AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.4

Uses and applications of electromagnetic waves

Past-paper questions

Tier	**Higher**
Question groups	**151**
Available paper years	**2003–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

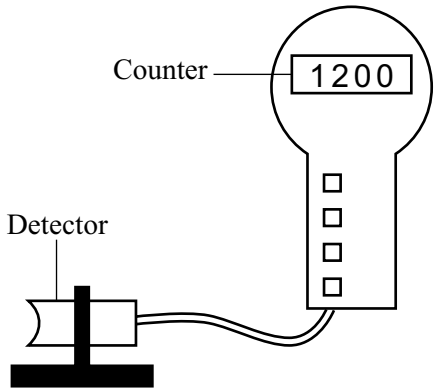
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.6.2.4 Uses and applications of electromagnetic waves

Question 01

June 2003 | 3451H | Original Q3 | Legacy

3 (a) The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.



(i) Name **one** source of background radiation.

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(1 mark)

(ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

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Background radiation level = ...counts per second

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 01 · continued

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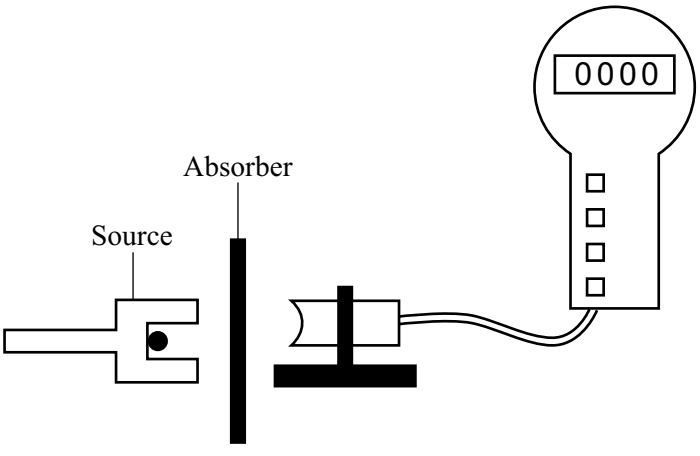
(b) The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.



Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

Absorber used	Average counts per second
No absorber	33
Card 1 mm thick	20
Metal 3 mm thick	2

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

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(3 marks)

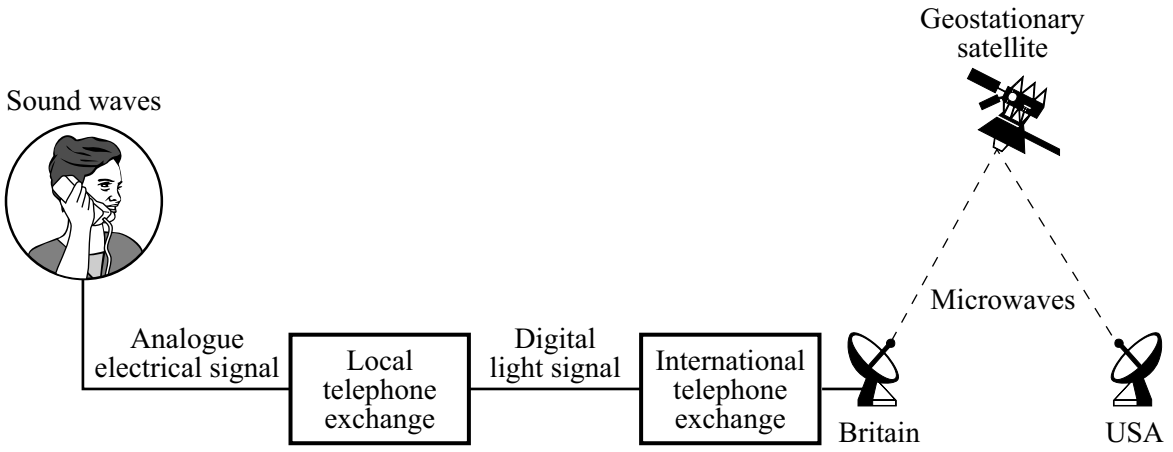
6

4.6.2.4 Uses and applications of electromagnetic waves

Question 02

June 2003 | 3451H | Original Q9 | Legacy

9 (a) The diagram shows, in a simplified form, how a telephone call can be transmitted from Britain to the USA.



(i) What is the difference between an analogue and a digital signal? You may wish to draw a diagram to help your answer.

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(2 marks)

(ii) Explain why the quality of an analogue signal transmitted over a long distance decreases, but the quality of a digital signal transmitted over the same distance does not change.

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(3 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 02 · continued

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(iii) Explain why the satellite used to receive and transmit the microwave signals is placed in a geostationary orbit.

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(2 marks)

(b) The picture shows a pre-natal scan obtained using ultrasonic waves.



(i) Explain how ultrasonic waves are used to produce the image of an unborn baby.

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(2 marks)

(ii) Give another use for ultrasonic waves.

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(1 mark)

10

4.6.2.4 Uses and applications of electromagnetic waves

Question 03

June 2003 | 3451H | Original Q14 | Legacy

14 (a) The table gives information about six radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
hydrogen-3	beta particle	12 years
iridium-192	gamma ray	74 days
polonium-210	alpha particle	138 days
polonium-213	alpha particle	less than 1 second
technetium-99	gamma ray	6 days
uranium-239	beta particle	24 minutes

(i) What is an alpha particle?

.....

(1 mark)

(ii) Two isotopes of polonium are given in the table. How do the nuclei of these two isotopes differ?

.....

(1 mark)

(iii) A doctor needs to monitor the blood flow through a patient's heart. The doctor injects a radioactive isotope into the patient's bloodstream. The radiation emitted by the isotope is then detected outside the body.

Which **one** of the isotopes in the table would the doctor inject into the bloodstream?

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Explain the reasons for your choice.

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(3 marks)

Question 03 · continued

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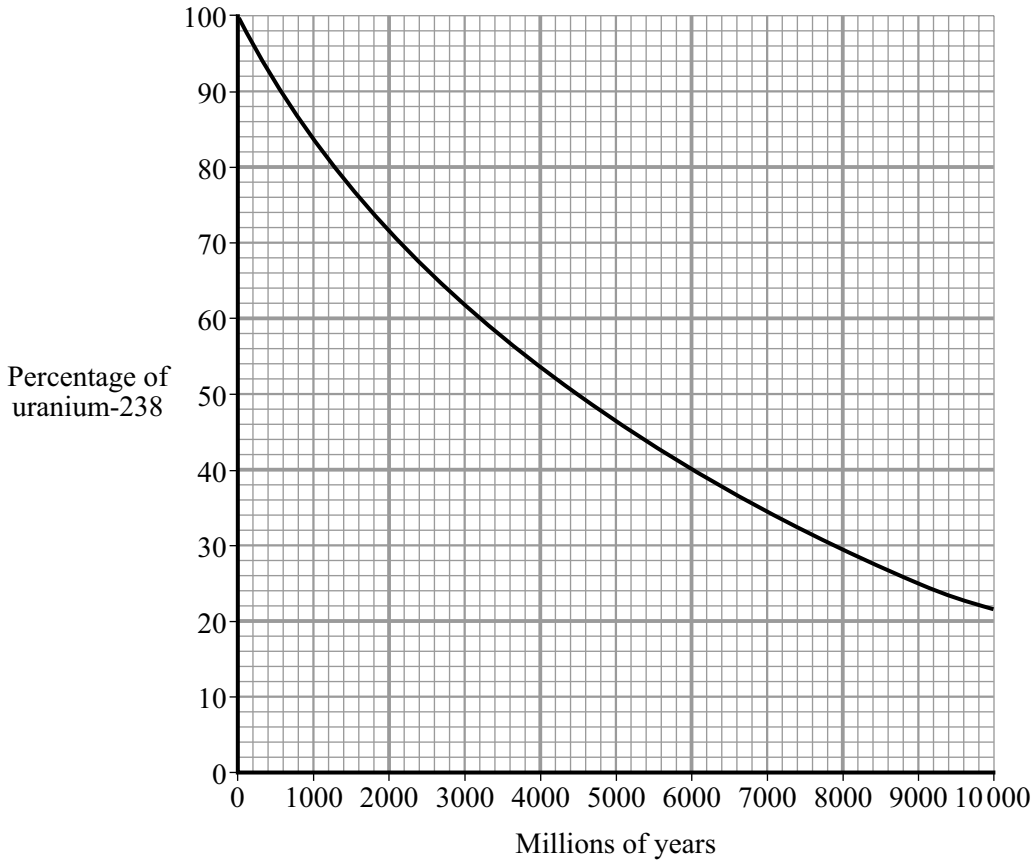
(b) Igneous rock contains uranium-238 which eventually changes to the stable isotope lead-206. The graph shows how the percentage of uranium-238 nuclei present in an igneous rock changes with time.



A rock sample is found to have seven atoms of uranium-238 for every three atoms of lead-206. Use the graph to estimate the age of the rock. Show clearly how you obtain your answer.

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Age of rock = ...million years

(2 marks)

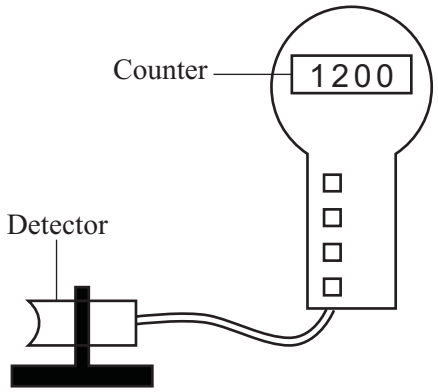
7

4.6.2.4 Uses and applications of electromagnetic waves

Question 04

June 2003 | 3462H3 | Original Q3 | Legacy

3 (a) The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.



(i) Name **one** source of background radiation.

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(1 mark)

(ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

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.....

Background radiation level = ...counts per second

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 04 · continued

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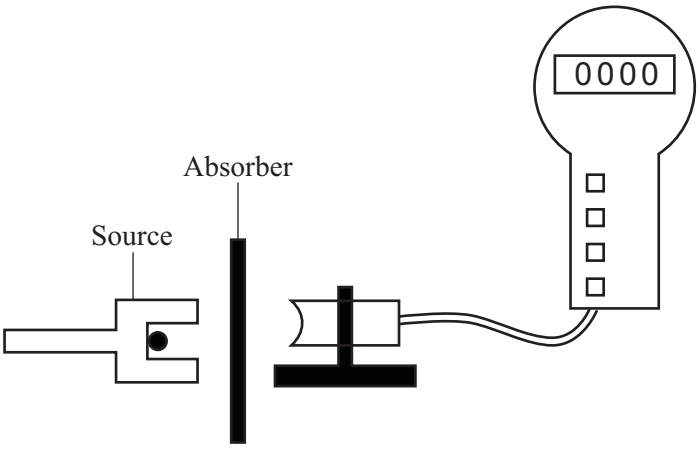
(b) The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.



Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

Absorber used	Average counts per second
No absorber	33
Card 1 mm thick	20
Metal 3 mm thick	2

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

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(3 marks)

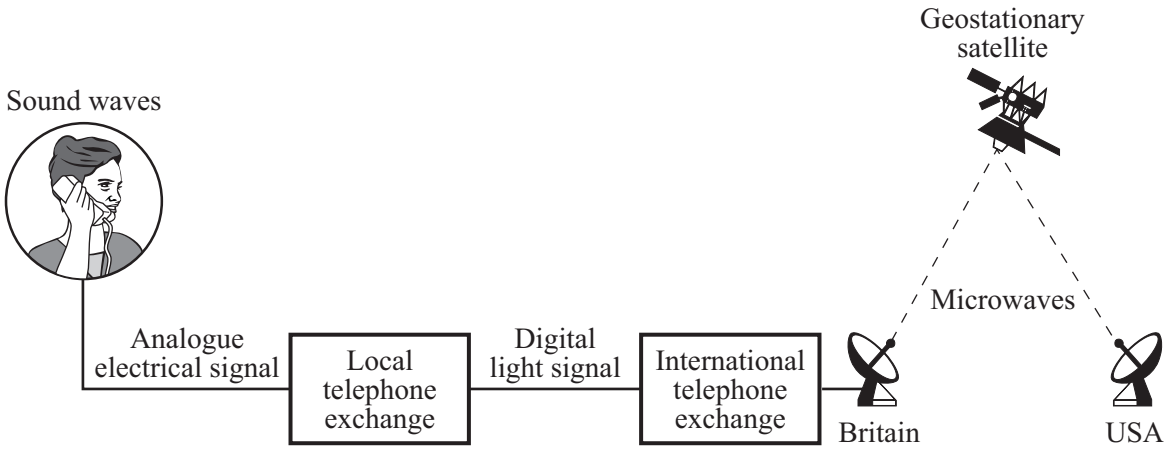
6

4.6.2.4 Uses and applications of electromagnetic waves

Question 05

June 2003 | 3462H3 | Original Q7 | Legacy

7 (a) The diagram shows, in a simplified form, how a telephone call can be transmitted from Britain to the USA.



(i) What is the difference between an analogue and a digital signal? You may wish to draw a diagram to help your answer.

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(2 marks)

(ii) Explain why the quality of an analogue signal transmitted over a long distance decreases, but the quality of a digital signal transmitted over the same distance does not change.

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(3 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 05 · continued

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(iii) Explain why the satellite used to receive and transmit the microwave signals is placed in a geostationary orbit.

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(2 marks)

(b) The picture shows a pre-natal scan obtained using ultrasonic waves.



(i) Explain how ultrasonic waves are used to produce the image of an unborn baby.

.....

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.....

(2 marks)

(ii) Give another use for ultrasonic waves.

.....

(1 mark)

10

4.6.2.4 Uses and applications of electromagnetic waves

Question 06

June 2003 | 3462H3 | Original Q12 | Legacy

12 (a) The table gives information about six radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
hydrogen-3	beta particle	12 years
iridium-192	gamma ray	74 days
polonium-210	alpha particle	138 days
polonium-213	alpha particle	less than 1 second
technetium-99	gamma ray	6 days
uranium-239	beta particle	24 minutes

(i) What is an alpha particle?

.....

(1 mark)

(ii) Two isotopes of polonium are given in the table. How do the nuclei of these two isotopes differ?

.....

(1 mark)

(iii) A doctor needs to monitor the blood flow through a patient's heart. The doctor injects a radioactive isotope into the patient's bloodstream. The radiation emitted by the isotope is then detected outside the body.

Which **one** of the isotopes in the table would the doctor inject into the bloodstream?

.....

Explain the reasons for your choice.

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(3 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 06 · continued

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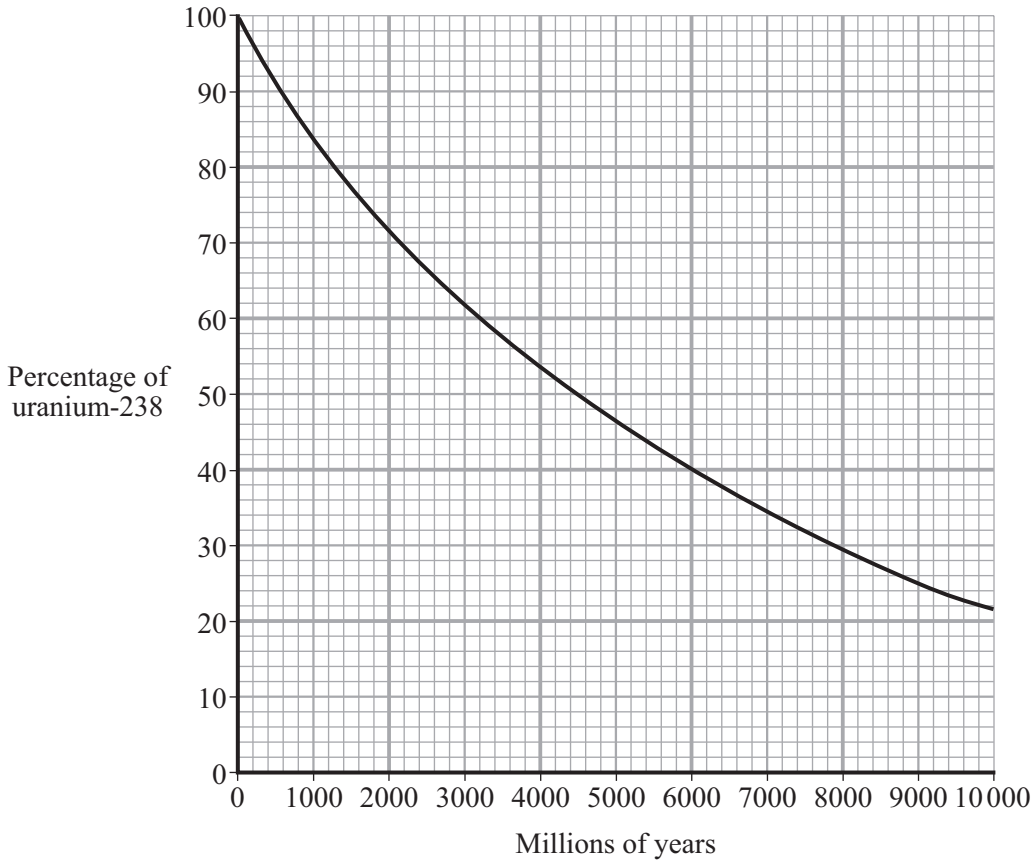
(b) Igneous rock contains uranium-238 which eventually changes to the stable isotope lead-206. The graph shows how the percentage of uranium-238 nuclei present in an igneous rock changes with time.



A rock sample is found to have seven atoms of uranium-238 for every three atoms of lead-206. Use the graph to estimate the age of the rock. Show clearly how you obtain your answer.

.....

.....

Age of rock = ...million years

(2 marks)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 07

June 2004 | 3451H | Original Q2 | Legacy

2 The diagram represents the electromagnetic spectrum.

Gamma rays	X-rays	Ultraviolet	Visible light	Infra red	Microwaves	Radio waves

(a) Name the type of electromagnetic radiation that is used:

(i) to sterilise surgical instruments;

.....

(1 mark)

(ii) to send a signal to a TV from a remote control.

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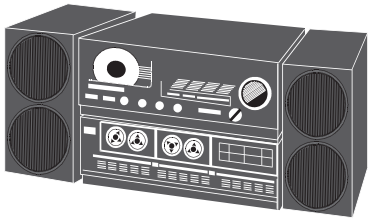
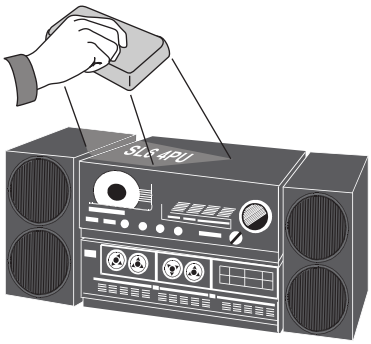
(1 mark)

(b) Valuable items can be security marked using special ink. The ink can only be seen in ultraviolet radiation.





Explain what happens to make the ink visible.

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(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 07 · continued

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(c) Explain why skin cells need to be protected from ultraviolet radiation.

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(2 marks)

(d) The following information is from an oven that combines a microwave and a grill.

Voltage	230 V
Microwave power	0.65 kW
Grill power	1.15 kW

(i) Name the **two** types of electromagnetic radiation that the oven can use to cook food.

..... and .....

(1 mark)

(ii) A joint of meat is cooked using both the microwave and the grill. Both are switched on at full power for half an hour.

Use the following equation to calculate the energy transferred, in kilowatt-hours, by the oven. Show clearly how you obtain your answer.

energy transferred = power × time

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energy transferred =.....kWh

(2 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 08

June 2004 | 3462H3 | Original Q2 | Legacy

2 The diagram represents the electromagnetic spectrum.

Gamma rays	X-rays	Ultraviolet	Visible light	Infra red	Microwaves	Radio waves

(a) Name the type of electromagnetic radiation that is used:

(i) to sterilise surgical instruments;

.....

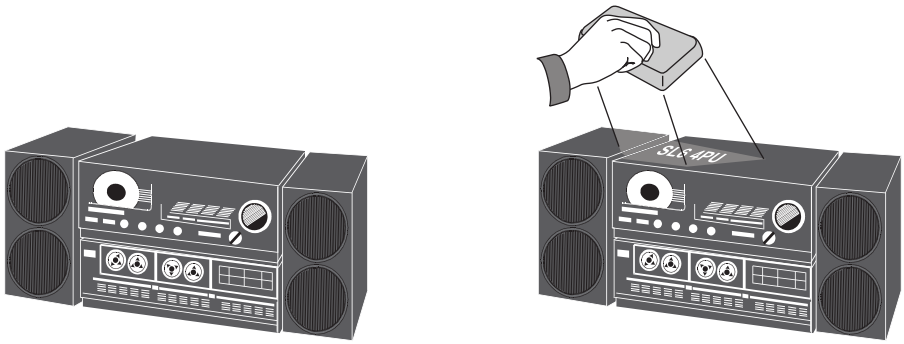
(1 mark)

(ii) to send a signal to a TV from a remote control.

.....

(1 mark)

(b) Valuable items can be security marked using special ink. The ink can only be seen in ultraviolet radiation.



Explain what happens to make the ink visible.

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(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 08 · continued

MARGIN BLANK

(c) Explain why skin cells need to be protected from ultraviolet radiation.

.....

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.....

.....

(2 marks)

(d) The following information is from an oven that combines a microwave and a grill.

Voltage	230 V
Microwave power	0.65 kW
Grill power	1.15 kW

(i) Name the **two** types of electromagnetic radiation that the oven can use to cook food.

..... and .....

(1 mark)

(ii) A joint of meat is cooked using both the microwave and the grill. Both are switched on at full power for half an hour.

Use the following equation to calculate the energy transferred, in kilowatt-hours, by the oven. Show clearly how you obtain your answer.

energy transferred = power × time

.....

.....

.....

energy transferred = ... kWh

(2 marks)

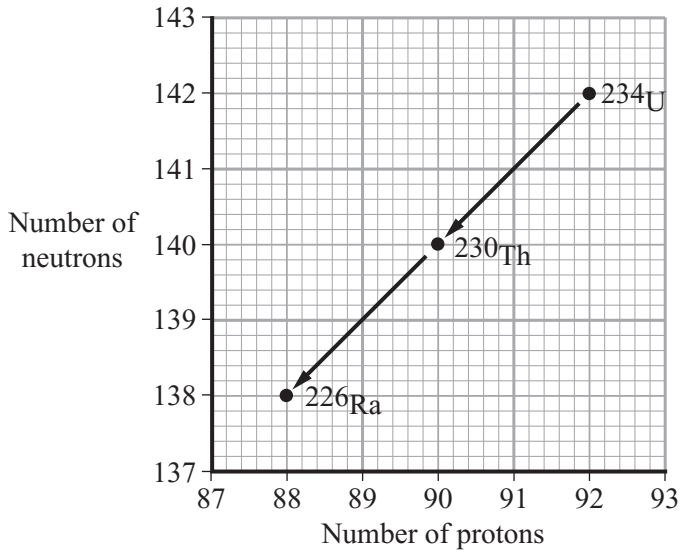
9

4.6.2.4 Uses and applications of electromagnetic waves

Question 09

June 2005 | 3451 | Original Q9 | Legacy

9 (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

.....

(1 mark)

(ii) What makes uranium and thorium different elements?

.....

(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

Why does the emission of gamma radiation **not** cause a new element to be formed?

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(1 mark)

Question 09 · continued

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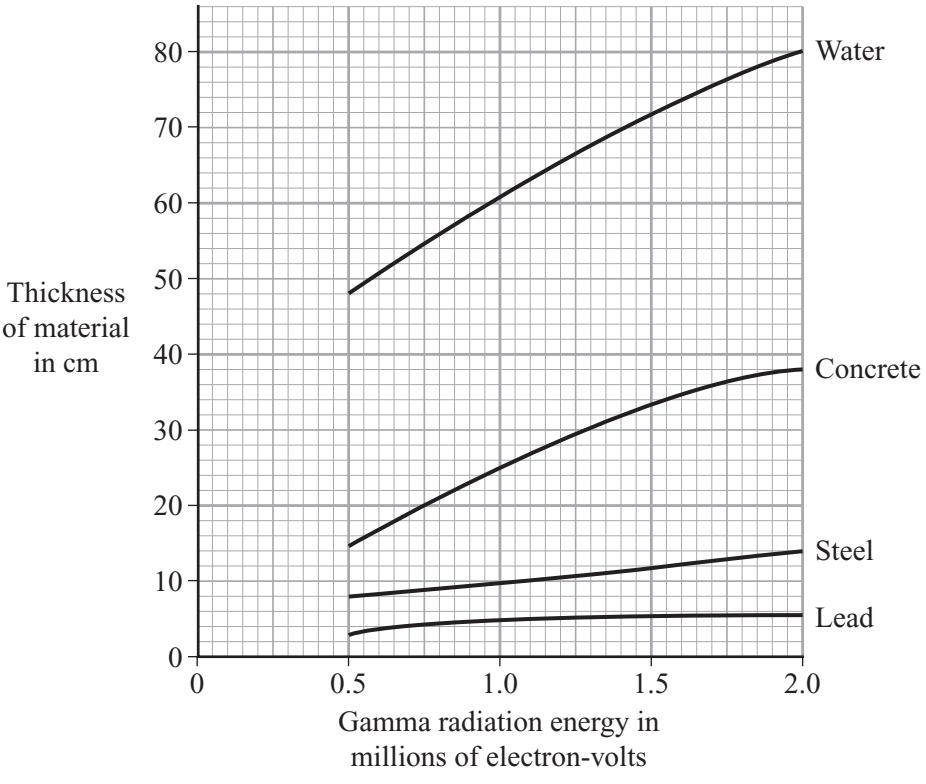
(b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

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(1 mark)

(ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

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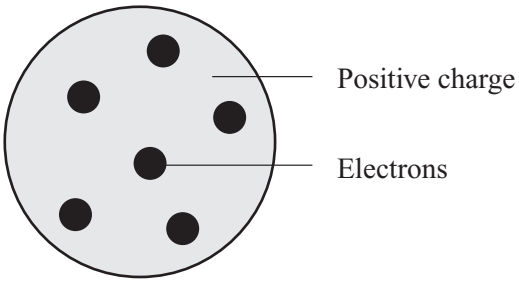
(2 marks)

QUESTION 9 CONTINUES ON THE NEXT PAGE

4.6.2.4 Uses and applications of electromagnetic waves

Question 09 · continued

(c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.
Explain how the results of this experiment led to a new model of the atom. You may include one or more diagrams in your answer.

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(3 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 10

June 2005 | 3451 | Original Q10 | Legacy

10 (a) Information transmitted through an optical fibre communications system is sent as a digital signal.

(i) Name **one** type of electromagnetic wave, other than visible light, used to carry information through an optical fibre.

.....

(1 mark)

(ii) What is a digital signal?

.....

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(1 mark)

(b) Information can be sent as an analogue signal. The signals weaken with distance and need to be amplified.
Explain why this causes the quality of the signal to deteriorate.

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(3 marks)

(c) Microwaves are used to send information within mobile phone networks.

Explain how microwaves could be harmful to living cells.

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(2 marks)

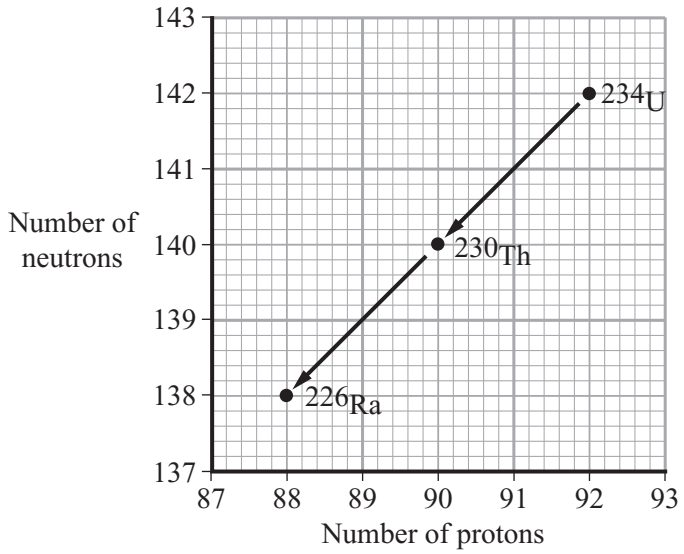
7

4.6.2.4 Uses and applications of electromagnetic waves

Question 11

June 2005 | 3462 | Original Q7 | Legacy

7 (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

.....

(1 mark)

(ii) What makes uranium and thorium different elements?

.....

(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

Why does the emission of gamma radiation **not** cause a new element to be formed?

.....

.....

(1 mark)

Question 11 · continued

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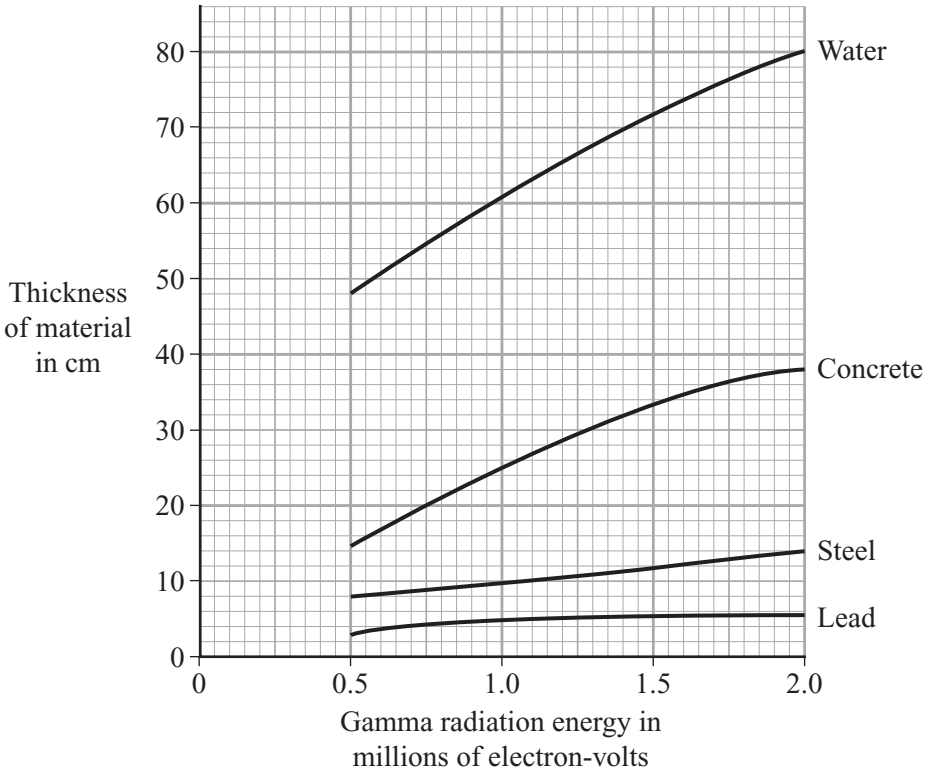
(b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

.....

.....

(1 mark)

(ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

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(2 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

4.6.2.4 Uses and applications of electromagnetic waves

Question 11 · continued

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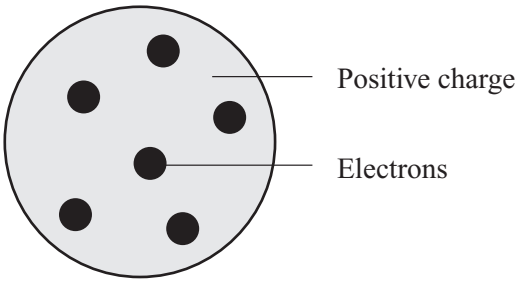
(c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

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(3 marks)

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4.6.2.4 Uses and applications of electromagnetic waves

Question 12

June 2005 | 3462 | Original Q8 | Legacy

8 (a) Information transmitted through an optical fibre communications system is sent as a digital signal.

(i) Name **one** type of electromagnetic wave, other than visible light, used to carry information through an optical fibre.

.....

(1 mark)

(ii) What is a digital signal?

.....

.....

(1 mark)

(b) Information can be sent as an analogue signal. The signals weaken with distance and need to be amplified.
Explain why this causes the quality of the signal to deteriorate.

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(3 marks)

(c) Microwaves are used to send information within mobile phone networks.

Explain how microwaves could be harmful to living cells.

.....

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(2 marks)

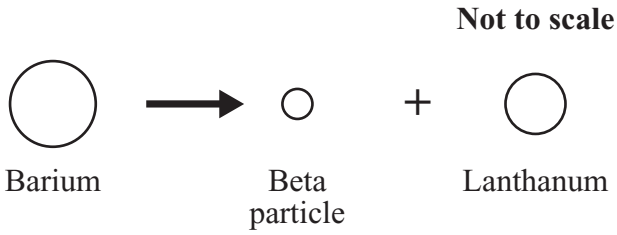
7

4.6.2.4 Uses and applications of electromagnetic waves

Question 13

June 2006 | 3451 | Original Q10 | Legacy

10 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.



(i) What is a beta particle?

.....

(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

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(1 mark)

(iii) Describe how a neutral atom may be changed by a collision with a beta particle.

.....

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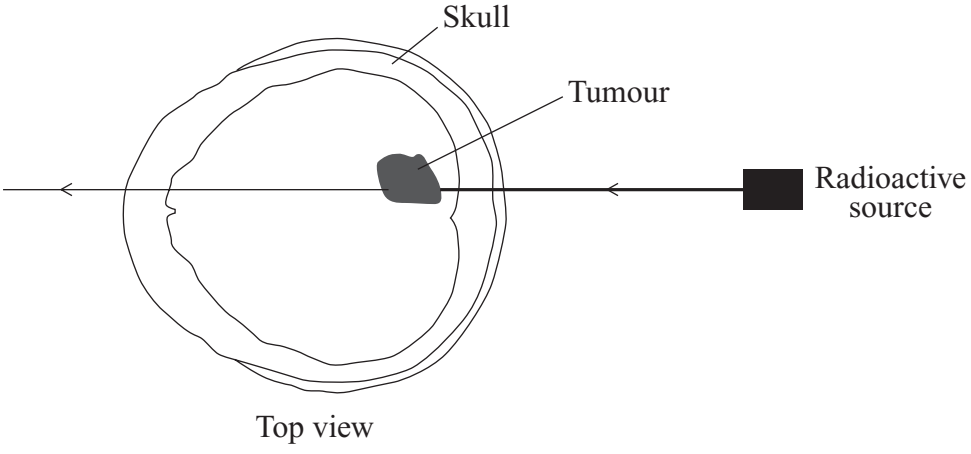
(1 mark)

(b) The diagram shows how radiation can be used to kill the cells of a brain tumour.



Why is a beta emitting radioactive source unsuitable for this purpose?

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(1 mark)

Question 13 · continued

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(c) The table gives the average radiation dose which someone in the UK receives in one year from background radiation.

Source of radiation	Dose in millisieverts
the ground	0.30
radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

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(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

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(2 marks)

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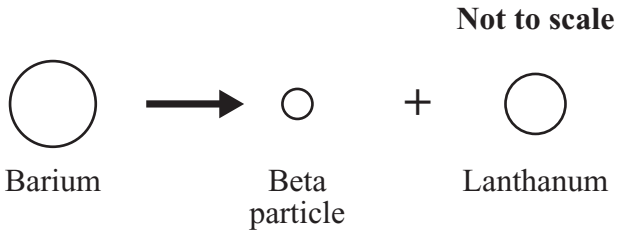
4.6.2.4 Uses and applications of electromagnetic waves

Question 14

June 2006 | 3462 | Original Q8 | Legacy

8 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.



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(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

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(1 mark)

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(1 mark)

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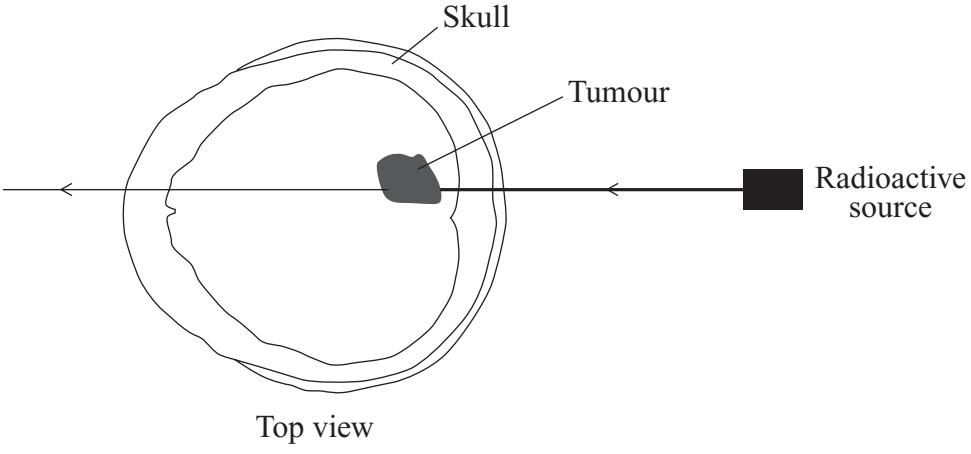

Why is a beta emitting radioactive source unsuitable for this purpose?

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.....

(1 mark)

Question 14 · continued

BLANK

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radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

.....

(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

.....

.....

.....

.....

(2 marks)

7

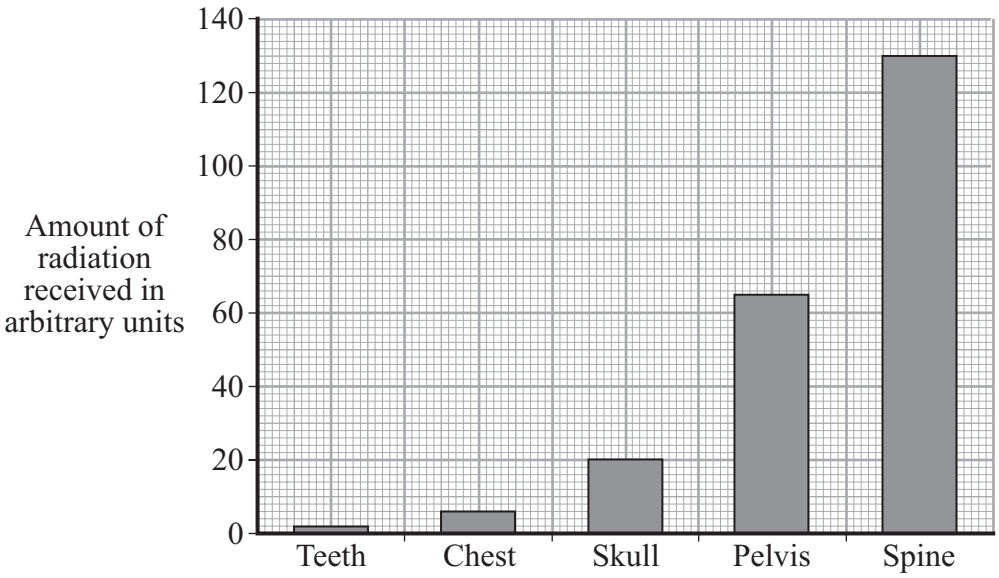
4.6.2.4 Uses and applications of electromagnetic waves

Question 15

November 2006 | PHY1B | Original Q1 | Legacy

QUESTION ONE

The graph shows the amount of radiation received by the body when different parts of the body are X-rayed.



Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A bar

B categoric

C dependent

D reliable

The part of the body X-rayed is described as a . . . **1** . . . variable.

The amount of radiation received is the . . . **2** . . . variable.

The data is displayed as a . . . **3** . . . chart.

Increasing the number of patients surveyed would make the data more . . . **4** . . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question 16

November 2006 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

Some substances give out radiation from the nuclei of their atoms.

5A A radioactive source emits alpha, beta and gamma radiation.

Which row in the table is correct?

	Deflected by a magnetic field?		
	Alpha	**Beta**	**Gamma**
1	no	no	yes
2	no	yes	no
3	yes	yes	no
4	yes	yes	yes

5B Americium oxide is used in smoke alarms. Atoms of americium can exist as different isotopes.

Which row in the table correctly describes the number of particles in the nucleus of an atom of each of two different isotopes of americium?

	Particles in each isotope	
1	different number of neutrons	different number of protons
2	different number of neutrons	same number of protons
3	same number of neutrons	different number of protons
4	same number of neutrons	same number of protons

5C The radioactive americium oxide used in a smoke alarm emits alpha particles.

These particles . . .

1 add electrons to the air.

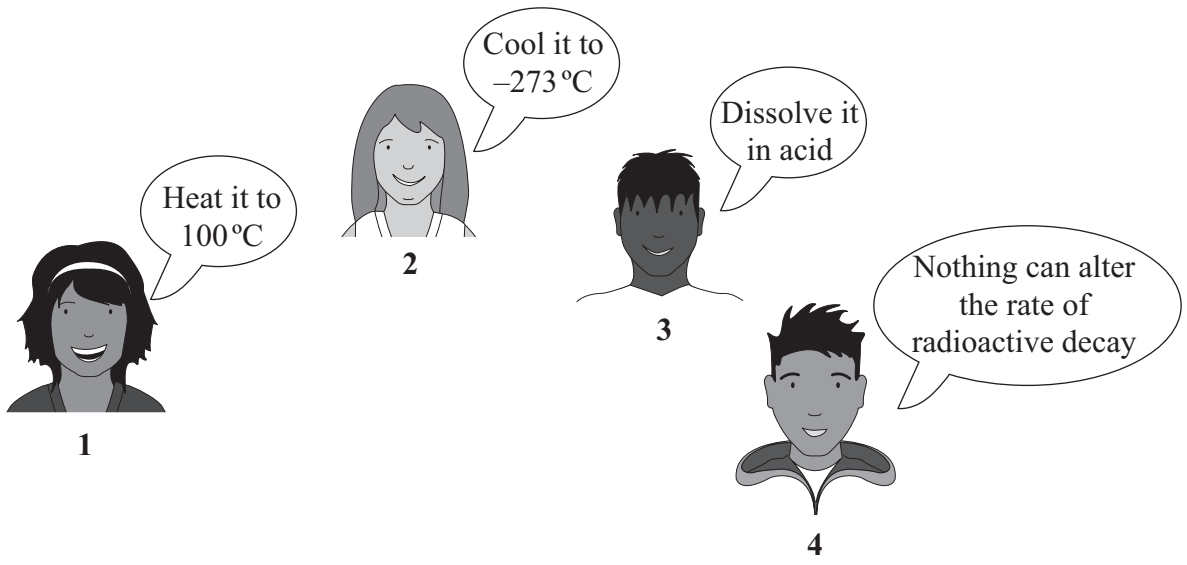
2 add neutrons to the air.

3 add protons to the air.

4 ionise particles in the air.

5D Four students discuss how to alter the rate of decay of a radioactive source.

Which student, **1**, **2**, **3** or **4**, is correct?



4.6.2.4 Uses and applications of electromagnetic waves

Question 17

November 2006 | PHY1B | Original Q6 | Legacy

QUESTION SIX

Skiers have an increased risk of damage from harmful rays from the Sun.



6A The best explanation of why the risk is increased is that . . .

1 the Sun's rays penetrate the skin more at a lower temperature.

2 the atmosphere absorbs more of the Sun's rays.

3 the skier moves at a high speed and this makes the rays penetrate the skin more.

4 the Sun's rays are reflected from the snow so more rays reach the skier.

6B Some skiers put special cream on the skin on their faces.

One reason this is done is so that the cream can . . .

1 absorb gamma rays.

2 keep the skier's skin warm.

3 produce an even suntan.

4 absorb ultraviolet radiation.

4.6.2.4 Uses and applications of electromagnetic waves

Question 17 · continued

6C The skier falls and has a suspected broken leg.

He is taken to hospital for an X-ray.

At the hospital, the X-ray technicians wear protective clothing and a badge that records exposure to X-rays.

They wear the badge to monitor their exposure because . . .

1 excess exposure to X-rays can damage body tissue.

2 the X-ray equipment gives off radioactive particles.

3 X-ray film contains toxins.

4 X-rays could make them glow in the dark.

6D The patient being X-rayed is not protected in the way that X-ray technicians are.

Why is this?

1 Images would not be obtained if the patient were fully protected.

2 Patients are not in contact with X-ray equipment.

3 The cost to provide protection for patients would be too high.

4 The time taken to protect each patient would be too long.

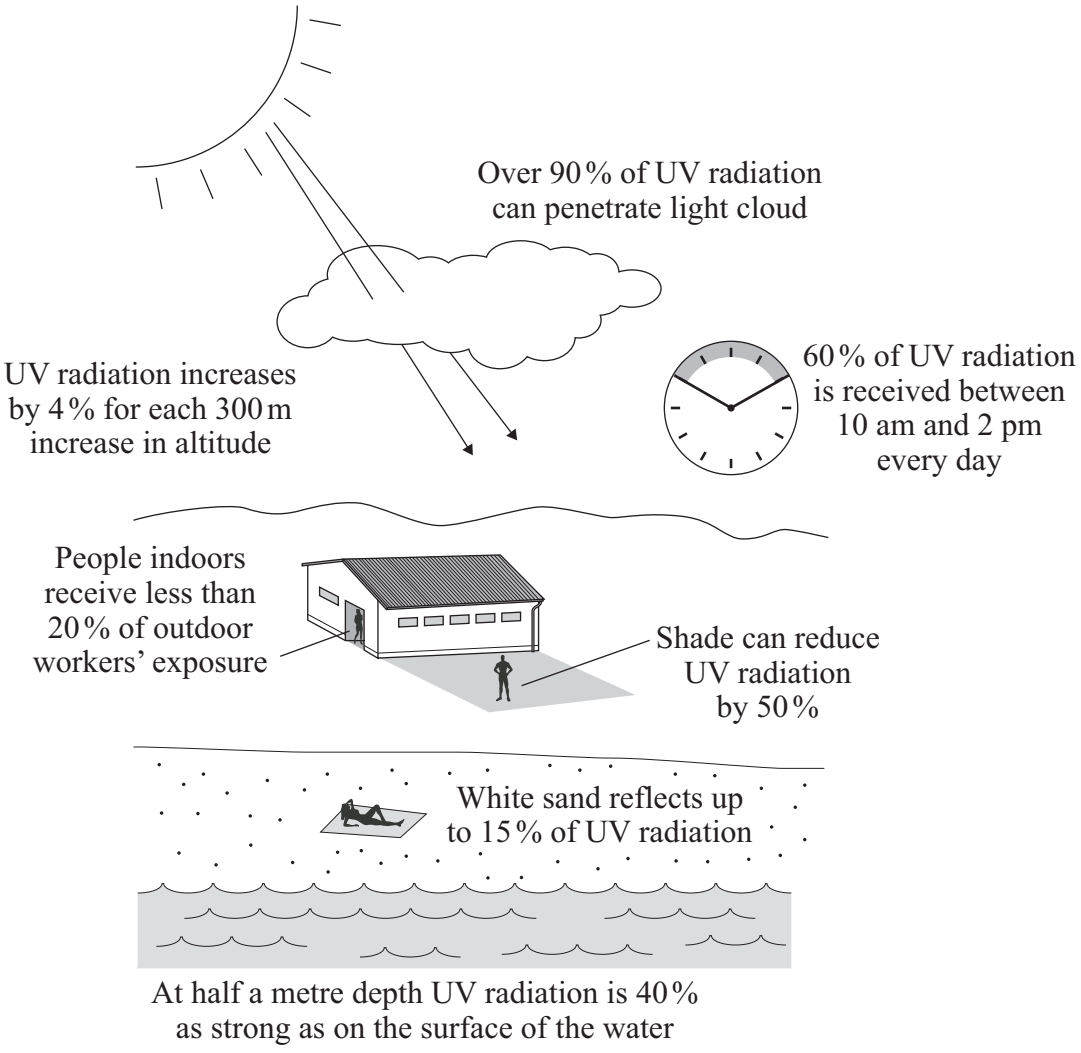
4.6.2.4 Uses and applications of electromagnetic waves

Question 18

November 2006 | PHY1B | Original Q9 | Legacy

QUESTION NINE

The diagram shows data about the reflection and absorption of ultraviolet (UV) radiation from the Sun. Excess exposure to UV radiation causes a variety of medical conditions including skin cancer.



