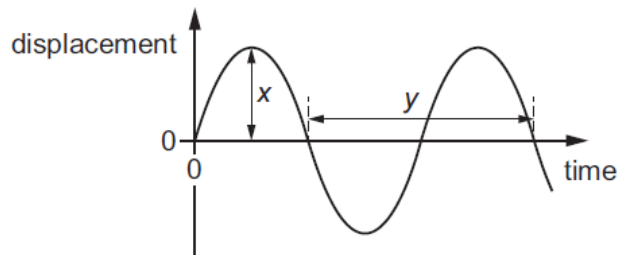


**1. June/2023/Paper\_9702/11/No.21**

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



Two measurements,  $x$  and  $y$ , are labelled on the graph.

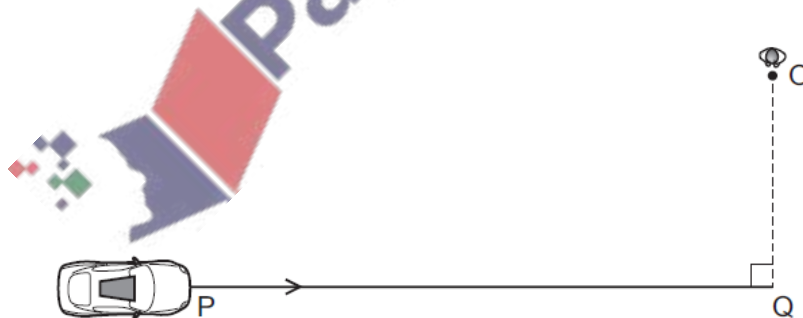
What do  $x$  and  $y$  represent?

	$x$	$y$
<b>A</b>	amplitude	period
<b>B</b>	frequency	period
<b>C</b>	amplitude	wavelength
<b>D</b>	frequency	wavelength

**2. June/2023/Paper\_9702/11/No.22**

A car travels at a constant speed along a straight line PQ.

A loudspeaker attached to the car emits sound of constant frequency  $f$ . A stationary observer is at point O.



What does the observer hear as the car moves from P towards Q?

- A** a frequency less than  $f$  that decreases as the car moves from P towards Q
- B** a frequency less than  $f$  that increases as the car moves from P towards Q
- C** a frequency more than  $f$  that decreases as the car moves from P towards Q
- D** a frequency more than  $f$  that increases as the car moves from P towards Q

3. June/2023/Paper\_9702/11/No.23

Some sources of electromagnetic waves in free space are listed.

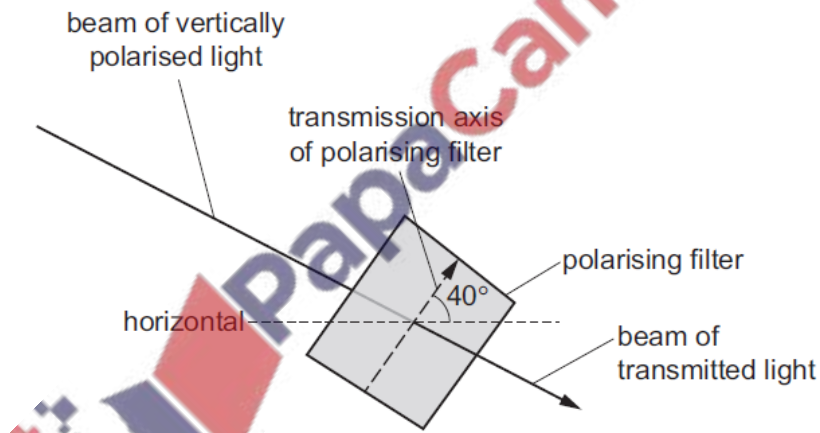
- 1 a radio wave transmitter
- 2 a source of X-rays
- 3 a 30 mm wavelength radar transmitter
- 4 a light-emitting diode that emits red light

Which list gives the sources in order of increasing wavelength, from left to right, of the waves emitted by the sources?

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

4. June/2023/Paper\_9702/11/No.24

A vertically polarised beam of light is incident normally on a polarising filter. The transmission axis of the filter is at an angle of  $40^\circ$  to the horizontal.



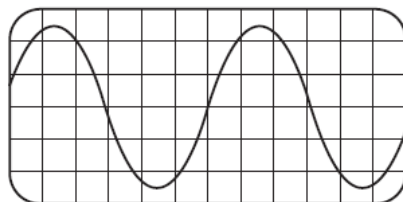
What is the ratio  $\frac{\text{amplitude of transmitted beam}}{\text{amplitude of incident beam}}$  ?

- A 0.41      B 0.59      C 0.64      D 0.77

5. June/2023/Paper\_9702/12/No.20

A microphone detects a sound wave. The microphone is connected to a cathode-ray oscilloscope (CRO).

