OCR
RECOGNISING ACHIEVEMENT

Friday 14 June 2013 – 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

G6350161 3

G 6 3 5 0 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 **24** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Fig. 1.1 shows part of an art installation by Bruce Munro that was displayed in Salisbury Cathedral in 2011. The installation consists of round towers made up of plastic bottles filled with water and illuminated with fibre optics.

Fig. 1.2 shows the inside of one of the towers, viewed from above. In each tower, a single lamp provides the illumination for all the bottles. The light travels from the lamp to the bottles through the optical fibres. The colour and intensity of the lights are controlled electronically in response to background music.

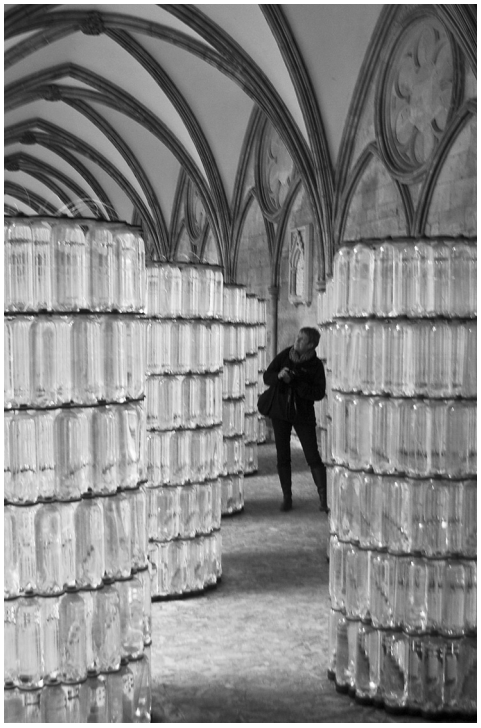

Fig. 1.1

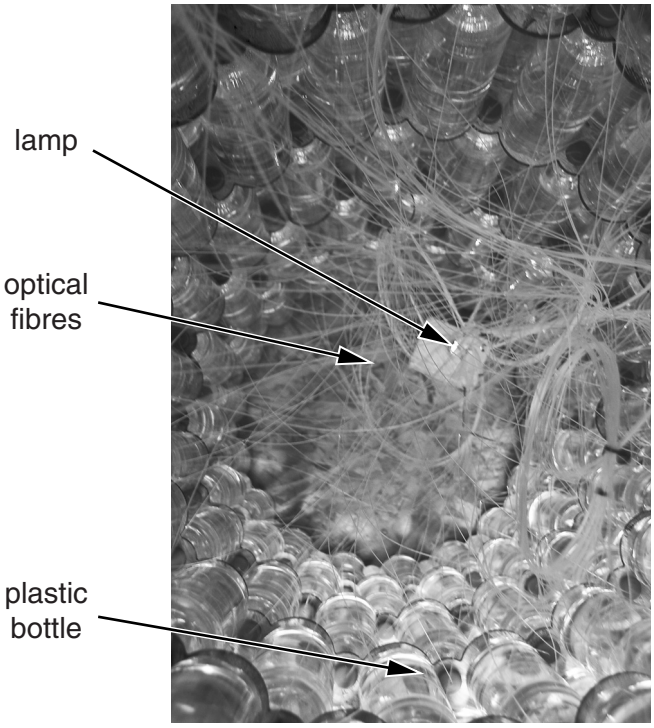

Fig. 1.2

(a) During one sequence the light changes from red to blue and gradually becomes brighter.

State how this affects the following properties of the light wave.

wavelength .....

frequency .....

speed .....

amplitude .....

[4]

(b) The optical fibres used for this application are single uniform strands of uncoated glass.

(i) Name the process that prevents light from leaking out of the sides of the fibres before it reaches the bottles.

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

(ii) Explain **how** this process prevents light from leaking out of the sides of the fibres.

Your answer should include a comparison of the refractive indices for light in glass and air, and a comparison of the speeds of light in glass and air.

Your answer should include a diagram.