Use information in the diagram to help you to answer the questions.

9A Compared with open fields at sea level, we would expect the UV radiation exposure at an altitude of 900 m to be increased by approximately . . .

1 4 %

2 12 %

3 30 %

4 36 %

4.6.2.4 Uses and applications of electromagnetic waves

9B What valid conclusion can be drawn from the information in the diagram?

1 More outdoor workers than indoor workers will develop skin cancer.

2 Outdoor workers are more likely than indoor workers to develop skin cancer.

3 Twice as many outdoor workers as indoor workers will develop skin cancer.

4 Working in the shade eliminates all risk of skin cancer caused by exposure to UV radiation.

9C Which of the following situations gives the **least** exposure to UV radiation?

1 in the shade between 3 pm and 4 pm on a cloudless day

2 in the shade between 3 pm and 4 pm on a cloudy day

3 on a beach between 1 pm and 2 pm on a cloudless day

4 on a beach between 1 pm and 2 pm on a cloudy day

9D Which one of the following is correct?

1 Outdoor swimming reduces the health risk due to UV radiation exposure equally over all parts of the body.

2 Mountain climbers have an increased risk of skin damage due to UV radiation exposure but to a smaller area of the body than swimmers.

3 There is no UV radiation in daylight on a cloudy day.

4 Working indoors eliminates exposure to UV radiation.

END OF TEST

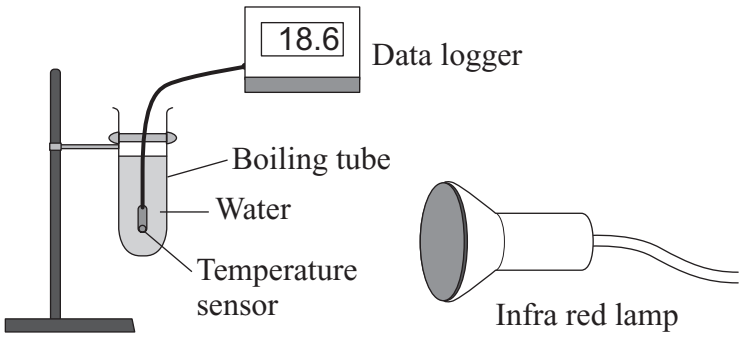
4.6.2.4 Uses and applications of electromagnetic waves

Question 19

January 2007 | PHY1H | Original Q1 | Legacy

1 A student had read about a glacier that had been covered in insulating material. The idea was to slow down the rate at which the glacier melts in the summer.

She investigated this idea using the apparatus shown in the diagram.



(a) These are the steps taken by the student.

- Measure 30 cm^3 of cold water into a boiling tube.
- Place the boiling tube 25 cm from an infra red lamp.
- Record the temperature of the water.
- Switch on the infra red lamp.
- Record the temperature of the water every minute for 5 minutes.
- Repeat with boiling tubes covered in different insulating materials.

(i) Why did she use an infra red lamp?

.....

(1 mark)

(ii) Name **one** control variable in this investigation.

.....

(1 mark)

(iii) Give **one** advantage of using a temperature sensor and data logger instead of a glass thermometer to measure temperature.

.....

.....

(1 mark)

Question 19 · continued

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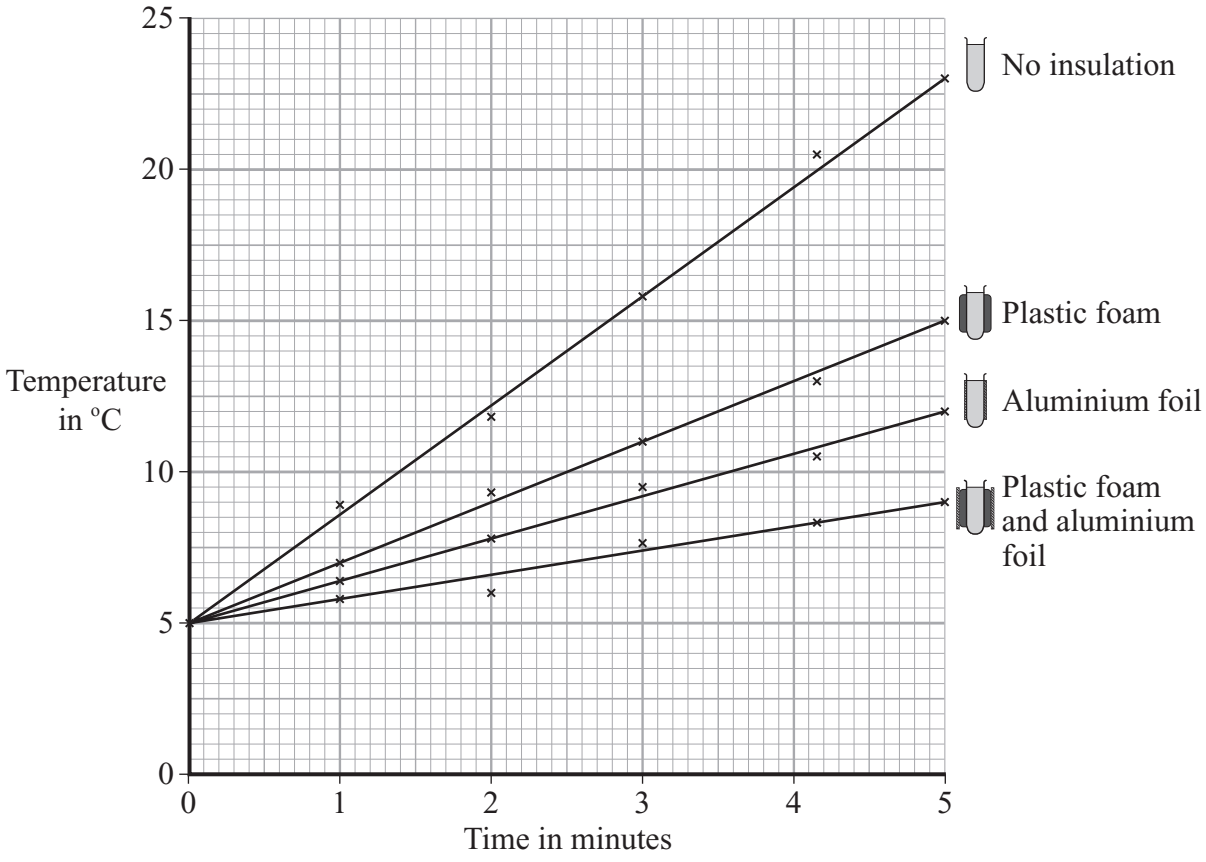
(b) The results of the investigation are shown in the graph.



(i) Why did the student use a boiling tube with no insulation?

.....

.....

(1 mark)

(ii) From her results, what should she recommend is used to insulate the glacier?

.....

(1 mark)

Question 1 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 19 · continued

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(iii) Explain why the insulation recommended by the student will reduce the heat transfer from the Sun to the glacier.

.....

.....

.....

.....

.....

(2 marks)

(c) Explain, in terms of particles, how heat is transferred through the glass wall of a boiling tube.

.....

.....

.....

.....

(2 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 20

4 (a) Alpha particles (α), beta particles (β) and gamma rays (γ) are types of nuclear radiation.

(i) Which of the three types of radiation is the most strongly ionising?

.....

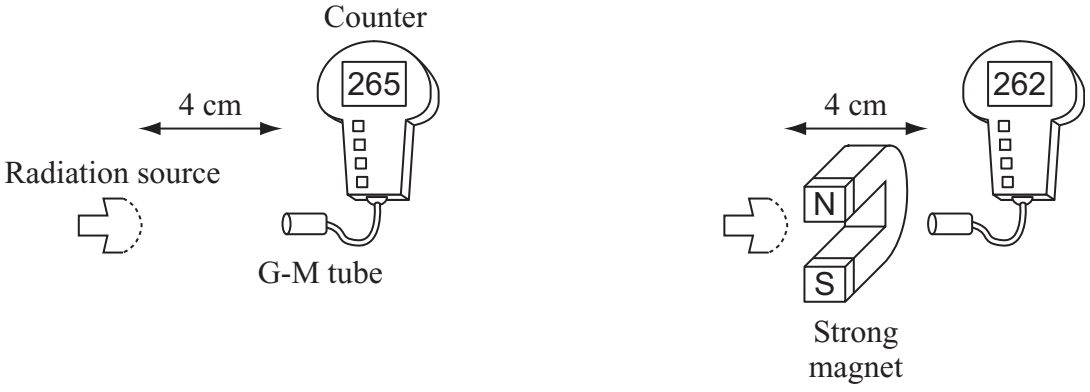
(1 mark)

(ii) What effect does nuclear radiation have on living cells?

.....

(1 mark)

(b) The diagrams show a G-M tube and counter used to measure the radiation emitted from a source. Both diagrams show the reading on the counter one minute after it was switched on.



Explain why the counter readings show that the source is giving out only gamma radiation.

.....

.....

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 20 · continued

BLANK

(c) The box gives information about the radioactive isotope technetium-99.

Type of radiation emitted: gamma
Half-life: 6 hours
Used as a medical tracer

What is meant by the term *half-life*?

.....

.....

(1 mark)

(d) To study the blood flow in a patient's lungs, a doctor injects a small quantity of a technetium-99 compound into the patient. The radiation emitted by the technetium-99 atoms is detected outside the patient's body.

Explain why a doctor would not use a radioactive isotope with a very short half-life, such as 2 seconds, as a medical tracer.

.....

.....

.....

.....

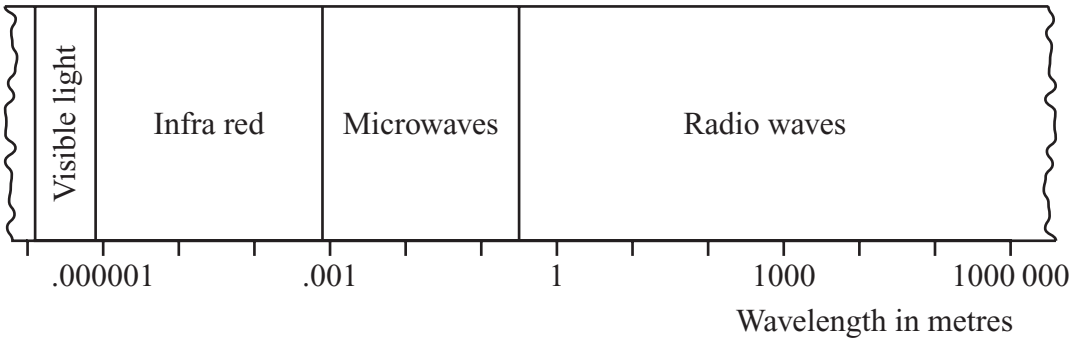
(2 marks)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 21

5 (a) The diagram represents part of the electromagnetic spectrum.



(i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

.....

(1 mark)

(ii) A radio station broadcasts at a frequency of 200 kHz.

Use the following equation to calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Wavelength = ... m

(2 marks)

(iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

(1 mark)

(b) Many radio stations now broadcast digital signals instead of *analogue* signals.

(i) What is an *analogue* signal?

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 21 · continued

BLANK

(ii) Give **one** reason why a radio station would broadcast digital signals instead of analogue signals.

.....

.....

(1 mark)

(c) A student thinks that because energy cannot be destroyed it is not possible to waste energy. So he leaves his radio, TV and computer on all the time, even when there is no one in the house.

Explain why he is wrong about not being able to waste energy.

.....

.....

.....

.....

(2 marks)

8

4.6.2.4 Uses and applications of electromagnetic waves

Question 22

March 2007 | PHY1B | Original Q1 | Legacy

QUESTION ONE

Read this extract from a magazine article.

X-rays and health

Students studied the health records of hospital patients who had been X-rayed in the previous three years. The patients were compared to a similar group who had not been X-rayed in the same period of time.

The students found that there was no significant difference in the health of the two groups.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A conclusion

B confidentiality

C control

D evidence

The group who had not been X-rayed is the . . . **1** . . . .

The data in the health records is the . . . **2** . . . .

What the students found out helps them to reach their . . . **3** . . . .

The ethical issue in such a study is the issue of . . . **4** . . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question 23

March 2007 | PHY1B | Original Q2 | Legacy

QUESTION TWO

Match types of electromagnetic radiation, **A**, **B**, **C** and **D**, with numbers **1–4** in the table.

A gamma rays

B microwaves

C ultraviolet rays

D X-rays

	Properties of radiation
1	do not penetrate human tissue below skin depth but can cause severe burns
2	penetrate only a few centimetres into human tissue but produce a lot of heat
3	pass through all types of human tissue, including bones, and can kill all types of cell
4	pass easily through soft human tissue without much absorption

4.6.2.4 Uses and applications of electromagnetic waves

Question 24

March 2007 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

A student has been learning about the electromagnetic spectrum.

4A Which part(s) of the electromagnetic spectrum can be used for communication?

1 radio waves only

2 radio waves and microwaves only

3 radio waves, microwaves and infra red rays only

4 radio waves, microwaves, infra red rays and visible light

4B Waves of the electromagnetic spectrum travel through space.

When they do, which property is the same for all of them?

1 energy

2 penetration

3 power

4 speed

4C The frequency of a radio signal is increased.

Which is correct?

1 Its speed decreases.

2 Its speed increases.

3 Its wavelength decreases.

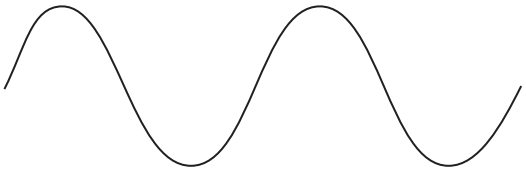
4 Its wavelength increases.

4.6.2.4 Uses and applications of electromagnetic waves

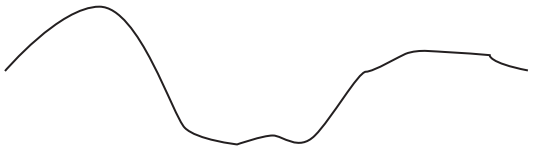
Question 24 · continued

4D Communication signals are often digital. The diagrams show four signals.

E



F



G



H

Which two could be digital?

1 **E** and **F**

2 **F** and **G**

3 **G** and **H**

4 **H** and **E**

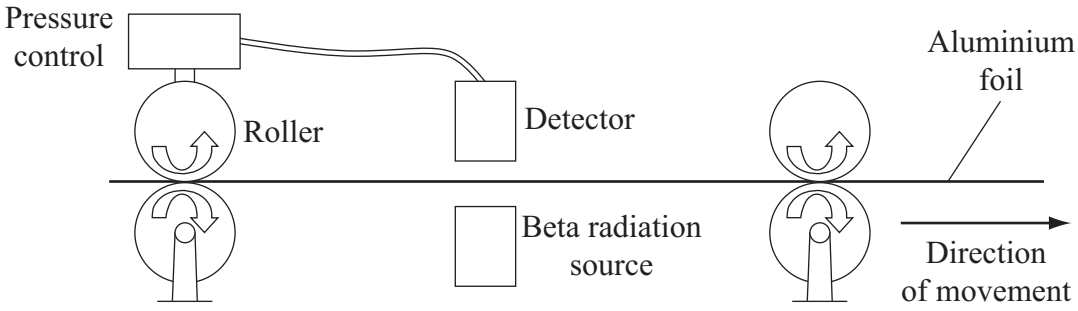
4.6.2.4 Uses and applications of electromagnetic waves

Question 25

March 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

The diagram shows how the thickness of aluminium foil is controlled during its manufacture. The thicker the aluminium foil, the more radiation it absorbs.



5A A beta particle consists of . . .

1 one electron.

2 one proton.

3 two protons.

4 two protons and two electrons.

5B Starting with the most penetrating radiation, which is the correct order?

1 alpha → beta → gamma

2 beta → alpha → gamma

3 beta → gamma → alpha

4 gamma → beta → alpha

5C Which sentence correctly explains why alpha and gamma radiation sources are unsuitable for use in this machine?

1 Alpha particles would be stopped by the foil but gamma rays would not be stopped.

2 Both would be stopped by the foil.

3 Gamma rays would be stopped by the foil but alpha particles would not be stopped.

4 Neither would be stopped by the foil.

4.6.2.4 Uses and applications of electromagnetic waves

5D A worker accidentally receives a short exposure to the beta radiation.

A day later, this is most likely to have caused . . .

1 cancer.

2 death.

3 hair loss.

4 skin burns.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 26

March 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

Use the equation to answer parts of this question.

wave speed	=	frequency	×	wavelength
(metres/second, m/s)		(hertz, Hz)		(metres, m)

7A A radio signal is broadcast at a frequency of 1500 kilohertz (kHz) and its speed is 300 million m/s.

What is its wavelength?

1 2 m

2 200 m

3 20 000 m

4 200 000 m

7B A microwave has a wavelength of 10 cm and its speed is 300 million m/s.

What is its frequency?

1 3 million Hz

2 30 million Hz

3 300 million Hz

4 3000 million Hz

7C Infra red signals can be sent through optical fibres.

This is because they are . . .

1 bent by a magnetic field in the optical fibre.

2 diffused through the optical fibre.

3 reflected from the inside surface of the optical fibre.

4 trapped in the centre of the optical fibre.

4.6.2.4 Uses and applications of electromagnetic waves

7D Which statement is true of radio waves?

1 They are mostly absorbed by soft tissue.

2 They do not include television signals.

3 They are not affected by the Earth's atmosphere.

4 They can create an alternating current in an electrical conductor.

Turn over for the next question

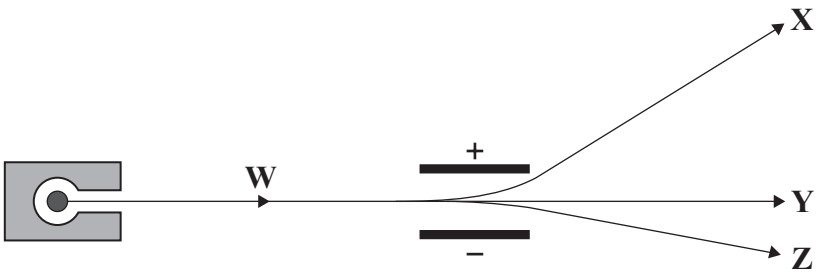
4.6.2.4 Uses and applications of electromagnetic waves

Question 27

June 2007 | PHY1B | Original Q2 | Legacy

QUESTION TWO

A source emits nuclear radiation. In front of it there is a gap in a powerful electrical field.



Match nuclear radiation types, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A alpha (α)

B beta (β)

C gamma (γ)

D alpha (α), beta (β) and gamma (γ)

Path **W** is the path of . . . **1** . . . radiation.

Path **X** is the path of . . . **2** . . . radiation.

Path **Y** is the path of . . . **3** . . . radiation.

Path **Z** is the path of . . . **4** . . . radiation.

4.6.2.4 Uses and applications of electromagnetic waves

Question 28

June 2007 | PHY1B | Original Q3 | Legacy

QUESTION THREE

Pills are often kept in bottles made from brown plastic. The brown plastic absorbs ultraviolet (UV) radiation which may cause chemical changes to take place in the pills.

A scientist carried out an investigation to compare the amount of UV radiation absorbed by four different pill bottles. Each bottle was made from a different type of plastic.

Instead of pills, she used UV-sensitive beads. The beads were white when kept in the dark. They changed to a red colour when exposed to UV radiation.

- She put twenty beads into each of the bottles.
- She then placed the bottles at equal distances from a UV lamp.
- She then measured the time it took for all of the beads in each bottle to change from white to red.

The table shows her results.

Bottle	Time taken, in minutes, for beads to turn red
W	19
X	37
Y	56
Z	24

3A What kind of variable was the type of pill bottle?

1 categoric

2 continuous

3 discrete

4 ordered

4.6.2.4 Uses and applications of electromagnetic waves

Question 28 · continued

3B Which of these was **not** a control variable in this investigation?

1 the number of beads

2 the distance of the bottle from the UV radiation

3 the intensity of the UV lamp

4 the type of plastic used for the bottle

3C Which bottle would be best for storing pills?

1 **W**

2 **X**

3 **Y**

4 **Z**

3D The best way of displaying the data from this investigation would be in the form of a . . .

1 bar chart.

2 line graph.

3 pie chart.

4 scattergram.

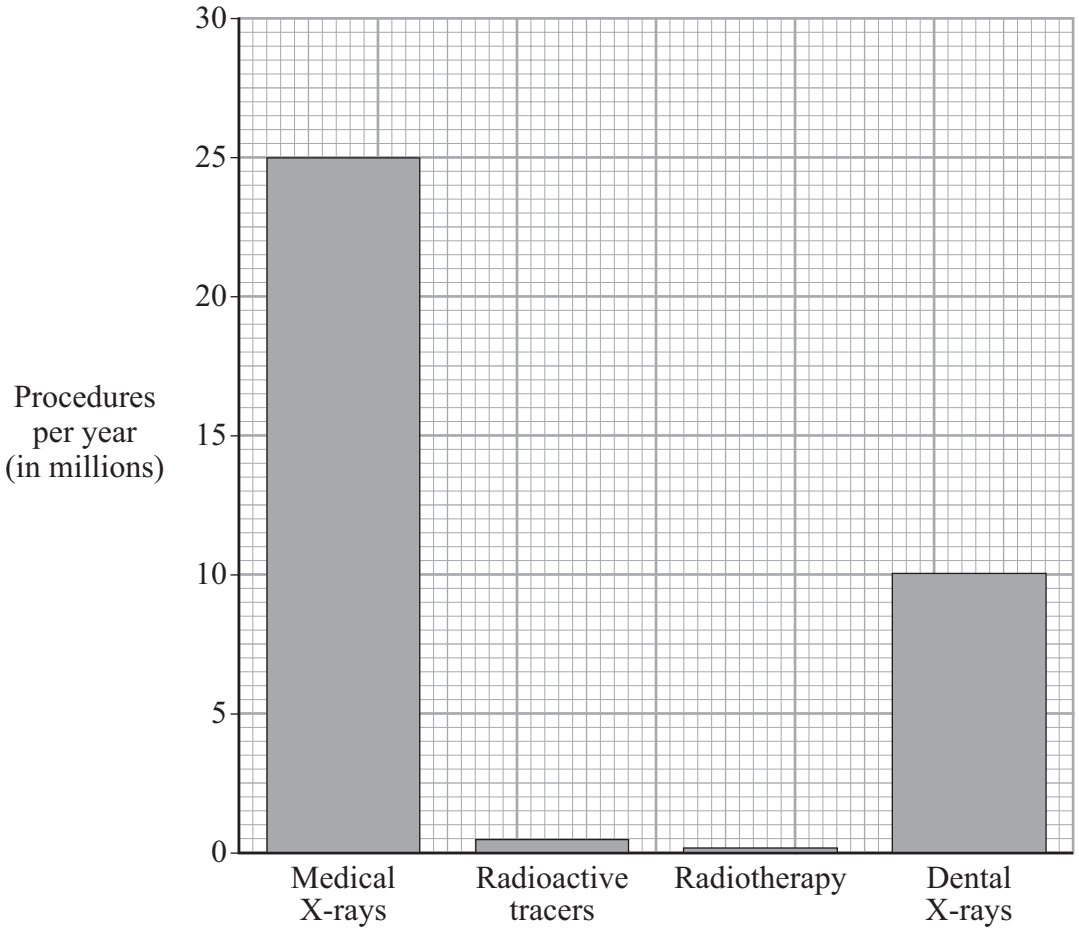
4.6.2.4 Uses and applications of electromagnetic waves

Question 29

June 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

The bar chart shows the number of medical procedures per year in the UK that involve exposure to electromagnetic and nuclear radiation.



5A In how many procedures were radioactive tracers used?

1 100 000

2 500 000

3 1 000 000

4 2 000 000

5B Which type of procedure is used to treat patients?

1 dental X-rays

2 medical X-rays

3 radioactive tracers

4 radiotherapy

4.6.2.4 Uses and applications of electromagnetic waves

5C What is the approximate total number of X-rays taken in the UK each year?

1 10 000

2 25 000

3 35 000

4 35 000 000

5D Medical X-rays are dangerous because . . .

1 they can pass through the body.

2 they cause burns to the skin.

3 they cause water inside cells to heat up.

4 they cause ionisation inside cells.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 30

June 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

This question is about the transmission of light by optical fibres.

7A Optical fibres can bend light around corners without loss of signal.

This is because . . .

1 absorption of the signal occurs in the optical fibre.

2 following signals push the signals around the corners.

3 reflection of the signal occurs inside the optical fibre.

4 light signals are digital signals.

7B Infra red and visible light are used to send signals along optical fibres.

Compared with other electromagnetic radiations, infra red and visible light . . .

1 have similar frequencies and wavelengths.

2 have very high frequencies and very high wavelengths.

3 have very low frequencies and very low wavelengths.

4 travel at different speeds.

7C Communication by electromagnetic radiation may be by analogue signals.

Which row of the table correctly describes the characteristics of these analogue signals?

	Speed	Signal type
1	constant	continuously varying
2	constant	only on or off
3	varies	continuously varying
4	varies	only on or off

4.6.2.4 Uses and applications of electromagnetic waves

Question 30 · continued

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

7D An infra red wave has a wavelength of 0.001 m and a wave speed of 300 000 000 m/s.

The frequency of this wave is:

1 3 Hz

2 30 Hz

3 30 000 Hz

4 300 000 000 000 Hz

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 31

June 2007 | PHY1B | Original Q8 | Legacy

QUESTION EIGHT

Americium-241 has a half-life of 432 years. A smoke detector uses the radiation from about 0.0002 g of americium-241 oxide. This substance emits alpha radiation. The alpha radiation ionises molecules in the air inside the smoke detector and this allows an electric current to flow. However, particles of smoke will absorb the radiation. This stops the electric current and causes the alarm to switch on.

8A When used as intended, a smoke detector is **not** a health hazard to humans.

This is because . . .

1 alpha particles are harmless.

2 alpha particles are the least harmful type of radiation.

3 alpha particles do **not** travel beyond the smoke alarm.

4 americium-241 has a long half-life.

8B Alpha particle emission is the most effective type of radiation for use in smoke detectors because . . .

1 alpha particles are heavier than beta particles.

2 alpha particles travel only short distances.

3 it is cheap to produce.

4 it is the most ionising type of radiation.

8C When an americium-241 atom emits an alpha particle, the new atom which is formed will have . . .

1 fewer protons only.

2 fewer neutrons only.

3 fewer electrons only.

4 fewer protons and fewer neutrons.

4.6.2.4 Uses and applications of electromagnetic waves

8D The table shows the properties of four radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
Californium-241	alpha	4 minutes
Cobalt-60	gamma	5 years
Strontium-90	beta	28 years
Technetium-99	gamma	6 hours

Which isotope would be the best to use as a tracer in the human body?

1 californium-241

2 cobalt-60

3 strontium-90

4 technetium-99

4.6.2.4 Uses and applications of electromagnetic waves

Question 32

June 2007 | PHY1H | Original Q1 | Legacy

1 Some types of food are treated with *gamma* radiation. Low doses of radiation slow down the ripening of fresh fruit and vegetables while higher doses of radiation kill the bacteria that make the food go off.

(a) (i) What is *gamma* radiation?

.....

(1 mark)

(ii) Food packed in crates or boxes can be treated using this method.

Why must a source that emits *gamma* radiation be used?

.....

.....

(1 mark)

(iii) A suitable source of gamma radiation is the isotope caesium 137.

Complete the following sentence by choosing the correct word from the box.

electrons	**neutrons**	**protons**

An atom of caesium 137 has two more ..... than an atom of caesium 135.

(1 mark)

Question 1 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 32 · continued

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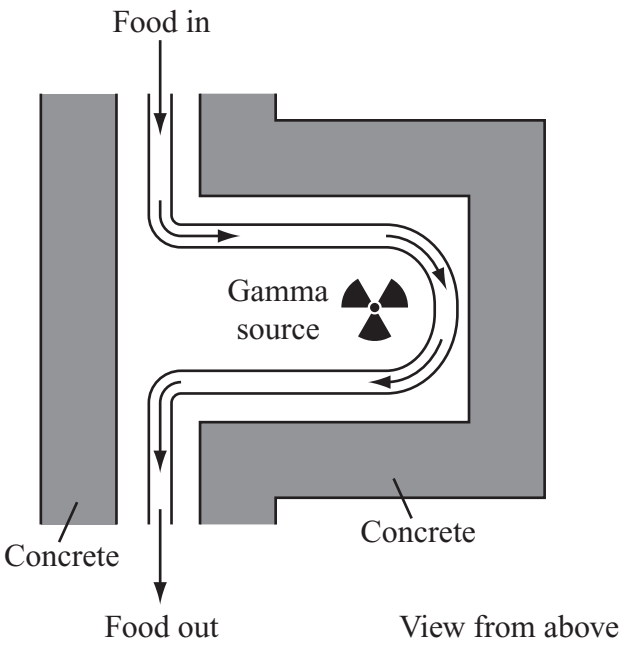
(b) The diagram shows how a conveyor belt can be used to move food past the radioactive source.



(i) How do the concrete walls reduce the radiation hazard to workers outside the food treatment area?

.....

.....

(1 mark)

(ii) Suggest **one** way that the dose of radiation received by the food could be increased other than by changing the radioactive source.

.....

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 32 · continued

BLANK

(c) Some people may not like the idea of eating food treated with radiation.

(i) What evidence could a food scientist produce to show that food treated with radiation is safe to eat?

.....

.....

.....

.....

(2 marks)

(ii) The diagram shows the sign displayed on food treated with radiation.



Why is it important for people to know which foods have been treated with radiation?

.....

.....

(1 mark)

8

4.6.2.4 Uses and applications of electromagnetic waves

Question 33

June 2007 | PHY1H | Original Q5 | Legacy

5 (a) The new Tetra communications system to be used by the police transmits *digital signals* using microwaves of wavelength 75 cm.
The signals travel through the air at 300 000 000 m/s.

(i) What is a *digital signal*?

.....

(1 mark)

(ii) Use the following equation to calculate the frequency of the microwaves used by the Tetra system. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Frequency = ... hertz
(2 marks)

(b) Read the following extract from a newspaper and then answer the questions that follow.

> Residents of Stag Hill Court, a luxury block of flats, are shocked at the plans to site a mobile phone mast on the roof of the flats. They oppose the mast on health grounds, quoting research in Germany that has found a possible increase in cases of cancer around mobile phone masts.
>
> A spokesperson for the telecoms company said, 'The residents should not worry. The research carried out by our own scientists has found no link between ill health and mobile phone masts'.
>
> This has not reassured the residents, who argue that new independent research is urgently needed.

(i) Explain why living near a mobile phone mast could cause ill health.

.....

.....

.....

.....

.....

.....
(3 marks)

Question 33 · continued

BLANK

(ii) Suggest **two** reasons why the residents have **not** been reassured by the research carried out by the telecoms company.

1 .....

.....

2 .....

.....

(2 marks)

8

Turn over for the next question

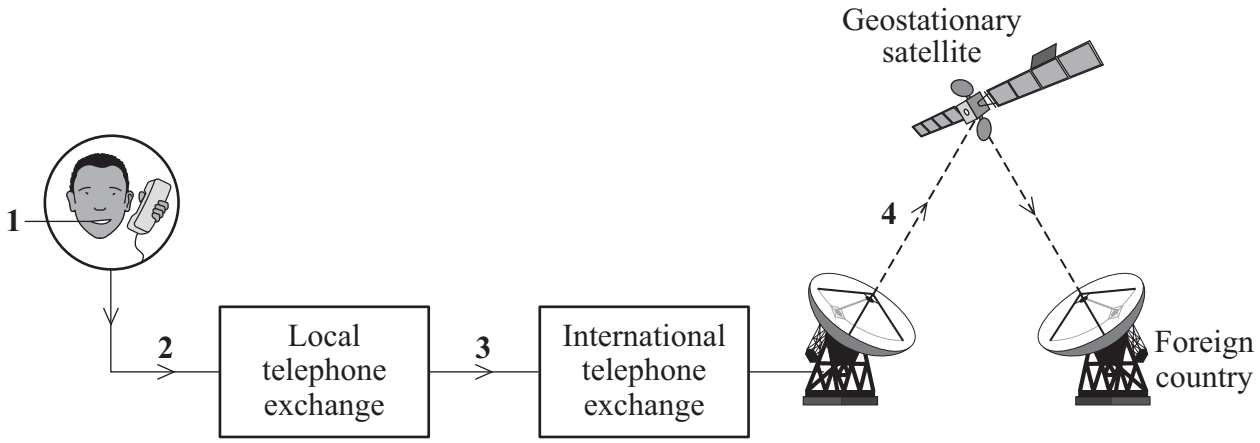
4.6.2.4 Uses and applications of electromagnetic waves

Question 34

November 2007 | PHY1B | Original Q1 | Legacy

QUESTION ONE

The diagram shows how a telephone call can be made to a foreign country.



Match waves and signals, **A**, **B**, **C** and **D**, with the numbers **1–4** on the diagram.

A analogue electrical signal

B digital light signal

C microwaves

D sound waves

4.6.2.4 Uses and applications of electromagnetic waves

Question 35

November 2007 | PHY1B | Original Q2 | Legacy

QUESTION TWO

The table gives typical frequencies for different types of electromagnetic radiation.

Match the names of the types of electromagnetic radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A infra red radiation

B ultraviolet radiation

C visible light

D X-rays

Type of electromagnetic radiation	Typical frequency in Hz
1	100 000 billion
2	1 000 000 billion
3	10 000 000 billion
4	100 000 000 billion

4.6.2.4 Uses and applications of electromagnetic waves

Question 36

November 2007 | PHY1B | Original Q4 | Legacy

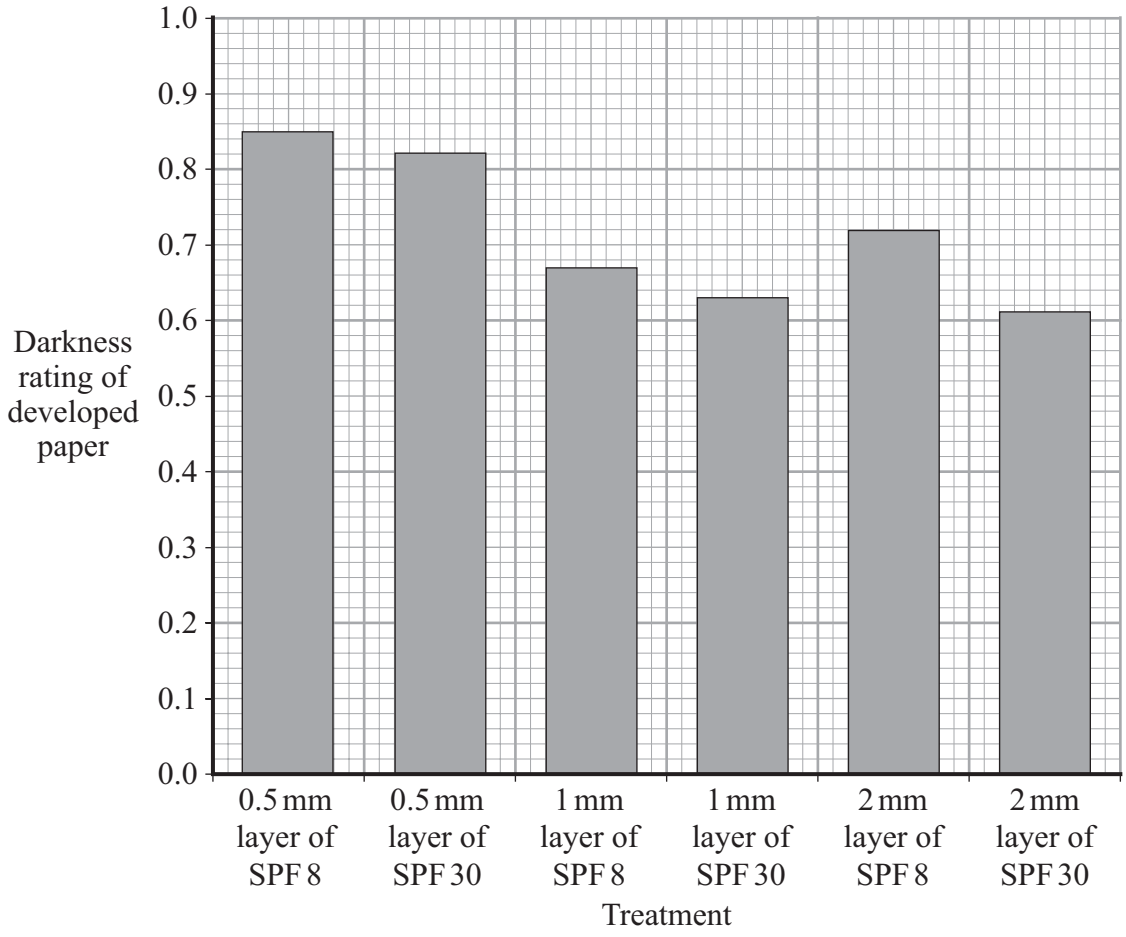
QUESTION FOUR

Doctors recommend that a 2 mm layer of sun cream with a sun protection factor (SPF) of 30 should be placed on the skin when you sunbathe.

A student investigated the effectiveness of sun creams in absorbing ultraviolet (UV) rays. She carried out her investigation in a dark room.

- She used sheets of a photographic paper sensitive to UV rays, wrapped in clear polythene.
- She applied two different sun creams, SPF 8 and SPF 30, to the polythene covering the photographic paper.
- She applied the creams in three different thicknesses, 0.5 mm, 1 mm and 2 mm.
- In a dark room, she exposed each piece of photographic paper to UV rays for 1 second.
- She then developed the photographic paper and measured the darkness of each piece of paper.
- A darkness rating of 1 means that all the UV rays penetrated the layer of sun cream; a darkness rating of 0 means that none of the UV rays penetrated the sun cream.

The graph shows her results.



4.6.2.4 Uses and applications of electromagnetic waves

Question 36 · continued November 2007 | PHY1B | Original Q4 | Legacy

4A What was the dependent variable in this investigation?

1 SPF value of sun cream

2 thickness of sun cream

3 time of exposure to UV rays

4 darkness rating of developed paper

4B Which treatment absorbed most UV rays?

1 0.5 mm layer of SPF 8 sun cream

2 0.5 mm layer of SPF 30 sun cream

3 1 mm layer of SPF 30 sun cream

4 2 mm layer of SPF 30 sun cream

4C Which treatment seemed to produce an anomalous result?

1 0.5 mm layer of SPF 8 sun cream

2 0.5 mm layer of SPF 30 sun cream

3 2 mm layer of SPF 8 sun cream

4 1 mm layer of SPF 30 sun cream

4D The data from this investigation . . .

1 proves that the doctors' recommendations are correct.

2 does **not** support the doctors' recommendations.

3 supports the doctors' recommendations.

4 turns a hypothesis into a theory.

4.6.2.4 Uses and applications of electromagnetic waves

Question 37

November 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

There are different types of electromagnetic radiation and nuclear radiation.

5A Which one of the following types of radiation is **not** used for communication?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5B Which one of the following types of radiation has the longest wavelength?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5C Which one of the following statements is **not** true of **both** ultraviolet radiation and infra red radiation?

1 They can be seen by the human eye.

2 They are members of the electromagnetic spectrum.

3 Each can have a range of different wavelengths and frequencies.

4 They travel at the same speed in a vacuum.

5D Which type of radiation is emitted by the nucleus of an atom of a radioactive isotope?

1 gamma radiation

2 X-rays

3 microwave radiation

4 ultraviolet radiation

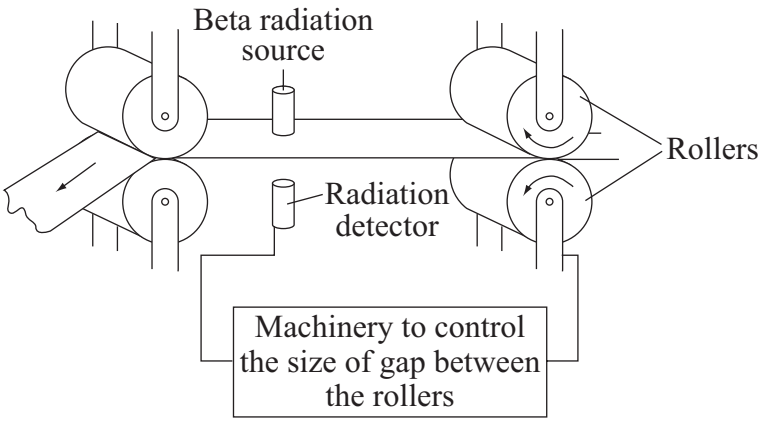
4.6.2.4 Uses and applications of electromagnetic waves

Question 38

November 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

The diagram shows a system used in a paper mill to control the thickness of the paper.



The paper passes through a narrow gap between a beta (β) radiation source and a detector.

7A Beta radiation passes through the paper more easily than alpha radiation because beta radiation . . .

1 consists of smaller particles than alpha radiation.

2 has a negative charge.

3 has a shorter frequency than alpha radiation.

4 has a longer wavelength than alpha radiation.

7B A radioactive source producing only gamma rays would be unsuitable because . . .

1 gamma radiation consists of rays rather than particles.

2 the paper would **not** stop any of the gamma rays reaching the radiation detector.

3 gamma rays are **not** affected by magnetic fields.

4 gamma rays are too dangerous to use.

4.6.2.4 Uses and applications of electromagnetic waves

Question 38 · continued

7C Beta particles are less dangerous to workers than alpha particles because they . . .

1 are deflected by magnetic fields.

2 are much less strongly ionising.

3 cannot penetrate skin.

4 have a much shorter range.

7D The most suitable half-life for the beta source in the system is . . .

1 six hours.

2 six days.

3 six months.

4 six years.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 39

4 (a) A radioactive source emits alpha (α), beta (β) and gamma (γ) radiation.

(i) Which **two** types of radiation will pass through a sheet of card?

.....

(1 mark)

(ii) Which **two** types of radiation would be deflected by an electric field?

.....

(1 mark)

(iii) Which type of radiation has the greatest range in air?

.....

(1 mark)

(b) A student suggests that the radioactive source should be stored in a freezer at –20 °C. The student thinks that this would reduce the radiation emitted from the source.

Suggest why the student is wrong.

.....

.....

(1 mark)

Question 4 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 39 · continued

BLANK

(c) Phosphorus-32 is a radioactive isotope that emits beta radiation.

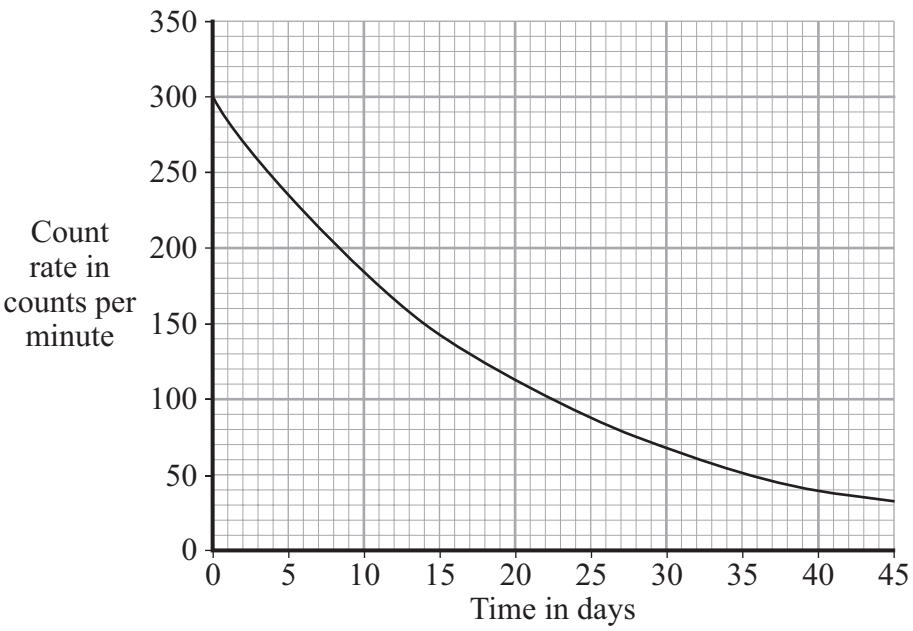
(i) How is an atom of phosphorus-32 different from an atom of the stable isotope phosphorus-31?

.....

.....

(1 mark)

(ii) The graph shows how the count rate of a sample of phosphorus-32 changes with time.



Use the graph to calculate the half-life of phosphorus-32.

Show clearly how you used the graph to obtain your answer.

.....

.....

Half-life = ... days

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 39 · continued

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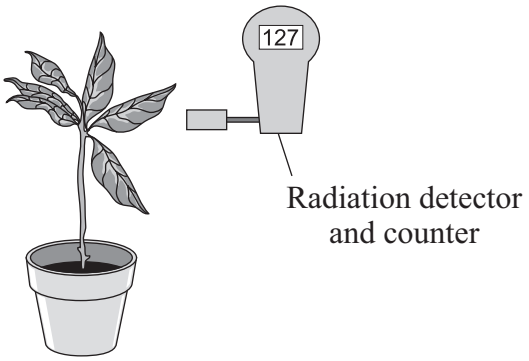
(iii) Plants use phosphorus compounds to grow. Watering the root system of a plant with a solution containing a phosphorus-32 compound can help scientists to understand the growth process.



Explain why phosphorus-32 is suitable for use as a tracer in this situation.

.....

.....

.....

.....

(2 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 40

5 (a) The wavelengths of four different types of electromagnetic wave, including visible light waves, are given in the table.

Type of wave	Wavelength
Visible light	0.0005 mm
A	1.1 km
B	100 mm
C	0.18 mm

Which of the waves, **A**, **B** or **C**, is an infra red wave? .....

(1 mark)

(b) A TV station broadcasts at 500 000 kHz. The waves travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the wavelength of the waves broadcast by this station.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2 marks)

(c) What happens when a metal aerial absorbs radio waves?

.....

.....

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 40 · continued

BLANK

(d) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Why would an X-ray telescope based on Earth not be able to detect X-rays emitted from distant stars?

.....

.....

(1 mark)

6

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 41

March 2008 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A gamma rays

B radio waves

C ultraviolet waves

D visible light

The type of electromagnetic radiation which can be used to send signals along optical fibres is . . . **1** . . . .

The type of electromagnetic radiation which has the highest frequency is . . . **2** . . . .

The type of radiation that has the longest wavelength is . . . **3** . . . .

The type of electromagnetic radiation used in sunbeds for tanning is . . . **4** . . . .

4.6.2.4 Uses and applications of electromagnetic waves

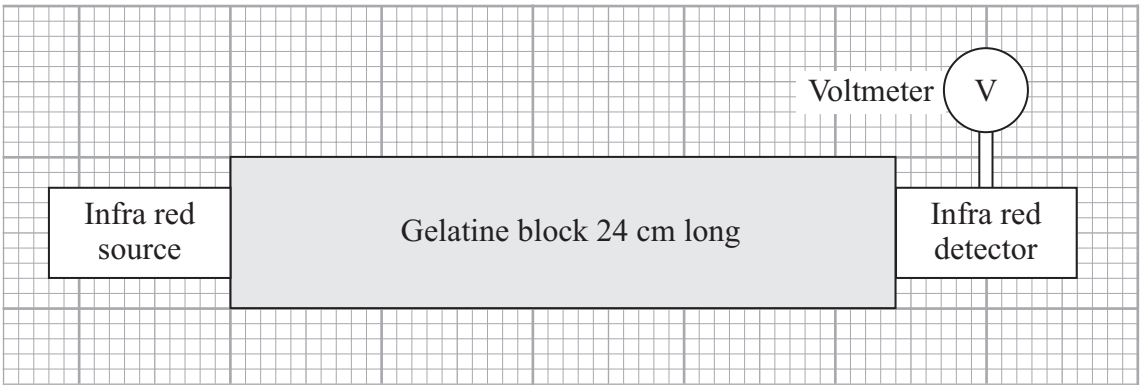
Question 42

March 2008 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

A student investigated the absorption of infra red radiation by a block of gelatine.