The shape of the trace on the screen of the CRO is shown.



Which property of the sound wave can be determined by using only the measurement of a horizontal distance on the screen and the value of a control setting of the CRO?

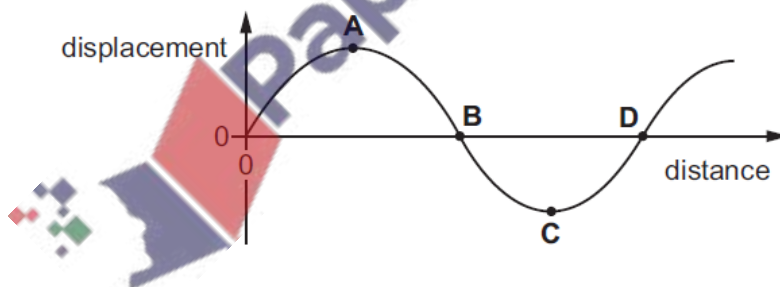
- A amplitude
- B frequency
- C speed
- D wavelength

6. June/2023/Paper\_9702/12/No.21

A longitudinal wave is travelling from left to right. The graph shows the variation of the displacement of the particles with distance along the wave at one instant in time.

Displacements to the right are positive; displacements to the left are negative.

Which labelled point represents a compression?



7. June/2023/Paper\_9702/12/No.22

A source X emits a sound wave of constant frequency  $f$ .

The wave is subsequently received at a stationary detector Y.

The frequency of the wave that is detected by Y is less than  $f$ .

What could be the reason for this?

- A Between X and Y, the wave undergoes diffraction.
- B Between X and Y, the wave undergoes reflection.
- C X is moving away from Y.
- D X is moving towards Y.

8. June/2023/Paper\_9702/12/No.23

A beam of visible light is in a vacuum.

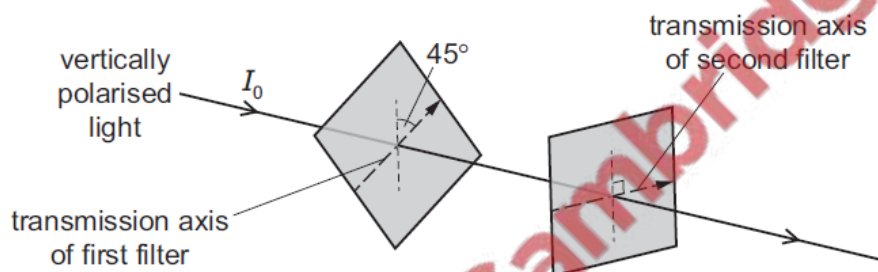
What could be the frequency of the light?

- A  $5.0 \times 10^5$  Hz    B  $5.0 \times 10^8$  Hz    C  $5.0 \times 10^{11}$  Hz    D  $5.0 \times 10^{14}$  Hz

9. June/2023/Paper\_9702/12/No.24

A vertically polarised beam of light of intensity  $I_0$  is incident normally on a polarising filter.

The transmission axis of the filter is at  $45^\circ$  to the vertical. The beam of light transmitted by this filter is then incident normally on a second filter. The transmission axis of the second filter is horizontal.



What is the intensity of the beam of light after transmission through the second filter?

- A 0                      B  $\frac{1}{4} I_0$                       C  $\frac{1}{2} I_0$                       D  $I_0$

10. June/2023/Paper\_9702/13/No.20

A progressive wave of frequency 1.5 kHz travels in a medium at a speed of  $340 \text{ m s}^{-1}$ .

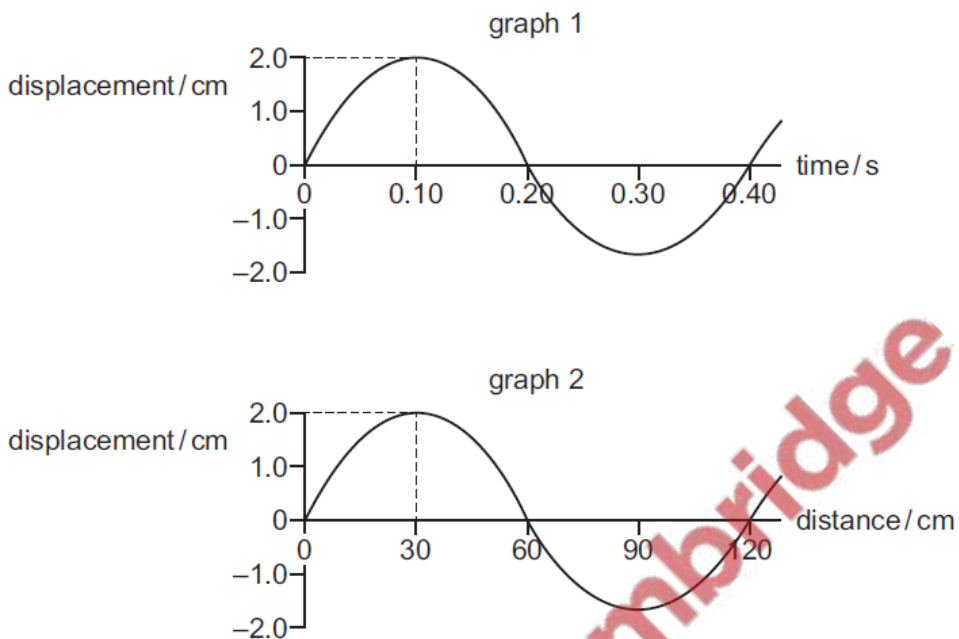
What is the minimum distance between two points on the wave that have a phase difference of  $70^\circ$ ?

