OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

APPLIED SCIENCE

Working Waves

G635

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)

Wednesday 9 June 2010
Morning

Duration: 1 hour 30 minutes

OCE/11704

G6351

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 A sound engineer uses his computer to display the waveform produced by different sources of sound.

(a) Sketch graphs of displacement against time for each of the following. No scale is required.

(i) A pure note such as that produced by a tuning fork.

[2]

(ii) The random sound produced on a radio by electrical noise.

[1]

(b) Describe one difference and one similarity the engineer might notice between the waveforms of

- a pure note such as that produced by a tuning fork
- a single note played by a musical instrument for several seconds.

difference .....

.....

.....

similarity .....

.....

..... **[2]**

(c) The engineer is researching using the internet. He sees a number of advertisements and articles.

(i) An advertisement for an electronic device that claims to produce polarised sound. State why this claim is incorrect.

.....

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

(ii) An advertisement for a device that produces polarised light.

1 How can light be polarised?

.....

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

2 Draw diagrams to show the difference between polarised and unpolarised light.

polarised

unpolarised

[2]

(iii) An offer for a material that will slow light down to two thirds of its speed in air. What might this material be?

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

(iv) An article about radio signals sent across the world by satellite. One problem with such signals is the time delay caused by the large distances involved. It is suggested in the article that this delay could be halved by doubling the frequency and therefore doubling the speed of the signal. Explain why this would not work.

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..... **[2]**

[Total: 12]

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2 **(a)** Referees and umpires increasingly use technical devices to determine the exact position of a ball used in a game. Thermal imaging can be used to confirm that a bat has hit a ball.

Suggest how thermal imaging can be used to confirm that a bat has hit a ball.

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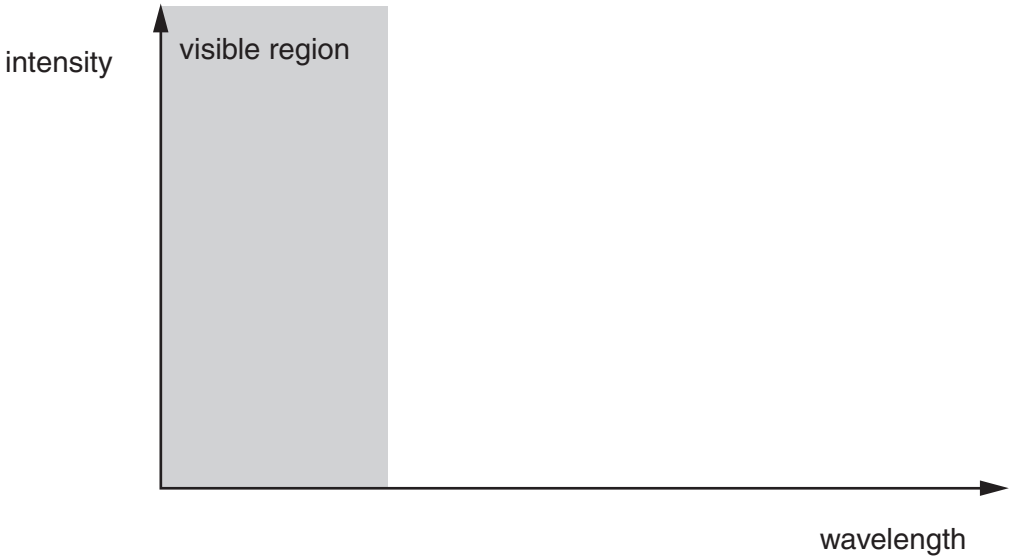
..... **[4]**

(b) A thermal imaging camera was tested by pointing it at a metal plate that was heated through a range of temperatures.

(i) On the axes below, sketch graphs to show the variation of intensity with wavelength for the radiation emitted by the plate

- at room temperature. Label this curve **room**.
- at a warmer temperature. Label this curve **warm**.
- when red-hot. Label this curve **red-hot**.

