AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.3

Properties of electromagnetic waves 2

Past-paper questions

Tier	**Foundation**
Question groups	**56**
Available paper years	**2004–2022**

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 01

June 2004 | 3451F | Original Q2 | Legacy

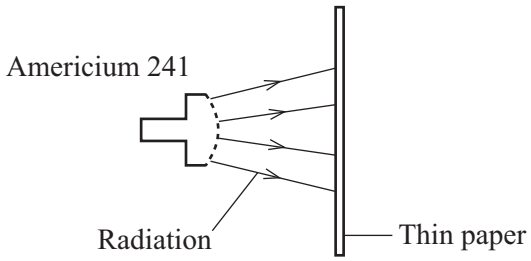
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.



Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

(1 mark)

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

(2 marks)

(d) Complete the sentence by choosing an answer from the box.

less than	**more than**	**the same as**

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

(1 mark)

5

4.6.2.3 Properties of electromagnetic waves 2

Question 02

June 2004 | 3451F | Original Q11 | Legacy

11 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;

.....

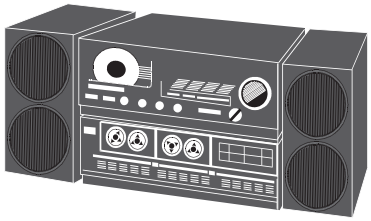
(1 mark)

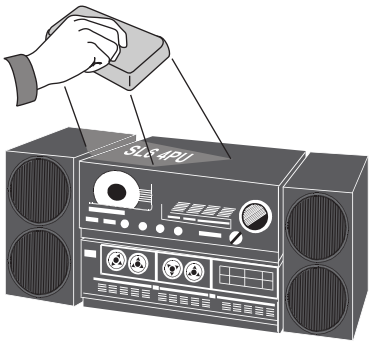
(ii) to send a signal to a TV from a remote control.

.....

(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.

.....

.....

.....

.....

(2 marks)

4.6.2.3 Properties of electromagnetic waves 2

Question 02 · continued

MARGIN BLANK

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

.....

.....

.....

.....

(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

4.6.2.3 Properties of electromagnetic waves 2

Question 03

June 2004 | 3462F3 | Original Q9 | Legacy

9 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;

.....

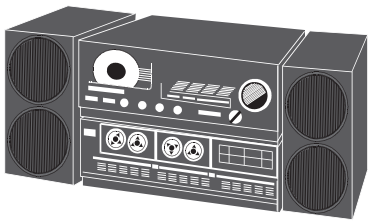
(1 mark)

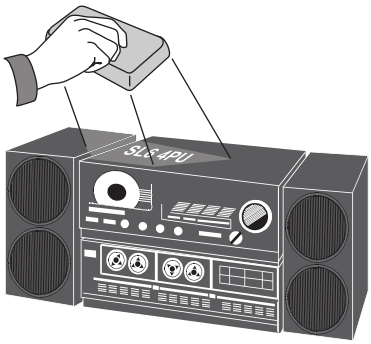
(ii) to send a signal to a TV from a remote control.

.....

(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.

.....

.....

.....

.....

(2 marks)

4.6.2.3 Properties of electromagnetic waves 2

Question 03 · continued

MARGIN
BLANK

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

.....

.....

.....

.....

(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)

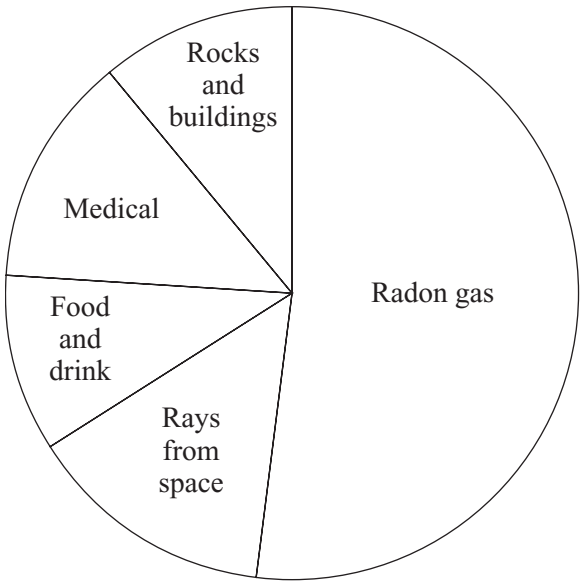
9

4.6.2.3 Properties of electromagnetic waves 2

Question 04

June 2005 | 3451 | Original Q5 | Legacy

5 (a) Radiation is around us all of the time. The pie chart shows the sources of this radiation.



(i) What is the main source of this radiation?

.....

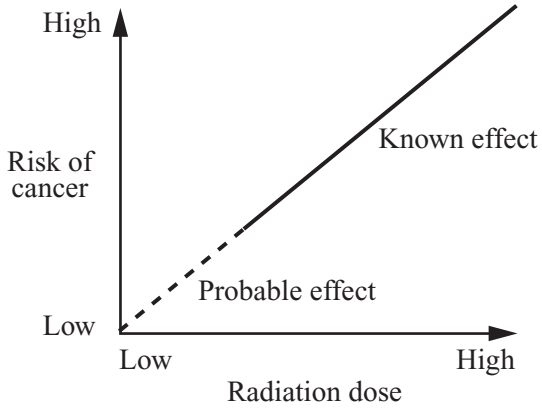
(1 mark)

(ii) What name is given to the radiation that is around us all of the time?