She placed a block of gelatine on a piece of graph paper and cut the block to a length of 24 cm. She then placed an infra red source touching one end of the block and an infra red detector touching the other end as shown in the diagram.

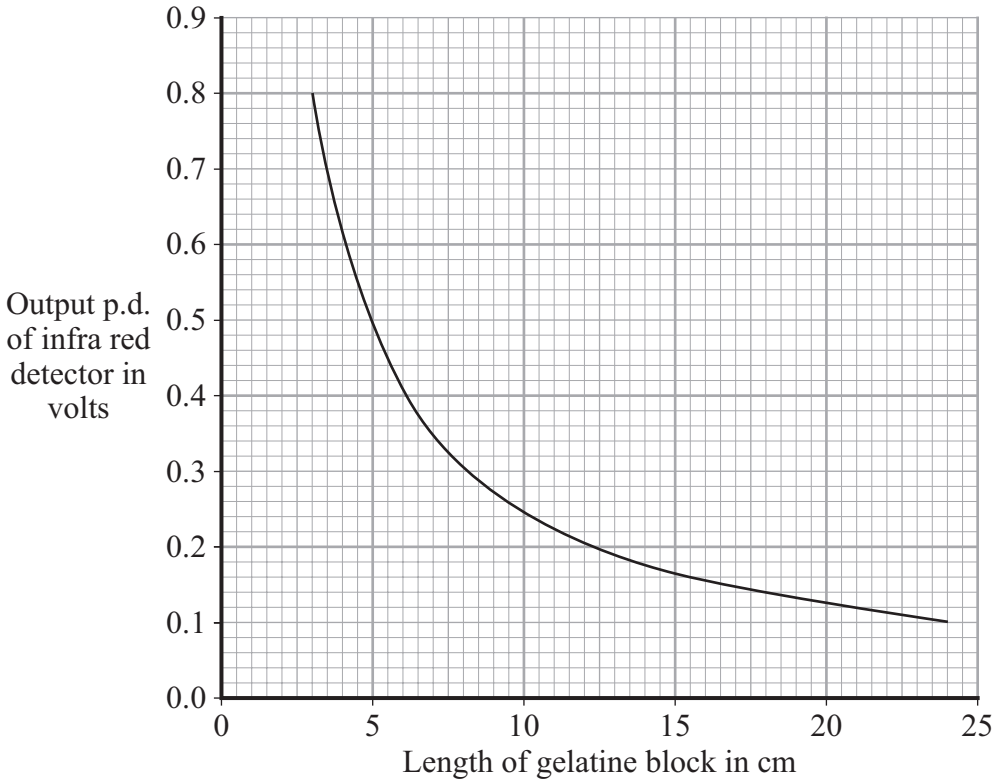


She recorded the output potential difference (p.d.) from the infra red detector.

She then repeated the experiment several times. Each time, she cut 2 cm off the gelatine block and set up the apparatus as shown in the diagram.

The graph shows her results.

The higher the intensity of infra red radiation received by the detector, the greater the output p.d.



3A What was the dependent variable in this experiment?

1 the position of the infra red source

2 the length of the gelatine block

3 the position of the infra red detector

4 the output p.d. from the infra red detector

3B Which is the best description of the pattern shown by the graph?

1 As the length of the gelatine block increases, the intensity of infra red radiation received by the detector decreases.

2 As the length of the gelatine block increases, the intensity of infra red radiation received by the detector decreases by a similar amount.

3 The longer the gelatine block, the larger the effect of cutting off 2 cm on the increase in the intensity of infra red radiation received by the detector.

4 There is no relationship between the length of the gelatine block and the intensity of infra red radiation received by the detector.

Question 3 continues on the next page

Question 42 · continued

3C The table shows the student's results.

Length of gelatine block in cm	Output p.d. in V
24.0	0.1
12.0	0.2
6.0	0.4
3.0	0.8

Based on the data that the student recorded, what was the sensitivity of the voltmeter?

1 0.1 V

2 0.2 V

3 0.4 V

4 1.0 V

3D Scientists carried out a similar investigation using glass optical fibres in place of the gelatine block. They found that there was no significant reduction in the output p.d. of the infra red detector until the fibre was several kilometres long.

This shows that . . .

1 gelatine absorbs infra red radiation much more strongly than glass.

2 glass is more transparent than water.

3 infra red radiation passes through solids faster than through liquids.

4 infra red radiation can pass through bent optical fibres.

4.6.2.4 Uses and applications of electromagnetic waves

Question 43

March 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Microwaves have many uses.

4A Microwaves can be used to cook food because they . . .

1 are at a high temperature when they leave the source in the oven.

2 travel straight through the food.

3 encourage the food to combine with oxygen.

4 transfer kinetic energy to the water molecules in the food.

4B Microwaves are used to transmit television broadcasts via a satellite because . . .

1 they can penetrate the atmosphere without significant loss of energy.

2 they do not interfere with aircraft navigation systems.

3 they have a longer wavelength than radio waves.

4 they have a lower frequency than radio waves.

4C More and more television and telephone transmissions use digital signals because digital signals . . .

1 are cheaper to use than analogue signals.

2 cause less risk to health.

3 are less prone to interference.

4 travel faster than analogue signals.

4D Some scientists think that mobile phones may be a health risk.

Their main concern is that the microwaves emitted by mobile phones . . .

1 may cause blistering of the ears.

2 may cause blindness.

3 may cause deafness.

4 may cause damage to genetic material in cells.

4.6.2.4 Uses and applications of electromagnetic waves

Question 44

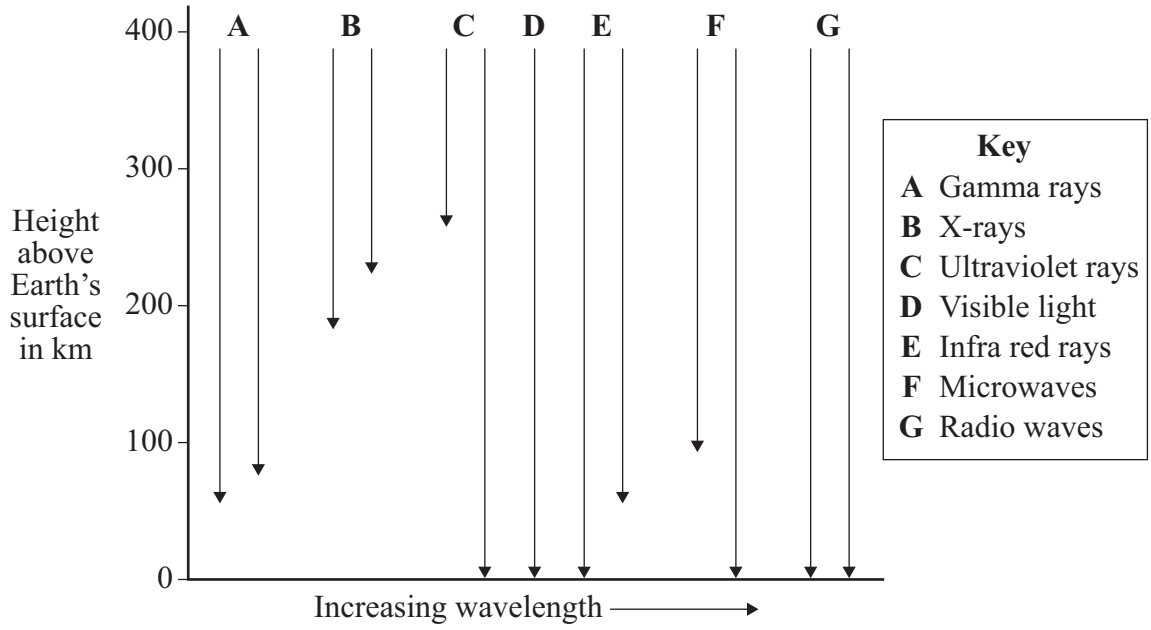
March 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

All forms of electromagnetic radiation from space are used by scientists to explore the Universe.

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9A Which one of the following statements is true?

1 Gamma radiation penetrates the atmosphere further than all other types of electromagnetic radiation.

2 All frequencies of microwaves reach Earth's surface.

3 No frequencies of radio waves reach Earth's surface.

4 Higher frequencies of ultraviolet radiation are completely absorbed by the atmosphere.

9B What would be the minimum height above the Earth for a satellite carrying a telescope designed to detect gamma rays and X-rays of all wavelengths?

1 50 km

2 70 km

3 180 km

4 230 km

4.6.2.4 Uses and applications of electromagnetic waves

Question 44 · continued March 2008 | PHY1BP | Original Q9 | Legacy

9C Which one of the following correctly describes the data on the diagram?

1 The absorption of electromagnetic radiation by the atmosphere is directly proportional to wavelength.

2 The absorption of electromagnetic radiation by the atmosphere is inversely proportional to wavelength.

3 The shorter the wavelength of electromagnetic radiation, the greater the absorption by the atmosphere.

4 Absorption of electromagnetic radiation does **not** depend only on wavelength.

9D Electromagnetic radiation from distant galaxies is very weak and is therefore very difficult to detect.

The Spitzer space telescope uses liquid helium to keep its scientific instruments at a very low temperature.

Which type of weak electromagnetic radiation would best be detected by instruments kept at this very low temperature?

1 gamma rays

2 X-rays

3 infra red rays

4 ultraviolet rays

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 45

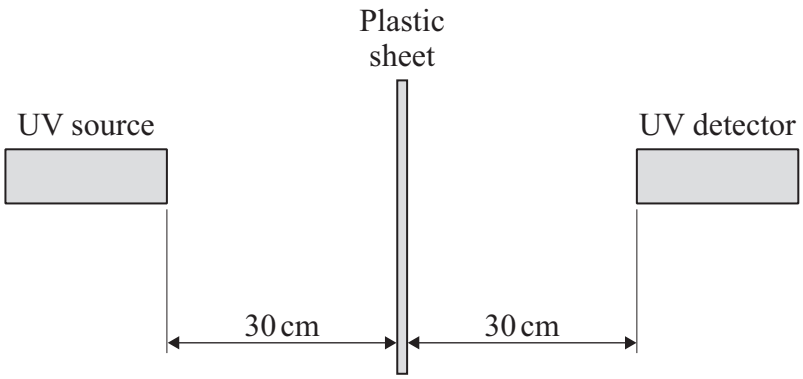
June 2008 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

A scientist investigated the different plastics used to make sunglasses. She wanted to find out which plastic was best at absorbing ultraviolet (UV) radiation.

She used sheets of four different types of plastic, **W**, **X**, **Y** and **Z**. Each plastic sheet was the same thickness. The plastic sheet, a UV source and a UV detector were set up as shown in the diagram.

The scientist recorded the intensity of the UV radiation reaching the detector through each type of plastic.



3A What kind of variable was the type of plastic used in this investigation?

1 categoric

2 continuous

3 discrete

4 ordered

Question 45 · continued

3B What was the dependent variable in this investigation?

1 the type of plastic

2 the distance from the UV source to the plastic sheet

3 the intensity of the UV radiation leaving the source

4 the intensity of the UV radiation reaching the detector

3C The table shows the intensity of UV radiation reaching the detector for each of the four types of plastic.

Type of plastic	Intensity of UV radiation reaching the detector in arbitrary units
W	15
X	13
Y	18
Z	16

Which plastic would give most protection to the eyes when used to make sunglasses?

1 **W**

2 **X**

3 **Y**

4 **Z**

3D The results of the investigation would have been more reliable if the scientist had . . .

1 used a range of thicknesses for each plastic.

2 used different intensities of UV radiation for each plastic.

3 varied the distance between the UV source and the plastic.

4 measured the intensity of UV radiation reaching the detector several times for each plastic.

4.6.2.4 Uses and applications of electromagnetic waves

Question 46

June 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

The table gives some information about four radioactive isotopes, **P**, **Q**, **R** and **S**.

Radioactive isotope		Type of radiation emitted	Half-life
P	americium-237	alpha	78 minutes
Q	americium-241	alpha	432 years
R	technetium-99	gamma	6 hours
S	krypton-78	beta	10.7 years

4A Which isotope emits an electron from the nucleus?

1 **P**

2 **Q**

3 **R**

4 **S**

4B Which isotope emits radiation with the longest range in air?

1 **P**

2 **Q**

3 **R**

4 **S**

4C Which isotope would be the most suitable for use in a system for controlling paper thickness in a paper factory?

1 **P**

2 **Q**

3 **R**

4 **S**

4.6.2.4 Uses and applications of electromagnetic waves

Question 46 · continued

4D Which isotope would be most suitable for monitoring the flow of blood through the heart?

1 **P**

2 **Q**

3 **R**

4 **S**

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 47

June 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The table gives information about some telescopes.

Name of telescope	Arecibo	COBE	Spitzer	Keck	Hopkins
Type of radiation detected	radio waves	microwaves	infra red	visible light	ultraviolet
Location of telescope	on the Earth's surface	in space	in space	high on the Earth's surface	in space

5A Why is the Keck telescope located high on the Earth's surface?

1 so that astronomers are not disturbed

2 it is cheaper to build in this location

3 to be closer to the stars it is observing

4 to be above clouds and dust in the Earth's atmosphere

5B The Hopkins telescope is located in space . . .

1 so that the astronomers are not exposed to ultraviolet radiation.

2 because not all ultraviolet radiation penetrates the Earth's atmosphere.

3 to be closer to the stars it is observing.

4 because there is not enough land on the Earth to build telescopes.

5C Which of the telescopes in the table might provide evidence of the red-shift of light from distant galaxies?

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.6.2.4 Uses and applications of electromagnetic waves

5D The longer the wavelength of the radiation being absorbed, the larger the telescope needs to be.

Which telescope is the largest?

1 Arecibo

2 Spitzer

3 Keck

4 Hopkins

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 48

June 2008 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1927, the Belgian priest Georges Lemaitre proposed that the universe began with an explosion. His proposal came after astronomers had observed red-shift in light from distant galaxies.

7A Red-shift is . . .

1 a decrease in wavelength of the light due to a galaxy moving away from the Earth.

2 an increase in wavelength of the light due to a galaxy moving away from the Earth.

3 a decrease in wavelength of the light due to a galaxy moving towards the Earth.

4 an increase in the wavelength of the light due to a galaxy moving towards the Earth.

7B In 1929, Edwin Hubble found experimental evidence that distant galaxies are moving away from us with speeds that are proportional to their distance from the Earth.

This suggests that . . .

1 the universe is contracting.

2 the universe started from a small initial point.

3 the universe has always been the same.

4 the galaxies are getting slower.

7C Later, in 1948, it was suggested that if the universe started with an explosion there should still be cosmic (microwave) background radiation in space left over from the explosion. This microwave radiation was discovered in 1964.

Its discovery . . .

1 proves that the universe started with a ‘big bang’.

2 proves that the universe is expanding.

3 provides strong evidence that the universe started with a ‘big bang’.

4 finally disproves all other theories of the origin of the universe.

4.6.2.4 Uses and applications of electromagnetic waves

Question 48 · continued June 2008 | PHY1BP | Original Q7 | Legacy

7D According to the latest theory, the universe was created 13.7 billion years ago.

This figure . . .

1 is both accurate and precise.

2 is a guess.

3 is an estimate based on reliable data.

4 is an estimate based on unreliable data.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

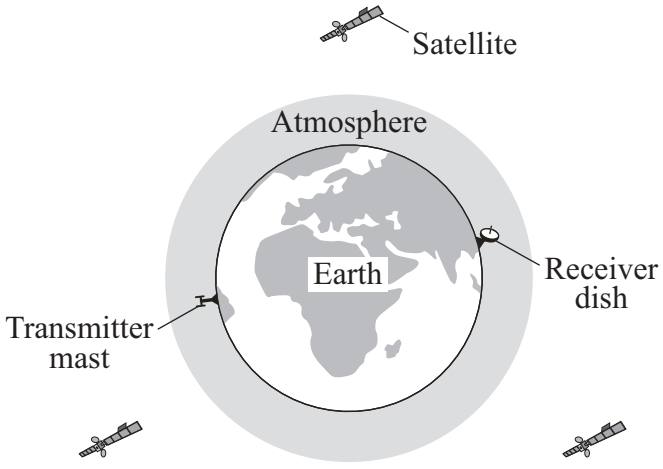
Question 49

June 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Satellite television broadcasts are transmitted as microwaves. In a vacuum, the microwaves travel at 300 million metres per second.

Television stations are changing the transmission method from analogue signals to digital signals. In a few years' time there will be no analogue television transmissions.



9A Microwaves are used for transmissions to and from satellites because they . . .

1 are never affected by interference.

2 are regarded as 100% safe by scientists.

3 cannot be seen by the human eye.

4 pass through the Earth's atmosphere easily.

9B Digital signals are better than analogue signals for transmitting satellite television programmes because digital signals . . .

1 can only be ON or OFF and so are less prone to distortion by interference.

2 do not need the use of a computer to process them.

3 pass through clouds and are not affected by weather.

4 travel at a higher speed in a vacuum.

4.6.2.4 Uses and applications of electromagnetic waves

Question 49 · continued June 2008 | PHY1BP | Original Q9 | Legacy

9C It is necessary to transmit from the transmitter mast to the receiver dish via a satellite because . . .

1 microwaves will not travel far.

2 microwaves do not travel in a curved path.

3 the Earth is rotating.

4 the waves spread out from the transmitter in all directions into space.

9D A new television channel will transmit via satellites using microwaves with a wavelength of 400 millimetres.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 MHz = 1 000 000 Hz

The frequency of the microwaves will be . . .

1 0.75 Hz

2 750 Hz

3 0.75 MHz

4 750 MHz

END OF TEST

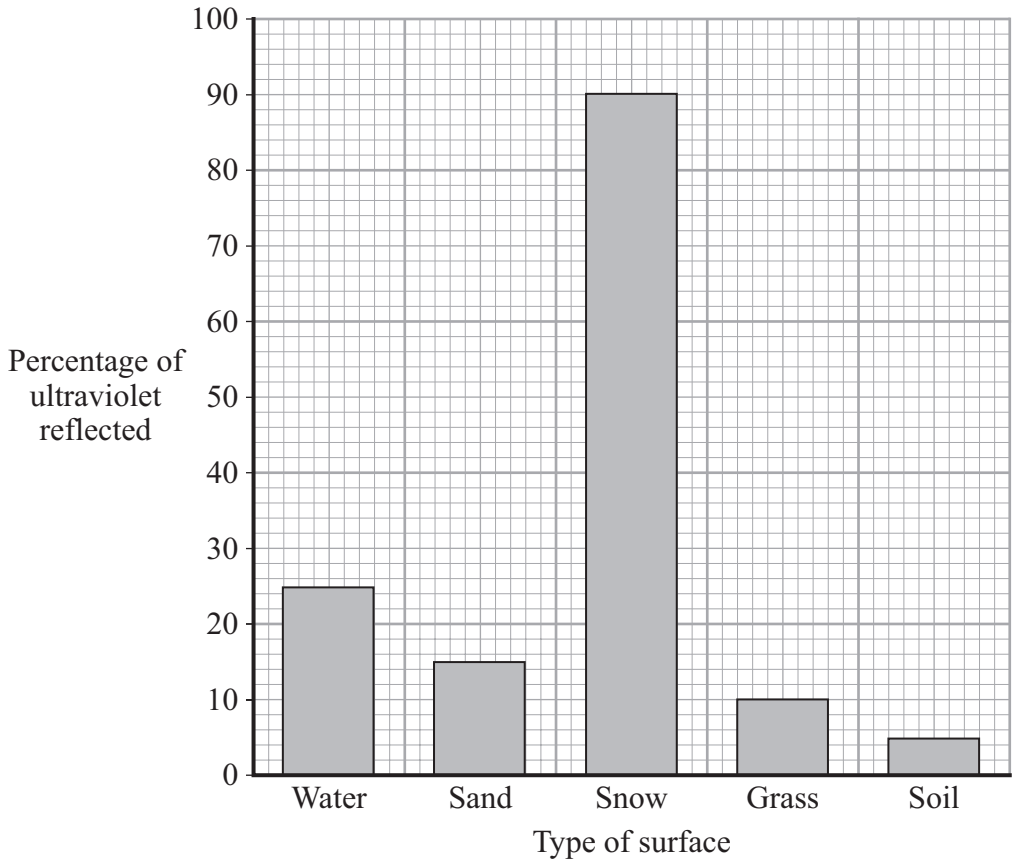
4.6.2.4 Uses and applications of electromagnetic waves

Question 50

June 2008 | PHY1H | Original Q2 | Legacy

2 (a) Ultraviolet (UV) radiation can be reflected or absorbed by a surface.

The percentage of ultraviolet radiation reflected by various surfaces is shown in the bar chart.



2 (a) (i) Which of these surfaces is the best **absorber** of ultraviolet radiation?

.....

(1 mark)

2 (a) (ii) Why has the data been shown as a bar chart rather than a line graph?

.....

.....

(1 mark)

2 (a) (iii) Who is likely to be exposed to more ultraviolet radiation, a skier or a golfer?

Draw a ring around your answer. **skier** **golfer**

Give a reason for your answer.

.....

.....

(1 mark)

Question 2 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 50 · continued

for mark

2 (a) (iv) State **one** harmful effect that ultraviolet radiation has on skin.

.....

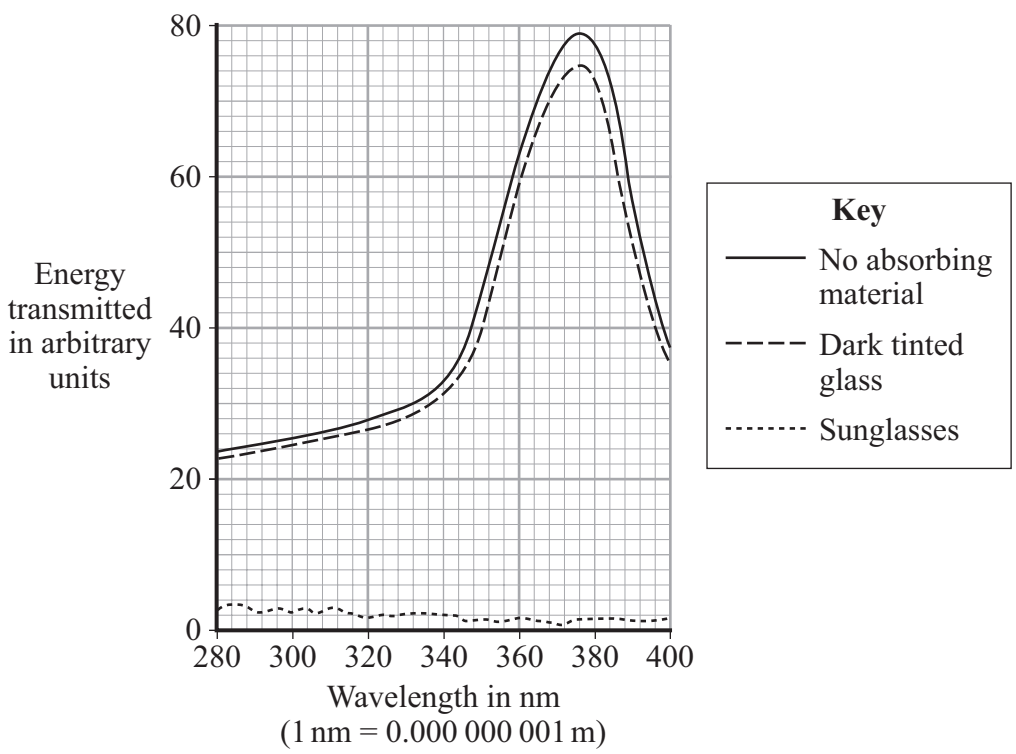
(1 mark)

2 (b) This is a label from a pair of sunglasses.

Sportswear Budget £5

- plastic lenses
- blocks 95% of ultraviolet rays
- UV absorbing up to wavelengths of 400 nm

A student tested the sunglasses by measuring the energy transmitted by the lenses for ultraviolet waves with a range of different wavelengths.
For comparison, the student also measured the transmission of ultraviolet waves through a piece of dark tinted glass.
The results of the tests are shown in the graph.



4.6.2.4 Uses and applications of electromagnetic waves

Question 50 · continued

for mark

2 (b) (i) Explain how the student's results support the claims made on the label.

.....

.....

.....

.....

(2 marks)

2 (b) (ii) Ultraviolet radiation can cause permanent eye damage.

Why should the lenses for sunglasses **not** be made from the dark tinted glass used in the student's tests?

.....

.....

(1 mark)

2 (c) An eye care charity predicts that within 10 years, everyone, when outside, will wear UV protection sunglasses most of the time. This is because the potential damage from ultraviolet radiation is so serious.

2 (c) (i) Which **one** of the following statements is the most likely reason for the prediction made by the eye care charity?

Put a tick (✓) in the box next to your answer.

Publicity and education will make people aware of the dangers. ☐

The price of UV blocking sunglasses will fall dramatically. ☐

The level of UV in the atmosphere will increase. ☐

(1 mark)

2 (c) (ii) Several manufacturers of sunglasses have said that the research they have carried out supports the view of the eye care charity.

Suggest why the research conducted by the manufacturers could be biased.

.....

.....

(1 mark)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 51

June 2008 | PHY1H | Original Q3 | Legacy

3 The table gives data about two space telescopes. The Hubble telescope is already in space, but the James Webb telescope is still being built.

Name of telescope	Mirror diameter in metres	Launch Year	Orbit distance from the Earth in kilometres
Hubble	2.4	1990	575
James Webb	6.5	2013	1 500 000

3 (a) Explain why the Hubble telescope produces clearer images than optical telescopes positioned on the Earth.

.....

.....

.....

.....

(2 marks)

3 (b) After the Hubble telescope was launched into space, scientists found that it was not able to focus properly. Astronauts sent into space were able to repair the fault.

The James Webb telescope is to be fully assembled and tested before it is launched into space. Suggest why.

.....

.....

.....

.....

(2 marks)

3 (c) To get the large mirror for the James Webb telescope into space, it will be folded in segments, launched into space and then opened out. This is a complicated process so a working scale model of the optical system has been built.

Suggest **one** reason why building a scale model is a good idea.

.....

.....

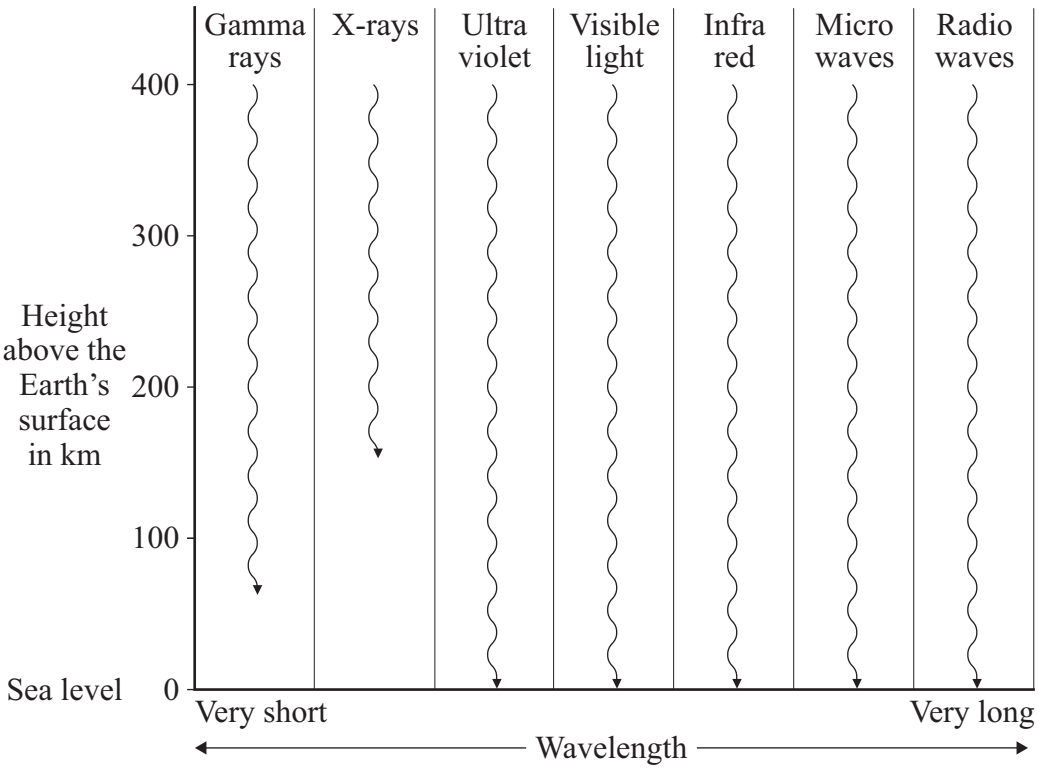
(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 51 · continued

for mark

3 (d) The diagram shows how far different types of electromagnetic wave can travel through the Earth's atmosphere before being absorbed.



Explain why an optical telescope can be positioned on the Earth but an X-ray telescope must be in space.

.....

.....

.....

.....

(2 marks)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 52

6 In 1986, a nuclear reactor exploded in a power station at Chernobyl in the Ukraine.

6 (a) The table gives information about some of the radioactive substances released into the air by the explosion.

Radioactive substance	Half-life	Type of radiation emitted
Iodine-131	8 days	beta and gamma
Caesium-134	2 years	beta
Caesium-137	30 years	beta

6 (a) (i) How is the structure of a caesium-134 atom different from the structure of a caesium-137 atom?

.....

(1 mark)

6 (a) (ii) What is a beta particle and from which part of an atom is a beta particle emitted?

.....

.....

(1 mark)

6 (a) (iii) Once a radioactive substance is dissolved in rainwater, it can enter the food chain.

Following the Chernobyl explosion, some milk supplies were found to be radioactive.

If one litre of milk contaminated with iodine-131 gives a count rate of 400 counts/second, how long will it take for the count rate to fall to 25 counts/second?

Show clearly how you work out your answer.

.....

.....

.....

Time taken = ... days

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 52 · continued

for mark

6 (a) (iv) After 20 years, the caesium-137 emitted into the atmosphere is a more serious problem than the iodine-131.

Explain why.

.....

.....

.....

.....

.....

(2 marks)

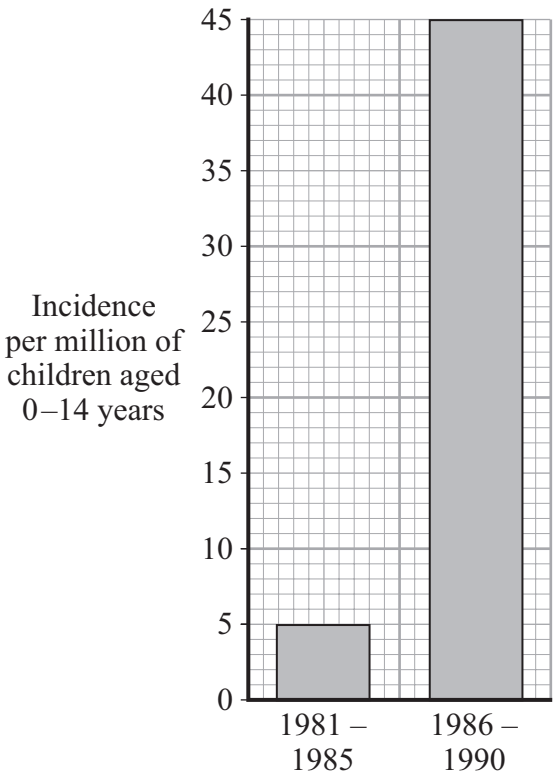
Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 52 · continued

for mark

6 (b) The bar chart compares the incidence of thyroid cancer in Ukrainian children, aged 0–14 years, before and after the Chernobyl explosion.



Of the children that developed thyroid cancer, 64% lived in the areas most contaminated by the radiation.

Considering this data, can you be certain that a child who developed thyroid cancer between 1986 and 1990 did so because of the Chernobyl explosion?

Explain the reason for your answer.

.....

.....

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 52 · continued

for mark

6 (c) In 1991, some scientists compared the health of two groups of people: a *control* group and a group that had been exposed to the radiation from Chernobyl.

What people would have been in the *control* group?

.....

(1 mark)

6 (d) Although there are some risks associated with nuclear power stations, it is likely that new ones will be built.

Give **two** reasons to justify the use of nuclear power.

1 .....

.....

2 .....

.....

(2 marks)

11

4.6.2.4 Uses and applications of electromagnetic waves

Question 53

November 2008 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

This question is about using electricity in the home.

9A When electricity is transmitted from a power station, it is stepped up from 25 kV to 300 kV.

This is done by a . . .

1 generator to decrease the current and make it safer.

2 generator to increase the current and make the electricity travel faster.

3 transformer to increase the current and reduce energy losses.

4 transformer to reduce the current and reduce energy losses.

The table shows the power ratings of four electrical appliances.

Fan heater	2 kW
Oven	3 kW
Kettle	2 kW
Microwave oven	0.75 kW

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

$$\text{energy transferred (kilowatt-hour, kWh)} = \text{power (kilowatt, kW)} \times \text{time (hour, h)}$$

$$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$$

The cost of electrical energy is 10 p per kilowatt-hour.

9B The kettle is used for a total of 30 minutes a day. It has an efficiency of 0.9

What is the cost of the energy wasted by the kettle each day?

1 0.6 p

2 1.0 p

3 6.0 p

4 9.0 p

9C The fan heater has a heating element and a motor to turn the blades of the fan. The power rating of the heater is 1800 W. To cool a room in the summer, only the fan is used.

How much would it cost to use the fan to cool a room for 5 hours?

1 0.1 p

2 1.0 p

3 10.0 p

4 100.0 p

9D A bowl of cauliflower cheese is cooked in a microwave oven for 6 minutes on half power.

How much does it cost to cook the cauliflower cheese?

1 0.375 p

2 0.750 p

3 1.500 p

4 2.250 p

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 54

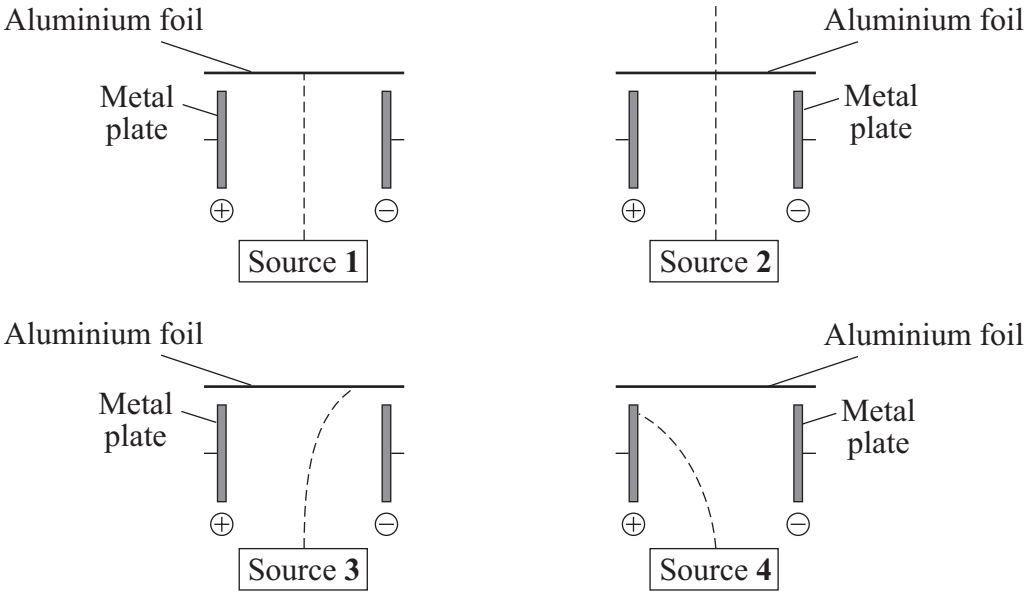
November 2008 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Radiation from four sources, **1**, **2**, **3** and **4**, is directed into an electric field between two metal plates.

There is a sheet of aluminium foil after the gap between the metal plates.

Light waves are not deflected in electric fields.



In each diagram, the dashed line (----------) shows the path of the radiation.

Match the types of radiation, **A**, **B**, **C** and **D**, with the sources **1–4**.

A alpha radiation

B beta radiation

C gamma radiation

D visible light

4.6.2.4 Uses and applications of electromagnetic waves

Question 55

November 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

This question is about the electromagnetic spectrum and its use in communications.

5A Which one of the following types of electromagnetic wave would **not** be suitable for communications?

1 infra red

2 microwave

3 gamma

4 visible light

5B Which types of electromagnetic waves can be used to send signals along optical fibres?

1 infra red and ultraviolet

2 infra red and visible light

3 infra red, ultraviolet and visible light

4 ultraviolet and visible light

5C By 2012, all TV signals in the UK will be digital.

This will be an improvement over analogue signals because . . .

1 digital signals are less prone to interference.

2 digital signals pick up interference and amplify it.

3 in an analogue signal, interference is treated as part of the original signal.

4 when analogue signals are amplified, interference is amplified.

4.6.2.4 Uses and applications of electromagnetic waves

Question 55 · continued

5D Electromagnetic waves travel at a speed of 300 000 km/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

A radio station transmits signals at a wavelength of 1.5 km.

The frequency of the waves is . . .

1 200 Hz

2 200 kHz

3 450 000 Hz

4 450 000 kHz

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 56

November 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

The tables show the types of radiation observed by different telescopes, and the types of radiation emitted by different parts of the universe.

Name of telescope	Type of radiation
Arecibo	Radio
COBE	Microwave
Hess	Gamma
Hopkins	Ultraviolet
Keck	Visible light
Spitzer	Infra red
XMM Newton	X-rays

Origin of radiation in universe	Main radiation emitted
Pulsars	Radio
Neutron stars	X-rays
Nebulae	Infra red
Stars	Visible light
Gamma ray bursts	Gamma
Big bang	Microwaves

6A Which telescope could be used to hunt for neutron stars in galaxies?

1 Arecibo

2 Spitzer

3 Hopkins

4 XMM Newton

6B Which telescope could be used to analyse the radiation of the universe left over from the 'big bang'?

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.6.2.4 Uses and applications of electromagnetic waves

Question 56 · continued

6C Which one of the following emits the longest wavelength radiation?

1 Gamma ray bursts

2 Neutron stars

3 Pulsars

4 Stars

6D Which one of the following emits radiation with the highest frequency?

1 Nebulae

2 Neutron stars

3 Pulsars

4 Stars

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 57

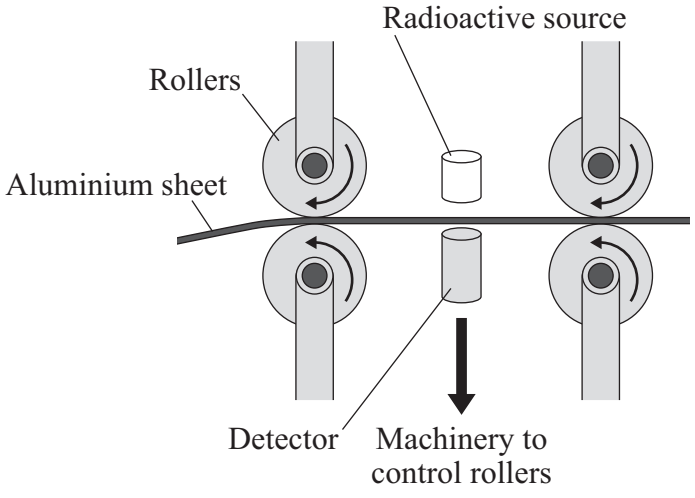
November 2008 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

The table shows the type of radiation emitted by, and the half-life of four radioactive isotopes, **P**, **Q**, **R** and **S**.

Radioactive isotope	Radiation emitted	Half-life
P	beta	6000 years
Q	alpha	400 years
R	gamma	6 hours
S	beta	30 seconds

7A The diagram shows how a radioactive isotope is used to monitor the thickness of aluminium in the continuous manufacture of aluminium sheet.



Which of the isotopes should be used?

1 **P**

2 **Q**

3 **R**

4 **S**

Question 57 · continued November 2008 | PHY1BP | Original Q7 | Legacy

7B A smoke alarm uses a small mass of a radioactive isotope. So that the alarm can be used safely in a house, isotope **Q** is used.

This is because isotope **Q** is an alpha emitter . . .

1 with a short half-life; alpha particles have a short range in air.

2 with a short half-life; alpha particles have a long range in air.

3 with a long half-life; alpha particles have a short range in air.

4 with a long half-life; alpha particles have a long range in air.

7C Radioactive isotopes can be injected into the human body to act as tracers in medical diagnosis.

The isotope used is . . .

1 **P** because it has a very long half-life and beta particles can reach the detector.

2 **Q** because it has a long half-life and alpha particles are relatively safe outside the body.

3 **R** because it has a short half-life and gamma rays can reach the detector.

4 **S** because it has a short half-life and beta particles can reach the detector.

7D Trees contain the radioactive isotope carbon-14. After a tree has been chopped down, the count rate from the carbon-14 it contains gradually decreases. By measuring the count rate and knowing the half-life of the isotope, the age of the dead wood can be estimated.

Which isotope could be used to estimate the age of a wooden box thought to be about 18 000 years old?

1 **P** because its half-life is about 6000 years so the box has existed for 3 half-lives.

2 **Q** because its half-life is about 400 years which means that the box has existed for 45 half-lives.

3 **R** because its half-life is about 30 seconds which means that it is safe to do the estimation.

4 **S** because its half-life is about 6 hours which is enough time to do the estimation.

4.6.2.4 Uses and applications of electromagnetic waves

Question 58

November 2008 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about two space telescopes.

The Hubble space telescope orbits the Earth at a distance of 569 km and detects visible light.

The James Webb space telescope is planned to be launched some time after 2013 and will orbit at about 1.5 million kilometres from the Earth and will detect infra red frequencies (rays).

8A The main advantage of the Hubble telescope being so far from Earth is the improvement in image quality.

This improvement is because . . .

1 there is little atmosphere to distort the data being received.

2 there is no light pollution from cities.

3 there is no gravity to distort the mirror in the telescope.

4 there is no need for access for service or repairs to the mirror in the telescope.

8B The James Webb space telescope should be able to receive data from distant galaxies billions of light years away from the Earth. It is shielded from the Sun to keep it at a temperature of –225°C and will contain a large mirror.

The reason that it is designed to detect infra red frequencies is that . . .

1 all the radiation emitted by the galaxies is in the infra red region of the spectrum.

2 infra red radiation can be detected in the dark.

3 much of the radiation we receive from galaxies is at infra red frequencies due to a significant red-shift.

4 we receive only infra red radiation from the galaxies.

8C The major reason for keeping the mirror so cold is to . . .

1 avoid the need to carry extra fuel to heat it.

2 keep it rigid.

3 minimise the infra red radiation from it which would confuse the data being collected.

4 stop it from melting.

4.6.2.4 Uses and applications of electromagnetic waves

Question 58 · continued

8D There are also radio telescopes on Earth.
The longer the wavelength of the radiation being absorbed, the larger a telescope needs to be.

Which row in the table gives the correct order of size for the telescopes?

	Smallest ← → Largest		
1	James Webb telescope	Hubble telescope	Radio telescope
2	Radio telescope	James Webb telescope	Hubble telescope
3	Hubble telescope	James Webb telescope	Radio telescope
4	Hubble telescope	Radio telescope	James Webb telescope

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 59

January 2009 | PHY1H | Original Q5 | Legacy

5 (a) Microwaves are one type of electromagnetic wave.

5 (a) (i) Which type of electromagnetic wave has a lower frequency than microwaves?

.....

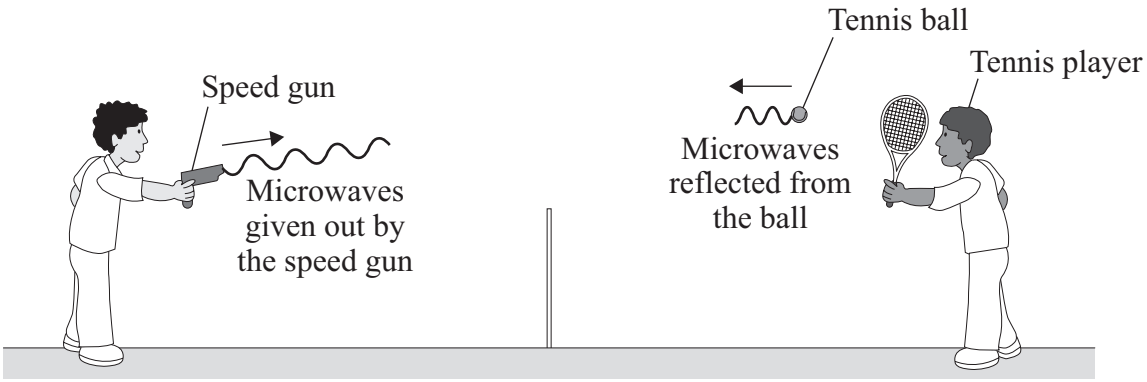
(1 mark)

5 (a) (ii) What do all types of electromagnetic wave transfer from one place to another?

.....

(1 mark)

5 (b) The picture shows a tennis coach using a speed gun to measure how fast the player serves the ball.



5 (b) (i) The microwaves transmitted by the speed gun have a frequency of 24 000 000 000 Hz and travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the wavelength of the microwaves emitted from the speed gun.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 59 · continued

for mark

5 (b) (ii) Some of the microwaves transmitted by the speed gun are absorbed by the ball.

What effect will the absorbed microwaves have on the ball?

.....

.....

(1 mark)

5 (b) (iii) Some of the microwaves transmitted by the speed gun are reflected from the moving ball back towards the speed gun.

Describe how the wavelength and frequency of the microwaves change as they are reflected from the moving ball.

.....

.....

.....

.....

(2 marks)

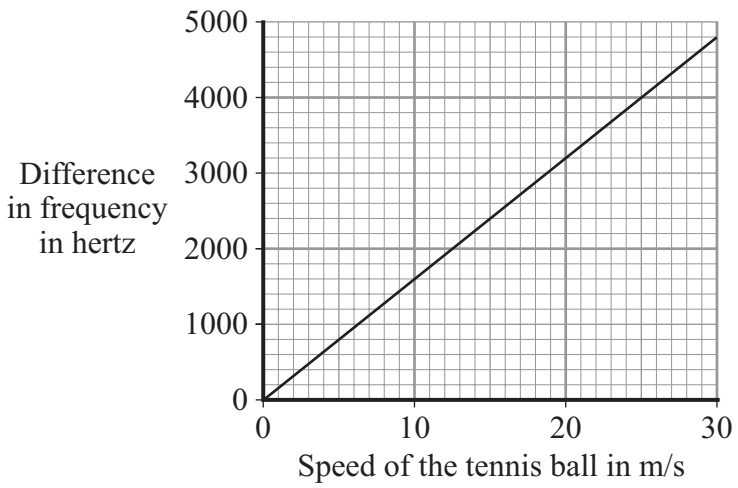
Question 5 continues on the next page

Question 59 · continued

for mark

5 (c) The difference in frequency between the transmitted and reflected waves is detected by the speed gun. This data is processed by a computer chip inside the speed gun, and then displayed as a speed.

5 (c) (i) The graph shows that the difference in frequency between the transmitted and reflected waves is directly proportional to the speed of the moving ball.



Why has a line graph been used to display the data?

.....

.....

(1 mark)

5 (c) (ii) Is it better to transfer the data to the computer as an analogue signal or as a digital signal?

.....

Give a reason for your answer.

.....

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 59 · continued

for mark

5 (c) (iii) What is the difference between an analogue signal and a digital signal?

You may draw a labelled diagram to help you with your answer.

.....

.....

.....

.....

(2 marks)

11

4.6.2.4 Uses and applications of electromagnetic waves

Question 60

6 (a) Complete the following table for an atom of uranium-238 ($^{238}_{92}U$).

mass number	238
number of protons	92
number of neutrons	

(1 mark)

6 (b) Complete the following sentence.

