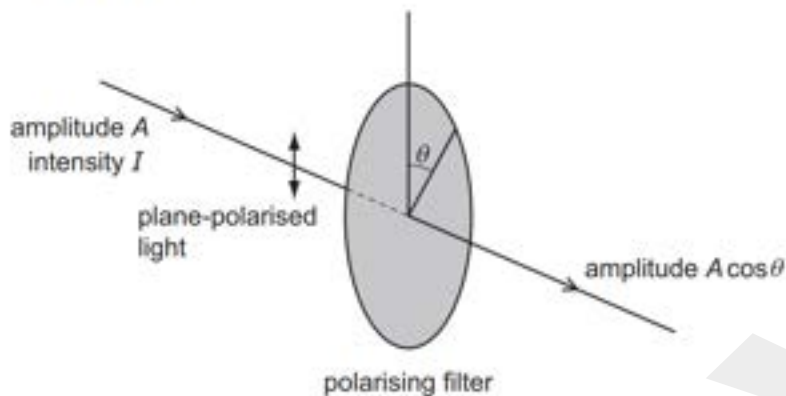


As the student walks from P to Q, he notices that the loudness of the sound rises and falls repeatedly.

What causes the loudness of the sound to vary?

- A diffraction of the sound waves  
 B interference of the sound waves  
 C polarisation of the sound waves  
 D reflection of the sound waves

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



The intensity of the initial beam is  $I$ .

What is the intensity of the emerging light when  $\theta$  is  $60.0^\circ$ ?

- A  $0.250I$       B  $0.500I$       C  $0.750I$       D  $0.866I$

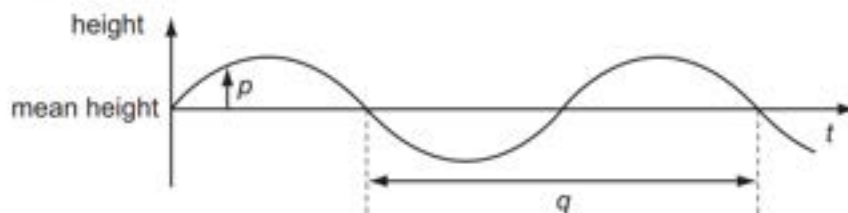
October/November 2013 (13)

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



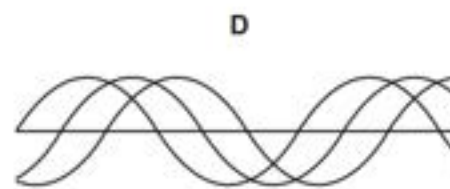
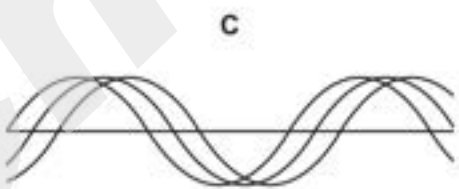
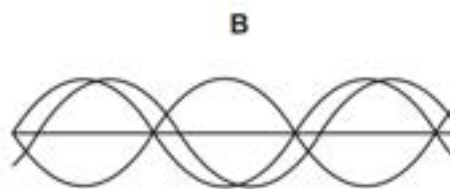
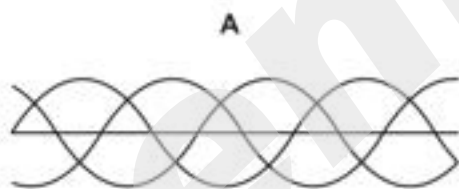
What are  $p$  and  $q$ ?

	$p$	$q$
<b>A</b>	displacement	period
<b>B</b>	displacement	wavelength
<b>C</b>	amplitude	period
<b>D</b>	amplitude	wavelength

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

They are added together to give a resultant wave.

In which case is the resultant wave zero?



- 27 A stationary sound wave has a series of nodes. The distance between the first and the sixth node is 30.0 cm.

What is the wavelength of the sound wave?

- A 5.0 cm      B 6.0 cm      C 10.0 cm      D 12.0 cm

- 28 What is meant by diffraction?

- A Addition of two coherent waves to produce a stationary wave pattern.  
B Bending of waves round an obstacle.  
C Change of direction when waves cross the boundary between one medium and another.  
D Splitting of white light into colours.

- 29 A student sets up apparatus to observe the double-slit interference of monochromatic light, as shown.



Interference fringes are formed on the screen.

Which change would increase the distance between adjacent fringes?

- A Decrease the distance between the two slits.  
B Decrease the width of each slit.  
C Move the screen closer to the double-slit.  
D Use light of a higher frequency.

May/June 2014 (11)



- 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
- 24 The speed  $v$  of waves in deep water is given by the equation

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

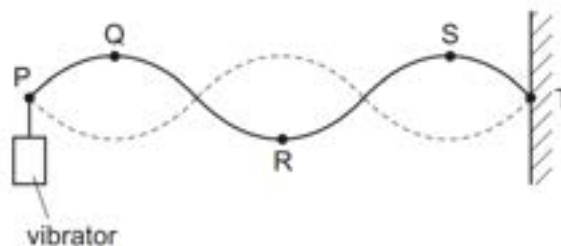
where  $\lambda$  is the wavelength of the waves and  $g$  is the acceleration of free fall.

A student measures the wavelength  $\lambda$  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  $\lambda$
- B  $f$  against  $\lambda^2$
- C  $f$  against  $\frac{1}{\lambda}$
- D  $f^2$  against  $\frac{1}{\lambda}$

- 25 A stationary wave on a stretched string is set up between two points P and T.



Which statement about the wave is correct?

- A Point R is at a node.
  - B Points Q and S vibrate in phase.
  - C The distance between P and T is three wavelengths.
  - D The wave shown has the lowest possible frequency.
- 26 A parallel beam of white light passes through a diffraction grating. Orange light of wavelength 600 nm in the fourth order diffraction maximum coincides with blue light in the fifth order diffraction maximum.

What is the wavelength of the blue light?

- A 450 nm
  - B 480 nm
  - C 500 nm
  - D 750 nm
- 27 The basic principle of note production in a horn is to set up a stationary wave in an air column.



