



Rewarding Learning

ADVANCED
General Certificate of Education
2024

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--

Life and Health Sciences

Assessment Unit A2 4

assessing

Sound and Light

MV18

[AZ041]

FRIDAY 21 JUNE, AFTERNOON

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.

You must answer the questions in the spaces provided.

Do not write on blank pages.

Complete in black ink only.

Answer **all nine** questions.

Information for Candidates

The total mark for this paper is 100.

Figures in brackets printed 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 2.

1 Ultraviolet, infrared, radio waves, microwaves and visible light are all electromagnetic waves.

(i) Electromagnetic waves transfer energy without transferring matter. State two other properties that electromagnetic waves have in common. [2 marks]

1. _____

2. _____

(ii) Complete the table below by adding the correct electromagnetic waves in each of the blank spaces. Choose your answers from the examples in bold at the beginning of this question. [2 marks]
Two examples have been completed for you.

Wave	Infrared	Visible light			
Wavelength in a vacuum	850 nm	5×10^{-7} m	100 nm	3.00 mm	1500 m

(iii) The frequency of the infrared waves shown in the table opposite is 352×10^{12} Hz.
Calculate the speed of these infrared waves in a vacuum. [4 marks]

Show your working out.

Speed = _____ ms^{-1}

(iv) Use your answer to **(iii)** to calculate the **frequency** of the visible light waves shown in the table in **(ii)**.
[2 marks]

Show your working out.

Frequency = _____ Hz

2 A radio set can be used to communicate sound waves.

Describe in detail the equipment and how it is used to communicate sound using radio waves. [8 marks]

You should include the following:

