Waves – 2023 Nov AS Physics 9702

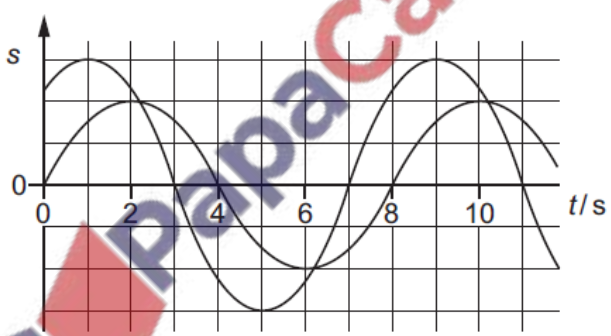
1. Nov/2023/Paper_ 9702/11/No.21

Which row is correct for both progressive transverse waves and progressive longitudinal waves?

	transverse waves	longitudinal waves
A	contain compressions and rarefactions	some can travel in a vacuum
B	can be polarised	contain compressions and rarefactions
C	vibrations are perpendicular to the direction of travel of the wave energy	can be polarised
D	some can travel in a vacuum	vibrations are perpendicular to the direction of travel of the wave energy

2. Nov/2023/Paper_ 9702/11/No.20

Two waves pass through a point P. The graph shows the variation with time *t* of the displacement *s* of the two waves at point P.



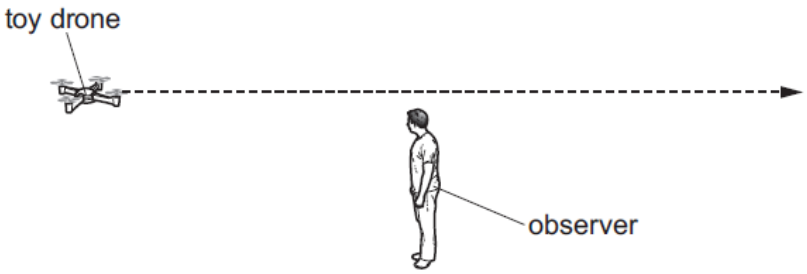
What is the phase difference between the two waves at point P?

A 0° **B** 45° **C** 90° **D** 180°

3. Nov/2023/Paper_ 9702/11/No.22

A toy drone emits a sound of constant frequency 800 Hz. The speed of the sound in the air is 330 $m\,s^{-1}$.

The drone moves along a straight path directly towards an observer and then continues in a straight line directly away from the observer. The speed of the drone is constant.



What is the velocity of the drone when the frequency of the sound heard by the observer is 850 Hz?

	magnitude of velocity / $m\,s^{-1}$	direction of velocity
A	19	away from the observer
B	21	away from the observer
C	19	towards the observer
D	21	towards the observer

4. Nov/2023/Paper_ 9702/11/No.23

Which statement about electromagnetic waves in a vacuum is correct?

A Infrared waves have shorter wavelengths than visible light waves.

B Microwaves have longer wavelengths than radio waves.

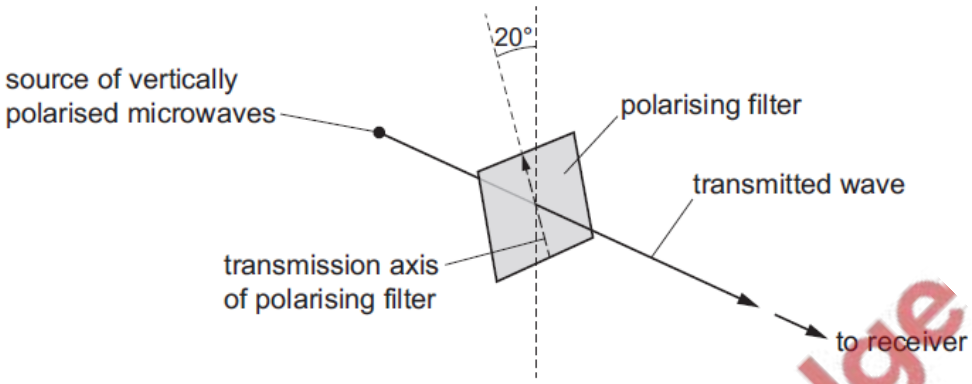
C Ultraviolet waves have higher frequencies than visible light waves.

D γ-rays have lower frequencies than X-rays.

