OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **G635**

APPLIED SCIENCE

Unit 16: Working waves

WEDNESDAY 11 JUNE 2008 Morning

Time: 1 hour 30 minutes

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

CUP/T37772

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.
- 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	**23**	
3	**16**	
4	**13**	
5	**18**	
TOTAL	**90**	

This document consists of **15** printed pages and **1** blank page.

[Turn over

Answer **all** the questions.

1 **(a)** A police team entered the ground floor of a house where a gunman was believed to be hiding. They used a thermal imaging camera to scan each room prior to entry. After the main area of the house was secured, officers pulled down the attic ladder. An officer raised the thermal imager into the loft. He methodically scanned 360 degrees of the room, without actually entering it.

(i) State **two** advantages of using a thermal imaging camera in this situation.

1. .....

2. ..... [2]

(ii) Suggest the approximate temperature to which the police thermal imaging camera needs to be sensitive in **this** application.

approximate temperature ..... °C [1]

(iii) Suggest the approximate temperature range that police thermal imaging cameras are designed to work at for a **range** of police applications. Explain your answer.

temperature range, from ..... °C to ..... °C

explanation .....

.....

..... [4]

(b) Thermal imaging cameras used by the fire service are not best suited for police use. Fire service cameras are typically designed to operate between 150 °C and 600 °C. Suggest why fire service thermal imaging cameras are designed in this way.

.....

..... [1]

(c) Fig. 1.1 shows the hot-body spectrum for a person.

(i) On Fig. 1.1 sketch the corresponding spectrum for the wall of a house. Label this line '**wall**'. [2]

(ii) On Fig. 1.1 sketch the corresponding spectrum for a bonfire. Label this line '**bonfire**'. [2]

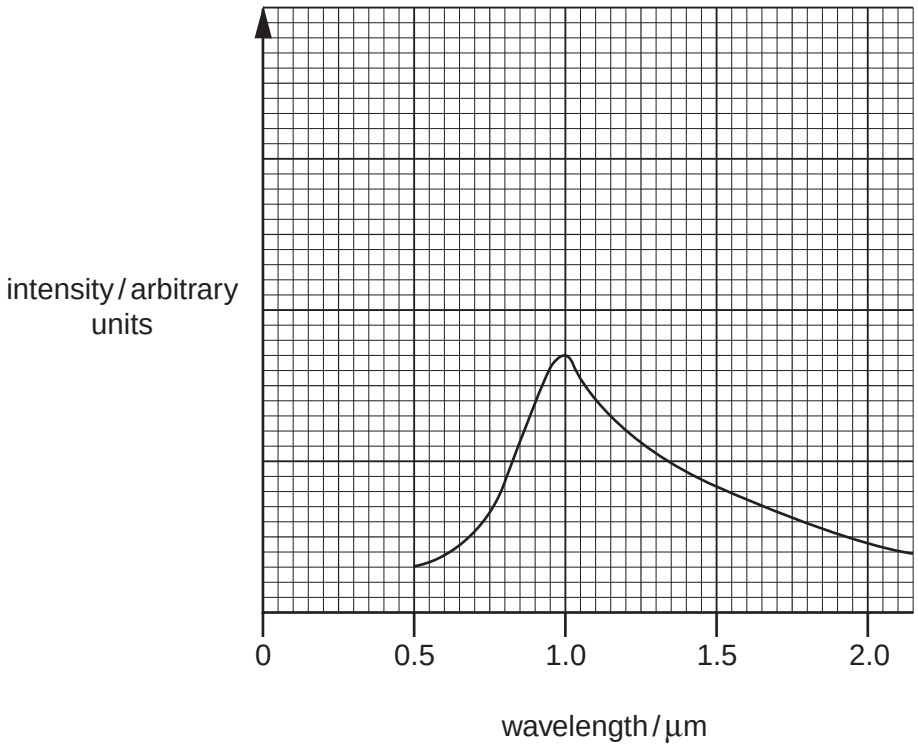

Fig. 1.1

(d) Police thermal imaging cameras work in the infra-red part of the electromagnetic spectrum. Police also use ordinary visible light cameras to take pictures of crime scenes. Visible light has wavelengths from 4.0×10^{-7} m to 7.0×10^{-7} m.

