OCR
Oxford Cambridge and RSA

Thursday 15 June 2017 – Morning

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

G6350 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 page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 Images can be made using radiation from all parts of the electromagnetic spectrum.

(a) An image made using **gamma rays** shows a patient's heart.

(i) Name the device used to capture this image.

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

(ii) The patient had been injected with a special isotope to produce the image.

State the purpose of the isotope.

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

(iii) The formation of this image is an example of gamma radiation used **diagnostically**.

Give an example of how gamma radiation can be used **therapeutically**.

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

(b) **Polarised light** was passed through a very thin slice of a rock sample, then through a polarising filter, before reaching a camera.

(i) Describe what is meant by '**polarised light**'.

.....

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

(ii) Suggest the function of the polarising filter placed between the rock sample and the camera.

.....

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

(c) **Microwave** radar data from a satellite was used to make another image. It showed the coverage of vegetation over large areas of the earth, unseen in visible light due to cloud.

(i) The boxes in Fig. 1 correspond approximately to regions of the electromagnetic spectrum.

Write the letter '**m**' in the box in Fig. 1 which indicates the microwave region of the electromagnetic spectrum. **[1]**

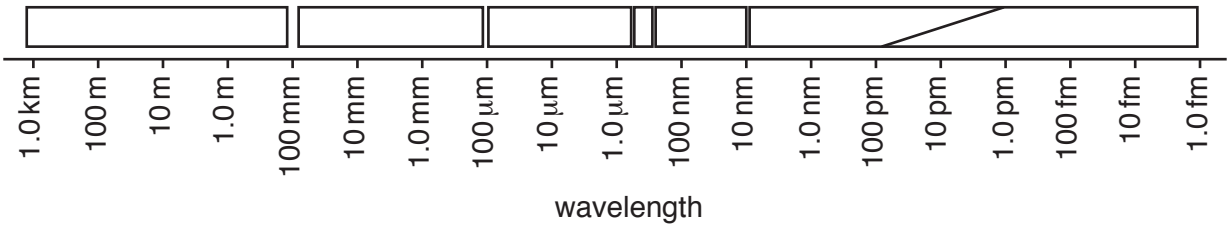


Fig. 1

(ii) Suggest what property of microwave radiation makes it suitable for use in this application.

.....

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

(d) The electromagnetic radiation near the left end of Fig. 1 has a wavelength of 1.0 km. The speed in a vacuum of this radiation is $3.00 \times 10^8\,m\,s^{-1}$.

Calculate its frequency.

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

(e) Near the other end of Fig. 1 the wavelength is 10 pm. Suggest a value for the speed of the electromagnetic radiation in a vacuum at this wavelength.

You may use the information given in **(d)**.

speed in vacuum = ... $m\,s^{-1}$ **[1]**

[Total: 11]

2 **(a)** A stretched wire is forced to vibrate by a mechanical oscillator. Figs 2.1 to 2.4 show a series of **standing** waves in the wire.

