



Rewarding Learning

ADVANCED
General Certificate of Education
2023

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit A2 4

assessing

Sound and Light

MV24

[AZ041]

WEDNESDAY 21 JUNE, MORNING

Time

1 hour 45 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all ten** questions.

Write your answers in the spaces provided.

Information for Candidates

The total mark for this paper is 100.

Figures in brackets at the end of each question indicate the marks awarded to each question, or part question.

You may use an electronic calculator.

Quality of written communication will be assessed in question **9(a)**.

1 Refraction is the change in direction of light at the boundary between two different media.

The human eye refracts light to form sharp images.

(a) Which part of the eye contributes most to the refraction of light to form an image?
[2 marks]

Explain your answer.

Part of the eye _____

Explanation

(b) Rods and cones are photoreceptors.

Tick (✓) the boxes in the table below which correctly describe the rods in a human eye. [2 marks]

There are more rods than cones	
There are three types of rods	
Rods are mostly located in the fovea	
Several rods are connected to one nerve cell	

(c) Some birds can change the shape of their cornea to provide accommodation.

What is accommodation and how is it achieved in the human eye? [4 marks]

(d) Suggest one visual limitation experienced by a person who has lost their vision in one eye. [1 mark]

2 The ear is an organ which is sensitive to a wide range of vibrations.

(a) (i) State the range of frequencies to which human ears are **most** sensitive and explain why the ear is most sensitive to these frequencies.

[2 marks]

(ii) Explain, in terms of energy, what is meant by the term sound intensity?
[1 mark]

(iii) What is the lowest intensity of sound that the ear can detect? [1 mark]
Give your answer in pWm^{-2} .

Intensity = _____ pWm^{-2}

3 Hearing losses are divided into two categories.

These are conductive loss, which refers to external sound vibrations not being transferred effectively, and nerve loss.

(a) (i) Suggest how conductive loss occurs at the tympanic membrane when there is mucus build-up in the middle ear. [1 mark]

(ii) How is fluid usually removed from the middle ear? [2 marks]

(iii) In which ear structure would nerve loss occur and in which part of the ear is this structure located?
[2 marks]

Over a person's lifetime, nerve loss can occur due to degeneration of cells.

(iv) Give another example of how nerve loss can occur in adults. [1 mark]

(b) Behind-the-ear hearing aids can be used to improve hearing for people who have experienced hearing issues due to nerve loss.

(i) How is the hearing aid able to improve hearing? [1 mark]

(ii) Suggest two limitations of behind-the-ear hearing aids used to improve hearing. [2 marks]

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(Questions continue overleaf)

- 4 A noise level safety test was completed for a power drill and a circular saw. The measurements were taken at a distance of 1.0 m from each piece of equipment.

Equipment	Decibel level/dB
Power drill	98
Circular saw	102

- (a) Why is a logarithmic scale useful when describing human hearing? [1 mark]

(b) (i) Calculate the sound intensity of the circular saw at a distance of 1.0 m.
[3 marks]

You are advised to show your working.

Intensity = _____ Wm^{-2}

(ii) When the power drill and circular saw are operating, the new sound intensity is found by adding the sound intensities of both pieces of equipment.

The sound intensity of the power drill at 1.0 m is 0.0063 Wm^{-2} .

Calculate the decibel level at a distance of 1.0 m if both the circular saw and power drill are operated at the same time. [4 marks]

You are advised to show your working.

Decibel level = _____ dB

(c) Some neighbours are unhappy about the loudness of the power tools.

(i) Why is loudness subjective?
[1 mark]

The loudness in phons of the power tools is to be determined.

