OCR
Oxford Cambridge and RSA

Wednesday 10 June 2015 – Afternoon

A2 GCE APPLIED SCIENCE

G635/01 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

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**.
- 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.
- You are advised to show all the steps in any calculations.
- This document consists of **24** pages. Any blank pages are indicated.

Answer **all** the questions.

1 A tuning fork consists of a short handle and two prongs. When hit with a rubber hammer, the prongs vibrate at a particular frequency and this can be used to tune musical instruments. A tuning fork manufacturer sells a range of the tuning forks 'suitable for school, university and laboratory use', as shown in Fig. 1.1.

Fig. 1.1

The frequencies of the musical notes produced by this range of tuning forks are shown in Table 1.1.

Musical Note	Frequency /Hz
C	256.0
D	288.0
E	320.0
F	341.3
G	384.0
A	426.6
B	480.0
C	512.0

Table 1.1

(a) State what is meant by the *frequency of a sound*.

....

.... **[1]**

(b) The speed of sound in dry air at 20 °C is 343.2 m s^{-1}.

Using Table 1.1, calculate the wavelength under these conditions of the note **F**.

Give your answer to an appropriate number of significant figures.

wavelength = ... m **[3]**

(c) Consider sound from the tuning fork that travels in the direction shown by the dotted line in Fig. 1.2. The point **X** in the diagram shows the position of an air molecule on the dotted line.

Describe the variation in the displacement of the molecule at **X** as one complete cycle of the sound passes. Ignore any random movement of the molecule.

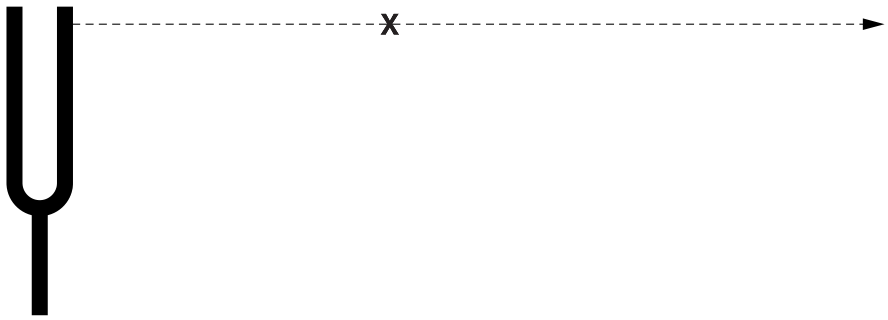


Fig. 1.2

....

....

....

....

.... **[3]**

(d) The two tuning forks that vibrate at frequencies of 256 Hz and 512 Hz (top and bottom of Table 1.1 on page 2) both produce the musical note **C**.

(i) Describe the difference you would hear between the sounds produced by these two tuning forks.

....

....

.... **[2]**

(ii) Both of the tuning forks are struck so that they vibrate. At one instant in time, sound waves from the forks are in phase.

State by how much (if at all) the phase of the 512 Hz fork leads or lags behind the 256 Hz fork:

1 when the 512 Hz fork has gone through **two complete cycles** after they were in phase

....

2 when the 512 Hz fork has gone through **one complete cycle** after they were in phase

....

3 when the 512 Hz fork has gone through **half a cycle** after they were in phase.

....
[4]

[Total: 13]

2 Fig. 2.1 shows the frequencies and corresponding wavelengths of electromagnetic radiation in a vacuum.

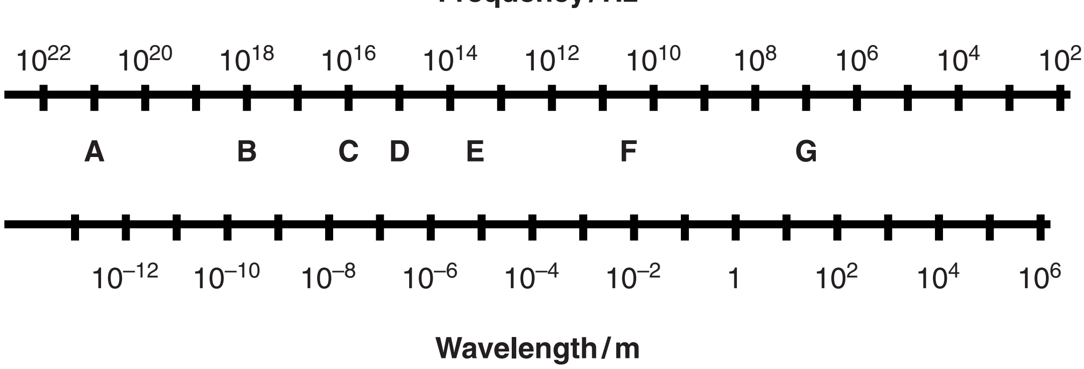


Fig. 2.1

The letters **A** to **G** on Fig. 2.1 indicate points within each of the main regions of the electromagnetic spectrum.

