24 Which row is correct for sound waves?

	can travel in a vacuum	can be polarised	can diffract through a gap
A	no	no	yes
B	yes	no	no
C	no	yes	no
D	no	yes	yes

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

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

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

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

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

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

27 A dolphin is swimming at a speed of $16.0\,m\,s^{-1}$ directly towards a stationary underwater microphone.

The dolphin emits a sound of frequency 122 kHz. The speed of sound in water is $1480\,m\,s^{-1}$.

What is the frequency of sound detected by the microphone?

A 1300 Hz **B** 1330 Hz **C** 121 kHz **D** 123 kHz

4 A laser emits visible light of a single frequency in a vacuum. The light is incident normally on a double slit and then forms a pattern of bright and dark fringes on a screen, as shown in Fig. 4.1.

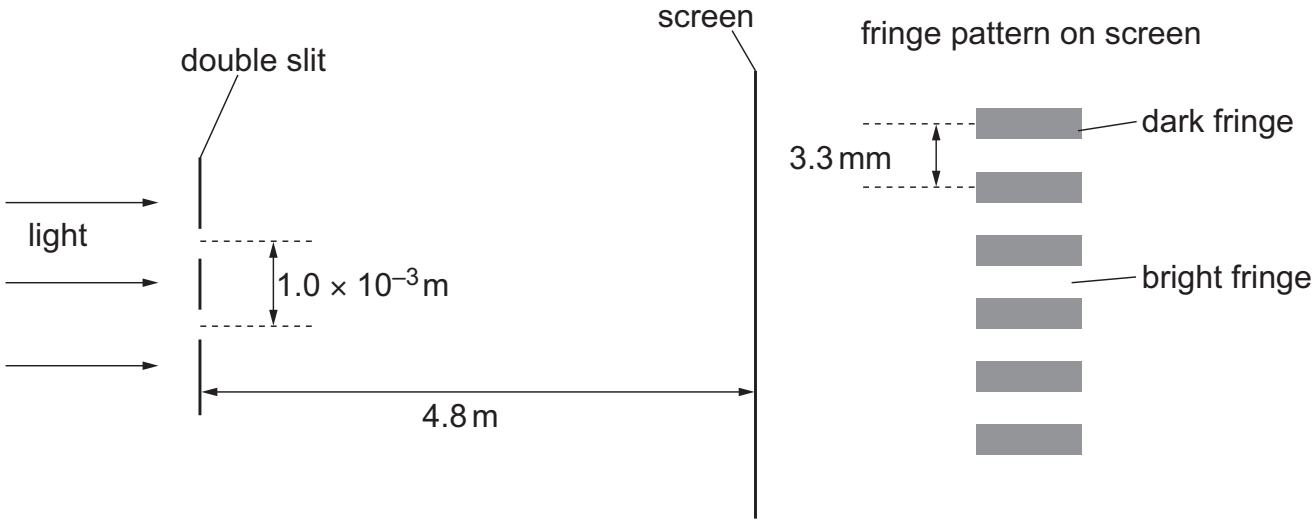


Fig. 4.1 (not to scale)

The separation of the slits is 1.0×10^{-3} m. The distance from the slits to the screen is 4.8 m. The distance between the centres of adjacent dark fringes on the screen is 3.3 mm.

(a) Explain how the pattern of bright and dark fringes is formed.

.....

.....

.....

.....

..... [3]

(b) Calculate the frequency of the light emitted by the laser.

frequency = ... Hz [4]

(c) The double slit is removed. A second laser is placed beside the first laser. The second laser produces visible light of a different frequency from that of the first laser. The beams of light from the two lasers overlap on the screen.

Explain why a steady pattern of bright and dark fringes is **not** formed on the screen.

.....

..... [1]

[Total: 8]

4 **(a)** State what is meant by diffraction of a wave.

.....

.....

..... [2]

(b) A beam of vertically polarised light of wavelength 540 nm is incident normally on a diffraction grating, as shown in Fig. 4.1.