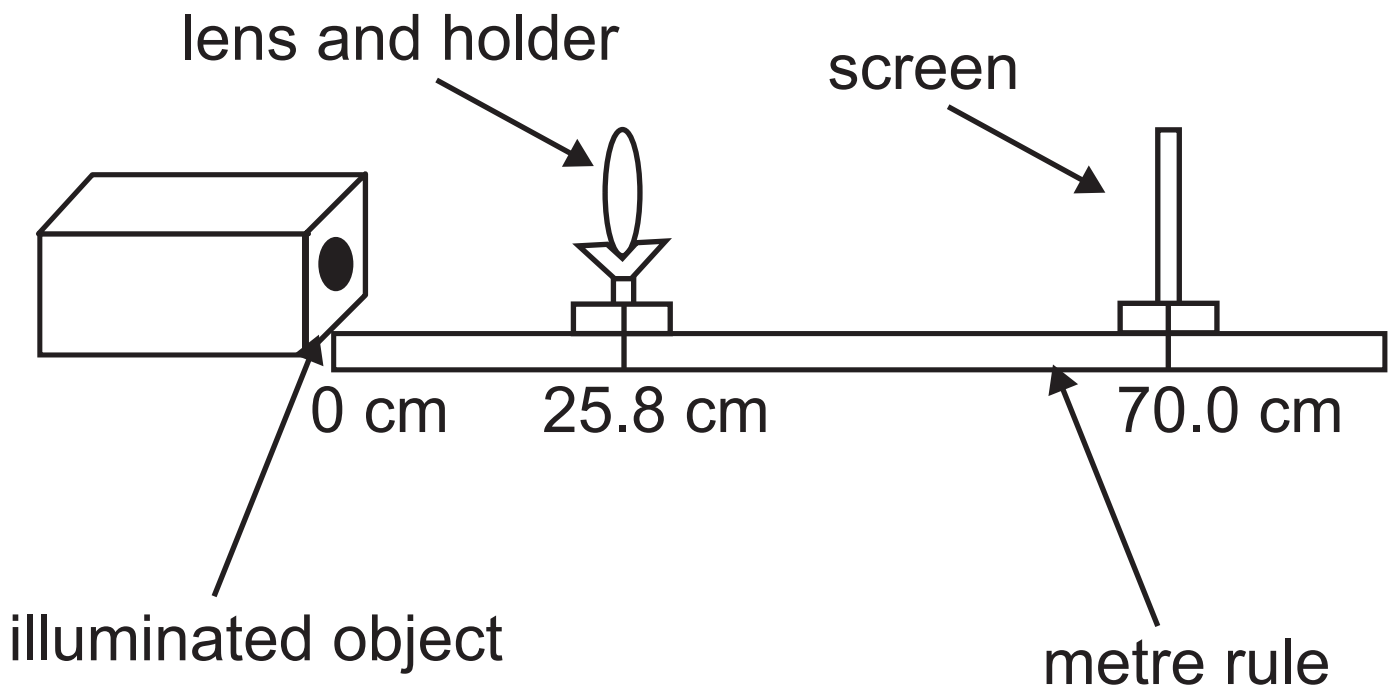
(ii) One of the pieces of equipment required for this procedure is a decibel meter. State the **two** other pieces of equipment which are required to determine the loudness.
[1 mark]

(iii) Describe the procedure to find the loudness of the power tools.
[3 marks]

- 5 A student completes an experiment to determine the focal length of a converging lens.

The student sets up the following apparatus.

The metre rule is placed with the object at the 0 cm mark and the screen is placed at the 70.0 cm mark as shown.



The lens was moved until a sharp image formed on the screen.

The position of the lens was recorded as 25.8 cm.

- (i) Calculate the focal length of the converging lens. [4 marks]

You are advised to show your working.

Focal length = _____ cm

(ii) Calculate the power of the converging lens. [2 marks]

You are advised to show your working.

Power = _____ D

(iii) The lens and screen were moved again and the student observed that no focused images could be found when the lens was placed at the 5.0 cm mark.

Explain why no image can be observed on the screen when the lens is placed 5.0 cm from the object. [2 marks]

6 (a) (i) The near point for a normal eye is 25.0 cm.

What is meant by the term near point? [1 mark]

(ii) A girl has a near point of 69.0 cm. Calculate the power of the reading glass lenses required to correct her near point. [3 marks]

You are advised to show your working.