Table 2.1 below contains statements about one or more of the regions of the electromagnetic spectrum.

In the right-hand column, insert the letter or letters corresponding to the region(s) to which the statement refers. The first row has been completed for you.

Letters may be used more than once.
Some answers may contain more than one letter.

Statement	**Region(s)**
Produced by sudden deceleration of electrons	B
Can be seen with the human eye	
Thermal radiation produced by objects at room temperature	
Thermal radiation produced by objects at a temperature of 800 K	
Thermal radiation produced by objects at a temperature of 40 000 K	
Has a velocity in a vacuum of $3.0 \times 10^8\,\mathrm{m\,s^{-1}}$	
Produced by alternating current in metal rods	

Table 2.1

[8]

[Total: 8]

3 Rozina is asked to recommend the most suitable thermal imaging camera for an engineering application.

(a) She tries out a thermal imaging camera.

Describe the appearance on the camera's screen of:

(i) two objects at **different** temperatures.

.... **[1]**

(ii) two objects at **the same** temperature.

.... **[1]**

(b) Two of the properties given in the camera specification are described below.

Name the property in each case.

(i) The smallest detail that can be detected or seen at a set distance.

name of property .... **[1]**

(ii) The smallest temperature difference between two adjacent pixels that the camera can differentiate.

name of property .... **[1]**

(c) Rozina finds that some camera specifications express the value of the property described in part **(b)(i)** in pixels – the smallest element of a detector and display. Two cameras, **A** and **B**, have detectors that are the same size.

Camera **A** has a 640×480 pixels detector and is used to look at an object 4.0 m from the camera.

Camera **B** has a 320×240 pixels detector.

How close to the object should camera **B** be placed to get the same image quality as camera **A**? Explain your answer.

....

....

....

....

.... **[2]**

(d) Rozina finds a camera with a value of the property described in **(b)(ii)** quoted as 'better than 40 mK'.

Explain why such a high specification might be more important for Rozina's engineering application than for a camera used by a rescue team looking for earthquake survivors.

Your answer should suggest what value might be acceptable for use by the rescue team.

....

....

....

....

....

....

.... **[3]**

[Total: 9]

4 Jason is a salesman. He sells optical fibre underwater lighting systems for swimming pools.

(a) State why it is safer to use optical fibres compared to conventional electric lights for underwater lighting.

....

.... **[1]**

(b) Bundles of optical fibres are made in two different types called coherent and incoherent bundles.

(i) Describe the difference between coherent and incoherent optical fibre bundles.

....

....

....

.... **[2]**

(ii) State whether coherent or incoherent optical fibre bundles are normally used for swimming pool underwater lighting systems.

Explain your answer.

....

....

.... **[1]**

Jason uses a conjuring trick to illustrate the principles used in optical fibres. He places a coin **underneath** a drinking glass and invites his customer to observe the coin through the side of the glass, as shown in Fig. 4.1.

The glass is then filled with water. To the customer observing through the side of the glass, the coin seems to disappear, as shown in Fig. 4.2. When the customer looks down through the water from above the glass, as shown in Fig. 4.3, on the next page, she can see the coin again.

