OCR
RECOGNISING ACHIEVEMENT

Friday 15 June 2012 – Morning

A2 GCE APPLIED SCIENCE

G635 Working Waves

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour 30 minutes

* G 6 3 5 *

* G 6 1 1 5 3 0 6 1 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- 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.
- 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.

Answer **all** the questions.

1 Samantha and Toby see a rainbow. Toby asks Samantha to explain the differences in the properties of red and blue light.

(a) State the **differences** in the properties of red and blue light.

.....

.....

.....

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

(b) Toby asks what other radiation is beyond the edges of the rainbow.

Name **two** types of radiation beyond the **violet** edge of the rainbow.

1. .....

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

(c) Samantha points to the vertical rods of the television aerial on her house shown in Fig. 1.1 and explains that a vertical electric field in radio waves causes an electric current in the aerial.

State what other type of field is also present in radio waves and the direction of this field compared to the electric field.

other type of field .....

direction .....

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

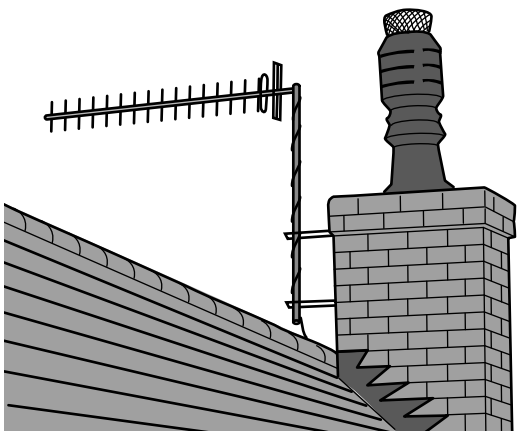

Fig. 1.1

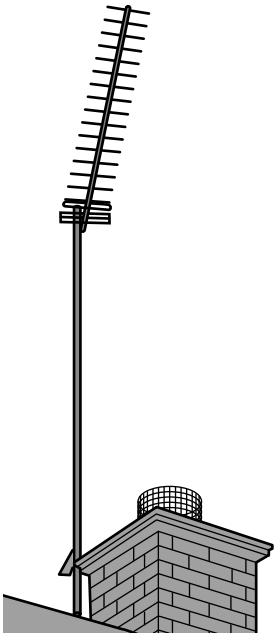

Fig. 1.2

(d) Toby asks why the television aerial on his house shown in Fig. 1.2 has horizontal rods. Samantha explains that the aerials receive polarised waves from different transmitters.

(i) State what is meant by the term *polarised*.

.....

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

(ii) Explain the **difference** between the signals from these two transmitters.

.....

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

(iii) Suggest why neighbouring transmitters need to emit different signals in this way.

.....

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

(e) Toby finds that the wave frequency of his local television transmitter is 474.0 MHz.

Calculate the wavelength of this wave. Give your answer to an appropriate number of significant figures.

(velocity of light $c = 2.997 \times 10^8\,\text{m}\,\text{s}^{-1}$)

wavelength = …… unit …… **[4]**

(f) Radio and television signals are produced by electronic circuits.

Suggest why electronic oscillator circuits cannot be used to produce visible light directly. Your answer should refer to the **frequency** given in part **(e)**.

.....

.....

.....

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

[Total: 15]

2 Fire fighters are called to a house fire.

(a) After they believe that they have put out the house fire, they use a thermal imaging camera to examine the house.

(i) Suggest **two** reasons why they might use a thermal imaging camera.

1. .....

.....

2. .....

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

(ii) State **two** places within the house that might appear different from each other on the image produced by the camera. State why they would appear different and describe the difference in appearance.

place 1 .....

place 2 .....

why they appear different .....

.....

how they appear different .....

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

(b) Investigators from the fire service think that the fire may have been caused by a red-hot lump of coal falling out of an open fire. They carry out further investigations using a fire in a laboratory.

(i) Using the axes provided, on **Fig. 2.1**, sketch a graph of the variation of intensity with wavelength for a red-hot coal immediately after it is taken from a fire and **label this line 'hot'**.