.....

(1 mark)

(b) Radiation can cause cancer. The graph shows that the risk of cancer depends on the radiation dose a person is exposed to.



Complete the following sentence.

The ..... the dose of radiation a person gets, the greater the risk of cancer.

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 04 · continued

MARGIN BLANK

(c) A worker in a nuclear power station wears a special badge (diagram **1**). Diagram **2** shows what is inside the badge. When the film inside the badge is developed, it will be dark in the places where it has absorbed radiation.

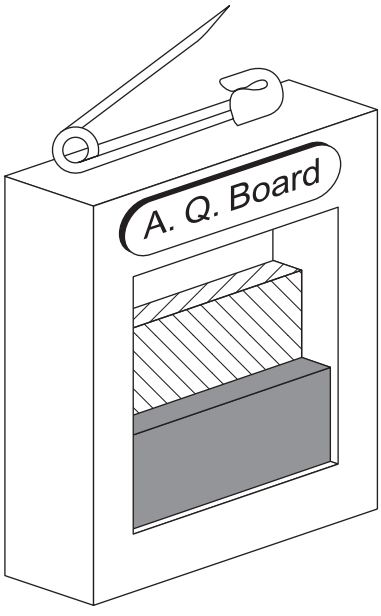


Diagram 1

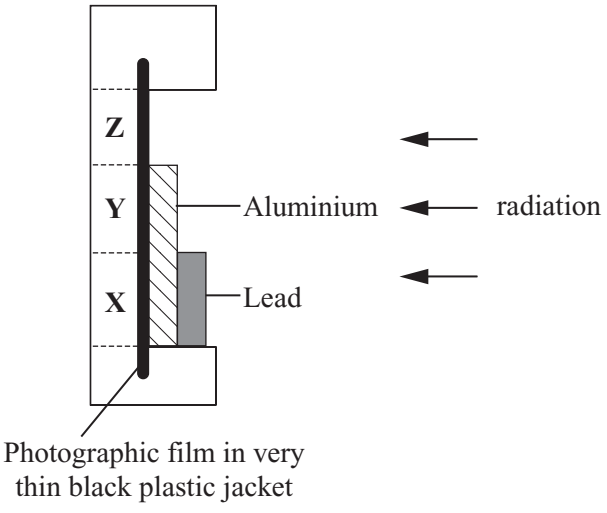


Diagram 2

Which part of the film, **X**, **Y** or **Z**, would darken if the worker had received a dose of alpha radiation?

.....

Give a reason for your answer.

.....

.....

(2 marks)

5

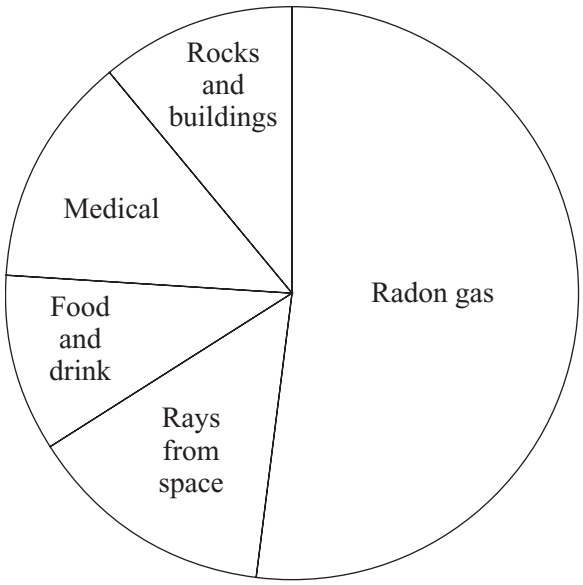
TURN OVER FOR THE NEXT QUESTION

4.6.2.3 Properties of electromagnetic waves 2

Question 05

June 2005 | 3462 | Original Q5 | Legacy

5 (a) Radiation is around us all of the time. The pie chart shows the sources of this radiation.



(i) What is the main source of this radiation?

.....

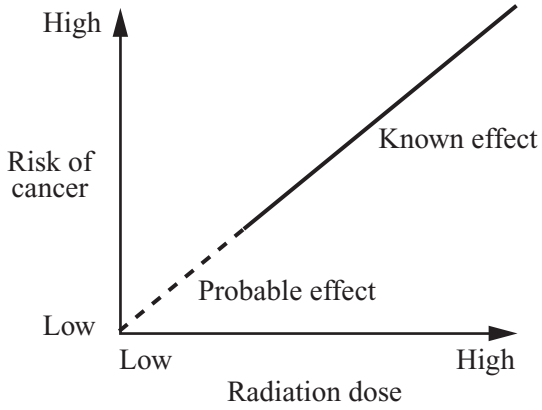
(1 mark)

(ii) What name is given to the radiation that is around us all of the time?

.....

(1 mark)

(b) Radiation can cause cancer. The graph shows that the risk of cancer depends on the radiation dose a person is exposed to.



Complete the following sentence.

The ..... the dose of radiation a person gets, the greater the risk of cancer.

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 05 · continued

MARGIN BLANK

(c) A worker in a nuclear power station wears a special badge (diagram **1**). Diagram **2** shows what is inside the badge. When the film inside the badge is developed, it will be dark in the places where it has absorbed radiation.