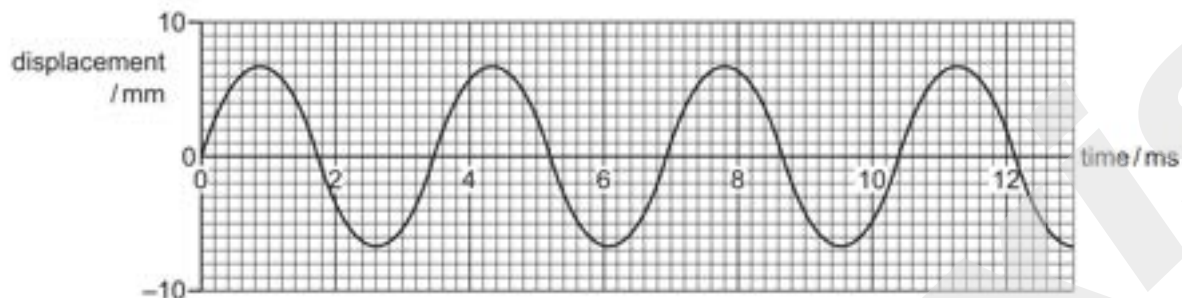
For any note produced by the horn, a node is formed at the mouthpiece and an antinode is formed at the bell. The frequency of the lowest note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

May/June 2014 (12)

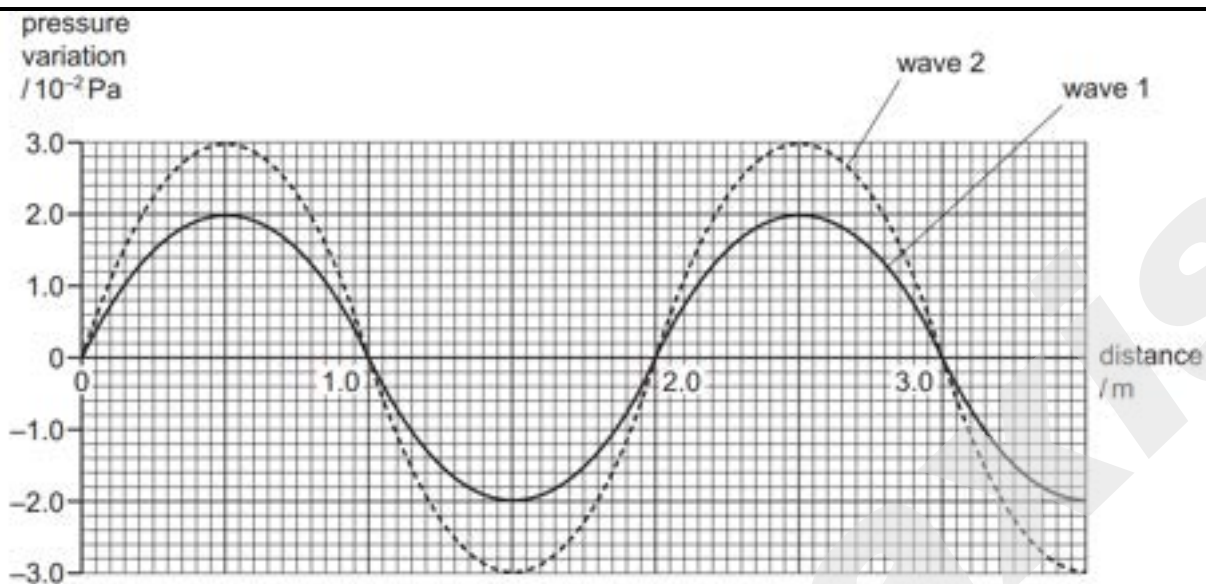
- 22 What, to two significant figures, are the period, the frequency and the amplitude of the wave represented by the graph?



	period /s	frequency /Hz	amplitude /m
<b>A</b>	0.0027	370	0.0067
<b>B</b>	0.0031	320	0.013
<b>C</b>	0.0035	290	0.0067
<b>D</b>	0.0042	240	0.013

- 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.



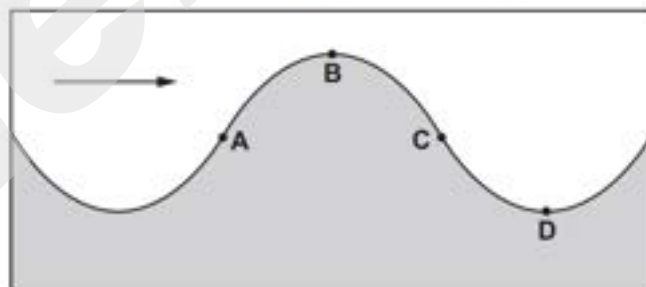
Wave 1 has an intensity of  $1.6 \times 10^{-6} \text{ W m}^{-2}$ .

What is the intensity of wave 2?

- A  $2.4 \times 10^{-6} \text{ W m}^{-2}$
- B  $3.0 \times 10^{-6} \text{ W m}^{-2}$
- C  $3.6 \times 10^{-6} \text{ W m}^{-2}$
- D  $4.5 \times 10^{-6} \text{ W m}^{-2}$

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?

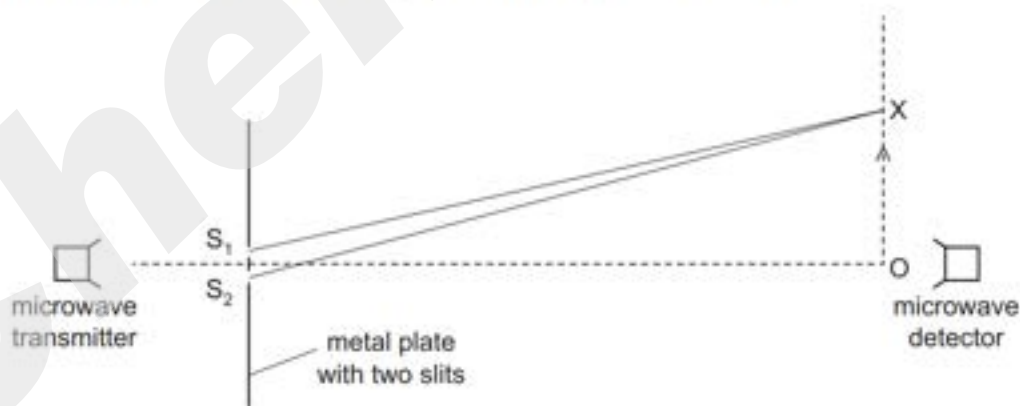




- 25 The principle of superposition states that a certain quantity is added when two or more waves meet at a point.