5. Nov/2023/Paper_ 9702/11/No.24

Vertically polarised microwaves are emitted from a source. The microwaves are detected by a receiver that is connected to a cathode-ray oscilloscope (CRO). The waveform displayed on the screen of the CRO has an amplitude of 2.6 cm.

A metal wire grid that acts as a polarising filter is now placed between the source and the receiver. The filter is orientated so that the plane of polarisation of the transmitted wave is at an angle of 20° to the vertical.



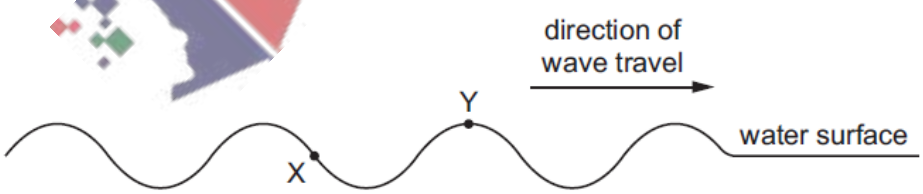
The distance between the source and receiver is unchanged. The settings on the CRO are also unchanged.

What is now the amplitude of the waveform displayed on the screen of the CRO?

A 0.30 cm **B** 0.89 cm **C** 2.3 cm **D** 2.4 cm

6. Nov/2023/Paper_ 9702/12/No.20

X and Y are two points on the surface of water in a ripple tank. A source of constant frequency generates a wave which travels past X and Y, causing them to oscillate vertically.



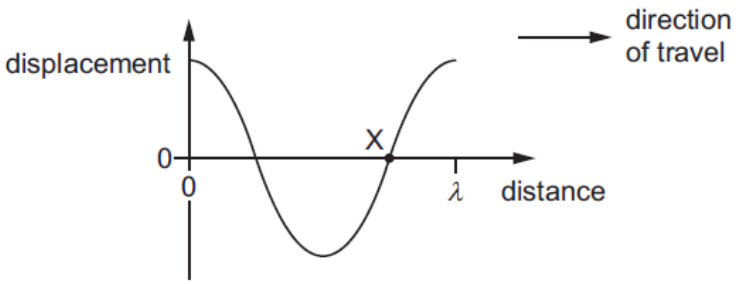
What is the phase difference between X and Y?

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

7. Nov/2023/Paper_ 9702/12/No.21

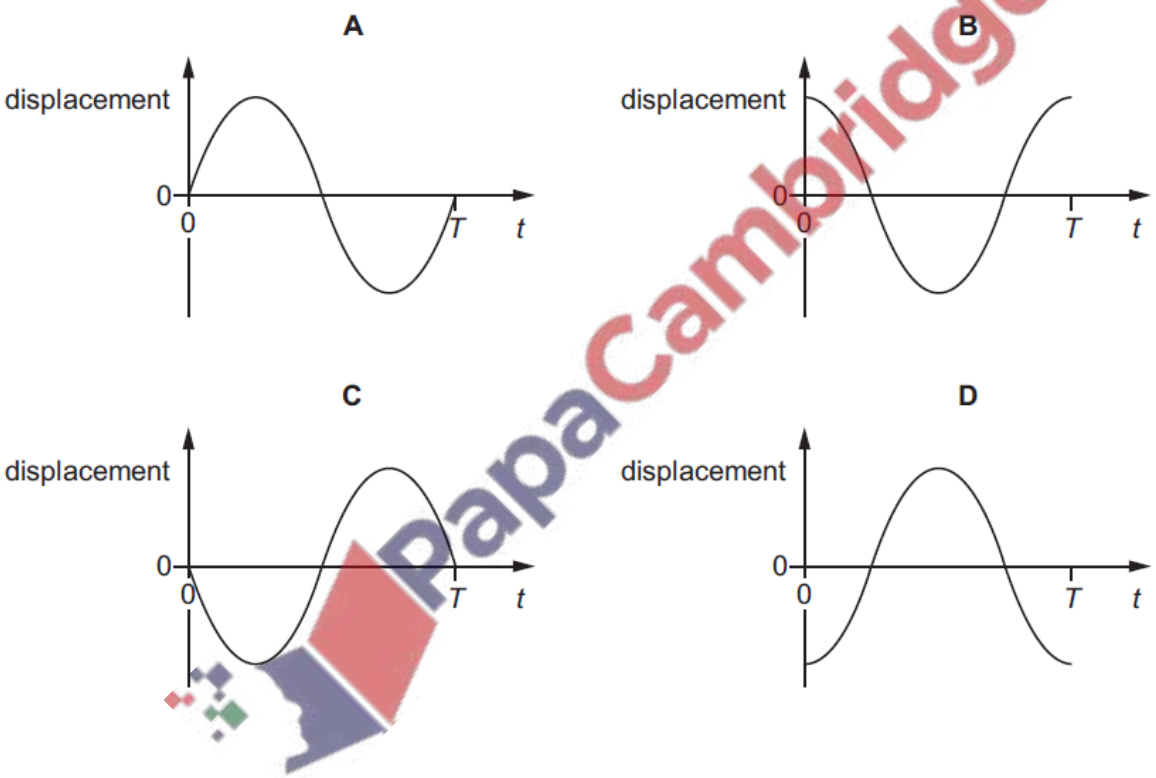
A transverse wave on a rope has wavelength λ and period T.