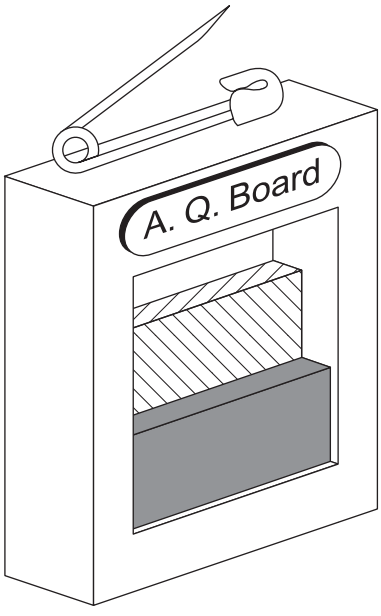


Diagram 1

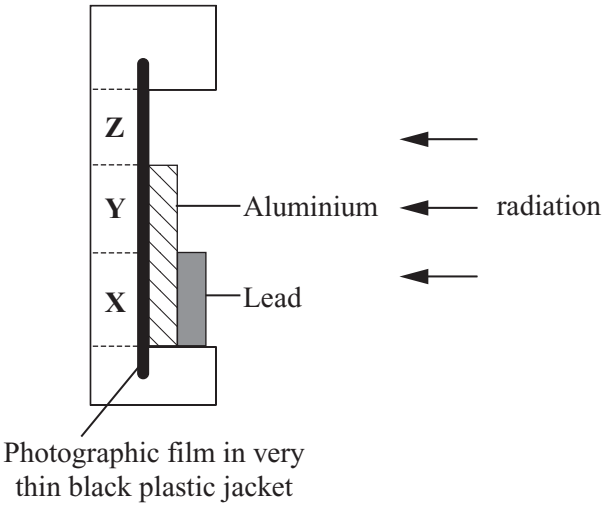


Diagram 2

Which part of the film, **X**, **Y** or **Z**, would darken if the worker had received a dose of alpha radiation?

.....

Give a reason for your answer.

.....

.....

(2 marks)

5

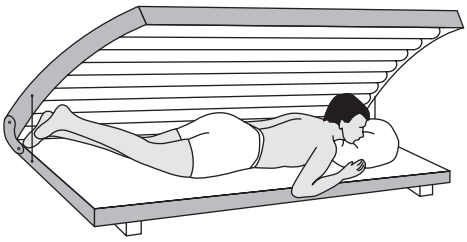
TURN OVER FOR THE NEXT QUESTION

4.6.2.3 Properties of electromagnetic waves 2

Question 06

June 2006 | 3451 | Original Q2 | Legacy

2 (a) The diagram shows a person using a sunbed.



(i) Which type of radiation is used in a sunbed to give a suntan?

Draw a ring around your answer.

infra red **light** **microwave** **ultraviolet**

(1 mark)

(ii) What can a high dose of radiation from a sunbed do to living cells?

.....

.....

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 06 · continued

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(b) The box contains the information shown on the side of a sunbed.

230 V	**1.8 kW**
50 Hz	**7.8 A**

(i) Which **one** of the following statements is true? Put a tick (✓) in the box next to your choice.

The sunbed uses an alternating current (a.c.) electricity supply. ☐

A 5 amp fuse should be used in the plug of the sunbed. ☐

The sunbed transfers 1.8 joules of energy every second. ☐

(1 mark)

(ii) In one week the sunbed is used for a total of 6 hours.

Use the following equation to calculate the number of units of energy transferred by the sunbed in 6 hours.

Show clearly how you work out your answer.

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

.....

.....

Energy transferred = ... kWh

(2 marks)

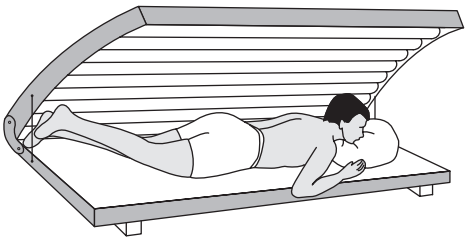
5

4.6.2.3 Properties of electromagnetic waves 2

Question 07

June 2006 | 3462 | Original Q2 | Legacy

2 (a) The diagram shows a person using a sunbed.



(i) Which type of radiation is used in a sunbed to give a suntan?

Draw a ring around your answer.

infra red **light** **microwave** **ultraviolet**

(1 mark)

(ii) What can a high dose of radiation from a sunbed do to living cells?

.....

.....

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 07 · continued

BLANK

(b) The box contains the information shown on the side of a sunbed.

230 V	**1.8 kW**
50 Hz	**7.8 A**

(i) Which **one** of the following statements is true? Put a tick (✓) in the box next to your choice.

The sunbed uses an alternating current (a.c.) electricity supply. ☐

A 5 amp fuse should be used in the plug of the sunbed. ☐

The sunbed transfers 1.8 joules of energy every second. ☐

(1 mark)

(ii) In one week the sunbed is used for a total of 6 hours.

Use the following equation to calculate the number of units of energy transferred by the sunbed in 6 hours.

Show clearly how you work out your answer.

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

.....

.....

Energy transferred = ... kWh

(2 marks)

5

4.6.2.3 Properties of electromagnetic waves 2

Question 08

2 (a) The names of three types of radiation are given in **List A**. Various properties of these three types of radiation are given in **List B**.

Draw a line to link each type of radiation in **List A** to its correct property in **List B**. Draw only **three** lines.

List A **Type of radiation**	**List B** **Property of radiation**
	not dangerous
alpha (α)	
	stopped by paper
beta (β)	
	travels at 300 000 000 m/s
gamma (γ)	
	travels up to 1 metre in air

(3 marks)

(b) This sign warns people that a radioactive source is being used in a laboratory.



