

**ADVANCED GCE
 APPLIED SCIENCE**

G635

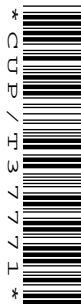
Unit 16: Working Waves

FRIDAY 25 JANUARY 2008

Morning

Time: 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials: Electronic calculator
 Ruler (cm/mm)



Candidate Forename

Candidate Surname

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or 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.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	20	
2	13	
3	25	
4	13	
5	19	
TOTAL	90	

This document consists of **16** printed pages.

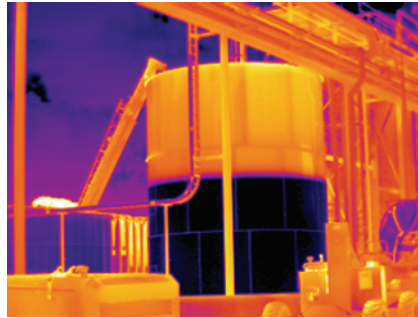
Answer **all** the questions.

- 1 Thermal imaging cameras are used in industry to monitor objects that would otherwise not be visible. For example, at Snodkins Plastics, the level of liquids in storage tanks is monitored this way.

A storage tank is shown in Fig. 1.1. The liquid inside the tank cannot be seen. Fig. 1.2 shows an image of the same tank taken using a thermal imaging camera.



Fig. 1.1



Courtesy Infrared Training Center, FLIR Systems, Inc.

Fig. 1.2

- (a) Using Fig. 1.2, explain how the liquid in the tank can be seen using thermal imaging.

.....

[2]

- (b) Thermal imaging cameras are also used in industry for preventative maintenance (i.e. looking for signs of problems so that they can be put right in good time). Suggest **one** example of such an application and explain the part played by thermal imaging.

application

explanation

.....
[3]

- (c) Snodkins Plastics employs a photographer to photograph samples of their products for publicity purposes. He uses a special photographic light bulb when taking pictures in the studio. Fig. 1.3 shows the hot-body spectrum for one of these light bulbs at a temperature of 4300 K.

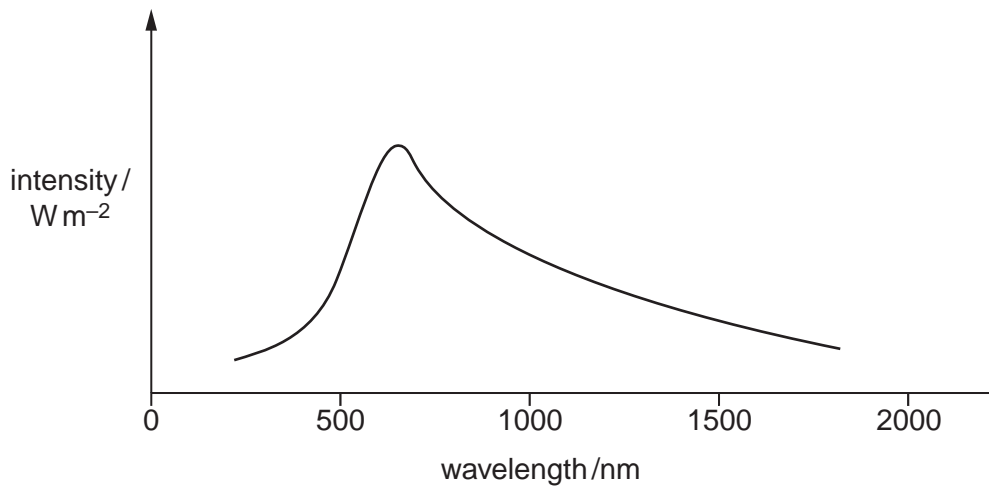


Fig. 1.3

- (i) From the graph, estimate the wavelength at which the peak intensity occurs for the special photographic light bulb. Give your answer in metres.

$$1 \text{ m} = 10^9 \text{ nm}$$

$$\text{wavelength} = \dots\dots\dots \text{ m} \quad [2]$$

- (ii) Use your answer to (i) to calculate the frequency corresponding to your measured wavelength.