coin visible

Fig. 4.1 Empty glass

coin not visible

Fig. 4.2 Glass full of water

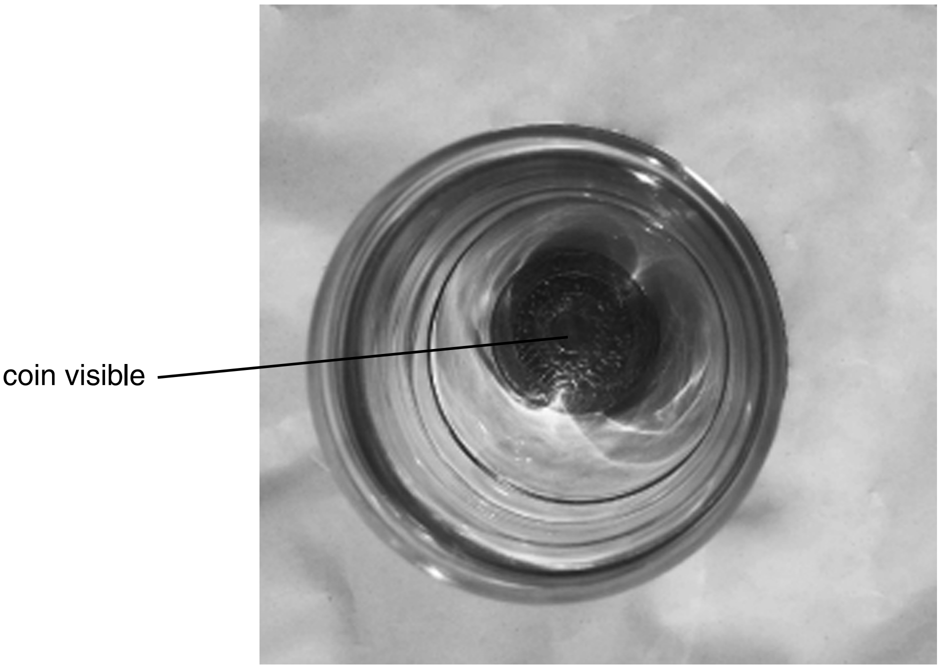


Fig. 4.3 Top view with glass full of water

Jason claims that the glass full of water is like an optical fibre because light rays from the coin do not escape through the side, but get reflected to the top of the glass.

(c) In the conjuring trick, a cylinder of water (refractive index 1.33) is surrounded by a layer of glass (refractive index 1.51). In a step-index optical fibre, a cylinder of one type of glass is coated with a layer of another type of glass.

Discuss whether the glass of water is an accurate model of a step-index optical fibre.

Your answer does not need to mention the bottom of the glass.

....

....

....

....

.... **[2]**

Fig. 4.4 is a ray diagram showing one ray of light from the coin passing into the **empty** glass and out through the side of the glass (critical angle = 41°).

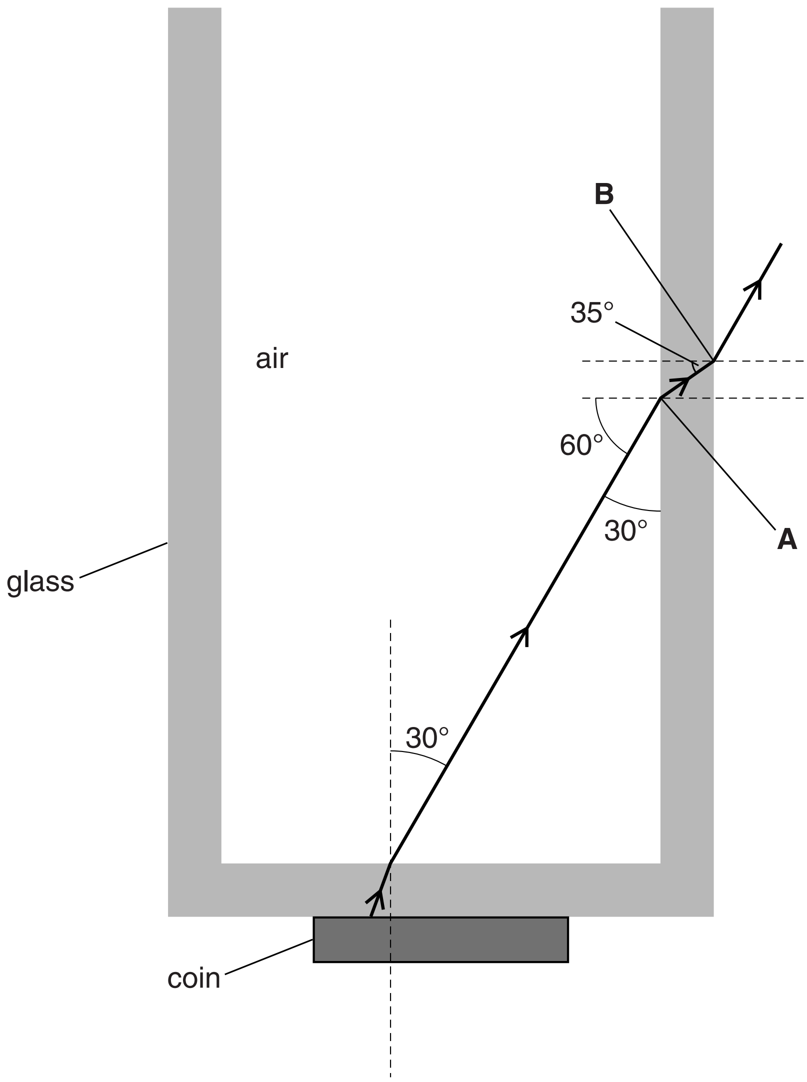


Fig. 4.4

(d) Explain why total internal reflection:

(i) does **not** take place at point **A**

....

