OCR
Oxford Cambridge and RSA

Thursday 16 June 2016 – 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

G6350 1

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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 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 website advertises an infrared thermal imaging camera. It is recommended for use by plumbers and electricians and for household security.

(a) (i) State **one** example of how a plumber or an electrician might use this camera.

.....

.....

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

(ii) Describe how you might use this camera for security in your home.

.....

.....

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

(iii) State the advantage of using an infrared camera for security rather than using a visible light webcam.

.....

.....

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

(b) The specification of the thermal imaging camera on the website includes the data shown in Table 1.1.

Temperature range of the scene: 0 °C to 100 °C
Operating temperature: 0 °C to 35 °C
Mass: 110 g
Dimensions: L 140 mm × W 61 mm × H 22 mm
Battery capacity: 1400 mA h
Sensitivity: ability to detect temperature differences as small as 0.1 °C

Table 1.1

(i) Using the data in Table 1.1, state the value of the thermal resolution of the camera.

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

(ii) Suggest why the camera must have a good thermal resolution to be useful to a plumber or electrician.

.....

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

[Total: 5]

2 A shop advertises the product shown in Fig. 2.1 as an 'Analogue clock radio'.

Fig. 2.1

(a) Explain why the clock radio can be described as analogue.

.....

.....

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

(b) State why the clock radio can be described as digital.

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

(c) Write the number '12' as a binary number.

.....

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

(d) Modern telephone signals are binary. Analogue sound signals can be converted to binary by pulse code modulation.

A short section of an analogue signal is shown in Fig. 2.2.

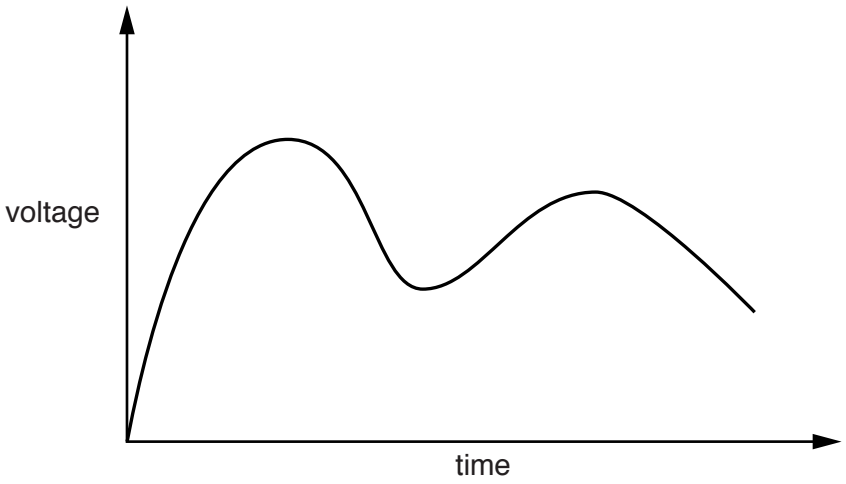

Fig. 2.2

Explain how pulse code modulation can be used to convert this signal from analogue to binary.

.....

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.....

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

[Total: 7]

3 Waves may be longitudinal or transverse. Both types of waves are used for communication.

(a) Sound is a type of longitudinal wave.

A source of sound, such as a tuning fork, causes the air molecules around it to vibrate. This vibration travels through the air to the ears of a listener.

The lines in Fig. 3.1a represent the positions of a set of molecules in undisturbed air.

The lines in Fig. 3.1b represent the positions of the set of molecules when sound is travelling through them between a tuning fork and a listener's ear.

(i) Explain how the differences between Figs 3.1a and 3.1b show that sound waves are longitudinal.

.....

.....

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

(ii) The lines in Fig. 3.1c represent the positions of the set of molecules a short time later.

Compare Figs 3.1b and 3.1c to explain how they show that this is **not** a standing wave.

.....

.....

.....