Why is it important to warn people that a radioactive source is being used?

.....

.....

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

BLANK

(c) To study the blood flow in a patient's lungs, a doctor injects some technetium-99 compound into the patient. The gamma radiation given out by the technetium-99 atoms is detected using a gamma camera outside the patient's body.

Which statement gives the reason why gamma radiation is used? Put a tick (✓) in the box next to your choice.

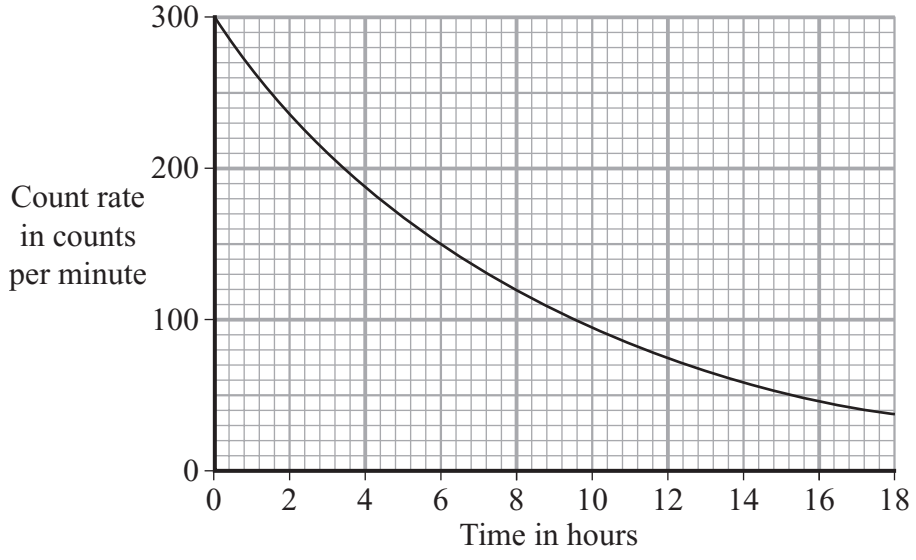
It can travel through a vacuum. ☐

It is not affected by a magnet. ☐

It can pass through the human body. ☐

(1 mark)

(d) The graph shows how the count rate from a sample of technetium-99 changes with time.



(i) How many hours does it take for the count rate to fall from 300 counts per minute to 150 counts per minute?

Time = ... hours
(1 mark)

(ii) What is the half-life of technetium-99?

Half-life = ... hours
(1 mark)

7

4.6.2.3 Properties of electromagnetic waves 2

Question 09

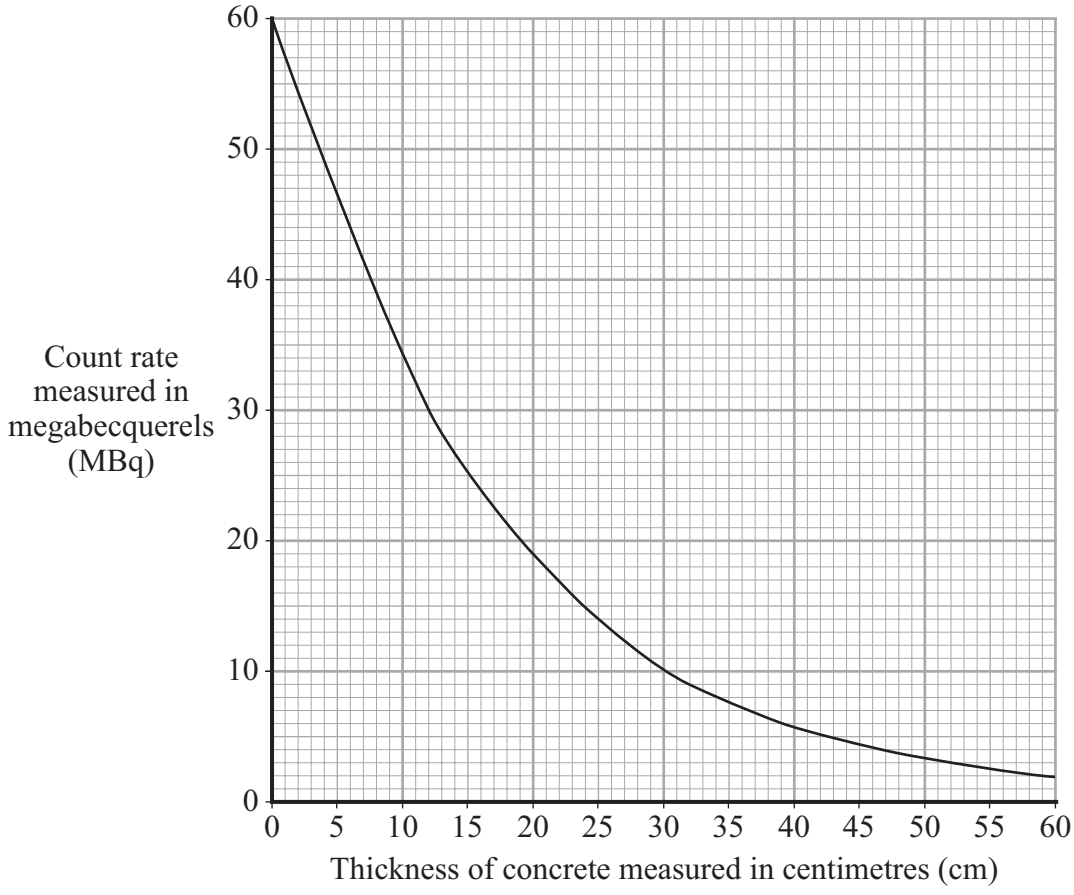
March 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

Gamma radiation is the most penetrating type of ionising radiation.