- A 4.4 cm                      B 8.8 cm                      C 18 cm                      D 23 cm

11. June/2023/Paper\_9702/13/No.21

Graph 1 shows the variation with time of displacement at a fixed distance along a progressive wave.

Graph 2 represents the same wave and shows the variation with distance of displacement at an instant in time.



What is the speed of the wave?

- A  $5.0 \text{ cm s}^{-1}$     B  $48 \text{ cm s}^{-1}$     C  $150 \text{ cm s}^{-1}$     D  $300 \text{ cm s}^{-1}$

12. June/2023/Paper\_9702/13/No.22

A vehicle moves with constant velocity along a road directly towards an observer. The observed frequency of the sound from the vehicle changes as the vehicle moves past the observer.

Which phenomenon explains the change in frequency?

- A diffraction  
B interference  
C polarisation  
D the Doppler effect

13. June/2023/Paper\_9702/13/No.23

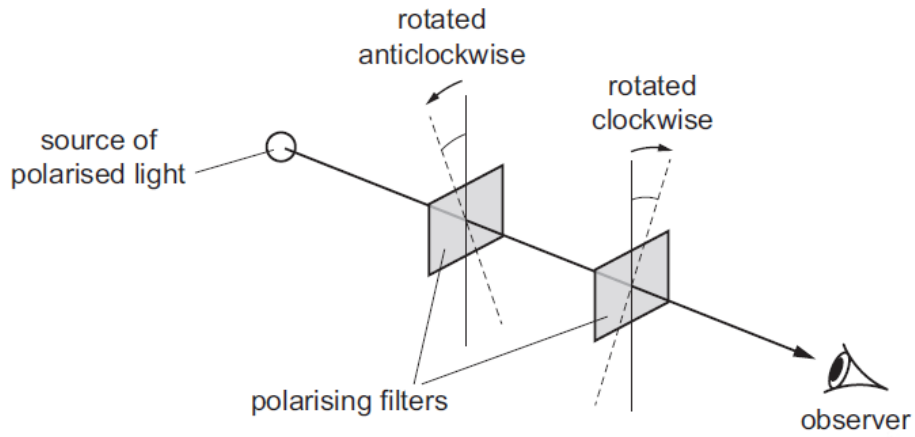
An electromagnetic wave has a wavelength of 2.1 cm in a vacuum.

Which region of the electromagnetic spectrum contains this wave?