What is this quantity?

- A amplitude
  - B displacement
  - C intensity
  - D wavelength
- 26 Light passes through a diffraction grating ruled at 1000 lines per cm and the same wavelength of light also passes through two narrow slits 0.5 mm apart. Both situations produce intensity maxima and minima on a screen.
- Which statement about the separation of the maxima on the screen and the sharpness of the maxima is correct?
- A The diffraction grating maxima are less widely spaced and are less sharp than the two-slit maxima.
  - B The diffraction grating maxima are less widely spaced and are sharper than the two-slit maxima.
  - C The diffraction grating maxima are more widely spaced and are less sharp than the two-slit maxima.
  - D The diffraction grating maxima are more widely spaced and are sharper than the two-slit maxima.
- 27 The diagram shows an experiment which has been set up to demonstrate two-source interference. Microwaves of wavelength  $\lambda$  pass through two slits  $S_1$  and  $S_2$ .



The detector is moved from point O in the direction of the arrow. The signal detected decreases until the detector reaches point X, and then starts to increase again as the detector moves beyond X.

Which equation correctly determines the position of X?



- A**  $OX = \lambda$
- B**  $OX = \lambda/2$
- C**  $S_2X - S_1X = \lambda$
- D**  $S_2X - S_1X = \lambda/2$

May/June 2014 (13)

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

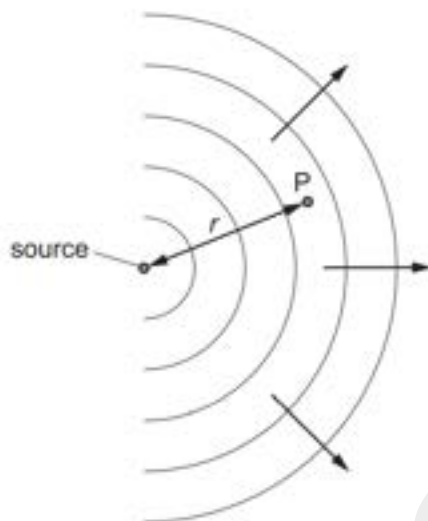
In order to determine the frequency of the sound wave, which part of the displayed waveform must be measured and which c.r.o. setting must be known?

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

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

- A**  $1 \times 10^3$  Hz to  $1 \times 10^9$  Hz
- B**  $1 \times 10^9$  Hz to  $1 \times 10^{11}$  Hz
- C**  $1 \times 10^{11}$  Hz to  $1 \times 10^{14}$  Hz
- D**  $1 \times 10^{14}$  Hz to  $1 \times 10^{17}$  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  $r$ ?

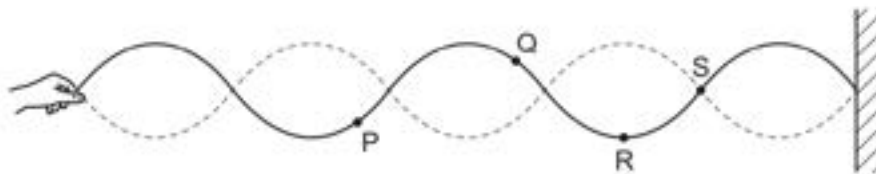
- A  $a^2 \propto \frac{1}{r}$       B  $a \propto \frac{1}{r}$       C  $a \propto \frac{1}{r^2}$       D  $a \propto \frac{1}{r^4}$

28 A student attempts to show the interference of light using two identical green LEDs.

Which statement explains why the experiment will **not** succeed?

- A The light waves from the sources are not coherent.  
 B The light waves from the sources do not have the same amplitude.  
 C The light waves from the sources have a range of wavelengths.  
 D The light waves from the sources are not monochromatic.

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



Which statement about the points on the string is correct?

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

30 Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which line of the table gives the effect of replacing the grating with one that has more lines per metre?

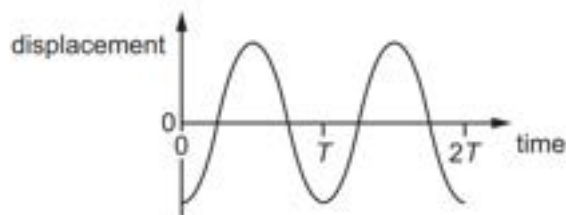
	number of orders of diffraction visible	angle between first and second orders of diffraction
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

October/November 2014 (11) & October/November 2014 (12)

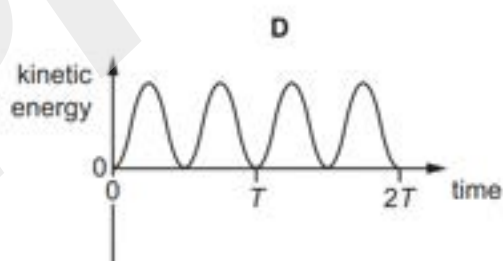
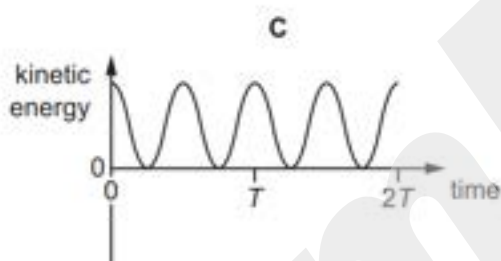
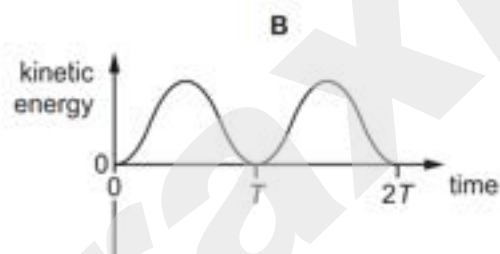
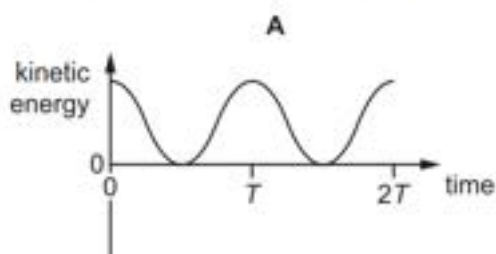
22 Which statement about electromagnetic radiation is correct?