Concrete is sometimes used to protect people from the harmful effects of gamma radiation.

The graph shows the count rate from a source of gamma radiation after it has passed through various thicknesses of concrete.



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

A 6

B 8

C 12

D 19

Count rate when the thickness is 20 cm = . . . **1** . . . MBq.

Thickness when count rate is 39 MBq = . . . **2** . . . cm.

Reduction in count rate when thickness is increased from 12 cm to 16 cm = . . . **3** . . . MBq.

Thickness needed to reduce the original count rate by half = . . . **4** . . . cm.

4.6.2.3 Properties of electromagnetic waves 2

Question 10

March 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

Electromagnetic radiation fills the Universe

Electromagnetic radiations belong to a spectrum of radiations which have many features in common.

7A In the box, the electromagnetic radiations are meant to be in order of increasing wavelength from left to right. Which one is in the wrong position?

X-rays	Infra red rays	Radio waves	Gamma rays
1	**2**	**3**	**4**

1 X-rays

2 infra red rays

3 radio waves

4 gamma rays

7B Which statement is correct?

1 All electromagnetic radiation can travel through a vacuum.

2 All electromagnetic radiation is visible to the human eye.

3 No electromagnetic radiation can travel through a vacuum.

4 No electromagnetic radiation is visible to the human eye.

4.6.2.3 Properties of electromagnetic waves 2

Question 10 · continued

7C Which statement about the wavelength of microwaves is correct?

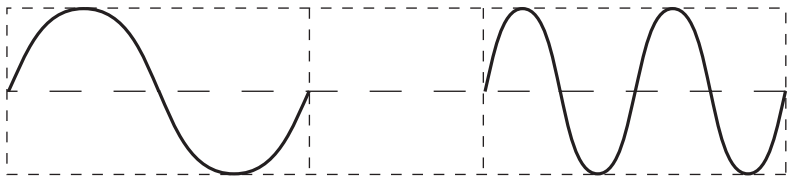
1 longer than both infra red rays and ultraviolet rays

2 longer than infra red rays but shorter than ultraviolet rays

3 shorter than both infra red rays and ultraviolet rays

4 shorter than infra red rays but longer than ultraviolet rays

7D Two electromagnetic waves are shown in the diagrams, which are drawn to the same scale.



X **Y**

Which sentence is correct?

1 The frequency of wave **X** is double that of wave **Y**.

2 The frequency of wave **Y** is double that of wave **X**.

3 The wavelength of wave **Y** is double that of wave **X**.

4 The wavelength of wave **Y** is four times that of wave **X**.

4.6.2.3 Properties of electromagnetic waves 2

Question 11

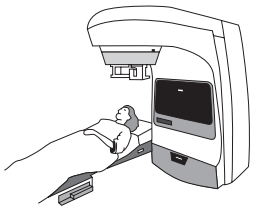
June 2007 | PHY1B | Original Q1 | Legacy

QUESTION ONE

Each of these applications uses electromagnetic radiation.

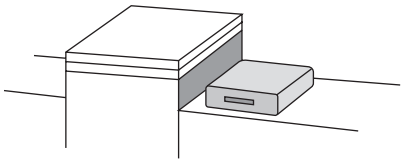
1

Killing cancer cells



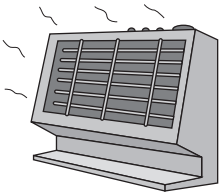
2

Checking bags at an airport



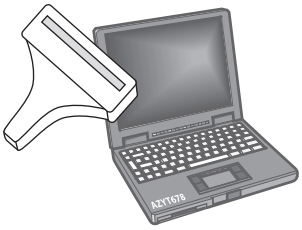
3

In radiant heaters



4

Seeing security markings



Match the parts of the electromagnetic spectrum, **A**, **B**, **C** and **D**, with the drawings labelled **1–4**.

A gamma rays

B infra red rays

C ultraviolet rays

D X-rays

4.6.2.3 Properties of electromagnetic waves 2

Question 12

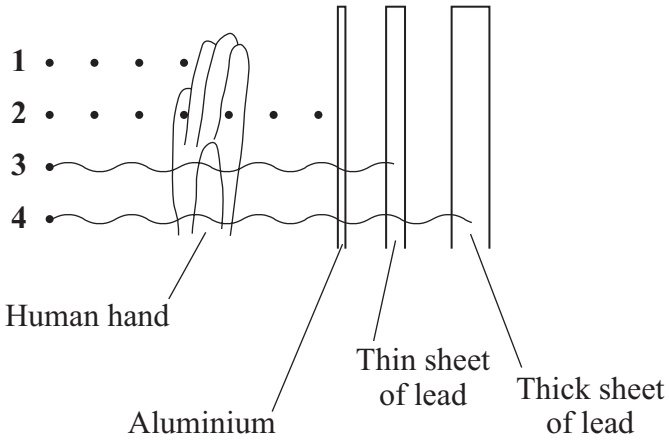
June 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

Technicians in hospitals may be exposed to various types of electromagnetic or nuclear radiation.