Power = _____ D

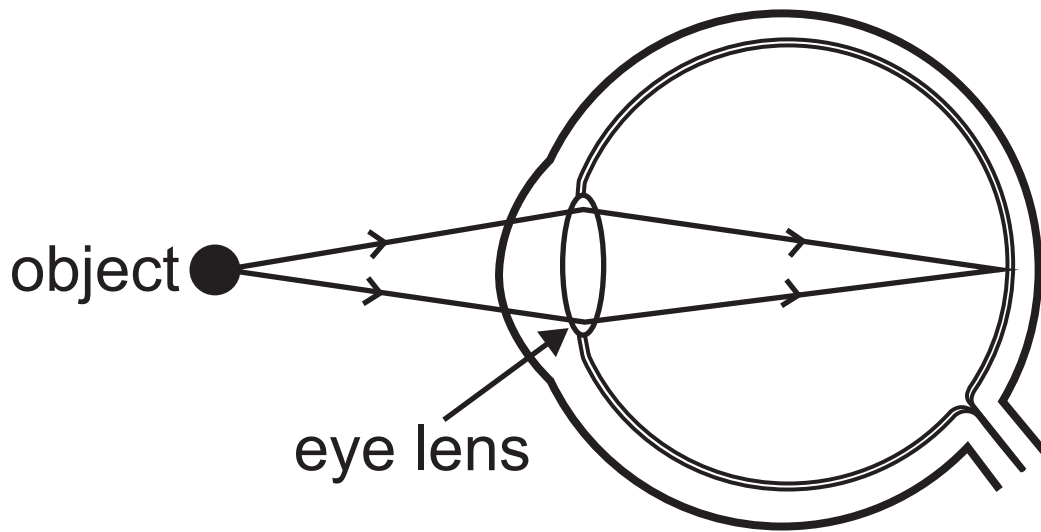
(iii) Before putting on the reading glasses the girl can focus clearly on objects which were 69 cm away and beyond.

When wearing the reading glasses, the girl can only focus on objects up to the focal length of the lens.

What is the new range of vision for the girl when wearing the reading glasses? [2 marks]

Range from _____ cm
to _____ cm

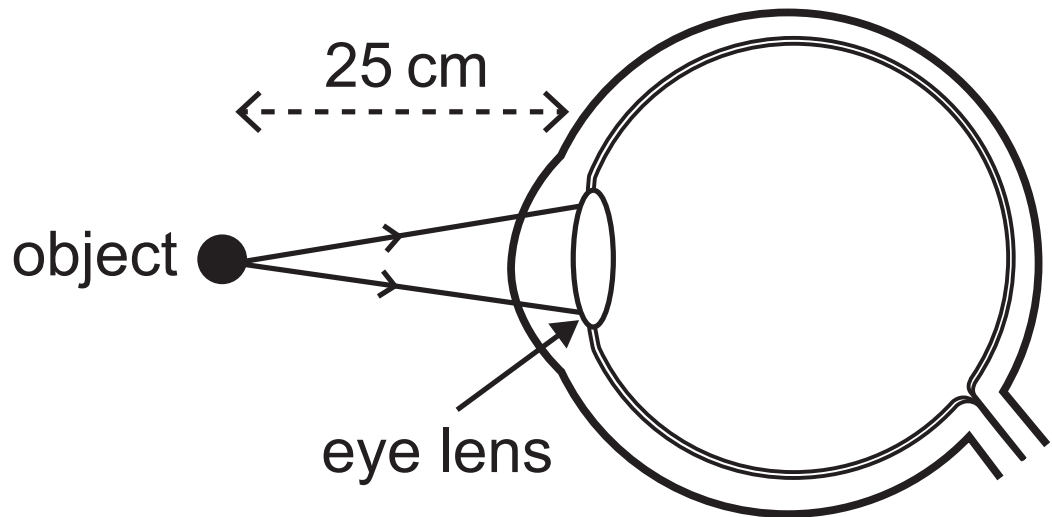
(b) The following diagram shows how a normal eye focuses on a close up object.



