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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Electromagnetic Spectrum

Paper 2 — Theory / Structured Questions (topical compilation)

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M.Eng NUS Singapore · B.Eng NUST · 15+ years of teaching experience in Singapore, UAE & Pakistan · 60,000+ subscribers and 20 million+ video lecture views.

1 Fig. 4.1 shows an incorrect electromagnetic spectrum drawn by a student. The parts of the spectrum and the wavelengths are in the wrong order. The values of the wavelengths do not match the correct parts of the spectrum.

short wavelength						long wavelength
microwaves	radio waves	ultraviolet	infra-red	gamma rays	X-rays	visible
10^{3} m	10^{-14} m	10^{-10} m	10^{-8} m	10^{-2} m	10^{-6} m	10^{-5} m

Fig. 4.1

(a) On Fig. 4.2, complete the table of the electromagnetic spectrum. Radio waves and their correct wavelength have been inserted for you.

short wavelength						long wavelength
						radio waves
						10^{3} m

[3]

Fig. 4.2

(b) State the speed of all electromagnetic waves in a vacuum.

.....[1]

(c) State two uses that are made of infra-red radiation.

.....

.....

.....[2]

5054/02/M/J/03/Q4

2 Fig. 9.1 shows the main parts of an electric grill. An electric current in the heating element causes it to become red hot and to emit visible light and infra-red radiation. The infra-red radiation is used to cook food.

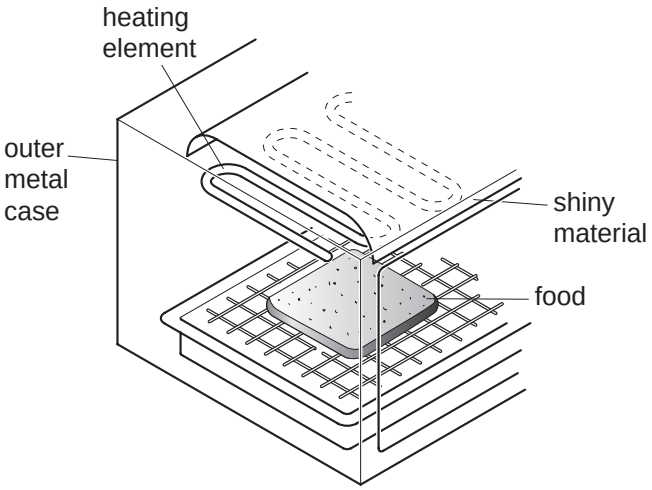

Fig. 9.1

(a) Infra-red radiation has a longer wavelength than visible light. Both are parts of the electromagnetic spectrum.

(i) Draw a diagram of the electromagnetic spectrum that shows visible light, infra-red and **three** other parts of the spectrum. Your diagram should put the parts of the spectrum in order of increasing wavelength.

[4]

5054/02 M/J/04/Q9

3 **(a)** Each object in the table below emits one main type of electromagnetic wave.
Complete the table by writing in the name of the type of wave.
One line has been written for you.

Object	Main type of electromagnetic wave emitted
radio transmitter	radio wave
remote control for a television	
radioactive source	

[2]

(b) X-rays are used in hospitals to produce images of bones and to show whether bones are broken.

(i) State what is used to detect X-rays.

.....

..... [1]

(ii) Explain the properties of X-rays that enable an image of a bone to be produced.

.....

.....

.....

.....

.....

..... [2]

5054/02/M/J/08/Q5

4 The fluorescent tube shown in Fig. 5.1 converts electrical energy into light more efficiently than a filament lamp.

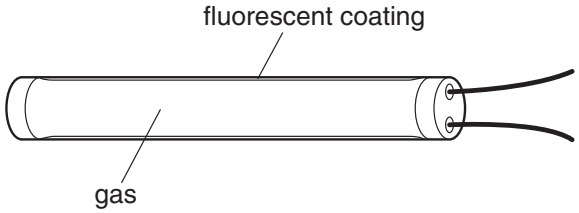

Fig. 5.1

In the gas inside the tube, both light and ultra-violet radiation are produced.

There is a fluorescent coating on the inside surface of the tube.

(a) Explain the purpose of the fluorescent coating.

.....

.....

..... [2]

(b) State the name of one region of the electromagnetic spectrum with wavelengths shorter than ultra-violet radiation.