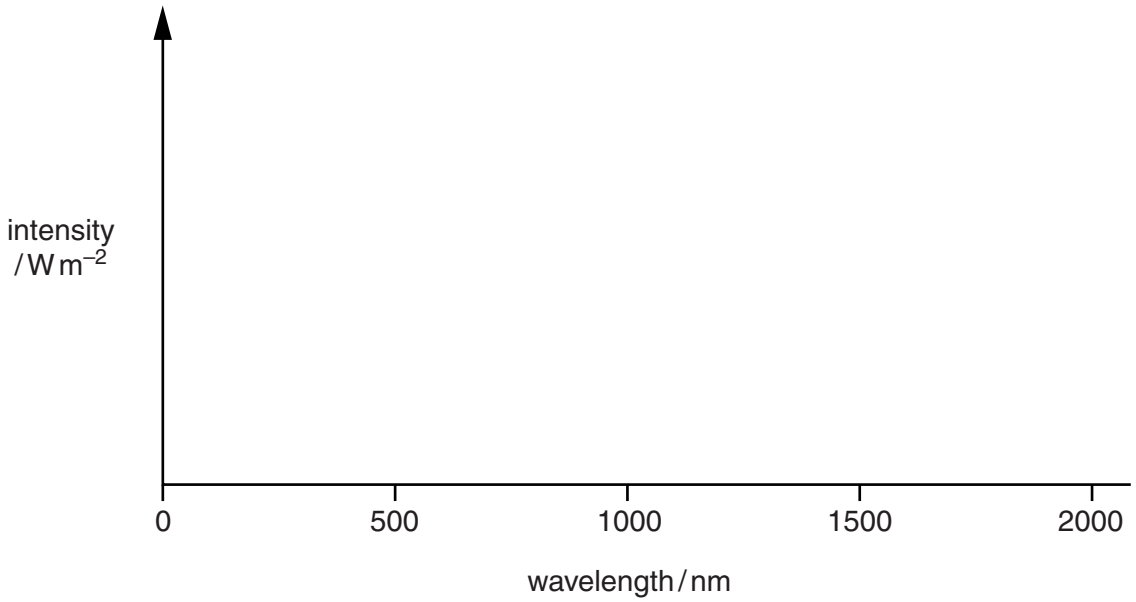

Fig. 2.1

[3]

(ii) A few minutes after taking the lump of coal from the fire, it appears black but it still feels warm.

On Fig. 2.1, sketch a graph of the variation of intensity with wavelength for the warm, black coal and **label this line 'warm'**. **[2]**

(iii) The following day the coal has cooled to room temperature. **On Fig. 2.1**, sketch a graph of the variation of intensity with wavelength for the coal at room temperature and **label this line 'cool'**. **[1]**

(c) The fire service investigators are comparing two thermal imaging cameras and find that one shows more detail than the other.

Name the property of a thermal imaging camera that tells the user how well it can distinguish between two **small** objects when there is a big temperature difference between them.

.....

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

(d) A thermal imaging camera with a thermal resolution of 2 °C is used to examine an object in a laboratory. Different parts of the surface of this object have been painted either red or blue and are at different temperatures.

Table 2.1 gives the temperature and the colour of the surface paint, for four parts of the object. The first row shows data used as a control. This has a surface painted red and a temperature of 25 °C.

Complete Table 2.1 to **compare** the images of other parts that the thermal imaging camera will produce with that of the control and **explain** these results.

Table 2.1

	surface paint colour	**surface temperature / °C**	**comparison of image produced by the thermal imaging camera with control**	**explanation**
control	red	25		
	blue	25		
	red	26		
	red	28		

[6]

[Total: 18]

3 Glass Applications Ltd. make various types of optical fibres.
The boxes on the left of Fig. 3.1 list three applications of optical fibres.
The boxes on the right list possible types of fibre.

(a) Draw **three** lines, each connecting **one** of the boxes on the left to the **most appropriate** box on the right.

	An incoherent bundle of multimode fibres
Endoscope used for medical examinations	
	A coherent bundle of multimode fibres
Lighting a display cabinet	An incoherent bundle of multimode fibres and a coherent bundle of multimode fibres
	An incoherent bundle of monomode fibres
Long distance communications	
	A coherent bundle of monomode fibres

Fig. 3.1

[3]

(b) Give reasons for each of your choices in part **(a)**.

(i) Endoscope used for medical examinations.

.....

.....

.....

.....

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

(ii) Lighting a display cabinet.

.....

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

(iii) Long distance communications.

.....

.....

.....

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

(c) In the past, Glass Applications Ltd. recommended graded-index fibres rather than step-index fibres for communications purposes.

Explain, with the aid of a diagram, how graded-index fibres overcome the problems associated with step-index fibres.

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..... **[6]**

(d) In their catalogue, Glass Applications Ltd. list a number of advantages of optical fibres for communications, compared to copper wire.

State **three** such advantages.

1. .....

.....

2. .....

.....

3. .....

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

QUESTION 3 CONTINUES ON PAGE 10

(e) In the laboratory, a technician measures the critical angle for a number of different types of glass.

(i) Figs. 3.2, 3.3 and 3.4 each show one of three rays entering a semicircular glass block in a test to measure the critical angle. Reflected rays are NOT shown.

Which of the angles marked ***p***, ***q***, ***r***, ***s*** and ***t*** is the critical angle?