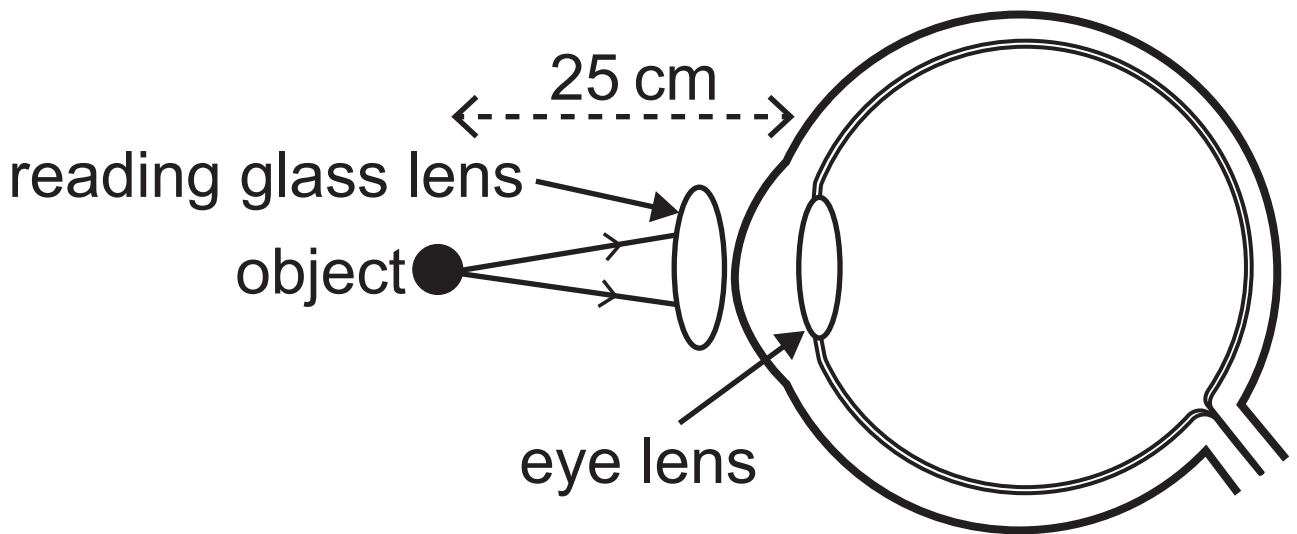
(i) Label the position of the retina and the cornea on the diagram above.
[1 mark]

(ii) Complete the following diagram to show the rays of light passing through a long-sighted eye **before** a lens is used to correct the eyesight.

[1 mark]



(iii) A reading-glass lens is used to correct the vision of a person with long sight. Complete the following diagram to show the rays of light passing through a long-sighted eye. [2 marks]



7 (a) Radio waves and microwaves are both electromagnetic waves used to transmit information over very long distances.

They have similar features such as:

- they both transfer energy;
- they can reflect and refract; and
- they both travel at $3.00 \times 10^8 \text{ ms}^{-1}$ in air.

(i) State one other similarity and one difference between these electromagnetic waves. [2 marks]

Similarity _____

Difference _____

(ii) How are radio wave signals created in a dipole antenna? [2 marks]

(b) Radar systems are used by aeroplanes to fly in low visibility by using echolocation.

(i) The transmitter sends out waves with a wavelength 50.0 cm.
Calculate the frequency of the radar waves. [3 marks]

You are advised to show your working.

Frequency = _____ Hz

(ii) When preparing for landing, the aeroplane radar transmitter emits a signal vertically downwards towards the ground and the receiver on the aeroplane detects the echo $4.03 \mu\text{s}$ later.

Calculate the height of the aeroplane above the ground. [4 marks]