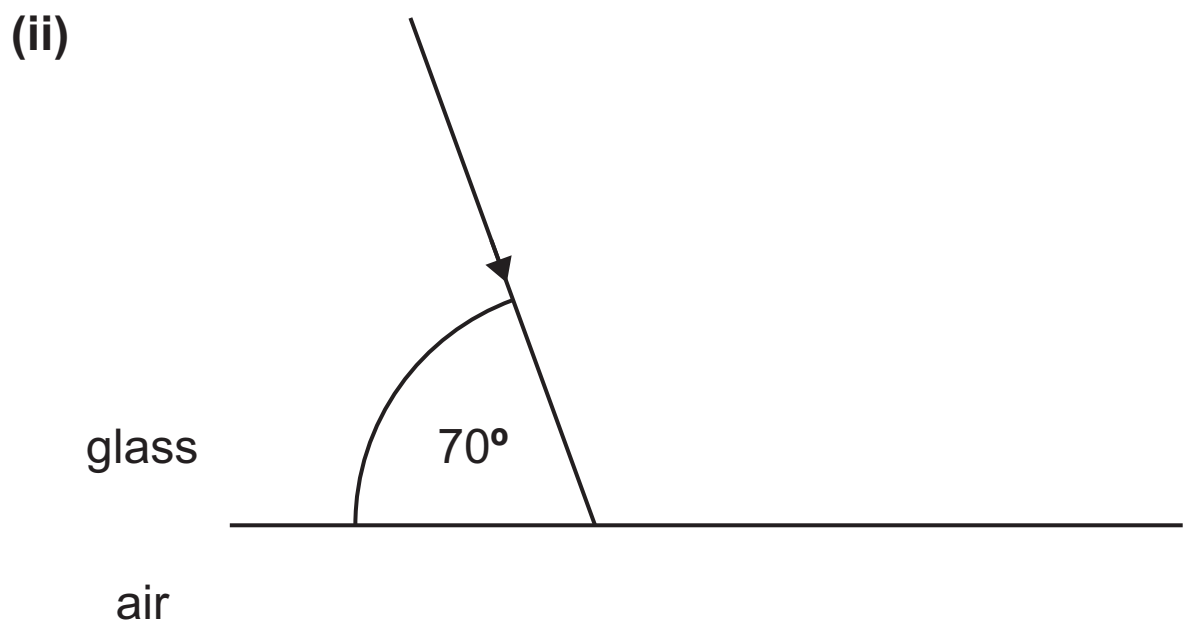
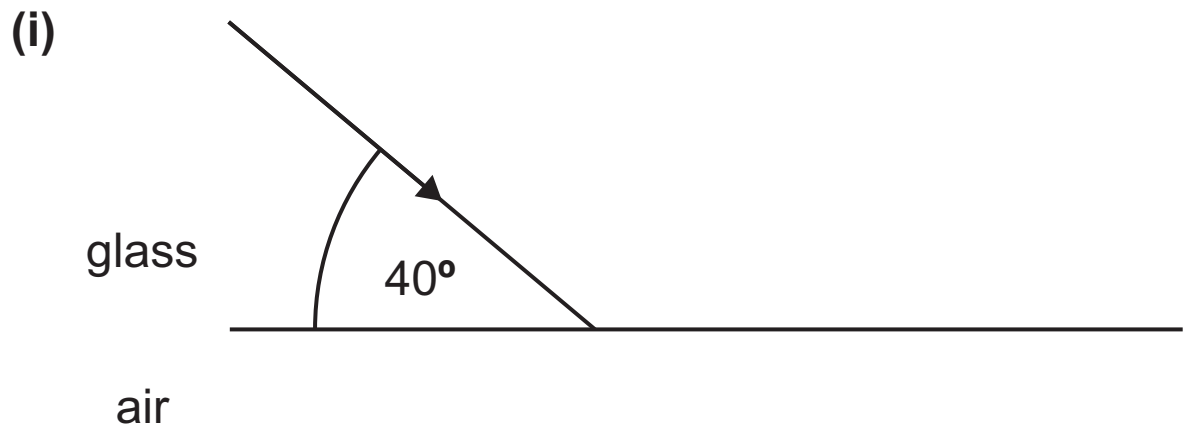
- a description of radio waves in terms of fields;
- the equipment used to turn sound into an electrical signal;
- the subatomic particle involved in the production of radio waves;
- the two pieces of equipment needed to produce and transmit radio waves;
- how radio waves are produced and transmitted using this equipment;
- how the transmission frequency of the radio signal is determined; and
- the piece of equipment used to encode the sound waves in the radio waves.

Quality of your written communication will be assessed in this question.

- 3 (a) A ray of light passes through a glass block and into the air.

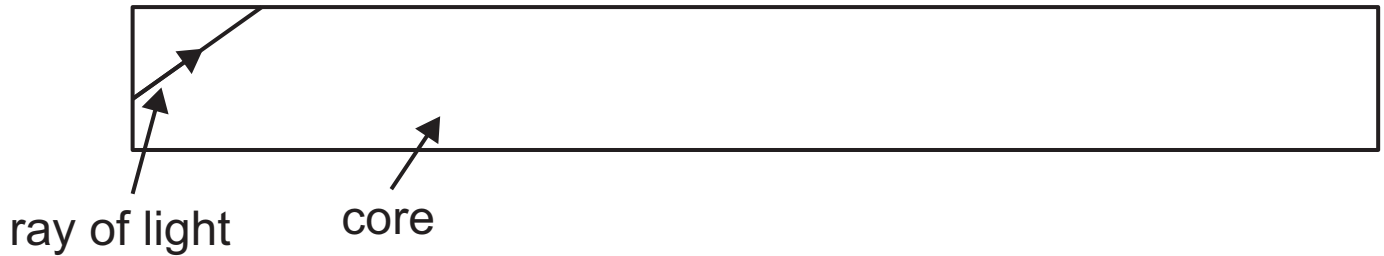
The critical angle of glass is 42° .

Complete the diagrams below to show the path(s) of each ray of light at the glass–air boundary. [3 marks]



(b) A multi-mode fibre-optic cable can be used to transfer light over short distances.