..... [1]

(c) The ultra-violet radiation inside the tube has a wavelength of 3.6×10^{-7} m. Calculate the frequency of the ultra-violet radiation.
(speed of light = 3.0×10^{8} m/s)

frequency = ... [2]

5054/21/M/J/11/Q5

5 Fig. 5.1 shows the electromagnetic spectrum.

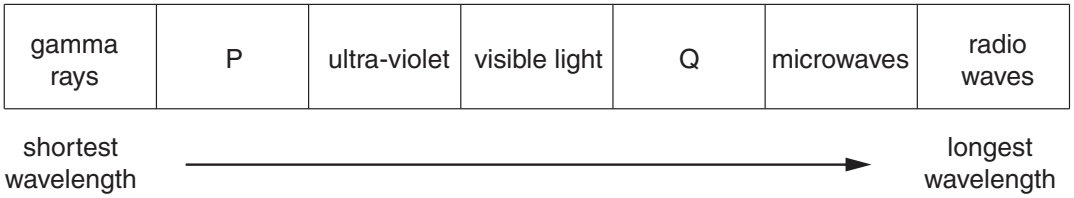

Fig. 5.1

Two components of the spectrum, P and Q, have not been named.

(a) State the name of

(i) component P,

.....[1]

(ii) component Q.

.....[1]

(b) All electromagnetic waves have a wavelength and a frequency. They all have changing magnetic and electric fields. State two other properties of all electromagnetic waves.

1. .....

.....

2. .....

.....

[2]

(c) State the component of the electromagnetic spectrum used for satellite communication.

.....[1]

5054/21/M/J/12/Q5

6 **(a)** The list below contains three components of the electromagnetic spectrum.

infra-red **gamma rays** **visible light**

Arrange the components in order of increasing wavelength.

..... [1]

(b) Satellites are used in the transmission of some television signals.

Fig. 4.1 shows a satellite above the television station where a television signal is generated.

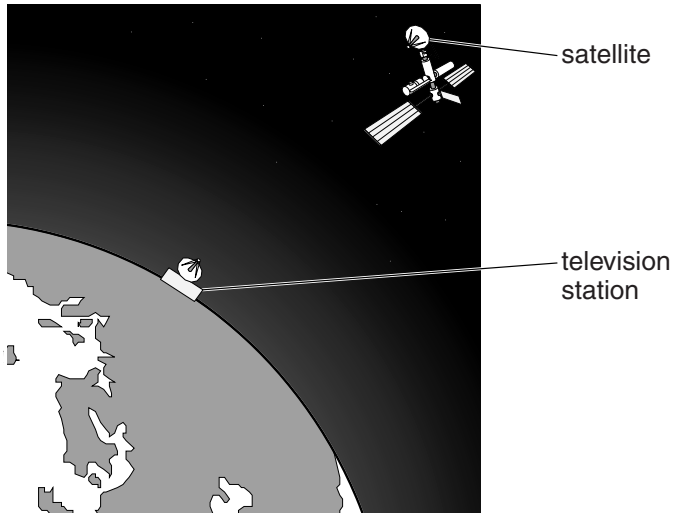

Fig. 4.1 (not to scale)

(i) State which component of the electromagnetic spectrum is used to transmit the television signal to the satellite.

..... [1]

(ii) Explain how the satellite is used.

.....

..... [1]

(iii) Suggest one advantage of using a satellite to transmit television signals.

.....

..... [1]

5054/22/M/J/13/Q4

7 Visible light, radio waves, X-rays, gamma rays and microwaves are some of the components of the electromagnetic spectrum.

(a) State two other components of the electromagnetic spectrum.

1. .....

2. .....
[1]

5054/22/M/J/14/Q5

8 Fig. 6.1 shows some of the colours in the visible part of the electromagnetic spectrum.

red	orange	yellow	green	blue

Fig. 6.1

(a) State which colour in Fig. 6.1 has

(i) the largest wavelength, ... [1]

(ii) the highest frequency. ..... [1]

(b) Visible light, infra-red, ultra-violet and radio waves are four components of the electromagnetic spectrum.

State two other components of the electromagnetic spectrum and describe a different use that is made of each component.

1. component .....

description of use .....

.....

.....

2. component .....

description of use .....

.....

.....

[4]

5054/22/M/J/16/Q6

9 Electromagnetic radiation is produced by the Sun and travels from the Sun to the Earth.

(a) Some of the statements below are true and some of them are false.