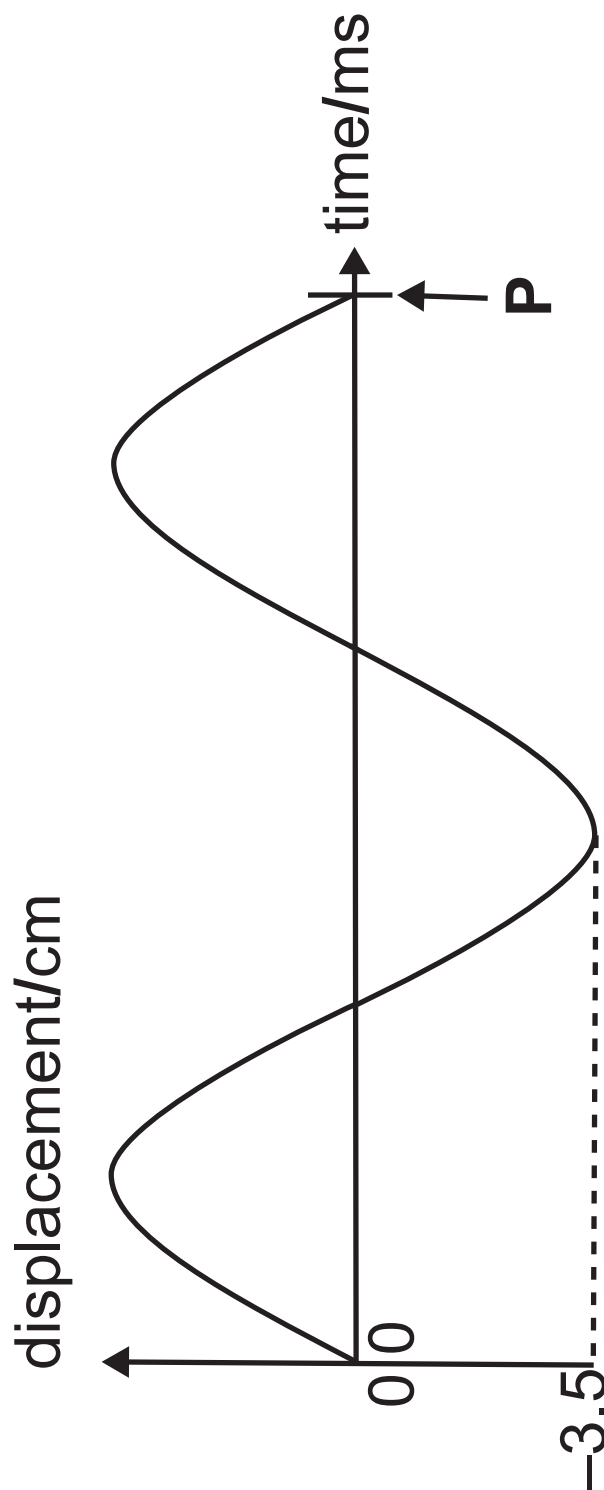
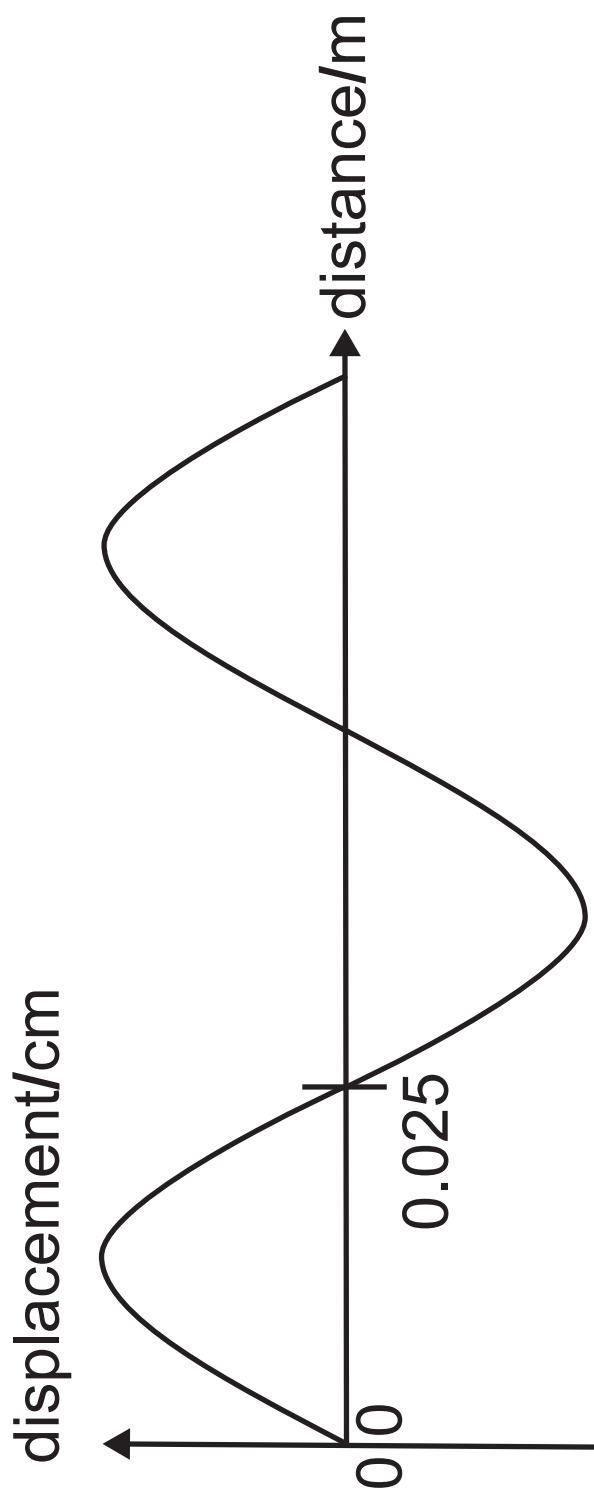
You are advised to show your working.

