OCR

Friday 13 June 2014 – 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

G 6 3 5 0 1

3136621205

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 restaurant serves a sponge pudding with a scoop of ice cream on a plate, as shown in Fig. 1.1.

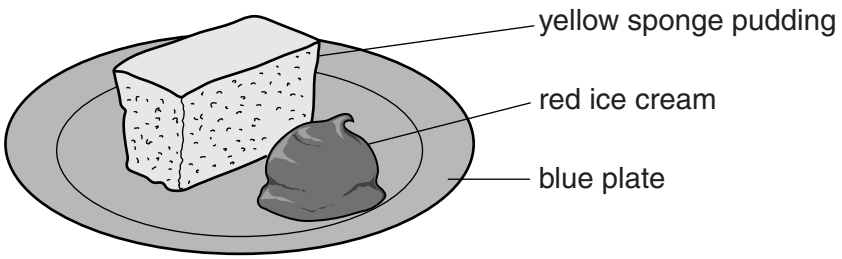

Fig. 1.1

Samples of a similar sponge pudding, ice cream and plate are tested in a food laboratory. Technicians measure the electromagnetic radiation given off by 1 cm^2 of the surface of each sample.

Table 1.1 shows some information about the samples.

Sample	Temperature / °C	Colour
Sponge pudding	40	yellow
Ice cream	–5	red
Plate	20	blue

Table 1.1

(a) In which region of the electromagnetic spectrum is the radiation **emitted** by:

1 the sponge pudding .....

2 the ice cream. .....

[1]

(b) (i) State which of the samples **emits** the **lowest intensity** of electromagnetic radiation.

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

(ii) State which of the samples **emits** the **shortest peak wavelength** of electromagnetic radiation.

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

(iii) State which of the samples **emits** the **lowest peak frequency** of electromagnetic radiation.

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

(iv) State which of the samples **reflects** the **shortest wavelength** of electromagnetic radiation.

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

(c) Describe the appearance of the image of the sponge pudding, ice cream and plate when observed using a thermal imaging camera.

.....

.....

.....

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

(d) After a few hours, the sponge pudding, ice cream and plate are all at room temperature and are photographed again using the thermal imaging camera.

Describe the appearance of this image.

.....

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

[Total: 8]

2 Peter travels to college on an old bus that vibrates a lot. The vibrations are caused by the engine and by the bus travelling along uneven parts of the road. Engineers can measure vibrations like these by attaching sensors to parts of the bus and displaying their output using a computer.

Sensors were placed along a metal bar in the bus.

(a) Fig. 2.1 shows the displacement at points along the bar (due to the vibrations) at the instant the sensors are switched on ($t = 0$).