Put a tick (✓) in the box after each statement to show whether it is true or false.

	true	false
Gamma rays are used to kill cancerous cells but can also cause cancer.	☐	☐
Infra-red is used in sun-beds.	☐	☐
Radio waves have the highest frequency in the electromagnetic spectrum.	☐	☐
The higher the frequency of the radiation the smaller is the wavelength in air.	☐	☐

[2]

5054/21/M/J/18/Q9

10 A star emits electromagnetic radiation over a range of wavelengths.

Fig. 4.1 shows the brightness of the radiation from the star at different wavelengths.

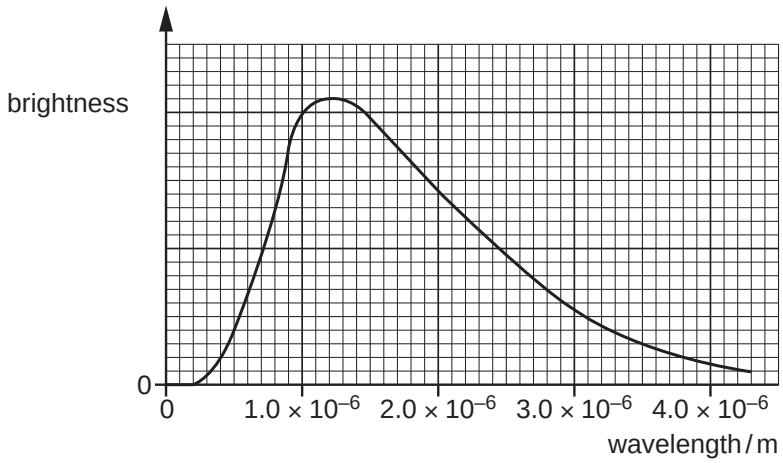

Fig. 4.1

Radiation from the star is brightest at one wavelength.

(a) Determine the wavelength where the radiation is brightest.

wavelength = ... [1]

(b) Visible light has a wavelength between 4.0×10^{-7} m and 7.0×10^{-7} m.

The radiation in **(a)** lies just outside the visible part of the electromagnetic spectrum.

State the name of the region of the spectrum that contains the radiation in **(a)**.

..... [1]

(c) Determine the frequency of the radiation in **(a)**.

The speed of light is 3.0×10^{8} m / s.

frequency = ... [3]

5054/22/M/J/19/Q4

11 Ultrasound and X-rays are both used in medical imaging.

(a) **(i)** Define what is meant by *ultrasound*.

.....

..... [2]

(ii) Describe what happens to ultrasound waves as they meet the boundary between two different materials.

.....

..... [2]

(iii) To produce the image of an unborn child, an ultrasound emitter and receiver are placed close together on the mother's skin.

Fig. 9.1 shows pulses detected by the receiver.

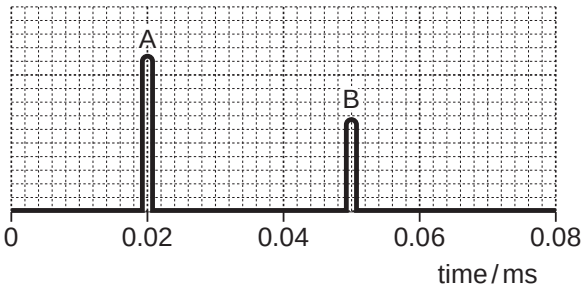

Fig. 9.1

Pulse A is the emitted pulse and pulse B is the first pulse that returns from the unborn child.

The average speed of ultrasound in human tissue is 1500 m / s.

Calculate the distance between the emitter and the child.

distance = ... [3]

(iv) The speed of ultrasound in human tissue is close to the speed of sound in water.

Suggest approximate values for the speed of sound in gases and solids.

speed in gases .....

speed in solids .....
[2]

5054/21/M/J/20/Q9

12 **(b)** Fig. 9.2 shows an X-ray image of a hand. An X-ray detector is placed just below the hand. An image of the bones and human tissue around the bones is formed on a screen by the detector.