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

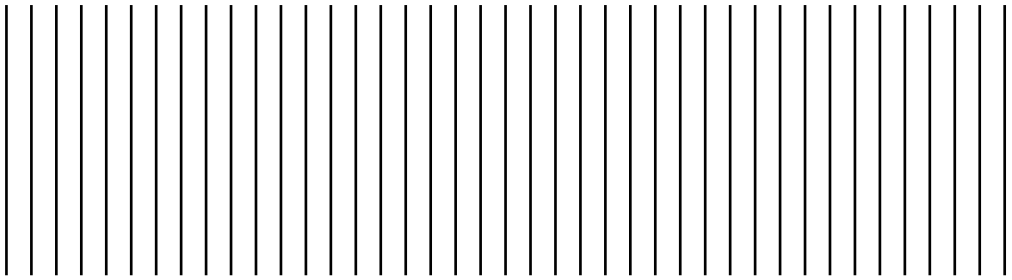


Fig. 3.1a

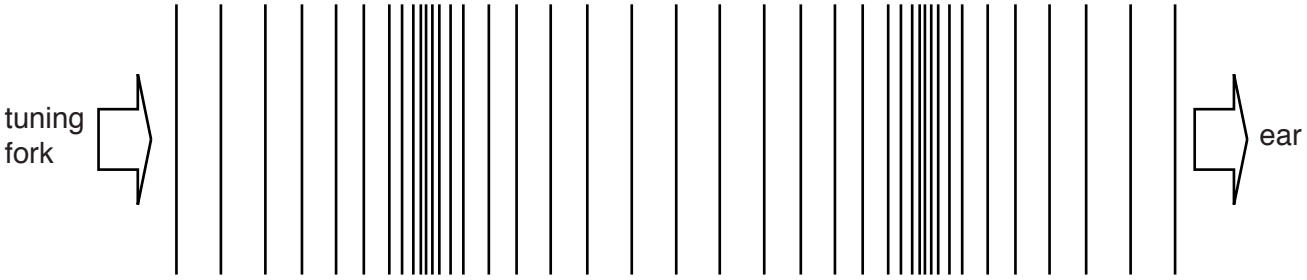


Fig. 3.1b

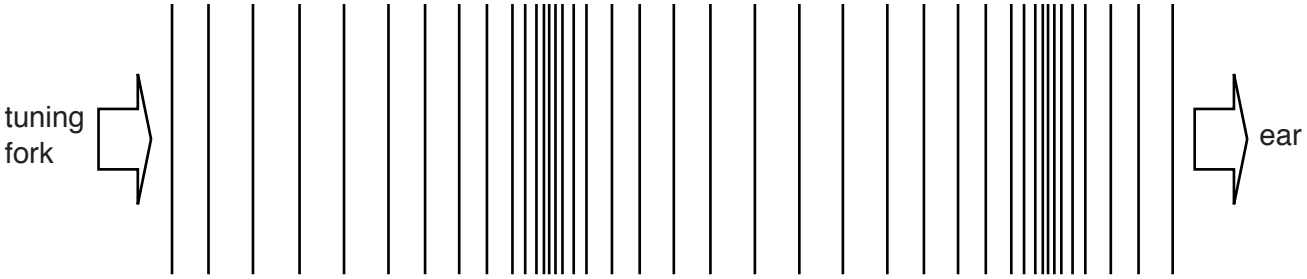


Fig. 3.1c

(b) Electromagnetic radiation is a type of transverse wave.

(i) An electromagnetic wave is a variation in an electric and a magnetic field at the same time.

The cross in Fig. 3.2 represents an electromagnetic wave going away from you into the paper. Draw and label arrows on Fig. 3.2 to show the directions of the electric and magnetic fields.

Fig. 3.2

[1]

(ii) Alternating current (a.c.) in a conductor produces electromagnetic radiation.

1 State which **two** regions of the electromagnetic spectrum can be produced in this way.

region .....

region .....

2 The range of frequencies of electromagnetic radiation that can be produced by alternating current is limited.

Explain how and why the range of frequencies is limited.

.....

.....

.....

[4]

(iii) Most devices that use electromagnetic waves only use one region of the electromagnetic spectrum.

Complete Table 3.1 by writing in the right-hand column an example of **one** device that uses electromagnetic radiation in **each** of regions 'A' and 'B'.

	Approximate wavelength range / m	**Approximate frequency range / Hz**	**Device**
Region A	1×10^{-12} to 1×10^{-8}	3×10^{20} to 3×10^{16}	
Region B	1×10^{-8} to 4×10^{-7}	3×10^{16} to 8×10^{14}	

[2]

Table 3.1

(iv) The values given for wavelength and frequency in Table 3.1 are approximate. One wavelength value given in the table is 4×10^{-7} m.

Select from the information in Table 3.1 the frequency value corresponding to the wavelength 4×10^{-7} m.

Corresponding value for frequency = ...Hz **[1]**

(v) Use your answer in **(iv)** to calculate the velocity of electromagnetic radiation.