....

.... **[1]**

(ii) does **not** take place at point **B**.

....

....

.... **[1]**

Fig. 4.5 is a ray diagram showing one ray of light from the coin passing into the glass **full of water** but **not** out through the side of the glass.

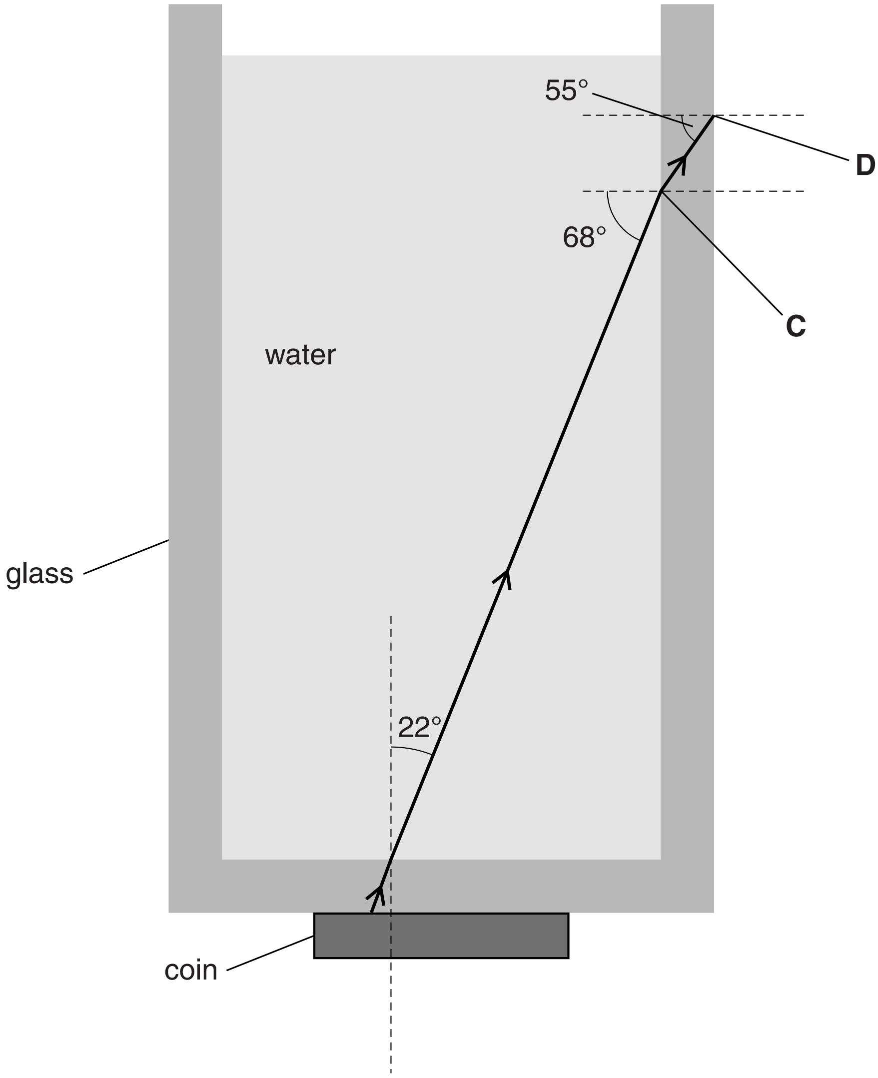


Fig. 4.5

(e) Explain why total internal reflection:

(i) does **not** take place at point **C**, even with water in the glass

....

.... **[1]**

(ii) **does** take place at point **D**.

....

.... **[1]**

(f) Fig. 4.6 below represents a graded-index optical fibre used for data transmission. A ray of light is shown entering the fibre.

(i) The shading shown in the diagram varies. This represents a variation of a property of the glass.

Name this property and describe the variation.

....

....

....

....

.... **[3]**

(ii) Draw a continuation of the ray through the graded-index optical fibre.