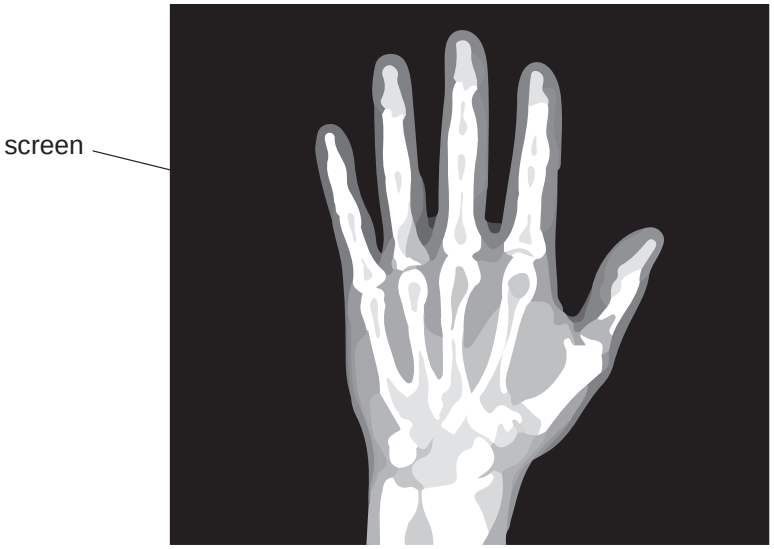

Fig. 9.2

(i) Describe what happens to the X-rays to produce the image.

.....

.....

.....

.....

..... [3]

(ii) The wavelength of the X-rays used is 2.0×10^{-9} m. The speed of electromagnetic waves is 3.0×10^{8} m/s.

Calculate the frequency of the X-rays.

frequency = ... [2]

(iii) Suggest one reason why X-rays are **not** used to form an image of an unborn child.

.....

..... [1]

5054/21/M/J/20/Q9

13 The components of the electromagnetic spectrum have different uses.

Microwaves are used in cooking and ultraviolet rays are used in sterilisation.

(a) Draw **one** line from each component of the spectrum to another suitable use for that component.

component	use
	sunbeds
microwaves	television controller
	satellite television
ultraviolet	airport security check of cases

[2]

5054/22/M/J/20/Q5

14 **(b)** Table 4.1 shows some sentences that a student writes about waves.

His teacher places a ring around each mistake.

Write a suitable correction for each mistake in Table 4.1. One has been done for you.

Table 4.1

sentence	correction
Sound travels at 3.0 × 10^8 m / s in air.	330
Sound with a higher pitch has a larger amplitude.	
X-rays are used for pre-natal scanning.	
In the electromagnetic spectrum, microwaves have the highest frequency.	

[3]

5054/21/M/J/21/Q4

15 **(d)** Fig. 8.4 shows a connection to the internet made from a remote station A using a satellite above the Earth's surface.

Data is sent between stations A and B using microwaves which travel to and from the satellite.

Station B is connected directly to the internet using optical fibre.

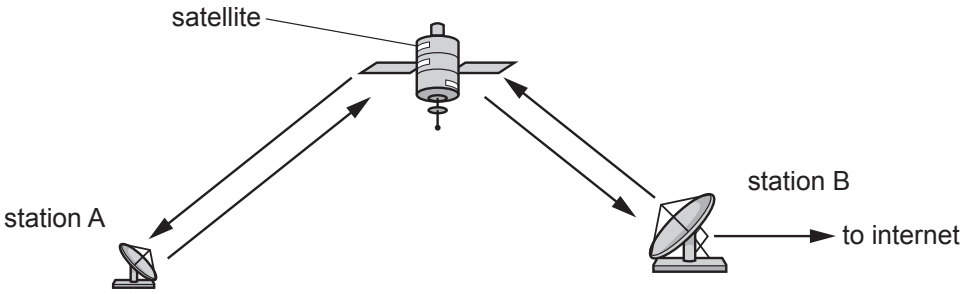

Fig. 8.4 (not to scale)

The speed of microwaves is 3.0×10^8 m/s.

Stations A and B are each 560 km from the satellite.

(i) Calculate the time taken for data to travel from A to B using microwaves.

time = ... [3]

(ii) The same data can be sent from A to B in a shorter time along the surface of the Earth using infrared waves to carry the information in optical fibres.

State **one** property that infrared waves and microwaves have in common.

.....

..... [1]

(iii) Suggest **one** other advantage of using optical fibres to connect stations A and B directly.

.....

..... [1]

5054/22/M/J/22/Q8

16 Microwaves are waves in the electromagnetic spectrum.

(a) **(i)** State the name of waves in one other part of the electromagnetic spectrum that have wavelengths longer than microwaves.