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

(c) This application uses single strand fibres. For many other applications, bundles of very thin fibres are used. These bundles can be coherent or incoherent.

(i) Describe the difference in the construction of coherent and incoherent optical fibre bundles.

.....

.....

.....

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

(ii) State an application where **incoherent** fibre bundles are likely to be chosen and give **one** reason for this choice.

application .....

reason .....

.....

.....

[2]

(iii) State an application where **coherent** fibre bundles are likely to be chosen and give **one** reason for this choice.

application .....

reason .....

.....

.....

[2]

(d) The light emerging into the bottles in the Bruce Munro art installation is then detected by the eyes of the observer. In some other applications, the light is detected by an electronic device.

Name **one** device that is used to detect light at the end of optical fibres.

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

(e) Optical fibres may be used for long distance communication. Signal degradation may be a problem when optical fibres are used in this way. Graded-index fibres are better in this respect than step-index fibres.

Explain how the radial variation of refractive index in graded-index fibres helps to reduce signal degradation.

You should use diagrams in your answer.

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

[Total: 21]

2 When the wind causes waves to travel in deep water, particles near the surface move in circular paths. This means that the waves are a combination of *'back and forth'* and *'up and down'* wave motions.

(a) State the name of the type of wave in which particles move *'back and forth'* along the direction of travel of the wave.

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

(b) State the name of the type of wave in which particles move *'up and down'* relative to the direction of travel of the wave when the wave is travelling in a horizontal direction.

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

(c) State, with a reason, whether the *'back and forth'* and the *'up and down'* motions of a water wave are polarised.

back and forth .....

.....

.....

up and down .....

.....

.....

[2]

(d) A ripple tank is a shallow glass tank of water used to demonstrate the properties of waves, as shown in Fig. 2.1.

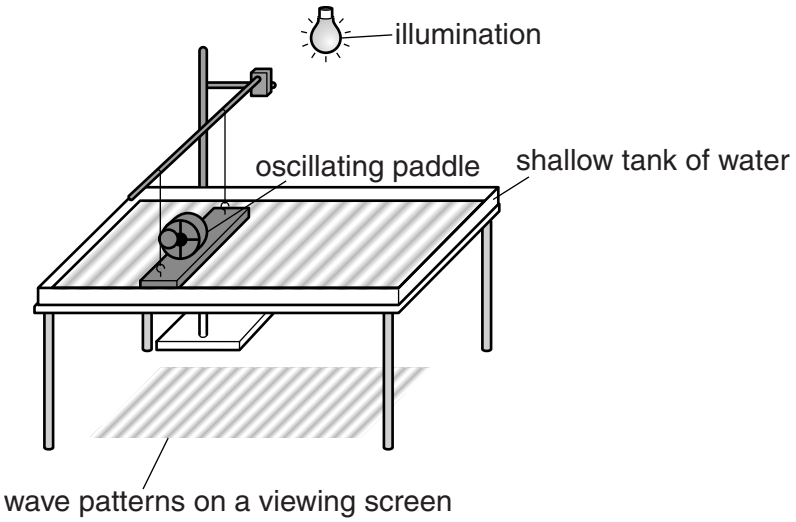

Fig. 2.1

(i) The waves in a ripple tank travel at $0.050\,m\,s^{-1}$.

Calculate the wavelength of a wave with a frequency of 5.0 Hz.

wavelength = ... unit ..... **[3]**

(ii) If the tank is made shallower by placing a sheet of glass in the bottom of the tank, the wave velocity decreases.

Describe what you would expect to happen to the frequency and wavelength of the wave in **(d)(i)** if it meets a shallower section of the tank where the velocity is **halved**.

frequency .....

.....

wavelength .....

.....

[3]

(e) A tsunami is a series of water waves that can travel across oceans. Tsunamis are usually caused by earthquakes or underwater volcanoes. Some tsunamis have caused major disasters.