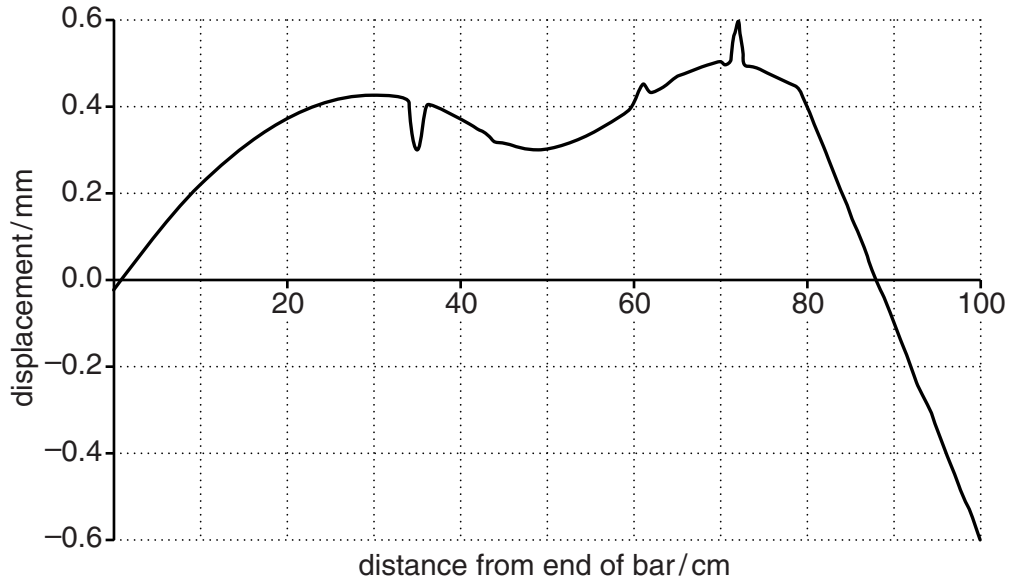

Fig. 2.1

Use Fig. 2.1 to find the displacement at a point 70 cm from the end of the bar at time $t = 0$.

displacement = ... mm **[1]**

(b) Fig. 2.2 shows the displacement at points along the bar (due to the vibrations) at time 0.1 ms after the sensors have been switched on.

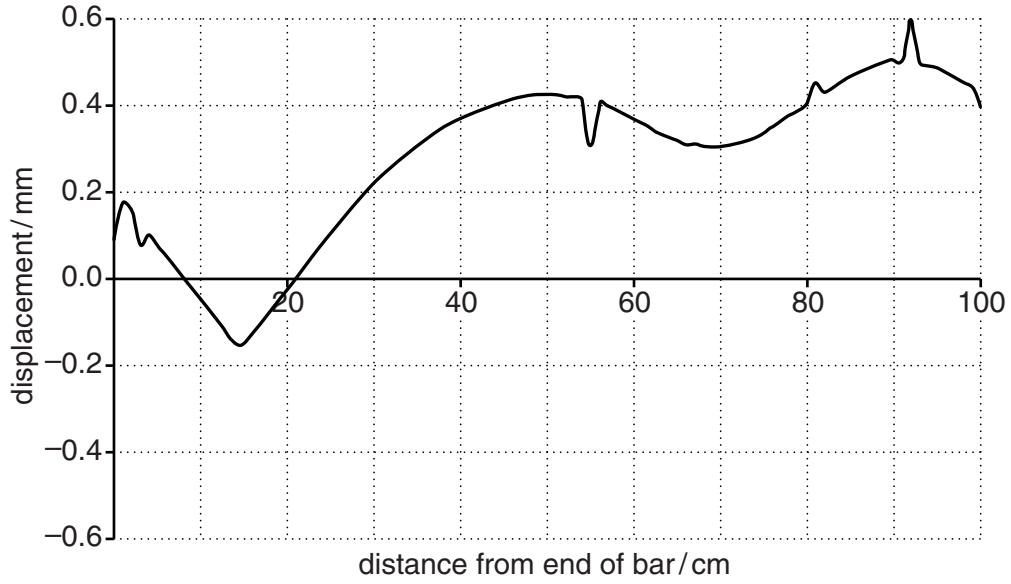

Fig. 2.2

Find the speed of the wave. Mark with an **X** on each of the graphs (Fig. 2.1 and Fig. 2.2) where you take your readings.
Record your readings and show your working.

speed = ... $m\,s^{-1}$ **[4]**

(c) State why it is **not** possible to find a wavelength for this wave.

.....

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

(d) Fig. 2.3a, opposite, represents a standing wave in a stretched string of length 1.2 m. The string is forced to vibrate at its first harmonic of 125 Hz.

(i) Determine the wavelength of the wave.

wavelength = ... m **[1]**

(ii) Use the information given and your answer to **(d)(i)** to calculate the speed of a travelling wave in the string.

speed = ... $m\,s^{-1}$ **[2]**

(iii) Fig. 2.3b, opposite, represents the standing wave a quarter of a cycle after Fig. 2.3a.

The time between when the wave is in the position shown in Fig. 2.3a and when it is in the position shown in Fig. 2.3b is called *t*.