- A Waves of wavelength  $5 \times 10^{-9}$  m are high-energy gamma rays.
- B Waves of wavelength  $3 \times 10^{-6}$  m are ultra-violet waves.
- C Waves of wavelength  $5 \times 10^{-7}$  m are infra-red waves.
- D Waves of wavelength  $9 \times 10^{-7}$  m are light waves.

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



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



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

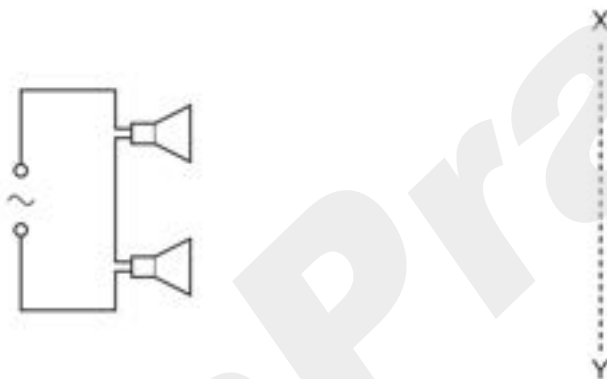
- A Light waves are reflected.
- B Light waves are scattered.
- C Microwaves pass through a metal grid.
- D Sound waves pass through a metal grid.

25 A stationary sound wave is produced in a tube.

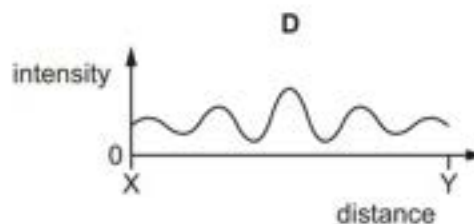
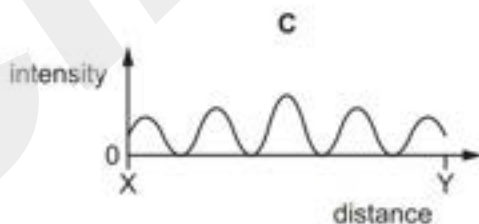
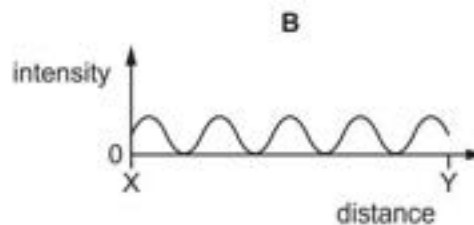
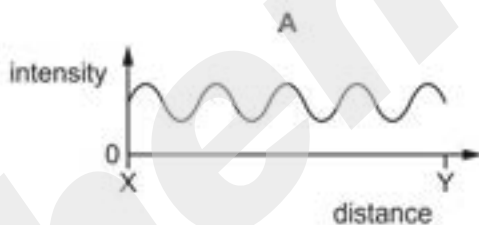
Which statement describes the wave speed?

- 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.

26 Two identical loudspeakers are connected in series to an a.c. supply, as shown.

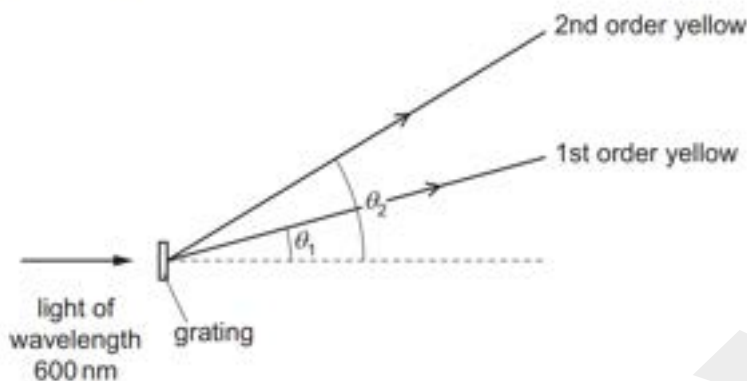


Which graph best shows the variation of the intensity of the sound with distance along the line XY?





- 27 A diffraction grating experiment is set up using yellow light of wavelength 600 nm. The grating has a slit separation of  $2.00 \mu\text{m}$ .



What is the angular separation ( $\theta_2 - \theta_1$ ) between the first and second order maxima of the yellow light?

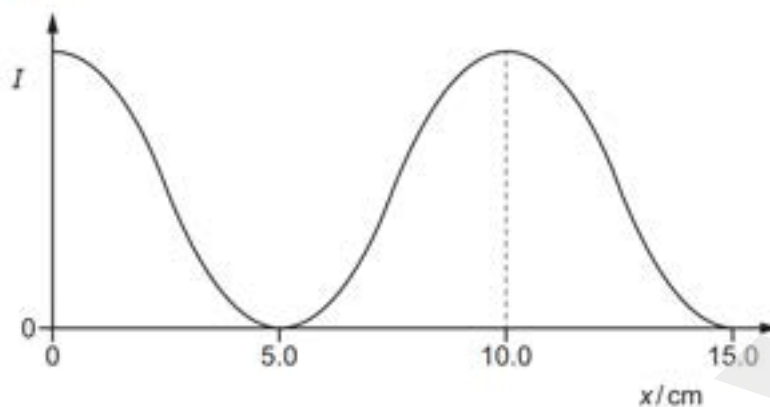
- A  $17.5^\circ$       B  $19.4^\circ$       C  $36.9^\circ$       D  $54.3^\circ$

October/November 2014 (13)

- 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.

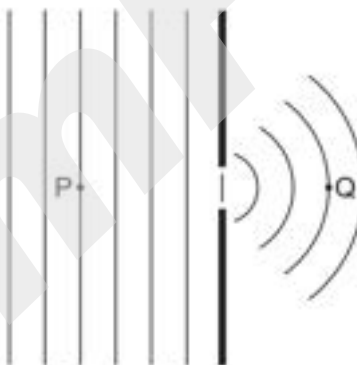
- 27 The variation with distance  $x$  of the intensity  $I$  along a stationary sound wave in air is shown by the following graph.



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.