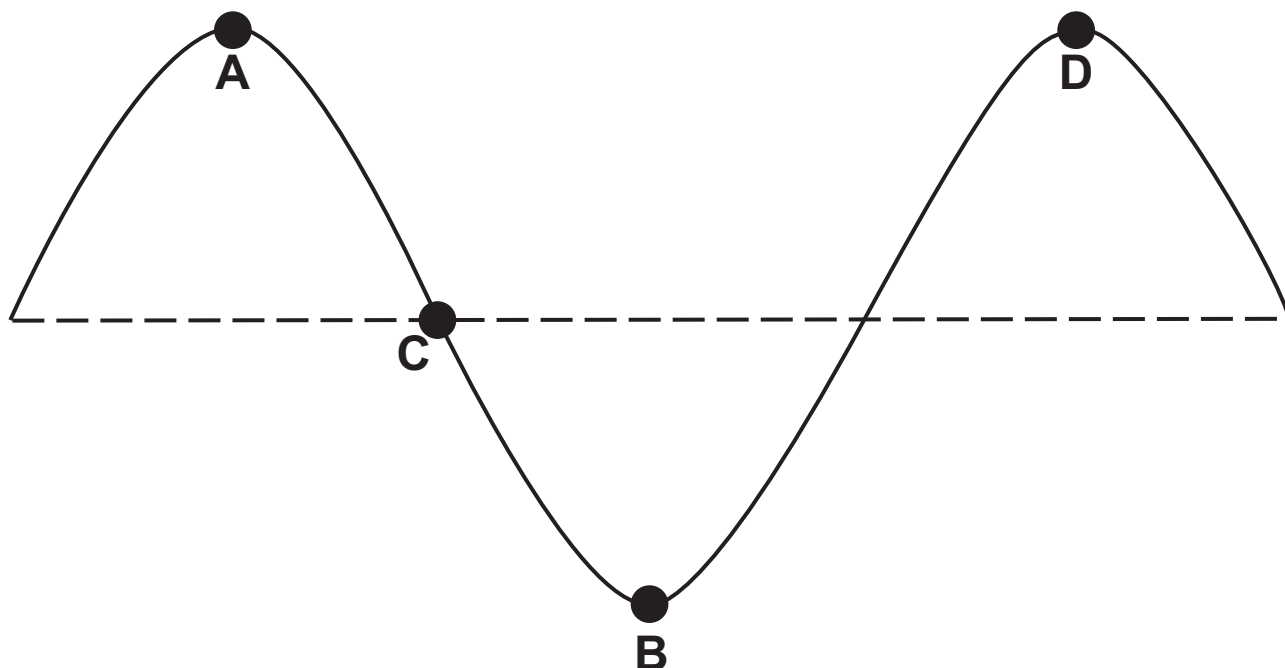
The following diagram shows a short section of the core of a multi-mode optical fibre.



(i) Using a ruler, complete the diagram above to show the path of the ray of light through the core of the multi-mode fibre. [1 mark]

(ii) Discuss in detail the reason why the structure of a multi-mode fibre makes it unsuitable for long range communication. [5 marks]

- 4 The following sketch of a wave shows a guitar string when it is vibrating.



- (a) Answer the following questions using the letters **A – D** in the sketch. [1 mark for each]

(i) The wavelength of the wave is the distance from

_____ to _____

(ii) The amplitude of the wave is the vertical distance from

_____ to _____

(iii) Two points on the string which are vibrating 270° out of phase are

_____ and _____

(b) The guitar string when plucked, creates a wave on the string with a frequency of 82.4 Hz.

