Candidate forename		Candidate surname	

Centre number						Candidate number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

G635

APPLIED SCIENCE

Working Waves

WEDNESDAY 26 JANUARY 2011: Morning
DURATION: 1 hour 30 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Electronic calculator
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (NF/CGW) 11MEP01282 41731

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **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.**
- **Answer ALL the questions.**

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.**

Answer ALL the questions.

1 (a) Table 1.1 lists some devices. Identify the type of wave associated with each device and tick the right-hand column if the wave is part of the electromagnetic spectrum.

The first row is completed for you.

Table 1.1

device	type of wave	
thermal imaging camera	infrared	✔
ultrasonic scanner		
endoscope		
mobile telephone		
CAT scanner		
guitar		
radiotherapy equipment		

[7]

(b) Figs. 1.1 and 1.2 are two graphs representing the same sine wave. These are on separate sheets.

(i) Use the graphs to determine the following:

1 amplitude _____ unit _____ [2]

2 wavelength _____ unit _____ [2]

3 period _____ unit _____ [2]

(ii) Using the values from (b)(i), calculate the following.

Show your working.

1 frequency

_____ Hz [2]

2 speed

_____ $m\,s^{-1}$ [2]

(iii) On Fig. 1.2, draw one cycle of a wave with a phase lag of $\frac{1}{4}$ of a cycle behind the wave shown. [2]

(c) (i) State two ways in which visible light can be polarised.

1. _____

_____

2. _____

_____ **[2]**

(ii) Describe the directions of the electric and magnetic fields in a polarised light wave

1 relative to the wave direction (direction of propagation)

_____

_____

_____

_____ **[2]**

2 relative to each other.

_____

_____ **[1]**

(iii) Explain how your answers in (c)(ii) would differ if the light was not polarised.

_____

_____

_____

_____ **[2]**

[Total: 26]

2 (a) Explain what is meant by a *perfect black body*.

_____

_____

_____

_____ **[2]**

(b) (i) On the axes below, sketch TWO graphs of intensity against wavelength to show how the total radiation and spectrum of radiation given off by a black body varies with temperature.

[4]

(ii) Describe how the appearance of the black body radiator varies with temperature.

_____

_____

_____

_____

_____

_____ **[3]**

(c) Fire-fighters controlling bush fires in Australia use aircraft to observe the smoke and fires. They use thermal imaging cameras as well as high-definition visible-light cameras.

(i) Explain why the fire-fighters can see through the smoke using a thermal imaging camera but not using a high-definition visible-light camera.

_____

_____

_____

_____

_____

_____ **[3]**

(ii) Give one example of what the fire-fighters might be able to observe through the smoke using the thermal imaging camera.

_____

_____ **[1]**

(iii) Describe how two objects at different temperatures would appear on the screen of the thermal imaging camera.

_____

_____ **[1]**

(d) State and describe one other application of thermal imaging cameras.

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

[Total: 18]

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3 Optical fibres carry telephone conversations and computer signals. They do this by transmitting light. The light is kept within the fibres by a process called total internal reflection.

(a) (i) Fig. 3.1 shows three diagrams of a block of glass with rays arriving at the surface from inside the block. Angle a is equal to the critical angle of glass.

Continue the paths of the three rays.

