OCR RECOGNISING ACHIEVEMENT

ADVANCED GCE
APPLIED SCIENCE
Working Waves

G635

Wednesday 22 June 2011
Morning

Duration: 1 hour 30 minutes

MODIFIED LANGUAGE

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
• 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**.
• You are advised to show all the steps in any calculations.
• 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.
• This document consists of **20** pages. Any blank pages are indicated.

OCR is an exempt Charity

Turn over

Answer **all** the questions.

1   An engineer is developing a wave machine for a new swimming pool. She measures the vertical displacement of water in a test tank as a wave passes through it. A computer automatically records simultaneous measurements at various points in the pool.

   (a) State what is meant by the term *displacement*.

   ....

   ....

   .... **[1]**

   (b) State the term used to refer to the **maximum displacement** of a wave.

   .... **[1]**

   (c) The computer takes simultaneous measurements at ten points **A**, **B**, **C**, **D**, **E**, **F**, **G**, **H**, **I** and **J**, placed 0.50 m apart along the direction in which the waves travel. In one test, wave peaks were detected simultaneously at points **A**, **D**, **G** and **J**, Fig. 1.1.
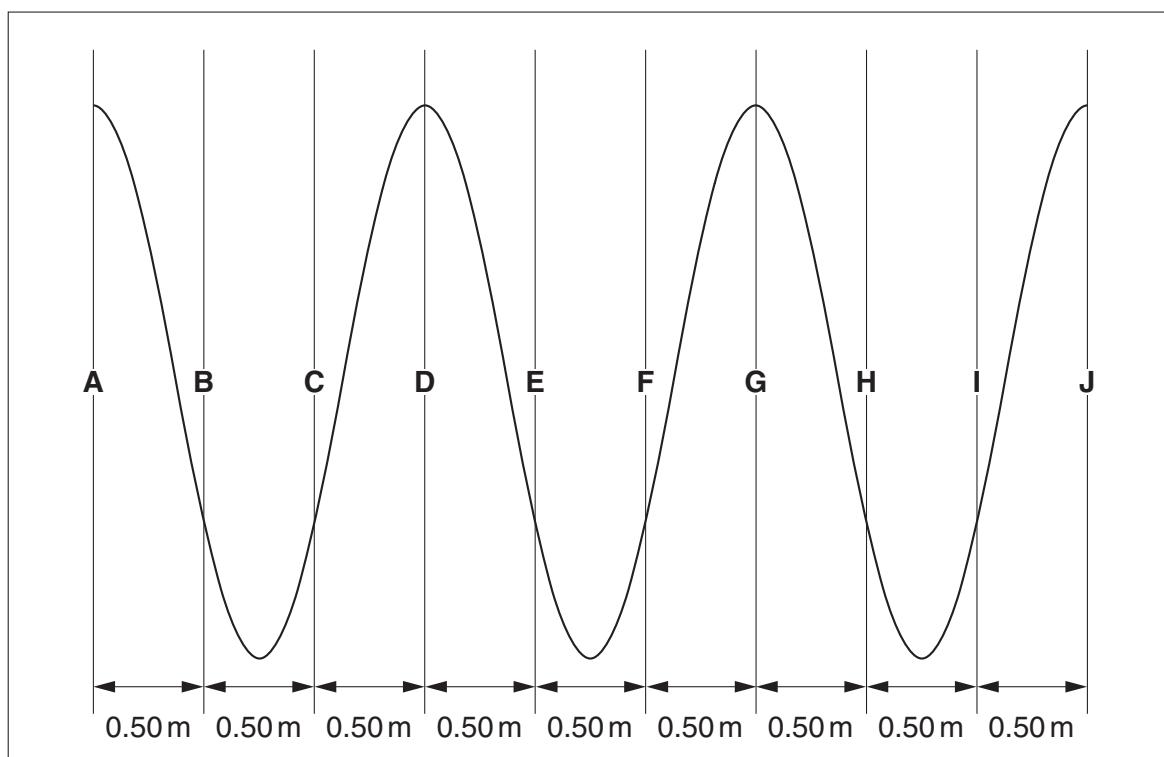
Fig. 1.1

   State the wavelength of the wave.

   wavelength = ... m **[1]**

(d) One peak takes 5.0 s to travel from detector **A** to detector **J**.