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

- A velocity  
 B frequency  
 C amplitude  
 D wavelength

- 29 An organ pipe of length  $l$  is open at both ends. Notes are produced by the pipe when stationary waves are set up.

The speed of sound in the air column is  $v$ .

What is the lowest (fundamental) frequency of the note produced by the pipe?

- A  $\frac{2v}{l}$       B  $\frac{v}{l}$       C  $\frac{v}{2l}$       D  $\frac{v}{4l}$

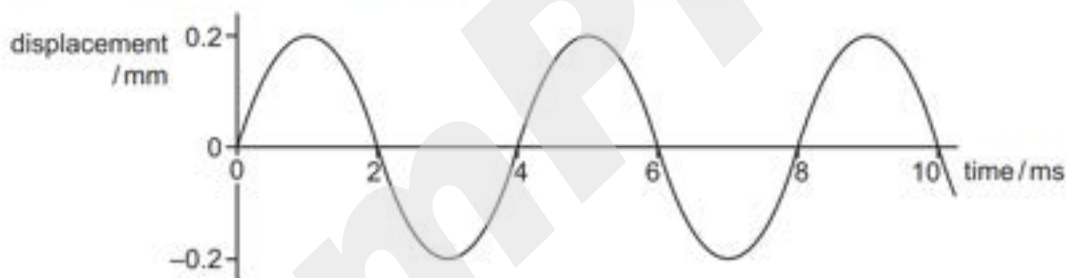
- 30 Interference fringes are produced on a screen by double-slit interference using light of wavelength 600 nm. The fringe separation is 4.0 mm and the separation of the slits is 0.60 mm.

What is the distance between the double slit and the screen?

- A 0.25 m      B 0.40 m      C 2.5 m      D 4.0 m

May/June 2015 (11)

- 24 A sound wave moves with a speed of  $320 \text{ ms}^{-1}$  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  $24 \text{ ms}^{-1}$  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  $3.0\text{Wm}^{-2}$ .

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

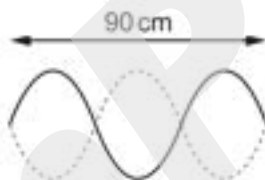
- A  $4.2\text{Wm}^{-2}$     B  $6.0\text{Wm}^{-2}$     C  $9.0\text{Wm}^{-2}$     D  $12\text{Wm}^{-2}$

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

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

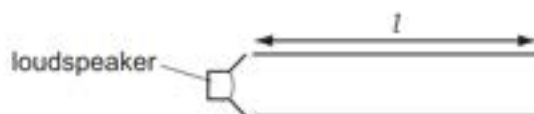


The frequency of the wave is  $12\text{Hz}$ .

What is the speed of the wave?

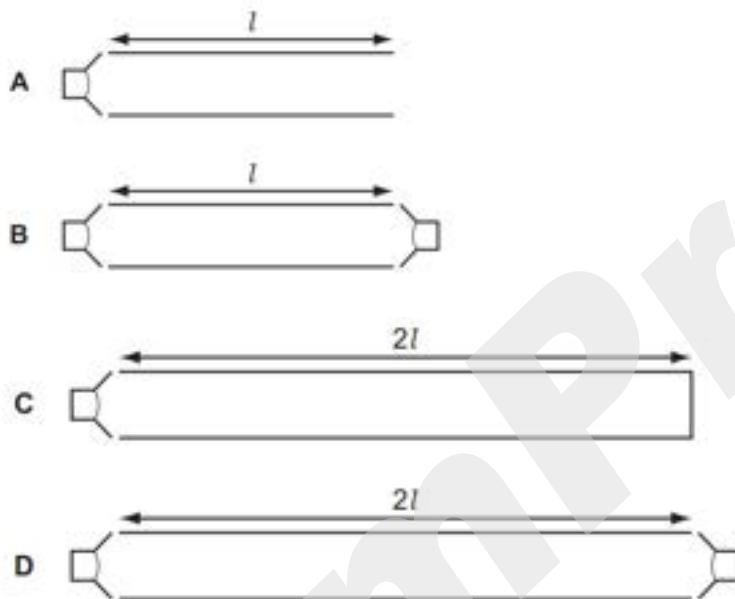
- A  $3.6\text{ms}^{-1}$     B  $7.2\text{ms}^{-1}$     C  $360\text{ms}^{-1}$     D  $720\text{ms}^{-1}$

- 29 A loudspeaker emitting sound of frequency  $f$  is placed at the open end of a pipe of length  $l$  which is closed at the other end. A standing wave is set up in the pipe.



A series of pipes are then set up with either one or two loudspeakers of frequency  $f$ . The pairs of loudspeakers vibrate in phase with each other.

Which pipe contains a standing wave?



- 30 In a double-slit experiment the distance between the fringes, on a screen, was too small to measure.

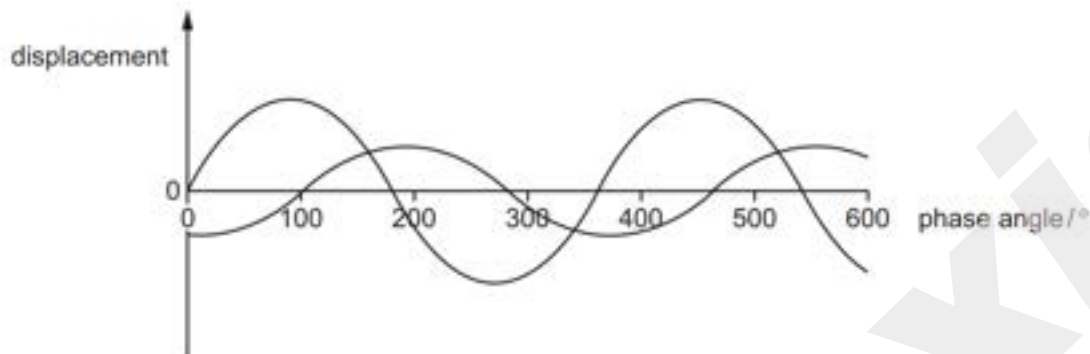
What would increase the distance between the fringes?