Height = _____ m

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(Questions continue overleaf)

- 8 (a) The graphs below provide information regarding the same wave.



(i) Tick the box which correctly describes the wave. [1 mark]

The wave shown is transverse

The wave shown is longitudinal

The wave shown could be either transverse or longitudinal

(ii) The wave has a frequency of 50 Hz.

Calculate the time taken for one wave to pass a fixed point. [2 marks]

You are advised to show your working.

Time = _____ s

(iii) What number should be written at point **P** on the displacement-time graph to represent a correct scale? [1 mark]

P = _____

(iv) Use the information on one of the graphs to determine the wavelength of the wave. [1 mark]

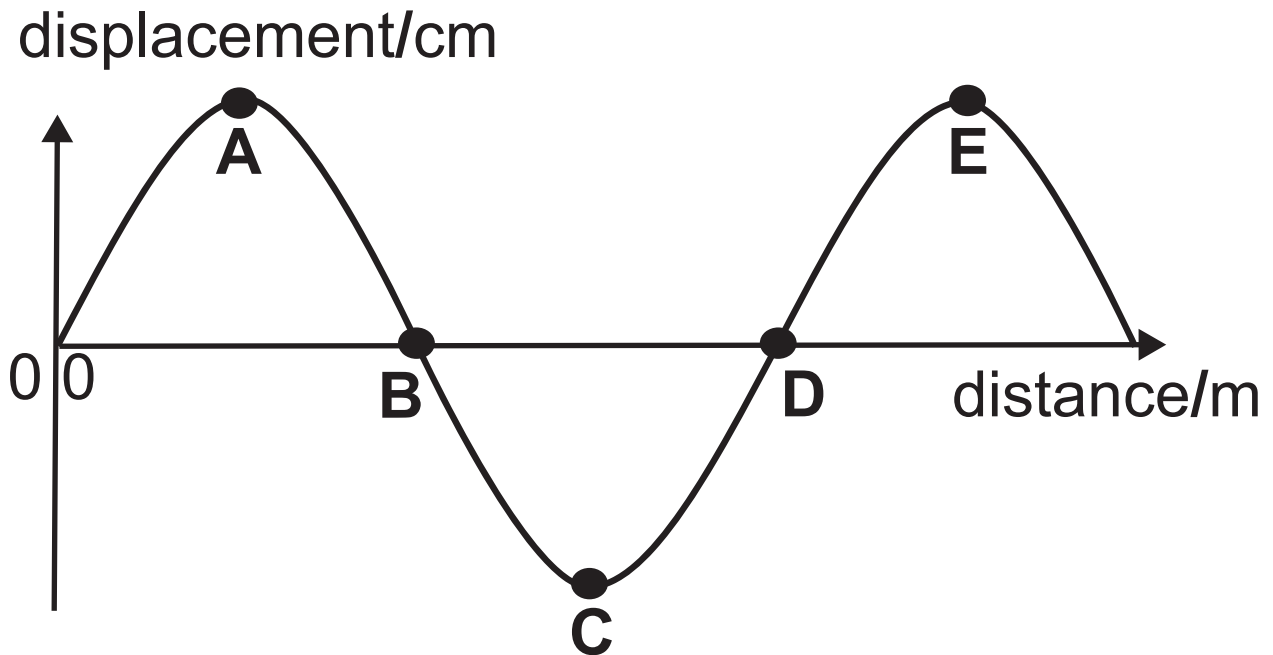
Wavelength = _____ m

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(Questions continue overleaf)

(b) The graph of another wave is shown below.

