

**ADVANCED GCE**  
**APPLIED SCIENCE**  
Working Waves

**G635**

Candidates answer on the question paper.

**OCR supplied materials:**

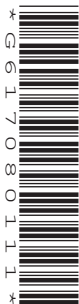
None

**Other materials required:**

- Electronic calculator
- Ruler (cm/mm)

**Wednesday 26 January 2011**  
**Morning**

**Duration: 1 hour 30 minutes**




Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the boxes above. 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.
- Do **not** write in the bar codes.

**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 **16** pages. Any blank pages are indicated.

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.

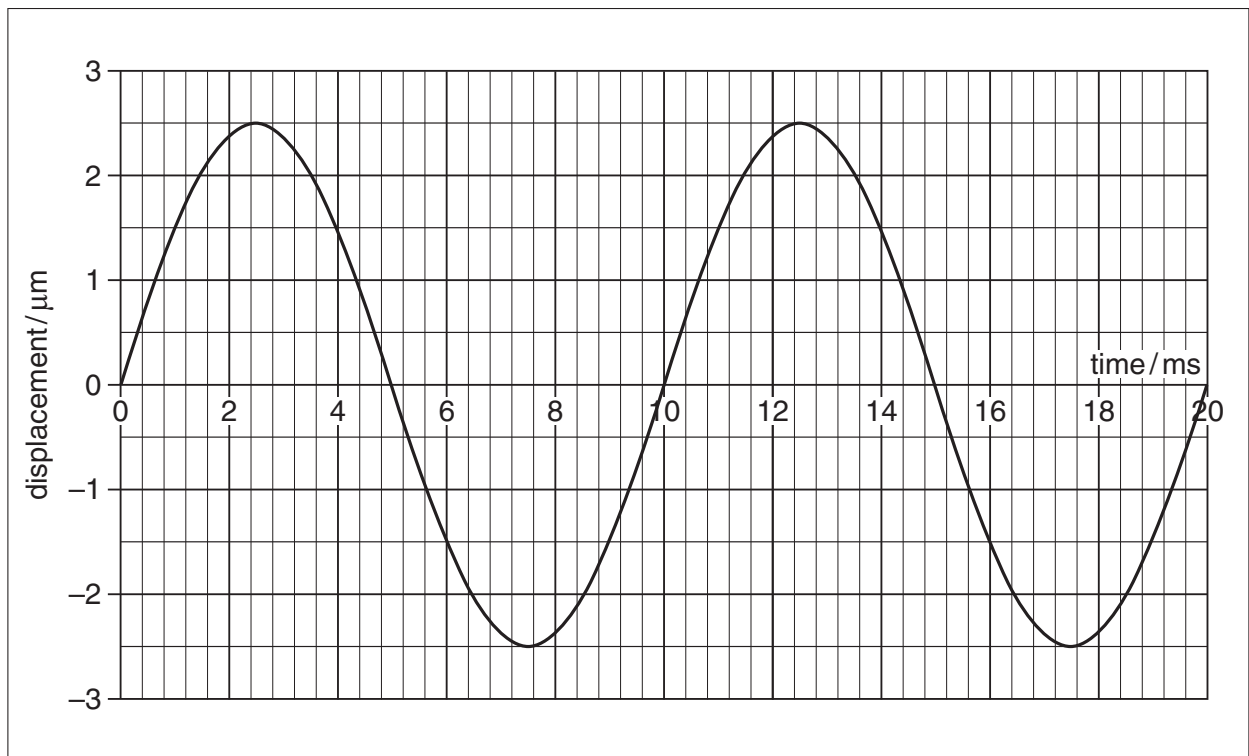
The first row is completed for you.