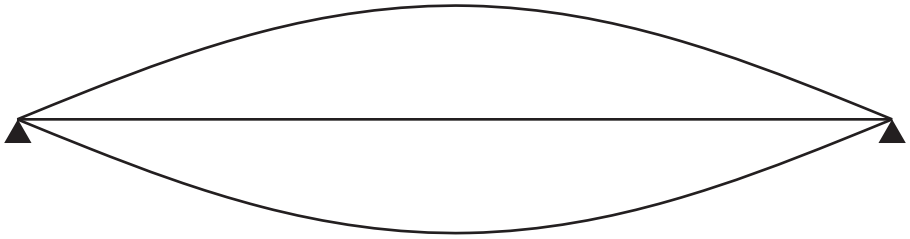


Fig. 2.1

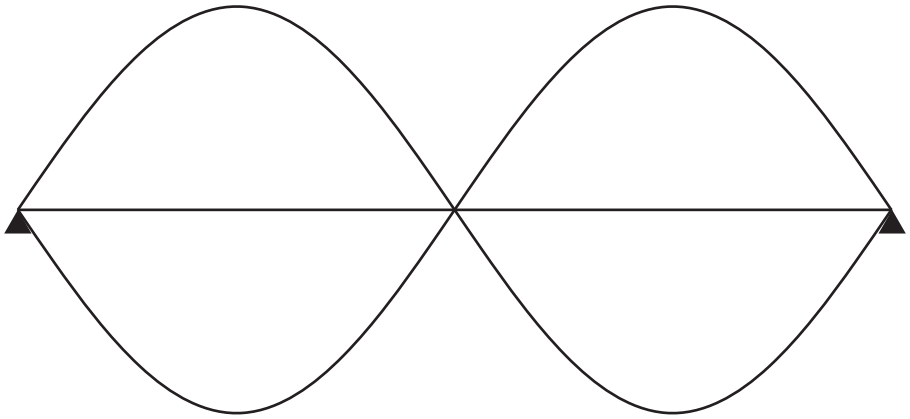


Fig. 2.2

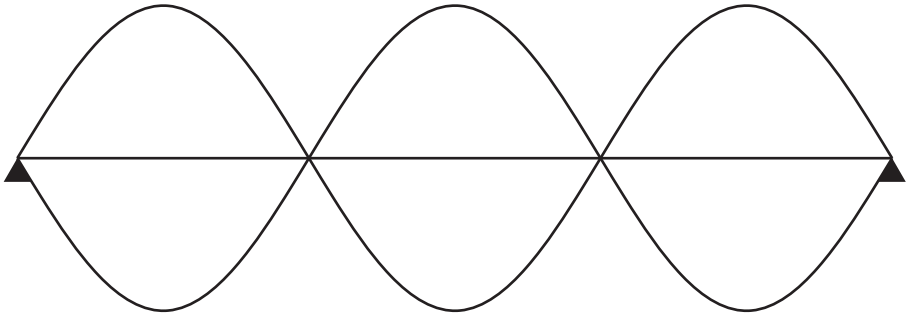


Fig. 2.3

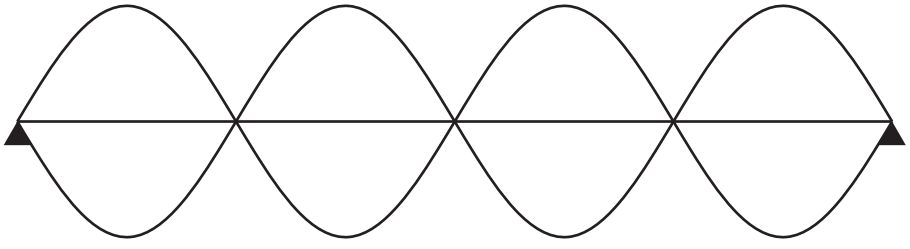


Fig. 2.4

(i) Label on any of Figs 2.1 to 2.4:

two nodes with the letter '**N**'
and
two antinodes with the letter '**A**'. **[1]**

(ii) To produce the standing waves, the **same** wire was stretched to the **same** tension in each case.

Describe what changes caused the differences between the different standing waves in Figs 2.1 to 2.4.

.....

.....

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

(iii) Small changes in the **wire** would cause the standing waves to collapse.

State **two** such changes.

.....

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

(iv) Fig. 2.5 is the same as Fig. 2.1. Draw a double-headed arrow on Fig. 2.5 to show how you would measure the amplitude of the wave.

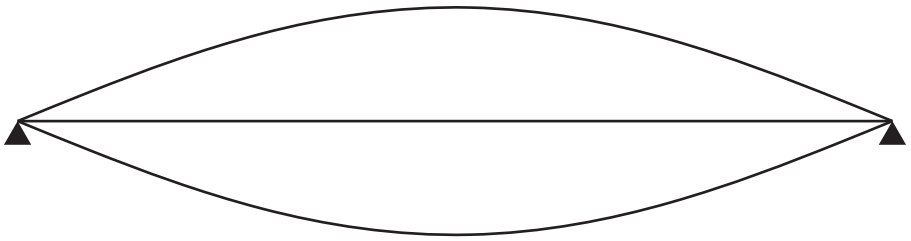


Fig. 2.5

[1]

(b) The thick solid line in Fig. 2.6 is a graph of a **progressive** wave.