.....[1]

(ii) A wave in the electromagnetic spectrum has a wavelength longer than microwaves. Explain why the frequency of this wave is lower than the frequency of microwaves.

.....

.....

.....

.....

.....[2]

(b) Microwaves are sometimes used to send telephone messages over long distances. They are sent from large dish aerials on top of high buildings or towers.

There are often several repeater or booster stations placed between the transmitter and the receiver, as illustrated in Fig. 3.1.

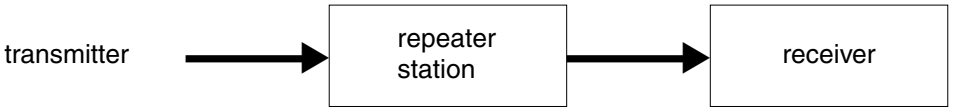

Fig. 3.1

State why

(i) the aerials are placed on top of high buildings or towers,

.....

.....

(ii) repeater or booster stations are necessary.

.....

.....
[2]

5054/2/O/N/02/Q3

17 X-rays, microwaves, ultra-violet rays and infra-red rays are different types of radiation in the electromagnetic spectrum.

(a) Write the name of one of these types of radiation in each of the boxes, placing them in order of increasing wavelength.

shortest wavelength ⟶ longest wavelength

[2]

(b) State one use of ultra-violet radiation.

.....

.....

..... [1]

(c) State two properties that are common to all types of radiation in the electromagnetic spectrum.

1. .....

.....

2. .....

..... [2]

5054/02/O/N/05/Q4

18 Stars that are being formed emit infra-red radiation. Some of this radiation is received by a telescope that orbits the Earth. Microwave signals from the telescope are sent to the Earth's surface, as shown in Fig. 11.1.

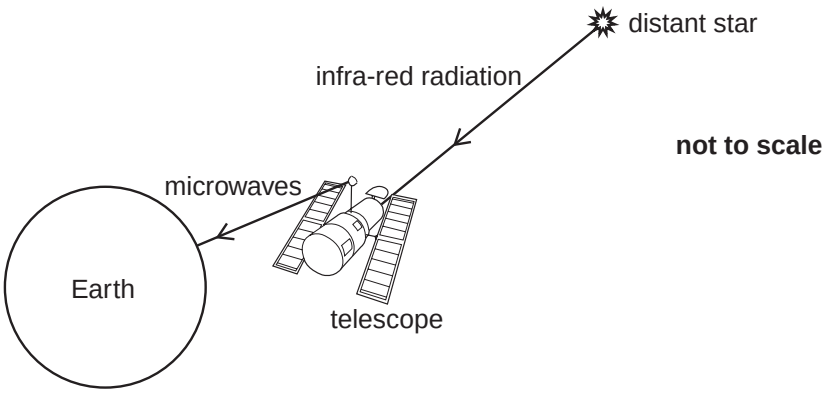

Fig. 11.1

(a) **(i)** Microwaves travel at a speed of 300 000 km/s. The telescope is 600 km above the Earth's surface. Calculate the time for a microwave signal from the telescope to reach the Earth's surface. [3]

(ii) Infra-red and microwave radiation are both part of the electromagnetic spectrum.

State **two** other similarities and give **one** difference between infra-red and microwave radiation. [3]

5054/02/O/N/06/Q11

19 A large number of television sets in a shop are tuned to the same station. The signal travels to some of the sets via a satellite in orbit above the Earth.

(a) (i) Explain why only electromagnetic waves are used to transmit the television signal.

.....

..... [1]

(ii) State the region of the electromagnetic spectrum used to transmit the television signal.

.....

..... [1]

(iii) Suggest why satellites are sometimes used to transmit television signals.

.....

..... [1]

(b) The other television sets receive the signal directly from a ground-based transmitter very near to the shop. A salesman notices that the signal sent via the satellite arrives 0.24 s later than the signal sent directly to the other television sets.

The speed of electromagnetic waves is 3.0×10^8 m / s.

Calculate the distance travelled by the television signal in 0.24 s.

distance = ... [2]

5054/21/O/N/10/Q4

20 **(b)** Violet light from C has a wavelength of 4.0×10^{-7} m.

(i) Calculate the frequency of this light, clearly stating the value of any constant used in the calculation.

frequency = ...[3]

(ii) State two different components of the electromagnetic spectrum that have wavelengths smaller than the wavelength of violet light.

1. .....