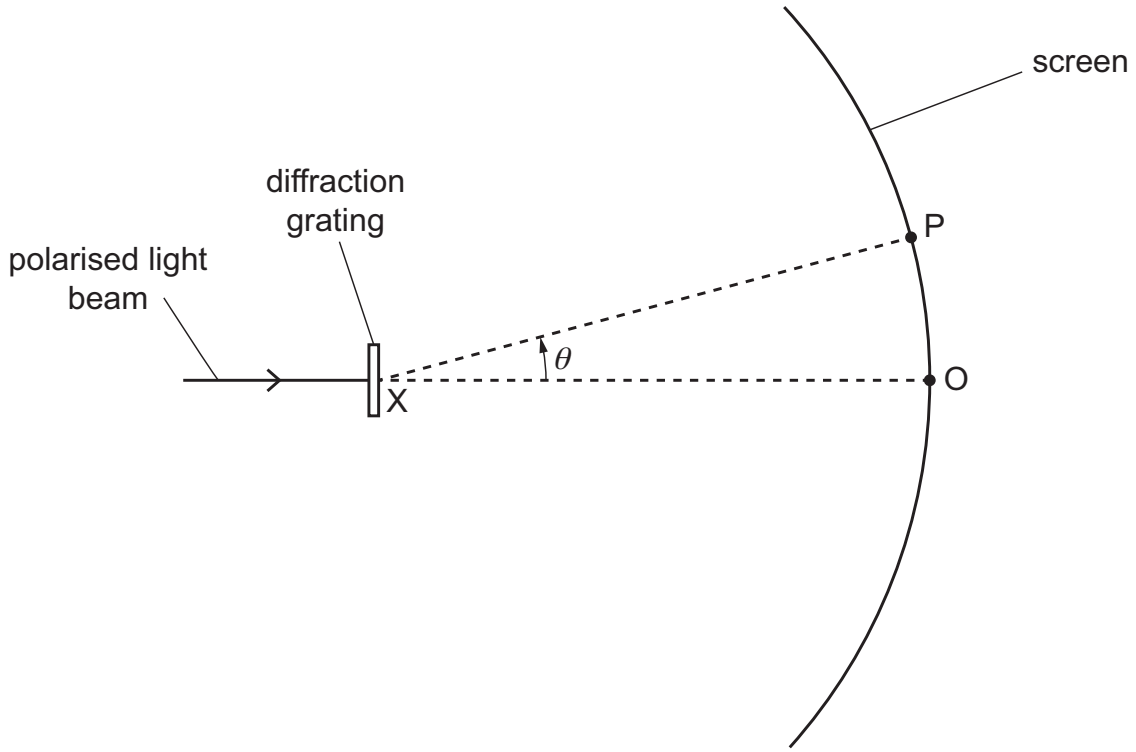


Fig. 4.1 (not to scale)

The diffraction grating has a line spacing of 5.0×10^{-6} m.

The light transmitted by the diffraction grating illuminates a circular screen. The diffraction grating is at the centre X of the circle.

The central bright fringe is formed at point O on the screen and has intensity I_0.

P is a point on the screen where the line XP is at a variable angle θ to the line XO. The intensity I of light on the screen at P varies with θ.

(i) Show that the angle θ at which the first-order bright fringe is formed is 6.2°.

[2]

(ii) Determine the value of θ at which the second-order bright fringe is formed.

θ = ...° [1]

(iii) On Fig. 4.2, sketch the variation of the intensity I with θ for values of θ from –15° to +15°.

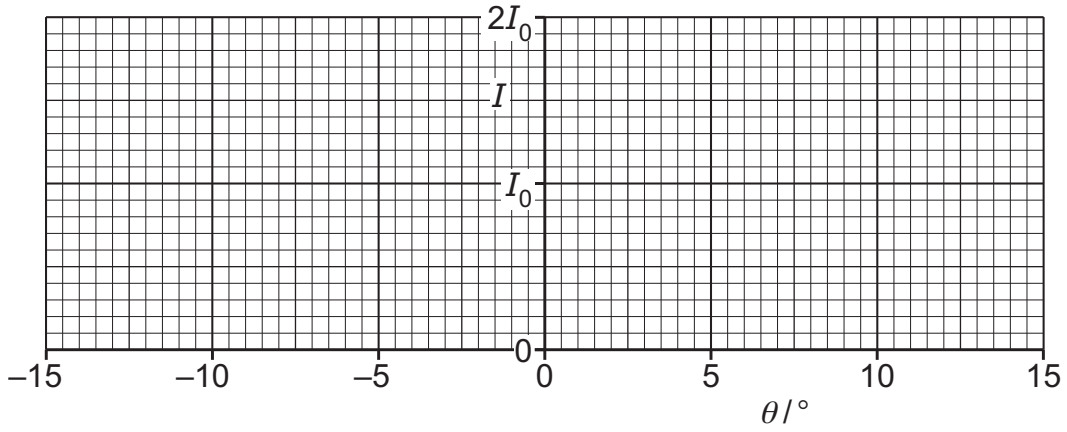


Fig. 4.2

[3]