In deep oceans the waves have a small amplitude, typically 300 mm, and a very long wavelength, typically hundreds of kilometres, and often pass unnoticed. The relationships between velocity, amplitude and wavelength of tsunami waves are more complicated than for waves in a ripple tank.

As they approach the shore, tsunamis slow down from their deep ocean speed of over 800 kilometres per hour to about 10% of that speed and their amplitude increases.

(i) State what is meant by the *amplitude* of a tsunami wave.

.....

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

(ii) Suggest why tsunamis grow in amplitude as they slow down.

.....

.....

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

(f) The waves discussed have all been examples of travelling (sometimes called progressive) waves.

Standing waves can be produced in strings or in a ripple tank by combining two similar waves moving in opposite directions.

(i) Fig. 2.2 shows a **travelling** wave at one moment in time. On the diagram, draw the wave ¼ of a cycle later.

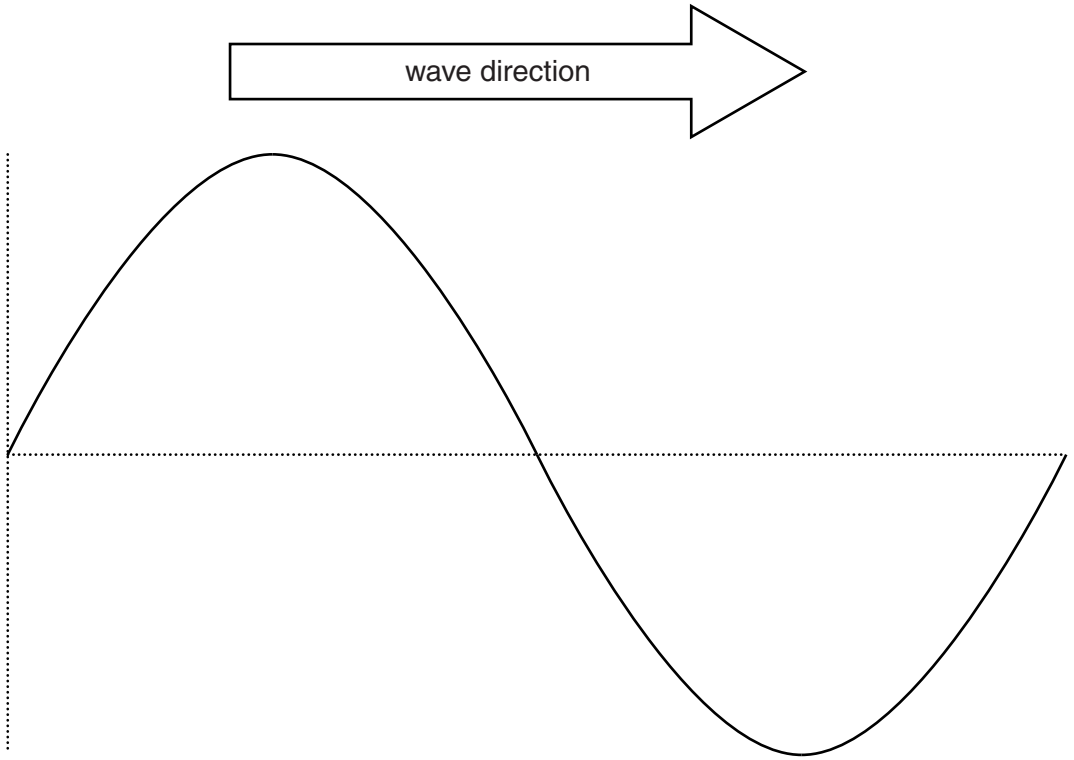

Fig. 2.2

[2]

(ii) Fig. 2.3 shows a **standing** wave at its peak. On the diagram, draw the wave ¼ of a cycle later.