Find the minimum value for the time *t*.

minimum time *t* = ... s **[3]**

(iv) Fig. 2.3c represents a standing wave produced in the same string at the same tension when forced to vibrate at the second harmonic.

Complete the sentences to compare the wavelength and frequency of this wave with the wavelength and frequency of the first harmonic.

1 The wavelength of the second harmonic is ..... times the wavelength of the first harmonic.

2 The frequency of the first overtone is ..... times the frequency of the first harmonic.

[2]

(v) On Fig. 2.3d, draw the third harmonic of the wave in Fig. 2.3a.
Do **not** show the moment when displacement is zero throughout, as in Fig. 2.3b. **[2]**

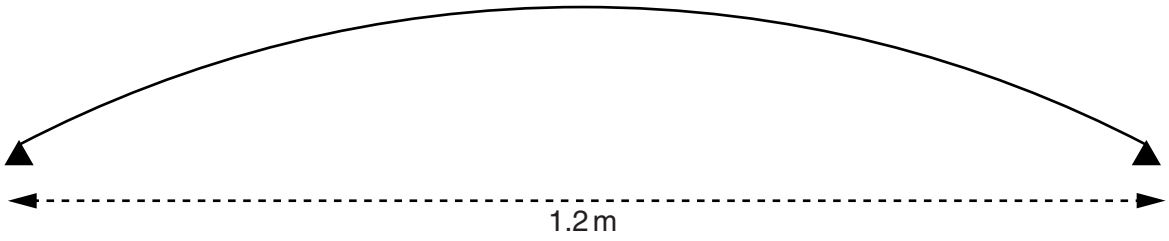

Fig. 2.3a

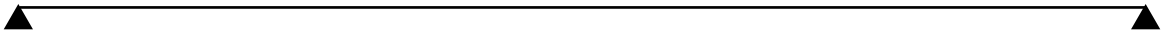

Fig. 2.3b

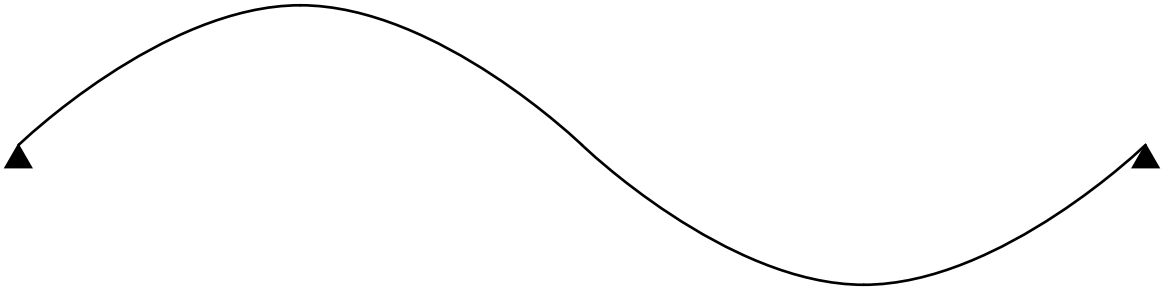

Fig. 2.3c

Fig. 2.3d

[Total: 16]

3 A company specialises in thermal imaging surveys. It flies aircraft over urban areas in order to record thermal images.

(a) During a thermal imaging survey for a local council, the company also records actual temperatures at ground level.

Suggest how these temperature measurements help clients to interpret the thermal images.

.....

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

(b) The company uses high specification thermal imaging cameras. These produce images with excellent spatial and thermal resolution.

- State what is meant by the terms *spatial resolution* and *thermal resolution*.
- Suggest and explain one example in this survey where the council would find good spatial resolution an advantage.
- Suggest and explain one example in this survey where the council would find good thermal resolution an advantage.

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

[Total: 7]

4 **(a)** Fig. 4.1 represents a cross-section of an optical fibre made of a single uncoated strand of glass.