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



A particle X is labelled.

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



8. Nov/2023/Paper_ 9702/12/No.22

A source of sound waves is moving at a constant speed directly towards a stationary observer.

The sound waves have a speed of 340 m s^{-1} and a frequency of 480 Hz. The observer hears sound waves of frequency 650 Hz.

What is the speed of the source?

A 89 m s^{-1} **B** 120 m s^{-1} **C** 250 m s^{-1} **D** 340 m s^{-1}

9. Nov/2023/Paper_ 9702/12/No.23

A student is investigating two electromagnetic waves, X and Y, in a vacuum.

Wave X has a wavelength of 5.2×10^{-7} m. Wave Y has a frequency of 9.4 GHz.

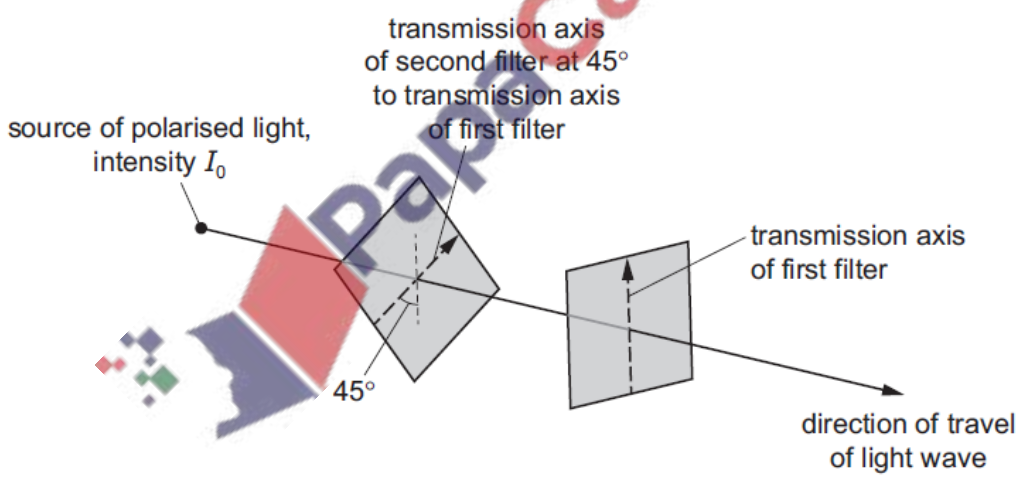
Which principal regions of the electromagnetic spectrum contain waves X and Y?

	X	Y
A	radio wave	ultraviolet
B	ultraviolet	visible
C	visible	microwave
D	microwave	radio wave

10. Nov/2023/Paper_ 9702/12/No.24

A plane polarised light wave of intensity I_0 is incident normally on a polarising filter. The initial intensity of the transmitted wave is 0.

A second polarising filter is then inserted between the source and the first filter. Its transmission axis is at 45° to the transmission axis of the first filter, as shown.



What is the intensity of the transmitted wave from the filter combination?