No numerical scale is required



[5]

(ii) Suggest what happens to the radiation emitted by the plate if it is heated to a much higher temperature than red-hot.

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..... **[2]**

(c) **(i)** Apart from use in sport, state one other use of thermal imaging cameras.

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

(ii) Compare and explain the differences between the images produced by a thermal imaging camera and a visible light camera for your application in **(c)(i)**.

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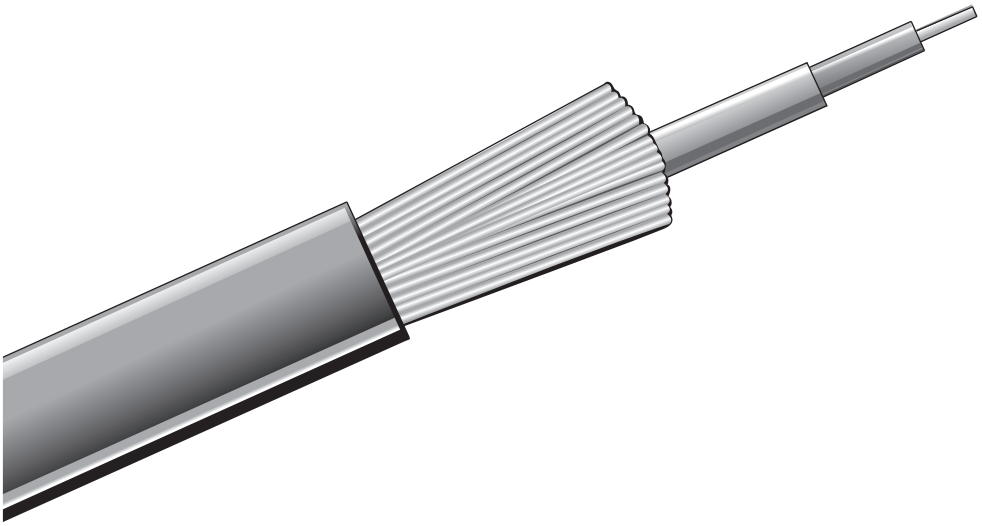
..... **[3]**

[Total:15]

3 The information below is taken from a newspaper article on optical fibres.



(a) Fill in the missing words.

As the light passes along the core it undergoes a process called .... reflection. This occurs because the ..... index of the core is greater than that of the cladding.

Plastic optical fibres are used in industrial and automotive applications. Long-haul telecommunications networks use all-glass optical fibres as these provide the greatest ..... .

Multimode optical fibres have core diameters of the order of ..... μm. These allow the use of cheaper LED light sources and work over distances up to 2000 m.

Monomode optical fibres have the highest possible bandwidths. However, the core diameters are of the order of ..... μm and launching light into such a small area is expensive requiring the use of semiconducting lasers. This cost is acceptable when the ends of the optical fibre are many kilometres apart in different towns. **[5]**

(b) Lasers used in telecommunications produce infrared radiation.

(i) Which **one** of the following is a wavelength for infrared radiation?
Circle the correct value.

1.4 nm 1.4 µm 1.4 cm 1.4 km **[1]**

(ii) Calculate the frequency corresponding to your answer to **(b)(i)**.
Velocity of electromagnetic waves in air = $3.0 \times 10^8\,m\,s^{-1}$

..... Hz **[3]**

(c) Use the information given in the newspaper article in **(a)** to explain why

(i) laser sources and monomode fibres are not used for local networks within a building

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..... **[2]**

(ii) laser sources and monomode fibres are used for optical cables connecting different towns.