(c) A polarising filter is placed in the path of the light beam that is incident on the diffraction grating in Fig. 4.1. The transmission axis of the filter is at 45° to the vertical.

Suggest how the variation of intensity with θ for the light on the screen compares with the answer in **(b)(iii)**.

.....

.....

..... [2]

[Total: 10]

4 **(a)** State the principle of superposition.

.....

.....

..... [2]

(b) An electromagnetic wave of wavelength 0.026 m in free space is incident normally on an aluminium sheet, as shown in Fig. 4.1.

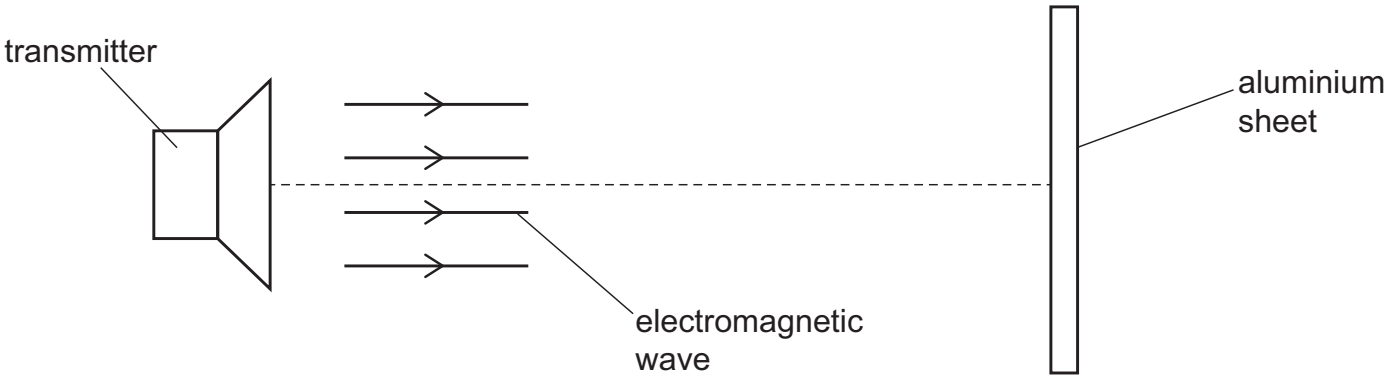


Fig. 4.1

The wave reflects at the aluminium sheet and a stationary wave is formed in the region between the transmitter and the sheet.

(i) Explain how the stationary wave, including its nodes and antinodes, is formed.

.....

.....

.....

.....

..... [3]

(ii) Calculate the frequency of the electromagnetic wave.

frequency = ... Hz [2]

(iii) State the principal region of the electromagnetic spectrum to which the wave belongs.

..... [1]

(iv) Determine the distance between a node and an adjacent antinode.

distance = ... m [1]

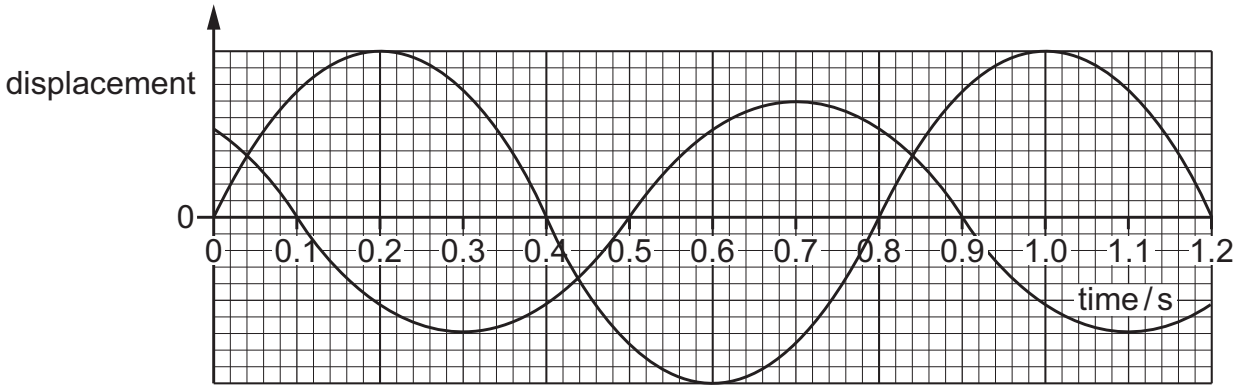
[Total: 9]