The name given to the number of protons in an atom is the proton number or the

..... .

(1 mark)

6 (c) An atom of uranium-238 ($^{238}_{92}U$) decays to form an atom of thorium-234 ($^{234}_{90}Th$).

6 (c) (i) What type of radiation, alpha, beta or gamma, is emitted by uranium-238?

.....

(1 mark)

6 (c) (ii) Why does an atom that decays by emitting alpha or beta radiation become an atom of a different element?

.....

.....

(1 mark)

4

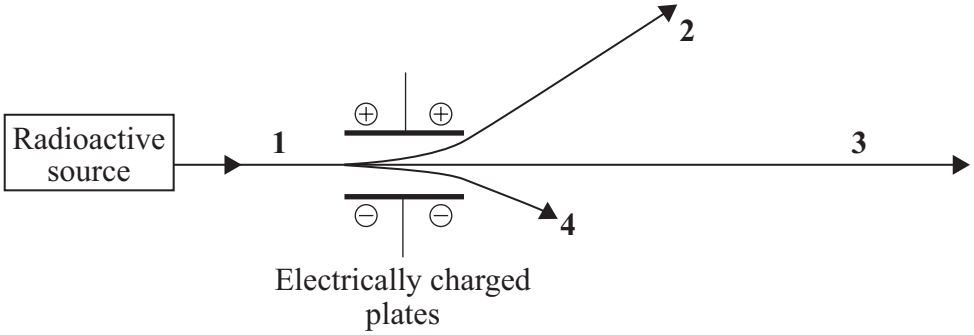
4.6.2.4 Uses and applications of electromagnetic waves

Question 61

March 2009 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

A beam of radiation from a radioactive source is passed between two electrically charged plates. The paths taken by the radiation are shown in the diagram.



Match the types of radiation, **A**, **B**, **C** and **D**, with the paths **1–4** in the diagram.

A alpha particles

B beta particles

C gamma rays

D alpha, beta and gamma radiation

4.6.2.4 Uses and applications of electromagnetic waves

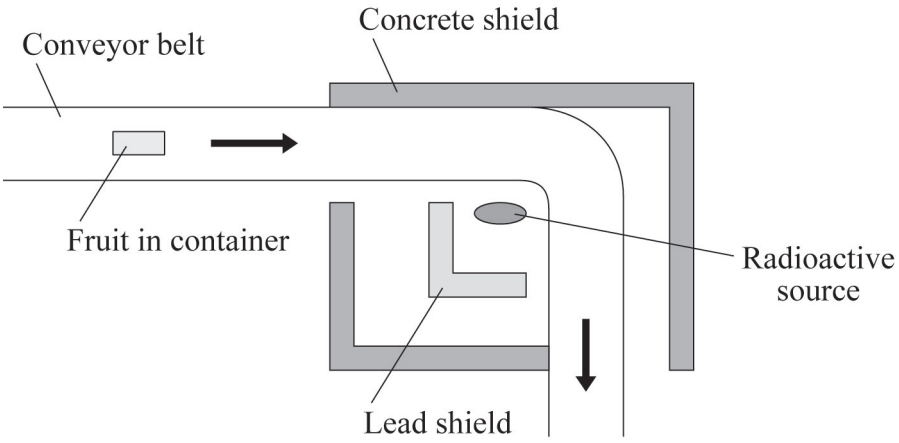
Question 62

March 2009 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

In some countries, fruit is passed in front of a radioactive source. The gamma radiation from the source kills bacteria. This keeps the fruit fresh for longer.

The main process is shown in the diagram.



3A Gamma radiation is used because it is . . .

1 able to penetrate the container and fruit.

2 stopped by the lead shield.

3 not harmful to people.

4 the only radiation that can kill bacteria.

3B The amount of radiation absorbed by the fruit can be increased by . . .

1 moving the source further from the fruit.

2 packing the fruit in thicker containers.

3 slowing down the conveyor belt.

4 speeding up the conveyor belt.

4.6.2.4 Uses and applications of electromagnetic waves

Question 62 · continued

3C Some fruit growers use X-ray machines instead of gamma ray sources.

The X-rays are safer to work with because . . .

1 gamma ray sources are used in hospitals.

2 X-ray machines can be switched on and off.

3 gamma rays have a lower frequency than X-rays.

4 X-rays have a shorter wavelength than gamma rays.

3D Some scientists investigated the effect of radiation on the vitamin C content of fruit.

They measured the amount of radiation absorbed by some fruit.

They also measured the amount of vitamin C in the fruit before and after the radiation treatment.

Which row of the table describes the variables for a fair test?

	Amount of radiation absorbed	Amount of vitamin C lost during irradiation	Size and type of fruit
1	independent	dependent	control
2	independent	control	dependent
3	dependent	independent	control
4	control	independent	dependent

4.6.2.4 Uses and applications of electromagnetic waves

Question 63

March 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about electromagnetic waves.

4A Changes may occur in substances when they absorb the energy carried by electromagnetic waves.

Which row in the table is correct?

	An alternating current is created in the substance	The substance becomes hotter
1	always	never
2	sometimes	always
3	sometimes	sometimes
4	never	sometimes

4B Radio waves travel in straight lines. However, some types of radio waves can be received on the opposite side of the Earth from the transmitter.

This happens because the radio waves are . . .

1 absorbed by the atmosphere.

2 interfered with by the atmosphere.

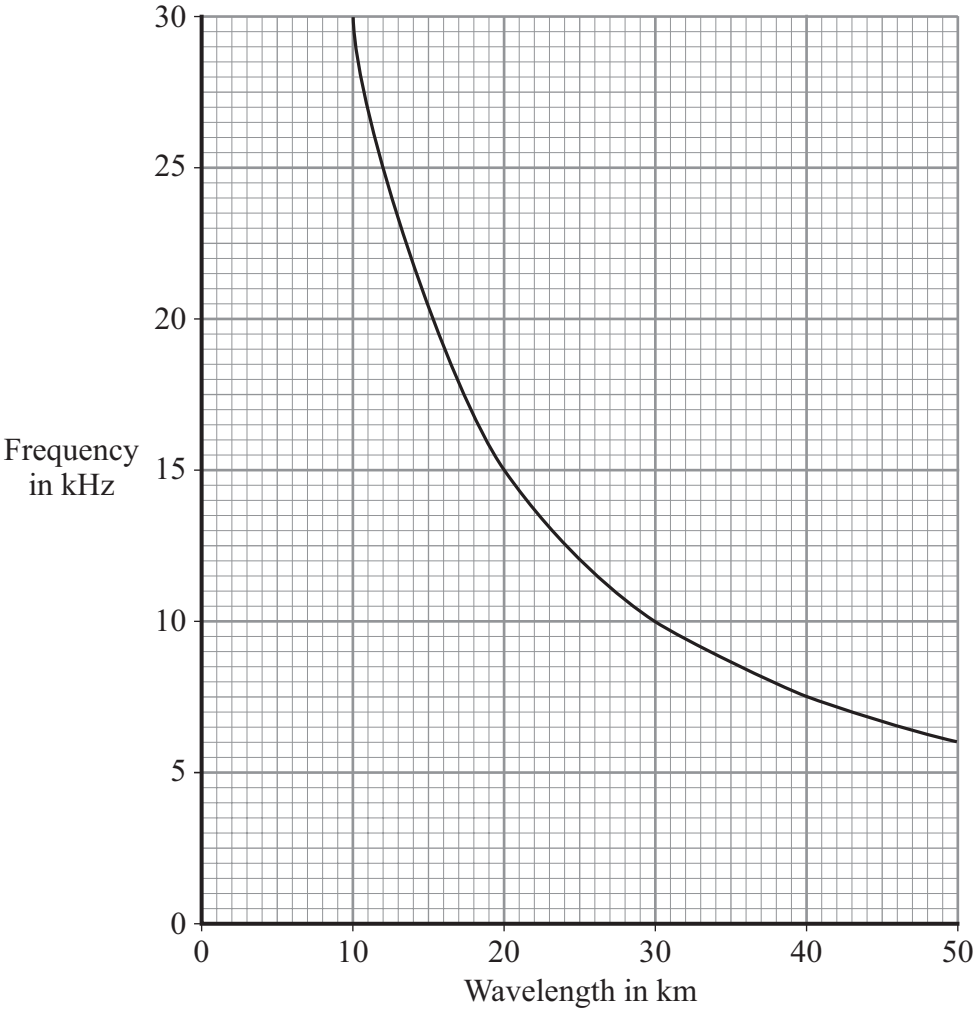
3 reflected by the atmosphere.

4 stopped by the atmosphere.

4.6.2.4 Uses and applications of electromagnetic waves

Question 63 · continued March 2009 | PHY1BP | Original Q4 | Legacy

The graph indicates how the frequency of electromagnetic waves changes with wavelength.



4C The graph shows that when the wavelength doubles, the frequency . . .

1 doubles.

2 halves.

3 quadruples.

4 stays the same.

4D What is the frequency of electromagnetic waves of wavelength 25 000 metres?

1 1.2 kHz

2 1.4 kHz

3 12 kHz

4 14 kHz

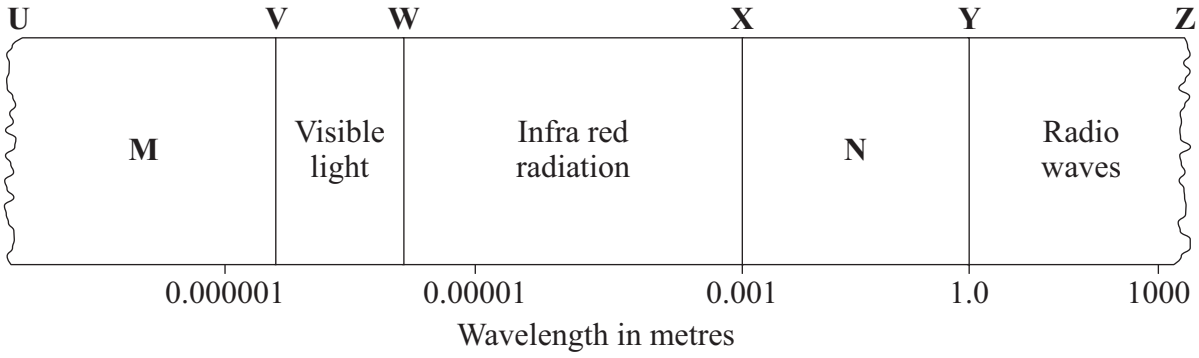
4.6.2.4 Uses and applications of electromagnetic waves

Question 64

March 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows part of the electromagnetic spectrum.



5A Which row of the table gives the types of electromagnetic radiation that are present in **M** and **N**?

	M	**N**
1	gamma	microwaves
2	gamma	ultraviolet
3	ultraviolet	gamma
4	ultraviolet	microwaves

5B Which section of the electromagnetic spectrum can be used for communications?

1 **U** to **Z**

2 **V** to **Z**

3 **W** to **Z**

4 **X** to **Z**

4.6.2.4 Uses and applications of electromagnetic waves

Question 64 · continued March 2009 | PHY1BP | Original Q5 | Legacy

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

All electromagnetic waves travel at a speed of 300 000 000 m/s.

5C BBC Radio 4 is carried by radio waves with a wavelength of 1500 m.

What is the frequency of these waves?

1 0.000 005 Hz

2 0.005 Hz

3 200 kHz

4 450 000 000 kHz

5D Compact fluorescent lamps (CFLs) emit infra red radiation. This radiation can interfere with the infra red signal emitted by remote controls for televisions.

An article about CFLs says that the infra red rays are emitted at a frequency of about 300 kHz.

This is incorrect because this frequency would mean that the wavelength is in . . .

1 the gamma ray part of the electromagnetic spectrum.

2 the microwave part of the electromagnetic spectrum.

3 the radio wave part of the electromagnetic spectrum.

4 the ultraviolet part of the electromagnetic spectrum.

4.6.2.4 Uses and applications of electromagnetic waves

Question 65

March 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Radium is an element with many isotopes. All of the isotopes of radium are radioactive. Natural radium emits alpha, beta and gamma radiation.

6A Alpha radiation is . . .

1 a very fast electron from the nucleus.

2 an electromagnetic wave of very high frequency.

3 a particle containing protons and neutrons.

4 a particle containing only neutrons.

6B Beta radiation has a longer range in air than alpha particles.

One of the reasons is that beta radiation is . . .

1 more highly ionising than alpha due to its larger electric charge.

2 more highly ionising than alpha due to its smaller electric charge.

3 less highly ionising than alpha due to its larger electric charge.

4 less highly ionising than alpha due to its smaller electric charge.

6C Gamma radiation is not electrically charged.

We know that it is not electrically charged because gamma radiation is . . .

1 deflected in magnetic fields but not in electric fields.

2 deflected in electric fields but not in magnetic fields.

3 deflected in both electric and magnetic fields.

4 not deflected in either electric or magnetic fields.

4.6.2.4 Uses and applications of electromagnetic waves

6D A sample of natural radium contains 8 g of isotope radium-211. Radium-211 has a half-life of 13 seconds.

After 26 seconds, . . .

1 half of the radium-211 atoms will have decayed.

2 all of the radium-211 atoms will have decayed.

3 only 2 g of radium-211 will remain.

4 the detected count rate from radium-211 will be zero.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 66

March 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Ultraviolet radiation is next to X-rays in the electromagnetic spectrum. Ultraviolet radiation consists of three regions: UVA, UVB, and UVC, as shown in the table.

	UVA	UVB	UVC	X-rays	

9A The UVA region of the spectrum has wavelengths between 315 and 400 nm. The visible light region of the spectrum extends to wavelengths of 700 nm.

In what wavelength region will violet light be found?

1 nanometre, 1 nm = 0.000 000 001 metre

1 360 – 400 nm

2 400 – 430 nm

3 620 – 700 nm

4 700 – 760 nm

9B Different types of electromagnetic radiation will penetrate materials to different depths. UVA will penetrate the top and middle layers of human skin. UVB will penetrate the top layer only.

This is surprising because gamma rays . . .

1 penetrate less than X-rays and have a lower frequency than X-rays.

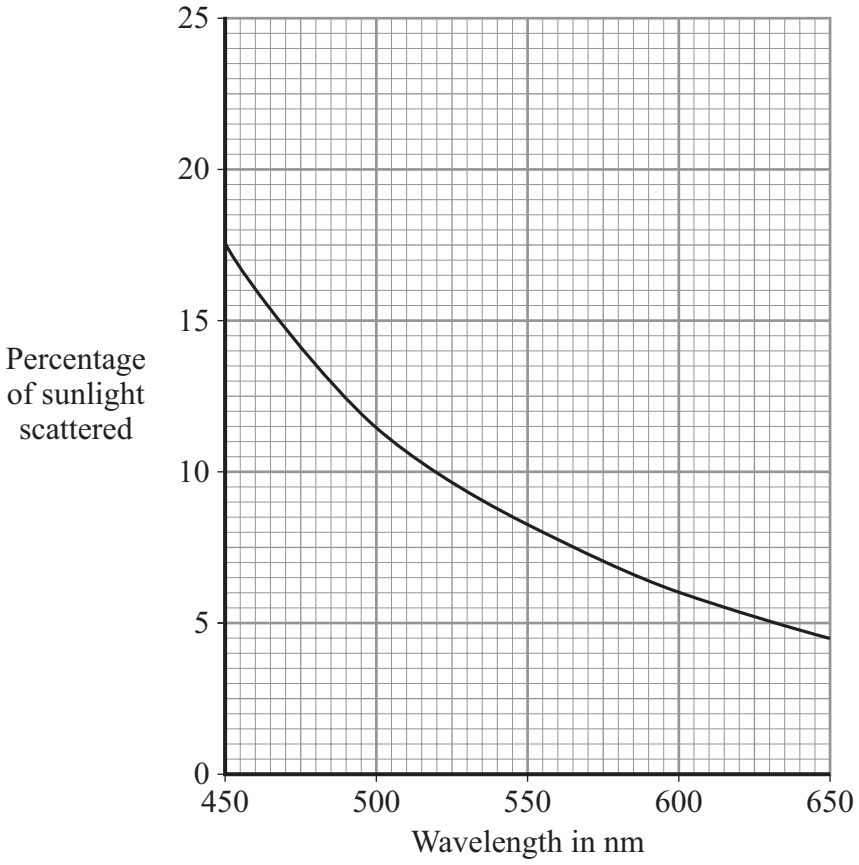
2 penetrate less than X-rays and have a higher frequency than X-rays.

3 penetrate more than X-rays and have a shorter wavelength than X-rays.

4 penetrate more than X-rays and have a longer wavelength than X-rays.

Question 66 · continued

9C The scattering of sunlight by the atmosphere causes the daylight colour of the sky to be blue. The graph shows how the scattering of sunlight changes with the wavelength.



What percentage of direct sunlight reaches the Earth **unscattered** at a wavelength of 500 nm?

1 11.5%

2 37.5%

3 62.5%

4 88.5%

9D How much scattering would you expect from ultraviolet rays?

1 less scattering than from visible light because ultraviolet rays have a lower frequency than visible light.

2 less scattering than from visible light because ultraviolet rays travel more slowly than visible light.

3 more scattering than from visible light because ultraviolet rays have a shorter wavelength than visible light.

4 the same scattering as from visible light because they both travel at the same speed.

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 67

June 2009 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

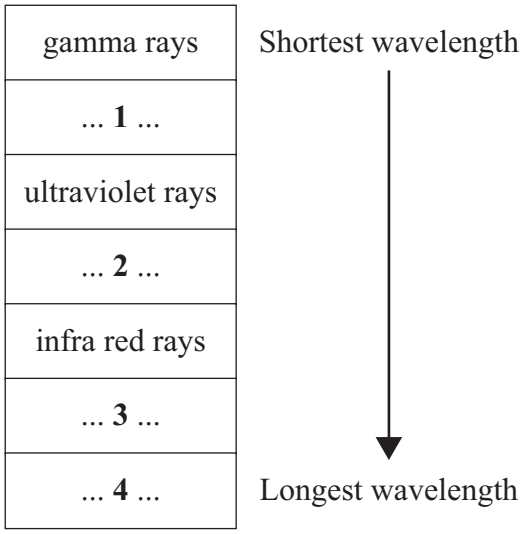
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A microwaves

B X-rays

C visible light

D radio waves



4.6.2.4 Uses and applications of electromagnetic waves

Question 68

June 2009 | PHY1BP | Original Q2 | Legacy

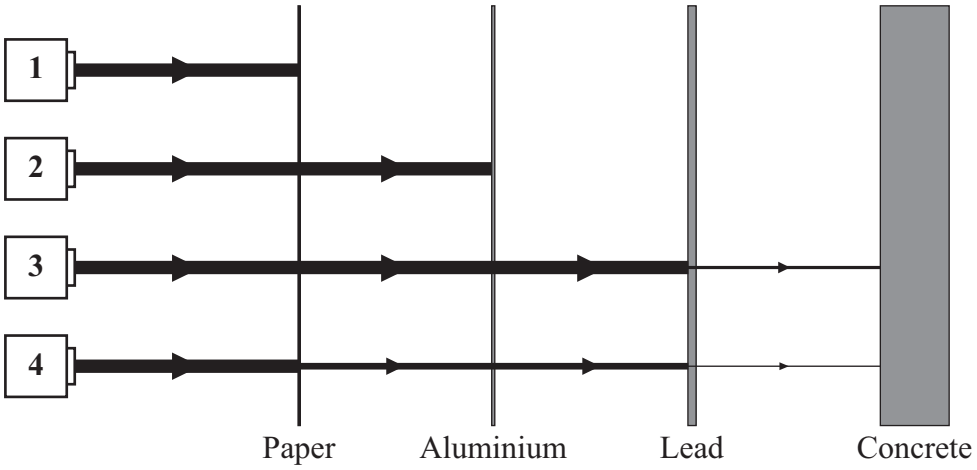
QUESTION TWO

The diagram shows four radioactive sources, **1**, **2**, **3** and **4**, each producing different types of nuclear radiation.

The thicker the horizontal lines in the diagram, the greater the intensity of the radiation.

Match the types of radiation, **A**, **B**, **C** and **D**, with the radioactive sources **1–4**.

Radioactive sources



A alpha only

B beta only

C gamma only

D alpha and gamma

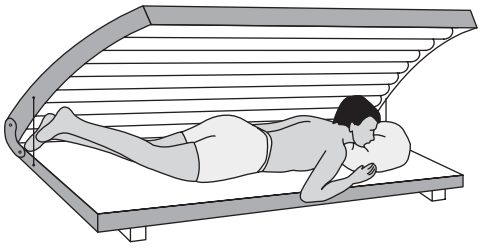
4.6.2.4 Uses and applications of electromagnetic waves

Question 69

June 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Some people use sunbeds to get a suntan. Sunbeds emit ultraviolet radiation which causes the skin to tan. Exposure to too much ultraviolet radiation can lead to the development of skin cancer.



Scientists investigated the risk of cancer developing in people who regularly used sunbeds.

The table gives their results.

	Regular users of sunbeds	Non-users of sunbeds
Number of people	1000	1000
Number of people with skin cancer in 1985	4	4
Number of people with skin cancer in 2005	13	5

4A The group that did not use sunbeds . . .

1 acted as the control group.

2 ensured that the results were reliable.

3 acted as the independent variable.

4 ensured that the results were accurate.

4B Repeating the investigation with another group of people would make the results more . . .

1 reliable.

2 precise.

3 biased.

4 random.

4.6.2.4 Uses and applications of electromagnetic waves

Question 69 · continued June 2009 | PHY1BP | Original Q4 | Legacy

4C These results show that . . .

1 regular use of sunbeds always leads to the development of skin cancers.

2 regular use of sunbeds can reduce the development of skin cancers.

3 regular use of sunbeds increases the risk of developing skin cancers.

4 non-users of sunbeds have a greater risk of developing skin cancers than regular users of sunbeds.

4D The government is concerned about the health of regular users of sunbeds because . . .

1 the sunbed industry is not regulated properly.

2 sunbeds contain cancer-producing chemicals.

3 there are no health benefits from using sunbeds.

4 treatment for skin cancers is an expensive burden on the Health Service.

4.6.2.4 Uses and applications of electromagnetic waves

Question 70

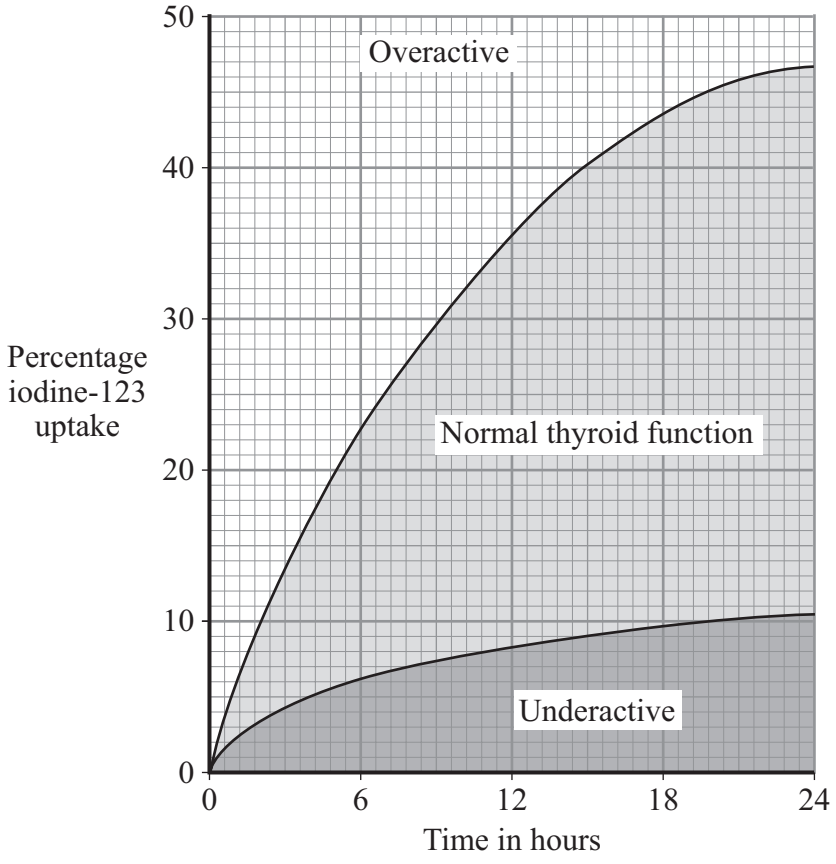
June 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The thyroid gland uses iodine to produce hormones (chemicals) which help to control the body's functions. If too much iodine is absorbed, the thyroid becomes overactive. If too little iodine is absorbed, the thyroid becomes underactive.

A radioactive isotope, iodine-123, is used as a tracer in the diagnosis of thyroid disease. Iodine-123 is a gamma emitter.

A patient having a diagnostic test is given a drink of sodium iodide which contains a small amount of iodine-123. A detector measures the gamma emission from the thyroid. The iodine uptake by the thyroid is measured and displayed, as shown in the graph.



5A A gamma emitter is used because gamma rays . . .

1 are not affected by electric fields.

2 can pass through body tissue easily.

3 travel at the speed of light.

4 have very long wavelengths.

Question 70 · continued

5B A patient is worried about drinking the radioactive liquid. The doctor tells him that the half-life of iodine-123 is 13 hours.

She explains that after 48 hours . . .

1 there will be no iodine-123 left in the body.

2 there will be less than 1/16 of the iodine-123 left in the body.

3 there will be less than 1/8 of the iodine-123 left in the body.

4 there will be no gamma radiation left in the body.

5C Three patients, **P**, **Q** and **R**, undergo the same diagnostic test. Their results are shown in the table.

Patient	Percentage of iodine-123 uptake after 6 hours	Percentage of iodine-123 uptake after 24 hours
P	1.0	5.0
Q	10.0	25.0
R	25.0	50.0

Using the graph, which one of the following statements is a correct conclusion?

1 All three patients are normal.

2 **P** and **Q** are normal; **R** is 'overactive'.

3 **P** and **R** are normal; **Q** is 'underactive'.

4 Only **Q** is normal.

5D Some medical students suggest that the rate of gamma emission from the iodine-123 is affected by different factors.

Which student is correct?

Student	Factor affecting rate of gamma emission
1	body temperature
2	age and sex of patient
3	length of time after the drink is taken
4	chemical composition of sodium iodide

4.6.2.4 Uses and applications of electromagnetic waves

Question 71

June 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Mobile phones make use of microwaves.

Microwave ovens use microwaves of a similar wavelength. These microwaves are absorbed by the water molecules in food.

Human and animal body tissues contain a lot of water molecules. Some people are worried that using mobile phones for long periods of time could lead to some form of brain damage.

Scientists have investigated this worry by exposing laboratory mice to mobile phone radiation and monitoring the mice for signs of brain abnormality.

6A Electromagnetic waves travel at a speed of 300 000 km/s. Some microwaves have a wavelength of 10 cm.

What is the frequency of these microwaves?

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 30 000 000 Hz

2 300 000 000 Hz

3 3 000 000 000 Hz

4 30 000 000 000 Hz

6B Electromagnetic waves that ionise may cause cancer. The higher the frequency of a wave, the more ionising the radiation.

Which type of radiation is most likely to cause cancer?

1 microwaves

2 infra red

3 ultraviolet

4 X-rays

4.6.2.4 Uses and applications of electromagnetic waves

Question 71 · continued June 2009 | PHY1BP | Original Q6 | Legacy

6C The power output of a microwave oven is at least 500 W.

The power output of mobile phones is limited to 2 W.

What is the most likely reason why this power limit was introduced?

1 to reduce interference between phones

2 to reduce heating effects on the brain

3 to allow phones to use the GPS (Global Positioning System)

4 to allow phones to use a digital signal

6D The tests on mice showed no evidence of brain abnormalities in the mice.

From this, the public can conclude that . . .

1 the results are not accurate because the tests were not carried out on humans.

2 as there is no evidence of danger to mice, there is probably no danger to humans.

3 as there is no evidence of danger to mice, there is no danger to humans.

4 the tests were not sensitive enough to record any evidence.

4.6.2.4 Uses and applications of electromagnetic waves

Question 72

June 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

Some types of electromagnetic radiation from space are absorbed by the Earth's atmosphere.

	Short wavelength radio	Short wavelength microwaves	Infra red	Visible light	Ultraviolet	X-rays	Gamma rays
Percentage absorbed by atmosphere	0	95	96	5	98	100	100

Different objects or events in the universe emit different types of electromagnetic radiation.

	Gamma ray bursts	Nebulae	Pulsars	Stars	Universe background radiation
Radiation emitted	gamma rays	infra red	radio	all types	short wavelength microwaves

The planets and moons of the solar system reflect light from the Sun.

7A Early civilisations observed the sky with the naked eye.

Which objects did they see?

1 moons, nebulae and pulsars

2 gamma ray bursts, moons and planets

3 nebulae and pulsars

4 moons, planets and stars

7B Telescopes that could detect electromagnetic waves of the lowest frequency were built in the 20th century. These telescopes are on the surface of the Earth.

From the information in the tables, which of the following, which could not have been observed before, could then be easily observed from the Earth's surface?

1 pulsars

2 gamma ray bursts

3 nebulae

4 stars

4.6.2.4 Uses and applications of electromagnetic waves

Question 72 · continued June 2009 | PHY1BP | Original Q7 | Legacy

7C In 1989, the background radiation from the universe was mapped from a telescope in space.

Why was this **not** done with telescopes based on Earth?

1 Because only 2% of ultraviolet radiation penetrates Earth's atmosphere.

2 Because only 4% of infra red radiation penetrates Earth's atmosphere.

3 Because only 5% of short wavelength microwave radiation penetrates Earth's atmosphere.

4 Because only 95% of visible radiation penetrates Earth's atmosphere.

7D The first table suggests that, with the exception of . . .

1 radio, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

2 radio, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

3 visible light, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

4 visible light, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

4.6.2.4 Uses and applications of electromagnetic waves

Question 73

June 2009 | PHY1H | Original Q1 | Legacy

1 (a) The table lists the names of seven telescopes. Each one of the telescopes is designed to detect a different one of the seven types of electromagnetic wave.
The table is incomplete.

Name of telescope	Type of wave detected
HESS	Gamma
XMM Newton	X-ray
FUSE	Ultraviolet
William Herschel	Visible light
Spitzer	
SPT	Microwave
Lovell	Radio

1 (a) (i) Which **one** of the telescopes is designed to detect the type of wave with the shortest wavelength?

.....

(1 mark)

1 (a) (ii) What type of wave is the Spitzer telescope designed to detect?

.....

(1 mark)

1 (b) The William Herschel telescope is on the Earth's surface. Another telescope, the Hubble telescope, which also detects visible light, orbits the Earth.

How is the image produced by the Hubble telescope better than the image produced by the William Herschel telescope?

.....

Give a reason for your answer.

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 73 · continued

for mark

1 (c) Some types of electromagnetic wave are absorbed by water.
The SPT telescope is located in the Antarctic, which is a dry environment.

Explain why it is better to have this type of telescope in a dry environment rather than in a wet, humid environment.

.....

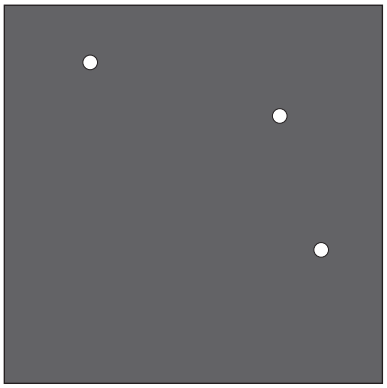
.....

.....

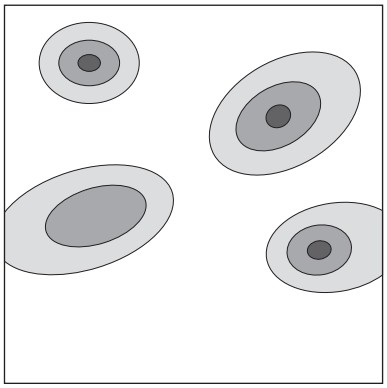
.....

(2 marks)

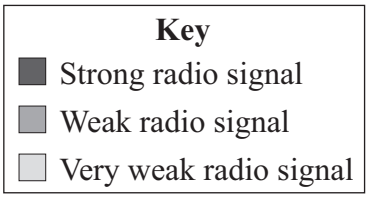
1 (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



Visible light image



Radio telescope image



Suggest what extra information can be gained from the radio telescope image compared with the visible light image.

.....

.....

(1 mark)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 74

June 2009 | PHY1H | Original Q2 | Legacy

2 (a) Mobile phone networks send digital signals using microwaves.

2 (a) (i) Give **one** advantage of sending information as a digital signal rather than as an analogue signal.

.....

.....

(1 mark)

2 (a) (ii) Give **one** other use of microwaves.

.....

.....

(1 mark)

2 (b) Some scientists think that there is a link between using a mobile phone and some types of illness. Other scientists disagree. They say that the evidence is limited and unreliable.

2 (b) (i) Suggest what scientists could do to show a link between using a mobile phone and illness.

.....

.....

(1 mark)

2 (b) (ii) How could scientists improve the reliability of the evidence?

.....

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 74 · continued

for mark

2 (b) (iii) Complete the following passage by drawing a ring around the word in the box that is correct.

There has been little or no experimental research into the health of children who use mobile phones.

This is partly because of the

economic
environmental
ethical

issues involved in using children in scientific research.

(1 mark)

2 (c) Before being sold, new mobile phones must be tested and given a SAR value.
The SAR value is a measure of the energy absorbed by the head while a mobile phone is being used.

The table gives the SAR value for three mobile phones made by different companies.
To be sold in the UK, a mobile phone must have a SAR value lower than 2.0 W/kg.

Mobile phone	SAR value in W/kg
J	0.18
K	0.86
L	1.40

2 (c) (i) All companies use the same test to measure a SAR value.

Why is using the same test important?

.....

.....

(1 mark)

Question 2 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 74 · continued

for mark

2 (c) (ii) Would the companies that make the mobile phones, **J**, **K** and **L**, be correct to claim that these three phones are totally safe to use?

Answer yes or no. .....

Give a reason for your answer.

.....

.....

(1 mark)

2 (d) Devices designed to protect a mobile phone user from microwave radiation are now available.

Why is it important that these devices are tested by scientists who are **not** working for the company that makes the devices?

.....

.....

(1 mark)

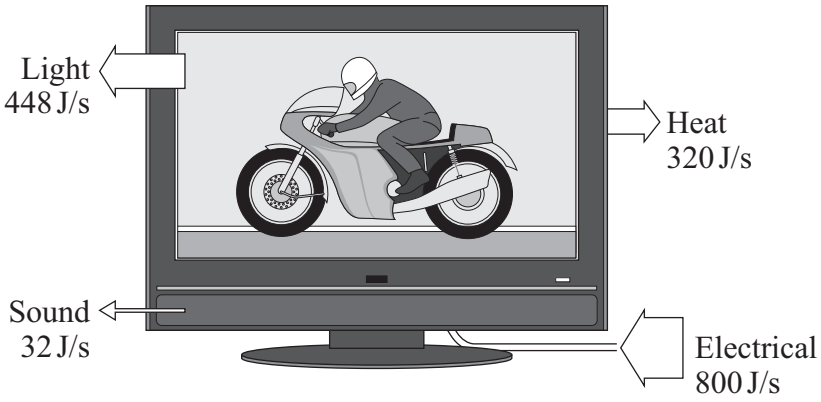
8

4.6.2.4 Uses and applications of electromagnetic waves

Question 75

June 2009 | PHY1H | Original Q3 | Legacy

3 (a) The diagram shows the energy transformations produced by a TV.



3 (a) (i) Use the information in the diagram and the equation in the box to calculate the efficiency of the TV.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

.....

.....

Efficiency = ...

(2 marks)

3 (a) (ii) What eventually happens to the useful energy transferred by the TV?

.....

.....

(1 mark)

Question 3 continues on the next page

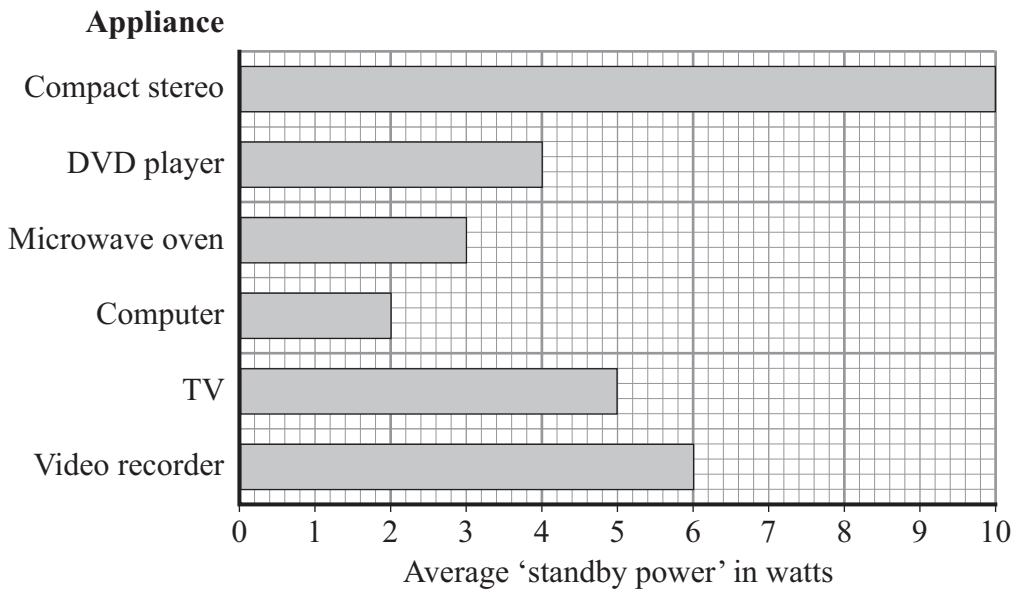
4.6.2.4 Uses and applications of electromagnetic waves

Question 75 · continued

for mark

3 (b) Electrical appliances left on standby use energy.

The bar chart shows the power for the appliances that one family leaves on standby when they go on holiday.



The family is on holiday for a total of 175 hours.

3 (b) (i) Use the information in the bar chart and the equation in the box to calculate the energy wasted by leaving the compact stereo on standby while the family is on holiday.

energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)

Show clearly how you work out your answer.

.....

.....

Energy wasted = ... kilowatt-hours

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 75 · continued

for mark

3 (b) (ii) Electricity costs 12 p per kilowatt-hour.

Use the equation in the box to calculate the cost of leaving the compact stereo on standby while the family is on holiday.

total cost = number of kilowatt-hours × cost per kilowatt-hours

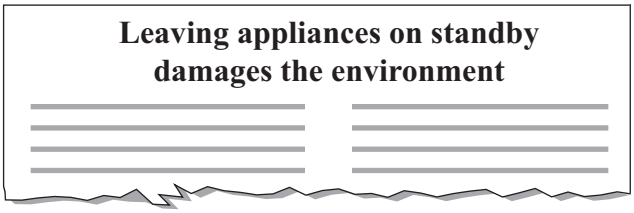
Show clearly how you work out your answer.

.....

Cost = ... p

(1 mark)

3 (c) A headline from a recent newspaper article is shown below.



Explain why leaving appliances on standby damages the environment.

.....

.....

.....

.....

(2 marks)

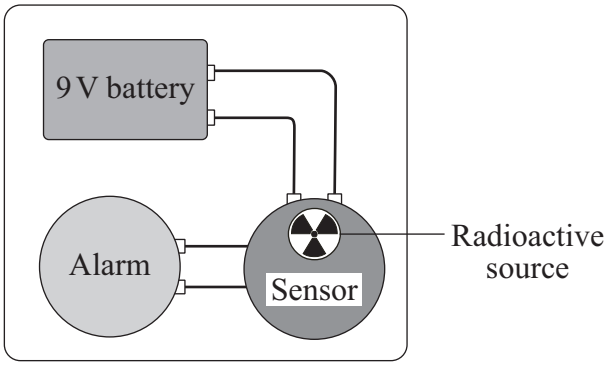
8

4.6.2.4 Uses and applications of electromagnetic waves

Question 76

June 2009 | PHY1H | Original Q6 | Legacy

6 (a) The diagram shows the parts of a smoke detector. The radioactive source emits alpha particles.



The alpha particles ionise the air inside the sensor which causes a small electric current. Any smoke getting into the sensor changes the current. The change in current sets the alarm off.

6 (a) (i) The smoke detector would **not** work if a radioactive source that emitted only gamma rays was used.

Why not?

.....

.....

(1 mark)

6 (a) (ii) Curium-242 is a radioactive isotope with a half-life of 160 days. It emits alpha particles.

Why is curium-242 **not** suitable for use inside smoke detectors?

.....

.....

(1 mark)

6 (a) (iii) Curium-242 and curium-244 are two of the isotopes of the element curium.

How is an atom of curium-242 different from an atom of curium-244?

.....

.....

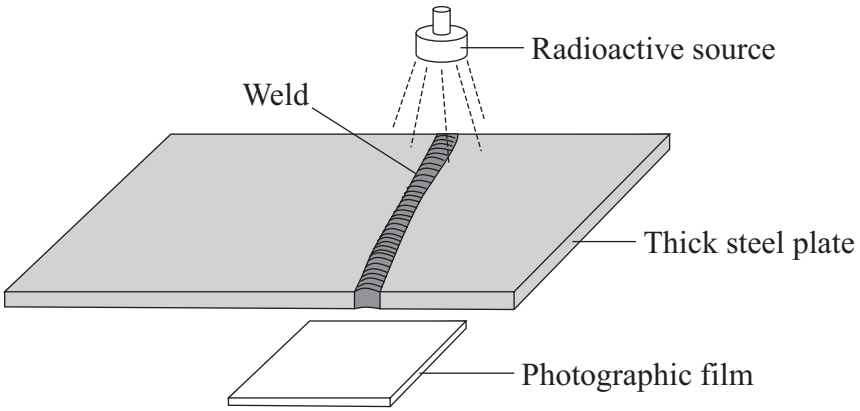
(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 76 · continued

for mark

6 (b) Sections of steel are often joined by welding them together. The diagram shows how a radioactive source can be used to check for tiny cracks in the weld.



Cracks in the weld will be shown up on the photographic film below the thick steel plate.

6 (b) (i) Which type of source, alpha, beta or gamma, should be used to check the weld?

.....

(1 mark)

6 (b) (ii) Give a reason why the other two types of source **cannot** be used.

.....

.....

(1 mark)

Question 6 continues on the next page

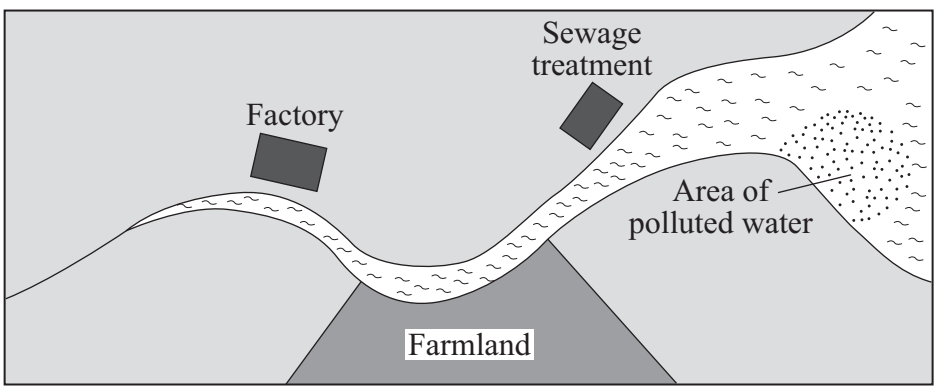
4.6.2.4 Uses and applications of electromagnetic waves

Question 76 · continued

for mark

6 (c) The diagram shows a map of a river and its estuary.

Environmental scientists have found that the water flowing into one part of the river estuary is polluted. To find where the pollution is coming from, the scientists use a radioactive isotope, gold-198.



6 (c) (i) Explain how the gold-198 is used to find where the pollution is coming from.

.....

.....

.....

.....

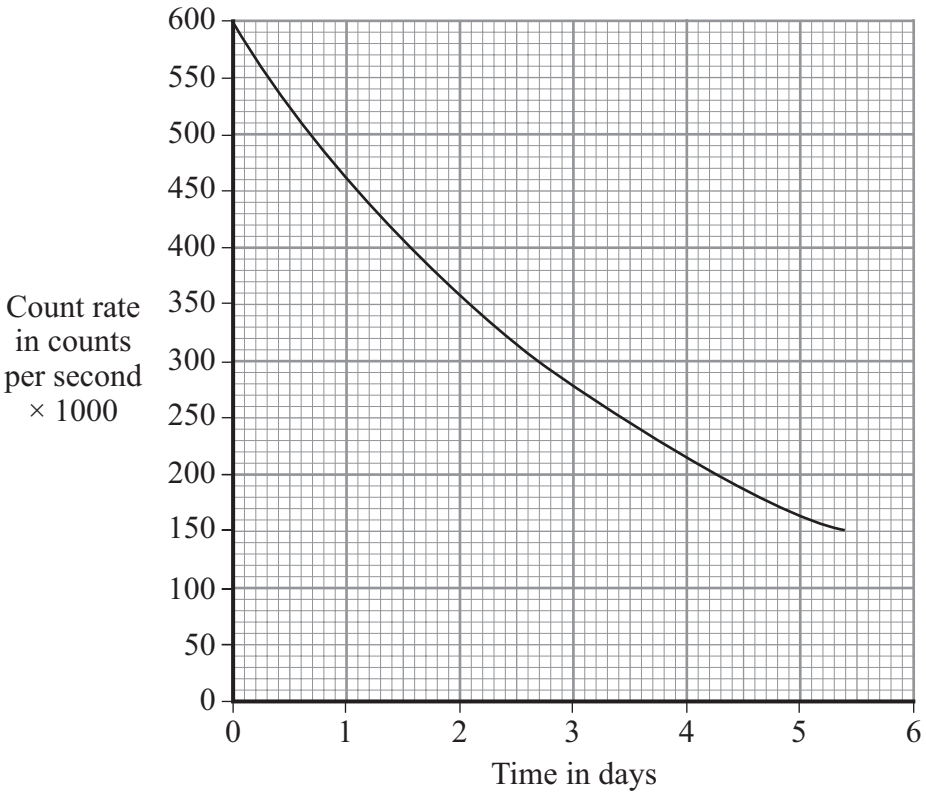
(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 76 · continued

for mark

6 (c) (ii) The graph shows how the count rate from a sample of gold-198 changes with time.



Use the graph to calculate the half-life of gold-198.

Show clearly on the graph how you obtain your answer.

.....

.....

Half-life = ... days

(2 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 77

November 2009 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

A notice in an office says:

Leaving your computer on standby overnight uses as much energy as microwaving six dinners

Switch it OFF

energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)

total cost = number of kilowatt-hours × cost per kilowatt-hour

Electricity costs 12 p per kilowatt-hour.

9A The instructions on a frozen cottage pie say: 'Cook in an 850 W microwave oven for 6 minutes'.

Approximately how much would it cost to cook 6 cottage pies, if they are cooked one at a time?

1 6 p

2 £1.02

3 £3.66

4 £36.72

9B A computer monitor in an office has a power rating of 300 W. Normal office hours are 9 am to 5 pm.

A sensible estimate of the energy wasted if it is left on overnight at full power is . . .

1 4.8 kWh

2 7.2 kWh

3 4800 kWh

4 7200 kWh

Question 77 · continued

9C The 300 W computer monitor can be switched to standby. The standby power is 3 W.

How much money is saved each hour by switching the monitor from full power to standby?

1 less than 1 p

2 3.6 p

3 33 p

4 36 p

9D It is estimated that in Britain 15 million televisions are left on standby for 20 hours per day. The European Parliament has passed a law to help to reduce this problem.

Suggest which of the following would have been included in the law.