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..... **[2]**

(d) **(i)** Label the boxes in Fig. 3.1 and draw the paths of rays to show how light is transmitted down multimode fibres:

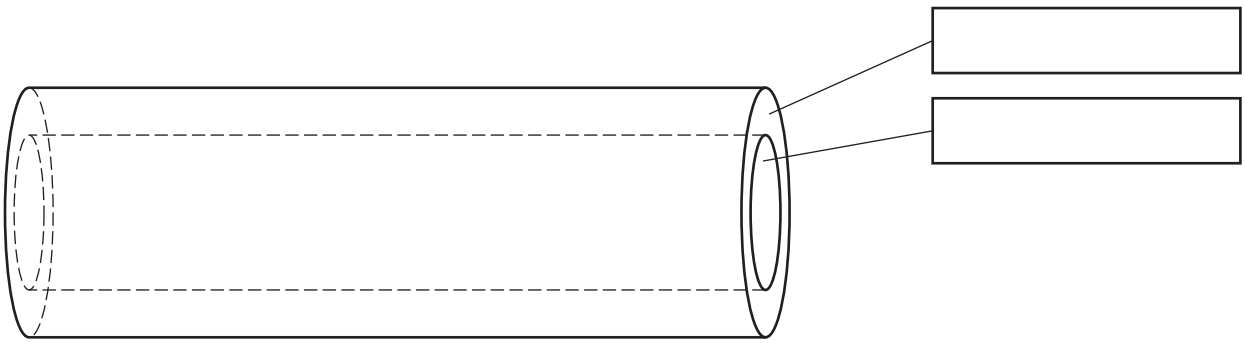

Fig. 3.1

[4]

(ii) In Fig. 3.2 draw the path of a ray to show how light is transmitted down a monomode fibre:

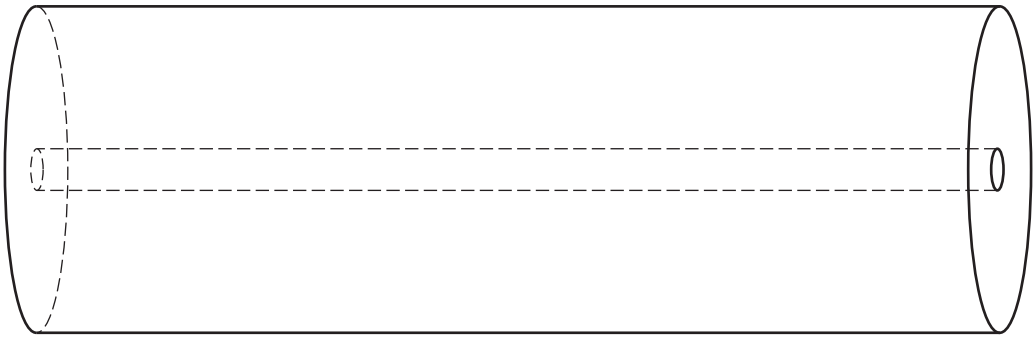

Fig. 3.2

[1]

(e) Another type of optical fibre is a graded-index fibre.
Discuss the advantage of graded-index fibres compared to step-index fibres.

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..... **[6]**

[Total: 24]

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4 If you have an analogue radio it may have a switch labelled MW/LW/FM.

Figs. 4.1 and 4.2 illustrate the principles of two ways in which analogue radio waves are modulated to carry sound.

(a) For each diagram name the type of modulation illustrated.