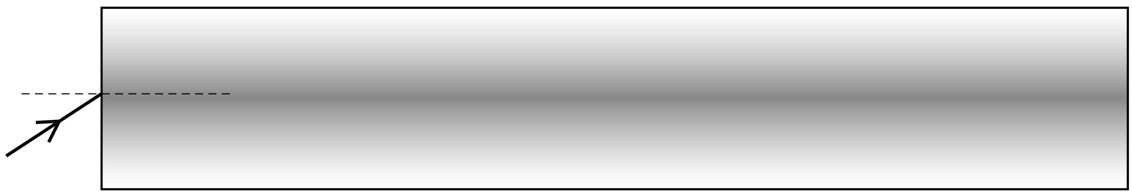


Fig. 4.6 Graded-index optical fibre

[3]

(iii) State and explain the advantages of graded-index optical fibres compared to step-index optical fibres for long distance data transmission.

....

....

....

....

....

....

....

....

....

.... **[5]**

[Total: 21]

5 Mobile phone systems enable very large numbers of us to share the small number of available radio frequencies. This is achieved by the use of cellular and multiple access technologies.

(a) Cellular technology divides the country into cells served by base stations.

Fig. 5.1 is a map showing the distribution of base stations (mobile phone masts) in one area of the United Kingdom. The scale indicates the distance on the map corresponding to 100 m. The width of the map shown represents about 1.5 km.

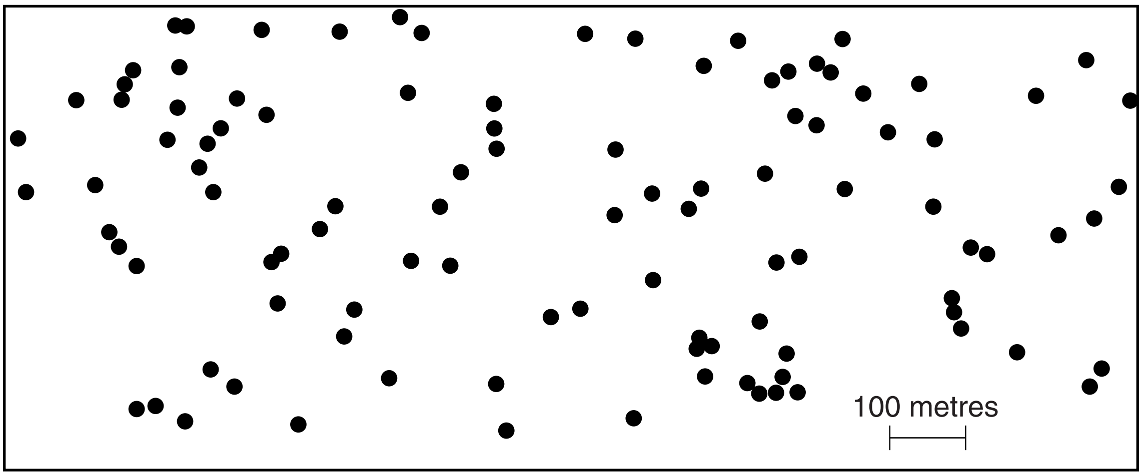


Fig. 5.1 Distribution of base stations

(i) Suggest the type of location represented by the map.

....

.... **[1]**

(ii) The distribution of base stations in Fig. 5.1 appears more random than the ideal hexagonal arrangement shown in Fig. 5.2 on the next page. One reason for this distribution is that base stations from more than one provider are shown.

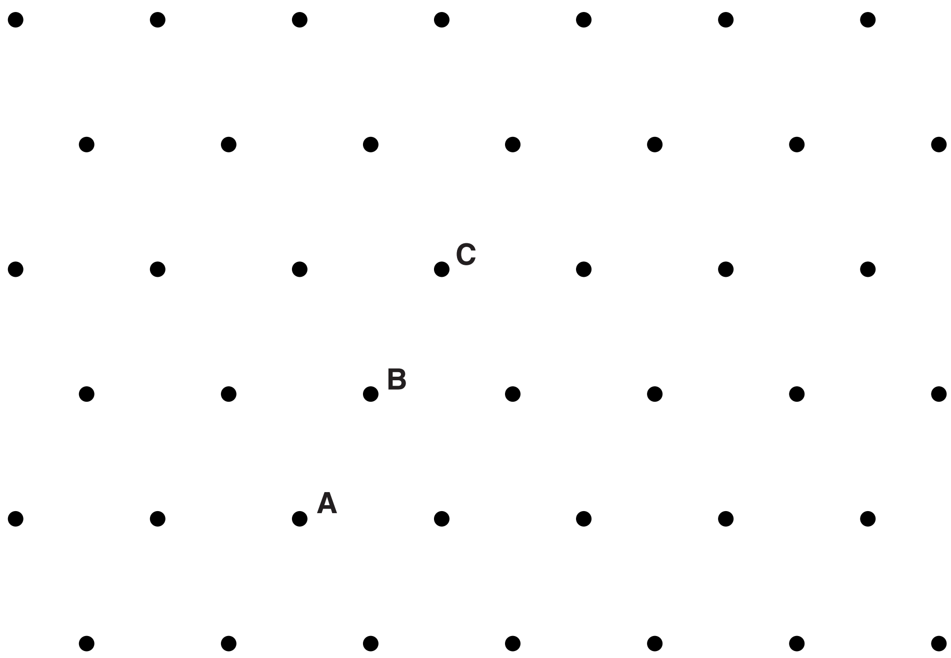
Suggest **two** other reasons.