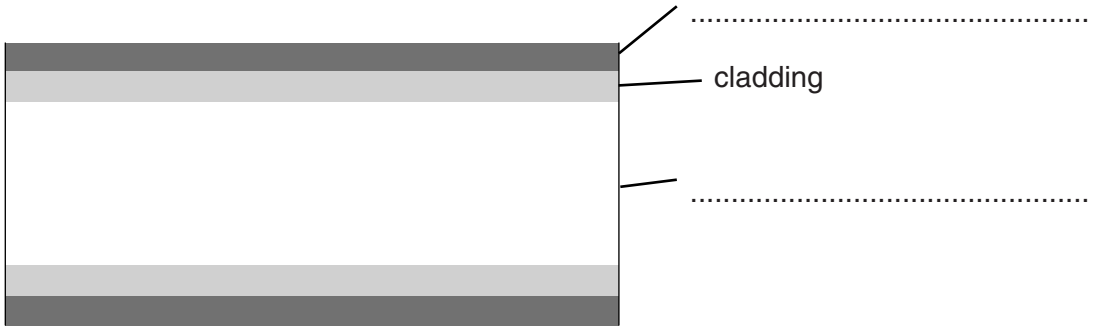
Not to scale.

Fig. 4.1

On Fig. 4.1, **A** and **B** represent two rays of light entering the glass.
Continue the paths of the two rays through the glass. **[2]**

(b) One type of multimode optical fibre is called step-index. Fig. 4.2 represents a cross-section of a single step-index fibre.

(i) Complete the labels of Fig. 4.2. **[2]**



Not to scale.

Fig. 4.2

(ii) Fig. 4.3 shows a square wave signal as it enters the step-index fibre.

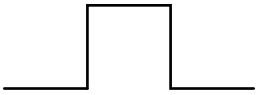


Fig. 4.3

Draw the shape of the signal when it arrives at the end of a long piece of step-index fibre in the space below.

[1]

(iii) Explain the effect you have drawn in **(b)(ii)**.

.....

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

(c) Another type of multimode optical fibre is called graded-index fibre.

(i) Describe the construction of a graded-index fibre.

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.....

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.....

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

(ii) The rectangle in Fig. 4.4 represents a graded-index fibre.

On Fig. 4.4, draw the shape of paths of rays of light travelling down a graded-index fibre.

Fig. 4.4

[1]

(iii) State why the paths you have drawn in **(c)(ii)** differ from the paths of rays in a step-index fibre.

.....

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

(iv) Describe the difference between the speed of the rays of light travelling down a graded-index fibre and a step-index fibre.

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

(v) A digital signal travelling down a long piece of a graded-index fibre is less degraded than a digital signal travelling down a long piece of step-index fibre.

Explain why.

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

(d) (i) Optical fibres are often arranged in bundles.

Draw the arrangement of the optical fibres in an incoherent bundle.

[1]

(ii) State why this type of bundle would **not** be suitable for communication applications.

.....

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

(iii) Draw the arrangement of the optical fibres in a coherent bundle.

[1]

(iv) In an endoscope, both types of fibre bundle are used.

State the function of each type of bundle when used in an endoscope.

incoherent .....

.....

coherent .....

.....

[2]

[Total: 22]

5 **(a)** Each example in Table 5.1 can be classified as:

- analogue
  or
- binary
  or
- digital other than binary
  or
- none of these.

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

Example	Analogue	Binary	Digital other than binary	None of these
The time shown on the face of a watch with rotating hands	✓			
Hazard symbols				
An amplitude modulated radio signal				
A DAB radio signal				
The numbering of years e.g. 2014				

[4]

Table 5.1

(b) Early internet connections are known as dial-up or narrowband. These usually transmit data at a rate of 56 kilobits per second (kbps), using a 4 kHz signal. Some people still use dial-up internet services.

A few years ago, 8 megabits per second (Mbps) broadband was regarded as a fast connection. This is transmitted using a signal frequency usually between 15 kHz and 1.1 MHz.