Give your answer to **one** significant figure.

velocity of electromagnetic radiation = ... m s^{-1} **[3]**

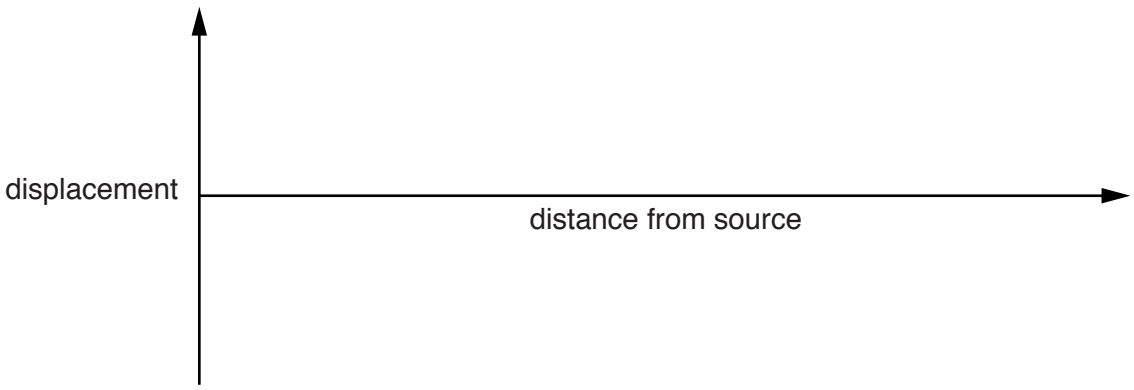
(vi) State why your answer should only be given to one significant figure.

.....

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

(c) Sound waves and electromagnetic waves can both be examples of repeating waves.

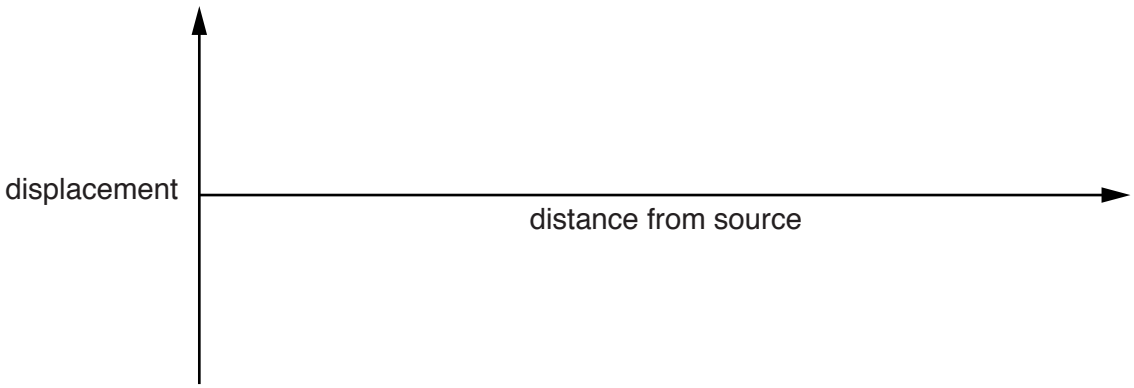
(i) **Draw on Fig. 3.3** an example of a repeating wave which is **not** a sine wave.



[1]

Fig. 3.3

(ii) **Draw on Fig. 3.4** an example of a non-repeating wave.



[1]

Fig. 3.4

(iii) The horizontal axes in Figs 3.3 and 3.4 are labelled 'distance from source'.

An engineer measured the variation in displacement caused by a wave as it passed **one** particular point over a period of 1 minute, and plotted the results on a graph.

State how the engineer should label the **two** axes on their graph.

vertical axis .....

horizontal axis .....

[2]

[Total: 19]

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4 Astronomers have compared stars with wildflowers because each star radiates a different colour of the rainbow.

Fig. 4.1 shows the total radiation emitted by three stars at temperatures of 7000 K, 5270 K and 400 K. The two vertical lines mark the limits of the visible part of the spectrum.