A 0 **B** $\frac{I_0}{8}$ **C** $\frac{I_0}{4}$ **D** $\frac{I_0}{2}$

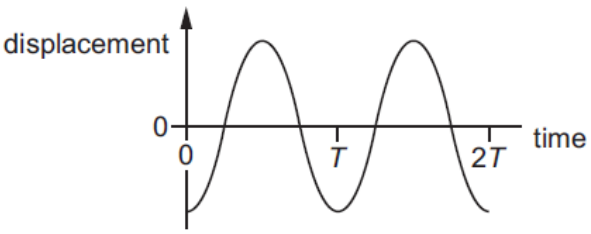
11. Nov/2023/Paper_ 9702/13/No.1

What is the best estimate of the wavelength of green light?

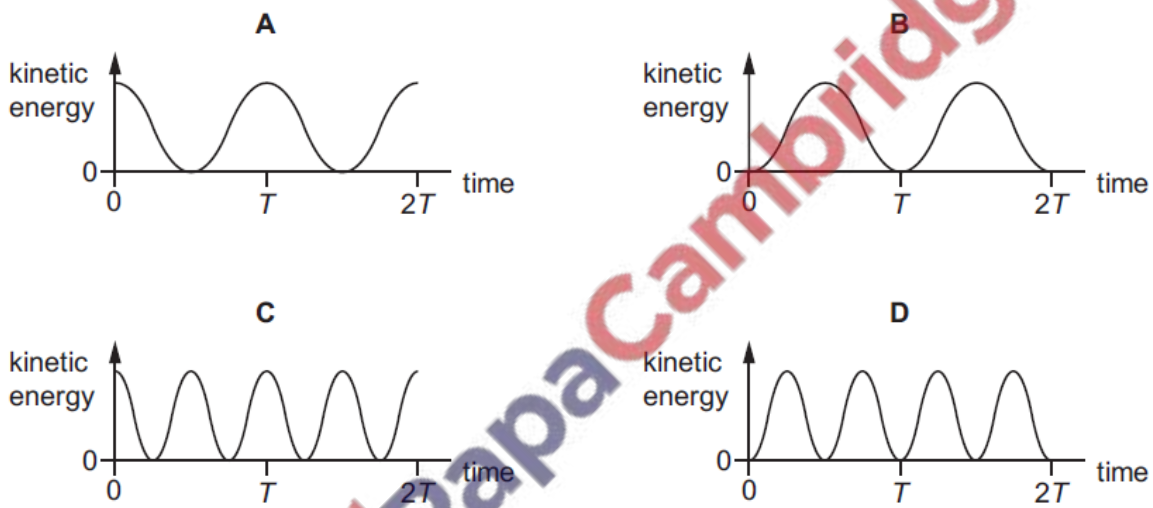
A 260 nm **B** 540 nm **C** 780 nm **D** 920 nm

12. Nov/2023/Paper_ 9702/13/No.20

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



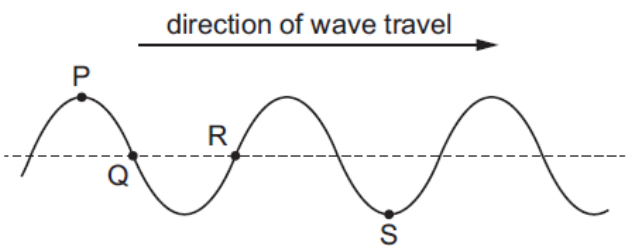
Which graph shows how the kinetic energy of the air particle varies with time?



13. Nov/2023/Paper_ 9702/13/No.21

A wave travels on the surface of water. P, Q, R and S are four particles of water on the surface.

The diagram shows the positions of the particles at one instant. The direction of travel of the wave is from left to right.



Which two particles are about to move upwards?

A P and R **B** P and S **C** R and S **D** Q and S

14. Nov/2023/Paper_ 9702/13/No.22

A loudspeaker emits sound of frequency f_s. The loudspeaker is attached to a car that moves with increasing speed directly towards a stationary observer.

Which statement describes the frequency of the sound heard by the observer?

A a frequency greater than f_s and increasing

B a frequency greater than f_s but decreasing

C a frequency less than f_s and decreasing

D a frequency less than f_s but increasing

15. Nov/2023/Paper_ 9702/13/No.23

Which statement about electromagnetic waves in a vacuum is correct?

A Amplitude is inversely proportional to velocity.

B Frequency is inversely proportional to wavelength.