Give your answer to two significant figures.

Include the correct unit in your answer.

$$\text{velocity of light} = 3.0 \times 10^8 \text{ m s}^{-1}$$

$$\text{frequency} = \dots\dots\dots \text{ unit } \dots\dots\dots [5]$$

(iii) The velocity of light in air = $3.0 \times 10^8 \text{ ms}^{-1}$. Compare this value with:

1. the velocity of light in a vacuum
[1]

2. the velocity of infrared radiation in air.
[1]

(iv) 1. State **one** region of the electromagnetic spectrum that occurs to the **left** of the line drawn in Fig. 1.4.
[1]

2. State **one** region of the electromagnetic spectrum that occurs to the **right** of the line drawn in Fig. 1.4.
[1]

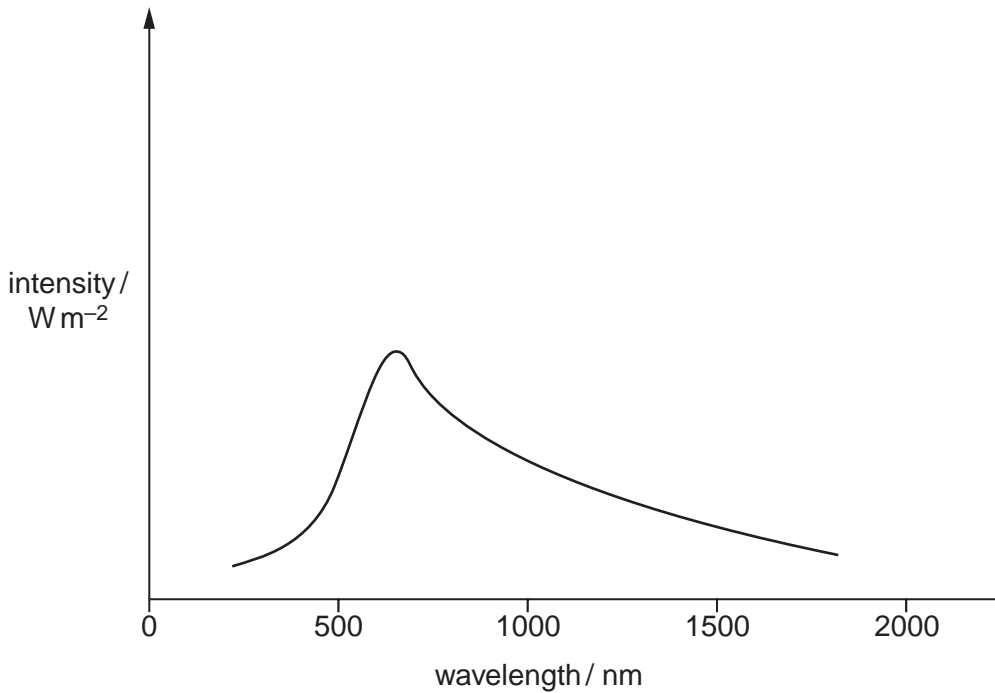


Fig. 1.4

(d) Fig. 1.4 is the same as Fig. 1.3, showing the hot-body spectrum for a special photographic light bulb.

(i) On Fig 1.4 sketch the corresponding spectrum for an ordinary light bulb at a temperature of 3000 K. Label this line '**bulb**'. [2]

(ii) On Fig. 1.4 sketch the corresponding spectrum for the sun at a temperature of 5800 K. Label this line '**sun**'. [2]

[Total: 20]

2 Polaroid ® is the trade name for a material used in sunglasses. Polaroid ® polarises light passing through it.

(a) Explain, with the aid of a diagram, the difference between unpolarised light and polarised light.

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

(b) Reflected light is polarised. Polaroid ® sunglasses were once advertised with the slogan 'reduce reflected glare'. Explain why Polaroid ® is particularly effective at blocking reflected light.