Draw a similar wave, but with a phase lag of $\pi/2$ radians (90°) on Fig. 2.7.

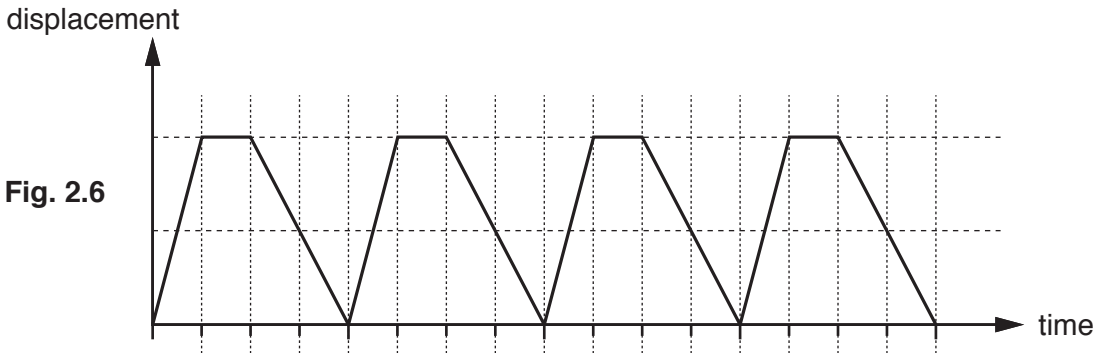


Fig. 2.6

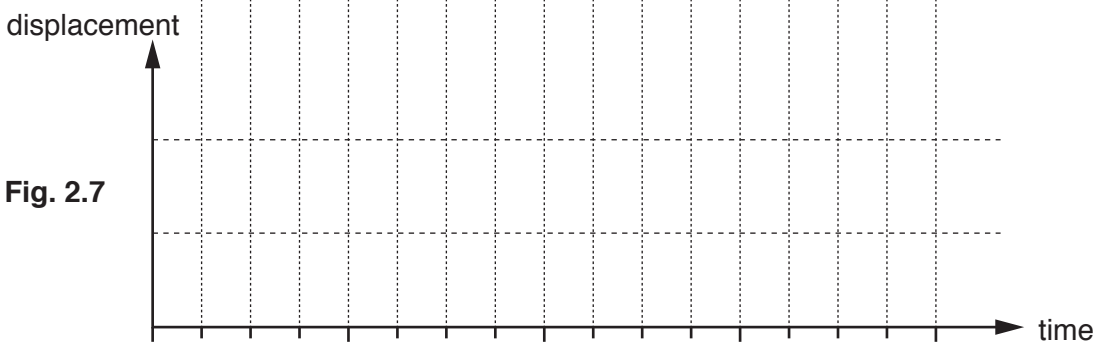


Fig. 2.7

[2]

[Total: 8]

3 **(a)** Fig. 3.1 shows a special cube used by photographers to calibrate the levels of white, grey and black in photographs. The suppliers claim that the hole in one side and the black-painted interior provide an example of "absolute black".

Discuss whether the hole and black interior are a "perfect black body".

Fig. 3.1

.....