- A infrared  
B microwave  
C radio wave  
D visible light

14. June/2023/Paper\_9702/13/No.24

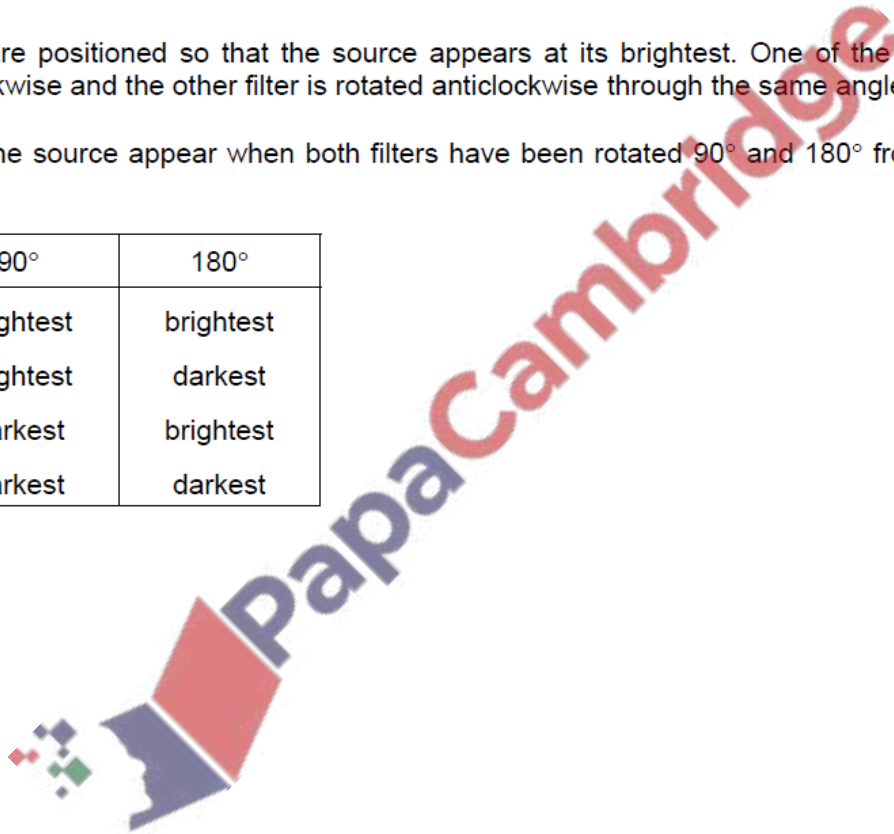
A source of plane polarised light is observed through two polarising filters.



The filters are positioned so that the source appears at its brightest. One of the filters is then rotated clockwise and the other filter is rotated anticlockwise through the same angle.

How does the source appear when both filters have been rotated  $90^\circ$  and  $180^\circ$  from their initial positions?

	$90^\circ$	$180^\circ$
<b>A</b>	brightest	brightest
<b>B</b>	brightest	darkest
<b>C</b>	darkest	brightest
<b>D</b>	darkest	darkest



15. June/2023/Paper\_9702/21/No.5(a)

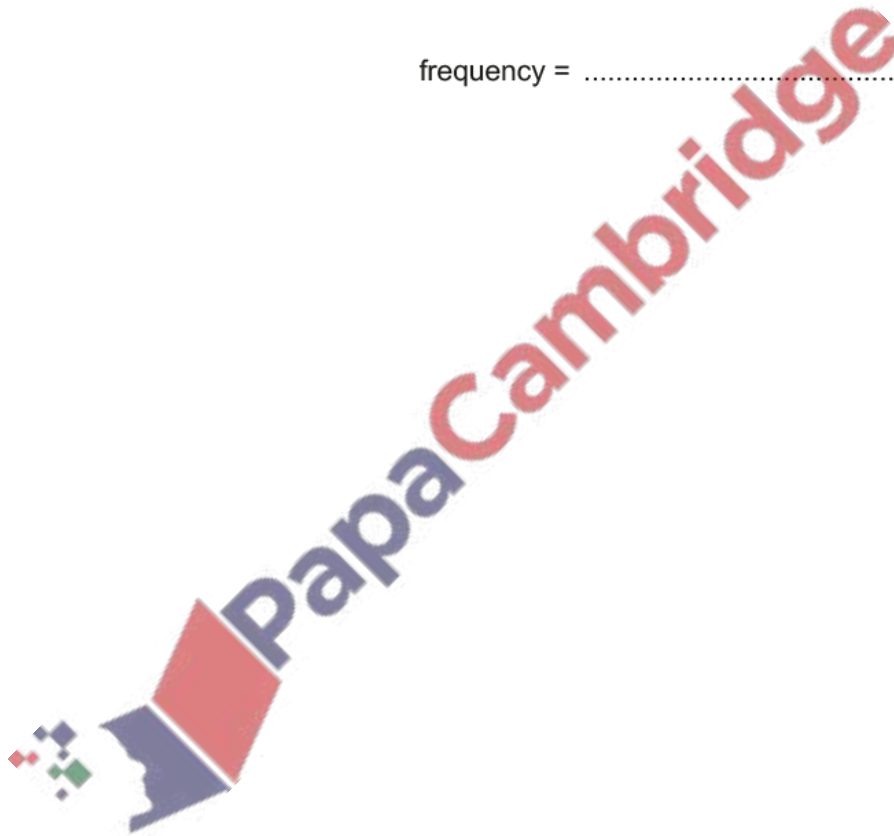
(a) An electromagnetic wave in a vacuum has a wavelength of  $8.4 \times 10^{-6}$  m.

(i) State the name of the principal region of the electromagnetic spectrum for the wave.

..... [1]

(ii) Calculate the frequency, in THz, of the wave.

frequency = ..... THz [2]



- (a) A progressive wave travels through a medium. The wave causes a particle of the medium to vibrate along a line P. The energy of the wave propagates along a line Q.

Compare the directions of lines P and Q if the wave is:

- (i) a transverse wave

..... [1]

- (ii) a longitudinal wave.