- A increasing the distance between the light source and the slits
- B increasing the distance between the slits and the screen
- C increasing the distance between the slits
- D increasing the frequency of the light source



May/June 2015 (12)

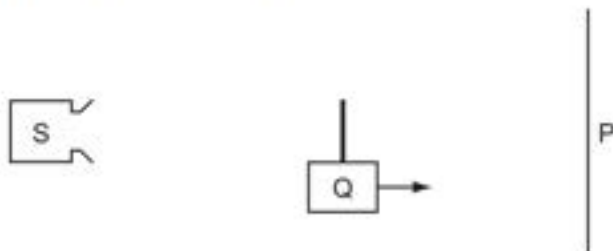
- 24 Two light waves of the same frequency are represented by the diagram.



What could be the phase difference between the two waves?

- A 150°      B 220°      C 260°      D 330°
- 25 A sound wave has a speed of  $330 \text{ m s}^{-1}$  and a frequency of 50 Hz.
- What is a possible distance between two points on the wave that have a phase difference of  $60^\circ$ ?
- A 0.03 m      B 1.1 m      C 2.2 m      D 6.6 m
- 26 What is **not** an **essential** condition for an observable interference pattern to occur between the waves from two sources?
- A The frequencies of the two sources must be equal.
- B The sources must be coherent.
- C The sources must emit waves of equal amplitude.
- D The waves from the two sources must overlap.

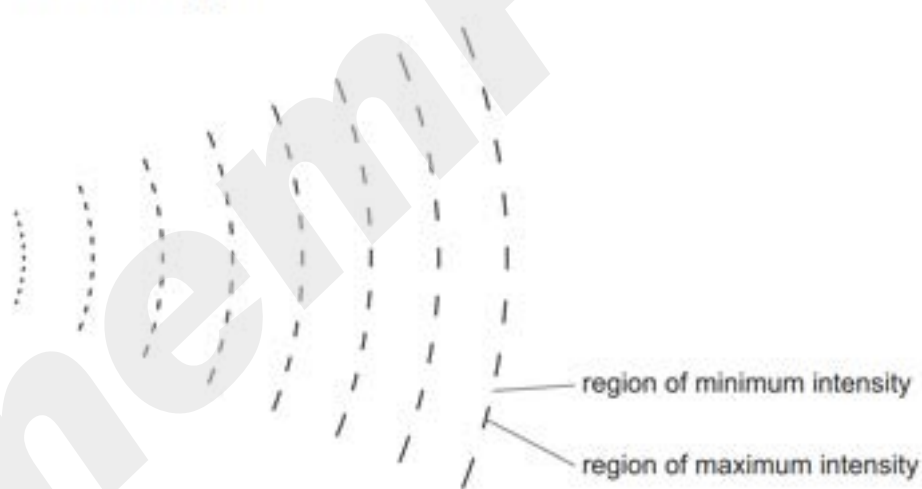
- 27 Source S emits microwaves with a constant amplitude. The microwaves hit a metal screen P and are reflected. A stationary wave is formed between S and P. The wavelength of the microwaves is much smaller than the distance between S and P.



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

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

- A decreases steadily
  - B increases and decreases regularly
  - C increases steadily
  - D remains constant
- 28 A pattern of waves was observed without being able to view the source of the waves. The pattern is represented in the diagram.

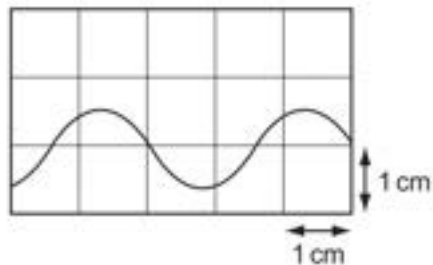


What can cause this pattern?

- A coherence only
- B diffraction and interference
- C diffraction only
- D interference only

May/June 2015 (13)

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

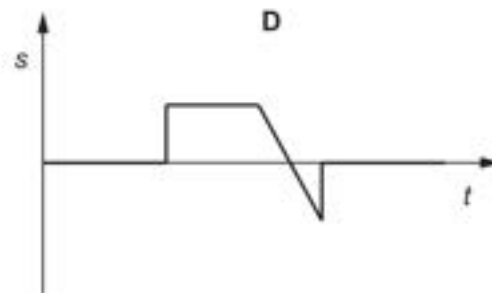
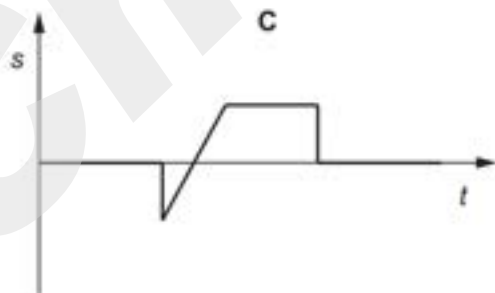
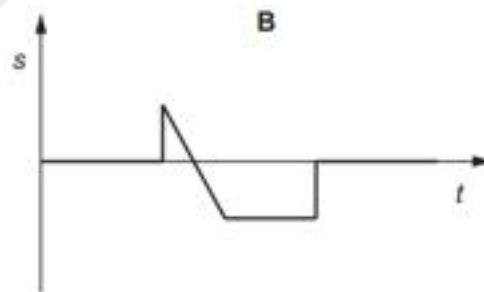
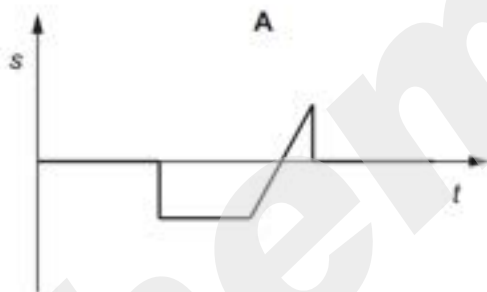


What is the frequency of the sound wave?

- A 6.7 Hz      B 67 Hz      C 6.7 kHz      D 67 kHz
- 26 A wave pulse moves along a stretched rope in the direction shown.