**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.



**Fig. 1.1**

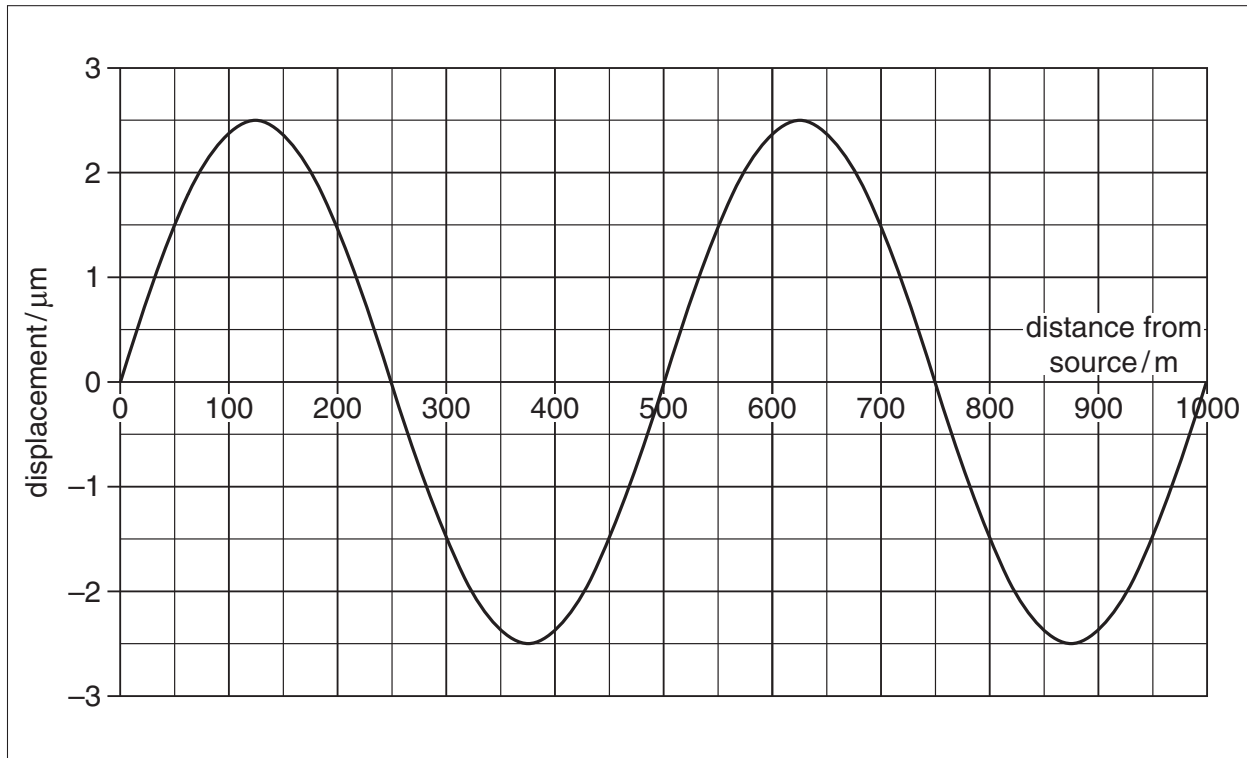


Fig. 1.2

(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

.....  $\text{ms}^{-1}$  [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.

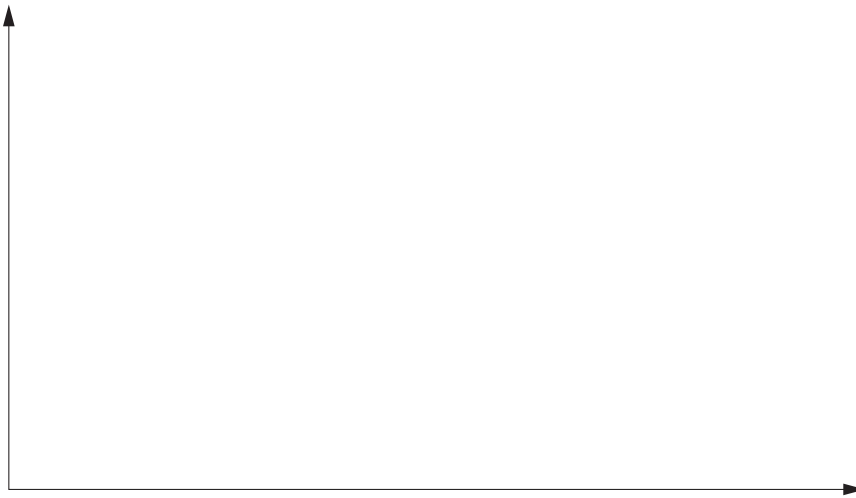
- .....  
.....  
.....  
..... [2]

[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.

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.....  
.....  
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.....  
..... [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.

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..... [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.

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

[Total: 18]

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  $\alpha$  is equal to the critical angle of glass.

Continue the paths of the three rays.

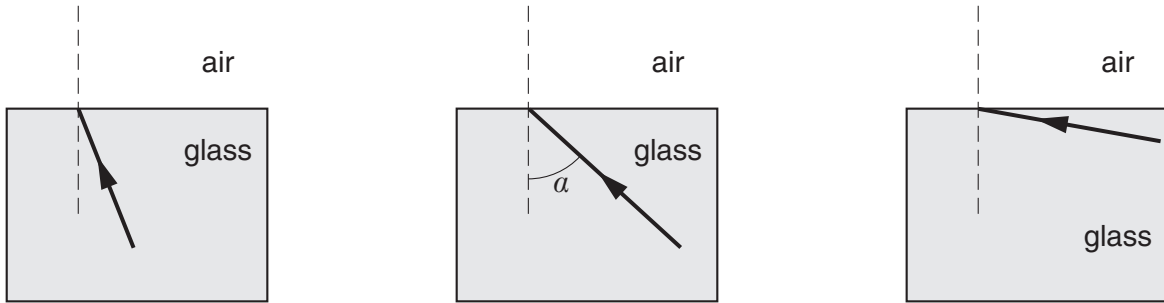


Fig. 3.1

[4]

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

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[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.



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.....  
..... [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.

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..... [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.

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..... [3]

[Total: 23]

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. ....  
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  - 2. ....  
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- [6]

[Total: 8]



**Fig. 4.1**

- 5 A group of Applied Science students devise a card game to help them learn about various devices associated with X-ray and  $\gamma$ -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  $\gamma$ -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.

<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em; font-weight: bold;">C</span> .....         </div> <p><math>\gamma</math>-camera</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em; font-weight: bold;">F</span> .....         </div> <p>X-ray filter</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em; font-weight: bold;">G</span> .....         </div> <p>Grid</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em; font-weight: bold;">I</span> .....         </div> <p>Image intensifying screen</p> </div>
<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Made of lead</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Uses fluorescent screens</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Made of aluminium</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Includes a scintillator</p> </div>
<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Placed either side of film</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Placed between source and patient</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Placed between patient and film</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Detects radiation from source inside the patient</p> </div>
<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Improves quality by removing low frequencies</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Reduces dose by converting energy to visible light</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Often used in conjunction with technetium-99m tracer</p> </div>	<div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <span>.....</span> </div> <p>Reduces blur by removing scattered rays</p> </div>

(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.

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..... [3]

[Total: 15]

**END OF QUESTION PAPER**





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