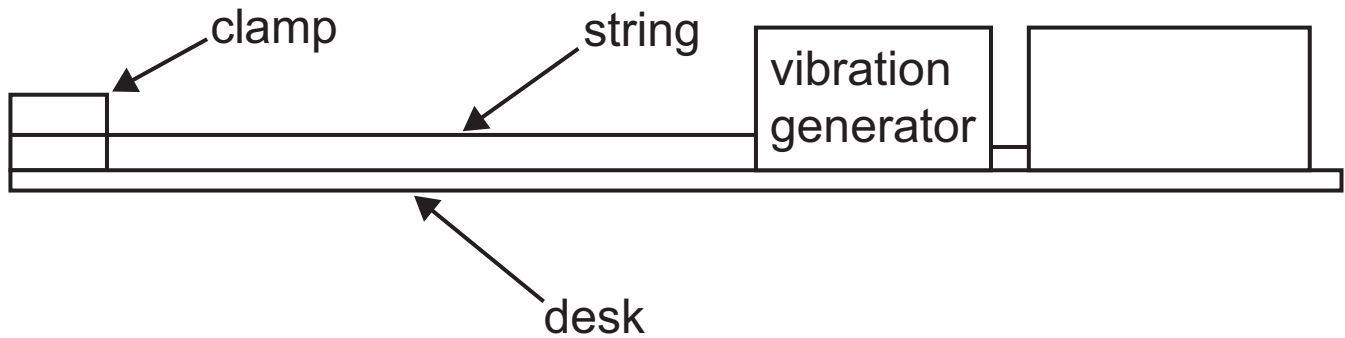
Calculate the time it takes for the string to complete five full oscillations. [3 marks]

Show your working out.

Time = _____ s

(c) Standing waves can be investigated in the laboratory.

The diagram below shows the arrangement of some of the equipment used to demonstrate standing waves.



(i) In the blank box in the diagram above, label the other piece of equipment which is essential to demonstrate standing waves. [1 mark]

(ii) How is the equipment in the diagram above used to demonstrate a standing wave pattern at the **first harmonic** (fundamental frequency)? [3 marks]

(iii) The frequency of the string when a standing wave pattern is observed at the first harmonic is f_0 .

What will the value of the frequency be when the string is vibrating at the **third harmonic**?

Give your answer in terms of f_0 . [1 mark]

(iv) Complete the diagram below to show the standing wave pattern for the string at the **third harmonic**. [1 mark]



(v) The length of the string between the fixed ends is measured to be 1.26 m.

Calculate the wavelength of the standing wave for the **third harmonic**. [1 mark]

Wavelength = _____ m

(vi) Nodal and antinodal positions are observed along the standing wave pattern on the string.

What is meant by the term **node**? [1 mark]

(vii) Label all nodes **N** and antinodes **A** on the diagram drawn in **(iv)**. [1 mark]

- 5 Employers must provide hearing protection for employees if they are likely to be exposed to loud sounds.

The decibel level (intensity level) above which workers must not be exposed is 87 dB.

- (i) What is meant by the term **sound intensity**?
[2 marks]

- (ii) The decibel level of the sound experienced by an employee operating a piece of machinery is 112 dB.

Calculate the intensity of this sound. **Give your answer to four decimal places.** [3 marks]

Show your working out.