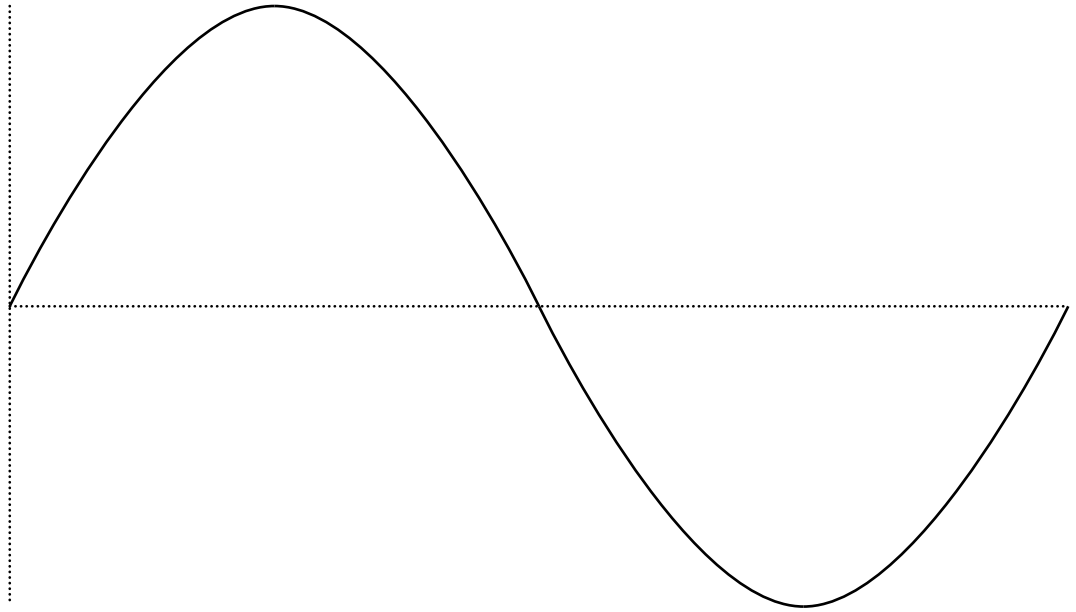

Fig. 2.3

[2]

[Total: 16]

3 Fig. 3.1 is a chart showing the wavelengths and frequencies of radiation in the electromagnetic spectrum. The visible region of the spectrum is shown by the shaded section.

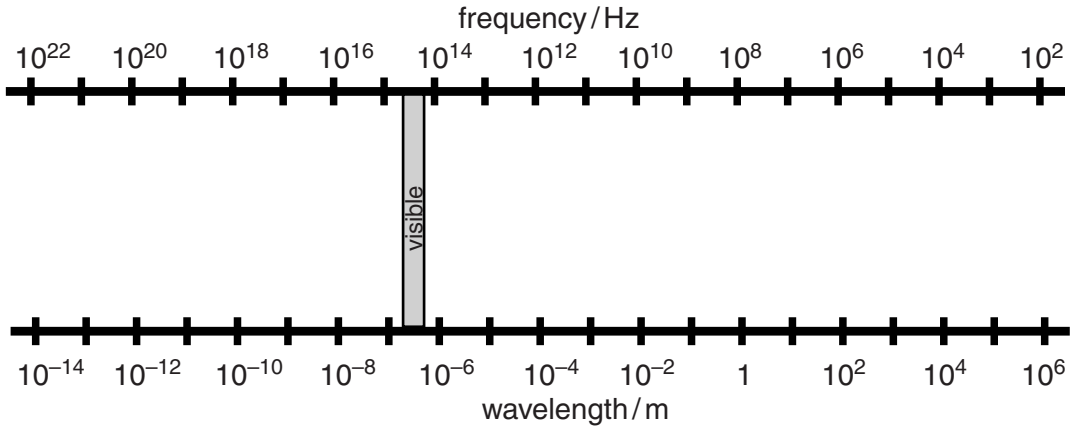

Fig. 3.1

(a) (i) On Fig. 3.1, write the letters **IR** to show the infrared region of the electromagnetic spectrum. **[1]**

(ii) On Fig. 3.1, write the letters **UV** to show the ultraviolet region of the electromagnetic spectrum. **[1]**

(b) Thermal imaging cameras are sensitive to radiation in the infrared region of the electromagnetic spectrum.