Calculate the frequency corresponding to the red end of the visible spectrum. Give your answer to two significant figures. Include the correct unit in your answer.

velocity of light in air = 3.0×10^{8} m s^{-1}

frequency = ... unit ..... [5]

(e) The police recommend that the public should write their postcode on possessions, such as DVD recorders, using special pens whose ink is only visible under ultraviolet light. The police use ultraviolet light to identify stolen goods, which can then be returned to their owners.

(i) Visible light has wavelengths from 4.0×10^{-7} m to 7.0×10^{-7} m.

velocity of light in air = 3.0×10^{8} m s^{-1}

1. Give the value of a wavelength in the ultraviolet part of the electromagnetic spectrum.

wavelength = ... m [1]

2. State the velocity of ultraviolet light in air.

velocity of ultraviolet light in air = ... m s^{-1} [1]

(ii) Use your knowledge of the penetration properties of ultraviolet radiation to explain why the police might not be able to read postcodes written with the special pen on a surface under a glass cover.

.....

..... [1]

[Total: 20]

2 Tom is a technician who installs optical fibre cables for computer systems. In one recent job he replaced the old multimode fibre in a local area network with monomode fibre.

(a) Fig. 2.1 shows a multimode step-index fibre.

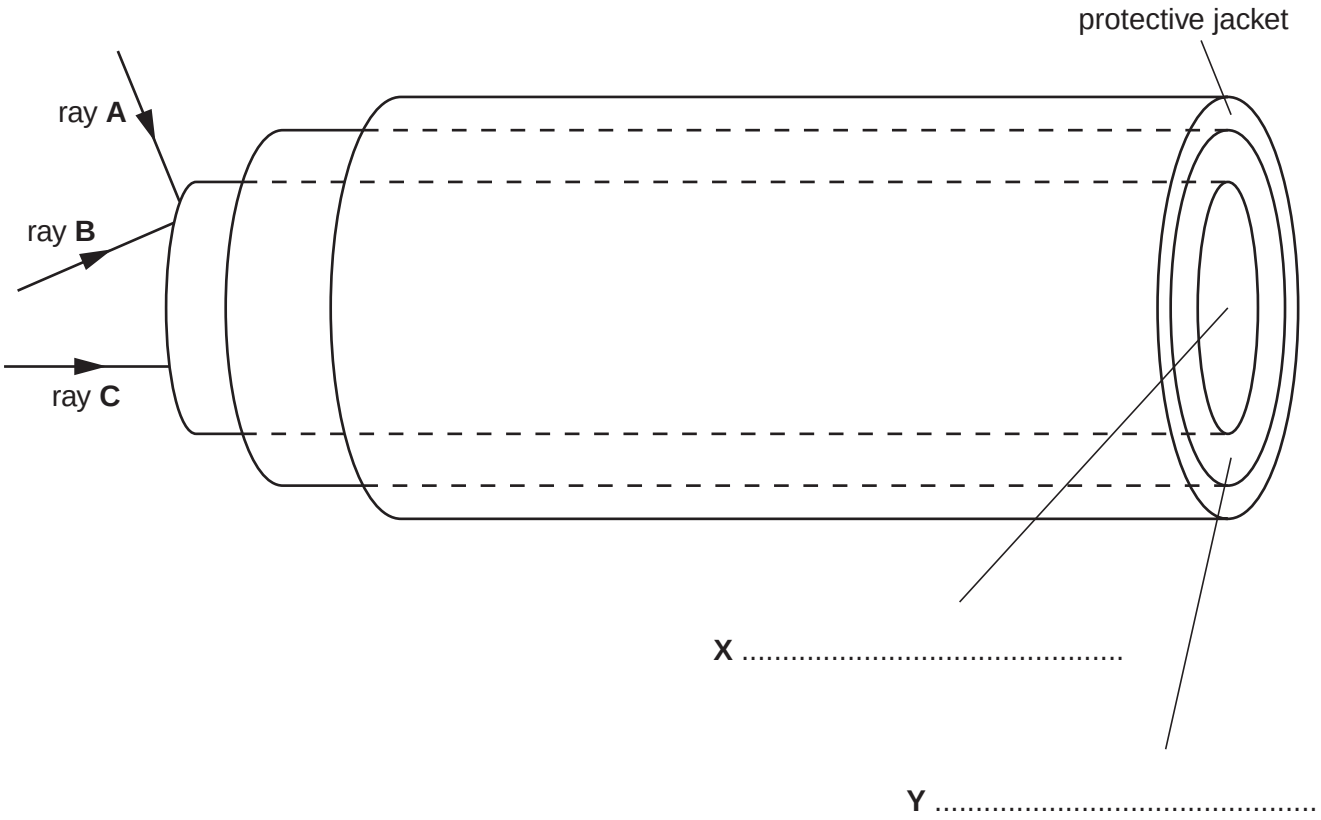

Fig. 2.1

(i) Label **X** and **Y**. [1]

(ii) On Fig. 2.1 the arrows represent three rays, **A**, **B**, and **C**, entering the fibre.
Draw, on Fig. 2.1, the path that each ray follows in the cable. [6]

(iii) Compare the distance rays **B** and **C** have travelled as they emerge from the right hand end of the fibre.

.....

..... [1]

(b) **(i)** Describe how the core of a monomode optical fibre differs from that of a multimode fibre.

.....

..... [1]

(ii) Describe the path of one ray that is transmitted down the fibre.

.....

..... [1]

(iii) State and explain the advantage of monomode compared to multimode step-index fibres.

advantage .....

explanation .....

.....

.....

..... [4]

(c) Another way of overcoming the disadvantage of multimode step-index fibres is to use graded-index fibres.