The penetrating power of four types of radiation is shown in the diagram.

Technicians in the X-ray department wear aprons containing a thin sheet of lead for protection.



Match the types of nuclear and electromagnetic radiation, **A**, **B**, **C**, and **D**, with the labels **1–4** on the diagram.

A gamma radiation

B X-ray radiation

C alpha radiation

D beta radiation

4.6.2.3 Properties of electromagnetic waves 2

Question 13

June 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE

There was an accident at the Chernobyl nuclear power station in April 1986. This resulted in the release of radioactive materials into the environment. Some of these materials may cause cancer of the thyroid gland in children.

The table shows the number of cases of thyroid cancer in children in two regions near the Chernobyl power station. It also shows the number of cases per 100 000 children in those regions.

		Childhood thyroid cancer cases per year, 1986–1998												
Region \ Year		86	87	88	89	90	91	92	93	94	95	96	97	98
Belarus	Number of cases	3	4	6	5	31	62	62	87	77	82	67	73	48
	Number of cases per 100 000 children	0.2	0.3	0.4	0.3	1.9	3.9	3.9	5.5	5.1	5.6	4.8	5.6	3.9
Ukraine	Number of cases	8	7	8	11	26	22	49	44	44	47	56	36	44
	Number of cases per 100 000 children	0.2	0.1	0.1	0.1	0.2	0.2	0.5	0.4	0.4	0.5	0.6	0.4	0.5

9A By how many did the number of cases of childhood thyroid cancer per year increase in the Belarus region between the year of the Chernobyl accident and 1995?

1 2

2 3

3 79

4 82

9B A city in Ukraine has 200 000 children.

How many cases of childhood thyroid cancer would be expected in the city in 1992?

1 1

2 2

3 5

4 49

4.6.2.3 Properties of electromagnetic waves 2

Question 13 · continued

One of the radioactive materials responsible for producing childhood thyroid cancer is iodine-131. Children may take in iodine-131 in contaminated food. The iodine-131 is accumulated by the thyroid gland.

9C The half-life of iodine-131 is 8 days. 100 atoms of iodine-131 are taken into the thyroid gland.

How many of these radioactive iodine-131 atoms will there be after 16 days?

1 25

2 50

3 75

4 100

9D Which type of radiation is most likely to cause damage by ionisation once inside the body?

1 alpha radiation

2 beta radiation

3 gamma radiation

4 ultraviolet radiation

END OF TEST

4.6.2.3 Properties of electromagnetic waves 2

Question 14

June 2007 | PHY1F | Original Q4 | Legacy

4 (a) Ultraviolet and visible light are both electromagnetic waves.

(i) Name **one** other type of electromagnetic wave.

.....

(1 mark)

(ii) Which **one** of the following statements is true for electromagnetic waves travelling through a vacuum?

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

All the waves have the same frequency. ☐

All the waves have the same wavelength. ☐

All the waves travel at the same speed. ☐

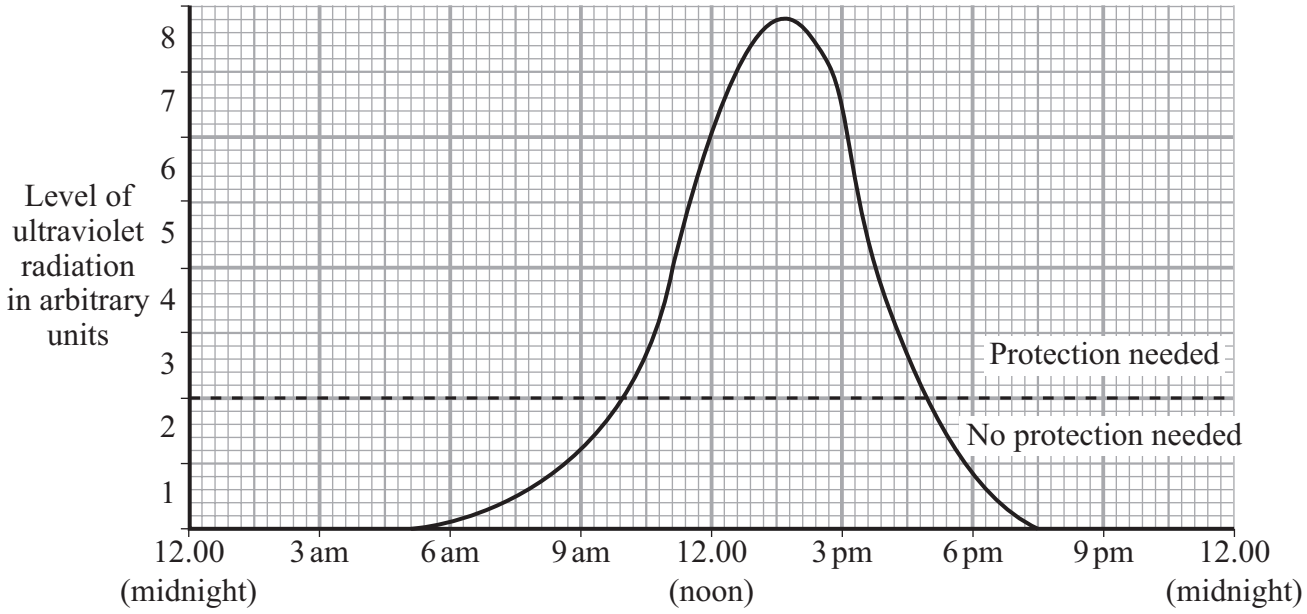
(1mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 14 · continued

BLANK

(b) The graph shows how the level of ultraviolet radiation changed during a summer day in England.