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

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

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

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



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

A 45° **B** 90° **C** 135° **D** 180°

5 A stationary loudspeaker emits sound of constant frequency. A microphone is placed near to the loudspeaker and connected to a cathode-ray oscilloscope (CRO). The trace on the screen of the CRO is shown in Fig. 5.1.

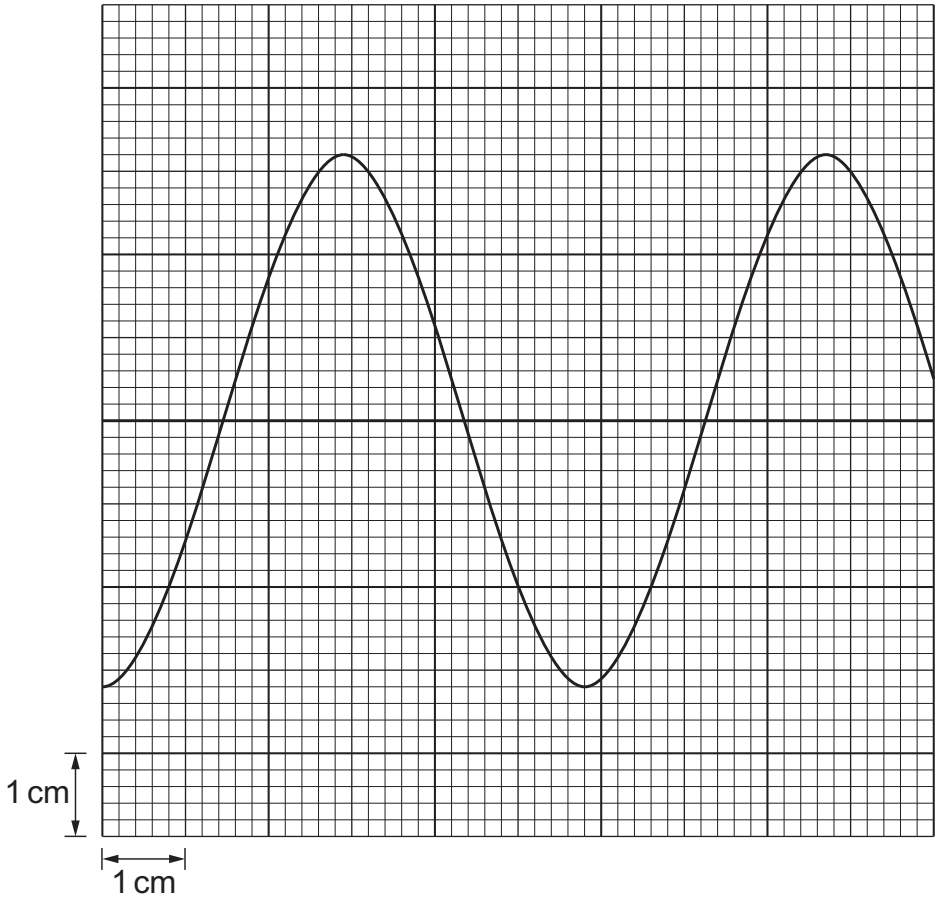


Fig. 5.1

The time-base of the CRO is set to $5.0 \times 10^{-4}\,\text{s}\,\text{cm}^{-1}$.

(a) The speed of the sound emitted by the loudspeaker is $330\,\text{m}\,\text{s}^{-1}$.

Determine the wavelength of the sound.

wavelength = ... m [3]

(b) The loudspeaker now moves in a straight line while emitting the same sound of constant frequency. The period of the trace on the CRO increases continuously.

Describe the motion of the loudspeaker.

.....

.....

..... [2]

[Total: 5]