(i) Explain why the image produced by a thermal imaging camera used by police is likely to show different false colours for disturbed and undisturbed ground.

.....

.....

.....

.....

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

(ii) Explain the terms *spatial* and *thermal resolution* when applied to a thermal imaging camera.

spatial resolution .....

.....

thermal resolution .....

.....

[2]

(c) In recent years the use of some types of aerosols has been prohibited because they were found to cause depletion of the ozone layer in the atmosphere.

Explain, with reference to ultraviolet radiation, how depletion of the ozone layer might lead to increased skin cancer among people who do a lot of sunbathing.

.....

.....

.....

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

[Total: 8]

4 **(a)** Table 4.1 lists some terms that are used in communications technologies. Each term has been given a letter to identify it.

Identifying letter	Term
P	up-link (applied to mobile phones/cell phones)
Q	down-link (applied to mobile phones/cell phones)
R	full-duplex system
S	half-duplex system
T	multiple access technology
U	cellular technologies

Table 4.1

Fig. 4.1 opposite shows a number of cards used in a game to help students learn these terms.

For each term, write its identifying letter on the card that best describes the term.
Each letter should be used **once** only. Some cards will be left blank. **[6]**

☐ Communication system where frequencies are reused in different parts of the country sufficiently far apart that the signals do not interfere	☐ Communication system where each frequency can be used only once	☐ Communication system where each frequency can be used by many people by use of multiplexing
☐ Signal transmission from a satellite to a mobile phone	☐ Signal transmission from a base station mast to a mobile phone	☐ Communication system using only one frequency so that users must take it in turns to speak
☐ Communication system which only ever operates in one direction	☐ Communication system using two separate frequencies so that users at both ends can talk at the same time	☐ Signal transmission from a mobile phone to a satellite
	☐ Signal transmission from a mobile phone to a base station mast	

Fig. 4.1

(b) The format of the information in the left hand column of Table 4.2 can be classified as either 'analogue', 'binary', 'digital other than binary', or 'none of these'.

Put **one** tick in each row to indicate which of these terms best describes the format. The first line has been done for you.

Information	Analogue	Binary	Digital other than binary	None of these
The time shown on the face of a watch with rotating hands	✓			
The frequency display '95.20' on the front of a radio				
Morse code Morse code is a method of transmitting text. Each letter is represented by dots and dashes with spaces in between. For example the international emergency signal SOS is represented by: Dot Dot Dot space Dash Dash Dash space Dot Dot Dot or ▪ ▪ ▪ _ _ _ ▪ ▪ ▪				
Data sent along an optical fibre used for telecommunications				
Light sent along an optical fibre in an endoscope				
The X-ray image of a broken bone stored on film				
The X-ray image of a broken bone stored on a computer				
Words in a book				
Books stored in the memory on a graphics tablet				

Table 4.2

[8]

[Total: 14]

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Question 5 begins on page 16

PLEASE DO NOT WRITE ON THIS PAGE

5 Table 5.1 lists three methods used for domestic internet connections.

Methods used for domestic internet connections	Data transmission speed
Broadband using conventional copper telephone wires	
Dial-up connections	
Broadband using fibre optic cables	

Table 5.1

(a) Indicate the relative speeds of data transmission of these methods by writing in the boxes on the right of Table 5.1:

1 for the **fastest**

2 for the **next fastest** and

3 for the **slowest** data transmission speed.

[1]

(b) Dial-up connections have a disadvantage which may inconvenience the user and which is unrelated to transmission speed.

State and explain the reason for this disadvantage.

disadvantage .....

.....

explanation .....

.....

[2]

(c) Fibre optic cables are used for television and internet connections. Fig. 5.1 below shows fibre optic cables attached to a bridge so that they can cross the River Tees. The fibre optic cables are indicated by the arrow that points to one of a number of loops made in the cable when it was installed.

(i) Suggest a possible reason for looping the cable in this way rather than laying it all in a straight line.

.....