(i) What serious health problem can be caused by exposure to the ultraviolet radiation from the Sun?

.....

(1 mark)

(ii) Explain why it would be sensible to stay out of the Sun between 10 am and 4 pm in the summer.

.....

.....

.....

.....

(2 marks)

5

4.6.2.3 Properties of electromagnetic waves 2

Question 15

March 2008 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

We use electromagnetic radiation in many different ways.

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

A infra red radiation

B gamma radiation

C visible light

D ultraviolet radiation

1	is used to send messages using a torch
2	is used in sunbeds
3	is used in heaters
4	is used to treat cancer

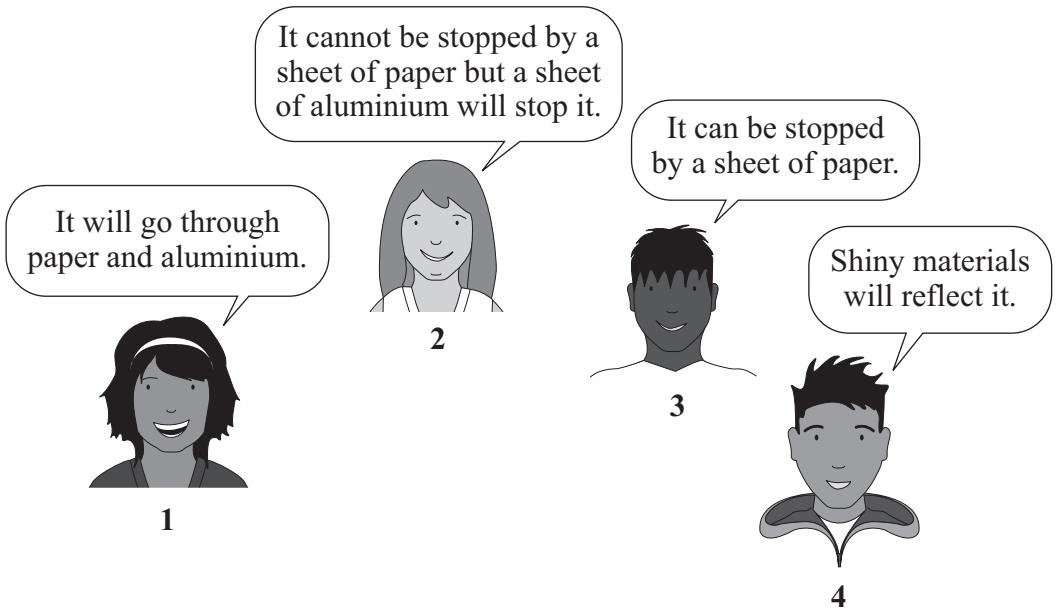
4.6.2.3 Properties of electromagnetic waves 2

Question 16

March 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Some students are talking about radiation.



Match words, **A**, **B**, **C** and **D**, with the students' statements **1–4**.

A alpha

B beta

C gamma

D visible light

4.6.2.3 Properties of electromagnetic waves 2

Question 17

June 2008 | PHY1F | Original Q3 | Legacy

3 (a) The names of three types of nuclear radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**. Draw only **three** lines.

List A Type of nuclear radiation	**List B** Property of radiation
	not deflected by an electric field
alpha	
	stopped by thin metal but not paper
beta	
	the most strongly ionising
gamma	
	will not harm living cells

(3 marks)

4.6.2.3 Properties of electromagnetic waves 2

Question 17 · continued

for mark

3 (b) Nuclear radiation is given out from the centre of some types of atom.

What name is given to the centre of an atom? .....

(1 mark)

3 (c) One of the substances in the table is used as a radioactive tracer. A hospital patient breathes in air containing the tracer. The radiation given out is measured by a doctor using a detector outside the patient's body.

Substance	Radiation given out	Solid, liquid or gas
X	alpha	gas
Y	gamma	gas
Z	gamma	solid

Which **one** of the substances, **X**, **Y** or **Z**, should be used as the tracer? .....

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

(3 marks)

3 (d) Radiation can also be used to kill the bacteria on fresh food.

Give **one** reason why farmers, shop owners or consumers may want food to be treated with radiation.

.....

.....

(1 mark)