..... [1]

- (b) A tube is closed at one end. A loudspeaker is placed near the other end of the tube, as shown in Fig. 5.1.

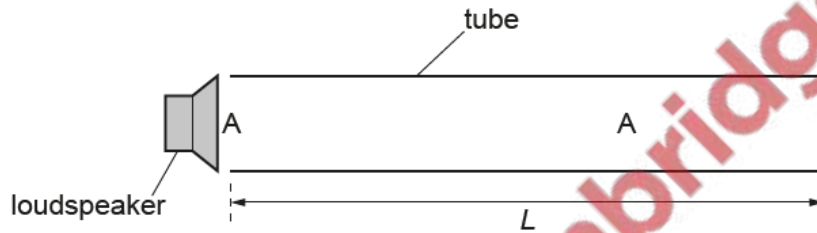


Fig. 5.1 (not to scale)

The loudspeaker emits sound of frequency  $1.7\text{ kHz}$ . The speed of sound in the air in the tube is  $340\text{ ms}^{-1}$ . A stationary wave is formed with an antinode A at the open end of the tube. There is only one other antinode A inside the tube, as shown in Fig. 5.1.

Determine:

- (i) the wavelength of the sound

wavelength = ..... m [2]

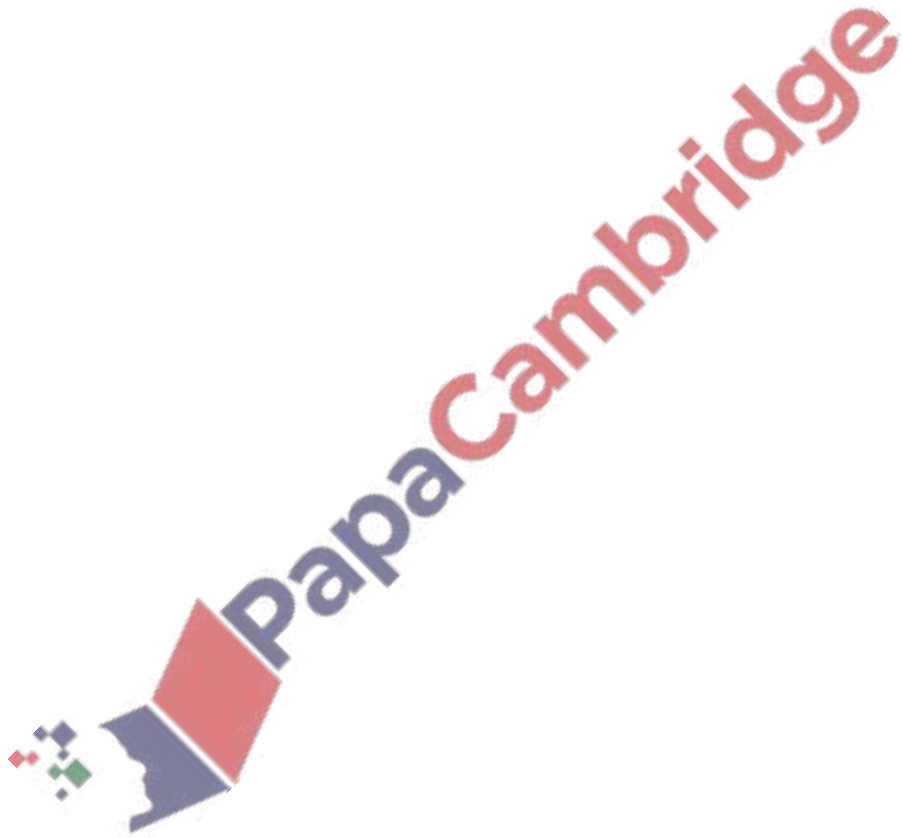
- (ii) the length  $L$  of the tube

$L = \dots\dots\dots$  m [1]



- (iii) the maximum wavelength of the sound from the loudspeaker that can produce a stationary wave in the tube.

maximum wavelength = .....m [1]



(a) For a progressive wave, state what is meant by the frequency.

.....  
 ..... [1]

(b) A loudspeaker, microphone and cathode-ray oscilloscope (CRO) are arranged as shown in Fig. 4.1.

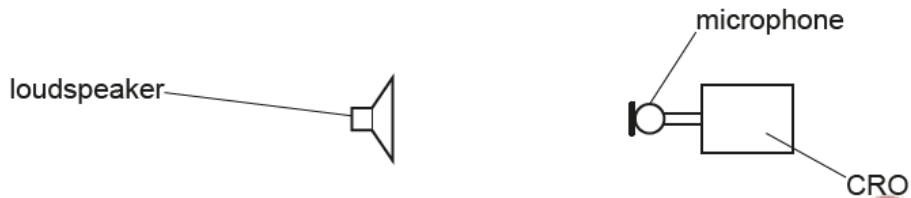


Fig. 4.1

The loudspeaker is emitting a sound wave which is detected by the microphone and displayed on the screen of the CRO as shown in Fig. 4.2.