Intensity = _____ Wm^{-2}

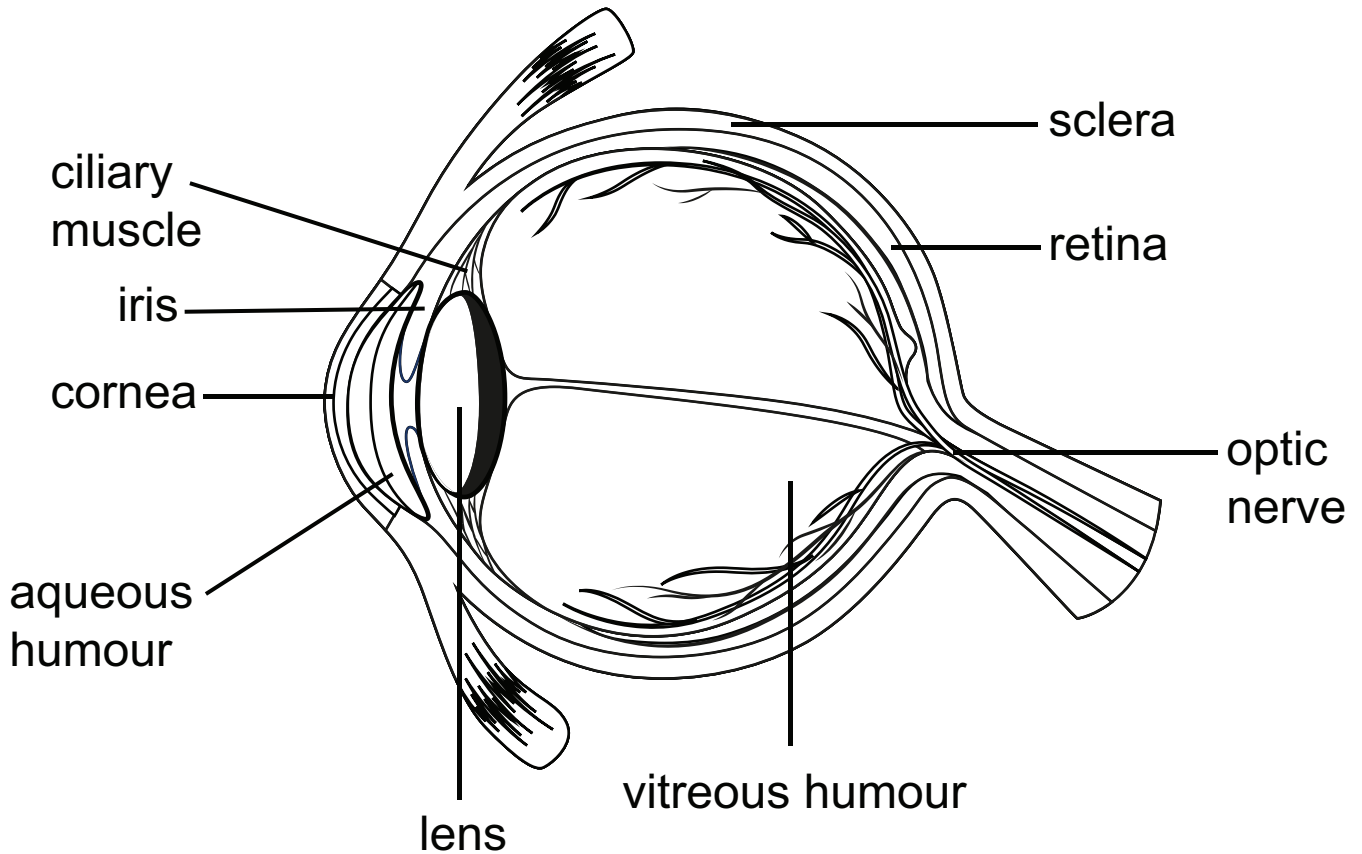
(iii) Disposable ear plugs reduce the intensity of the sound reaching the ear by 0.1576 Wm^{-2} .

The decibel level (intensity level) above which workers must not be exposed is 87 dB.

By performing a suitable calculation, evaluate if disposable ear plugs are suitable ear protection for this machinery. [5 marks]

Show your working out

6 The following diagram shows a human eye.



(a) (i) Retinal damage can occur if too much light enters the eye.

State the part of the eye which controls the amount of light reaching the retina.

Discuss how the amount of light reaching the retina is controlled. [2 marks]

(ii) The aqueous humour performs two functions in the eye.

Describe these two functions. [2 marks]

1. _____

2. _____

(b) Laser eye surgery can be performed on the cornea to improve long-sightedness.

(i) What is meant by the term **long-sightedness**?
[1 mark]

(ii) During laser eye surgery the cornea shape is changed.