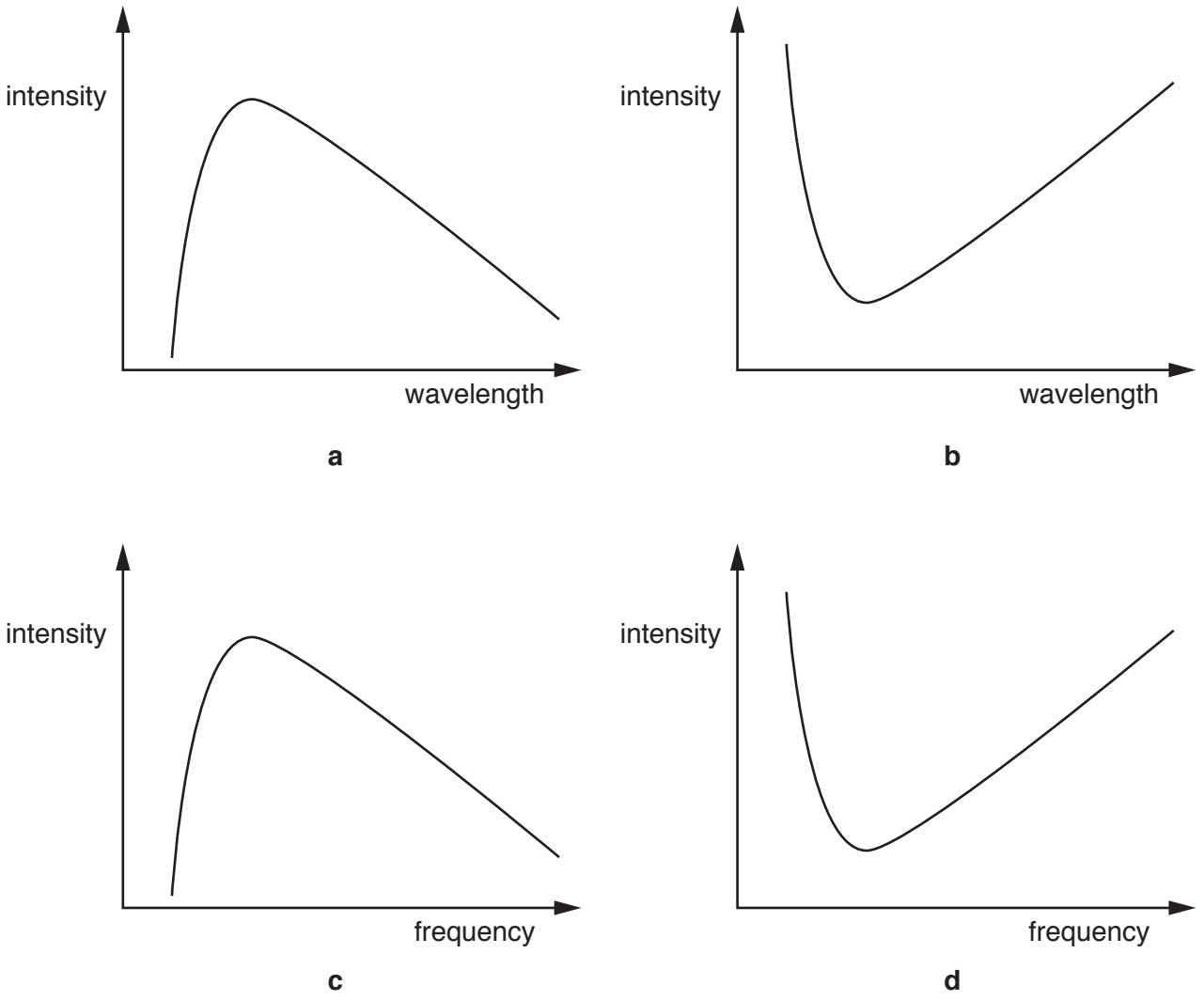
.....

.....

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

(b) (i) Circle the letter that indicates which of the diagrams **a** to **d** in Fig. 3.2 most accurately shows the emission spectrum of the sun (5800 K).

Diagram: **a** **b** **c** **d**



[1]

Fig. 3.2

(ii) State **two** differences between the emission spectrum of a blue star at 40 000 K and the emission spectrum of the sun.

.....

.....

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

(c) A satellite carries a thermal imaging camera and a normal visible light camera to take images of mountains on the earth.