2. .....
[2]

(iii) **1.** Discuss a medical application of **one** of these components of the electromagnetic spectrum.

.....

.....

.....

.....

.....[3]

2. State a health risk associated with this component of the electromagnetic spectrum.

.....

.....[1]

5054/22/O/N/10/Q9

21 Fig. 4.1 represents a microwave travelling in air through points A and B.

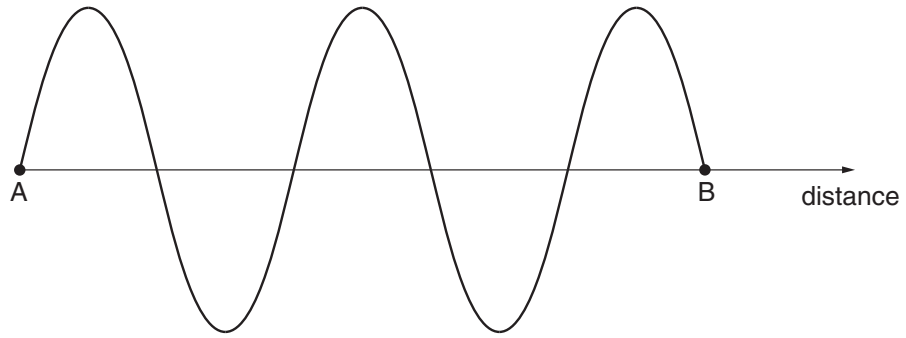

Fig. 4.1 (not to scale)

The distance between A and B is 40 cm.

(a) State the speed of microwaves in air.

speed = ...[1]

(b) Determine the wavelength of the microwave shown in Fig. 4.1.

wavelength = ...[1]

(c) Describe how microwaves are used in the transmission of television signals by satellite.

.....

.....

.....

.....[3]

(d) State two properties common to all electromagnetic waves.

1. .....

2. .....

[2]

5054/22/O/N/11/Q4

22 **(a)** Fig. 6.1 shows part of a page from a pupil's notebook.

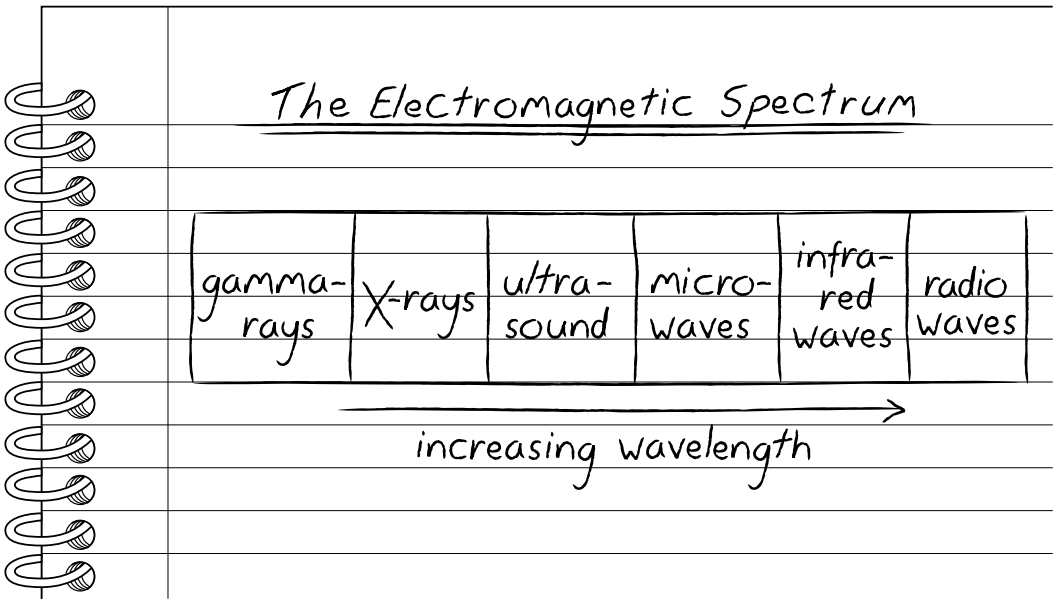

Fig. 6.1

List three errors in the pupil's notes.

1. .....

2. .....

3. .....

[3]

(b) State and explain one application of X-rays in engineering.

.....

.....

..... [2]

5054/21/O/N/12/Q4

23 (c) (iii) 2. Infra-red radiation is often detected by using a sensitive thermometer with a bulb that has been painted black.