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

- (c) Photographers sometimes attach a Polaroid® filter to the front of their cameras. The filter can be rotated.

Fig. 2.1, 2.2 and 2.3 show pictures of the same scene. One picture is taken without the Polaroid® filter. The other two are taken with the filter rotated to different positions.



© J Bull/OCR

Fig. 2.1



© J Bull/OCR

Fig. 2.2



© J Bull/OCR

Fig. 2.3

(i) Identify the picture that was taken with the filter positioned to minimise reflected glare.

.....[1]

(ii) Explain how you have identified this picture.

.....[1]

(iii) The two pictures taken **with** the filter are different from each other. Explain the reason for this difference.

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

(d) State and explain whether the following can be polarised

(i) sound waves

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

(ii) microwaves.

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

[Total: 13]

- 3 An electrical instrument manufacturer decides to illuminate an instrument panel by a set of optical fibres that all start at a single light bulb and are then bent round to different parts of the panel. This is illustrated in Fig. 3.1.

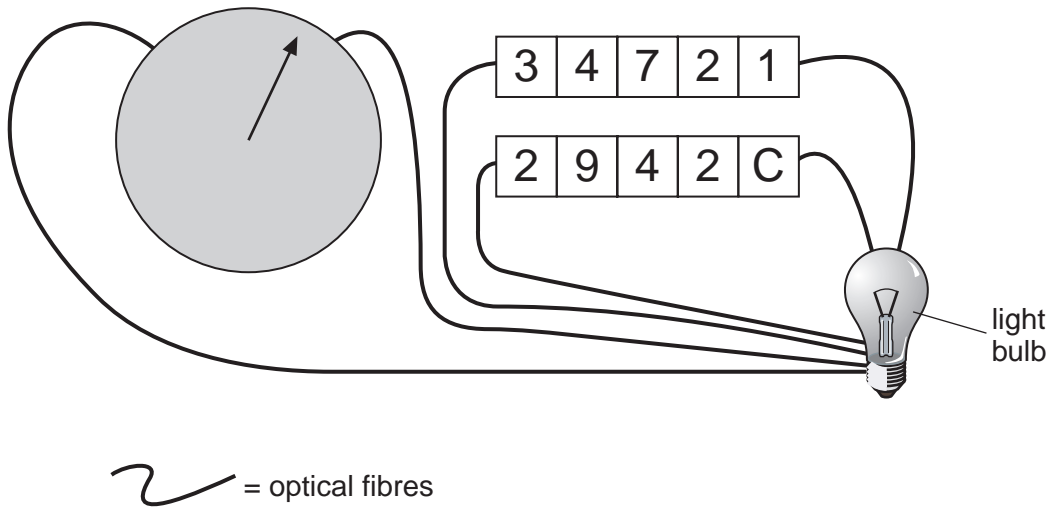


Fig. 3.1

- (a) State **two** materials from which optical fibres are commonly made.

1

2 [2]

- (b) Most of the light entering each fibre emerges at the other end. Explain why little, or none of the light, emerges through the sides of the fibre.

In this section, 1 mark is available for spelling, punctuation and grammar.

.....

 [3]

QWC [1]

(c) The manufacturer considers an alternative arrangement using incoherent bundles of fibres instead of a single fibre leading to each location on the panel.

(i) State what is meant by an incoherent bundle of fibres.

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

(ii) Give a reason why the manufacturer chooses incoherent bundles of fibres rather than coherent bundles and explain why they are satisfactory for this application.

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

(d) At a conference, the manufacturer's research director meets staff from other companies who use coherent bundles of fibres in their products.

(i) Give an example of an application where a coherent bundle of fibres **must** be used.

.....[1]

(ii) Explain why it is necessary to use a coherent bundle in an application such as your answer to (i).

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

(e) On returning from the conference, the research director considers replacing the uncoated fibres in the instrument panel with step-index fibres.

(i) Describe the construction of a step-index optical fibre.