Show that the velocity of the wave is 0.90 m s⁻¹.

[1]

(e) Use your answers to parts **(c)** and **(d)** to find the frequency of the wave.

frequency = ... units .... **[3]**

(f) How many times will the water at point **A** go through one complete cycle during the time that the wave travels from detector **A** to detector **J**?

number of times = ... **[3]**

Turn over

4

(g) The engineer decides to set up standing waves in the water in the test tank. He arranges a second wave machine at the other end of the tank to send waves towards the first machine.

Describe the difference that would be observed between these standing waves and the progressive waves produced by either wave machine on its own.

....

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....

....

.... **[3]**

(h) Standing waves can also be produced on a wire. One standing wave is shown in Fig. 1.2. The solid line and the dotted line show positions of the wire at different times.
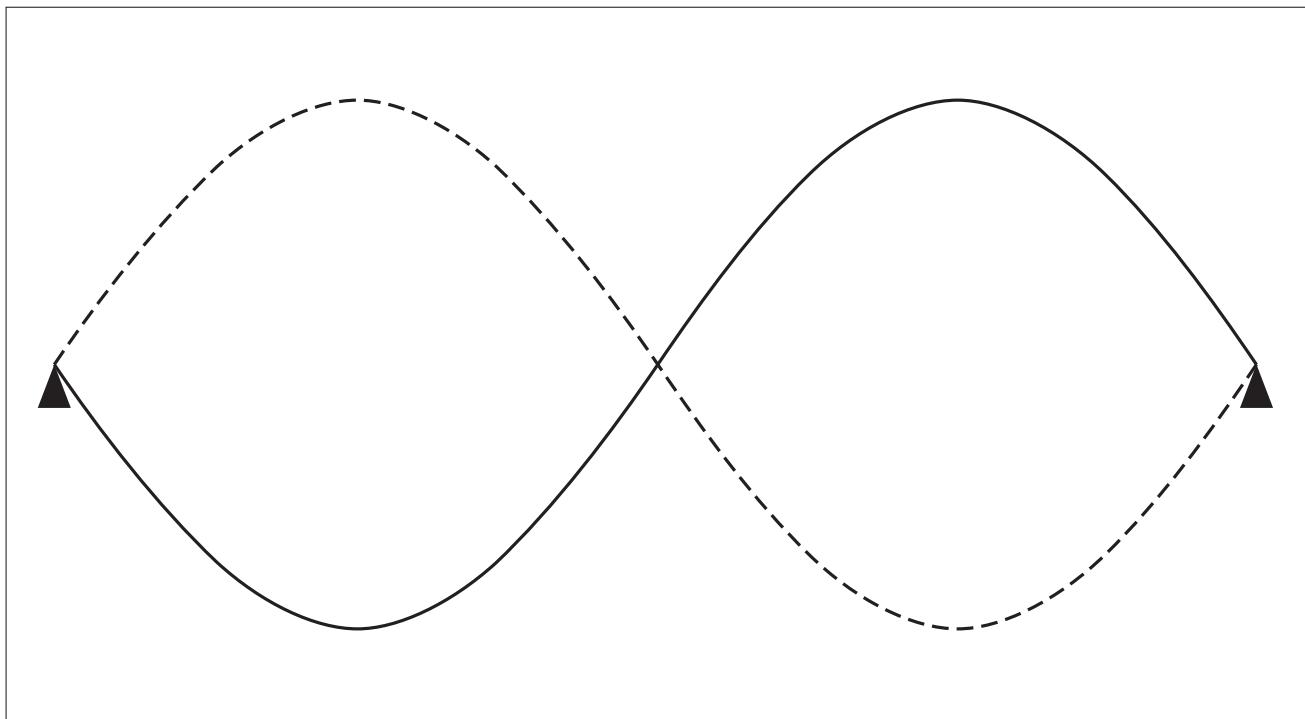
Fig. 1.2

(i) On the diagram mark the positions of:

- **two** nodes, with the letter '**N**'

- **two** antinodes, with the letter '**A**'

[2]

(ii) If the wire is 2.0 m long state the wavelength of the wave.

wavelength = ... m [1]

(iii) In another experiment, the student measured the distance between a node and the nearest antinode. The distance was 0.33 m.