1 decrease the price of televisions

2 make it compulsory for television owners to switch off their television sets when not in use

3 set a 1 W limit on standby power for all televisions

4 set a 1 W limit on standby power for all new televisions

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

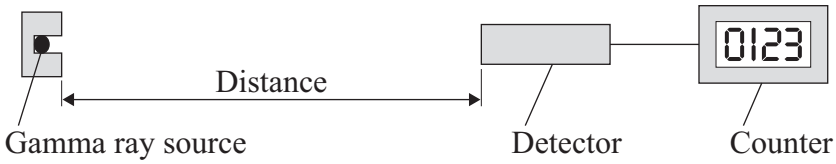
Question 78

November 2009 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

Harmful Gamma Radiation? .... Keep safe, keep away!

A sixth form student decided to test the truth of the newspaper headline. She used a gamma ray source and a detector to measure the amount of radiation reaching the detector per second. She repeated the experiment and calculated the mean count rates. She then moved the detector further away from the source and repeated the procedure.



Her results are shown in the table.

Distance from source in metres	Count rate in counts per second		
	Test 1	Test 2	Mean
0.2	480	484	482
0.4	121	127	124
0.6	55	55	55
0.8	30	32	31
1.0	20	18	19

4.6.2.4 Uses and applications of electromagnetic waves

Question 78 · continued

3A The results with the greatest range of count rate occur at a distance from the source of . . .

1 0.2 m

2 0.4 m

3 0.8 m

4 1.0 m

3B She repeated the experiment and calculated the mean to make her results more . . .

1 accurate.

2 controlled.

3 varied.

4 reliable.

3C A valid conclusion based on her results would be that . . .

1 1.0 m is a safe distance to be from the source.

2 the count rate decreases as the distance from the source increases.

3 the count rate will be almost zero at a distance of 1.2 m from the source.

4 there is no such thing as a safe distance from a gamma source.

3D Another way in which the count rate could be reduced would be to . . .

1 reduce the air temperature between the source and detector.

2 place a thick sheet of lead between the source and detector.

3 produce a strong electric field between the source and detector.

4 produce a strong magnetic field between the source and detector.

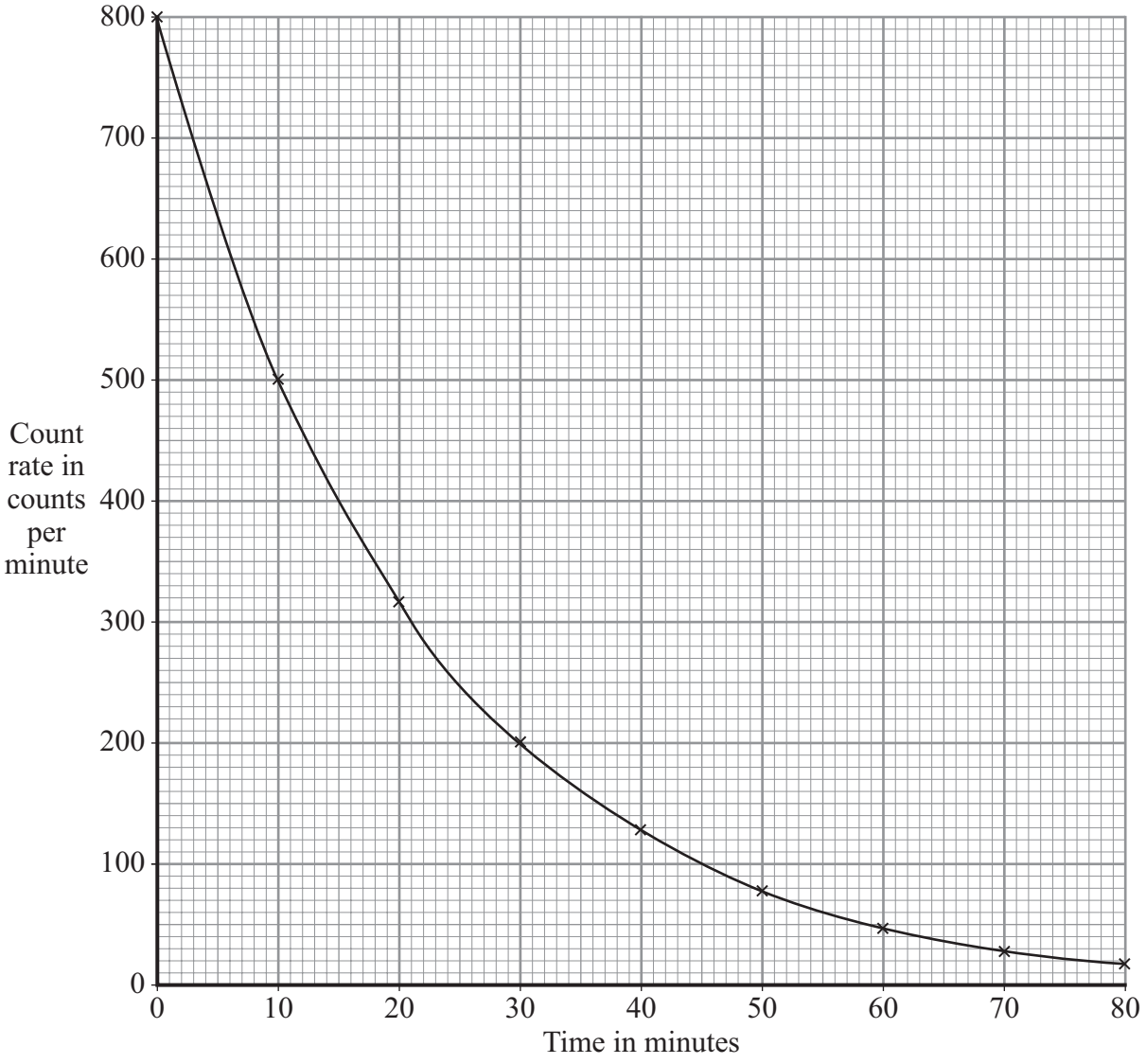
4.6.2.4 Uses and applications of electromagnetic waves

Question 79

November 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

The graph shows how the count rate of a radioactive isotope varies with time.



4A What is the half-life of the isotope?

1 10 minutes

2 15 minutes

3 20 minutes

4 80 minutes

4B The person who plotted the graph has drawn a line graph rather than a bar chart.

What is the reason for this?

1 Both the count rate and time are continuous variables.

2 Time is a discrete variable and count rate is a continuous variable.

3 Time is a continuous variable and count rate is a categoric variable.

4 Both the count rate and time are discrete variables.

4C The government recommends that all homes are fitted with smoke alarms. Americium-241 is used in these alarms. Americium-241 emits alpha particles and has a half-life of 460 years.

The americium-241 is safe to use in homes because . . .

1 it has a long half-life.

2 alpha particles travel only a few centimetres in air.

3 smoke alarm batteries are replaced regularly.

4 its nucleus has 146 neutrons.

4D This information is about the isotope technetium-99.

- It emits gamma radiation.
- Its half-life is 6 hours.
- It decays to a stable isotope of rubidium.
- It is used for diagnostic medical studies.
- It is put into the body.

A doctor wants to convince a patient that technetium-99 is safe to use to diagnose a medical problem.

Which of the following should he use to reassure the patient?

1 Rubidium is a rare metallic element.

2 Gamma radiation is part of the electromagnetic spectrum.

3 The half-life of the technetium-99 isotope is relatively short.

4 There is no risk in using radioactive materials.

4.6.2.4 Uses and applications of electromagnetic waves

Question 80

November 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The Sun emits different types of radiation. These types of radiation travel from the Sun until they reach the Earth's atmosphere. In the atmosphere, some types of radiation are reflected, some are absorbed and some are transmitted to the Earth's surface, where they cause the Earth to warm up.

Human activity has produced large amounts of carbon dioxide gas which has increased the amount of carbon dioxide in the atmosphere. The carbon dioxide helps to trap the Earth's heat and so contributes to the 'greenhouse' effect, which results in the Earth becoming hotter.

5A On their journey from the Sun to the Earth, all the types of radiation travel with the same . . .

1 energy.

2 frequency.

3 speed.

4 wavelength.

5B The ozone layer in the Earth's atmosphere absorbs some of the Sun's ultraviolet radiation.

Ultraviolet radiation can . . .

1 be detected by your eyes.

2 give your skin a suntan.

3 cool your skin.

4 pass through flesh but not bone.

5C Most of the Sun's infra red radiation is emitted with a wavelength of about 0.5 micrometres. Most of the Earth's infra red radiation is emitted with a wavelength of about 10 micrometres.

Carbon dioxide molecules in the atmosphere can absorb infra red radiation with wavelengths between 2 micrometres and 17 micrometres.

1 micrometre = 1 millionth of a metre

Therefore, the carbon dioxide will . . .

1 absorb the Sun's infra red radiation and absorb the Earth's infra red radiation.

2 absorb the Sun's infra red radiation and transmit the Earth's infra red radiation.

3 transmit the Sun's infra red radiation and absorb the Earth's infra red radiation.

4 transmit the Sun's infra red radiation and transmit the Earth's infra red radiation.

4.6.2.4 Uses and applications of electromagnetic waves

5D As an object gets hotter, its main infra red emission wavelength gets shorter.

If human activity continues to increase the amount of carbon dioxide gas in the atmosphere, then the Earth will emit . . .

1 more energy, with a shorter main emission wavelength.

2 more energy, with the same main emission wavelength.

3 the same energy, with a shorter main emission wavelength.

4 the same energy, with the same main emission wavelength.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 81

November 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

There are two types of radio wave that carry television signals, VHF and UHF.

7A Some UHF waves have a frequency that is ten times bigger than some VHF waves.

The wavelength of these UHF waves, in comparison to the VHF ones, is . . .

1 ten times as big because they travel faster.

2 one tenth as big because they travel faster.

3 ten times as big because they travel at the same speed.

4 one tenth as big because they travel at the same speed.

7B One television channel transmits using waves of frequency 1000 MHz.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

Speed of electromagnetic waves in a vacuum = 300 000 km/s

1 MHz = 1 million hertz

What is the wavelength of these waves?

1 0.3 m

2 3.0 m

3 0.3 km

4 3.0 km

4.6.2.4 Uses and applications of electromagnetic waves

Question 81 · continued

7C All television transmitters in the UK are going to be switched from analogue to digital signals.

Which row in the table is correct?

	Analogue signals	Digital signals
1	continuously varying	more prone to interference and cannot be processed by a computer
2	less prone to interference and can be easily processed by a computer	discrete values only, generally on and off
3	continuously varying	less prone to interference and can be easily processed by a computer
4	discrete values only, generally on and off	continuously varying

7D An aerial receives television signals.

The energy transferred by an electromagnetic wave carrying the television signal . . .

1 makes the aerial hotter so that it can detect the signal.

2 makes the aerial colder so that it can detect the signal.

3 creates an alternating current in the aerial with the same frequency as the wave.

4 creates a direct current in the aerial with the same frequency as the wave.

4.6.2.4 Uses and applications of electromagnetic waves

Question 82

November 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Visible light from space can be gathered and focused by optical telescopes.

9A Optical telescopes used to observe objects in space are limited because they can only be used . . .

1 as ground-based telescopes.

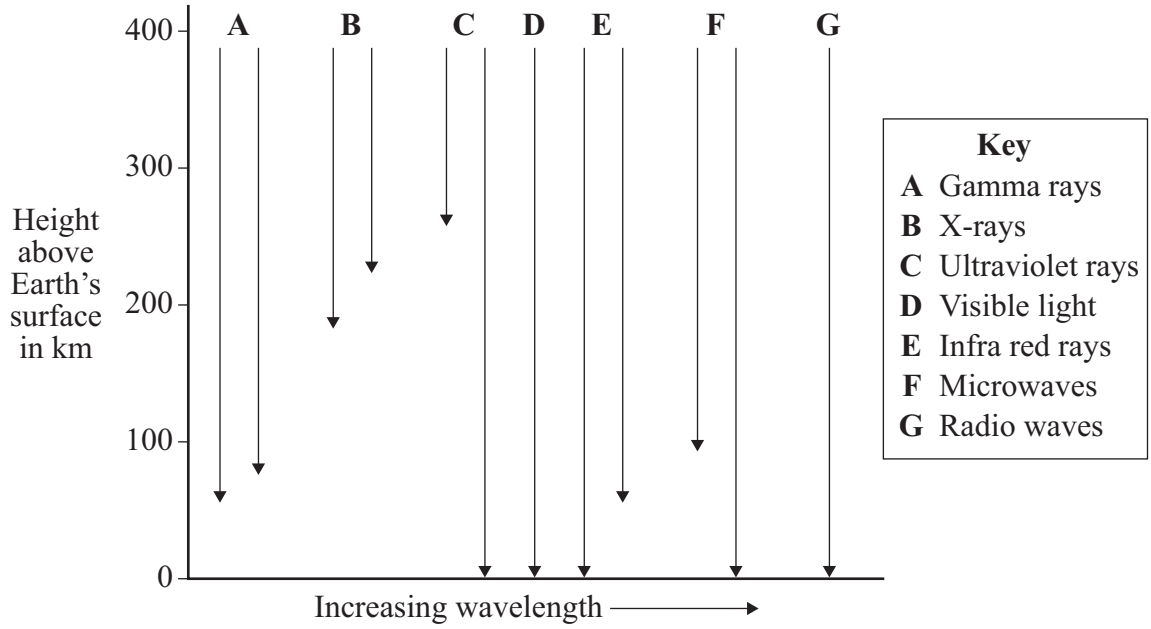
2 at night.

3 to observe a small region of the electromagnetic spectrum.

4 to observe one region of the sky.

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9B Radio telescopes are sited on the ground.

This is because radio waves . . .

1 are emitted by many stars.

2 can penetrate the atmosphere.

3 have a shorter wavelength than microwaves.

4 have more energy than infra red waves.

4.6.2.4 Uses and applications of electromagnetic waves

Question 82 · continued

9C The types of radiation collected by four telescopes, **M**, **N**, **P** and **Q**, are given in the table.

Telescope	Radiation collected
M	infra red waves
N	gamma rays
P	X-rays
Q	microwaves

Which telescopes could be operated from an aircraft flying at an altitude of 12 km?

1 **M** and **N**

2 **N** and **P**

3 **P** and **Q**

4 **Q** and **M**

9D What is the minimum height above the Earth for a satellite to be able to use telescope **P**?

1 50 km

2 70 km

3 180 km

4 250 km

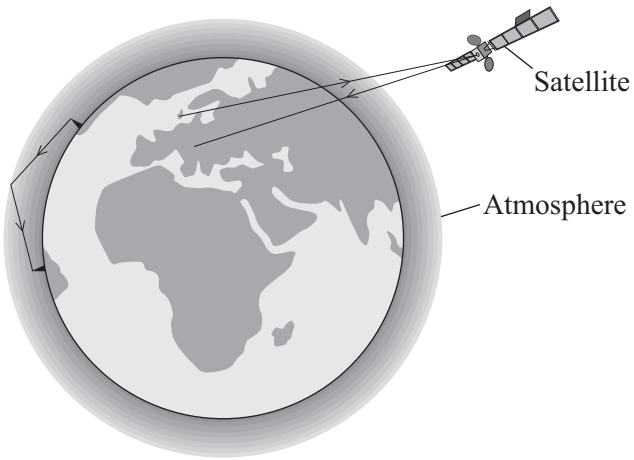
END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 83

January 2010 | PHY1H | Original Q3 | Legacy

3 (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



3 (a) (i) What type of wave is used to send information to and from satellites?

.....

(1 mark)

3 (a) (ii) What property of this type of wave makes it suitable for satellite communications?

.....

(1 mark)

3 (b) The diagram shows two types of signal that can be used to send information. One of the signals is an analogue signal. The other is a digital signal.



Describe the differences between an analogue signal and a digital signal.

.....

.....

.....

.....

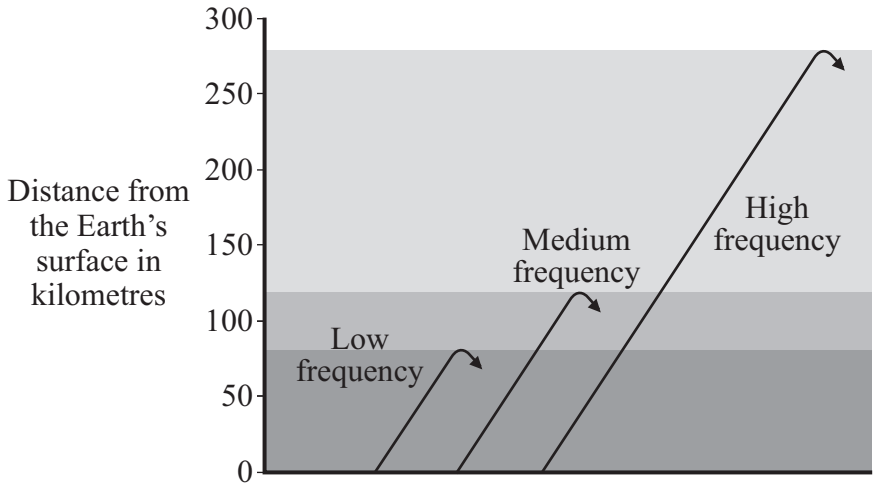
(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 83 · continued

for mark

3 (c) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

.....

.....

(1 mark)

3 (d) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Use the equation in the box to calculate the frequency, in kilohertz (kHz), of these waves.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

.....

Frequency = ... kHz

(2 marks)

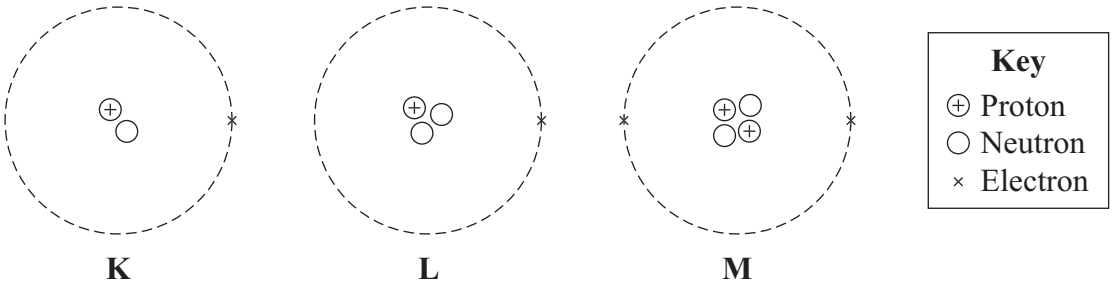
7

4.6.2.4 Uses and applications of electromagnetic waves

Question 84

January 2010 | PHY2H | Original Q3 | Legacy

3 (a) The diagram represents 3 atoms, **K**, **L** and **M**.



K **L** **M**

3 (a) (i) Which **two** of the atoms are isotopes of the same element?

..... and .....

(1 mark)

3 (a) (ii) Give a reason why the **two** atoms that you chose in part (a)(i) are:

(1) atoms of the same element .....

.....

(2) different isotopes of the same element. .....

.....

.....

(2 marks)

3 (b) The table gives some information about the radioactive isotope thorium-230.

mass number	230
atomic number	90

3 (b) (i) How many electrons are there in an atom of thorium-230?

.....

(1 mark)

3 (b) (ii) How many neutrons are there in an atom of thorium-230?

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 84 · continued

for mark

3 (c) When a thorium-230 nucleus decays, it emits radiation and changes into radium-226.

$$^{230}_{90}\text{Th} \longrightarrow {}^{226}_{88}\text{Ra} + \boxed{\text{Radiation}}$$

What type of radiation, alpha, beta or gamma, is emitted by thorium-230?

.....

Explain the reason for your answer.

.....

.....

.....

.....

.....

(3 marks)

8

4.6.2.4 Uses and applications of electromagnetic waves

Question 85

3 (a) Explain what an ultrasound wave is.

.....

.....

.....

.....

(2 marks)

3 (b) Ultrasound waves can be used to clean jewellery.

One method is to put the jewellery in a bath of cleaning fluid which contains an electronic oscillator. The electronic oscillator generates ultrasound waves in the cleaning fluid.

Suggest how these waves clean the jewellery.

.....

.....

.....

.....

(2 marks)

3 (c) Ultrasound is used for pre-natal scanning. This is much safer than using X-rays. However, doctors were only sure it was safe after experiments on mice.

Explain whether or not you think that these experiments were justified.

.....

.....

.....

.....

(2 marks)

6

4.6.2.4 Uses and applications of electromagnetic waves

Question 86

March 2010 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

There are two types of communication signal: analogue and digital.

4A Which pair of diagrams correctly shows the patterns for digital and analogue signals?

	Digital signal pattern	Analogue signal pattern
1		
2		
3		
4		

4B One reason for using digital signals rather than analogue signals for communication is that . . .

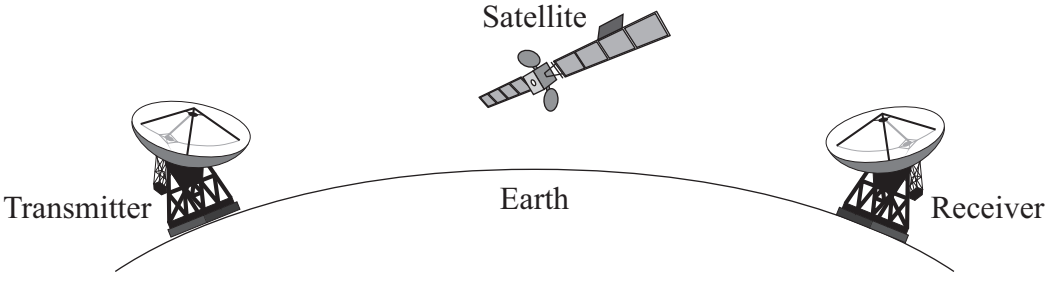
1 analogue signals are less prone to interference.

2 analogue signals can have only two values.

3 digital signals are continuously variable.

4 digital signals can be easily processed by computers.

4C Satellites in orbit around the Earth receive and transmit microwave signals for international telephone communication.



Microwaves are used because . . .

1 they are the only type of electromagnetic wave that can travel through a vacuum.

2 they are not absorbed by the Earth's atmosphere.

3 they follow the curvature of the Earth.

4 they travel faster than radio waves.

4.6.2.4 Uses and applications of electromagnetic waves

Question 86 · continued March 2010 | PHY1BP | Original Q4 | Legacy

4D Properties of waves are often demonstrated in schools using waves on water.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

A wave generator with a frequency of 50 Hz produces water waves with a wavelength of 2 cm.

At what speed do the waves travel?

1 1 m/s

2 25 m/s

3 100 m/s

4 2500 m/s

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 87

March 2010 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

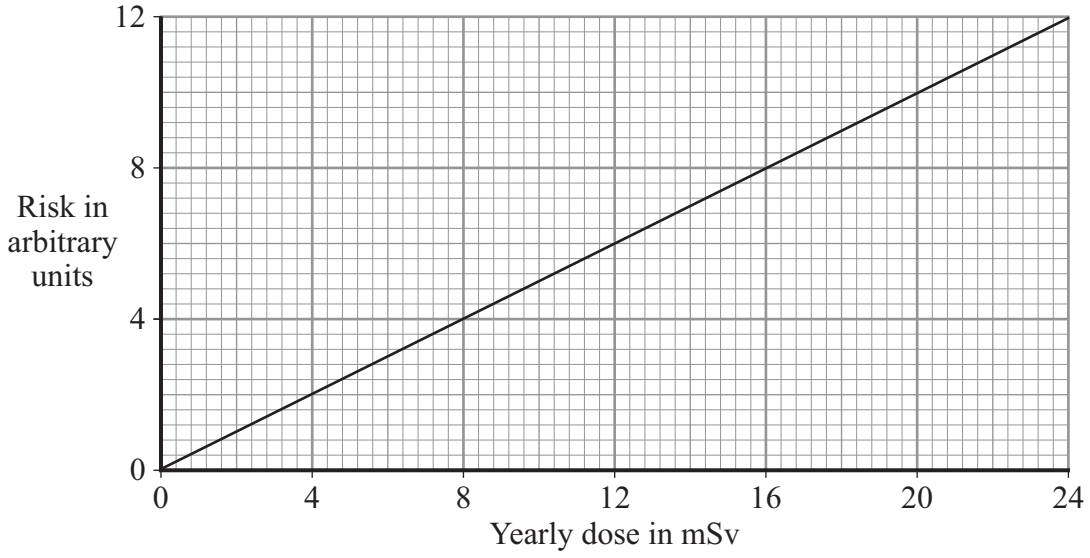
Workers in industries that use radioactive materials have the amount of radiation they receive carefully monitored. The amount of radiation received is called the dose. The industries set dose limits.

The table shows the maximum yearly dose that is allowed for three groups of people. The higher the dose of radiation received, the greater the risk of developing cancer.

Description	Yearly dose limit in millisieverts (mSv)
Member of the public	1
Worker under 18 years	6
Pregnant adult worker	4

A millisievert is a unit of radiation dose.

5A The graph shows how the risk changes with the yearly dose.



The graph shows that the risk . . .

1 does not depend on the yearly dose.

2 is 2 arbitrary units for a member of the public.

3 is inversely proportional to the yearly dose.

4 is directly proportional to the yearly dose.

4.6.2.4 Uses and applications of electromagnetic waves

Question 87 · continued March 2010 | PHY1BP | Original Q5 | Legacy

5B The yearly dose limit for an adult worker is five times that of a pregnant adult worker.

What is the risk (in arbitrary units) for an adult worker?

1 3

2 10

3 15

4 20

5C Nuclear power stations produce radiation.

Which one of the following does **not** reduce the risk to power station workers?

1 building power stations far from centres of population

2 giving the workers protective clothing

3 monitoring the dose each worker receives to ensure that radiation limits are not exceeded

4 shielding the workers from the source of radiation

5D Workers may be subjected to alpha, beta or gamma radiation.

Outside the body, alpha is less dangerous to workers than beta because alpha radiation . . .

1 cannot penetrate the skin.

2 is deflected by electric fields.

3 is much less strongly ionising.

4 has a much longer range.

4.6.2.4 Uses and applications of electromagnetic waves

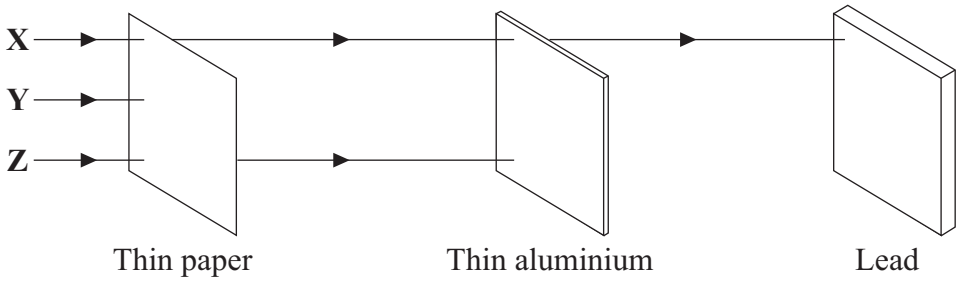
Question 88

March 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about radioactive substances and the radiation they emit.

The diagram shows how each type of radiation, **X**, **Y** and **Z**, is absorbed by different materials.



6A Which row in **Table 1** shows the correct radiation types?

Table 1

	X	Y	Z
1	beta	alpha	gamma
2	gamma	alpha	beta
3	beta	gamma	alpha
4	gamma	beta	alpha

6B When gamma radiation is absorbed, . . .

1 the absorber increases in mass.

2 the absorber shows a rise in temperature.

3 the radiation will become helium gas.

4 the radiation will transform into light.

4.6.2.4 Uses and applications of electromagnetic waves

Question 88 · continued

6C Which row in **Table 2** correctly describes the three types of radiation?

Table 2

	Alpha	Beta	Gamma
1	an electron from outside the nucleus	a helium nucleus	a short wavelength electromagnetic wave
2	a short wavelength electromagnetic wave	an electron from outside the nucleus	a helium nucleus
3	a helium nucleus	an electron from inside the nucleus	a high frequency electromagnetic wave
4	a helium nucleus	a short wavelength electromagnetic wave	an electron from inside the nucleus

6D The radioactive gas thoron, which has a half-life of 50 seconds, is used in an experiment. At the end of the experiment, the count rate had fallen to $\frac{1}{32}$ of the count rate at the beginning.

The time taken to carry out the experiment was . . .

1 200 seconds.

2 250 seconds.

3 300 seconds.

4 1600 seconds.

4.6.2.4 Uses and applications of electromagnetic waves

Question 89

March 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

Some of the world's best telescopes are placed on the tops of mountains. These telescopes detect infra red and visible light waves from distant stars and galaxies.

Some space telescopes detect X-rays from these galaxies. These telescopes are placed above the Earth's atmosphere.

7A The Hubble Space Telescope (HST) has been in orbit around the Earth since 1990. The HST is an optical telescope.

What is the advantage of placing the HST in orbit around the Earth?

1 Light, gathered by the HST, has not been distorted by the atmosphere.

2 Once the HST goes into orbit, it costs nothing to run.

3 The HST can observe the whole sky in one orbit.

4 The HST picks up clearer pictures because it is nearer to space.

7B A ground-based telescope could not detect X-rays from space because . . .

1 there are no X-rays in space.

2 the Earth's atmosphere absorbs X-rays.

3 X-rays are harmful to people.

4 X-rays are digital signals.

7C The longer the wavelength of the radiation being received, the larger the diameter of the receiving dish of the telescope needs to be.

The telescopes with the largest dishes are those detecting . . .

1 gamma rays.

2 radio waves.

3 visible light.

4 X-rays.

4.6.2.4 Uses and applications of electromagnetic waves

Question 89 · continued March 2010 | PHY1BP | Original Q7 | Legacy

7D Images of distant galaxies produced by the Hubble telescope provide evidence to support the idea that the universe . . .

1 has a definite edge.

2 is contracting.

3 is expanding.

4 is neither expanding nor contracting.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 90

March 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

This question is about electromagnetic radiation.

9A Electromagnetic radiations are . . .

1 disturbances in an electric field.

2 disturbances of the air between source and receiver.

3 waves caused by pressure changes in a vacuum.

4 waves of very high frequency.

9B When electromagnetic radiation reaches a substance, . . .

1 all wavelengths will be absorbed by the substance.

2 all wavelengths will be reflected by the substance.

3 all wavelengths will be transmitted through the substance.

4 some wavelengths may be absorbed, some reflected and some transmitted.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

All electromagnetic waves travel at 300 000 km/s.

9C Most schools have microwave generators that produce microwaves with a wavelength of 3 cm.

What is the frequency of these microwaves?

1 900 kHz

2 10 000 kHz

3 900 000 kHz

4 10 000 000 kHz

9D BBC Radio 4 transmits radio waves at a frequency of 200 kHz.

What is the wavelength of Radio 4?

1 1.5 m

2 600 m

3 1500 m

4 60 km

END OF TEST

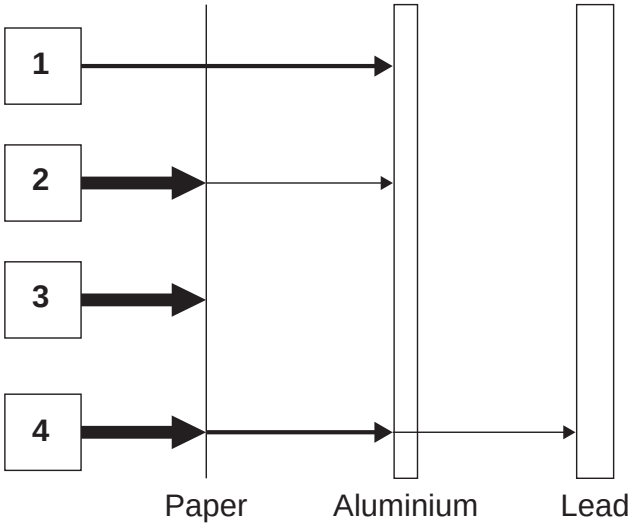
4.6.2.4 Uses and applications of electromagnetic waves

Question 91

QUESTION TWO

Three absorbers are placed in front of four sources of radiation, **1**, **2**, **3** and **4**.

The amount of radiation is represented by the thickness of the horizontal arrows.



Match statements, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagram.

A Source gives off alpha radiation only.

B Source gives off alpha and beta radiation only.

C Source gives off alpha, beta and gamma radiation.

D Source gives off beta radiation only.

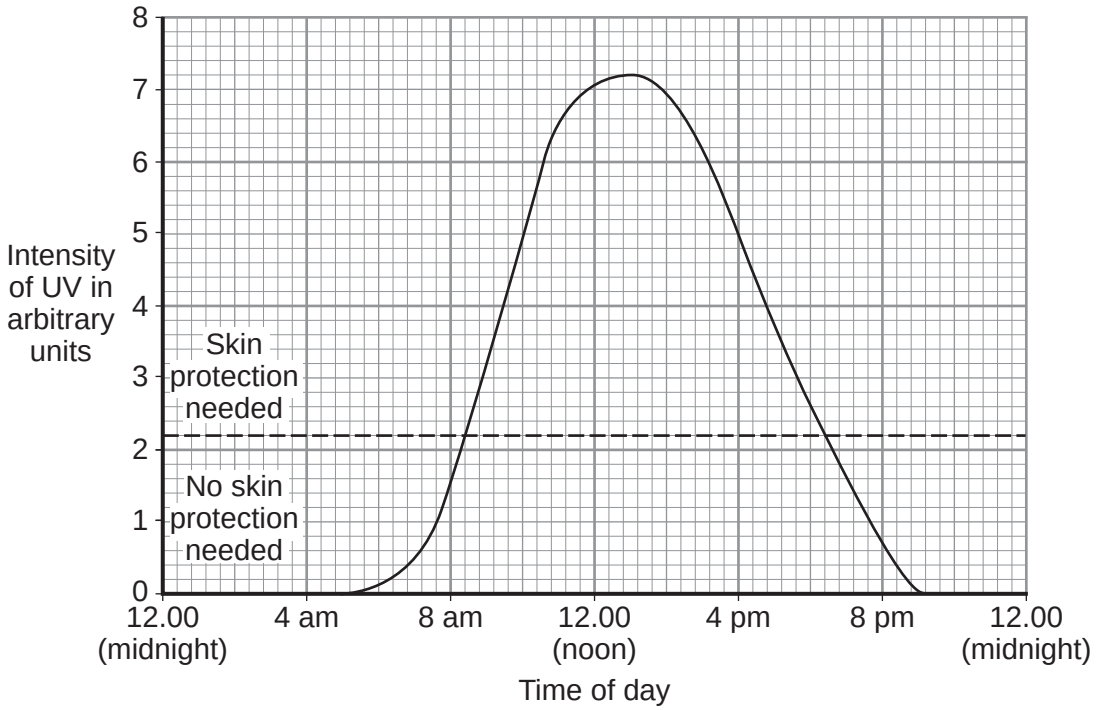
4.6.2.4 Uses and applications of electromagnetic waves

Question 92

June 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The graph shows how the intensity of ultraviolet (UV) radiation changes during a typical day in June in the UK.



3A The intensity of UV radiation reaches a maximum at . . .

1 9.30 am

2 12.00 noon

3 1.00 pm

4 5.00 pm

4.6.2.4 Uses and applications of electromagnetic waves

Question 92 · continued

3B The dashed line (– – – –) on the graph shows the intensity above which you should protect your skin from UV radiation by using sunscreen cream.

For approximately how long is the intensity of UV radiation high enough to suggest that protection is needed?

1 0 hours

2 7 hours

3 10 hours

4 16 hours

3C For a typical day in December in the UK, how would you expect the graph to be different?

	Peak	Area under the graph
1	higher	the same
2	lower	the same
3	higher	bigger
4	lower	smaller

3D UV radiation travels as an electromagnetic wave.

Which row in the table below correctly shows the speed and frequency of UV compared with the speed and frequency of visible light?

	Speed of UV compared with visible light	Frequency of UV compared with visible light
1	slower	lower
2	same	higher
3	faster	higher
4	same	lower

4.6.2.4 Uses and applications of electromagnetic waves

Question 93

June 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Radio and television programmes are transmitted through the air over long distances.

The information is carried by electromagnetic waves.

6A Compared with light waves, radio waves . . .

1 have a shorter wavelength and a higher speed.

2 have a lower frequency and the same speed.

3 have a longer wavelength and a lower speed.

4 have a higher frequency and the same speed.

6B A radio programme is broadcast on a wavelength of 1500 metres. The speed of the wave is 300 000 000 m/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

The frequency of these waves is . . .

1 200 Hz

2 200 kHz

3 450 000 Hz

4 450 000 kHz

6C Over the next few years, all television signals will be changed from analogue to digital.

One advantage to television broadcasters of using digital signals instead of analogue signals is that . . .

1 they are easier to generate.

2 they are less prone to interference.

3 they can travel faster.

4 they can travel further.

4.6.2.4 Uses and applications of electromagnetic waves

6D Some people are worried about the effects of living close to a powerful radio transmitter.

Close to one transmitter, it was found that the number of children with leukaemia was slightly higher than normal. Leukaemia is a type of cancer of the blood.

What conclusion could you make from this observation?

1 Radio waves cause leukaemia.

2 There may be a connection between radio waves and leukaemia.

3 Adults are less likely than children to develop leukaemia.

4 Children should not be allowed to live near a radio transmitter.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 94

June 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1896, Henri Becquerel was doing an experiment with uranium. He first thought that uranium absorbed energy from the Sun and then re-emitted the energy as X-rays. Then, on a cloudy day, he found that the uranium emitted radiation even when the uranium sample was wrapped in black paper.

7A This suggests that . . .

1 his original theory was wrong and further investigation was needed.

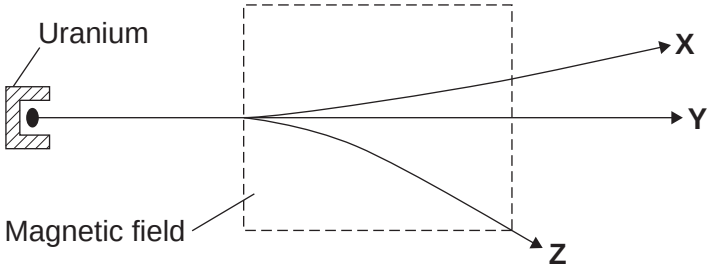
2 his test was fair but more variables needed to be controlled.

3 his original theory was correct and further investigation was needed.

4 his test was not fair and more variables needed to be controlled.

7B Becquerel passed the radiation emitted by uranium through a magnetic field. He found that there were three different types of radiation.

The diagram shows the paths of the three types of radiation, **X**, **Y** and **Z**, in the magnetic field.



Later, Ernest Rutherford called the three types of radiation alpha, beta and gamma.

Which is the correct row in the table?

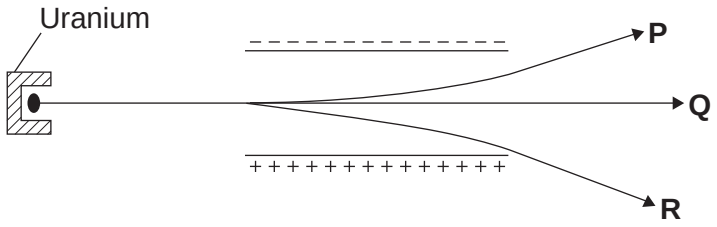
	X	Y	Z
1	alpha	beta	gamma
2	alpha	gamma	beta
3	beta	alpha	gamma
4	beta	gamma	alpha

4.6.2.4 Uses and applications of electromagnetic waves

Question 94 · continued

7C The radiation emitted by uranium can also be deflected in an electric field between two charged plates.

The diagram shows the paths taken by the three types of radiation, **P**, **Q** and **R**, in an electric field.



The explanation for the different paths is that . . .

1 **P** and **R** have the same electric charge and **Q** is uncharged.

2 **P** and **R** are oppositely charged and **P** has a larger mass than **R**.

3 **P** and **R** are oppositely charged and **R** has a larger charge than **P**.

4 **Q** is uncharged and has a larger mass than both **P** and **R**.

7D Rutherford measured the range in air of the three types of radiation.

Which row of the table gives the correct order of range?

	Shortest range ⟶ **Longest range**		
1	alpha	beta	gamma
2	alpha	gamma	beta
3	beta	alpha	gamma
4	beta	gamma	alpha

4.6.2.4 Uses and applications of electromagnetic waves

Question 95

June 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Thermal imaging cameras are used by rescue workers to search for people trapped under rubble after an earthquake. Like all warm objects, the living human body emits infra red radiation. The cameras detect this infra red radiation. Electronic circuits in the camera produce a colour image in which different colours correspond to different wavelengths of infra red radiation.

The table shows the image colour, infra red wavelength and the temperature of the object.

Image colour	Infra red wavelength in micrometres	Temperature of object in °C
Red	9.51	32
Red-orange	9.45	34
Orange	9.4	36
Orange-yellow	9.32	38
Yellow	9.26	40
Yellow-white	9.2	42

9A Two of the values of wavelength in the table show a lower . . .

1 calibration.

2 precision.

3 range.

4 reliability.

9B A scientist wanted to display this data as a line graph.

Which row in the table below shows the scales which would best display the data?

	x-axis (wavelength in micrometres)	y-axis (temperature in °C)
1	0 to 10	0 to 50
2	0 to 10	30 to 50
3	9 to 10	0 to 50
4	9 to 10	30 to 50

4.6.2.4 Uses and applications of electromagnetic waves

Question 95 · continued

9C A thermal image of a small boy is mainly orange.

Under identical conditions, the thermal image of a much larger man would be . . .

1 mainly yellow because the man's body has a greater mass.

2 mainly red because the man's body has a larger surface area.

3 a mixture of red, orange and yellow because the man's body has a larger mass and a larger surface area.

4 mainly orange because the man and the boy have approximately the same body temperature.

9D At night, police officers use thermal imaging cameras to track criminals running away from crime scenes.

These cameras work better at night than during the day because at night . . .

1 the criminals emit more infra red radiation.

2 the cooler surroundings emit less infra red radiation.

3 the cooler surroundings emit less visible light.

4 the criminals wear black clothes.

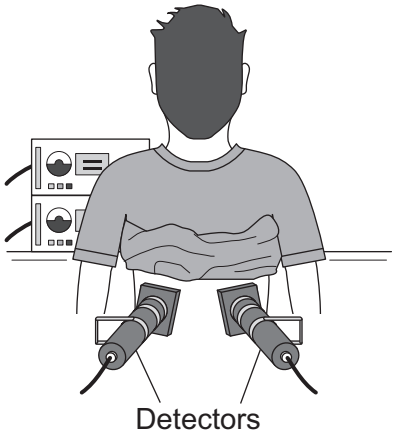
END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 96

June 2010 | PHY1H | Original Q2 | Legacy

2 (a) A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.



The doctor injects a small amount of technetium-99 into the patient's bloodstream.

Technetium-99 emits *gamma radiation*.

Give **two** reasons why an isotope that emits gamma radiation is injected into the patient rather than an isotope that emits alpha radiation.

1 .....

.....

2 .....

.....

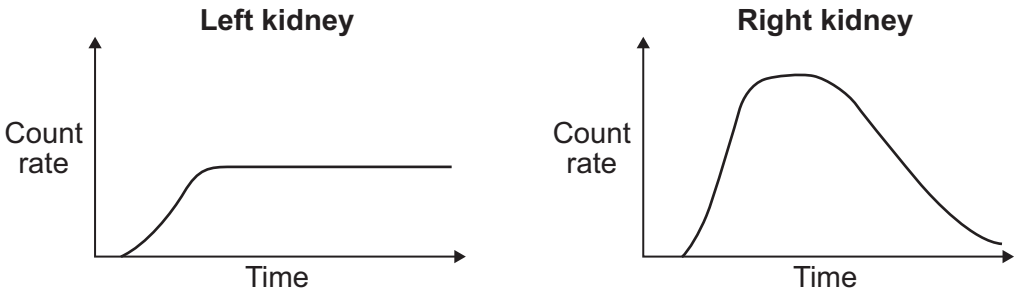
(2 marks)

Question 96 · continued

2 (b) If the patient's kidneys are working correctly, the technetium-99 will pass from the bloodstream into the kidneys and then into the patient's urine.

Detectors are used to measure the radiation emitted from the kidneys.

The level of radiation emitted from each kidney is recorded on a graph.



2 (b) (i) How do the graphs show that technetium-99 is passing from the bloodstream into each kidney?

.....

.....

(1 mark)

2 (b) (ii) By looking at the graphs, the doctor is able to tell if there is a problem with the patient's kidneys.

Which **one** of the following statements is correct?

Put a tick (✓) in the box next to your answer.

Only the right kidney is working correctly. ☐

Only the left kidney is working correctly. ☐

Both kidneys are working correctly. ☐

Explain the reason for your answer.

.....

.....

.....

.....

(3 marks)

Question 2 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 96 · continued

2 (c) The patient was worried about having a radioactive isotope injected into their body. The doctor explained that the risk to the patient's health was very small as technetium-99 has a short *half-life*.

2 (c) (i) What does the term *half-life* mean?

.....

.....

(1 mark)

2 (c) (ii) Explain why it is important that the doctor uses an isotope with a short half-life rather than an isotope with a long half-life.

.....

.....

.....

.....

(2 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 97

June 2010 | PHY1H | Original Q4 | Legacy

4 (a) Microwaves and visible light are two types of electromagnetic wave. Both can be used for communications.

4 (a) (i) Give **two** properties that are common to both visible light and microwaves.

1 .....

.....

2 .....

.....

(2 marks)

4 (a) (ii) Name **two** more types of electromagnetic wave that can be used for communications.

..... and .....

(1 mark)

4 (b) Wi-Fi is a system that joins computers to the internet without using wires. Microwaves, with a wavelength of 12.5 cm, are used to link a computer to a device called a router. Microwaves travel through the air at 300 000 000 m/s.

Use the equation in the box to calculate the frequency of the microwaves used to link the computer to the router.

wave speed = frequency × wavelength

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Frequency = ...

(3 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 97 · continued

4 (c) Wi-Fi is used widely in schools. However, not everyone thinks that this is a good idea.

A politician commented on the increasing use of Wi-Fi. He said: 'I believe that these systems may be harmful to children.'

However, one group of scientists said that there is no reason why Wi-Fi should not be used in schools. These scientists also suggested that there is a need for further research.

4 (c) (i) Suggest what the politician could have done to persuade people that what he said was not just an opinion.

.....

.....

(1 mark)

4 (c) (ii) Why did the group of scientists suggest that there is a need for further research?

.....

.....

(1 mark)

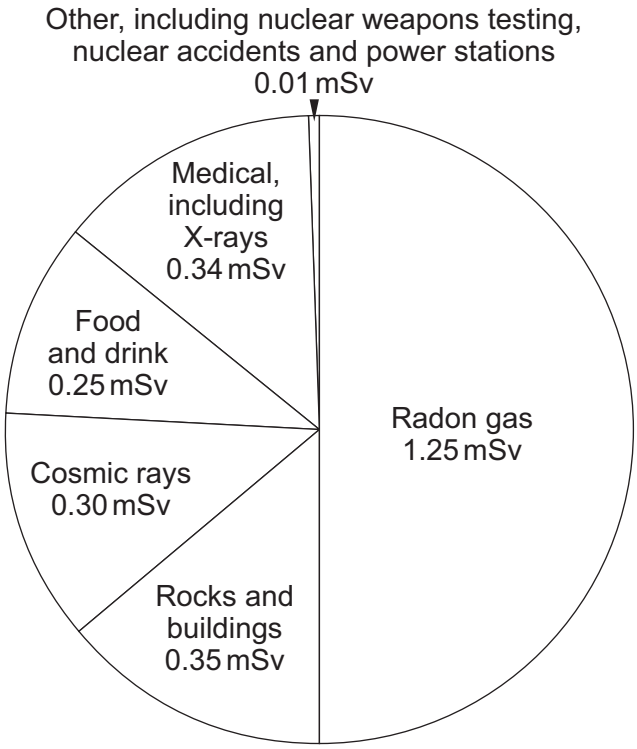
8

4.6.2.4 Uses and applications of electromagnetic waves

Question 98

June 2010 | PHY2H | Original Q2 | Legacy

2 The pie chart shows the sources of the background radiation and the radiation doses that the average person in the UK is exposed to in one year.
Radiation dose is measured in millisieverts (mSv).