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

(ii) Explain why step-index fibres are more effective than uncoated fibres.

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

(f) A work experience student in the research department is asked to measure the refractive index of a rectangular block.

(i) Write a set of instructions that the student might be given. Your answer should include a diagram, method, measurements to be taken and how the student should process her results.

In this section, 1 mark is available for a clear, ordered answer.

.....
.....
.....
.....
.....[7]

QWC [1]

(ii) State what the student might do to minimise errors.

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

[Total: 25]

4 An advertisement for a mobile phone states:

The 'Dumo' is a dual-mode mobile phone. It works as a dual-band GSM phone as well as a 3G phone so it works with your own SIM card on any network.

(a) (i) What is meant by 'dual-mode'?

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

(ii) What is meant by 'dual-band'?

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

(b) (i) State what the letters GSM stand for.

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

(ii) State which cellular access technology is used as the standard in GSM.

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

(iii) Name **one** alternative cellular access technology.

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

(iv) Complete the table below to describe the cellular access technologies in your answers to (ii) and (iii).

Standard cellular access technology	Alternative cellular access technology
.....
.....
.....
.....
.....
.....
.....

[4]

(c) Give **two** factors that may affect mobile phone signal strength.

1

2 [2]

- (d) Communication systems are used to transfer information data as well as voice transmission. ASCII code is commonly for this purpose.

Complete Table 4.1 using the binary codes given in Table 4.2.

(
P							
C							
M							
)							

Table 4.1

Char	Binary	Char	Binary	Char	Binary	Char	Binary
Space	0100000	8	0111000	P	1010000	h	1101000
!	0100001	9	0111001	Q	1010001	i	1101001
"	0100010	:	0111010	R	1010010	j	1101010
#	0100011	;	0111011	S	1010011	k	1101011
\$	0100100	<	0111100	T	1010100	l	1101100
%	0100101	=	0111101	U	1010101	m	1101101
&	0100110	>	0111110	V	1010110	n	1101110
'	0100111	?	0111111	W	1010111	o	1101111
(	0101000	@	1000000	X	1011000	p	1110000
)	0101001	A	1000001	Y	1011001	q	1110001
*	0101010	B	1000010	Z	1011010	r	1110010
+	0101011	C	1000011	[	1011011	s	1110011
,	0101100	D	1000100	\	1011100	t	1110100
-	0101101	E	1000101	]	1011101	u	1110101
.	0101110	F	1000110	^	1011110	v	1110110
/	0101111	G	1000111	_	1011111	w	1110111
0	0110000	H	1001000	`	1100000	x	1111000
1	0110001	I	1001001	a	1100001	y	1111001
2	0110010	J	1001010	b	1100010	z	1111010
3	0110011	K	1001011	c	1100011	{	1111011
4	0110100	L	1001100	d	1100100	|	1111100
5	0110101	M	1001101	e	1100101	}	1111101
6	0110110	N	1001110	f	1100110	~	1111110
7	0110111	O	1001111	g	1100111		

Table 4.2

[2]

[Total: 13]

5 Following a road traffic accident, a motorcyclist is taken to the radiography department of her local hospital. The radiography department uses X-rays and γ -rays for imaging.

(a) The motorcyclist's leg is X-rayed. Explain why the motorcyclist's bones show up on the X-ray image more clearly than soft tissue.

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

(b) X-rays have harmful effects.

(i) The motorcyclist is pregnant, but the doctor still recommends that an X-ray is needed.

Suggest what special precaution a radiographer might take with this patient.

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

(ii) Suggest **two** actions the radiographer might take to protect himself.

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

(c) How do X-rays damage cells?

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

(d) The radiographer also operates a CAT scanner. CAT scanners can produce much more detailed information than conventional X-ray machines. Explain why.

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

- (e) X-rays and γ -rays are not only used diagnostically. Describe and explain a medical non-diagnostic use of these radiations.

.....

.....

.....

.....[3]

[Total: 19]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

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