Calculate the wavelength in this experiment.

wavelength = ... m [2]

[Total: 18]

2 Thermal imaging cameras are used to produce images of objects that might not be visible to the naked eye.

(a) State which region of the electromagnetic spectrum is used in thermal imaging.

.... **[1]**

(b) State what is meant by a *perfect black body*.

....

.... **[1]**

(c) Describe and explain how an electrical engineer would use thermal imaging to detect faults in electric circuits.

....

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....

.... **[5]**

(d) A television wildlife programme shows a cat at night using a thermal imaging camera.

Explain why the cat's ears appear a different colour from the rest of its body on a thermal image.

....

....

....

.... **[2]**

(e) The specification of a particular thermal imaging camera claims good spatial and thermal resolution.

State what is meant by these terms.

spatial resolution ....

....

....

thermal resolution ....

....

.... **[2]**

[Total: 11]

3 Dr Macduff gives a talk about his work to a group of college students. He describes how he uses an endoscope to examine inside patients.

(a) An endoscope is a device used in medicine to examine patients internally. The endoscope transmits light to illuminate the area being examined and transmits images for the doctor to view. An endoscope uses large numbers of optical fibres together in bundles. Some bundles are *coherent* and some are *incoherent*.

With the aid of diagrams, explain the terms *coherent* and *incoherent* and why each type of bundle is used in an endoscope.

....

....

....

....

....

....

....

.... **[6]**

(b) (i) Give one **other** example of an application where **coherent** bundles are necessary.

....

.... **[1]**

(ii) Give one **other** example of an application where **incoherent** bundles are normally used.

....

.... **[1]**

(c) Under certain conditions light rays undergo TIR. Optical fibres use this phenomenon.

(i) State what the letters *TIR* stand for.

.... **[1]**

(ii) Fig. 3.1 shows a ray about to enter an optical fibre.
Draw the path of the ray as it passes through the fibre.
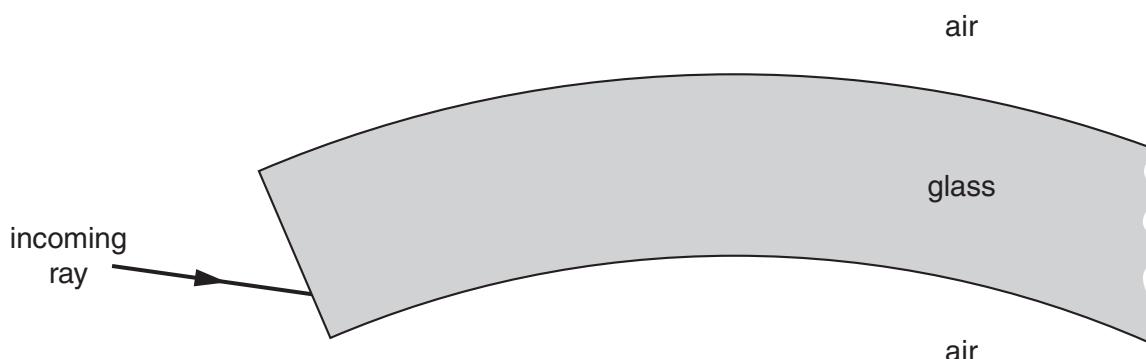
Fig. 3.1 **[3]**

(iii) Describe why TIR occurs as light passes through the uncoated optical fibre.

....

....

....