2 (a) (i) What is the total radiation dose that the average person in the UK receives?

.....

.....

Total radiation dose = ... mSv
(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 98 · continued

2 (a) (ii) A student looked at the pie chart and then wrote down three statements.

Which **one** of the following statements is a correct conclusion from this data?

Put a tick (✓) in the box next to your answer.

In the future, more people will be exposed to a greater proportion of radon gas. ☐

People that have never had an X-ray get 50% of their radiation dose from radon gas. ☐

The radiation dose from natural sources is much greater than from artificial sources. ☐

(1 mark)

Question 2 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 98 · continued

2 (b) The concentration of radon gas inside a home can vary from day to day. In some homes, the level can build up to produce a significant health risk. It is estimated that each year 1000 to 2000 people die because of the effects of radiation from radon gas.

2 (b) (i) It is not possible to give an exact figure for the number of deaths caused by the effects of radiation from radon gas. Why?

.....

.....

(1 mark)

The table gives data for the radiation levels measured in homes in 4 different parts of the UK. The radiation levels were measured using two detectors, one in the living room and one in the bedroom. The measurements were taken over 3 months.

Area of the UK	Number of homes in the area	Number of homes in the sample	Average radiation level in Bq/m^3	Maximum radiation level in Bq/m^3
A	590 000	160	15	81
B	484 000	130	18	92
C	221 000	68 000	162	10 000
D	318 000	35 300	95	6 900

2 (b) (ii) Give **one** reason why the measurements were taken over 3 months using detectors in different rooms.

.....

.....

(1 mark)

2 (b) (iii) Use information from the table to suggest why a much higher proportion of homes were sampled in areas **C** and **D** than in areas **A** and **B**.

.....

.....

.....

(2 marks)

6

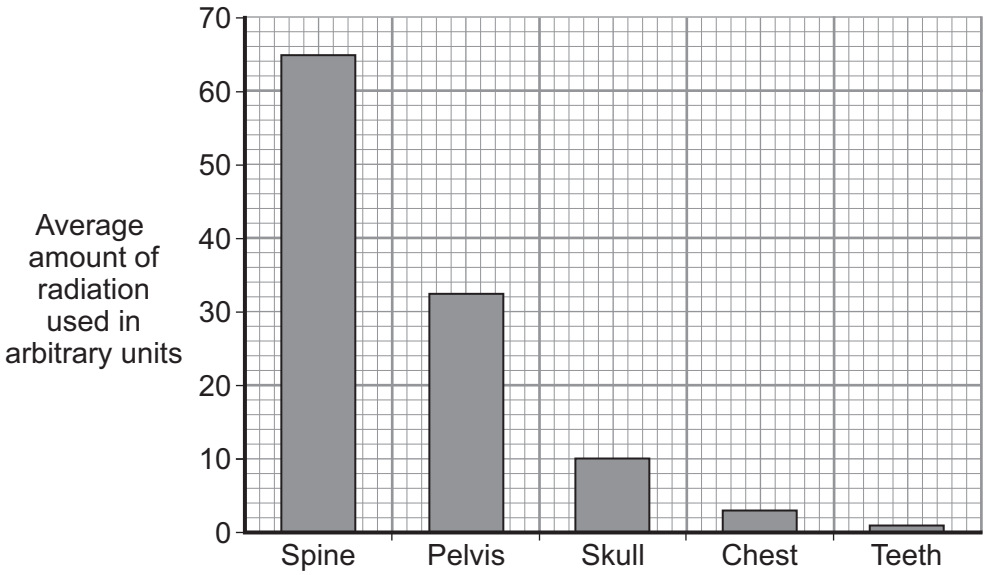
4.6.2.4 Uses and applications of electromagnetic waves

Question 99

November 2010 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

A survey was carried out on patients having X-rays taken at a hospital.
The graph shows the average amount of radiation used when X-rays were taken of different parts of the body.



Match words, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the sentences.

A categoric

B continuous

C dependent

D reliable

The data is **not** shown as a line graph because only one variable is . . . **1** . . . .

The amount of radiation used is the . . . **2** . . . variable.

The part of the body of which an X-ray is taken is a . . . **3** . . . variable.

Surveying more patients would make the data more . . . **4** . . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question 100

November 2010 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

Fluorescers are substances that are used to make objects look brighter. Fluorescers absorb ultraviolet radiation and re-emit it as visible light. This makes the object glow when exposed to ultraviolet radiation.

- Laundry detergents contain fluorescers to make 'white look even whiter'.
- Dental compounds contain fluorescers to make teeth look brighter.
- Since 1950, fluorescers have been added to white paper to brighten it.

5A A white shirt has been washed in detergent containing a fluorescer.

The white shirt will . . .

1 be much cleaner.

2 glow in the dark.

3 look cleaner.

4 stay cleaner for longer.

5B A dentist paints someone's teeth with enamel containing a fluorescer.

The enamel absorbs ultraviolet radiation from sunlight and then emits light with . . .

1 a higher frequency and a longer wavelength.

2 a higher frequency and a shorter wavelength.

3 a lower frequency and a longer wavelength.

4 a lower frequency and a shorter wavelength.

5C A document is dated 1805. The document glows when it is viewed in ultraviolet light.

The document is likely to . . .

1 be a forgery.

2 have been printed before 1805.

3 have a dull surface.

4 have a shiny surface.

4.6.2.4 Uses and applications of electromagnetic waves

Question 100 · continued

5D The ultraviolet radiation used to view the document has a wavelength of 0.000 000 1 metres.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

Speed of electromagnetic waves = 300 000 000 m/s

What is the frequency of ultraviolet radiation of wavelength 0.000 000 1 metres?

1 30 Hz

2 3 000 000 Hz

3 3 000 000 000 Hz

4 3 000 000 000 000 000 Hz

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 101

November 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Waves from different parts of the electromagnetic spectrum are used for communications.

6A Optical fibres can bend light around corners.

This is because the light . . .

1 is absorbed in the optical fibre.

2 is transmitted through the walls of the optical fibre.

3 is reflected inside the optical fibre.

4 travels faster in the optical fibre.

6B A metal aerial absorbs the energy carried by radio waves. This creates an alternating current (a.c.) in the metal and may produce a temperature change.

Which row in the table is correct?

	Frequency of a.c. produced	Temperature of metal
1	higher than the frequency of the radio waves	increases
2	the same as the frequency of the radio waves	increases
3	lower than the frequency of the radio waves	decreases
4	the same as the frequency of the radio waves	decreases

6C Television and telephone signals sent via satellites use microwaves rather than long wavelength radio waves.

This is because microwaves . . .

1 can pass easily through the Earth's atmosphere.

2 can travel through a vacuum.

3 have longer wavelengths than radio waves.

4 travel faster than radio waves.

4.6.2.4 Uses and applications of electromagnetic waves

Question 101 · continued

6D Digital signals are replacing analogue signals in television and telephone transmissions.

Which one of the following statements is correct?

1 Digital signals have discrete values only and are more prone to interference than analogue signals.

2 Digital signals have discrete values only and are less prone to interference than analogue signals.

3 Digital signals vary continuously and are more prone to interference than analogue signals.

4 Digital signals vary continuously and are less prone to interference than analogue signals.

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 102

November 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1927, a scientist proposed that the universe began with an explosion. His proposal came after astronomers had observed red-shift in light from distant galaxies.

7A Red-shift is an apparent . . .

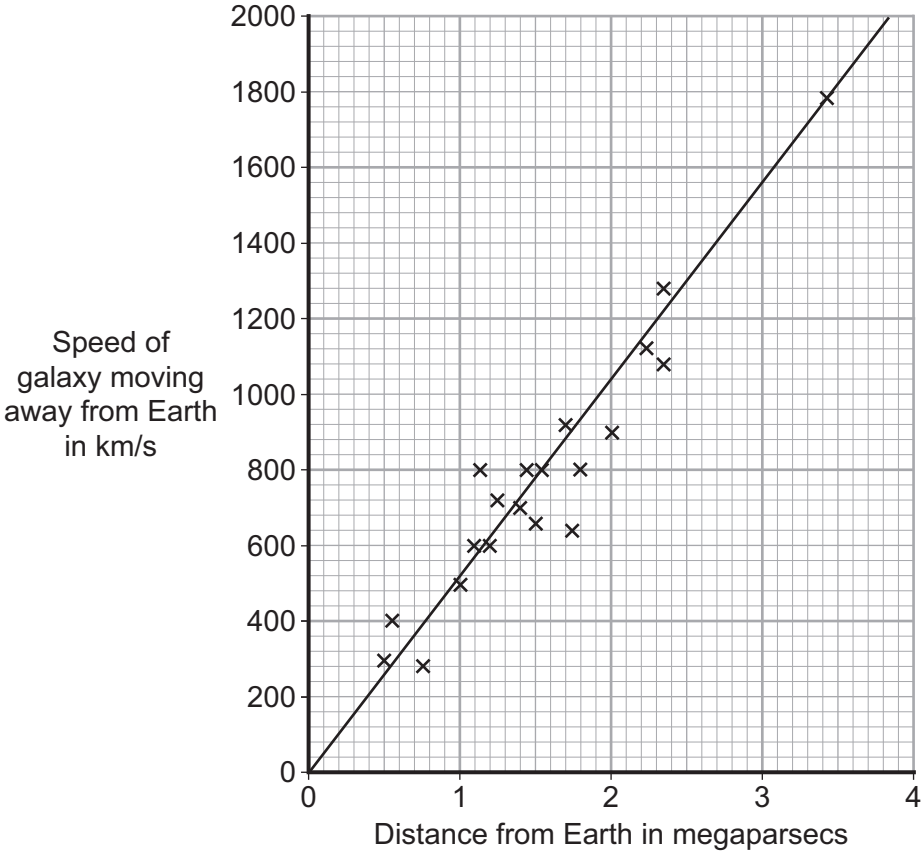
1 decrease in wavelength of the light due to a galaxy moving away from the Earth.

2 increase in wavelength of the light due to a galaxy moving away from the Earth.

3 decrease in wavelength of the light due to a galaxy moving towards the Earth.

4 increase in the wavelength of the light due to a galaxy moving towards the Earth.

The graph shows the results of calculations made by the astronomer Edwin Hubble. He plotted the speed at which the galaxies are moving away from Earth against their distance from Earth. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 000 km.



4.6.2.4 Uses and applications of electromagnetic waves

7B Hubble's results suggest that . . .

1 more results are needed before we can say there is a relationship between the speed of a galaxy and the distance of the galaxy from Earth.

2 there is a negative relationship between the speed of a galaxy and the distance of the galaxy from Earth.

3 the speed of a galaxy is directly proportional to the distance of the galaxy from Earth.

4 the graph points are too scattered to give a meaningful relationship.

7C The gradient of the line of best fit on the graph is known as the Hubble constant. The Hubble constant can be used to estimate the age of the universe.

From this data, the approximate value of the Hubble constant in km/s per megaparsec is . . .

1 4

2 500

3 1000

4 2000

7D Hubble's calculations support the 'big bang' theory. The 'big bang' theory says that the universe is expanding.

In 1948, George Gamow predicted that there should be microwave radiation left over from the 'big bang'. This radiation was discovered in the 1960s, and was confirmed by the Cosmic Background Explorer satellite in the early 1990s.

This discovery . . .

1 disproves the involvement of a god in the origin of the universe.

2 gives information to help us know what happened before the 'big bang'.

3 provides evidence which eliminates all other theories of the origin of the universe.

4 provides evidence in support of the 'big bang' theory.

4.6.2.4 Uses and applications of electromagnetic waves

Question 103

November 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

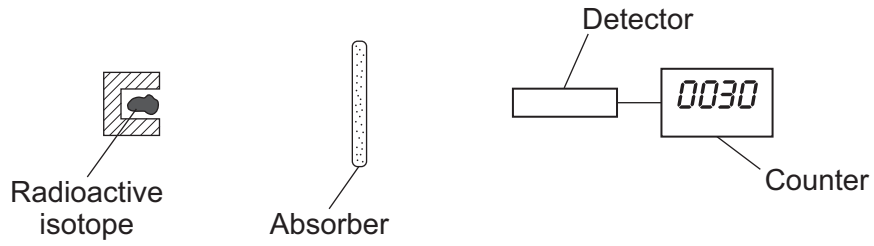
Radioactive isotopes may emit alpha, beta or gamma radiation.

A sixth-form student carried out experiments on different radioactive isotopes, **S**, **T** and **V**.

She was told that:

- all three types of radiation are emitted
- the experiments must be done in a vacuum.

In the first experiment, she put different absorbers in turn between each of the isotopes and a detector. She measured the count rate from each isotope.



The results are shown in **Table 1**.

Table 1

Isotope	Count rate in counts per second			
	No absorber	Sheet of paper	10 mm of aluminium	100 mm of lead
S	40	40	40	2
T	60	20	18	4
V	75	74	0	0

8A From these results, it can be concluded that isotope **V** emits . . .

1 alpha radiation only.

2 beta radiation only.

3 gamma radiation only.

4 alpha and gamma radiation.

8B Which source emits more than one type of radiation?

1 **S**

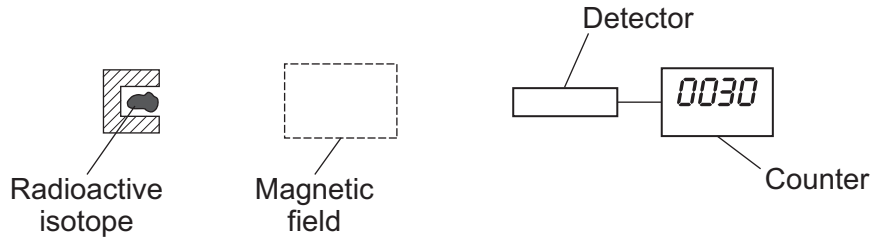
2 **T**

3 **V**

4 none of them

4.6.2.4 Uses and applications of electromagnetic waves

8C In a second experiment, the absorber was replaced by a magnetic field.



The results are shown in **Table 2**.

Table 2

Isotope	Count rate in counts per second	
	Without magnetic field	With magnetic field
S	40	40
T	60	20
V	75	0

Which one of the following conclusions from the experiment is correct?

1 **V** could be a gamma emitter and a beta emitter.

2 **V** and **T** both emit gamma radiation.

3 **S** is either an alpha emitter or a beta emitter.

4 **T** could be an alpha emitter and a gamma emitter.

8D Some types of radiation are deflected by a magnetic field.

This is because the radiation . . .

1 is like a wave.

2 has a positive charge or a negative charge.

3 has north poles and south poles.

4 has no mass.

4.6.2.4 Uses and applications of electromagnetic waves

Question 104

November 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Four hundred years ago, Galileo pointed his small, primitive telescope at the night sky.

His telescope had lenses to focus light from the stars.

Today, much larger optical telescopes use large curved mirrors to focus light. The largest single-piece mirror has a diameter of 8.4 m. If the diameter was made any larger, the mirror would deform under its own weight. Very large telescopes use smaller mirrors linked together.

The table gives the effective diameters of the mirrors in several large optical telescopes.

Telescope	Keck	Giant Magellan Telescope (GMT)	Thirty Metre Telescope(TMT)	Very Large Telescope (VLT)
Effective diameter of mirror in metres	10.0	27.0	30.0	32.8

9A The TMT has nine times the light-collecting power of the Keck telescope mirror.

This is because the light-collecting power of a telescope is . . .

1 directly proportional to the diameter of the mirror.

2 inversely proportional to the diameter of the mirror.

3 directly proportional to the square of the diameter of the mirror.

4 inversely proportional to the square of the diameter of the mirror.

9B The VLT is located in a desert high in the mountains of South America.

The VLT produces sharp images because . . .

1 the VLT is nearer to the stars than optical telescopes at sea level.

2 light rays are more easily reflected higher in the atmosphere.

3 the night sky in the desert is clear and dark.

4 at the top of a mountain the telescope weighs less.

4.6.2.4 Uses and applications of electromagnetic waves

9C Some telescopes are put into orbit round the Earth.

This is so that the telescopes . . .

1 can detect only visible light.

2 can detect only the electromagnetic waves that the Earth's atmosphere absorbs.

3 can detect visible light and sound waves.

4 can detect electromagnetic waves that do not reach the Earth's surface.

9D The smaller the diameter of a telescope, the higher the frequency of the waves that it can detect.

Pulsars are objects in space that emit radio waves. Pulsars were discovered using radio telescopes based on Earth.

The telescope that first detected the radiation from a pulsar had a diameter . . .

1 about the same size as the diameter of an optical telescope because the frequencies it detects are about the same.

2 smaller than the diameter of an optical telescope because the frequencies it detects are lower.

3 larger than the diameter of an optical telescope because the frequencies it detects are higher.

4 larger than the diameter of an optical telescope because the frequencies it detects are lower.

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 105

January 2011 | PHY1H | Original Q1 | Legacy

1 Small sailing boats can be fitted with a passive radar device. The device increases the chance that the small boat will be seen on the radar screen of a large ship.
The radar transmitter on the large ship emits microwaves.

1 (a) Microwaves and radio waves are both part of the electromagnetic spectrum.

How are microwaves different from radio waves?

.....

.....

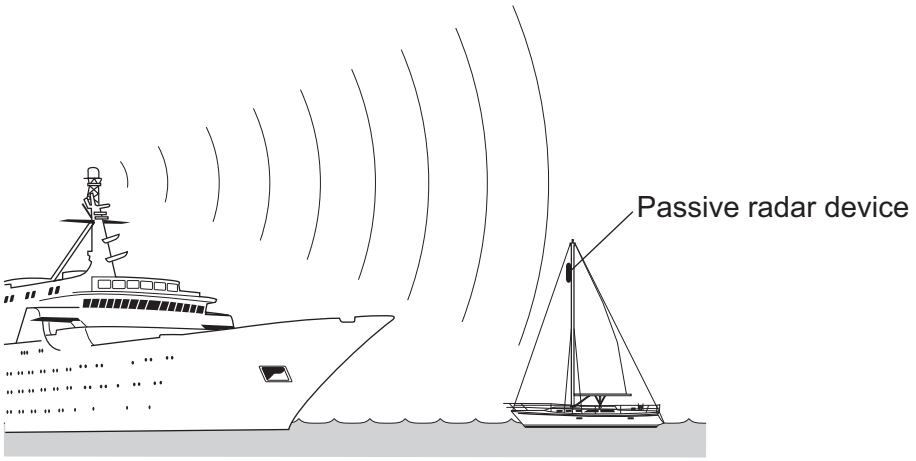
(1 mark)

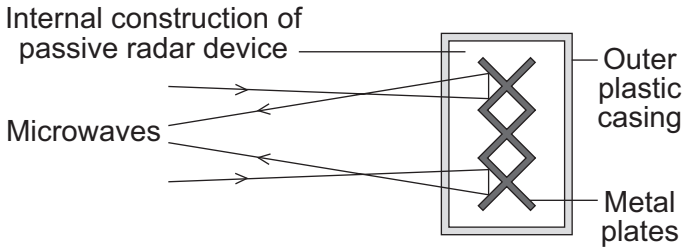
1 (b) How fast do microwaves travel through the air or a vacuum compared to radio waves?

.....

(1 mark)

1 (c) The diagrams show the position of a passive radar device on a small boat and the internal construction of one type of passive radar device.





4.6.2.4 Uses and applications of electromagnetic waves

Question 105 · continued

Microwaves can be absorbed, reflected or transmitted by different materials and types of surface.

Explain what happens to the microwaves from the ship's transmitter when they reach the passive radar device.

.....

.....

.....

.....

(2 marks)

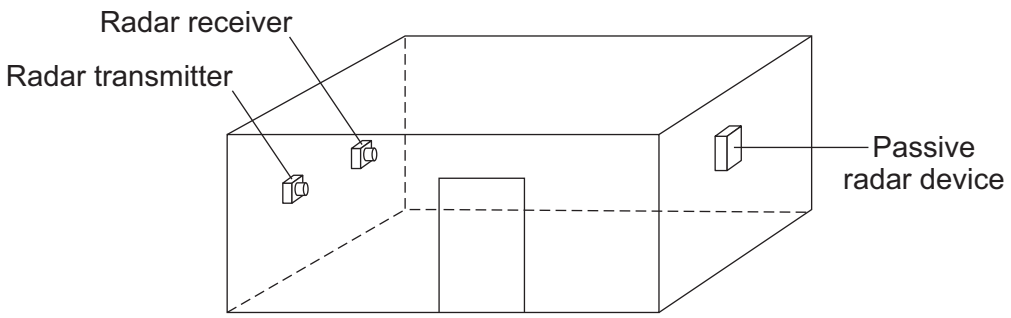
Question 1 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 105 · continued

1 (d) Each type of passive radar device has an RCS value. The larger the RCS value, the easier it is for a small boat fitted with the device to be detected.

An independent group of scientists measured the RCS values of 4 different types of device. The RCS value for each device was measured in the same room using the same equipment.



1 (d) (i) Why are the walls of the room covered in a material that absorbs the waves emitted by the radar transmitter?

.....

.....

(1 mark)

1 (d) (ii) Why is it important to use the same room and the same equipment?

.....

.....

(1 mark)

1 (d) (iii) Why is it important that the measurements are made by an independent group of scientists?

.....

.....

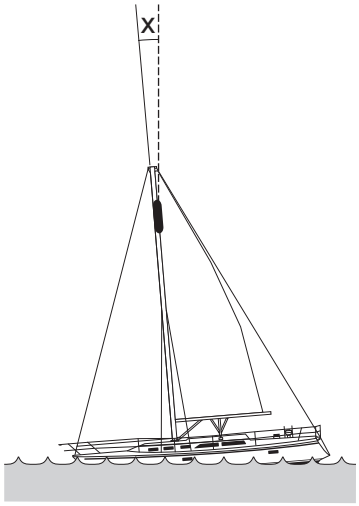
(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 105 · continued

1 (e) The movement of a small boat causes the mast and device to lean over, therefore the RCS values were measured at different angles.

The table gives the RCS values obtained by the scientists.



Device	Angle X			
	0°	5°	10°	15°
A	1.4	1.6	1.7	1.8
B	4.7	2.6	2.3	1.9
C	9.3	3.3	1.9	1.1
D	4.5	4.8	5.0	4.6

1 (e) (i) Describe how the RCS values for **device A** are different to the RCS values for **device B**.

.....

.....

.....

.....

(2 marks)

1 (e) (ii) The scientists recommended that a passive radar device fitted to a small boat should have:

- the largest possible RCS value
- an RCS value consistently above 2.0

Which **one** of the devices, **A**, **B**, **C** or **D**, would you recommend that someone fits to their boat?

.....

Give a reason for your answer.

.....

.....

(1 mark)

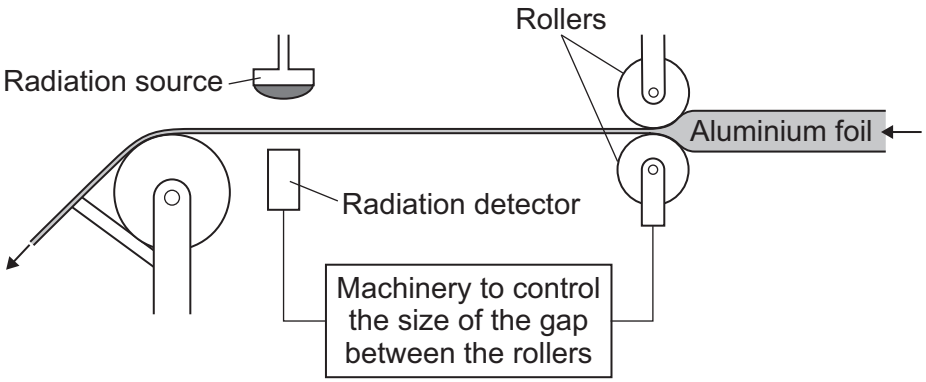
10

4.6.2.4 Uses and applications of electromagnetic waves

Question 106

January 2011 | PHY1H | Original Q7 | Legacy

7 The diagram shows a system used to control the thickness of aluminium foil as it is being rolled. A radiation source and detector are used to monitor the thickness of the foil.



7 (a) Which type of source, alpha, beta or gamma, should be used in this control system?

.....

Explain why each of the other two types of source would **not** be suitable.

.....

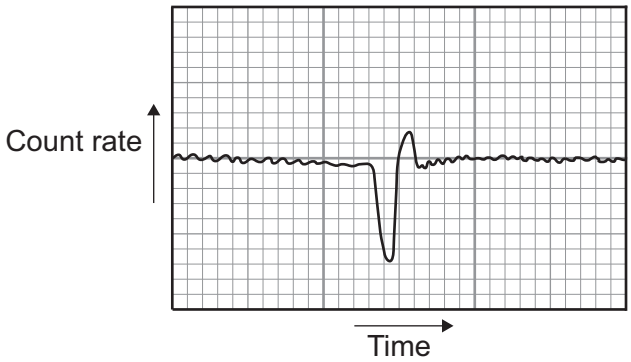
.....

.....

.....

(3 marks)

7 (b) The chart shows how the count rate recorded by the detector varies over a short period of time.



4.6.2.4 Uses and applications of electromagnetic waves

Question 106 · continued

Use the graph to explain how the thickness of the foil changes, and how the control system responds to this change.

.....

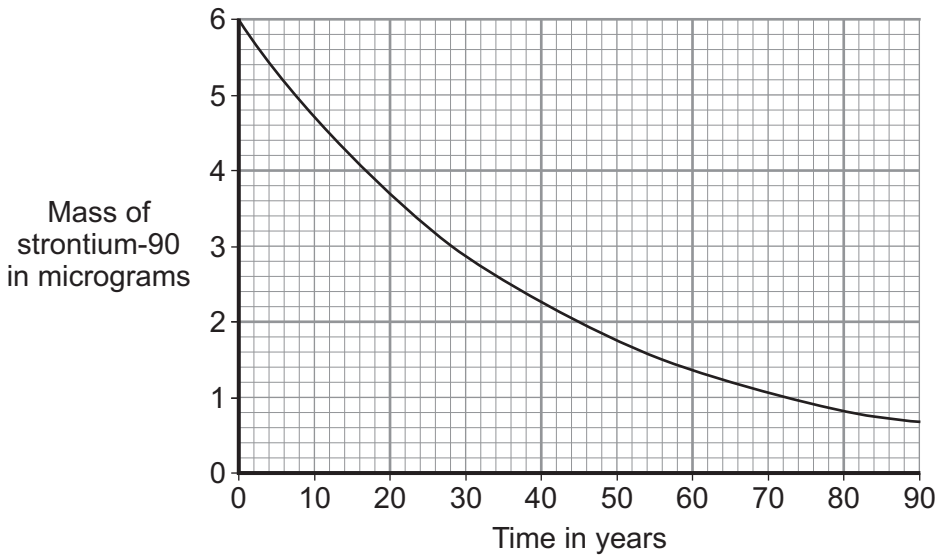
.....

.....

.....

(2 marks)

7 (c) When first used, the radiation source contains 6 micrograms of strontium-90.
The graph shows how the mass of the strontium-90 will decrease as the nuclei decay.



The control system will continue to work with the same source until 75% of the original strontium-90 nuclei have decayed.

After how many years will the source need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

.....

.....

.....

Number of years = ...

(2 marks)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 107

January 2011 | PHY2H | Original Q3 | Legacy

3 (a) Background radiation is all around us all the time.

3 (a) (i) Radon is a natural source of background radiation.

Name another natural source of background radiation.

.....

(1 mark)

3 (a) (ii) X-rays are an artificial source of background radiation.

Name another artificial source of background radiation.

.....

(1 mark)

3 (a) (iii) An atom of radon-222 decays by emitting an alpha particle.
The equation representing the decay is shown below.

$$^{222}_{86}\text{Rn} \longrightarrow {}^{218}_{84}\text{X} + \text{alpha particle}$$

How can you tell from the equation that 'X' is not an atom of radon?

.....

.....

(1 mark)

Question 3 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 107 · continued

3 (b) Having an X-ray taken increases your exposure to radiation.

The table gives:

- the radiation doses received for 6 different medical X-rays;
- the number of days' of exposure to natural background radiation each dose is equivalent to.

Medical X-ray	Radiation dose received (in arbitrary units)	Equivalent number of days of exposure to natural background radiation
Chest	2	2.4
Skull	7	8.4
Pelvis	22	26.4
Hip	44	52.8
Spine	140	
CT head scan	200	240

A hospital patient has an X-ray of the spine taken.
Calculate the number of days of exposure to natural background radiation that an X-ray of the spine is equivalent to.

Show how you work out your answer.

.....

.....

.....

Equivalent number of days = ...

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 107 · continued

3 (c) Scientists have shown that X-rays increase the risk of developing cancer.
The scientists came to this conclusion by studying the medical history of people placed in one of two groups, **A** or **B**.
The group into which people were put depended on their X-ray record.

3 (c) (i) Person **J** has been placed into group **A**.
Place each of the people, **K**, **L**, **M**, **N** and **O**, into the appropriate group, **A** or **B**.

Person	J 	K 	L 	M 	N 	O 
Medical X-ray record	3 arm	None	None	2 skull	None	4 leg

Group A	Group B
J	

(1 mark)

3 (c) (ii) To be able to make a fair comparison, what is important about the number of people in each of the two groups studied by the scientists?

.....

.....

(1 mark)

3 (c) (iii) What data would the scientists have compared in order to come to the conclusion that X-rays increase the risk of developing cancer?

.....

.....

(1 mark)

Question 3 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 107 · continued

3 (c) (iv) The chance of developing cancer due to a CT head scan is about 1 in 10 000.
The chance of developing cancer naturally is about 1 in 4.

A hospital patient is advised by a doctor that she needs to have a CT head scan.
The doctor explains to the patient the risks involved.

Do you think that the patient should give her permission for the CT scan to be taken?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1 mark)

9

4.6.2.4 Uses and applications of electromagnetic waves

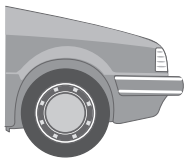
Question 108

March 2011 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about controlling some forms of radiation.

1



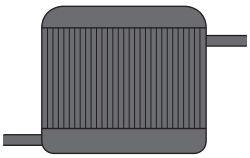
Car headlight has a shiny coating inside

2



Camera is matt black inside

3



Car radiator is painted matt black

4



Soil is covered with black plastic

Match statements, **A**, **B**, **C** and **D**, with diagrams **1**–**4**.

A is designed to increase the rate at which infra red radiation is absorbed

B is designed to increase the rate at which infra red radiation is emitted

C is designed to improve the ability to reflect visible light

D is designed to prevent the reflection of visible light

4.6.2.4 Uses and applications of electromagnetic waves

Question 109

QUESTION TWO

Radioactive isotopes have many uses.

The table gives the types of radiation emitted and the half-lives of four radioactive isotopes, **A**, **B**, **C** and **D**.

Isotope	Radiation emitted	Half-life
A	alpha	432 years
B	beta	29 years
C	gamma	6 hours
D	gamma	5 years

Match isotopes, **A**, **B**, **C** and **D**, with the most appropriate uses **1**–**4** in the table below.

	Use
1	controlling the thickness of aluminium foil as it is produced
2	sterilising medical instruments used in an operating theatre
3	injecting into a patient as a medical tracer
4	used inside a smoke detector

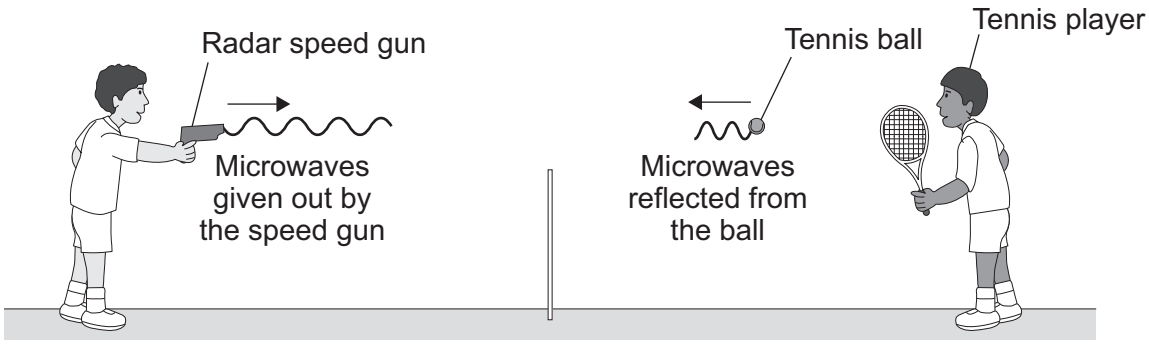
4.6.2.4 Uses and applications of electromagnetic waves

Question 110

March 2011 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The picture shows a radar speed gun being used to measure how fast a tennis player hits the ball.



Some of the microwaves from the radar speed gun are absorbed by the ball and some are reflected by the ball.

3A What effect will the absorbed microwaves have on the ball?

1 The temperature of the ball will increase slightly.

2 The ball will go faster.

3 The temperature of the ball will decrease slightly.

4 The ball will go slower.

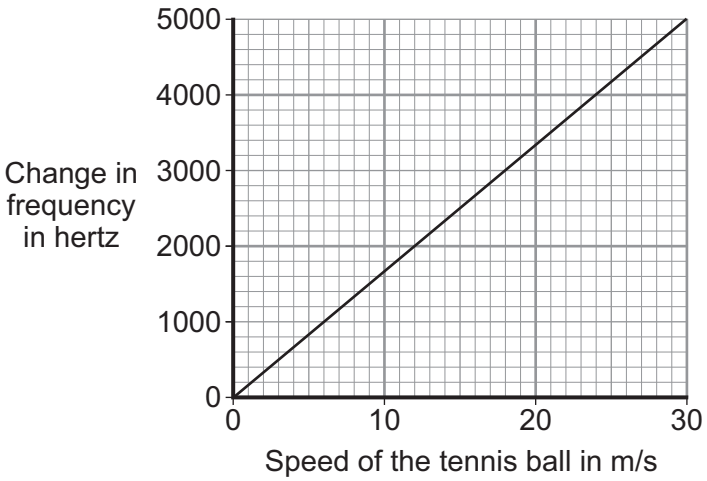
3B Which row in the table describes how the frequency and wavelength of the reflected microwaves are different from the microwaves given out by the speed gun?

	Frequency of reflected waves	Wavelength of reflected waves
1	higher	longer
2	lower	shorter
3	higher	shorter
4	lower	longer

4.6.2.4 Uses and applications of electromagnetic waves

Question 110 · continued

The graph shows how the change in frequency of the microwaves depends on the speed of the ball.



3C The data has been drawn as a line graph because . . .

1 frequency and speed are both categoric variables.

2 frequency and speed are both continuous variables.

3 frequency is a categoric variable and speed is a continuous variable.

4 frequency is a continuous variable and speed is a categoric variable.

3D The speed gun measures the change in frequency as 3000 Hz.

What is the speed of the ball?

1 18 m/s

2 20 m/s

3 21 m/s

4 22 m/s

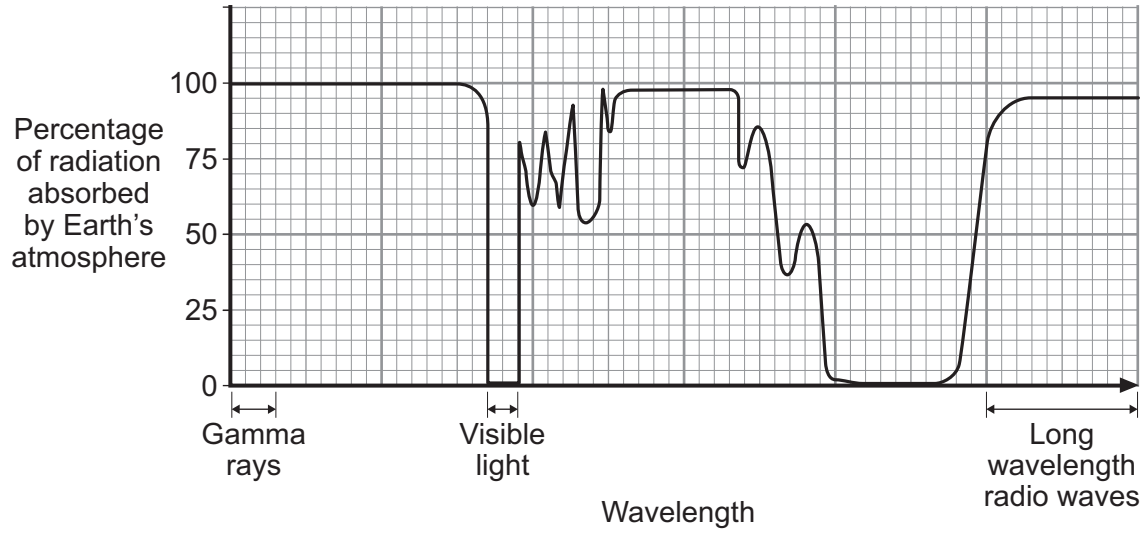
4.6.2.4 Uses and applications of electromagnetic waves

Question 111

March 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

The diagram shows the absorption of electromagnetic radiation by the Earth's atmosphere.



4A The diagram shows that . . .

1 all wavelengths of gamma radiation reach the Earth's surface.

2 all wavelengths of radio waves reach the Earth's surface.

3 all wavelengths of ultraviolet radiation reach the Earth's surface.

4 all wavelengths of visible light reach the Earth's surface.

4B Some objects in space emit X-rays.

Where would you put a telescope to detect these X-rays?

1 above the Earth's atmosphere

2 at the top of a hill

3 at ground level in a hot desert

4 at ground level in the Antarctic

4.6.2.4 Uses and applications of electromagnetic waves

Question 111 · continued

The table gives information about some space telescopes.

Name	Hubble	Compton	Chandra	Spitzer
Launched in	1990	1991	1999	2003
Detects	infra red rays ultraviolet rays visible light	gamma rays	X-rays	infra red rays

4C Which statement about these space telescopes can be deduced from the information in the table?

1 They all collect data using mirrors.

2 They all detect electromagnetic radiation.

3 They are all in space at present.

4 They were all used to study the Earth.

4D From the information in the table, which one of the following emissions could be detected by one of these space telescopes?

1 alpha particles

2 nuclear radiation

3 radio waves

4 sound waves

4.6.2.4 Uses and applications of electromagnetic waves

Question 112

March 2011 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 2009, the European Space Agency launched two space telescopes: the Herschel and the Planck.

Also in 2009, the US space shuttle Atlantis was launched. Atlantis carried seven astronauts to service the Hubble space telescope.

The table gives information about the three space telescopes.

	Hubble	Herschel	Planck
Distance from Earth	560 km	1.5 million km	1.5 million km
Radiation detected	Visible light, ultraviolet	Infra red	Microwaves
Cost of 2009 launch	£1 billion (for servicing)	Total for the 2 telescopes - £1.7 billion	
Objects observed	Distant stars and galaxies	Early development of galaxies	Radiation left over from the 'Big Bang'

7A The Hubble and Herschel telescopes both contain mirrors. The diameter of the mirror in the Herschel telescope is 50 % larger than the diameter of the main mirror in the Hubble telescope.

This means that the . . .

1 Herschel mirror is capable of collecting more energy each second than the Hubble mirror.

2 cost of the Herschel telescope is higher than the cost of the Hubble servicing mission.

3 Herschel telescope is much lighter than the Hubble telescope.

4 orbit of the Herschel telescope is much larger than the orbit of the Hubble telescope.

7B The larger the diameter of a telescope mirror, the longer the wavelength of radiation it can detect.

The order of increasing diameters for the space telescopes in the table is . . .

1 Herschel; Hubble; Planck.

2 Hubble; Herschel; Planck.

3 Planck; Herschel; Hubble.

4 Planck; Hubble; Herschel.

7C The table refers to radiation left over from the ‘Big Bang’.

What is the ‘Big Bang’?

1 a theory that the light from distant galaxies shows a red-shift

2 an observation that the universe is expanding

3 a theory that the universe began from a very small initial point

4 evidence that distant galaxies are moving away from the Earth

7D A survey showed that a lot of people living in the UK think that the money spent on the launches in 2009 would have been better spent on feeding starving people in the developing world.

The people in the survey are concerned about . . .

1 political and scientific issues.

2 political and environmental issues.

3 economic and environmental issues.

4 economic and ethical issues.

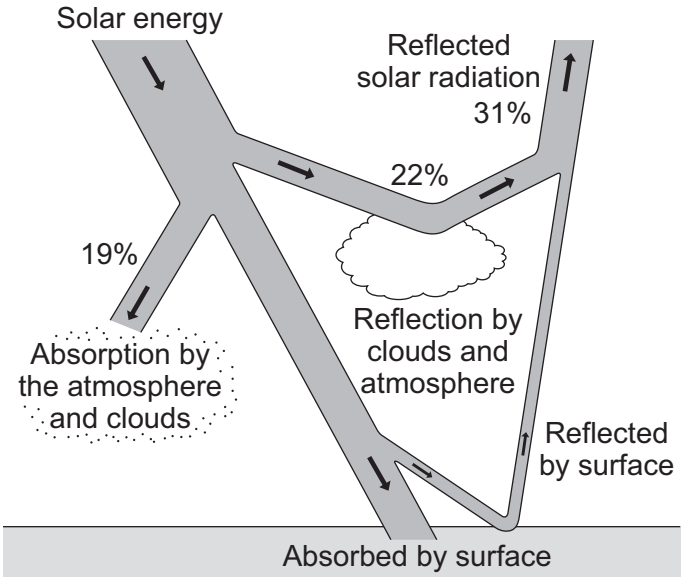
4.6.2.4 Uses and applications of electromagnetic waves

Question 113

March 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

The diagram shows what happens to solar energy as it enters the Earth's atmosphere on one day.



9A What percentage of the energy is absorbed by the Earth's surface?

1 28 %

2 50%

3 72 %

4 78 %

9B Solar radiation consists of different groups from the electromagnetic spectrum. In the ultraviolet region there are three main types, as shown in the diagram below.

Gamma	X-ray	Ultraviolet **UVC UVB UVA**	Visible	Infra red	Microwave	Radio

Which of the following statements is correct?

1 UVA rays have the same frequency, longer wavelength and travel at a faster speed than UVB rays.

2 UVB rays have a lower frequency, the same wavelength and travel at the same speed as UVC rays.

3 UVB rays have a lower frequency, a longer wavelength and travel at the same speed as UVC rays.

4 UVB rays have a higher frequency, a shorter wavelength and travel at a slower speed than UVC rays.

4.6.2.4 Uses and applications of electromagnetic waves

Question 113 · continued

A measure of the ability of a surface to reflect sunlight is called the 'albedo' of the surface.

The *albedo* has a range of values from 0 (no reflection) to 1 (total reflection).

The table below gives the *albedo* values for some surfaces on the Earth.

Surface	Albedo
forest	0.06 – 0.14
crops	0.15 – 0.25
dry soil	0.24 – 0.35
ice	0.33 – 0.38
dry sand	0.36 – 0.44
old snow	0.42 – 0.60
new concrete	0.50 – 0.60
fresh snow	0.80 – 0.90

9C From the table, which of the following surfaces has the biggest range of *albedo* values?

1 crops

2 dry sand

3 dry soil

4 old snow

9D The average *albedo* of the Earth – atmosphere system is currently about 0.30. Scientists think that this value may rise over the next 50 years.

Which one of the following statements supports their idea?

1 More crops are being produced.

2 The Earth is getting further away from the Sun.

3 There is a decrease in forest area and an increase in urban areas.

4 Less fresh snow is being deposited because of climate change.

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

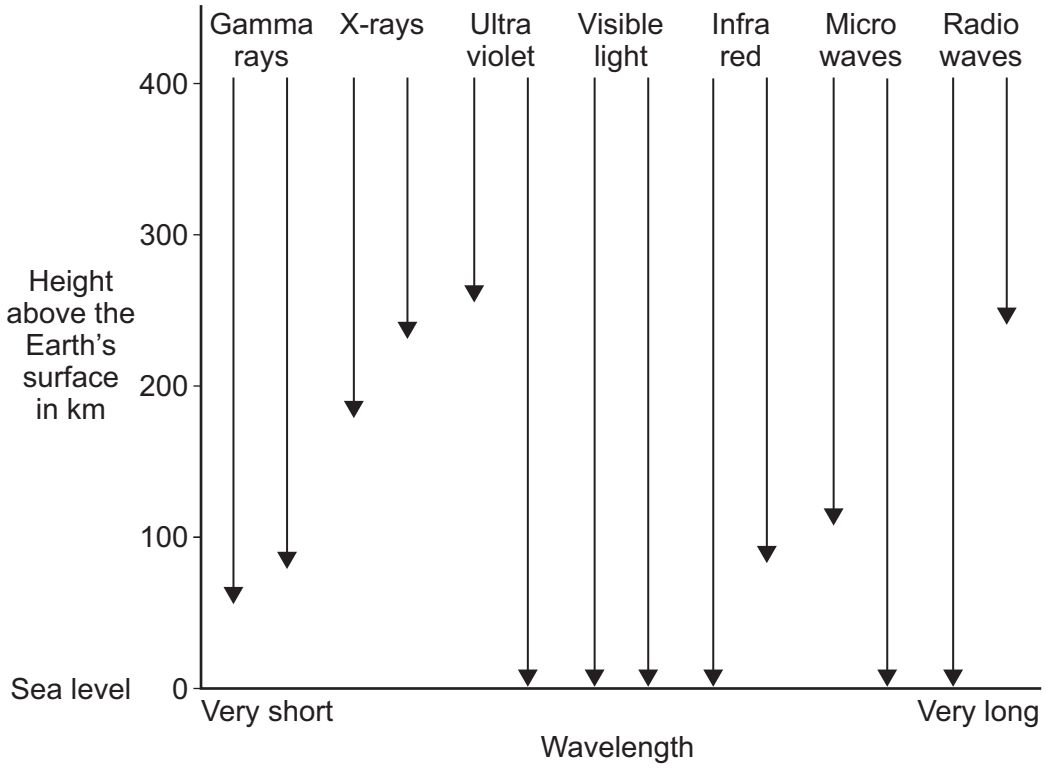
Question 114

June 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Telescopes can be based on the Earth's surface or put into orbit in space.

The diagram shows how far electromagnetic waves penetrate the Earth's atmosphere. For some types of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



4A Telescopes on Earth detect **all** wavelengths of . . .

1 radio waves only.

2 visible light only.

3 radio waves and visible light.

4 visible light and X-rays.

4B Which of the following statements about the use of telescopes in space is true?

1 The atmosphere distorts the image produced by the telescope.

2 The telescopes are affected by light pollution from the Earth.

3 The telescopes can detect electromagnetic waves that cannot reach the Earth's surface.

4 The telescopes are easy to repair and maintain.

4.6.2.4 Uses and applications of electromagnetic waves

Question 114 · continued

The table gives information about some space telescopes. Each telescope detects a different type of electromagnetic radiation.

Telescope	Wavelength detected in nanometres
INTEGRAL	less than 0.01
Chandra	0.01 – 20
FUSE	20 – 400
Hubble	400 – 700
Spitzer	1000 – 1 000 000

4C The Hubble telescope detects visible light.