Points A, B, C, D and E represent different positions on the wave.



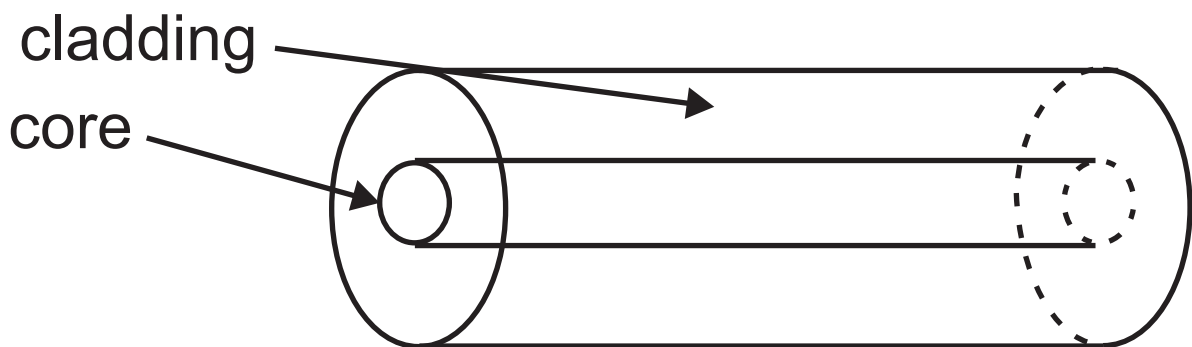
(i) Which point(s) on the graph represent the wave particles oscillating in phase with A? [1 mark]

(ii) Which point(s) on the graph represent the wave particles oscillating in antiphase with C? [1 mark]

(iii) Mark an X on the graph to represent one point where particles are oscillating with a phase difference of 45° with those at point D. [1 mark]

(b) (i) What is meant by the term **total internal reflection** and how can it be observed? [2 marks]

(ii) Complete the simplified diagram of a **single mode fibre optic cable** by showing a ray of light travelling along the fibre. [1 mark]