Explain why the blackened bulb makes the thermometer a good detector of infra-red radiation.

.....

.....[1]

(d) Explain the role played by infra-red radiation in intruder alarms.

.....

.....

.....

.....

.....[2]

5054/22/O/N/16/Q10

24 Fig. 10.1 represents the electromagnetic spectrum.

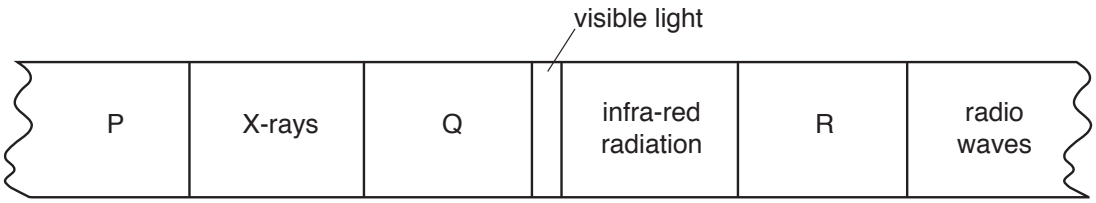

Fig. 10.1

(a) State the name of the component of the electromagnetic spectrum that is found in region

(i) P, ...

(ii) Q, ...

(iii) R. .....
[2]

(b) On Fig. 10.1, mark a tick (✓) in all of the boxes that represent the components with frequencies greater than the frequencies of visible light. [1]

(c) The speed of electromagnetic radiation in a vacuum is 3.0×10^8 m/s.

A television remote controller uses infra-red radiation of wavelength 9.4×10^{-7} m.

(i) Calculate the frequency of this radiation.

frequency = ... [3]

(ii) Explain how infra-red radiation is used in television remote controllers.

.....

.....

.....

..... [2]

5054/21/O/N/17/Q10

25 Fig. 4.1 represents the electromagnetic spectrum.

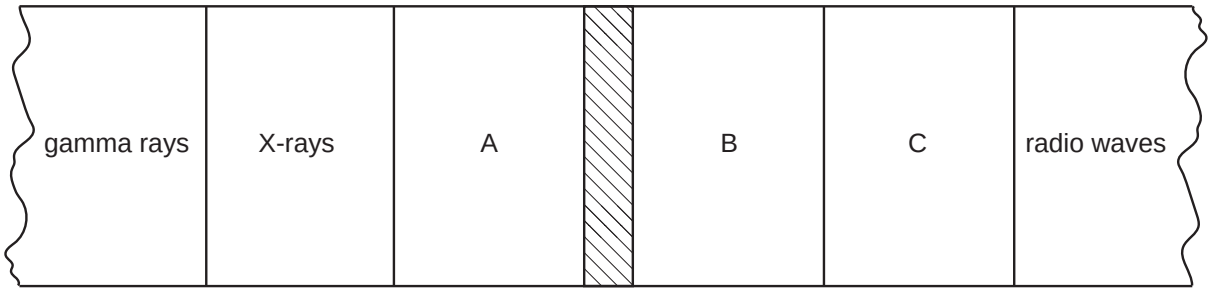

Fig. 4.1

The shaded region in the middle is the visible light spectrum.

(a) State the name of the component labelled:

- A .....
- B .....
- C .....

[2]

(b) State the name of the component of the electromagnetic spectrum that has:

the greatest frequency .....

the smallest wavelength .....

[1]

(c) Explain how X-rays are used to produce an image of a broken bone in a patient's leg.

.....

.....

.....

.....

..... [3]

5054/21/O/N/19/Q4

26 A type of nuclear reaction takes place at the centre of the Sun. The reaction releases thermal energy.

(a) State the name of the type of nuclear reaction that takes place at the centre of the Sun.

..... [1]

(b) Thermal energy is emitted from the surface of the Sun into space. The energy is transferred through the vacuum of space by thermal radiation.

(i) Describe the radiation that is emitted from the surface of the Sun.

.....

.....

..... [2]

(ii) State the speed of this radiation in a vacuum.

speed = ... [1]

(iii) The Earth is 1.5×10^{11} m from the surface of the Sun.

Calculate the time taken for this radiation to travel to Earth.

time = ... [2]

(c) Explain one advantage of wearing white clothes on sunny days.

.....

.....

..... [2]

5054/21/O/N/21/Q3