Circle the correct statement to indicate what happens to the cornea during laser surgery to correct long-sightedness. [2 marks]

Explain your answer.

The cornea is made more curved

The cornea is made less curved

Explanation _____

(c) The maximum power of an eye lens is 18.1 D.

Calculate the focal length of this lens. [3 marks]

Show your working out.

Focal length = _____ m

7 Spectacle lenses can be used to correct eyesight problems.

An experiment was carried out to measure the focal length of a spectacle lens.

The object distance, u , from the lens and image distance, v , from the lens were recorded.

The table below shows the three sets of readings taken during the experiment.

- (i) Complete the table by inserting the missing units in the table headings and calculating the missing values for $\frac{1}{u}$ and $\frac{1}{v}$. [3 marks]

All calculations should be completed to **3 significant figures**.

u / m	v / m	$\frac{1}{u} / \text{_____}$	$\frac{1}{v} / \text{_____}$
0.600	1.708		
0.750	1.092		
1.000	0.795		

(ii) Use the values in the table to show that a reliable value for the focal length of the spectacle lens is approximately 44.3 cm. [5 marks]

Show your working out.

(iii) When the spectacle lens in (ii) is worn, the wearer can comfortably read a book when it is placed at the normal near point which is 25.0 cm from the eye.

Calculate the distance the book would have been placed in front of the eye for the reader to see clearly **before** the spectacle lens was worn. [4 marks]

Show your working out.

Distance = _____ cm

(iv) The reader in (iii) looks up from the book.

What is the furthest distance from his eye he can clearly see with the spectacle lens still in place? [2 marks]

Explain your answer.