(i) State which region of the electromagnetic spectrum is detected by a thermal imaging camera.

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

(ii) Explain why different areas of mountains appear as different colours in the thermal imaging camera image.

.....

.....

.....

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

(iii) Suggest **two** advantages of using a thermal imaging camera in this application.

1 .....

.....

2 .....

.....

[2]

(iv) State the meaning of the following terms used in the specifications of thermal imaging cameras:

1 spatial resolution.....

.....

2 thermal resolution .....

.....

[2]

(v) Suggest why low values of each of these properties would be better for producing the satellite image of the mountains:

1 spatial resolution.....

.....

2 thermal resolution .....

.....

[2]

[Total: 15]

4 **(a)** Fig. 4.1 is a three-dimensional view of a block of glass called a right-angled prism. It has a right angle between two of its faces and 45° angles between two other pairs of faces. Right-angled prisms like this are used as reflectors.

The critical angle of the glass is 42°.

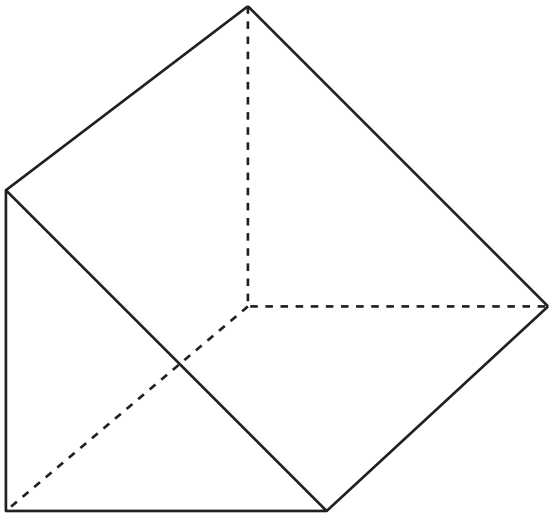


Fig. 4.1

Fig. 4.2 is a two-dimensional view of the same prism with a light ray entering it.

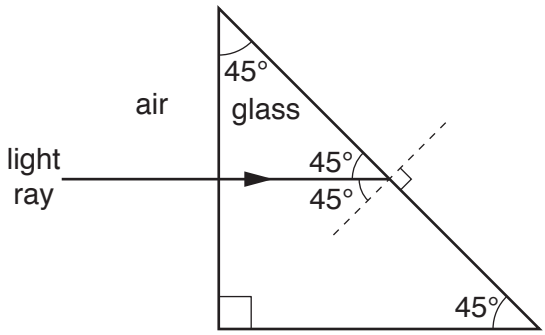


Fig. 4.2

(i) Draw on Fig. 4.2 to show what happens to the light ray after it meets the diagonal face. **[1]**

(ii) Fig. 4.3 shows a two-dimensional view of a different right-angled prism, with a light ray entering it. It is made from the same glass but has angles of 90°, 60° and 30°.

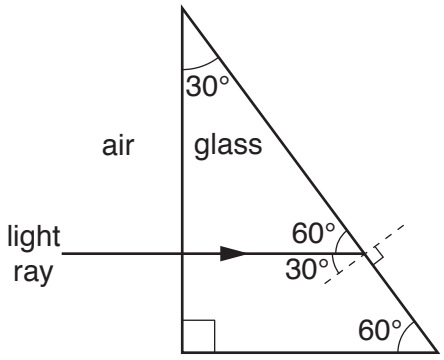


Fig. 4.3

Draw on Fig. 4.3 to show what happens to the light ray after it meets the diagonal face. **[1]**

(iii) State whether your answer to **4(a)(ii)** shows what happens to **all** the energy of the incident ray.

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

(iv) Explain why the ideas behind your answers to **(i)** and **(ii)** are important in understanding optical fibres.

.....

.....

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

(b) The refractive index between the glass used in the prisms in **(a)** and air is 1.5. In a typical step-index optical fibre, the relative refractive index between the core and cladding is 1.03.