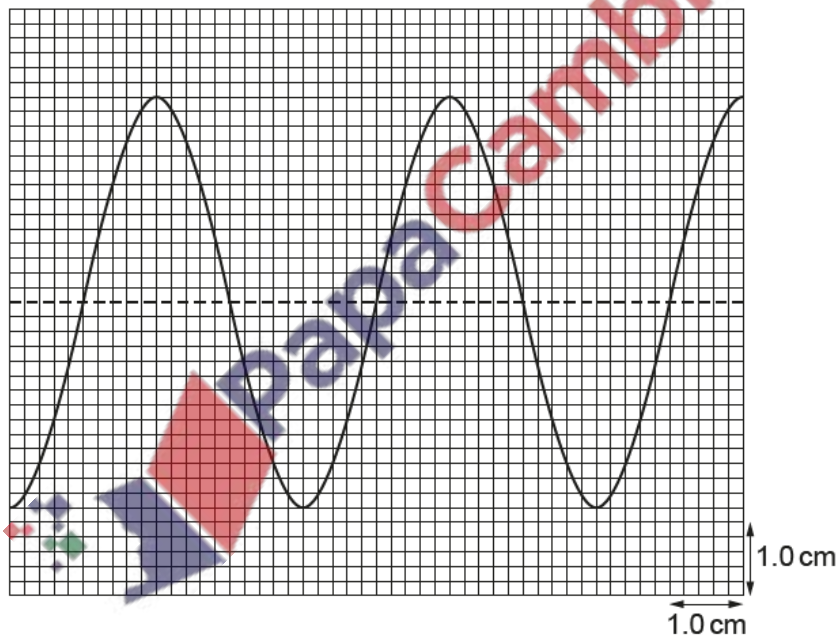


Fig. 4.2

The time-base on the CRO is set to  $0.50 \text{ ms cm}^{-1}$  and the y-gain is set to  $0.20 \text{ V cm}^{-1}$ .

Calculate:

- (i) the frequency of the sound wave

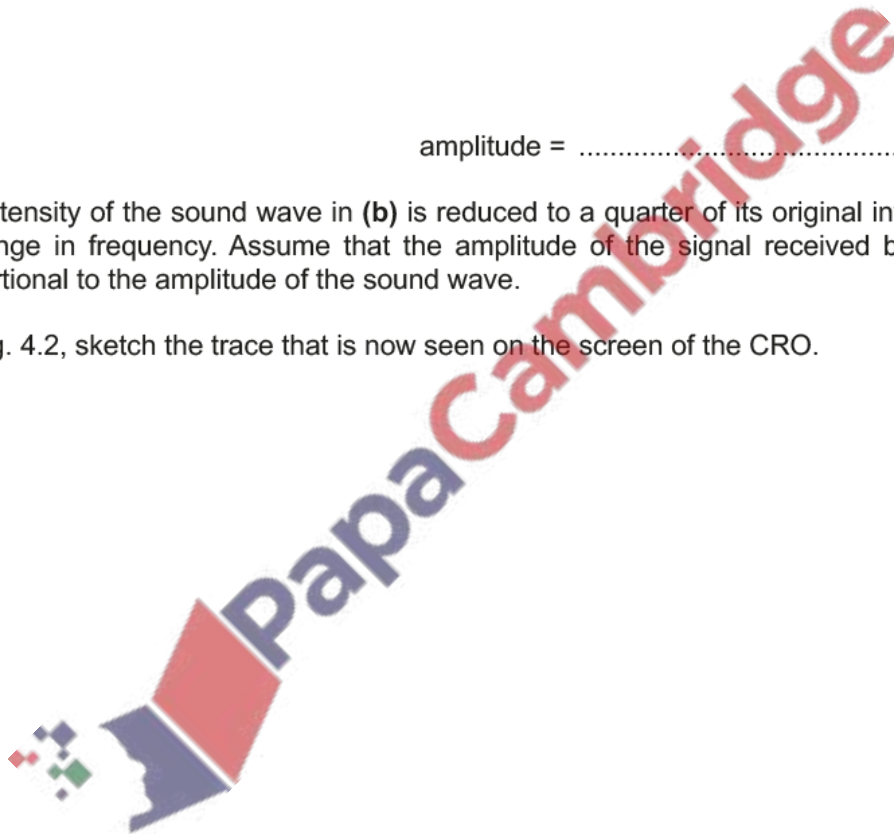
frequency = ..... Hz [2]

- (ii) the amplitude of the signal received by the CRO.

amplitude = ..... V [1]

- (c) The intensity of the sound wave in (b) is reduced to a quarter of its original intensity without a change in frequency. Assume that the amplitude of the signal received by the CRO is proportional to the amplitude of the sound wave.