Critical angle is letter .....**[1]**

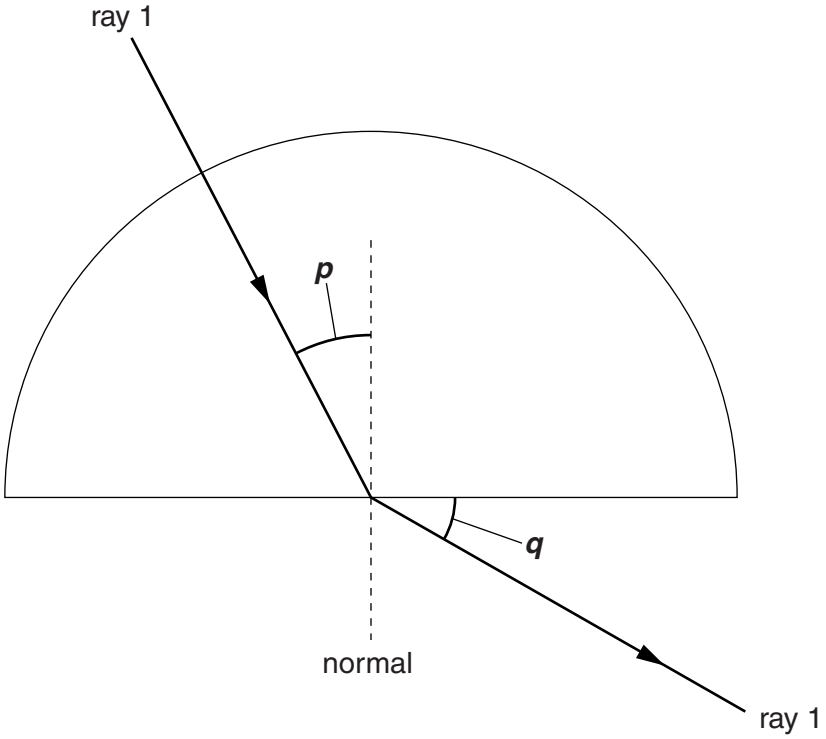

Fig. 3.2

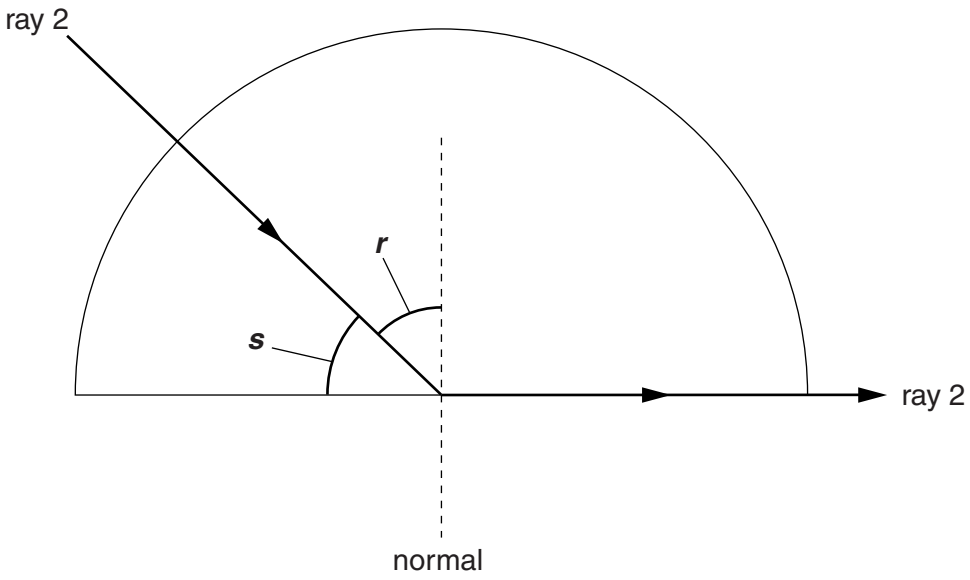

Fig. 3.3

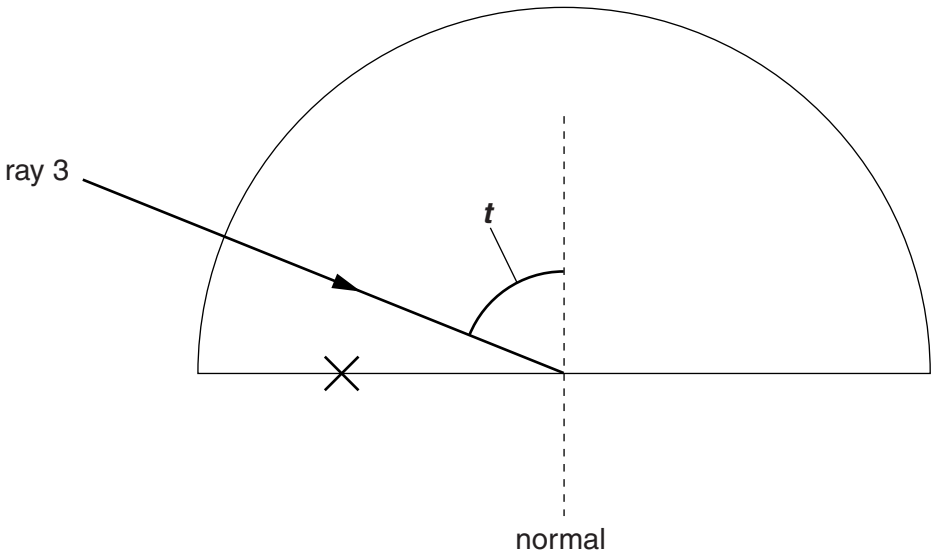

Fig. 3.4

(ii) All three of the rays shown entering the block are directed towards the centre of the circle.

Explain why rays pointing towards other places such as the point marked with a cross in Fig. 3.4 are not used in this experiment.

.....

.....

.....

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

(iii) On the appropriate diagram, draw in the **totally** internally reflected ray. **[1]**

[Total: 22]

QUESTION 4 STARTS ON PAGE 12

4 Maisie learns that her new DAB (digital) radio uses **binary signals**. Her old analogue radio had a **digital display** showing the frequency to which it was tuned.

(a) State the difference between the digital numbers in the binary DAB signal and the digital display showing the frequency.

.....

.....

.....

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

(b) Maisie's old radio used analogue signals. Sometimes she listened to programmes broadcast using FM. To receive other stations she switched to another analogue system.

(i) State what the letters FM stand for.

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

(ii) On the axes in Fig. 4.1, sketch an FM signal.

Fig. 4.1

[3]

(iii) Describe how an AM signal differs from an FM signal.

.....

.....

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

[Total: 8]

5 **(a)** Delroy finds his father's old CB radio in the attic. His father explains that CB radios used the same frequency for sending and receiving calls, so that he could not speak and listen at the same time.

(i) State the name given to a communication system that only works in one direction at a time.

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

(ii) Delroy's mobile phone works in both directions at the same time. State the name given to a communication system that works in both directions at the same time.

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

(b) In the first half of the twentieth century only a few groups of people, such as the emergency services, were allowed to use mobile communication devices, such as two-way radios. This was because the number of available frequencies is limited.

Explain **two** developments that have made it possible to allow us all to use mobile phones.
You may use a diagram to help with your answer.

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..... **[6]**

(c) The quality of voice reception on landline telephones is poorer than when using broadband over the same lines.

Explain why broadband gives better sound quality over the same telephone wires.