Which telescope detects infra red radiation?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

4D Which telescope detects X-rays?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

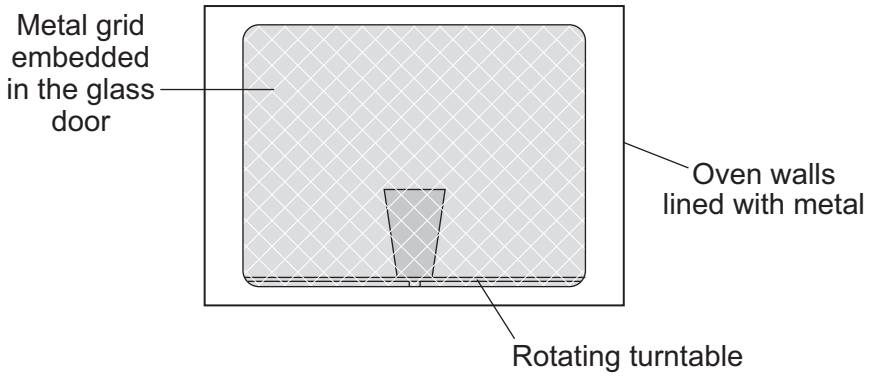
4.6.2.4 Uses and applications of electromagnetic waves

Question 115

June 2011 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows a microwave oven.



The microwaves have a frequency of 2500 MHz.

1 MHz = 1 000 000 Hz

5A The wave speed of the microwaves is 300 000 000 m/s.

What is the wavelength of the microwaves?

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 0.12 m

2 1.2 m

3 7.5 m

4 8.3 m

5B Which one of the following statements about electromagnetic radiations best explains why food can be heated by microwaves?

1 All electromagnetic radiations are disturbances in an electric field.

2 All electromagnetic radiations travel through a vacuum at the same speed.

3 All electromagnetic radiations travel as waves.

4 All electromagnetic radiations move energy from one place to another.

4.6.2.4 Uses and applications of electromagnetic waves

Question 115 · continued

5C The inside walls of the microwave oven are lined with metal. The door has a metal grid embedded in the glass.

The reason for using metal is that . . .

1 microwaves create an alternating current in the metal.

2 microwaves reflect off metal surfaces.

3 microwaves are absorbed by metals.

4 microwaves are transmitted by metals.

5D Microwaves are dangerous to living creatures. Microwaves can also affect radio and television reception.

Which feature of the oven shown in the diagram makes sure that microwaves do not escape through the door?

1 the rotating turntable

2 the metal lining

3 the embedded metal grid

4 the glass

4.6.2.4 Uses and applications of electromagnetic waves

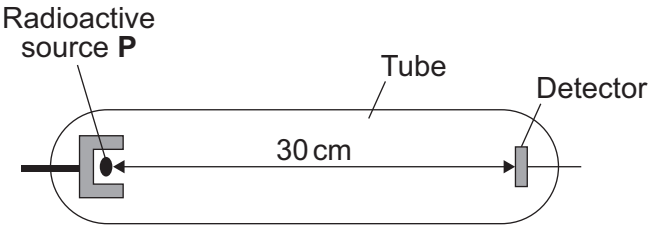
Question 116

June 2011 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Ernest Rutherford did many experiments in studying the properties of radioactive sources. He gave names to the three types of radiation emitted by radioactive sources.

One experiment used apparatus similar to that shown.



6A Rutherford found that when the air in the tube was removed, the radiation from **P** was detected. When the air was returned to the tube, no radiation was detected.

The radioactive source **P** emitted . . .

1 alpha particles.

2 beta particles.

3 gamma rays.

4 X-rays.

6B Another radioactive source, **Q**, was used. When a magnetic field was applied across the tube with no air inside, it made no difference to the radiation detected.

This shows that **Q** emits . . .

1 alpha and beta particles.

2 alpha particles and gamma rays.

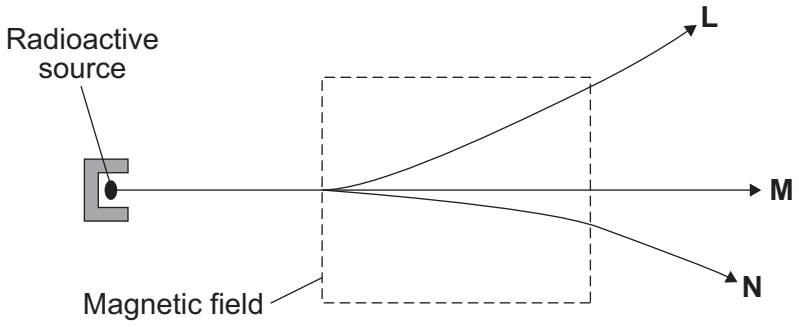
3 beta particles only.

4 gamma rays only.

4.6.2.4 Uses and applications of electromagnetic waves

Question 116 · continued

6C The diagram shows three types of radiation, **L**, **M** and **N**, from a radioactive source. They are passing through a magnetic field.



Radiation **N** is deflected less than radiation **L** and in the opposite direction.

This is because radiation **N** consists of particles which . . .

1 have a smaller mass than **L** and the same charge.

2 have a bigger mass than **L** and the same charge.

3 have a smaller mass than **L** and the opposite charge.

4 have a bigger mass than **L** and the opposite charge.

6D Which row in the table correctly identifies the three types of radiation emitted by radioactive materials?

	Alpha	Beta	Gamma
1	an electron	a helium nucleus	an electromagnetic wave
2	a helium nucleus	an electromagnetic wave	an electron
3	a helium nucleus	an electron	an electromagnetic wave
4	an electron	an electromagnetic wave	an electron

4.6.2.4 Uses and applications of electromagnetic waves

Question 117

June 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

The transmission of television programmes in all areas of the UK is changing from using analogue signals to using digital signals.

8A Which row in the table correctly describes digital signals?

1	continuously variable	can be easily processed by computers
2	continuously variable	cannot be easily processed by computers
3	discrete values only	can be easily processed by computers
4	discrete values only	cannot be easily processed by computers

8B Cable television transmission sends signals along optical fibres made from glass.

One of the reasons for using these fibres is that . . .

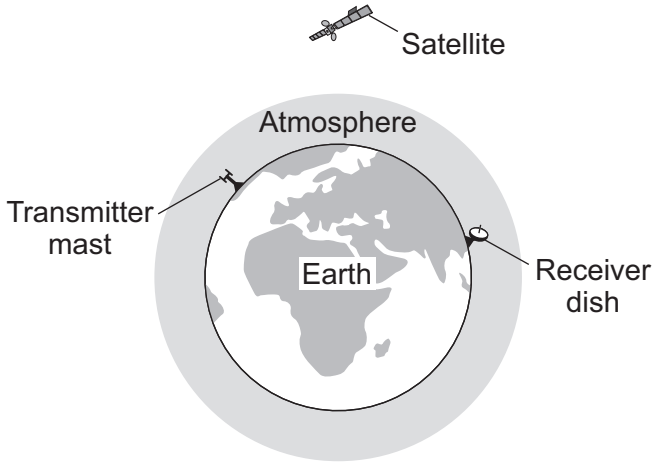
1 radio waves travel faster in glass than they do in air.

2 radio waves can be reflected inside the fibre so that the signal can go round corners.

3 visible light can travel through the walls of the fibre, just as it does through a window.

4 visible light can be reflected inside the fibre so that the signal can go round corners.

8C Satellite television programmes are transmitted from one side of the Earth to the other side.



4.6.2.4 Uses and applications of electromagnetic waves

Question 117 · continued

Which row in the table correctly describes the type of electromagnetic wave used and the reason for using this type of wave?

	Type of electromagnetic wave	Reason for use
1	microwaves	can travel in a curved path
2	microwaves	can pass through the Earth's atmosphere
3	radio waves	can travel in a curved path
4	radio waves	can pass through the Earth's atmosphere

8D Digital signals are better than analogue signals for transmitting satellite television programmes because . . .

1 they travel at a higher speed in a vacuum.

2 they spread out in all directions from the transmitter.

3 they are less prone to distortion by interference.

4 when amplified, any interference they have picked up is not amplified.

4.6.2.4 Uses and applications of electromagnetic waves

Question 118

June 2011 | PHY1H | Original Q5 | Legacy

5 LOFAR is a new type of telescope designed to observe the lowest frequency radio waves. It consists of thousands of simple radio antennae linked to a super-computer. This combines all the signals to give a single output.

5 (a) (i) Give **one** reason, apart from its physical size, why a telescope such as LOFAR is positioned on the Earth and not on a satellite in space.

.....

.....

(1 mark)

5 (a) (ii) Why are the analogue signals from the antennae converted into digital signals before being sent to the computer?

.....

.....

(1 mark)

5 (b) One of the main purposes of the LOFAR telescope is to study the period of time a few hundred thousand years after the big bang. This is done by measuring the *red-shift* of the waves emitted by hydrogen atoms in very distant galaxies.

5 (b) (i) What is *red-shift*?

.....

.....

(1 mark)

5 (b) (ii) The LOFAR telescope has a sensitivity 20 times greater than other radio telescopes.

What does this statement mean?

.....

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 118 · continued

5 (b) (iii) The Ancient Greeks believed that the Universe went on forever; it never changed and had no beginning. It had always existed.

How are the ideas put forward by the big bang theory different from the beliefs of the Ancient Greeks?

.....

.....

.....

.....

(2 marks)

5 (c) Some scientists are using the LOFAR super-computer for Earth based investigations. For example, to study the effect of natural gas extraction on ground levels in the Netherlands.

Suggest **one** positive benefit of developing technologies that can be used by many different groups of scientists.

.....

.....

(1 mark)

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 119

November 2011 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

The frequencies of the waves in the electromagnetic spectrum can be grouped into types.

Match types, **A**, **B**, **C** and **D**, with the descriptions **1**–**4** in the table.

A gamma rays

B infra red rays

C radio waves

D ultraviolet rays

1	They have a higher frequency than X-rays.
2	They have a lower frequency than microwaves.
3	They have a lower frequency than visible light but a higher frequency than microwaves.
4	They have a lower frequency than X-rays but a higher frequency than visible light.

4.6.2.4 Uses and applications of electromagnetic waves

Question 120

November 2011 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

X-rays are useful for obtaining images of internal parts of the body. However, there are dangers from exposure to X-rays.

3A Why is exposure to X-rays dangerous?

1 X-rays are poisonous.

2 X-rays can damage cells.

3 Your body can store up X-rays.

4 Your body becomes immune to X-rays.

3B There is a maximum dose of radiation from X-rays that you should not exceed each year.

The table shows the percentage of this maximum that you receive from X-ray scans of different parts of the body.

Part of the body being X-rayed	Percentage of maximum yearly allowed dose
Chest	5
Teeth	1
Pelvis	24
Spine	40

What is the best way to display the data in the table?

1 a bar chart, because one of the variables is categoric

2 a bar chart, because both of the variables are continuous

3 a line graph, because one of the variables is categoric

4 a line graph, because both of the variables are continuous

3C A patient has two chest X-rays and one spine X-ray taken in one year.

How much of the maximum yearly allowed dose has he received?

1 45 %

2 50 %

3 70 %

4 85 %

3D A dentist taking an X-ray of a patient's teeth needs to protect himself from the radiation.

He does this by . . .

1 taking no more than 1000 X-rays in a year.

2 operating the X-ray machine from outside the room.

3 making sure that the patient wears a lead apron.

4 wearing special gloves.

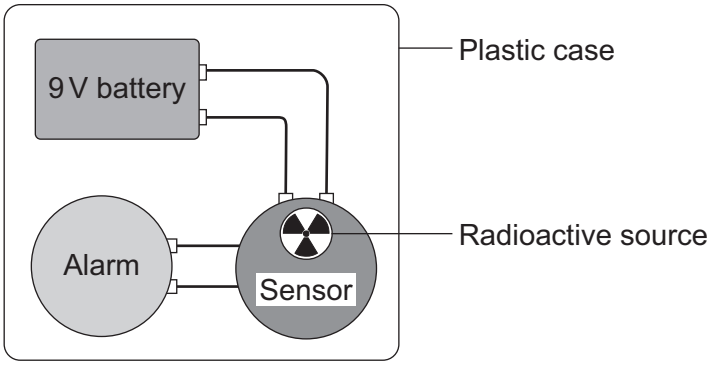
4.6.2.4 Uses and applications of electromagnetic waves

Question 121

November 2011 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

The diagram shows the parts of a smoke detector. The radioactive source emits alpha particles.



The alpha particles ionise the air inside the sensor, which causes a small electric current. Any smoke getting into the sensor will absorb alpha particles. This reduces the current. The change in current sets off the alarm.

7A A source that emits alpha particles will not harm people in the same room as the detector.

This is because alpha particles . . .

1 do not damage human cells.

2 are highly ionising.

3 will not pass through the plastic case.

4 are deflected by the Earth's magnetic field.

7B The smoke detector would **not** work if a radioactive source that emitted only gamma rays was used.

This is because gamma rays . . .

1 would pass through the plastic case.

2 would not ionise the air inside the sensor sufficiently.

3 travel through the air at the same speed as light.

4 would be affected by the battery.

Question 121 · continued

7C An alpha particle consists of . . .

1 2 electrons and 2 neutrons.

2 2 electrons and 2 protons.

3 2 neutrons and 2 protons.

4 2 neutrons only.

7D The radioactive source has a half-life of about 400 years.

What fraction of the nuclei in the source will have decayed in 1200 years?

1 $\frac{1}{8}$

2 $\frac{1}{3}$

3 $\frac{2}{3}$

4 $\frac{7}{8}$

4.6.2.4 Uses and applications of electromagnetic waves

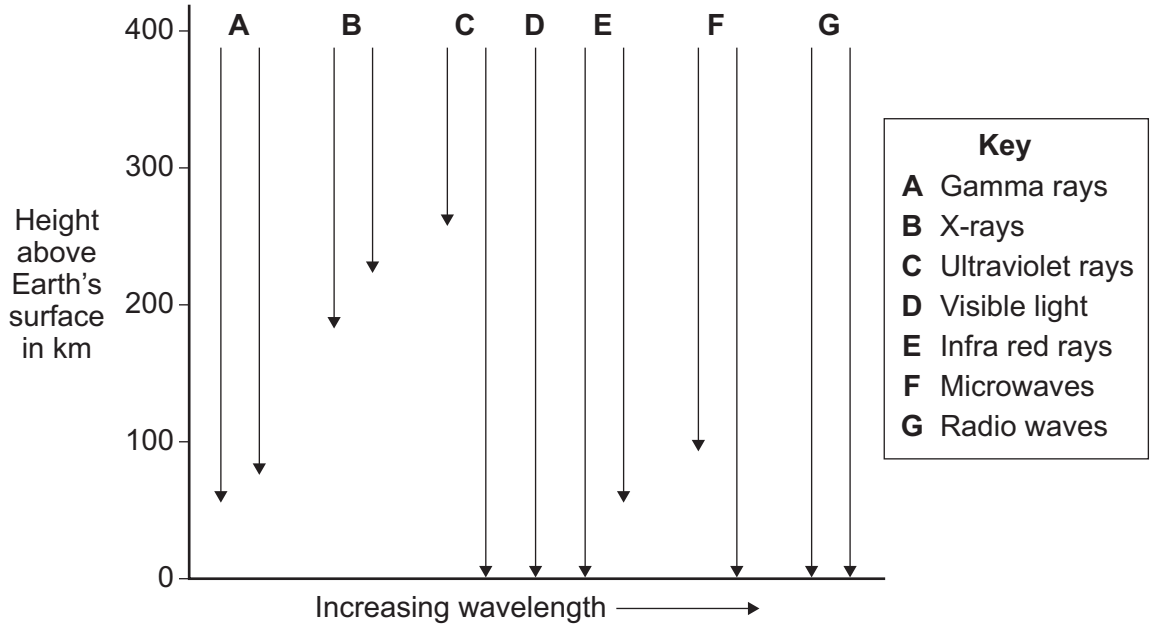
Question 122

November 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a particular type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9A Which one of the following statements is true?

1 Gamma rays penetrate the atmosphere further than all other types of electromagnetic radiation.

2 All frequencies of ultraviolet radiation reach the Earth's surface.

3 No frequencies of radio waves reach the Earth's surface.

4 Higher frequencies of microwaves are completely absorbed by the atmosphere.

9B What would be the minimum height above the Earth for a satellite carrying telescopes designed to detect gamma rays, X-rays and ultraviolet radiation of all wavelengths?

1 50 km

2 70 km

3 180 km

4 260 km

4.6.2.4 Uses and applications of electromagnetic waves

Question 122 · continued

9C Optical telescopes used to observe objects in space are limited because they can be used only . . .

1 as ground-based telescopes.

2 at night.

3 to observe a small region of the electromagnetic spectrum.

4 to observe one region of the sky.

9D Electromagnetic radiation from distant galaxies is very weak and is therefore very difficult to detect.

Some space telescopes use liquid helium to keep scientific instruments at a very low temperature.

Which type of weak electromagnetic radiation would best be detected by instruments kept at a very low temperature?

1 gamma rays

2 X-rays

3 infra red rays

4 ultraviolet rays

END OF TEST

4.6.2.4 Uses and applications of electromagnetic waves

Question 123

June 2012 | PH1HP | Original Q1 | Legacy

1 A wood burning stove is used to heat a room.



The fire in the stove uses wood as a fuel. The fire heats the matt black metal case of the stove.

1 (a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

.....

.....

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 123 · continued

1 (b) Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

.....

Efficiency = ...

(2 marks)

1 (c) Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

.....

(1 mark)

1 (d) Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1 .....

.....

2 .....

.....

(2 marks)

Question 1 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 123 · continued

1 (e) The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

Mass of metal case	100 kg
Starting temperature of metal case	20 °C
Final temperature of metal case	70 °C
Specific heat capacity of metal case	510 J/kg °C

Calculate the energy required to raise the temperature of the metal case to 70 °C.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

.....

Energy required = ...

(3 marks)

10

4.6.2.4 Uses and applications of electromagnetic waves

Question 124

June 2012 | PH1HP | Original Q5 | Legacy

5 Radio waves and microwaves are two types of electromagnetic wave.

Both waves:

- can be used for communications
- travel at the same speed through air.

5 (a) Give **two** more properties that are the same for both radio waves and microwaves.

1 .....

.....

2 .....

.....

(2 marks)

5 (b) Some satellites are used to transmit television programmes. Signals are sent to, and transmitted from, the satellites using microwaves.

What is the property of microwaves that allows them to be used for satellite communications?

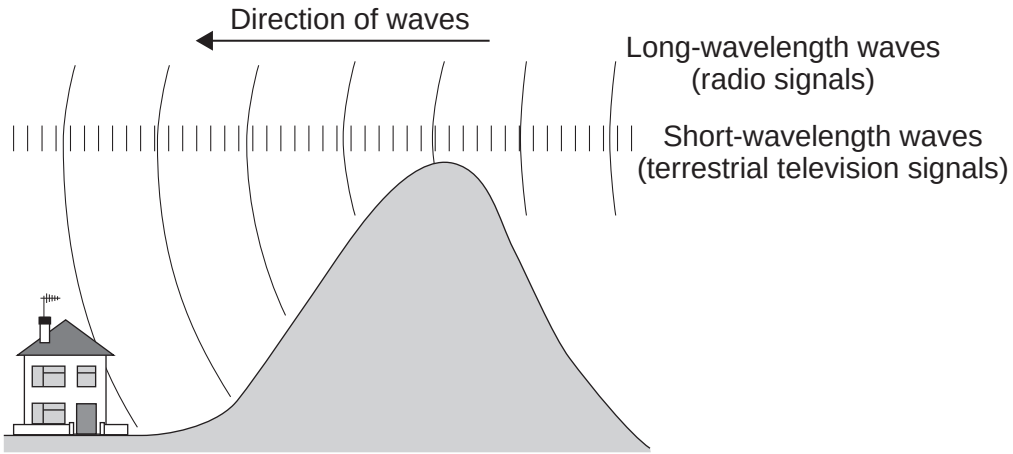
.....

.....

(1 mark)

5 (c) Terrestrial television does not use satellites.

Terrestrial television signals and radio signals both use radio waves.
Radio signals are transmitted at a longer wavelength than terrestrial television signals.



4.6.2.4 Uses and applications of electromagnetic waves

Question 124 · continued

In hilly areas it may be possible to receive radio signals but not receive terrestrial television signals.

Explain why.

.....

.....

.....

.....

.....

.....

(3 marks)

5 (d) Electromagnetic waves travel at a speed of 3.0×10^8 m/s.
A radio station transmits waves with a wavelength of 2.5×10^2 m.

Calculate the frequency of the radio waves.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Frequency = ...

(3 marks)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 125

June 2012 | PH1HP | Original Q8 | Legacy

8 (a) The 'Big Bang' theory uses red-shift as evidence to explain the beginning of the Universe.

How does the red-shift from distant galaxies provide evidence for the beginning of the Universe?

.....

.....

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.....

.....

.....

(3 marks)

8 (b) Cosmic microwave background radiation (CMBR) is a type of electromagnetic radiation. CMBR fills the Universe. It was first discovered in 1965 by two astronomers called Penzias and Wilson.

8 (b) (i) What do scientists believe is the origin of CMBR?

.....

.....

(1 mark)

8 (b) (ii) Why was the discovery of CMBR so important to the scientists believing the 'Big Bang' theory to be correct?

.....

.....

(1 mark)

8 (b) (iii) How is the wavelength of CMBR likely to change, if at all, over the next billion years?

.....

Give a reason for your answer.

.....

.....

(2 marks)

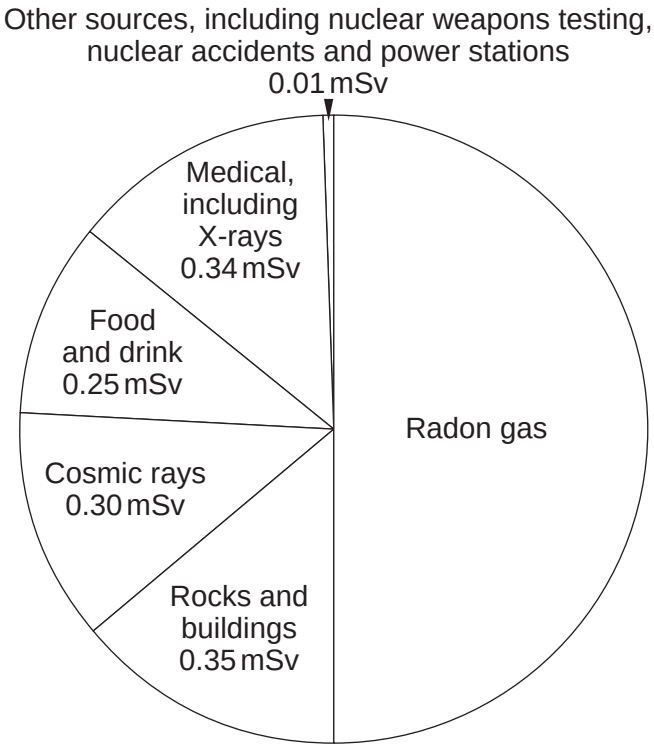
4.6.2.4 Uses and applications of electromagnetic waves

Question 126

June 2012 | PH2HP | Original Q2 | Legacy

2 The pie chart shows the sources of the background radiation and the radiation doses that the average person in the UK is exposed to in one year.

Radiation dose is measured in millisieverts (mSv).



2 (a) (i) What is the radiation dose that the average person in the UK receives from radon gas?

.....

.....

Radiation dose from radon gas = ... mSv

(1 mark)

2 (a) (ii) A person may receive a higher than average dose of radiation from background sources.

Suggest **two** reasons why.

1 .....

.....

2 .....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 126 · continued

2 (b) Exposure to radon gas can cause lung cancer.
A recent study has compared the risk of getting lung cancer, by the age of 75 years, for cigarette smokers and non-smokers.
The people in the study had been exposed throughout their lives to different levels of radon gas.
A summary of the data produced from the study is given in the table.

Exposure to radon gas	Risk of lung cancer by age of 75	
	Non-smoker	Smoker
No exposure	0.4%	10%
Moderate exposure	1.0%	14%
Very high exposure	1.5%	32%

2 (b) (i) Why were people that have had **no exposure** to radon gas included in the study?

.....

.....

(1 mark)

2 (b) (ii) Using information from the table, what conclusions can be made about exposure to radon gas and the risk of getting lung cancer?

.....

.....

.....

.....

.....

(2 marks)

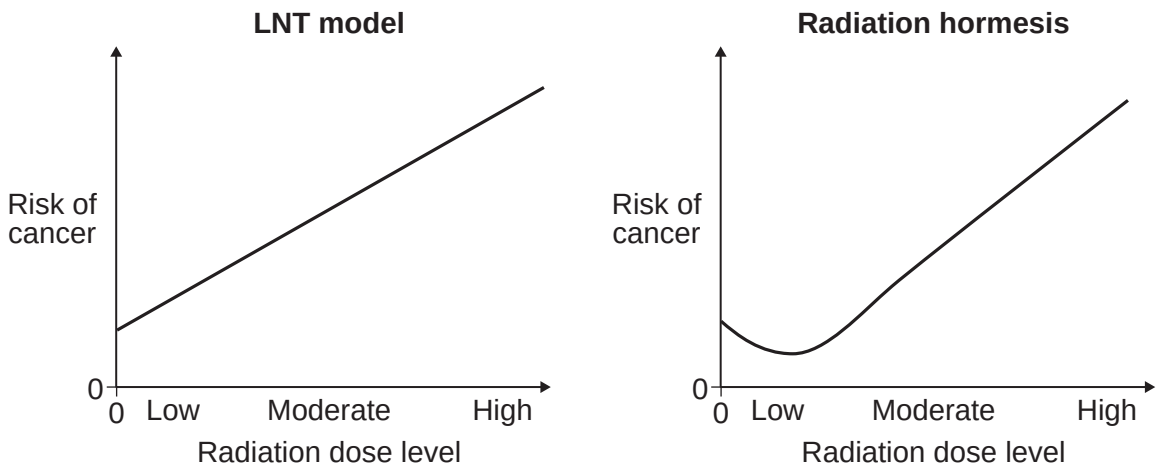
Question 2 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 126 · continued

2 (c) At the moment, the regulations designed to protect people from over-exposure to radiation are based on a model called the 'linear no-threshold' (LNT) model.
Some scientists believe that the LNT model is too simple. These scientists believe that at low radiation levels a process called 'radiation hormesis' happens.

The graphs show that each model suggests a link between the risk of developing a cancer and exposure to low levels of radiation.



The link between the risk of developing cancer and exposure to low levels of radiation suggested by each of the models is different.

Describe how.

.....

.....

.....

.....

.....

(2 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 126 · continued

2 (d) Scientists have conducted experiments in which mice have been exposed to different levels of radiation. The number of mice developing a cancer has then been measured.

Discuss whether it is ethical to use animals in scientific experiments.

.....

.....

.....

.....

.....

(2 marks)

10

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

Question 127

January 2013 | PH1HP | Original Q5 | Legacy

5 Galaxies emit all types of electromagnetic wave.

5 (a) (i) Which type of electromagnetic wave has the shortest wavelength?

.....

(1 mark)

5 (a) (ii) State **one** difference between an ultraviolet wave and a visible light wave.

.....

.....

(1 mark)

5 (b) Electromagnetic waves travel through space at a speed of 3.0×10^8 m/s.

The radio waves emitted from a distant galaxy have a wavelength of 25 metres.

Calculate the frequency of the radio waves emitted from the galaxy and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Frequency = ...

(3 marks)

5 (c) Scientists use a radio telescope to measure the wavelength of the radio waves emitted from the galaxy in part **(b)** as the waves reach the Earth. The scientists measure the wavelength as 25.2 metres. The effect causing this observed increase in wavelength is called red-shift.

5 (c) (i) The waves emitted from most galaxies show red-shift.

What does red-shift tell scientists about the direction most galaxies are moving?

.....

.....

(1 mark)

4.6.2.4 Uses and applications of electromagnetic waves

Question 127 · continued

5 (c) (ii) The size of the red-shift is **not** the same for all galaxies.

What information can scientists find out about a galaxy when they measure the size of the red-shift the galaxy produces?

.....

.....

.....

.....

(2 marks)

5 (c) (iii) What does the observation of red-shift suggest is happening to the Universe?

.....

.....

(1 mark)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 128

June 2013 | PH1HP | Original Q7 | Legacy

7 (a) Electromagnetic waves form a continuous spectrum with a range of wavelengths.

What is the approximate range of wavelengths of electromagnetic waves?

Tick (✓) **one** box.

10^{-15} metres to 10^{4} metres ☐

10^{-4} metres to 10^{15} metres ☐

10^{-6} metres to 10^{6} metres ☐

(1 mark)

7 (b) Infrared waves and microwaves are used for communications.

7 (b) (i) Give **one** example of infrared waves being used for communication.

.....

.....

(1 mark)

7 (b) (ii) A mobile phone network uses microwaves to transmit signals through the air. The microwaves have a frequency of 1.8×10^{9} Hz and travel at a speed of 3.0×10^{8} m/s.

Calculate the wavelength of the microwaves.

Use the correct equation from the Physics Equations Sheet.

Give your answer to **two** significant figures.

.....

.....

.....

Wavelength = ... m

(3 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 128 · continued

7 (c) Some scientists suggest there is a possible link between using a mobile phone and male fertility.

The results of their study are given in the table.

Mobile phone use in hours per day	Sperm count in millions of sperm cells per cm^3 of semen
0	86
less than 2	69
2 – 4	59
more than 4	50

The results show a negative correlation: the more hours a mobile phone is used each day, the lower the sperm count. However, the results do **not** necessarily mean using a mobile phone causes the reduced sperm count.

Suggest **one** reason why.

.....

.....

(1 mark)

6

4.6.2.4 Uses and applications of electromagnetic waves

Question 129

June 2013 | PH1HP | Original Q8 | Legacy

8 (a) Observation of the spectra from distant galaxies provides evidence to support the 'Big Bang' theory.

8 (a) (i) Complete the following sentence.

Many scientists think that the 'Big Bang' theory describes the .....

..... .

(1 mark)

8 (a) (ii) Tick (✓) **one** box to complete the sentence.

The discovery of cosmic microwave background radiation was important

because it …

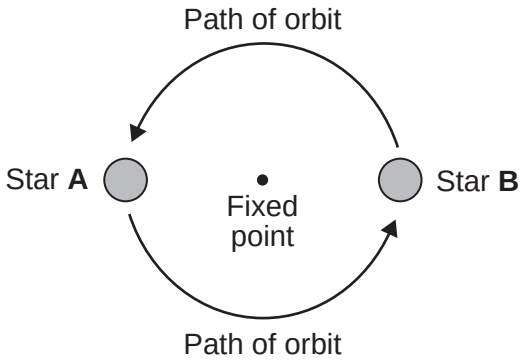
proved the 'Big Bang' theory to be correct. ☐

provided more evidence to support the 'Big Bang' theory. ☐

proved the Universe will continue to expand forever. ☐

(1 mark)

8 (b) Many stars are part of a binary star system. Binary star systems have two stars.

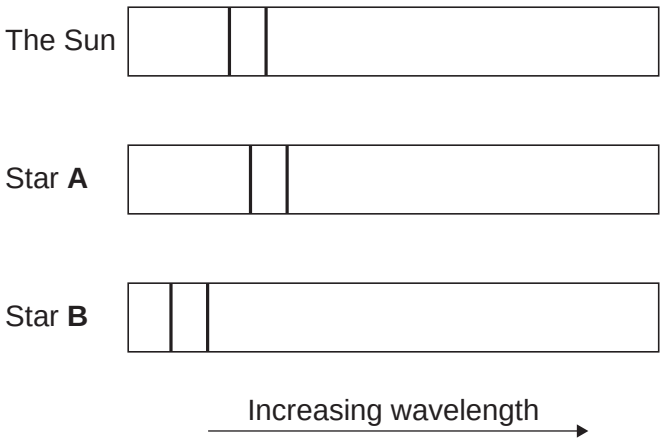


The visible spectrum from stars includes dark lines. These lines are at specific wavelengths.

4.6.2.4 Uses and applications of electromagnetic waves

Question 129 · continued

The diagram shows the position of two dark lines in the spectrum from the Sun. It also shows the same lines in the spectra from two stars **A** and **B** in a binary star system at the same point in time.



8 (b) (i) What name is given to the effect shown in the spectrum from star **A**?

.....

(1 mark)

8 (b) (ii) Scientists have concluded that the two stars in a binary star system orbit around a fixed point between the two stars.

A comparison of the spectra from the two stars in a binary star system provides evidence to support this conclusion.

Explain how.

.....

.....

.....

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.....

.....

.....

(3 marks)

6

4.6.2.4 Uses and applications of electromagnetic waves

Question 130

June 2013 | PH3HP | Original Q3 | Legacy

3 Ultrasound and X-rays are waves used in hospitals to create images of the inside of the human body. To produce the images below, the waves must enter the human body.

Ultrasound scan of an unborn child



X-ray of a broken bone



3 (a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Describe the features of ultrasound and X-rays, and what happens to each type of wave after it has entered the human body.

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(6 marks)

4.6.2.4 Uses and applications of electromagnetic waves

Question 130 · continued

3 (b) It would **not** be safe to use X-rays to produce an image of an unborn child.

Explain why.

.....

.....

.....

.....

(2 marks)

3 (c) Ultrasound can be used for medical treatments as well as for imaging.

Give **one** use of ultrasound for medical treatment.

.....

.....

(1 mark)

9

4.6.2.4 Uses and applications of electromagnetic waves

Question 131

June 2014 | PH2HP | Original Q6 | Legacy

6 (a) There are many isotopes of the element molybdenum (Mo).

What do the nuclei of different molybdenum isotopes have in common?

[1 mark]

.....

6 (b) The isotope molybdenum-99 is produced inside some nuclear power stations from the nuclear fission of uranium-235.

6 (b) (i) What happens during the process of nuclear fission?

[1 mark]

.....

.....

6 (b) (ii) Inside which part of a nuclear power station would molybdenum be produced?

[1 mark]

.....

6 (c) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.

$$^{99}_{42}\text{Mo} \longrightarrow {}^{99}_{43}\text{Tc} + \text{Radiation}$$

What type of radiation is emitted by molybdenum-99?

[2 marks]

.....

Give a reason for your answer.

.....

.....

Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 131 · continued

6 (d) Technetium-99 has a short half-life and emits gamma radiation.

What is meant by the term 'half-life'?

[1 mark]

.....

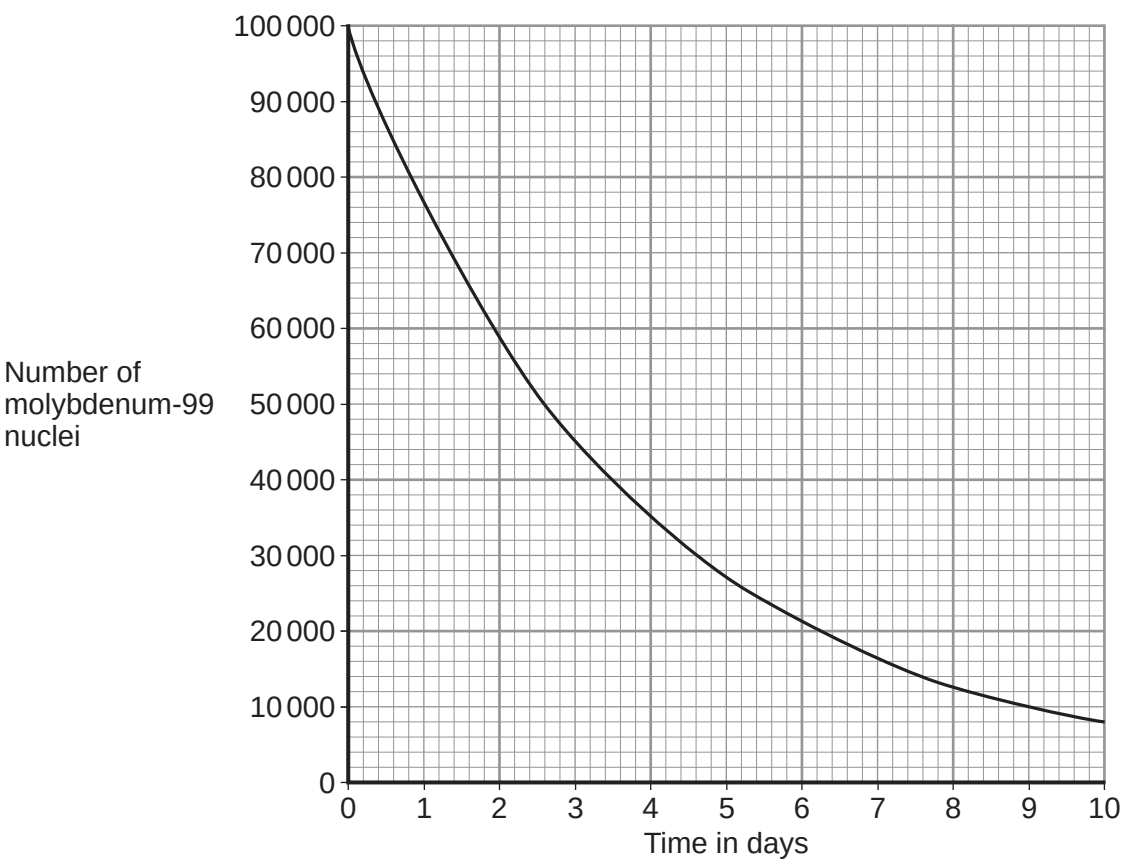
.....

.....

6 (e) Technetium-99 is used by doctors as a medical tracer. In hospitals it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.

6 (e) (i) **Figure 7** shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.

Figure 7



4.6.2.4 Uses and applications of electromagnetic waves

Question 131 · continued

A technetium generator will continue to produce sufficient technetium-99 until 80% of the original molybdenum nuclei have decayed.

After how many days will a source of molybdenum-99 inside a technetium-99 generator need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

[2 marks]

.....

.....

.....

Number of days = ...

6 (e) (ii) Medical tracers are injected into a patient's body; this involves some risk to the patient's health.

Explain the risk to the patient of using a radioactive substance as a medical tracer.

[2 marks]

.....

.....

.....

.....

6 (e) (iii) Even though there may be a risk, doctors frequently use radioactive substances for medical diagnosis and treatments.

Suggest why.

[1 mark]

.....

.....

11

4.6.2.4 Uses and applications of electromagnetic waves

Question 132

June 2014 | PH3HP | Original Q1 | Legacy

1 (a) What is ultrasound?

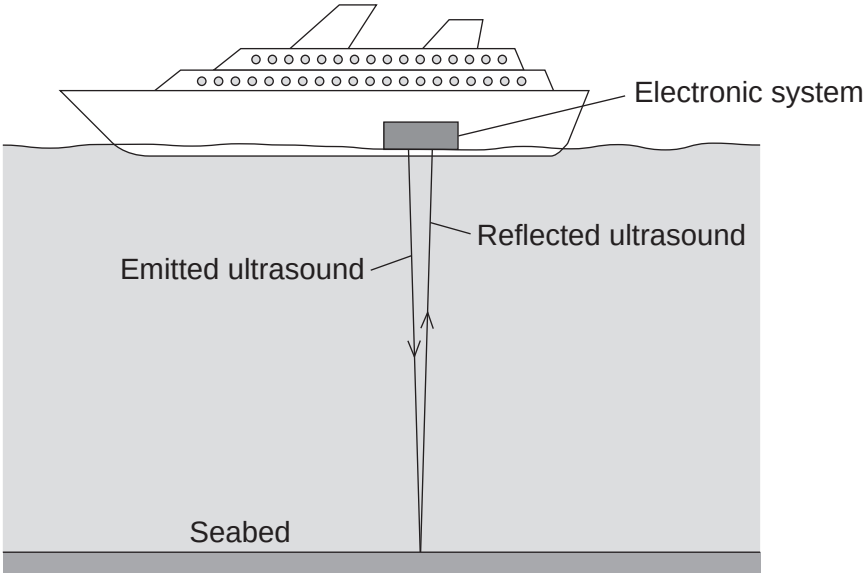
[1 mark]

.....

.....

1 (b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m/s

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

Depth of water = ... metres

4.6.2.4 Uses and applications of electromagnetic waves

Question 132 · continued

1 (c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

[1 mark]

.....

1 (d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2



State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

[2 marks]

Advantage of CT scanning .....

.....

.....

Disadvantage of CT scanning .....

.....

.....

7

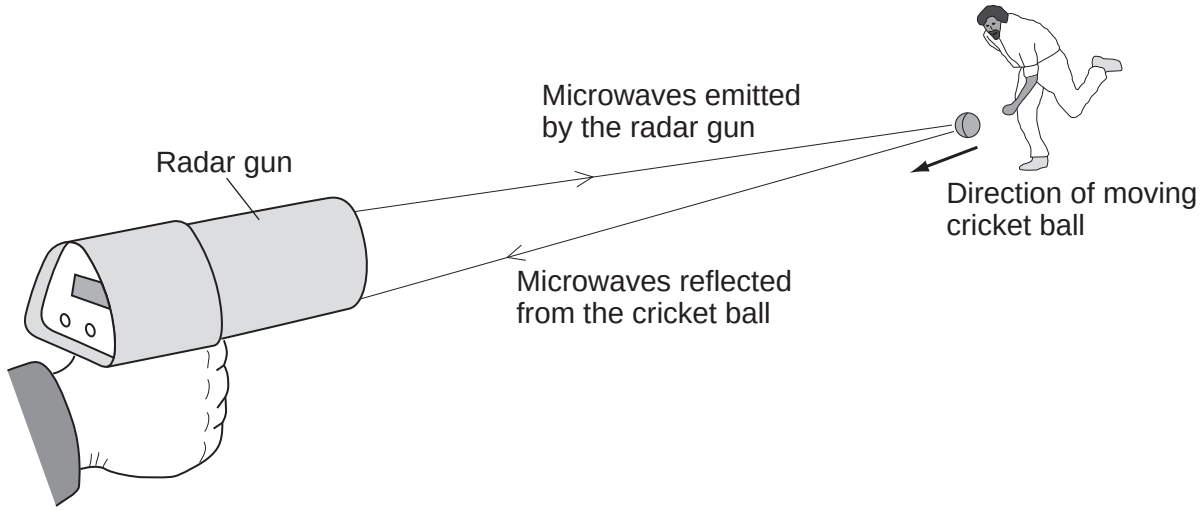
4.6.2.4 Uses and applications of electromagnetic waves

Question 133

June 2015 | PH1HP | Original Q6 | Legacy

6 A radar gun is used to determine the speed of a cricket ball during a cricket match. The radar gun emits a beam of microwaves. The microwaves are reflected from the moving ball, as shown in **Figure 6**.

Figure 6



Comparing the microwaves emitted by the radar gun with the microwaves reflected from the cricket ball enables the speed of the ball to be determined.

6 (a) What is the name given to the effect used to determine the speed of the cricket ball?

[1 mark]

.....

6 (b) Compare the wavelength, frequency and speed of the **reflected** microwaves with the wavelength, frequency and speed of the microwaves emitted by the radar gun.

[3 marks]

.....

.....

.....

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.....

.....

4

4.6.2.4 Uses and applications of electromagnetic waves

Question 134

June 2015 | PH3HP | Original Q3 | Legacy

3 (a) Complete the following sentences.

[2 marks]

Ultrasound waves have a minimum frequency

of ..... hertz.

The wavelength of an X-ray is about the same as

the diameter of ..... .

3 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Figure 5 shows one medical use of ultrasound and one medical use of X-rays.

Figure 5





Compare the medical uses of ultrasound and X-rays.

Your answer should include the risks, if any, and precautions, if any, associated with the use of ultrasound and X-rays.

[6 marks]

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4.6.2.4 Uses and applications of electromagnetic waves

Question 135

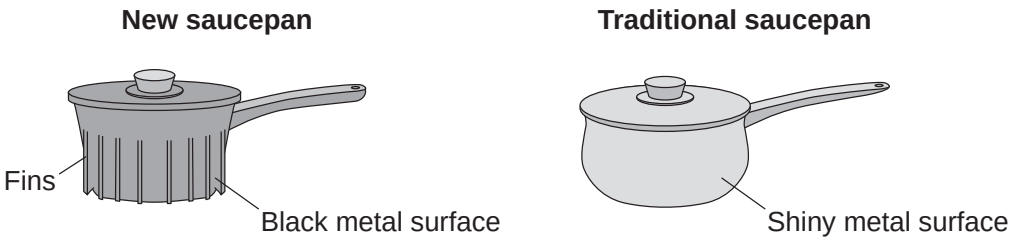
June 2016 | PH1HP | Original Q3 | Legacy

3 (a) Heating food in a saucepan over a gas flame is inefficient.
Suggest why.

[2 marks]

3 (b) A new saucepan has been designed that heats up food much faster than a traditional saucepan. **Figure 4** shows the two saucepans.

Figure 4



Describe how the features of the new saucepan cause the food to heat up faster than when the food is heated in the traditional saucepan.

[2 marks]

Fins

Black metal surface

3 (c) State the relationship between the temperature of the saucepan and the rate at which the saucepan emits infrared radiation.

[1 mark]

5

4.6.2.4 Uses and applications of electromagnetic waves

Question 136

June 2016 | PH1HP | Original Q4 | Legacy

4 Infrared and microwaves are two types of electromagnetic radiation.

4 (a) (i) State **one** example of the use of each type of radiation for communication.

[2 marks]

Infrared: _____

Microwaves: _____

4 (a) (ii) Some of the properties of infrared and microwaves are the same.

State **two** of these properties.

[2 marks]

1 _____

_____

2 _____

_____

4 (b) In 1964, physicists discovered microwave radiation that filled the universe.

4 (b) (i) Name this type of radiation.

[1 mark]

_____

4 (b) (ii) State the importance of this discovery made by the physicists.

[1 mark]

_____

_____

6

4.6.2.4 Uses and applications of electromagnetic waves

Question 137

June 2016 | PH2HP | Original Q2 | Legacy

2 Alpha particles, beta particles and gamma rays are types of nuclear radiation.

2 (a) Describe the structure of an alpha particle.

[1 mark]

2 (b) Nuclear radiation can change atoms into ions by the process of ionisation.

2 (b) (i) Which type of nuclear radiation is the least ionising?

[1 mark]

Tick (✓) **one** box.

alpha particles ☐ beta particles ☐ gamma rays ☐

2 (b) (ii) What happens to the structure of an atom when the atom is ionised?

[1 mark]

2 (c) People working with sources of nuclear radiation risk damaging their health.

State **one** precaution these people should take to reduce the risk to their health.

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 137 · continued

2 (d) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

The type of radiation emitted from a radioactive source can be identified by comparing the properties of the radiation to the properties of alpha, beta and gamma radiation.

Describe the properties of alpha, beta and gamma radiation in terms of their:

- penetration through materials
- range in air
- deflection in a magnetic field.

[6 marks]

Extra space

10

4.6.2.4 Uses and applications of electromagnetic waves

Question 138

June 2016 | PH2HP | Original Q6 | Legacy

6 (a) Brown dwarf stars are thought to have been formed in the same way as other stars.
They are too small for nuclear fusion reactions to take place in them.
Brown dwarf stars emit infrared radiation but are not hot enough to emit visible light.

6 (a) (i) Describe how a star is formed.

[2 marks]

6 (a) (ii) Describe the process of nuclear fusion.

[1 mark]

6 (a) (iii) Scientists predicted that brown dwarf stars existed before the first one was discovered in 1995.

Suggest **one** reason why scientists are now able to observe and identify brown dwarf stars.

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 138 · continued

6 (b) In the 18th century some scientists suggested a theory about how the planets formed in the Solar System. The theory was that after the Sun formed, there were cool discs of matter rotating around the Sun. These cool discs of matter formed the planets. The scientists thought this must have happened around other stars too.

6 (b) (i) Thinking about this theory, what would the scientists have predicted to have been formed in other parts of the Universe?

[1 mark]

6 (b) (ii) Since the 1980s scientists studying young stars have shown the stars to be surrounded by cool discs of rotating matter.

What was the importance of these observations to the theory the scientists suggested in the 18th century?

[1 mark]

6 (c) The Earth contains elements heavier than iron.

Why is the presence of elements heavier than iron in the Earth evidence that the Solar System was formed from material produced after a massive star exploded?

[1 mark]

7

4.6.2.4 Uses and applications of electromagnetic waves

Question 139

June 2016 | PH3HP | Original Q3 | Legacy

3 X-rays and ultrasound can both be used for scanning internal organs.

3 (a) Ultrasound is used to scan unborn babies but X-rays are **not** used to scan unborn babies.