Describe how this lower relative refractive index, compared to glass used in the prisms, affects:

(i) the critical angle.

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

(ii) whether light can travel down the optical fibre.

.....

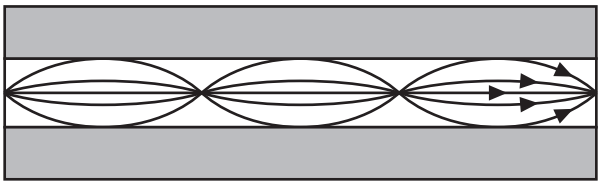
.....

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

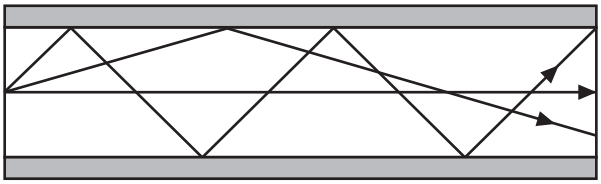
(c) Fig. 4.4 shows light passing along three types of optical fibre.

Write, beside each one, the name of the type of optical fibre.

1 .....



2 .....



3 .....

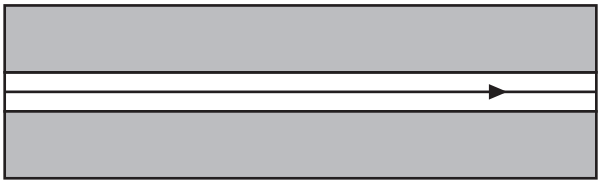


Fig. 4.4

[3]

(d) Fig. 4.5 shows a signal **entering** the optical fibres in **(c)**.

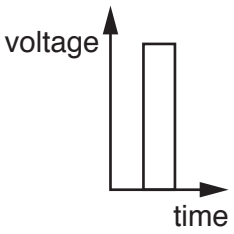
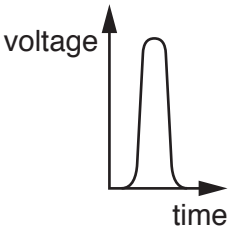


Fig. 4.5

Figs 4.6–4.8 show the signals **leaving** each of the optical fibres.

Write under each one, the **number** of the corresponding optical fibre in Fig. 4.4.



.....

Fig. 4.6

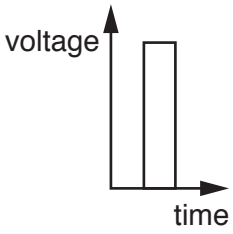


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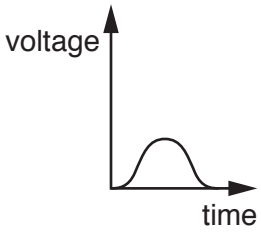
Fig. 4.7



.....

Fig. 4.8

[1]

(e) Telephone companies often prefer to use optical fibres rather than conventional copper wires for data transmission.

State the **two** advantages of optical fibres compared to conventional copper wires which are **most** important for a communications link between the security services and the government.

1 .....

2 .....

[2]

(f) State and explain which type of optical fibre **bundle** you would choose for public telephone communications links.

Type of optical fibre bundle .....

Reason for choice .....

.....

[1]

[Total: 16]

5 **(a)** Fig. 5.1 shows part of a poster advertising a stage show by a radio presenter. The poster uses two waveforms to represent 'radio'.