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.....

.....

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

[Total: 10]

6 A group of radiologists is preparing a set of leaflets for patients about to undergo diagnosis or treatment. Two of the leaflets are about the use of gamma rays (γ rays).

(a) Complete the following sections of the leaflets about radioactive tracers.

(i) Patients are sometimes injected with a radioactive tracer called technetium-99m. The gamma-rays from tracers are sometimes preferred for diagnosis instead of X-rays because:

.....

.....

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

(ii) Technetium-99m has the following advantages compared to some alternative radioactive tracers:

1. .....

.....

2. .....

.....

3. .....

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

(b) The gamma rays emitted by the tracer are monitored using a gamma camera. A more detailed leaflet is prepared for educational purposes rather than for patients. Fill in the missing words in the leaflet below.

The tracer emits tiny amounts of radiation. The gamma camera contains a crystal which converts the energy from the radiation into flashes of light. These flashes are picked up by a ....., which converts the flashes into electrical signals. The electrical signals are analysed by a ..... to construct an ..... . The collimator is made of ..... . It is placed between the ..... and the scintillator (special crystal). The collimator has many parallel holes drilled in it. This ensures that the image is ..... by absorbing gamma photons that are not travelling at right angles to the crystal.

[6]

(c) Another leaflet for patients is about the therapeutic use of gamma rays. Patients are sometimes confused by the fact that gamma rays can both cause and cure cancer.

(i) Describe the process by which gamma rays kill cancerous cells.

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.....

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.....

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

(ii) State how gamma rays can also cause cancer.

.....

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

(iii) Suggest **one** reason why the patient might agree to undergo radiotherapy despite the risk to healthy cells.

.....

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

(d) Staff in a radiography department need to minimise the dose of radiation they receive.

Give **two** examples of ways in which the dose can be minimised.

1. .....

.....

2. .....

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

[Total: 17]

END OF QUESTION PAPER

ADDITIONAL PAGES

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.