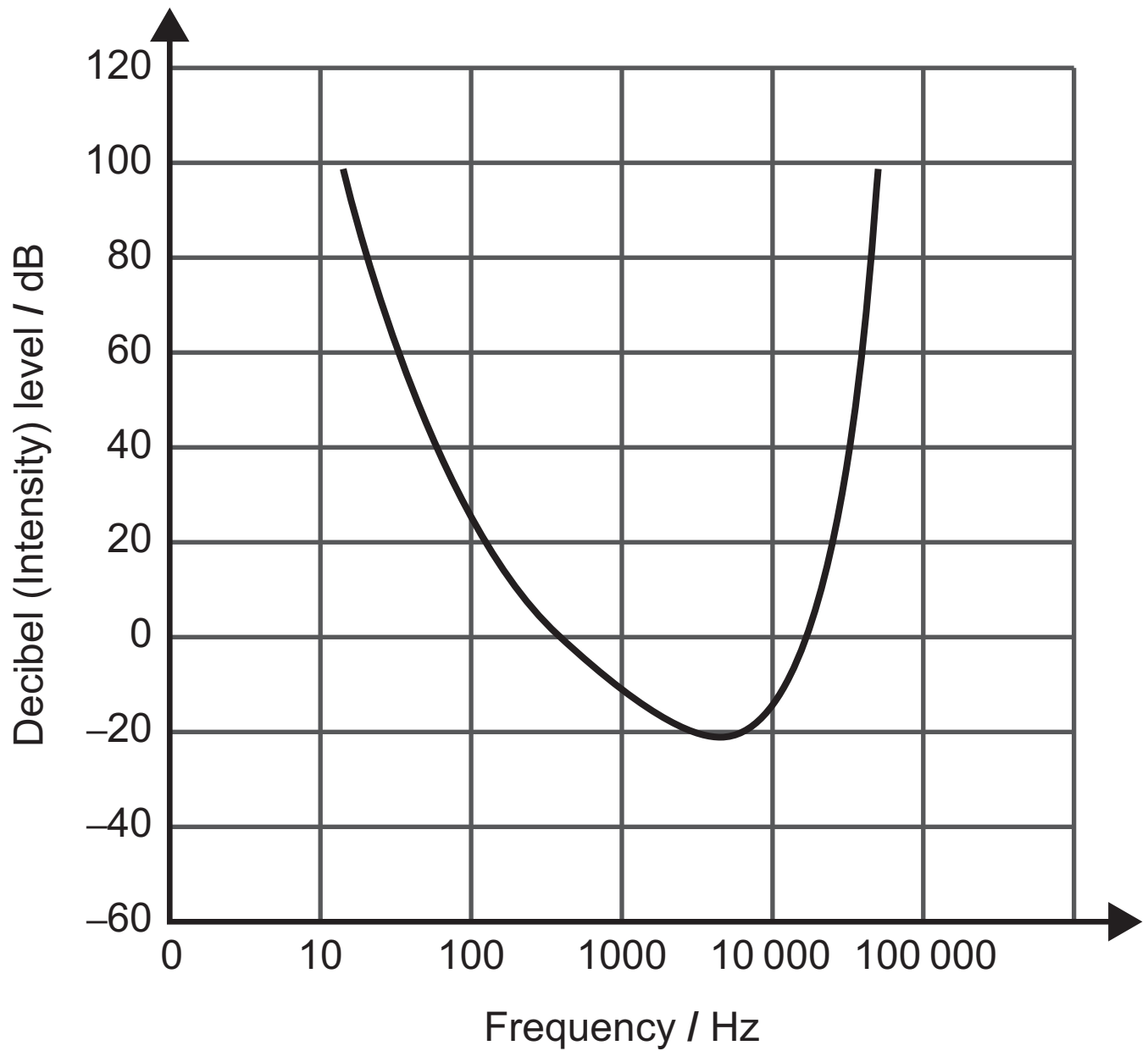
Distance _____ cm

Explanation _____

Blank Page
(Questions continue overleaf)

- 8 (a) The graph below shows the intensity response against sound frequency for dogs.

The frequency scale is logarithmic.



- (i)** The audible frequency range for a normal human ear is 20 Hz to 20 kHz.

How does the audible frequency range for dogs compare to that of a normal human ear? [2 marks]

You do not need to write values for the frequency range of the dog.

- (ii)** State the threshold intensity level of hearing for a normal human ear and compare this to the threshold of hearing for dogs. [2 marks]

(b) The human ear is divided into three interconnected sections: the outer, middle and inner ear.

- (i)** List the main parts of the outer ear. [2 marks]

- (ii)** Which part of the middle ear connects to the oval window? [1 mark]

9 (a) (i) Loudness is subjective.

What does this mean? [1 mark]