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

(ii) Explain why the fibre optic cable would not work properly if the radius of the loop was too small.

.....

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

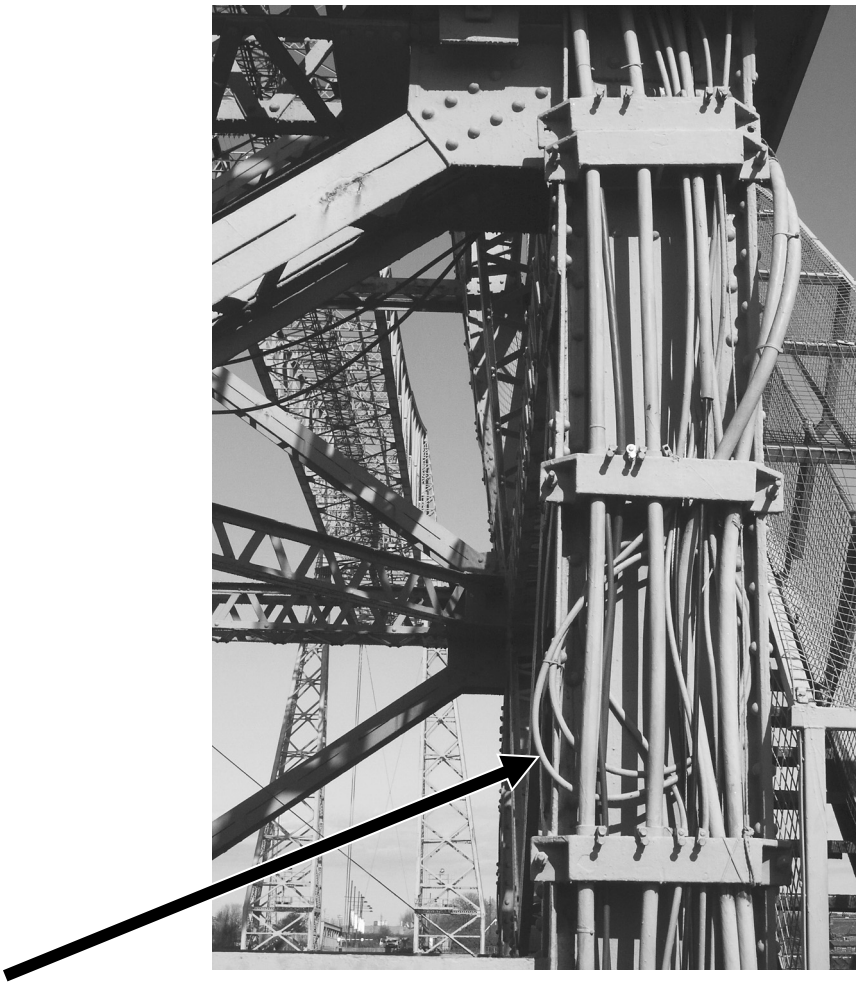

Fig. 5.1

[Total: 7]

6 Technetium-99m is a radioactive material that is used as a tracer for medical diagnosis. It has a physical half-life of 6 hours.

(a) Suggest why a material with this half-life is preferred rather than an alternative with:

(i) a much **shorter** physical half-life

.....

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

(ii) a much **longer** physical half-life.

.....

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

(b) A radiation detector placed close to a bottle containing a sample of technetium-99m detects 1000 gamma photons in one minute.

Calculate how many gamma photons you would expect to detect with the same arrangement in the same time, 18 hours later.

answer = ... photons **[3]**

(c) It is found that the rate of emission of radiation from a patient following examination using a technetium-99m tracer declines much faster than that of the sample in the bottle in **(b)**.

(i) Explain the reason for this additional decline in the rate of emission of radiation in the patient.

.....

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

(ii) State what effect this will have on the overall half-life of technetium-99m tracer in the patient compared to the sample in the bottle.

.....

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

(iii) State the term used for the half-life due to the process explained in **(c)(i)**.

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

(d) A special device is used to produce images from the radiation emitted by a patient who has been given a dose of technetium-99m tracer.