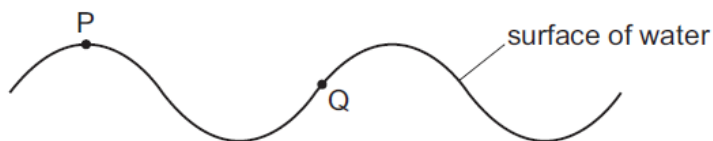
On Fig. 4.2, sketch the trace that is now seen on the screen of the CRO. [3]



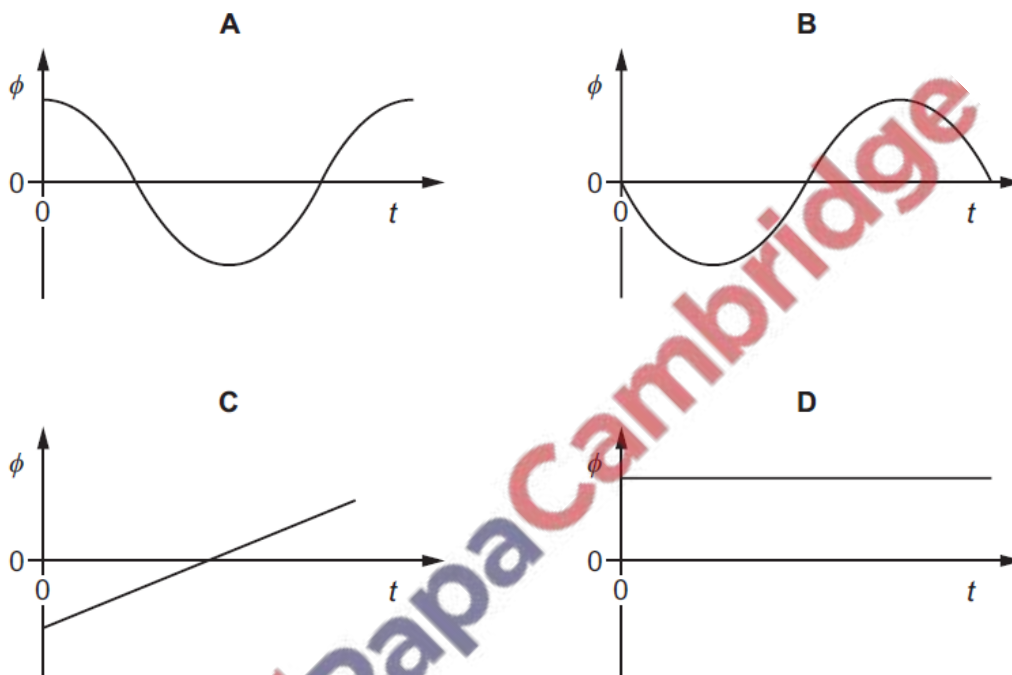
18. March/2023/Paper\_9702/12/No.20

In a progressive water wave, two particles, P and Q, on the surface of the water, are a fixed horizontal distance apart. P and Q oscillate vertically.

At time  $t = 0$ , the wave is as shown.



Which graph best represents the variation with time  $t$  of the phase difference  $\phi$  between the oscillation of the water particle P and the oscillation of the water particle Q?



19. March/2023/Paper\_9702/12/No.21

Which statement about longitudinal waves and transverse waves is **not** correct?

- A Both waves can be polarised.
- B Both waves can form stationary waves.
- C Both waves can transfer energy as progressive waves.
- D Both waves obey the equation  $v = f\lambda$ .

20. March/2023/Paper\_9702/12/No.22

An observer hears a sound wave emitted from a moving source.

The observed frequency is less than the frequency of sound emitted from the source.

What could be the reason for this?

- A The source is moving away from the observer.
- B The source is moving towards the observer.
- C The speed of the sound wave in air decreases due to the movement of the source.
- D The speed of the sound wave in air increases due to the movement of the source.