Domestic broadband speeds of 40 Mbps and higher are now commonly available in the UK. These use electromagnetic radiation with a typical wavelength of 1.5 µm.

A typical 3G mobile download speed in the UK is 1.5 Mbps using electromagnetic radiation with a frequency of about 2 GHz.

(i) Describe each of the following internet connection systems with particular reference to the frequency and wavelength data given above.

- Dial-up system
- 8 Mbps system
- 40 Mbps system
- 3G system

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

(ii) Suggest **two** reasons, apart from costs, why some people still use dial-up.

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

(iii) Information signals generally travel through a medium at nearly the speed of light.

Explain what internet providers mean when they advertise 'faster' broadband speeds.

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

(c) Explain why the strength of mobile phone signals is affected by the inverse square law.

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

[Total: 16]

6 Radiology departments in hospitals are involved in both diagnosis and treatment of patients.

(a) Lead screening (shielding) is used in radiology departments to reduce the radiation dose received by staff. Radiation safety engineers use the half-thickness value of lead to determine the thickness of screening required.

(i) State the meaning of the term *half-thickness value*.

.....

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

(ii) The half-thickness value of lead for gamma rays of a given energy is 0.068 cm.

Calculate the thickness of lead required to reduce the count rate on a radiation detector from 10 000 counts min^{-1} with no lead, to 2500 counts min^{-1}.

thickness of lead required = ... cm **[2]**

(b) The amount of blurring in X-ray images can be reduced by using a narrow X-ray beam. This effect can be demonstrated using shadows cast by a beam of visible light.
In one particular demonstration, a cardboard arrow was placed about 30 cm from a white wall in a dark room. A light was then shone onto the arrow

- first by a small torch (Fig. 6.1)
- then by a fluorescent light tube (Fig. 6.2).

On Fig. 6.1 and Fig. 6.2 some (but not all) of the rays of light have been drawn.

(i) For the shadow caused by the small torch in Fig. 6.1:

- compare the brightness of the light falling on the wall between the points **A** to **E and**
- explain the degree of sharpness of the shadow formed.