1 ....

2 ....

[2]

(iii) On Fig. 5.2, draw the cell or cells served by base station **A**.



[2]

Fig. 5.2 Ideal hexagonal arrangement

(iv) Comment on the radio frequencies that can be chosen for base stations **A**, **B** and **C**.

....

....

.... **[2]**

(b) Explain how multiple access technology enables very large numbers of people to share the small number of available radio frequencies.

....

....

....

....

.... **[2]**

[Total: 9]

6 Digital Audio Broadcasting (DAB) is the type of digital radio broadcasting used in the United Kingdom.

An organisation is campaigning against the proposed switch-off of national FM radio transmissions in the UK. It claims that the quality produced by DAB stations is not as good as that of FM.

The organisation recommends that listeners use internet radio instead of DAB.

(a) FM is one type of analogue radio transmission.

(i) State what the abbreviation FM stands for.

.... **[1]**

(ii) Explain the difference between **analogue** and **digital** radio transmissions.

....

....

....

....

.... **[3]**

(iii) Name another type of analogue radio transmission and explain how it differs from FM.

....

....

....

....

.... **[3]**

(b) Both DAB and internet radio use compressed digital files.

Suggest why compression is necessary.

....

....

.... **[1]**

(c) Pulse code modulation (PCM) is one method of analogue-to-digital conversion.

State **two** factors that might affect the sampling rate in PCM.

....

....

....

....

.... **[2]**

[Total: 10]

7 The word 'radiation' is often used to mean ionising radiation, but it can also include non-ionising radiation.

(a) Fig. 7.1 shows a small selection of hazard warning signs labelled **A** to **E**.

A **B** **C** **D** **E**

Fig. 7.1

When answering the questions, each of the letters, **A** to **E**, may be used once, more than once or not at all.

State which sign or signs, **A** to **E**, warn of the following hazards:

(i) hazards caused by ionising radiation .... **[1]**

(ii) hazards caused by electromagnetic radiation .... **[1]**

(iii) hazards caused by waves .... **[1]**

(b) Give **two** examples of ionising radiation.

....

.... **[1]**

(c) State what is meant by the term *ionising radiation*.

....

.... **[1]**

(d) Explain how ionising radiation damages living cells.

....

....

....

.... **[2]**

(e) Give **two** examples of health problems that might result from exposure to ionising radiation.

....

....

....

.... **[2]**

(f) Ionising radiation may be used in hospitals for both diagnosis and treatment.

(i) State **one** example of the use of ionising radiation for **diagnosis**.

.... **[1]**

(ii) State **one** example of the use of ionising radiation for **treatment**.

.... **[1]**

(iii) How might a doctor justify the use of ionising radiation on patients, despite the hazards?

....

....

.... **[1]**

Question 7 (g) begins on page 20

(g) For each of the cases described below, give a different way in which the radiation dose may be reduced.

(i) **Patients** undergoing **diagnosis** using ionising radiation.

....

.... **[1]**

(ii) **Patients** undergoing **treatment** using ionising radiation.

....

.... **[1]**

(iii) **Hospital staff** providing diagnosis or treatment using ionising radiation.

....

.... **[1]**

(h) The intensity of an X-ray beam that has passed through a body has been affected by all the layers it has passed through. It is much more helpful to the doctor if there is an image of each individual layer. A device which solves this problem is the Computerised Axial Tomographic (CAT) scanner.

Describe the basic principles of CAT scanning.

[5]

[Total: 20]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.