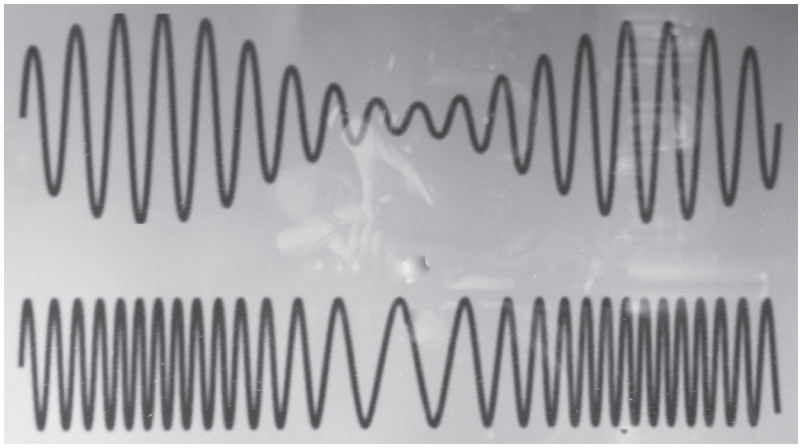


Fig. 5.1

(i) State the name given to the type of radio wave shown in the top half of Fig. 5.1.

.....

State the name given to the type of radio wave shown in the bottom half of Fig. 5.1.

.....

[2]

(ii) The horizontal axes in Fig. 5.1 could be either of two possible variables.

State **both** of the possible variables plotted along the horizontal axis for the waves in Fig. 5.1.

1 .....

2 .....

[1]

(iii) For artistic reasons, the original poster showed the waves rotated by 90° as shown in Fig. 5.2.

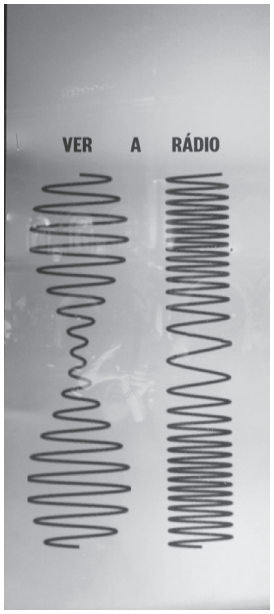


Fig. 5.2

State why **scientists** choose to draw the graph as shown in Fig. 5.1.

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

(b) Digital radio transmissions use binary coding. **1101** is a binary number.

(i) State the equivalent of this number to the base 10 (i.e. the "normal" decimal system).

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

(ii) Add **two** to the binary number **1101** and give the answer in binary.

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

(iii) State **one** similarity and **one** difference between the terms digital and binary.

similarity .....

difference .....

[1]

(c) Some homes still have to rely on broadband connections over conventional copper telephone lines.

How are broadband connections over conventional telephone lines made faster than dial up connections?

.....

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

[Total: 8]

6 **(a)** Cellular mobile telephone networks re-use frequencies.

(i) State **one** reason for frequency re-use.

.....

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

(ii) State where frequencies **cannot** be re-used and explain why not.

Where frequencies **cannot** be re-used .....

.....

Why not .....

.....

[2]

(b) Explain one other feature of the mobile phone system that makes it possible for multiple mobile phone users to make calls in the **same cell** using the **same frequency**.

.....

.....

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

(c) Sheila is an engineer working for a new mobile telephone company. The company asks her to suggest where the mobile phone masts (base stations) should be placed.

Outline what she should consider as she does this job.

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..... **[5]**

[Total: 10]

7 **(a)** X-rays and infra-red radiation are both used in non-destructive fault finding in engineering.

(i) Give **one** example where X-rays might be chosen rather than infra-red radiation for non-destructive testing.

.....

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

(ii) Give a reason why infra-red radiation would not be suitable in your example in **(i)**.

.....

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

(iii) Give an example where infra-red radiation might be chosen rather than X-rays for non-destructive testing.

.....

.....

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

(b) X-ray image quality is improved by using a **narrow X-ray beam**.

In a classroom demonstration the effect of using a narrow beam can be shown using visible light.

Fig. 7.1 shows rays of light from a narrow source as they are either stopped by an object, or pass it and fall on a screen.