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

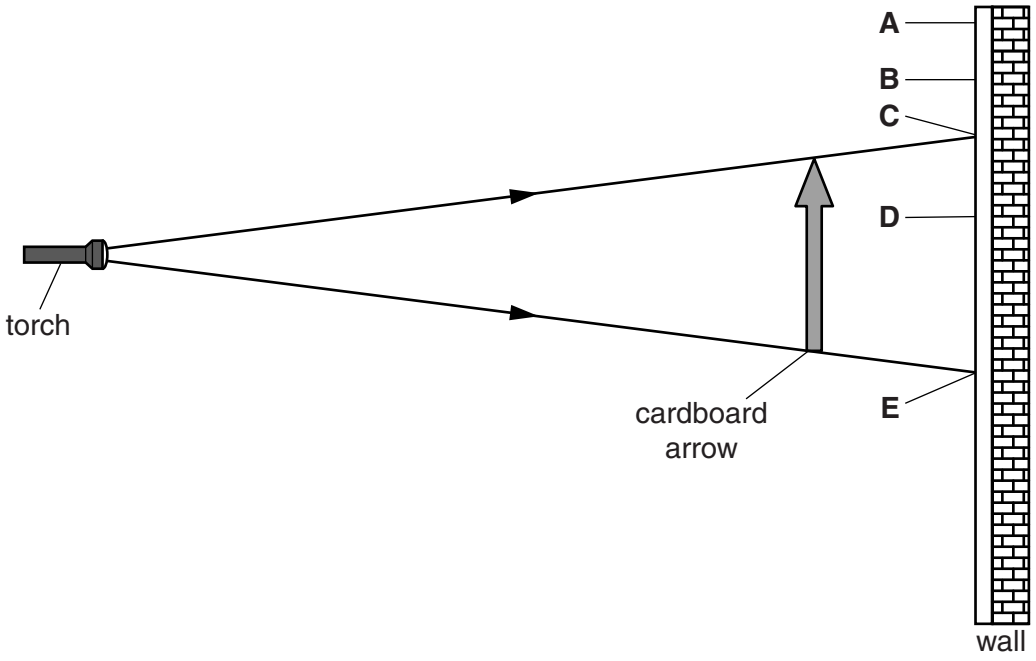

Fig. 6.1

(ii) For the shadow caused by the fluorescent light tube in Fig. 6.2:

- compare the brightness of the light falling on the wall between points **M** to **P** **and**
- explain the degree of sharpness of the shadow formed.

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

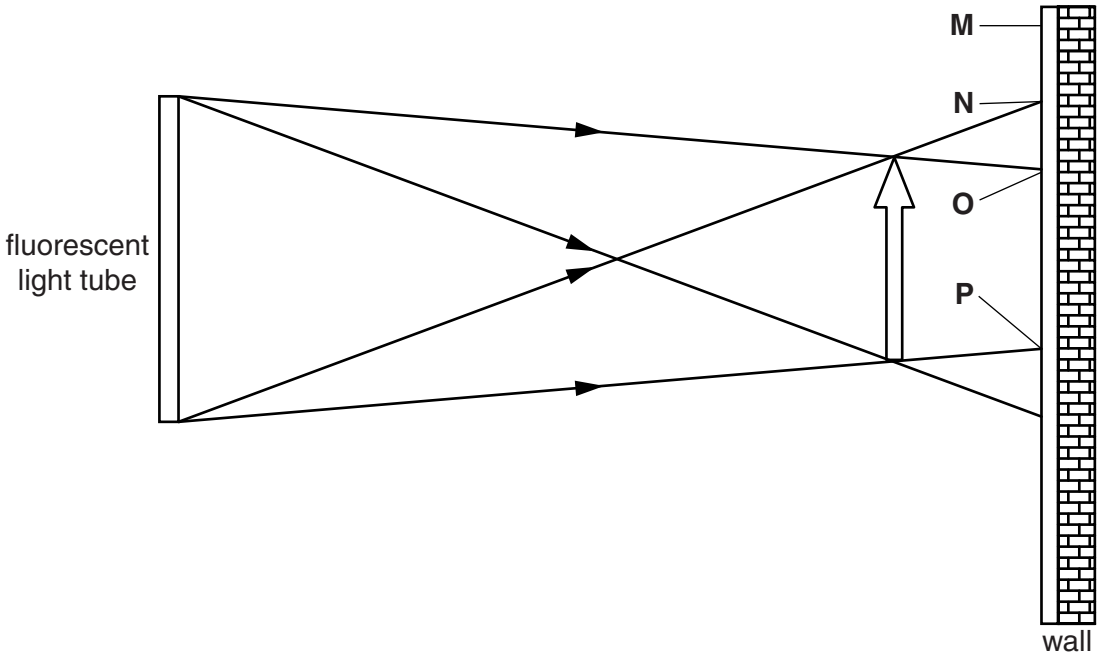

Fig. 6.2

(c) (i) Radioactive materials can be used for treatment as well as for diagnosis.

Explain the meaning of each of these terms:

Treatment .....

.....

Diagnosis .....

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

(ii) Intravenous injections of technetium-99m tracer are given to patients so that doctors can investigate their medical condition and make a diagnosis.

What is the purpose of a tracer when injected intravenously?

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.....

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

(iii) State **three** advantages of technetium-99m compared to alternative radioactive tracers.

1 .....

.....

2 .....

.....

3 .....

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[3]

(iv) State what instrument is used to detect the radiation emitted by the tracer in the patient.

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

(v) Describe the collimator used in this instrument and state its purpose.

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

[Total: 21]

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.

PLEASE DO NOT WRITE ON THIS PAGE