.... **[2]**

(d) After Dr Macduff's talk, Peter and Julie carry out an experiment in the college laboratory to measure the critical angle of a semicircular block of glass. They use a ray box to send a ray into the curved surface of the block towards the centre of the circle. They rotate the block until the emerging ray is parallel to the flat surface as shown in Fig. 3.2. Julie measures the angle θ and records her value of 39°.

ray entering
the block along
the normal to the
curved surface

reflected ray

θ

emerging ray
parallel to the
flat surface

normal to the
flat surface
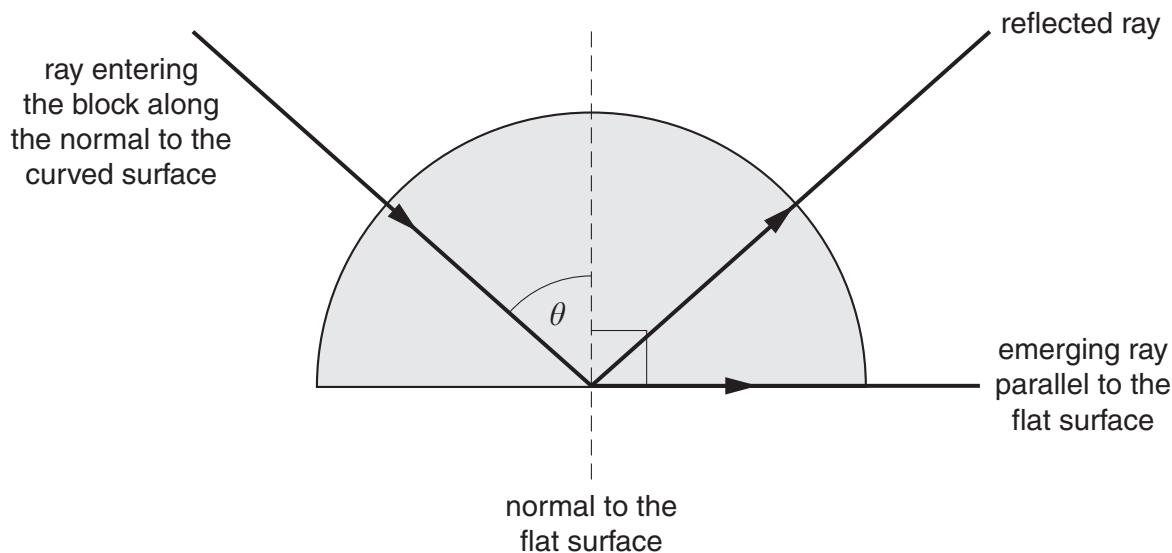
Fig. 3.2

(i) State the critical angle of the glass.

.... **[1]**

(ii) Use your answer to **(d)(i)** and Table 3.1 to find the refractive index *n* of the glass. Give your answer to 2 significant figures.

$$\sin(\text{critical angle}) = \frac{1}{n}$$

Table 3.1

angle/degrees	sin (angle)
35	0.57
36	0.59
37	0.60
38	0.62
39	0.63
40	0.64
41	0.66
42	0.67
43	0.68
44	0.69
45	0.71
46	0.72
47	0.73
48	0.74
49	0.75
50	0.77
51	0.78
52	0.79
53	0.80
54	0.81
55	0.82

refractive index = ... **[2]**

Turn over

(e) Step-index optical fibres have a glass core coated with a second layer of glass of lower refractive index.

    (i) State the name given to this second layer.

        .... **[1]**

    (ii) One effect of this second layer is to increase the critical angle.

        State and explain how this will affect the rays as they pass along the fibre.

        ....

        ....

        ....

        .... **[2]**

    (iii) A further layer, sometimes of an opaque material, is placed around the outside.

        1 State the name given to this layer.

        .... **[1]**

        2 State the purpose of this layer.

        ....

        .... **[1]**

[Total: 22]

4 An internet blog states:

'Full-duplex communications systems are easier to use than half-duplex systems. The term simplex is commonly defined as one where signals can only flow in one direction such as broadcast radio or television.'

(a) (i) State what is meant by the term *half-duplex* communication system.

....

.... **[1]**

(ii) Give one example of a **half-duplex** communication system.

....

.... **[1]**

(b) (i) State what is meant by the term *full-duplex* communication system.