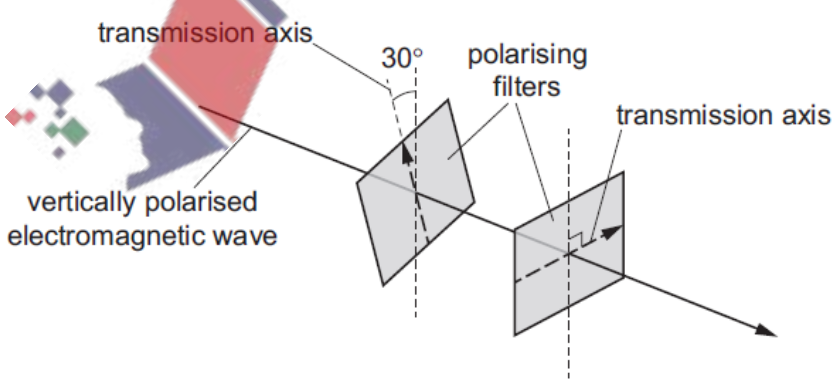
C Intensity is proportional to amplitude.

D Velocity is proportional to wavelength.

16. Nov/2023/Paper_ 9702/13/No.24

A vertically polarised electromagnetic wave of intensity I_0 is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 30° to the vertical.

The transmitted wave from the first filter is then incident normally on a second polarising filter. The transmission axis of this filter is at an angle of 90° to the vertical.



What is the intensity of the wave after passing through the second filter?

A 0 **B** $0.063\,I_0$ **C** $0.19\,I_0$ **D** $0.56\,I_0$

(a) State the principle of superposition.

.....

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..... [2]

(b) Coherent light is incident normally on two identical slits X and Y. The diffracted light emerging from the slits superposes to produce an interference pattern on a screen positioned at a distance of 1.9 m from the slits.

Fig. 4.1 shows the arrangement and the central part of the interference pattern of bright and dark fringes formed on the screen.

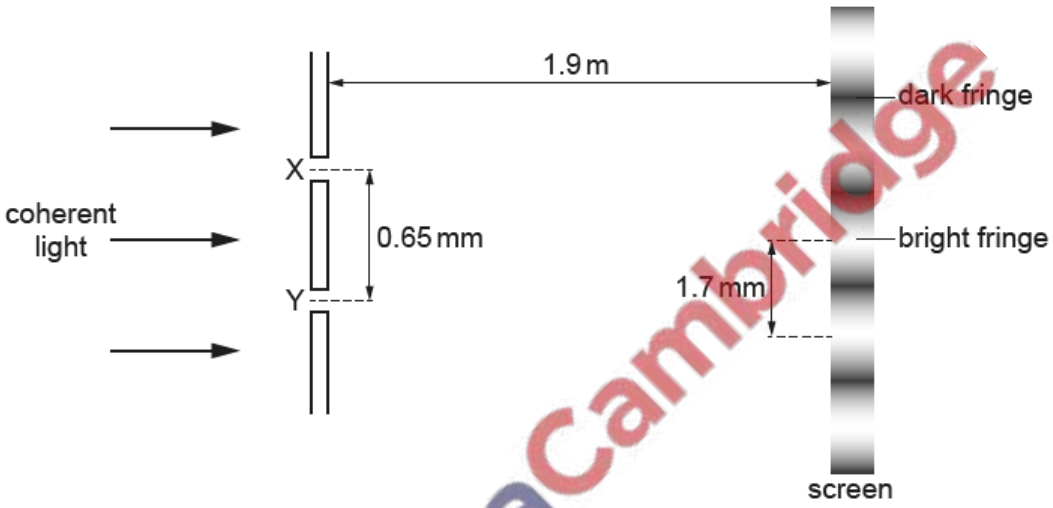

Fig. 4.1 (not to scale)

The separation of the slits is 0.65 mm. The distance between the centres of adjacent bright fringes is 1.7 mm.

Calculate the wavelength λ of the light.

λ = ... m [3]

(c) Light waves from slits X and Y in **(b)** arrive at a point between adjacent bright fringes on the screen. Fig. 4.2 shows the variation of displacement with time for the waves arriving at the point where they meet.