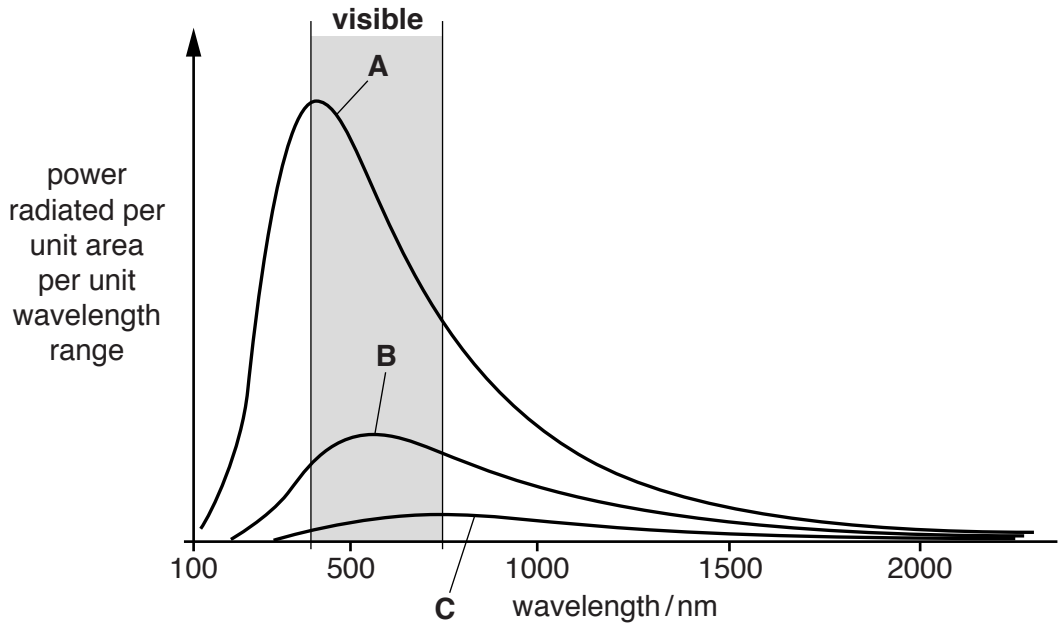

Fig. 4.1

(a) Write **A**, **B** or **C** below to show which line in Fig. 4.1 corresponds to each of the given temperatures.

400 K .....

5270 K .....

7000 K .....

[1]

(b) Suggest the colour of each of the three stars. Explain your answers.

A colour .....

explanation .....

.....

B colour .....

explanation .....

.....

C colour .....

explanation .....

.....

[6]

(c) A perfect black body may emit colours such as those in part **(b)** above.

Explain why is it called a black body.

.....

.....

.....

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

[Total: 9]

5 The principle used in fibre optics was first demonstrated in the 19th century. It was not until the 1950s that experiments cladding a simple fibre with another layer of glass were carried out.

In recent years, telephone companies have replaced many of the old copper telephone wires with monomode optical fibres.

(a) (i) State **two** advantages of cladding a simple fibre with another layer of glass.

1 .....

2 .....
[2]

(ii) State the difference in the refractive index of these two layers.

.....

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

(iii) Explain what effect the difference in the refractive index has on rays of light passing down the fibre.

.....

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

(b) Light travels along optical fibres even when they are slightly curved.

Explain how the critical angle determines how much the fibre can be bent before light leaks. You may include a diagram in your answer.

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

(c) Fig. 5.1a shows a square wave signal as it enters a step-index fibre.

Fig. 5.1b shows the signal as it leaves the fibre after travelling a distance of 1 km.

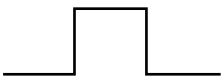

Fig. 5.1a

Fig. 5.1b

Explain the reason for this distortion of the signal.

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

(d) Monomode fibres are used for telephone cables because they require fewer repeater stations than step-index fibres.

Explain why monomode fibres require fewer repeater stations than step-index fibres.

.....

.....

.....

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

(e) State **two** advantages, other than 'fewer repeater stations', of using optical fibres for transmission when compared to copper wires.

1 .....

2 .....

[2]

(f) A manufacturer of optical fibres has a laboratory to test its products. A work experience student is asked to do some simple measurement exercises.

(i) The first exercise is to measure the refractive index of a rectangular block of glass. The student is asked to place a block of glass on a piece of paper and to trace the path of a ray of light on the paper.

The block and ray are shown in Fig. 5.2.

Describe the method the student should use to trace the ray.

