Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

G635

APPLIED SCIENCE

Unit 16: Working Waves

WEDNESDAY 10 JUNE 2009: 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

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INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **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.**
- **Write your answer to each question in the space provided, however additional paper may be used if necessary.**

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.**
- **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.**

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Answer ALL the questions.

1 Sunlight is made up of many colours, including red and blue.

(a) (i) State whether the wavelength of blue light is higher, lower, or the same as that of red light.

_____ **[1]**

(ii) State whether the frequency of blue light is higher, lower, or the same as that of red light.

_____ **[1]**

(iii) Compare the velocity in air of blue light and red light.

_____

_____ **[1]**

(iv) An astronomer observes light from the sky in the daytime and measures the wavelength of one of the colours in the light as 4.2×10^{-7} m. Calculate the frequency of this light. State the formula you use.

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

formula _____

frequency = _____ **Hz [3]**

(b) Sunlight reaches us both directly and indirectly. In Fig. 1.1, path A shows sunlight reaching a point on the Earth's surface directly and path B shows sunlight reaching the point after being scattered in the atmosphere.

not to scale

FIG. 1.1

The scattered light is polarised.

Fig. 1.2 and Fig. 1.3 on the opposite page are photographs taken in the direction of the scattered light.
Fig. 1.2 is taken through a piece of polarising material.
Fig. 1.3 is taken without the polarising material.

(i) Explain how Fig. 1.2 shows that scattered light is polarised.

_____

_____

_____ **[2]**

FIG. 1.2

FIG. 1.3

(ii) Describe what would happen to the image in Fig. 1.2 if the polariser was rotated gradually through 180°.

_____

_____

_____ **[2]**

(c) Name <u>ONE</u> type of wave that cannot be polarised.

_____ **[1]**

(d) Sunlight passes through a vacuum in space before reaching the Earth.

(i) Name the group of waves that can travel through a vacuum.

_____ **[1]**

(ii) State the names of <u>TWO</u> regions of this group of waves other than sunlight.

[2]

1. _____

Will/will not* penetrate a thin aluminium foil.

***Delete as appropriate**

2. _____

Will/will not* penetrate a thin aluminium foil.

***Delete as appropriate**

(iii) In the box beside each of your answers to (d)(ii), indicate whether your example will penetrate a thin aluminium (metal) foil. [1]

[Total: 15]

2 It is important to line up rollers in a conveyor belt properly to minimise friction. A thermal imaging company offers a service to engineering firms to locate rollers that are out of line.

(a) State what effect friction can cause in working machinery.

_____ **[1]**

(b) When the thermal imaging company uses its camera to examine a conveyor belt belonging to one of its customers it detects radiation caused by excess friction.
Describe what could be seen on its screen.

_____

_____ **[2]**

(c) Explain how an infra-red camera identifies these areas of friction.

_____

_____ **[3]**

(d) Suggest TWO advantages of routine testing using a thermal imaging system for this purpose.

_____

_____

_____ **[2]**

(e) (i) In a laboratory test, a metal roller is heated until the radiation it emits is just visible to the eye, even in the dark.
State the colour of this visible radiation and explain why it is emitted.

_____

_____

_____

_____ **[2]**

(ii) If the metal roller is heated to an even higher temperature, describe and explain the further changes in the visible radiation emitted.

_____

_____ **[2]**

[Total: 12]

3 (a) First generation (1G) mobile phones used analogue systems and FDMA technology.

(i) Explain what is meant by an analogue system in this context.

_____

_____

_____ **[2]**

(ii) State what the letters FDMA stand for.

_____

_____ **[1]**

(iii) Explain how FDMA permitted more than one user to make calls to the same base station.

_____

_____

_____ **[2]**

(b) Now that a large proportion of the population already own a mobile phone, manufacturers make the purchase of a new phone attractive by adding new features. 3G technology is intended for the multimedia cell-phone and has increased bandwidth and transfer rates to accommodate web-based applications and phone-based video files.

Third generation (3G) mobile phones use digital systems. They can use a version of CDMA technology (or similar alternatives).

(i) Explain what is meant by a *digital system* in this context.

_____

_____

_____ **[2]**

(ii) State what the letters CDMA stand for.

_____

_____ **[1]**

(iii) CDMA permits transmission and downloading of videos. This was not possible with FDMA or TDMA.

1 State why it was not practical to transmit videos using FDMA or TDMA.

_____

_____ **[1]**

2 Explain how CDMA permits transmission of videos.

_____

_____

_____ **[2]**

(c) Three friends discuss occasions when they have not been able to make or receive calls on their mobile phones (even though their batteries were fully charged and their accounts were in credit!). In each case suggest and explain a likely reason for their difficulty.

(i) Wayne could not make a call when he was leaving the match at the end of the football cup final.

_____

_____ **[2]**

(ii) Abdul could not make a call when he was walking in a region where the land was flat and where not many people lived.

_____

_____

_____

_____ **[2]**

(iii) Sheila could not make a call when she was in a mountainous region.