....

.... **[1]**

(ii) Give one example of a **full-duplex** communication system.

....

.... **[1]**

(c) The term simplex communication system is sometimes defined as meaning the same as half-duplex.

State **one** difference between this definition and the one given in the blog quoted above.

....

....

.... **[1]**

(d) (i) Figs. 4.1 to 4.4 show a number of ways of displaying data.

Identify which are digital and which are analogue by circling the correct term under each picture.
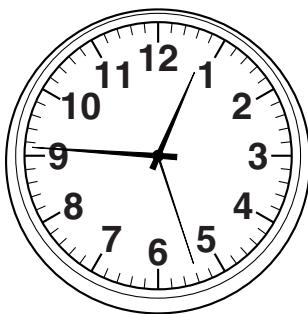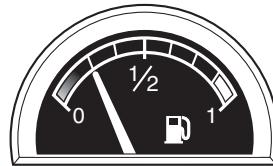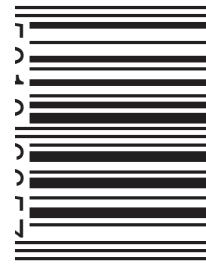
Fig. 4.1	Fig. 4.2	Fig. 4.3	Fig. 4.4
digital	digital	digital	digital
analogue	analogue	analogue	analogue

[1]

(ii) Explain the difference between the terms *binary* and *digital*.
You may refer to the diagrams in Figs. 4.1 to 4.4.

....

....

....

.... **[2]**

(e) The government plans to replace AM and FM radio by digital transmissions.

(i) State what the letters *AM* and *FM* stand for.

AM ....

FM .... **[2]**

(ii) Explain the difference between AM and FM radio transmissions.

....

....

....

.... **[2]**

[Total: 12]

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Question 5 starts on page 16

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5 In the United States, mobile telephones are called cell phones.

(a) State the size of a typical mobile phone cell.

.... **[1]**

(b) Draw a diagram showing an ideal cell layout.

Your diagram should include at least **four** cells.

[1]

(c) On your diagram, mark the positions of **three** base stations with **X**. **[2]**

(d) Explain why a system of cells is used.

....

....

....

....

....

....

.... **[3]**

(e) State one other way in which maximum use is made of available frequencies in mobile phone systems.

....

.... **[1]**

(f) State what is meant by the terms *up-link* and *down-link* in terrestrial mobile phone systems.

up-link ....

....

down-link ....

.... **[1]**

[Total: 9]

6 Gamma (γ) rays and X-rays are used in hospitals for both diagnosis and treatment.

(a) Patients sometimes ask their doctor why ionising radiation can be harmful.

Give **three** key points that their doctor might make in his reply.

....

....

....

....

....

....

.... **[3]**

(b) Diagnosis of broken bones is often carried out using X-radiation.

State **two** ways of keeping X-ray radiation dose as low as possible while obtaining a good image.

....

....

....

....

.... **[2]**

(c) A patient, Mr Williams, is advised to have radiotherapy using an external γ source. He is worried about the radiation hazards.

(i) Suggest the factors a doctor might discuss with Mr Williams to help him decide whether to agree to the treatment.

....

....

....

....

....

.... **[3]**

(ii) State how the radiologist can keep the dose received by Mr Williams to a minimum.

....

....

.... **[1]**

(d) Another patient, Ms Malone, is having a radiotherapy examination using a technetium-99m tracer.

Technetium-99m has a physical half-life of 6 hours and a biological half-life of 12 hours.

(i) What is meant by the term *physical half-life*?

....

....

....

....

.... **[2]**

(ii) What is meant by the term *biological half-life*?

....

....

.... **[1]**

(iii) A radiation meter detects 20 counts per second from a sample of technetium-99m in a glass container.

Calculate the reading on the meter 12 hours later.

meter reading = ... counts per second **[3]**

(iv) Calculate the overall half-life of the technetium-99m tracer that has been injected into Ms Malone.

overall half-life = ... hours **[3]**

[Total: 18]

END OF QUESTION PAPER