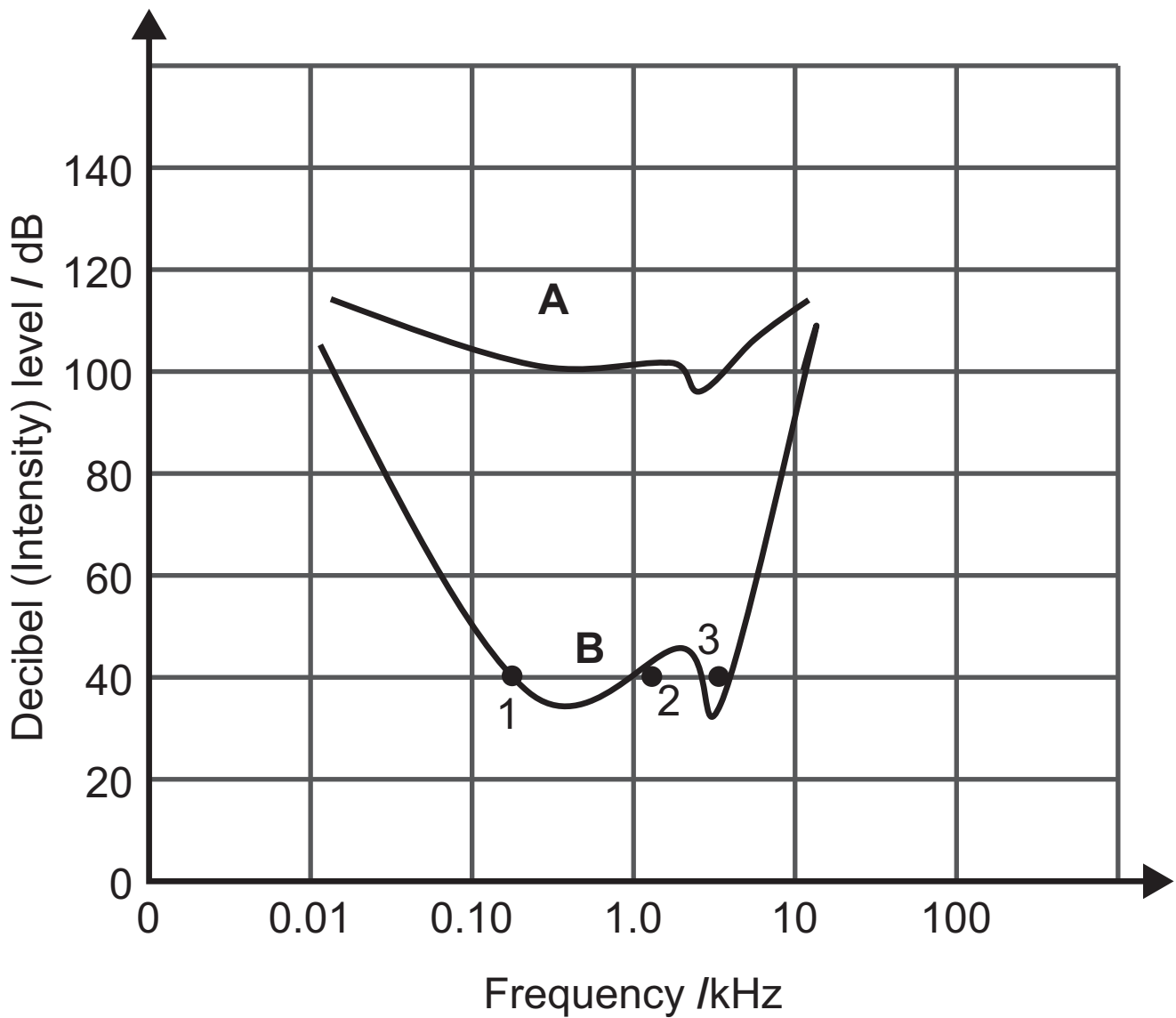
(ii) Suggest a reason relating to the structure of the ear which would account for loudness being subjective. [1 mark]

(iii) Loudness is measured in phons.

What is the frequency of the standard source against which the loudness of an unknown sound is established? [1 mark]

Frequency = _____ Hz

(b) The graph below shows two equal loudness curves for a normal ear.



(i) Use the graph to determine the value of loudness in phons for curve **A**. [1 mark]

Loudness of A = _____ phons

(ii) Explain in detail the significance of the dip in both of the equal loudness curves at approximately 3 to 4 kHz. [2 marks]

(iii) What is the difference in the ear's response for the equal loudness curves **A** and **B**? [2 marks]

(iv) On the graph on page 28, points 1, 2 and 3 represent sounds which have the same decibel (intensity) level, but not the same loudness.

Put the sounds in order of loudness starting with the loudest and finishing with the quietest. [3 marks]

Explain your answer.

Order _____

Explanation _____

This is the end of the question paper

SOURCES

Q4(c) . . . © *Principal Examiner*

Q6 © *Getty Images*

Q8(a) . . . © *Principal Examiner*

Q9(b) . . . © *Principal Examiner*

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total Marks	

Examiner Number

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA will be happy to rectify any omissions of acknowledgement in future if notified.