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



27 The table contains statements about stationary and progressive waves.

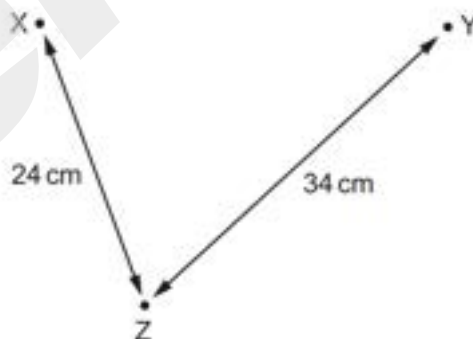
Which row is correct?

	stationary wave	progressive wave
<b>A</b>	all particles vibrate with the same amplitude	all particles vibrate with the same amplitude
<b>B</b>	energy is transferred along the wave	energy is transferred along the wave
<b>C</b>	particles in adjacent loops vibrate in antiphase	particles vibrate in phase with their immediate neighbours
<b>D</b>	particles one wavelength apart vibrate in phase	particles one wavelength apart vibrate in phase

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

29 Wave generators at points X and Y produce water waves of the same wavelength. At point Z, the waves from X have the same amplitude as the waves from Y. Distances XZ and YZ are as shown.



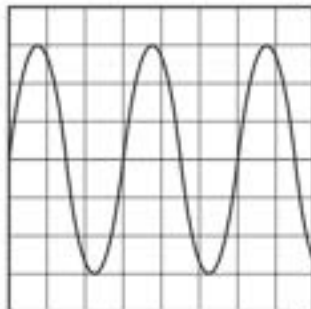
When the wave generators operate in phase, the amplitude of oscillation at Z is zero.

What could be the wavelength of the waves?

- A 2 cm
- B 3 cm
- C 4 cm
- D 6 cm

October/November 2015 (11)

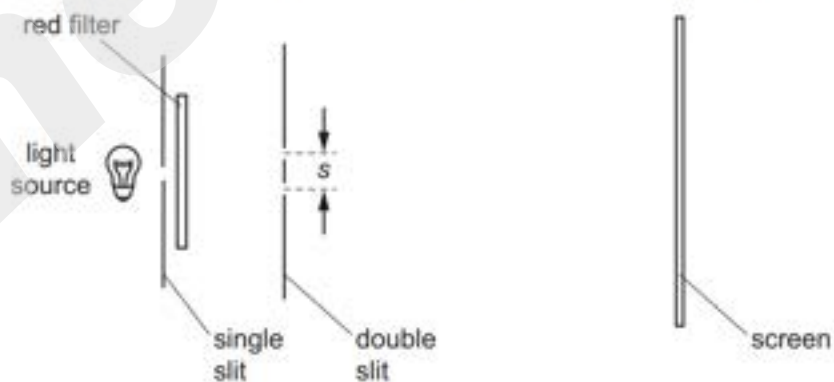
- 24 A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.



The time-base setting is 0.50 ms per division.

What is the frequency of the sound wave?

- A 250 Hz      B 500 Hz      C 670 Hz      D 1300 Hz
- 25 Part of a car was damaged by heating when, on a sunny day, the car was left in front of a curved mirrored building which focussed reflected sunlight onto the car.
- Which statement about sunlight correctly explains this observation?
- A Sunlight contains infra-red radiation.  
 B Sunlight contains ultraviolet radiation.  
 C Sunlight is a longitudinal progressive wave which carries energy.  
 D Sunlight is a transverse standing wave which carries energy.
- 26 A student sets up an experiment to investigate double-slit interference of light but finds that the interference fringes observed on the screen are too close to each other to be distinguished.



Which change would help the student to distinguish the fringes?



- A decrease the distance  $s$  between the two slits
- B increase the width of each slit
- C move the screen closer to the light source
- D use a blue filter instead of a red filter

27 Ships have been damaged by water waves with large amplitudes. These waves could have been formed by adding the displacements of smaller waves.

Which term describes this phenomenon?

- A diffraction
- B polarisation
- C refraction
- D superposition

28 Water waves of wavelength  $\lambda$  are diffracted as they pass through a gap of width  $d$  in a barrier.

Which combination of wavelength and gap width would produce the greatest angle of diffraction?

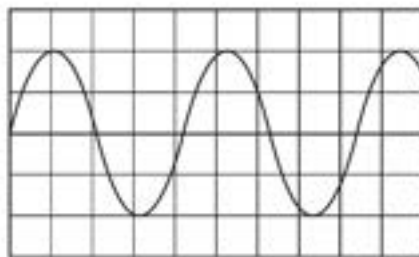
	gap width	wavelength
A	$\frac{1}{2}d$	$2\lambda$
B	$\frac{1}{2}d$	$\frac{1}{2}\lambda$
C	$2d$	$2\lambda$
D	$2d$	$\frac{1}{2}\lambda$

October/November 2015 (12)

25 Which of the following wave motions may be used to demonstrate the phenomenon of polarisation?

- A a sound wave from a thunderclap
- B a surface wave in a water ripple tank
- C a stationary wave in an organ pipe
- D a stationary wave on a stretched wire

- 26 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/div.

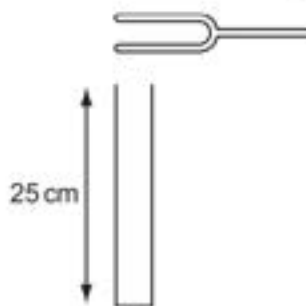
What is the frequency of the wave?

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

Which row is correct?

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

- 28 The diagram shows a tuning fork above a tube of air of length 25 cm.