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

(i) Describe the structure of the core of graded-index optical fibres.

.....

.....

.....

..... [4]

Quality of Written Communication [1]

(ii) Explain why graded-index fibres are better than multimode step-index fibres for transmitting information.

.....

.....

..... [2]

(d) Infra-red sources are normally used for fibre-optic transmission systems. Infra-red waves travel as oscillations in electric and magnetic fields that are at right angles to each other and to the direction of travel.

(i) Name another type of wave that has these properties.

..... [1]

(ii) Name one type of wave that does **not** have these properties.

..... [1]

[Total: 23]

3 Jenny has a dial-up connection to the internet that operates via a modem. She wishes to increase the rate of transmission and to be able to speak on the telephone while online. She is therefore considering changing to a broadband system that also works via her telephone line.

(a) State and explain how the use of 0–20 kHz and 26 kHz–1.1 MHz channels make this possible.

.....

.....

.....

..... [3]

(b) Broadband uses digital signals, but telephone signals have traditionally been analogue. Explain the difference between analogue and digital signals.

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

.....

.....

.....

..... [3]

Quality of Written Communication [1]

(c) State **two** advantages of digital compared to analogue signals.

1. .....

.....

2. .....

..... [2]

(d) The analogue signal from a microphone must be processed if is to be transmitted as a digital signal. Name this process and describe how it works.

process .....

description .....

.....

.....

.....

..... [5]

(e) Name the opposite process to the one you have described in **(d)** and give an example of an application for which it might be used.

opposite process .....

example .....

..... [2]

[Total: 16]

4 John gets good reception on his mobile phone while at college because the base station aerial is on the roof. Fig. 4.1 shows the cluster of various communications aerials on the college roof.