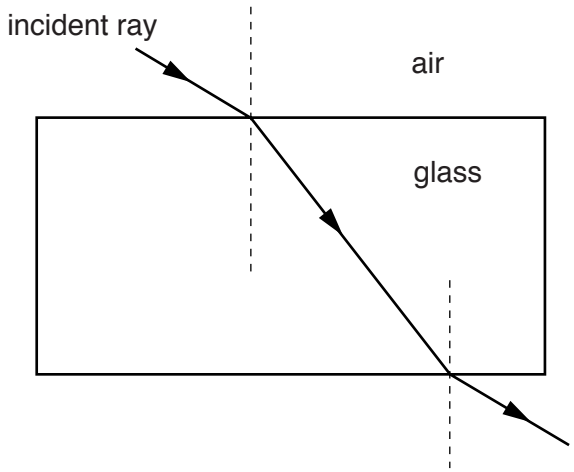

Fig. 5.2

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

(ii) The second exercise is to measure the critical angle of the block of glass shown in Fig. 5.3. The block is mounted on a turntable so that it can rotate relative to the incident ray. The centre of curvature of the block is marked with a letter 'X' as shown in Fig. 5.3.

Explain why it is important to position the block so that 'X' is at the centre of the turntable.

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

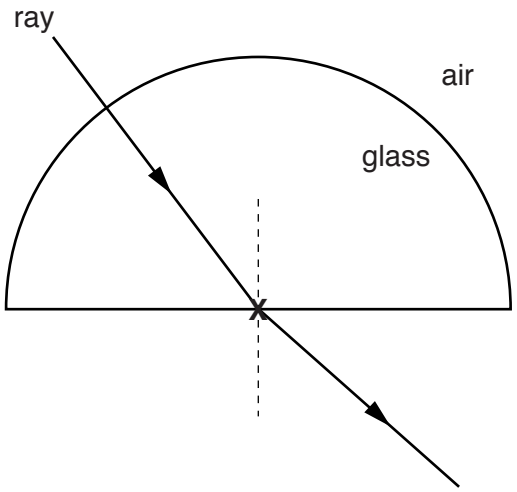

Fig. 5.3

(iii) The third exercise involves sending light down an optical fibre and detecting it at the other end.

1 State what device is used to send light into an optical fibre for communications.

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

2 State what device can be used to detect the light.

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

(iv) In the final exercise the student tests coherent and incoherent bundles of optical fibres.

Suggest **one** application in which **each** of these types of bundles would be preferred.

coherent .....

.....

incoherent .....

.....

[2]

[Total: 23]

6 Fig. 6.1 shows an idealised view of the arrangement of some of the transmitters in a mobile phone network. (NB: This is a simplified view in which the masts are shown at the centres of the cells.)

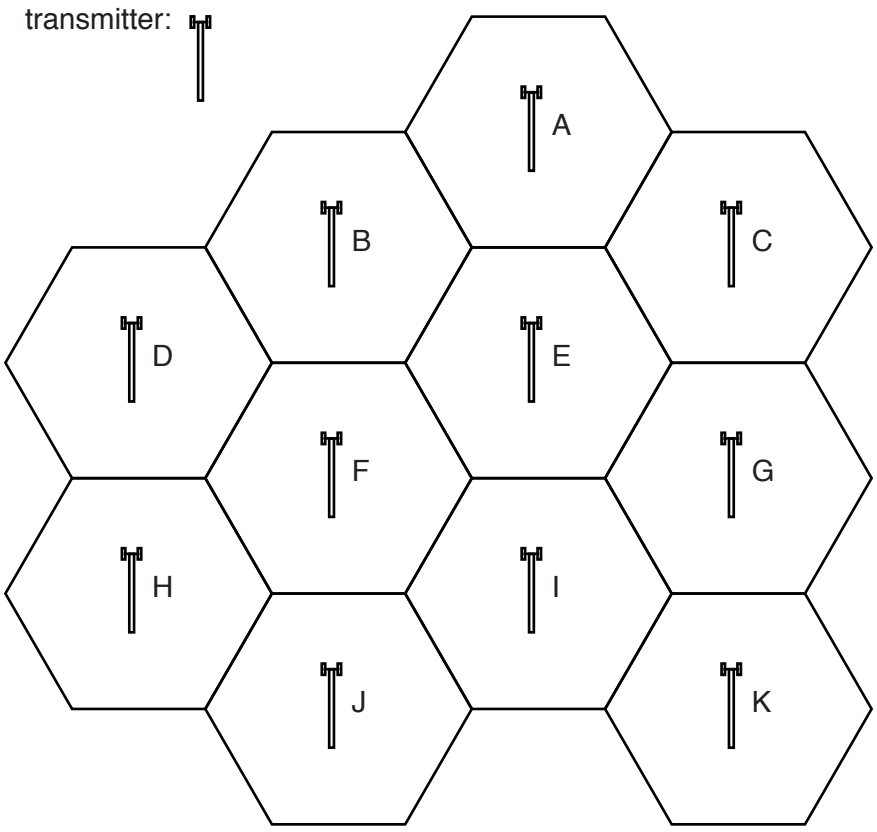

Fig. 6.1

(a) In practice, the size and shape of cells is much more irregular than that shown in Fig. 6.1.