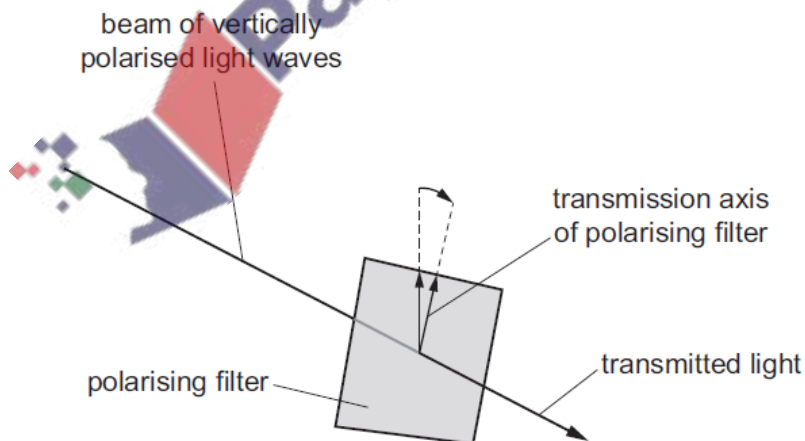
21. March/2023/Paper\_9702/12/No.23

What is the approximate range of frequencies of electromagnetic radiation visible to the human eye?

- A (430–750) kHz
- B (430–750) MHz
- C (430–750) GHz
- D (430–750) THz

22. March/2023/Paper\_9702/12/No.24

A beam of vertically polarised light is incident normally on a polarising filter. The filter can be rotated so that it is always in a plane perpendicular to the beam. The transmission axis of the filter is initially vertical.

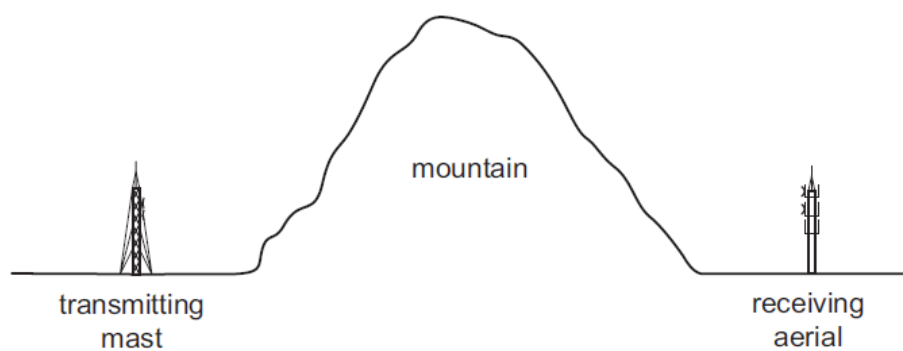


The filter is first rotated clockwise by an angle of  $30^\circ$  so that the transmitted light waves have intensity  $I_{30}$ . The filter is then rotated clockwise by a further angle of  $30^\circ$ .

What is the new intensity of the transmitted light waves?

- A  $0.25 I_{30}$
- B  $0.33 I_{30}$
- C  $0.75 I_{30}$
- D  $0.87 I_{30}$

A transmitting mast sends out microwaves of wavelength 1.5 cm and radio waves of wavelength 1.5 km.



NOT TO SCALE

A receiving aerial behind a mountain can detect the radio waves but not the microwaves.

What is the reason for this?

- A The radio waves are coherent but the microwaves are not.
- B The radio waves are diffracted around the mountain but the microwaves are not.
- C The radio waves are reflected by the mountain but the microwaves are not.
- D The radio waves travel at the speed of light but the microwaves do not.



- (a) A microphone and cathode-ray oscilloscope (CRO) are used to analyse a sound wave of frequency 5000 Hz. The trace that is displayed on the screen of the CRO is shown in Fig. 5.1.

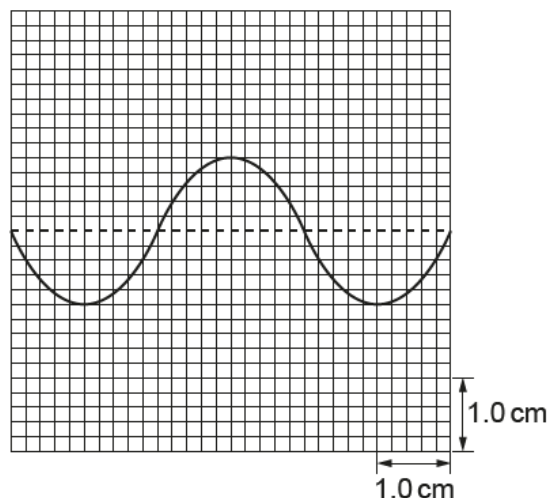


Fig. 5.1

- (i) Determine the time-base setting, in  $\text{s cm}^{-1}$ , of the CRO.

time-base setting = .....  $\text{s cm}^{-1}$  [2]

- (ii) The intensity of the sound detected by the microphone is now increased from its initial value of  $I$  to a new value of  $3I$ . The frequency of the sound is unchanged. Assume that the amplitude of the trace on the CRO screen is proportional to the amplitude of the sound wave.

On Fig. 5.1, sketch the new trace shown on the screen of the CRO. [3]