(i) Name this device.

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

(ii) Fig. 6.1 shows a block diagram of this device. Some of the labels have been omitted. Complete the diagram by writing in the labels in the boxes on the left of the diagram.

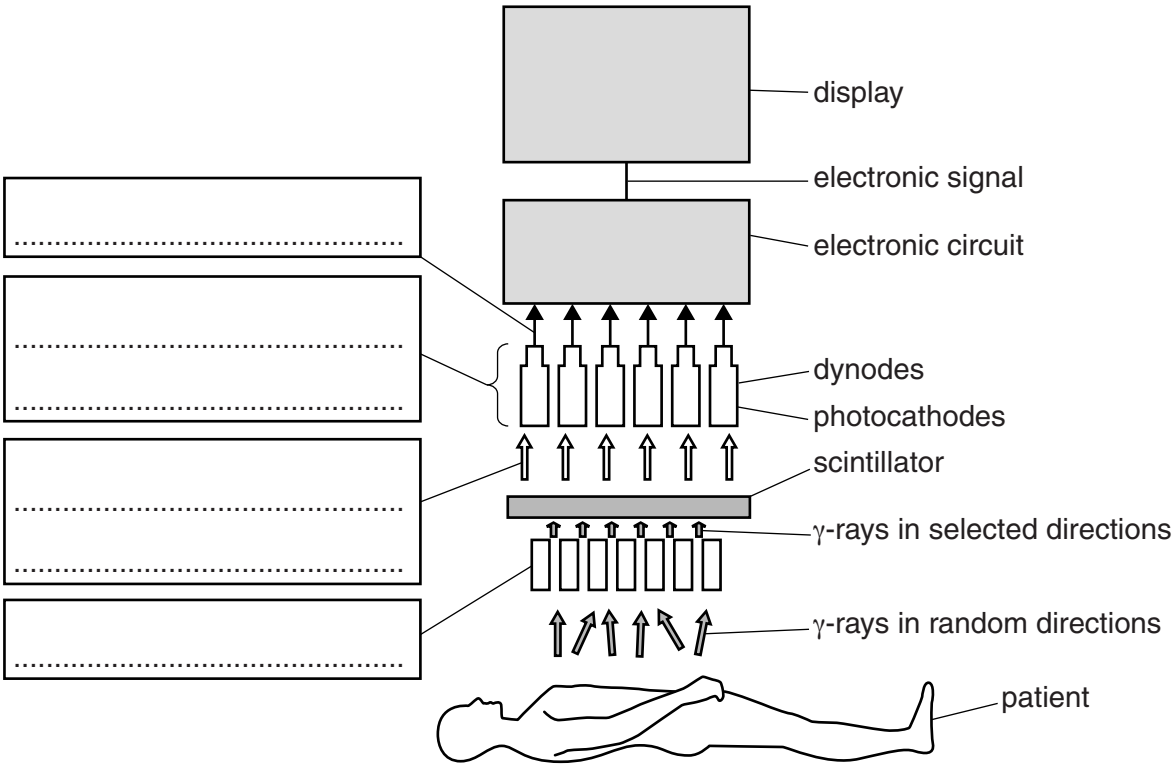

Fig. 6.1

[4]

[Total: 13]

7 X-ray imaging is an important tool in medical diagnosis, but X-rays can damage health.

(a) Other than cost, state why, despite the hazardous nature of X-rays, they continue to be used as a common tool in medical diagnosis.

.....

.....

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

(b) The X-ray dose to patients, when images were produced on film, could be reduced by the use of image-intensifying screens.

Describe and explain how image-intensifying screens reduce the intensity of X-rays needed to form an image.

.....

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.....

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.....

.....

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

(c) The quality of X-ray images can be improved by the use of a grid, narrow beams and filtration.

Briefly explain each of these techniques:

(i) use of a grid

.....

.....

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

(ii) use of narrow beams

.....

.....

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

(iii) filtration.

.....

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

[Total: 11]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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