List **two** reasons for these differences.

1 .....

.....

2 .....

.....

[2]

(b) Explain the terms *up-link* and *down-link* when referring to mobile phone usage.

.....

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

(c) Mobile phones use radio signals.

Explain what is meant by full duplex and half duplex radio systems.

full duplex .....

.....

half duplex .....

.....

[2]

(d) In Fig. 6.1, discuss which of the transmitters A to E and G to K could use the same frequency as transmitter F, and which could not.

Use your answer to explain how cellular technology makes it possible for a large number of people to use their mobile phones at the same time.

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

[Total: 11]

7 X-rays and γ-rays are used in hospitals so that health workers can see beneath the skin. X-ray imaging is a non-invasive technique, which means that surgery is not needed to examine a patient.

(a) X-ray image quality can be improved by using a **grid**. Fig. 7.1 is a diagram of an X-ray beam passing through a patient and meeting a grid before reaching the sensor.

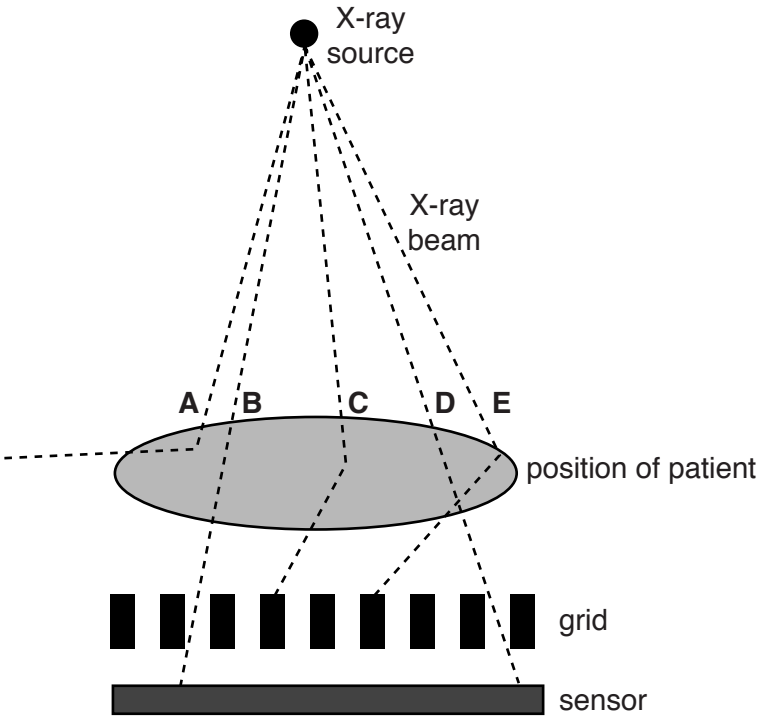

Fig. 7.1

Describe and explain, with reference to Fig. 7.1, how the grid improves the quality of X-ray images.

You should refer to the rays labelled **A** to **E** in your answer.

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.....

.....

..... **[4]**

(b) Image-intensifying screens are used with X-ray film to reduce dose rate.

(i) Fluorescent screens are used in image-intensifying screens and are also found in most digital X-ray cameras.

Describe what these fluorescent screens do.

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

(ii) Describe the differences between the processes used in image-intensifying screens and in digital X-ray cameras.

.....

.....

.....

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

(c) Explain how X-ray images are formed and why some parts of the body do not form good X-ray images.

.....

.....

.....

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

(d) Radioactive tracers which emit γ-rays are put into patients' bodies to obtain images of parts of the body which do not form good X-ray images.

A radioactive tracer has a physical half-life of 6 hours and a biological half-life of 12 hours.

(i) State what is meant by *physical half-life*.

.....

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

(ii) State what is meant by *biological half-life*.

.....

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

(iii) Calculate the overall (effective) half-life of the tracer. Show your working.

Overall (effective) half-life of the tracer = ... hours **[3]**

(e) Ionising radiation is used therapeutically to kill cancerous cells.

Explain how doctors can minimise the radiation dose to healthy cells.

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.....

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

[Total: 16]

END OF QUESTION PAPER

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).