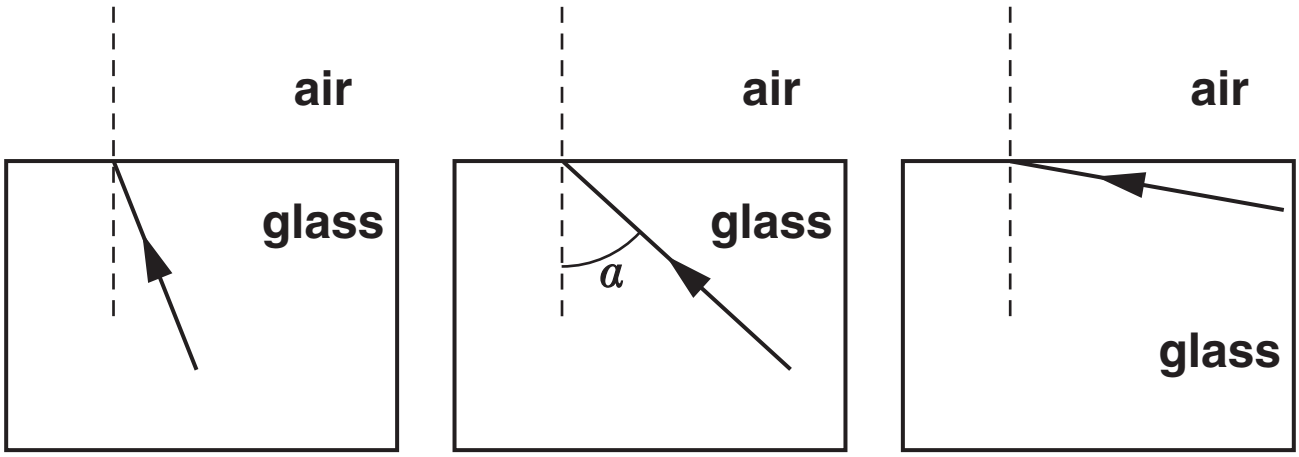

Fig. 3.1

[4]

(ii) Explain what is meant by *total internal reflection* and the condition under which it occurs.

_____

_____

_____

_____

_____

_____ **[3]**

(iii) State why total internal reflection is important in optical fibres.

_____

_____ **[1]**

(b) (i) Describe the structure of step-index optical fibres. You may illustrate your answer with the aid of a diagram.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[6]**

(ii) Describe how the structure of graded-index optical fibres differs from that of step-index optical fibres.

_____

_____

_____

_____ **[2]**

(iii) State and explain the advantage of using graded-index optical fibres, compared to step-index optical fibres, for long-distance data transmission. You may illustrate your answer with the aid of a diagram.

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

(c) Most domestic broadband connections use conventional telephone lines.

Explain why much faster data transmission rates are possible using broadband, compared to dial-up connections, using the same conventional telephone lines.

_____

_____

_____

_____

_____

_____ **[3]**

[Total: 23]

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4 The use of mobile telephones has grown rapidly in recent years so that we now rely on them for both business and social purposes.

(a) Sometimes it is not possible to contact another user because the signal strength is too low. State TWO possible reasons for low signal strength.

1. _____

_____

2. _____

_____ **[2]**

(b) A friend asks you why it is necessary to have many mobile phone masts, like the one in Fig. 4.1, scattered across the country. He suggests that it would be better to have one taller mast serving the whole of the UK.

Explain two reasons why this would not be possible.

1. _____

_____

_____

_____

_____

_____

2. _____

_____

_____

_____

_____

_____ **[6]**

[Total: 8]

Fig. 4.1

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5 A group of Applied Science students devise a card game to help them learn about various devices associated with X-ray and γ-ray imaging. Students have to collect a set of four cards associated with one particular device.

(a) Mark each card with a letter corresponding to the device to which it relates. Use the following letters:

- **'C' if the card is about use of a γ-camera**
- **'F' if the card is about use of an X-ray Filter**
- **'G' if the card is about use of a Grid**
- **'I' if the card is about use of an Image Intensifying Screen**

The first four cards have been completed for you.

TURN OVER FOR CARDS

C

γ-camera

F

X-ray filter

Made of lead

Uses fluorescent screens

Placed either side of film

Placed between source and patient

Improves quality by removing low frequencies

Reduces dose by converting energy to visible light

G **Grid**	I **Image intensifying screen**
☐ **Made of aluminium**	☐ **Includes a scintillator**
☐ **Placed between patient and film**	☐ **Detects radiation from source inside the patient**
☐ **Often used in conjunction with technetium-99m tracer**	☐ **Reduces blur by removing scattered rays**

[12]

(b) Identify the protection measures that may be taken in order to minimise the radiation dose received by staff working in X-ray imaging or radiotherapy treatment areas in hospitals.

_____

_____

_____

_____

_____

_____ **[3]**

[Total: 15]

END OF QUESTION PAPER

ADDITIONAL PAGES

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

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