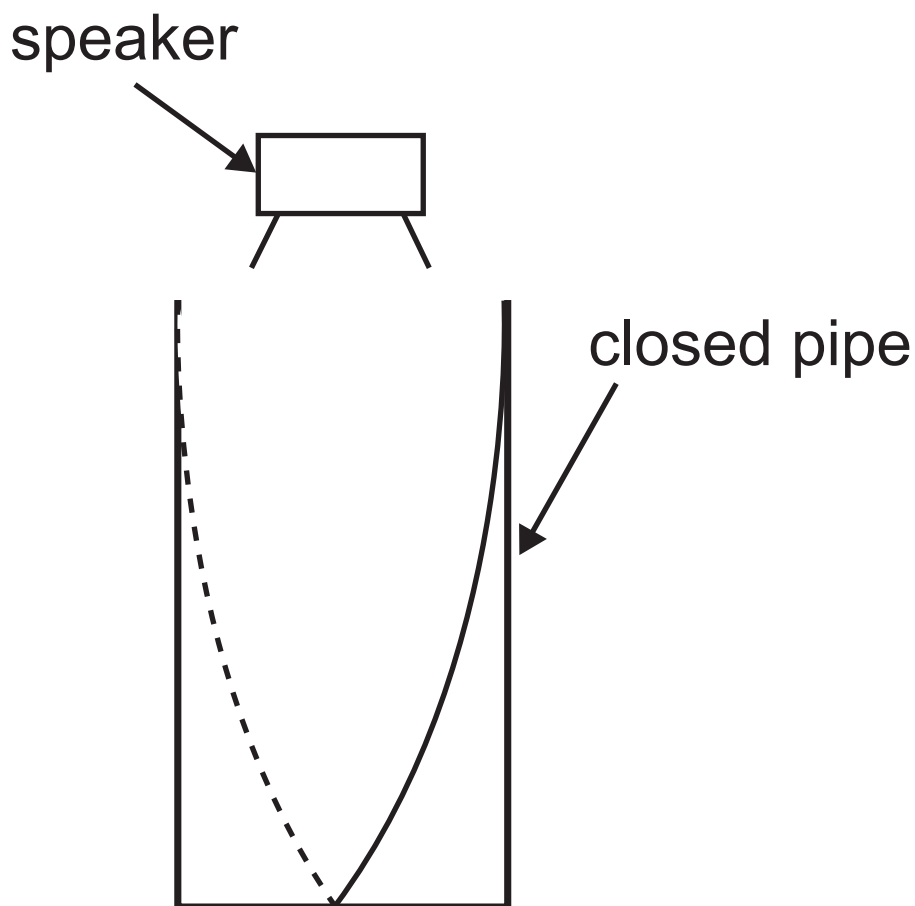


(iii) State an example of when single mode fibre optic cables are more useful than multimode cables. [1 mark]

10 (a) How are standing waves created?
[2 marks]

(b) The diagram below shows a standing wave pattern of a sound wave in a closed pipe of length 28.0 cm.

The standing wave pattern shown is for the first harmonic which occurs at a frequency of 300 Hz.



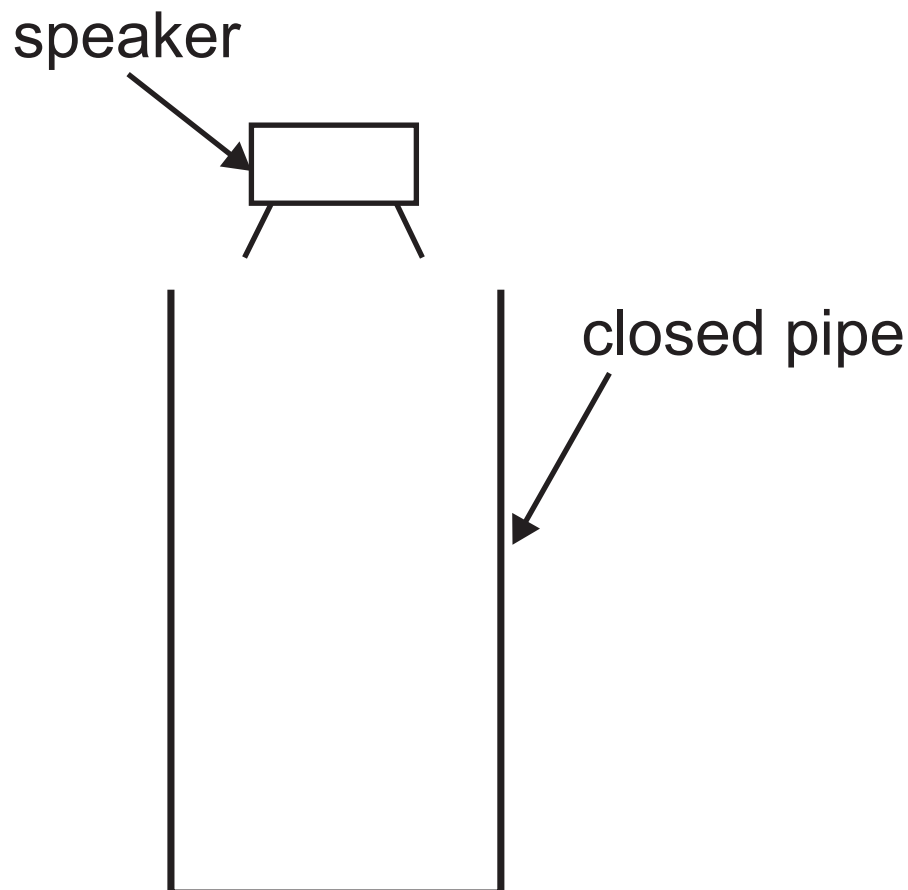
(i) Mark the positions of all nodes N and antinodes A on the diagram opposite.
[1 mark]

(ii) What is the wavelength of the sound generated by the speaker when the frequency is 300 Hz? [1 mark]

Wavelength = _____ cm

The frequency of the signal generator is increased to 1500 Hz and a different standing wave is formed in the same closed pipe.

(iii) Complete the diagram below by drawing the standing wave pattern observed for a frequency of 1500 Hz [1 mark]



(iv) Calculate the new wavelength of the standing wave. [2 marks]

Wavelength = _____ cm

**This is the end of the
question paper**

SOURCES

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Question Number	Marks
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Total Marks	

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