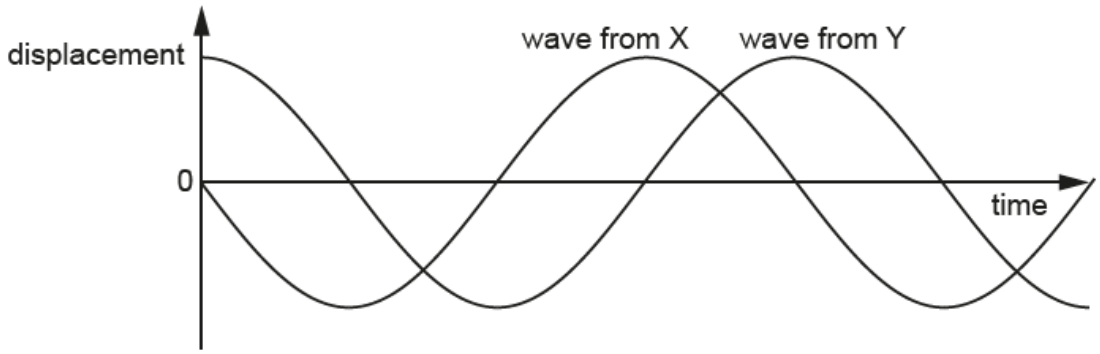

Fig. 4.2

A student makes two statements about the waves at this point:

Statement 1: 'The phase difference between the waves is 90°.'

Statement 2: 'The amplitude of the resultant wave is zero.'

(i) Explain how statement 1 is correct.

.....

.....

..... [1]

(ii) State and explain whether statement 2 is correct.

.....

.....

..... [1]

(d) The width of each slit in **(b)** is decreased by the same amount. There is no change to the separation of the slits.

Describe and explain the effect, if any, of this change on the appearance of the interference pattern.

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..... [2]

[Total: 9]

18. Nov/2023/Paper_ 9702/22/No.5(b, c)

(b) State what is meant by the diffraction of a wave.

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..... [2]

(c) A beam of light of wavelength 4.3×10^{-7} m is incident normally on a diffraction grating in air, as shown in Fig. 5.3.

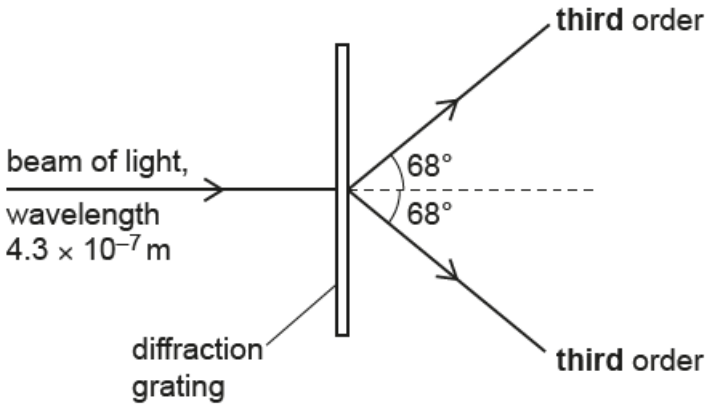

Fig. 5.3 (not to scale)

The **third**-order diffraction maximum of the light is at an angle of 68° to the direction of the incident light beam.

(i) Calculate the line spacing d of the diffraction grating.

d = ... m [2]

(ii) Determine a different wavelength of **visible** light that will also produce a diffraction maximum at an angle of 68°.

wavelength = ... m [2]

19. Nov/2023/Paper_ 9702/23/No.6

A train travels at constant speed along a straight horizontal track towards an observer standing adjacent to the track, as shown in Fig. 6.1.

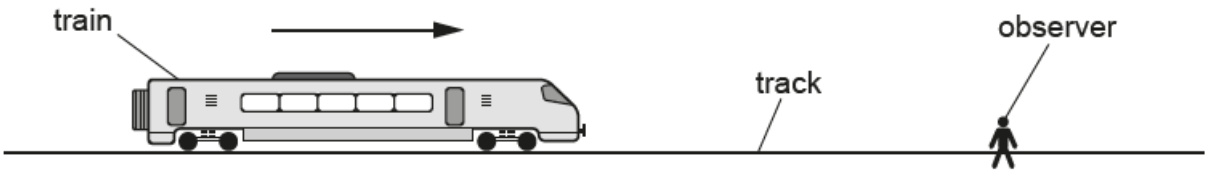

Fig. 6.1

The train sounds its horn continuously as it approaches the observer. The horn emits a sound of constant frequency 251 Hz. The frequency of sound heard by the observer is 291 Hz. The speed of sound in air is 340 m s^{-1}.