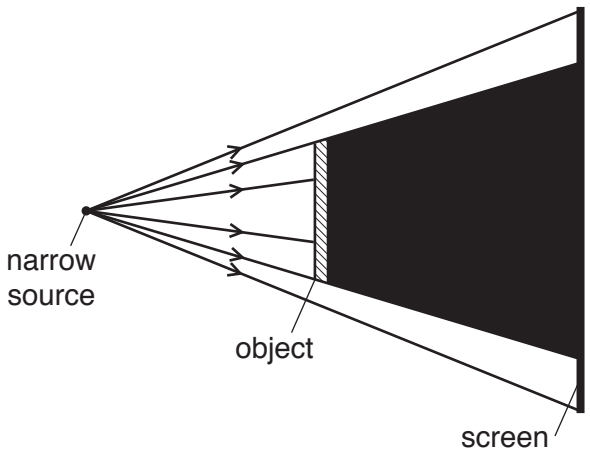

Fig. 7.1

Fig. 7.2 shows rays of light from a wider source as they are stopped by the same object, or pass it and fall on a screen. All the components are in the same places as Fig. 7.1.

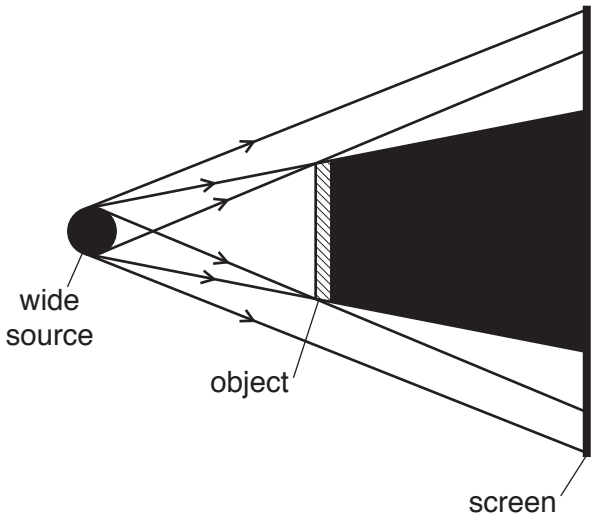

Fig. 7.2

Use Fig. 7.1 and Fig. 7.2 to explain why a narrow X-ray beam would give a sharper image.

.....

.....

.....

.....

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

(c) Medical X-ray image quality is also improved by using **filtration**. Explain this statement.

.....

.....

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

[Total: 8]

8 **(a)** Some types of radiation cause ionisation, others do not.

(i) Tick the right hand column in Table 8 to show which types of radiation **can** cause ionisation.

Type of radiation	Cause ionisation
Gamma-rays	
Infra-red	
Microwaves	
Mobile phone signals	
Visible light	
Wireless internet connections (wifi)	
X-rays	

Table 8

[2]

(ii) Atoms can be ionised by radiation.

Describe what happens to the **structure** and **charge** of an atom when it is ionised by radiation.

Structure .....

Charge .....

[2]

(iii) The atom could be part of a cell.

Describe what might happen to the **cell** because of the ionisation.

.....

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

(b) **Staff** working in hospitals with ionising radiation, sometimes stand behind a lead screen. This reduces their radiation dose.

The half-thickness value of lead = 4.2 mm.

A hospital uses a lead screen 8.4 mm thick.

Calculate the fraction to which the screen reduces the radiation dose the staff receive:

$$\text{fraction} = \frac{\text{dose with the screen}}{\text{dose without screen}}$$

fraction = ... **[2]**

(c) Gabor is a hospital **patient**. He is going to have a CAT scan.

(i) Exposure to radiation during the scan could slightly increase his chances of developing cancer many years later. This risk is estimated at 1 in 2000.

Suggest why he might accept this risk.

.....

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

(ii) Describe how the moving parts in a CAT scanner help to produce a detailed image.

Your answer should include:

- the position of the moving parts relative to the patient
- the movement of these parts relative to the patient
- the measurements made
- the device used to produce the image from the measurements made
- the type of image produced

.....

.....

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.....

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

[Total: 14]

ADDITIONAL ANSWER SPACE

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