Fig. 4.1

(a) John does not get such good reception on his mobile phone at home.

Suggest **two** possible reasons for this.

1. .....

2. ..... [2]

(b) John would like his network provider to build a base station near his home. State **four** factors that a company would take into account when deciding where to locate base stations.

1. .....

2. .....

3. .....

4. ..... [4]

(c) Mobile phones are sometimes called cell-phones. Explain what you understand by the cell in "cell-phone" and state how the aerial on the college roof is related to the cell.

.....

.....

.....

..... [3]

(d) State why the use of a large number of cells increases the number of users a network can carry.

.....

..... [1]

(e) Before mobile phones were invented, John's father was a CB radio enthusiast. One disadvantage of CB radios compared to mobile phones is that they are half-duplex devices.

(i) Mobile phones are not half-duplex. What are they?

..... [1]

(ii) Explain this difference.

.....

.....

..... [2]

[Total: 13]

5 **(a)** Jo has to have her hip X-rayed regularly because of a problem with her hip joint.

(i) State how the quality of an X-ray image is affected by the width of the X-ray beam.

.....

..... [1]

(ii) The radiologist uses an image-intensifying screen as shown in Fig. 5.1 to reduce the radiation dose that Jo receives.

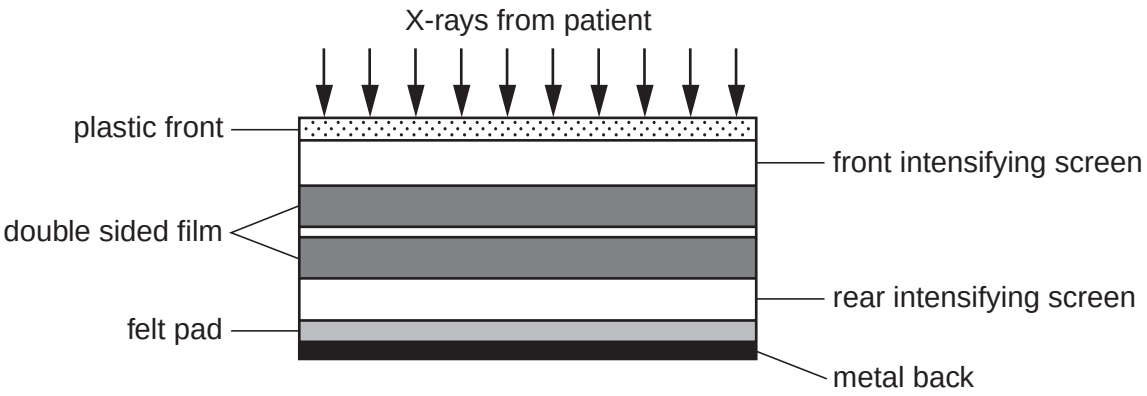

Fig. 5.1

Describe how the image-intensifying screen reduces the radiation dose.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Jo's mother had her chest X-rayed. Doctors investigated further, using a technetium-99m tracer.

(i) Explain how the tracer can be detected.

.....

.....

..... [2]

(ii) Doctors may be reluctant to carry out this procedure with a patient who is breastfeeding. Suggest why this might be.

.....

.....

..... [2]

(iii) State **two** properties of technetium-99m that make it suitable for use as a radioactive tracer, and suggest reasons why each property makes it more suitable than other tracers, for this purpose.

	suitability	**reason**
1	....	....
2	....	....

[4]

(c) Some years ago, Jo's grandfather was given a "barium meal" before he was X-rayed to investigate a problem with his digestive tract. When Jo's father suffered a similar problem recently an endoscope was used instead.

(i) Explain the function of the "barium meal".

.....

.....

..... [2]

(ii) Suggest **two** reasons why the two men were investigated in different ways.

.....

.....

..... [2]

[Total: 18]

END OF QUESTION PAPER

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