(a) Calculate the speed of the train.

speed = ... m s^{-1} [2]

(b) The train approaches and then passes the observer. The intensity I of the sound heard by the observer varies with the distance d of the horn from the observer.

When the horn is at a distance x_0 from the observer, the intensity I of the sound heard is I_0 and the amplitude A of the sound wave at the observer is A_0.

Fig. 6.2 shows the variation with d/x_0 of I/I_0 as the train moves away from the observer.

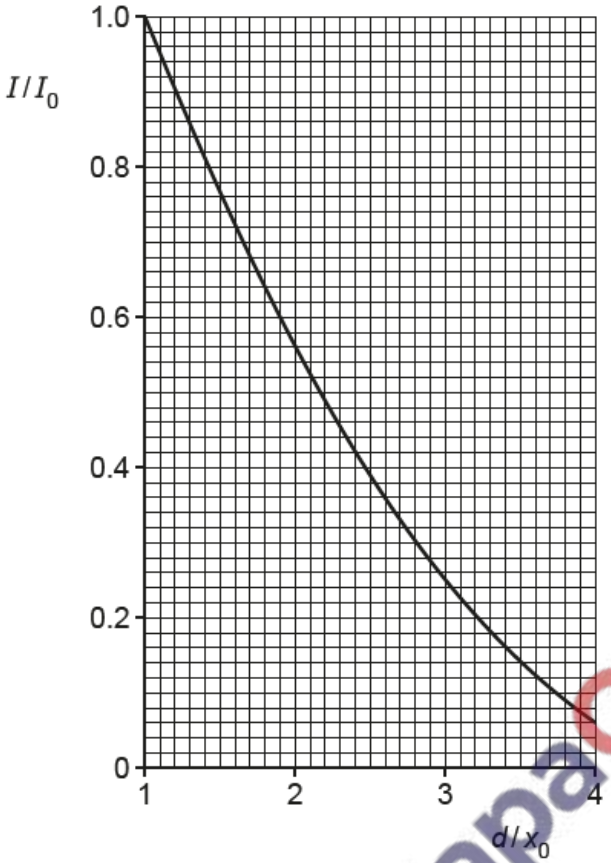

Fig. 6.2

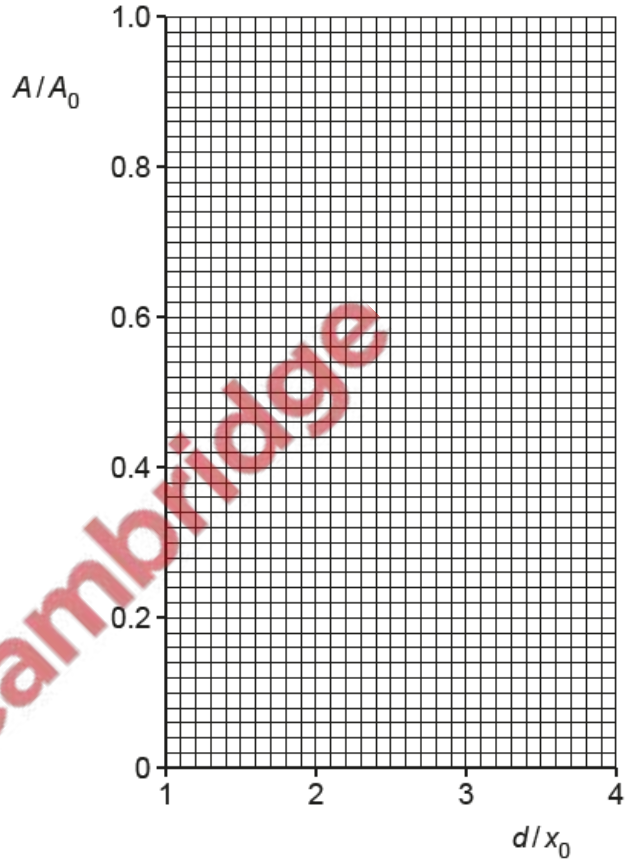

Fig. 6.3

(i) State the relationship between amplitude A and intensity I for a progressive wave.

..... [1]

(ii) On Fig. 6.3, sketch the variation with d/x_0 of A/A_0. [2]

[Total: 5]

(ii) State the principal region of the electromagnetic spectrum to which the waves belong.

..... [1]

[Total: 6]