(i) Fig. 4.1 = ... modulation. **[1]**

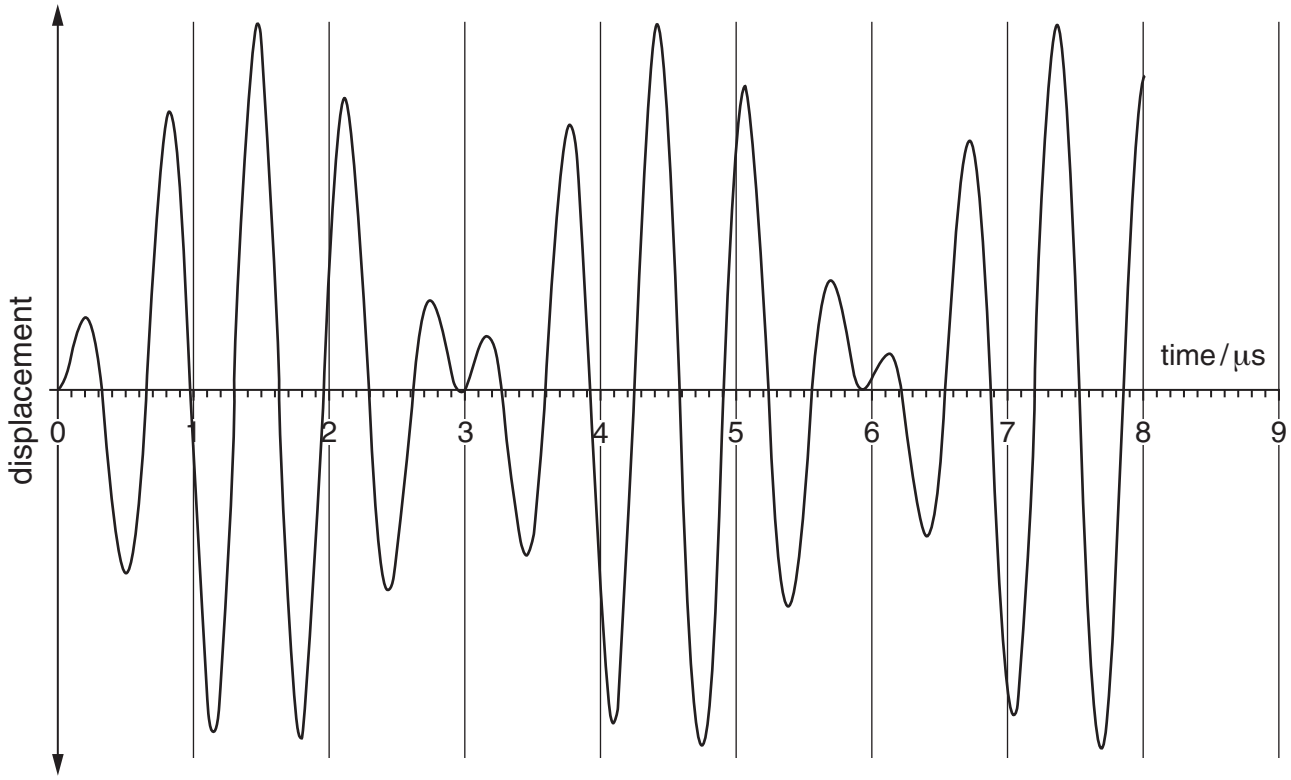

Fig. 4.1

(ii) Fig. 4.2 = ... modulation. **[1]**

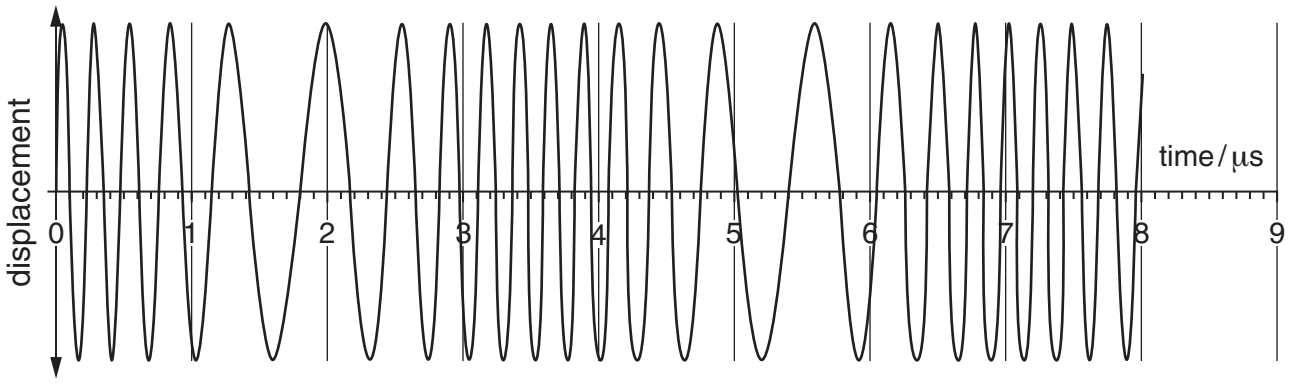

Fig. 4.2

(b) (i) Find the frequency of the **carrier** (radio) wave in Fig. 4.1.