_____

_____ **[1]**

(d) Sheila is a member of a mountain rescue group. They sometimes use citizens' band (CB) radio to communicate with each other. Unlike mobile phones, CB radio uses the same frequency to transmit and receive. This is sometimes called "push to talk" since you must depress a microphone button each time you want to talk.

(i) Name the type of technology where only one person can talk at a time.

_____ **[1]**

(ii) Name the type of technology, used in mobile phones, where two people can talk at the same time.

_____ **[1]**

(e) Different parts of the world use different mobile phone systems. Standard UK phones will work in parts of Europe but if travelling further, it may be necessary to carry a dual-band or dual-mode handset.

(i) State what is meant by a *dual-band* handset.

_____

_____ **[1]**

(ii) State what is meant by a *dual-mode* handset.

_____

_____ **[1]**

(f) Telephone landlines are used for connecting computers to the Internet.
Explain how and why broadband connections are better than dial-up connections.

_____

_____

_____

_____ **[3]**

[Total: 23]

4 An optical fibre manufacturer makes step-index optical fibres by coating the core with a cladding of glass containing different concentrations of boron.

(a) Optical fibres are used for transmitting telephone signals. State <u>THREE</u> advantages of fibre optic transmission of signals compared to traditional copper wire.

_____

_____

_____ **[3]**

(b) Light will pass along a simple glass fibre with no cladding.

(i) Name the process that prevents light from escaping from the sides of the fibre.

_____

_____ **[1]**

(ii) Under certain conditions, light may escape from the fibre.
Describe <u>ONE</u> such condition.

_____

_____ **[1]**

(c) (i) State whether the velocity of light in the core is greater than, equal to or less than the velocity of light in the cladding.

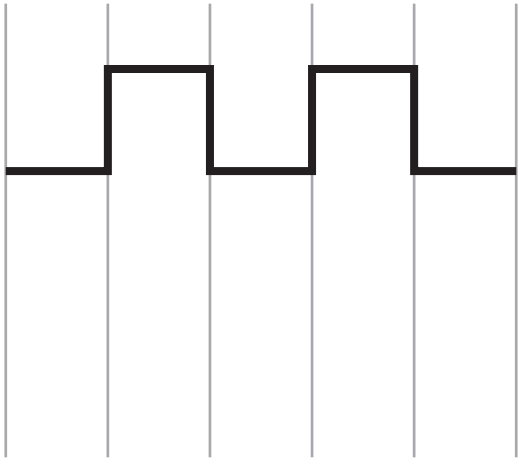
_____ **[1]**

(ii) State whether the refractive index of the core, relative to air, is greater than, equal to or less than the refractive index of the core, relative to air of the cladding.

_____ **[1]**

(d) Signals that emerge from step-index optical fibres have been degraded.

(i) Fig. 4.1 shows a square wave signal that is sent into a multimode fibre. In the space below draw the signal as it emerges from the fibre.



[3]

FIG. 4.1

(ii) Explain why this degradation takes place.

_____

_____

_____

_____ **[3]**

(iii) State ONE example of an application where this would NOT be a problem.

_____

_____ **[1]**

(e) This problem of degradation with step-index fibres is overcome by the use of graded-index optical fibres.
Explain how graded-index fibres overcome the problem.

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

_____

_____

_____

_____

_____

_____ **[3]**

Quality of Written Communication [1]

(f) The problem of degradation with step-index fibres can also be overcome by the use of monomode optical fibres.
Explain how monomode fibres overcome the problem, giving an indication of the diameter of the fibres.

_____

_____

_____

_____

_____

_____ **[3]**

[Total: 21]

5 (a) Two patients, Mr Singh and Mr Smith, received radiation treatment in hospital. Mr Singh was irradiated and Mr Smith became temporarily radioactive.

(i) State the meaning of the terms *irradiated* and *radioactive*.

irradiated _____

_____ **[1]**

radioactive _____

_____ **[1]**

(ii) Give <u>ONE</u> example where each may occur as part of their treatments.

irradiation example _____

_____ **[1]**

radioactive example _____

_____ **[1]**

(b) Staff treating Mr Smith and Mr Singh may be exposed to radiation. Explain how exposure to X and γ radiation damages cells and causes health hazards.

_____

_____

_____

_____ **[3]**

(c) Describe <u>ONE</u> way in which the dose of radiation received by radiotherapy staff is monitored.

_____

_____ **[1]**

(d) Describe <u>TWO</u> ways in which the dose of radiation received by radiotherapy staff is minimised.

_____

_____

_____ **[2]**

(e) In another part of the hospital, X-rays are used to produce images for diagnosis e.g. of broken bones.
Describe and explain how each of the following techniques is used to improve the quality of the images.

(i) Use of a grid.

_____

_____

_____ **[2]**

(ii) Making the X-ray beam narrow.

_____

_____

_____ **[2]**

(f) Describe <u>BRIEFLY</u> how CAT scanners produce more detailed images than conventional X-rays.

In this section, one mark may be awarded for spelling, punctuation and grammar.

_____

_____

_____

_____

_____

_____ **[4]**

Quality of Written Communication [1]

[Total: 19]

END OF QUESTION PAPER

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