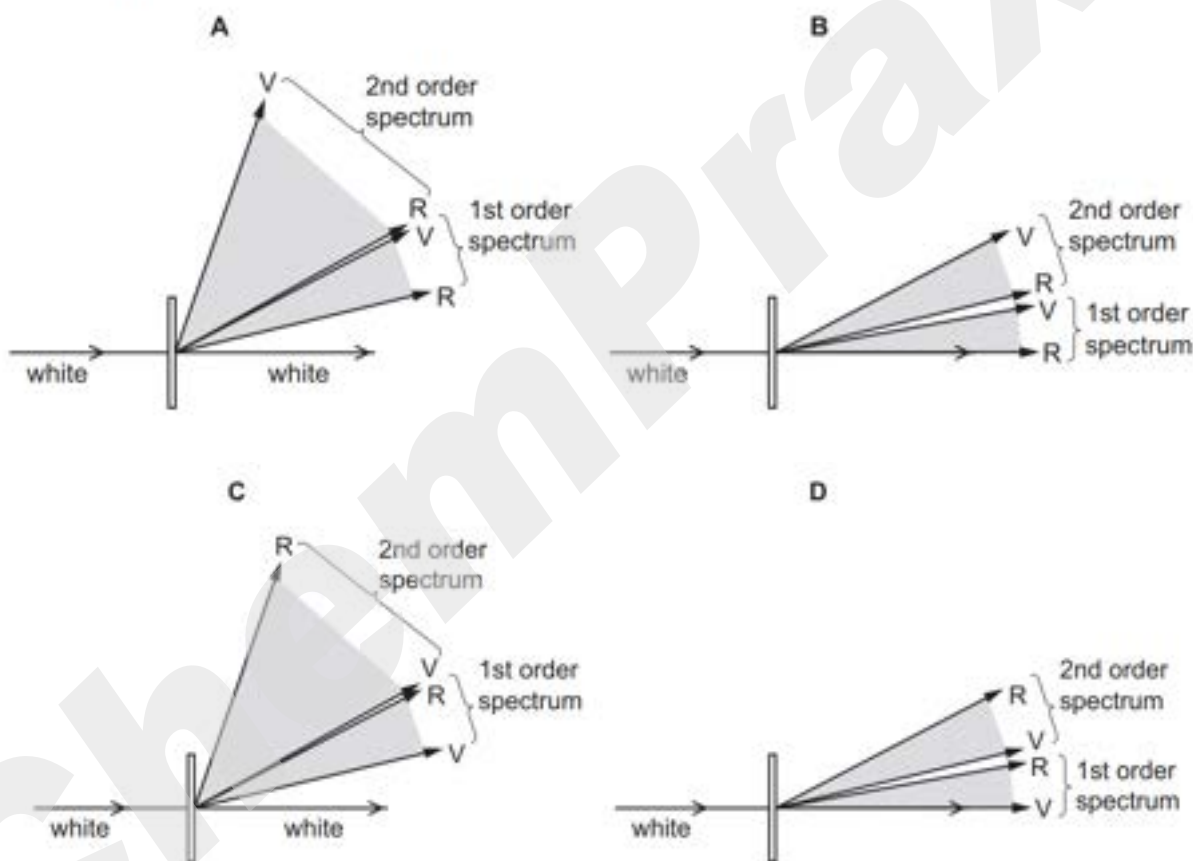
A stationary wave is set up in the tube with the same frequency as the tuning fork. The lower end of the tube is sealed. This is the minimum length of tube with the lower end sealed that creates a stationary wave.

Which other lengths of tubes, sealed at their lower end, will also create a stationary wave?

- A 37.5 cm and 50 cm
- B 50 cm and 75 cm
- C 75 cm and 100 cm
- D 75 cm and 125 cm

- 29 White light consists of many wavelengths. The wavelength of red light R is approximately twice the wavelength of violet light V. When white light is incident normally on a diffraction grating, several spectra can be formed.

Which diagram shows the possible distributions of light in the first order and the second order spectra?



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

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

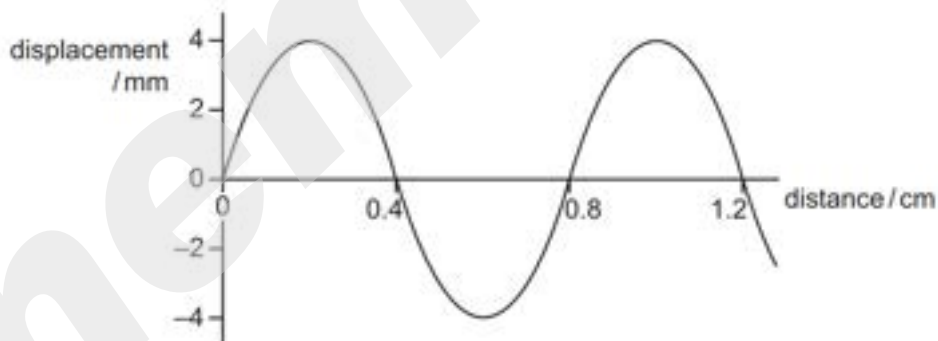
- A** The waves must have equal frequency, but a different speed and wavelength.
- B** The waves must have equal speed, but a different wavelength and frequency.
- C** The waves must have equal speed, frequency and wavelength.
- D** The waves must have equal wavelength, but a different speed and frequency.

October/November 2015 (13)

- 22** When all the other features of a wave are constant, which relationship is correct?

- A** Amplitude is directly proportional to velocity.
- B** Intensity is directly proportional to amplitude.
- C** Velocity is directly proportional to wavelength.
- D** Wavelength is directly proportional to frequency.

- 23** A vibrating rod makes a water wave in a ripple tank. The graph shows the displacement of the wave at one instant as it travels away from the rod. The wave speed is  $2.0 \text{ cm s}^{-1}$ .



What is the frequency of the wave?

- A** 0.8 Hz
- B** 1.6 Hz
- C** 2.5 Hz
- D** 5.0 Hz



24 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.

25 Monochromatic light passes through two narrow slits and produces an interference pattern on a screen some distance away. The interference fringes are very close together.

Which change would **increase** the distance between the fringes?

- A Increase the brightness of the light source.
- B Increase the distance between the slits and the screen.
- C Increase the distance between the two slits.
- D Increase the frequency of the light used.

26 The following statements describe the diffraction of waves passing through a narrow slit.

Which statement is **not** correct?

- A Both transverse and longitudinal waves can be diffracted.
- B Diffraction can only be seen with light when the light is monochromatic.
- C Red light diffracts through a greater angle than blue light.
- D The angle of diffraction increases when the width of the slit decreases.

27 Monochromatic light is directed onto a pair of slits. Interference fringes that are 2.0 mm apart are observed on a distant screen.

The frequency of the light used is then doubled and the slit separation is halved.

How far apart are the new interference fringes?

- A 0.50 mm      B 2.0 mm      C 4.0 mm      D 8.0 mm



- 28 A diffraction grating has  $N$  lines per unit length and is placed at  $90^\circ$  to monochromatic light of wavelength  $\lambda$ .

What is the expression for  $\theta$ , the angle to the normal to the grating at which the third order diffraction peak is observed?

- A  $\sin \theta = \frac{1}{3N\lambda}$     B  $\sin \theta = \frac{N\lambda}{3}$     C  $\sin \theta = 3N\lambda$     D  $\sin \theta = \frac{3\lambda}{N}$