You should record appropriate measurements.

measurements .....

.....

From your measurements calculate the frequency.

frequency = ... unit ..... **[4]**

(ii) The period of a wave is the time taken for one complete cycle.
Find the period of the **modulating sound** wave in Fig. 4.1.

period = ... unit ..... **[2]**

(c) State one advantage and one disadvantage of using digital radio transmissions compared with the types of modulation shown in Figs. 4.1 and 4.2.

advantage .....

.....

disadvantage .....

..... **[2]**

[Total: 10]

5 Ahmed is considering upgrading his internet connection so that he can download videos.

(a) Dial-up connections provide relatively slow speed of internet data transmission.
Broadband allows greater speed of transmission even though it uses the same telephone wires.
Suggest why.

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..... **[3]**

(b) Ahmed sees an advertisement offering even faster downloading of videos than is possible using ordinary copper-wire phone lines.

(i) State what kind of connection is used by this advertiser instead of conventional phone lines.

.....

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

(ii) State why this connection offers faster downloading.

.....

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

(iii) State why Ahmed might find that this service is not available to his home.

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

[Total: 6]

6 Amina's mobile phone indicates the signal strength by the number of aerial symbols on the phone display.

(a) As she rides into town on the bus she notices that the signal strength gradually increases. Suggest why the signal strength increases as Amina approaches town.

.....

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

(b) The signal strength 8 km from a tall building near the centre of town is a quarter of the signal strength 4 km from that building.
Suggest the significance of the tall building and the type of relationship (law) between signal strength and distance this demonstrates.

significance of the tall building .....

.....

.....

relationship .....

.....

..... **[2]**

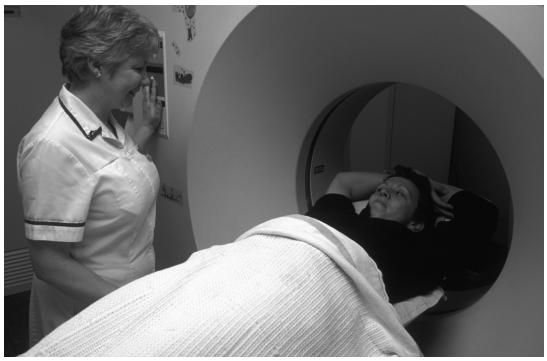
(c) The signal strength always drops on one particular stretch of road near town.
Suggest a likely reason for this.

.....

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

[Total: 4]

7 **(a)** After Mary broke her arm while ice skating, a radiologist at the hospital examined a conventional X-ray image of the bone.
Some years later, Mary suffered from a problem with her liver so she was sent for a CAT scan.



(i) Describe the **physical** movements that the full-body CAT scanner makes while the image is being taken.

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..... **[2]**

(ii) Describe and explain how the production of images by a CAT scanner differs from the production of a conventional X-ray image.

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..... **[5]**

(b) When Mary went for the CAT scan, she was warned in advance that she would have to stay very still while data was collected. Suggest why this was necessary.

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

(c) While in the waiting room, Mary met a patient who was going to be examined using a γ-camera to obtain images of part of his body.
Describe the principles of the γ-camera.

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..... **[5]**

(d) Technetium-99m is commonly used as a radioactive tracer.

(i) What is meant by the term *radioactive tracer*?

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

(ii) List five advantages of technetium-99m as a tracer.

1. .....

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2. .....

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3. .....

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4. .....

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5. .....

..... **[5]**

[Total: 19]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

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