Explain why.

[3 marks]

3 (b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image.

Describe how.

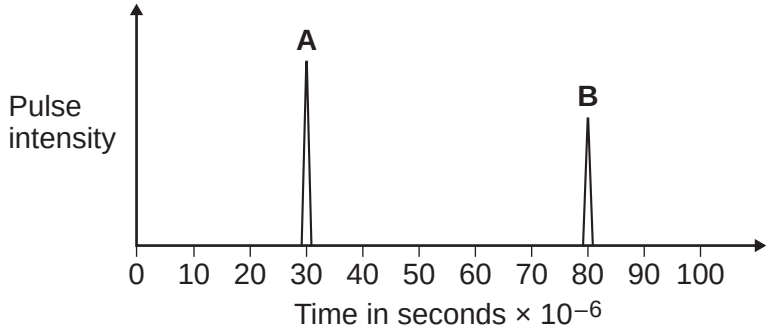
[2 marks]

4.6.2.4 Uses and applications of electromagnetic waves

Question 139 · continued

3 (c) **Figure 4** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled **A**. The returning pulse picked up by the receiver is labelled **B**.

Figure 4



The closest distance between the unborn baby and the mother's skin is 4.0 cm.
Use information from **Figure 4** to calculate the average speed of the pulse.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Average speed = _____ m/s

Question 3 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 139 · continued

3 (d) **Figure 5** shows an X-ray of an arm with a broken bone.

Figure 5



3 (d) (i) Describe how X-rays are able to produce an image of bones.

[3 marks]

_____

_____

_____

_____

_____

_____

3 (d) (ii) Complete the following sentence.

X-rays are able to produce detailed images because their wavelength

is very _____ .

[1 mark]

12

4.6.2.4 Uses and applications of electromagnetic waves

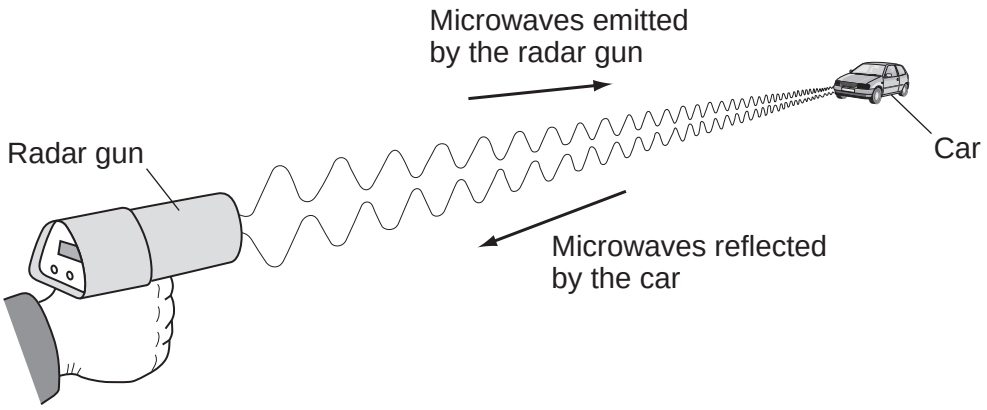
Question 140

June 2017 | PH1HP | Original Q4 | Legacy

4 A radar gun can be used to measure the speed of a car.

Microwaves are emitted by the radar gun and reflected by the car, as shown in **Figure 4**.

Figure 4



4 (a) The microwaves reflected by the moving car have a different frequency from the microwaves emitted by the radar gun.

What is the name of the effect causing this change in frequency?

[1 mark]

_____

4 (b) The data in **Table 2** are measurements taken from three different cars on the same piece of road.

Table 2

Car	Frequency of emitted microwaves in kHz	Frequency of reflected microwaves in kHz
A	27 000 000	27 000 002
B	27 000 000	27 000 000
C	27 000 000	26 999 997

4.6.2.4 Uses and applications of electromagnetic waves

Question 140 · continued

4 (b) (i) State which car in **Table 2** is moving towards the radar gun. Give a reason for your answer.

[2 marks]

Car _____

Reason _____

_____

4 (b) (ii) State which car in **Table 2** is moving the fastest. Give a reason for your answer.

[2 marks]

Car _____

Reason _____

_____

5

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

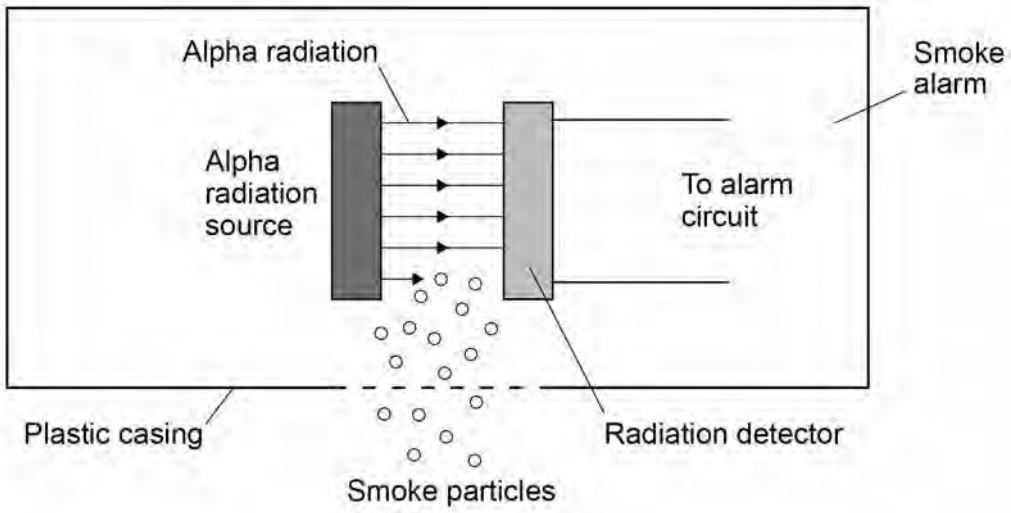
Question 141

June 2018 | 8463/1H | Original Q6

0 6 Smoke alarms contain an alpha radiation source and a radiation detector.

Figure 9 shows part of the inside of a smoke alarm.

Figure 9



0 6 . 1 The smoke alarm stays off while alpha radiation reaches the detector.

Why does the alarm switch on when smoke particles enter the plastic casing?

[1 mark]

0 6 . 2 Why is it safe to use a source of alpha radiation in a house?

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 141 · continued

0 6 . 3 The smoke alarm would not work with a radiation source that emits beta or gamma radiation.

Explain why.

[2 marks]

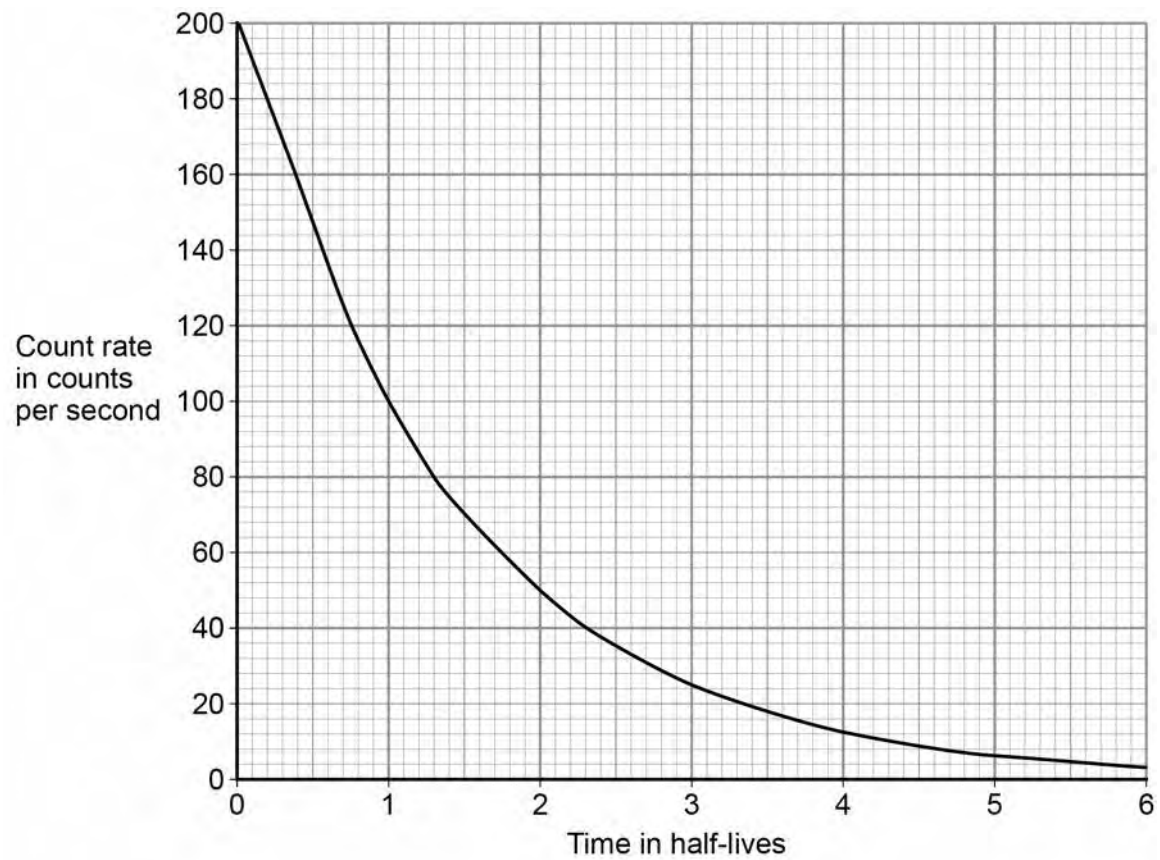
Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 141 · continued

0 6 . 4 **Figure 10** shows how the count rate detected from the radiation source in the smoke alarm changes with time.

Figure 10



The smoke alarm switches on when the count rate falls to 80 counts per second.

Explain why the radiation source inside the smoke alarm should have a long half-life.

[2 marks]

4.6.2.4 Uses and applications of electromagnetic waves

Question 141 · continued

0 6 . 5 **Figure 11** shows a patient who has been injected with a radioactive source for medical diagnosis.

Figure 11



Explain the ideal properties of a radioactive source for use in medical diagnosis.

[4 marks]

10

4.6.2.4 Uses and applications of electromagnetic waves

Question 142

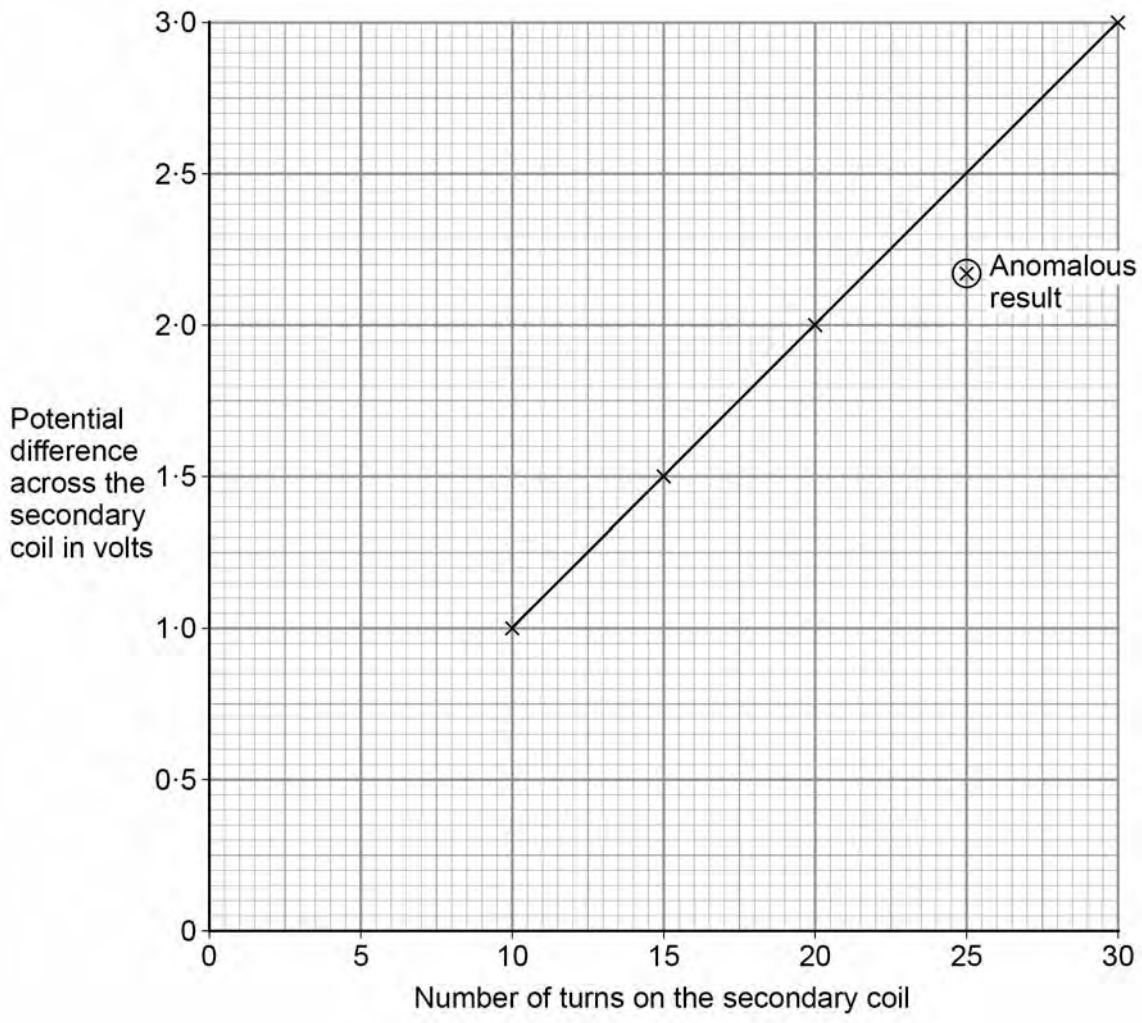
June 2018 | 8463/2H | Original Q7

0 7 A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 12 shows the results collected by the student.

Figure 12



0 7 . 1 **Figure 12** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 142 · continued

0 7 . 2 The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 12** that this happens?

[1 mark]

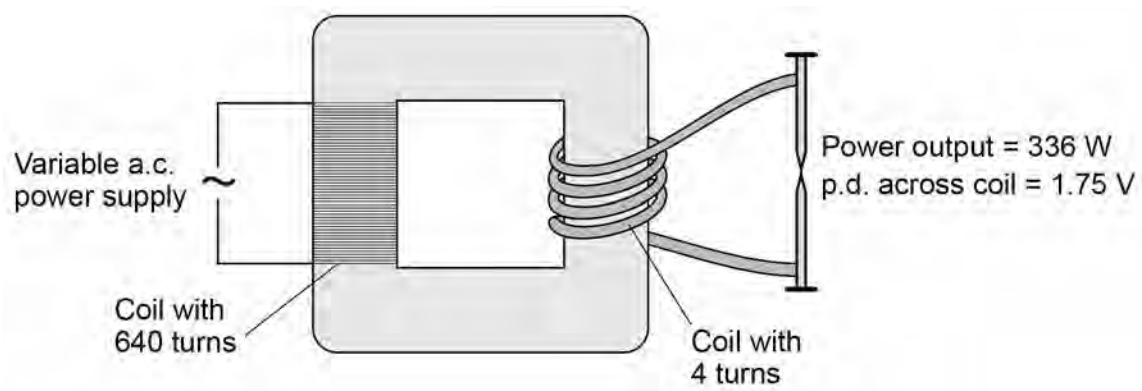
Question 7 continues on the next page

Question 142 · continued

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 13 shows a transformer demonstrating how a large current can heat and join two nails together.

Figure 13



0 7 . 3 How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

[1 mark]

0 7 . 4 Calculate the current from the power supply needed to provide a power output of 336 W.

Use the data in **Figure 13**.

The transformer is 100% efficient.

[5 marks]

Current = _____ A

8

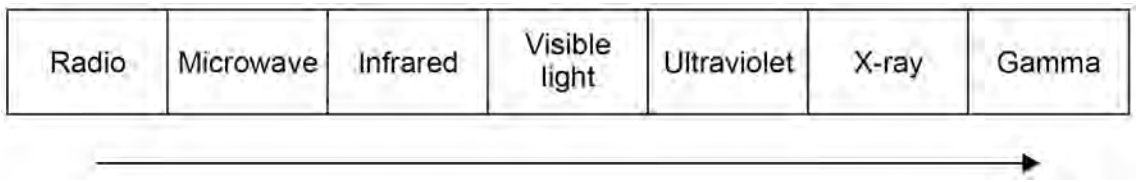
4.6.2.4 Uses and applications of electromagnetic waves

Question 143

June 2019 | 8463/2H | Original Q7

0 7 . 1 **Figure 12** shows the electromagnetic spectrum.

Figure 12



Which statement is correct for the direction of the arrow in **Figure 12**?

[1 mark]

Tick (✓) **one** box.

The wavelength decreases and the wave speed in air increases. ☐

The frequency increases and the wavelength increases. ☐

The frequency increases and the wave speed in air stays the same. ☐

The wavelength increases and the wave speed in air increases. ☐

0 7 . 2 Explain how the properties of X-rays make them suitable for the medical imaging of bones.

[2 marks]

Question 7 continues on the next page

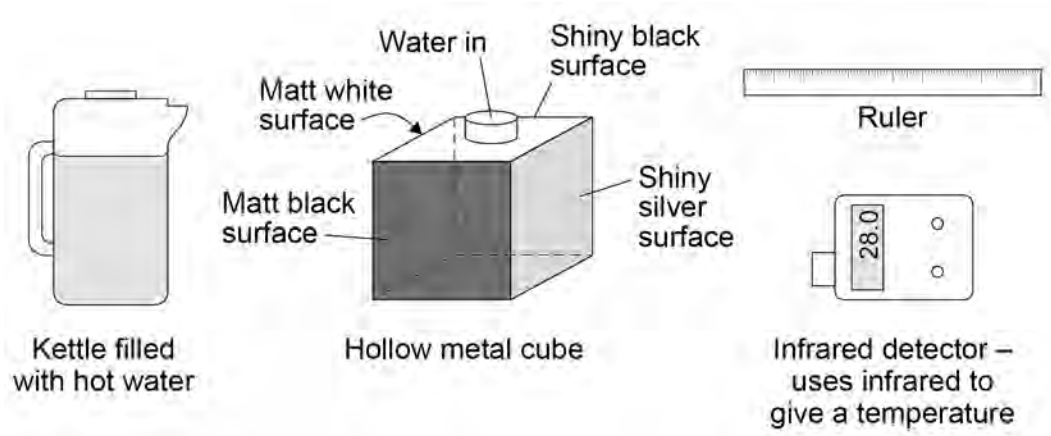
Question 143 · continued

A student investigated the infrared radiation emitted from the sides of a hollow metal cube.

The sides of the cube are different colours or textures.

Figure 13 shows the equipment used.

Figure 13



Boiling water was poured into the cube. The amount of infrared radiation emitted from each vertical surface was then measured.

0 7 . 3 Boiling water is a hazard in this investigation.

Suggest how the risk of harm could be reduced in this investigation.

[1 mark]

0 7 . 4 What is the control variable in this investigation?

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 143 · continued

Table 2 shows the results.

Table 2

Type of surface	Temperature in °C
Matt black	68.0
Matt white	65.5
Shiny black	66.3
Shiny silver	28.0

0 7 . 5 The four temperature values in **Table 2** cannot be used to show that the infrared detector gives precise readings.

Give the reason why.

[1 mark]

0 7 . 6 The student looked at the data in **Table 2** and concluded:

'A black surface always emits more infrared radiation than a white surface.'

Explain how using an infrared detector with a resolution of 1 °C would have affected the student's conclusion.

[2 marks]

4.6.2.4 Uses and applications of electromagnetic waves

Question 143 · continued

Albedo is a measure of the amount of solar radiation reflected by an object compared to the total solar radiation incident on the object.

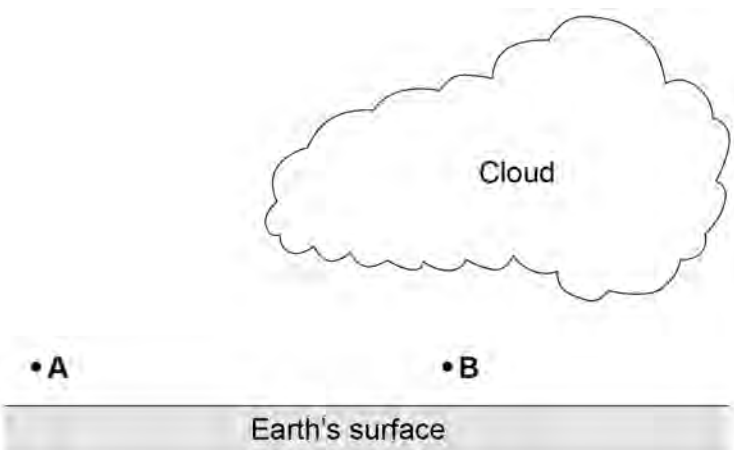
A perfect reflector has an Albedo value of 1.0
A perfect absorber has an Albedo value of 0.0

0 7 . 7 What is the Albedo value of a perfect black body?

[1 mark]

0 7 . 8 **Figure 14** shows two points, **A** and **B**, just above the Earth's surface.

Figure 14



The average Albedo value of the Earth's surface is 0.3
The Albedo value of thick cloud varies between 0.6 and 0.9

At night the air at point **A** cools faster than the air at point **B**.

Explain why.

[3 marks]

12

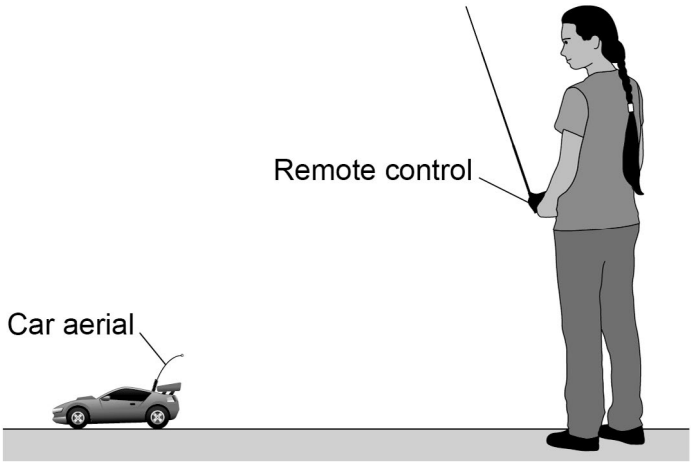
4.6.2.4 Uses and applications of electromagnetic waves

Question 144

November 2020 | 8463/2H | Original Q6

0 6 **Figure 8** shows a student playing with a remote-controlled car.

Figure 8



0 6 . 1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

Wavelength = _____ Unit _____

4.6.2.4 Uses and applications of electromagnetic waves

Question 144 · continued

0 6 . 2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

0 6 . 3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

[2 marks]

1

2

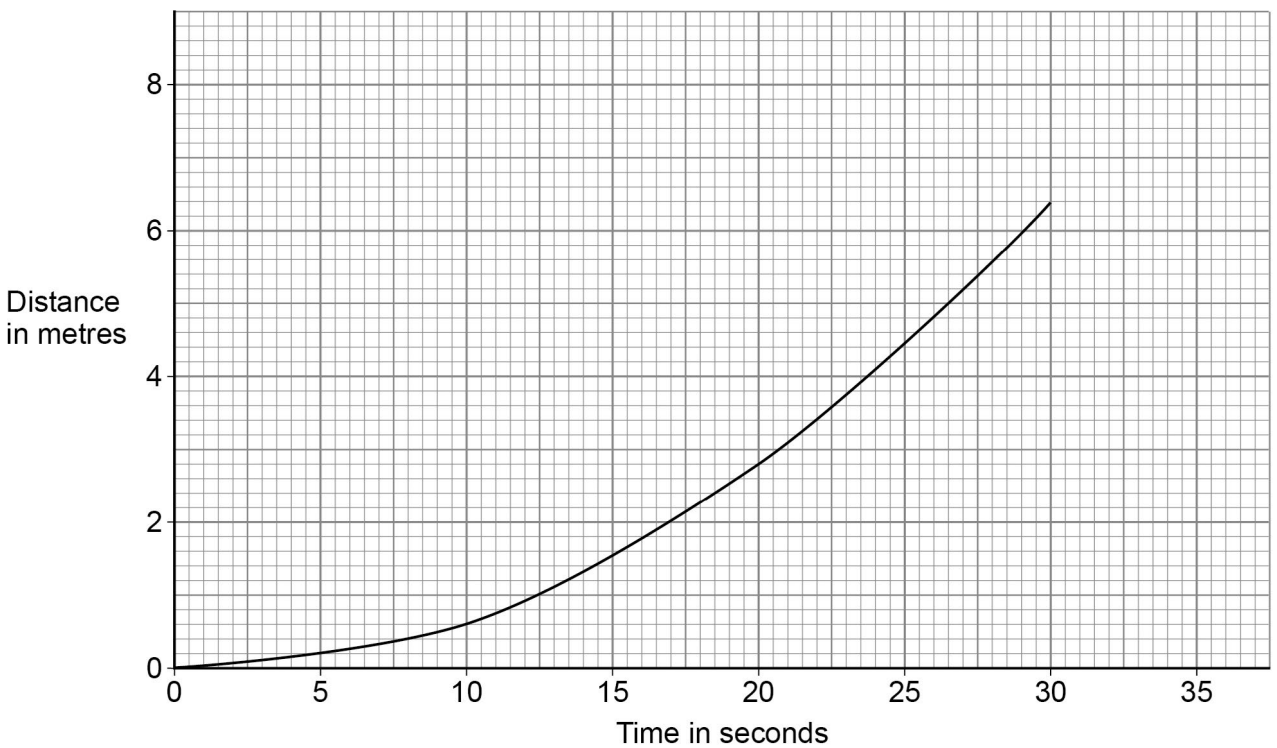
Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 144 · continued

Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



0 6 . 4 Describe the motion of the car during the first 30 seconds.

[1 mark]

0 6 . 5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

Speed = _____ m/s

4.6.2.4 Uses and applications of electromagnetic waves

Question 144 · continued

0 6 . 6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

Resultant force = _____ N

0 6 . 7 Explain why the car has a maximum speed.

[4 marks]

24

4.6.2.4 Uses and applications of electromagnetic waves

Question 145

November 2021 | 8463/2H | Original Q5

0 5 Ultraviolet is a type of electromagnetic wave.

0 5 . 1 Give **one** use of ultraviolet.

[1 mark]

_____

0 5 . 2 An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

[1 mark]

Tick (✓) **one** box.

3×10^{7} m ☐

3×10^{-7} m ☐

3×10^{9} m ☐

3×10^{-9} m ☐

0 5 . 3 The speed of ultraviolet waves is 3×10^{8} m/s.

Calculate the frequency of the ultraviolet wave.

Use your answer to Question **05.2**

[3 marks]

_____

_____

_____

_____

_____

Frequency = _____ Hz

4.6.2.4 Uses and applications of electromagnetic waves

Question 145 · continued

0 5 . 4 **Table 1** gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

Table 1

	Ultraviolet	Wave E	Wave F	Wave G
Wavelength in nanometres	300	0.1	600	100 000

Draw **one** line from each wave to the name of the wave.

[1 mark]

Wave	Name
Wave E	Infrared
Wave F	Visible light
Wave G	X-rays

0 5 . 5 Electromagnetic waves are transverse.

Some other types of wave are longitudinal.

Describe the difference between transverse and longitudinal waves.

[2 marks]

8

4.6.2.4 Uses and applications of electromagnetic waves

Question 146

June 2022 | 8463/1H | Original Q7

0 7 Alpha particles, beta particles and gamma rays are types of nuclear radiation.

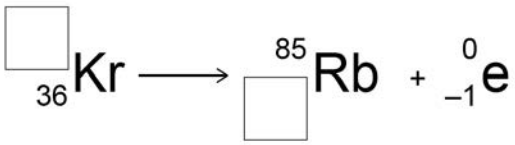
0 7 . 1 What does an alpha particle consist of?

[1 mark]

0 7 . 2 A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

Complete the nuclear equation for this decay by writing the missing number in each box.

[2 marks]



0 7 . 3 Internal contamination of the human body means radioactive material is inside the human body.

Explain how the risk from internal contamination is different to the risk from external irradiation by a source of alpha radiation.

[5 marks]

8

4.6.2.4 Uses and applications of electromagnetic waves

Question 147

June 2023 | 8463/2H | Original Q1

0 1 Infrared waves are transverse waves.

0 1 . 1 Complete the sentence.

[1 mark]

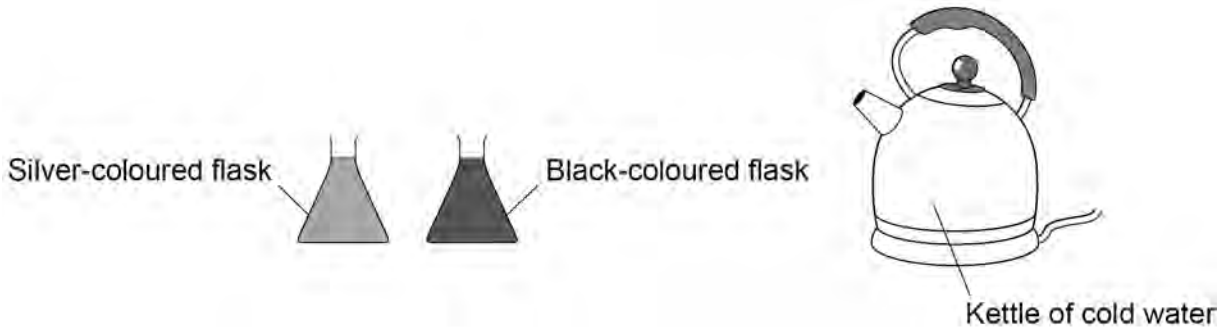
In a transverse wave, the direction of oscillation is _____

to the direction of energy transfer by the wave.

A student investigated how the colour of a surface affects the rate at which the surface emits infrared radiation.

Figure 1 shows some of the equipment used.

Figure 1



4.6.2.4 Uses and applications of electromagnetic waves

Question 147 · continued

0 1 . 2 The student wrote the following hypothesis:

‘The black-coloured flask will emit more infrared radiation than the silver-coloured flask during 10 minutes of cooling.’

Describe a method to test this hypothesis.

[6 marks]

Question 1 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 147 · continued

0 1 . 3 When will the flasks emit infrared radiation at the greatest rate?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

During the 1st minute ☐

During the 5th minute ☐

During the 9th minute ☐

Reason _____

_____

Question 147 · continued

Another student investigated the absorption of infrared radiation by different surface colours.

The student filled four hollow metal cubes with cold water.

Each cube was the same size but had a different surface colour.

The cubes were then placed the same distance from an infrared heater.

After 10 minutes, the student measured the temperature increase of the water inside each cube.

0 1 . 4 What was the dependent variable in this investigation?

[1 mark]

0 1 . 5 **Table 1** shows the results.

Table 1

Surface colour of the cube	Temperature increase after 10 minutes in °C
Matt white	3.0
Shiny white	2.0
Matt black	6.5
Shiny black	4.0

Give **two** conclusions that can be made from the results in **Table 1**.

[2 marks]

1

2

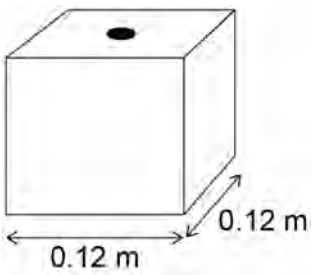
4.6.2.4 Uses and applications of electromagnetic waves

Question 147 · continued

Figure 2 shows one of the cubes. The cube is filled with water.

The weight of the water exerts a pressure on the bottom of the cube.

Figure 2



Use the Physics Equations Sheet to answer questions **01.6** and **01.7**.

0 1 . 6 Which equation correctly links area, force and pressure?

[1 mark]

Tick (✓) **one** box.

pressure = force × area^2 ☐

pressure = force × area ☐

pressure = $\frac{\text{force}}{\text{area}}$ ☐

pressure = $\frac{\text{area}}{\text{force}}$ ☐

4.6.2.4 Uses and applications of electromagnetic waves

Question 147 · continued

0 1 . 7 The water pressure at the bottom of the cube is 1500 Pa.

Calculate the force of the water on the bottom of the cube.

[4 marks]

Force = _____ N

17

Turn over for the next question

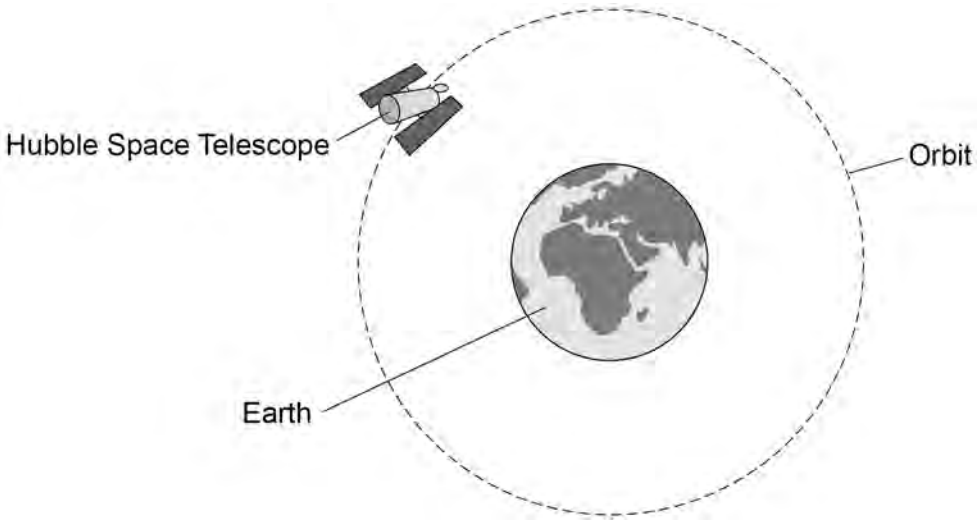
4.6.2.4 Uses and applications of electromagnetic waves

Question 148

June 2023 | 8463/2H | Original Q6

0 6 **Figure 15** shows the Hubble Space Telescope orbiting the Earth.

Figure 15



0 6 . 1 What name is given to objects that orbit a planet?

[1 mark]

Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 148 · continued

0 6 . 2 A space telescope uses microwaves to communicate with the Earth.

A microwave has a wavelength of 12.5 cm.

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

Calculate the frequency of the microwave.

Use the Physics Equations Sheet.

Give your answer in standard form.

[5 marks]

Frequency (in standard form) = _____ Hz

0 6 . 3 Explain the effect of the Earth's gravitational force on the motion of the Hubble Space Telescope.

[3 marks]

4.6.2.4 Uses and applications of electromagnetic waves

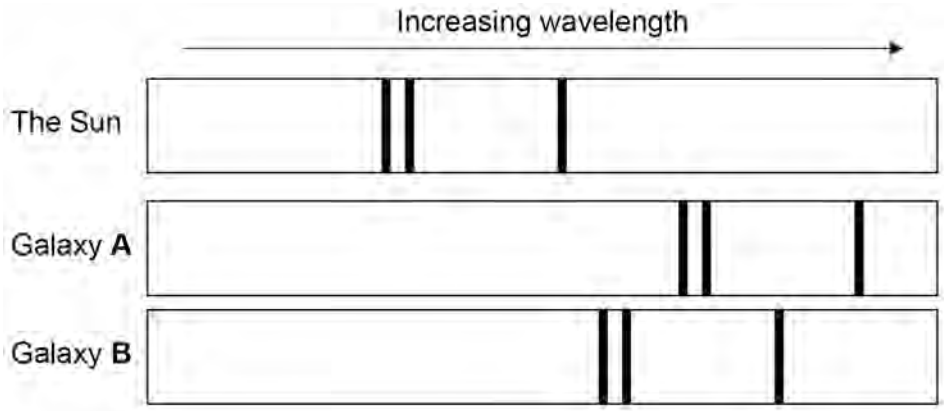
Question 148 · continued

0 6 . 4 The Hubble Space Telescope can detect visible light from distant galaxies.

The visible light spectra from stars and galaxies include dark lines at specific wavelengths.

Figure 16 shows the visible light spectra from the Sun and two galaxies.

Figure 16



Explain what conclusions can be made about galaxies **A** and **B**.

[3 marks]

12

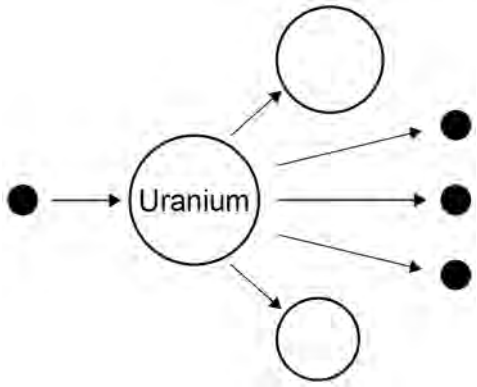
4.6.2.4 Uses and applications of electromagnetic waves

Question 149

0 2 The process of nuclear fission is used in nuclear power stations.

Figure 2 shows the process of nuclear fission.

Figure 2



0 2 . 1 Complete the sentences.

Choose answers from the box.

[3 marks]

electrons	**gamma rays**	**neutrons**	**nuclei**	**protons**

In nuclear power stations, energy is released from

uranium _____.

The uranium in **Figure 2** splits into two parts and

releases three _____.

The process of nuclear fission releases electromagnetic radiation in the

form of _____.

4.6.2.4 Uses and applications of electromagnetic waves

Question 149 · continued

Use the Physics Equations Sheet to answer questions **02.2** and **02.3**.

0 2 . 2 Write down the equation which links energy (*E*), power (*P*) and time (*t*).

[1 mark]

0 2 . 3 A nuclear power station has a power output of 500 MW.

Calculate the energy output in 3600 s.

Give your answer in J.

[3 marks]

Energy output = _____ J

0 2 . 4 Radioactive waste produced by nuclear power stations has a long half-life.

Suggest **one** precaution taken to reduce the hazard caused by radioactive waste from power stations.

[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 149 · continued

0 2 . 5 Nuclear power stations do **not** generate electricity every day of the year.

One nuclear power station generated electricity for 92% of a year.

one year = 365 days

Calculate the number of days during the year that the nuclear power station generated electricity.

[2 marks]

Number of days = _____

10

Turn over for the next question

4.6.2.4 Uses and applications of electromagnetic waves

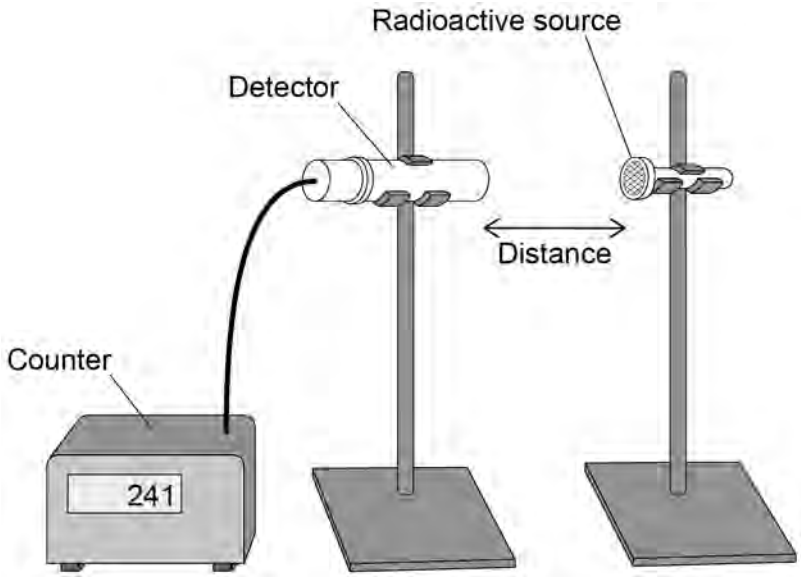
Question 150

June 2024 | 8463/1H | Original Q9

0 9 A teacher investigated the radiation emitted by two different radioactive sources, **A** and **B**.

Figure 14 shows a radiation detector positioned near one of the radioactive sources.

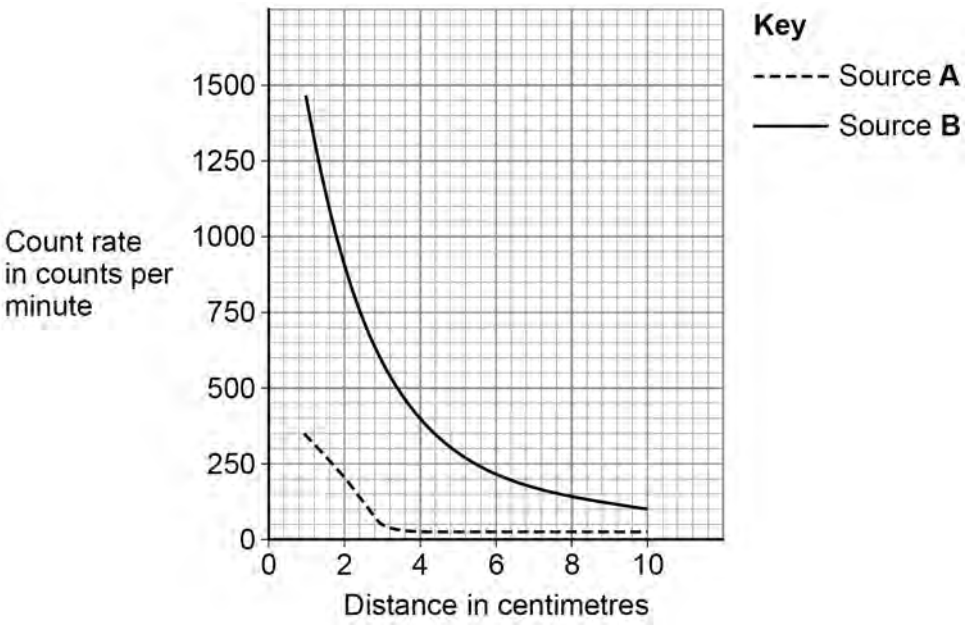
Figure 14



The teacher measured the count rate at different distances for each radioactive source.

Figure 15 shows the results.

Figure 15



4.6.2.4 Uses and applications of electromagnetic waves

Question 150 · continued

0 9 . 1 Explain how **Figure 15** shows that Source **A** only emits alpha radiation.

[3 marks]

0 9 . 2 **Figure 15** can **not** be used to determine if Source **B** emits beta radiation or gamma radiation.

Explain how an absorbing material could be used to show which type of radiation is emitted by Source **B**.

[2 marks]

Question 9 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 150 · continued

The teacher took safety precautions during the experiment.

0 9 . 3 Suggest **one** safety precaution the teacher would have taken to reduce the radiation dose the teacher received.

[1 mark]

0 9 . 4 Suggest **one** safety precaution that the teacher would have taken to avoid becoming contaminated.

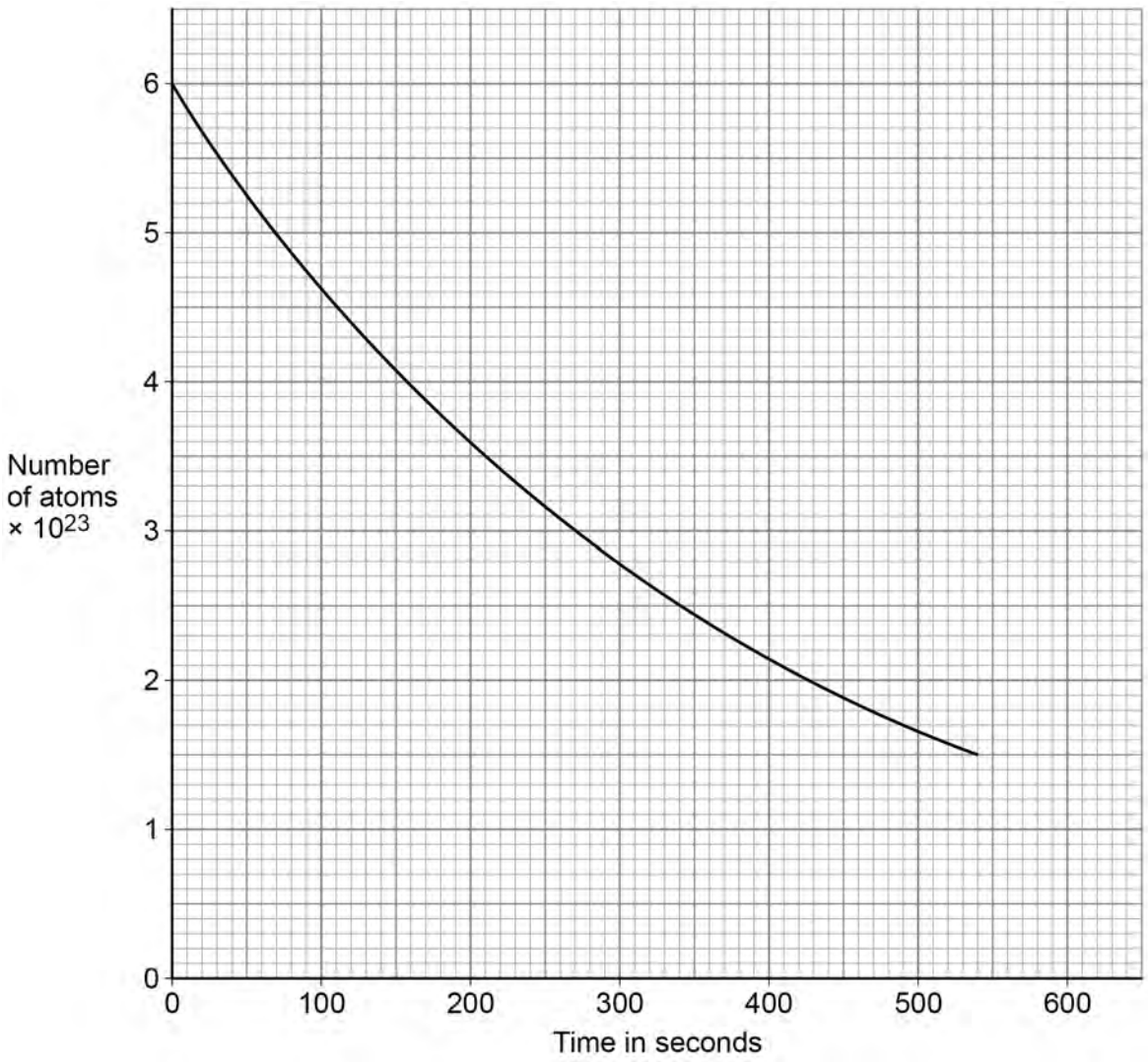
[1 mark]

4.6.2.4 Uses and applications of electromagnetic waves

Question 150 · continued

0 9 . 5 **Figure 16** shows how the number of atoms of a radioactive element in a sample varied with time.

Figure 16



Activity is the rate at which a source of unstable nuclei decays.

Determine the activity of the radioactive sample at 300 seconds.

Give the unit.

[4 marks]

Activity = _____ Unit _____

11

4.6.2.4 Uses and applications of electromagnetic waves

Question 151

June 2024 | 8463/2H | Original Q6

0 6 Radio waves and gamma rays both transfer energy.

0 6 . 1 Give **three** other similarities between radio waves and gamma rays.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

4.6.2.4 Uses and applications of electromagnetic waves

Question 151 · continued

June 2024 | 8463/2H | Original Q6

Both radio waves and gamma rays are used in medicine.

0 6 . 2 Give **one** medical use of gamma rays.

[1 mark]

0 6 . 3 Explain why exposure to gamma rays can be harmful but exposure to radio waves is **not** harmful.

[2 marks]

0 6 . 4 Some medical scanners produce radio waves at a specific frequency.

Explain how radio waves are produced at a specific frequency.

[2 marks]

8