8

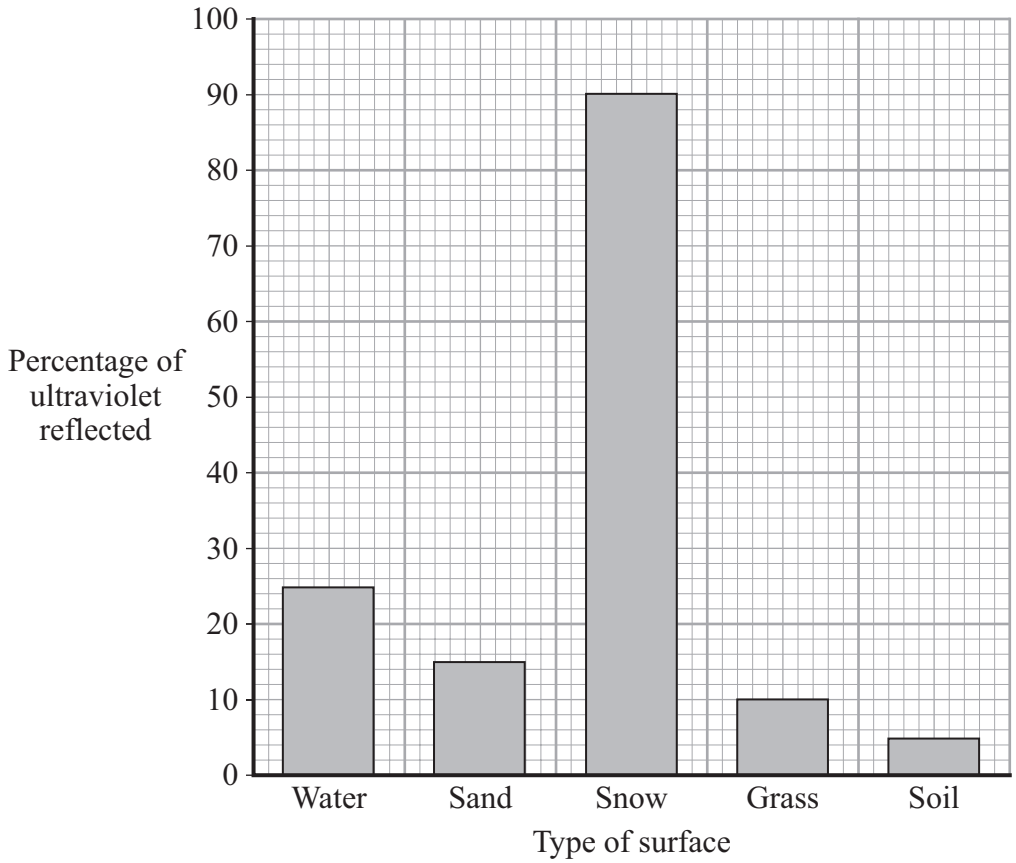
4.6.2.3 Properties of electromagnetic waves 2

Question 18

June 2008 | PHY1F | Original Q6 | Legacy

6 (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.



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

.....

(1 mark)

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

.....

.....

(1 mark)

6 (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 6 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 18 · continued

for mark

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

.....

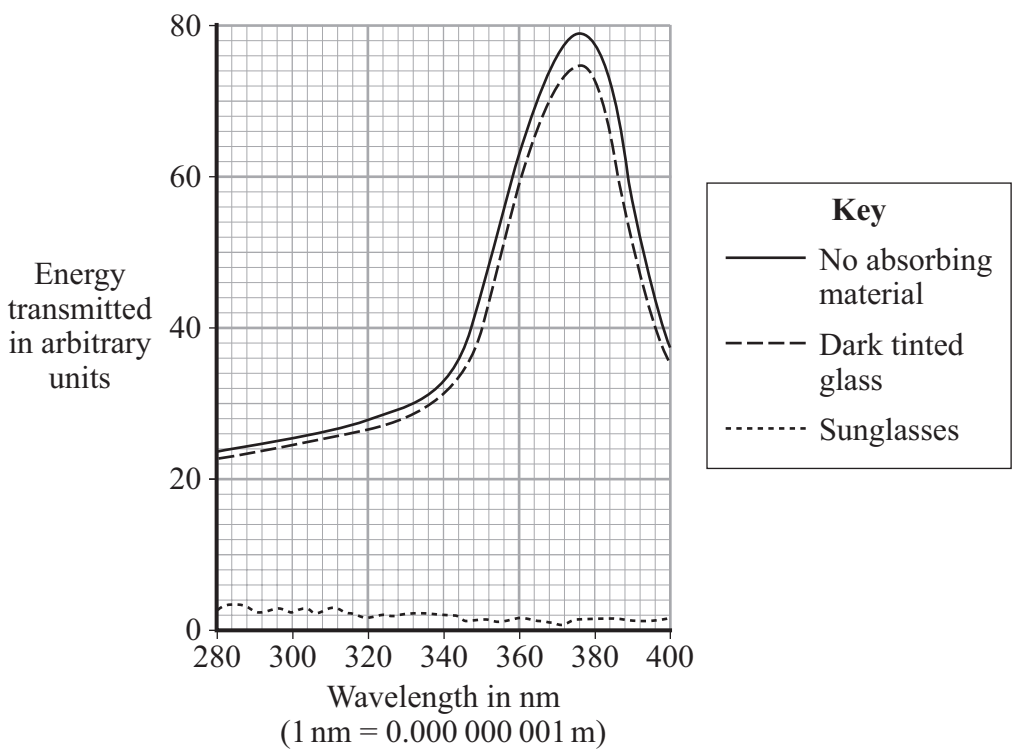
(1 mark)

6 (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.



4.6.2.3 Properties of electromagnetic waves 2

Question 18 · continued

for mark

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

.....

.....

.....

.....

(2 marks)

6 (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)

6 (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.

6 (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)

6 (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

4.6.2.3 Properties of electromagnetic waves 2

Question 19

June 2008 | PHY2F | Original Q6 | Legacy

6 (a) The table gives information about the radioactive isotope, radon-222.

mass number	222
atomic number	86
radiation emitted	alpha particle

6 (a) (i) Complete the following sentence.

The mass number is the total number of..... and

..... inside an atom.

(2 marks)

6 (a) (ii) Radon-222 is an isotope of radon.

How many protons are there in an atom of radon-222?

..... *(1 mark)*

6 (a) (iii) When an atom of radon-222 emits an alpha particle, the radon-222 changes into an atom of polonium-218.

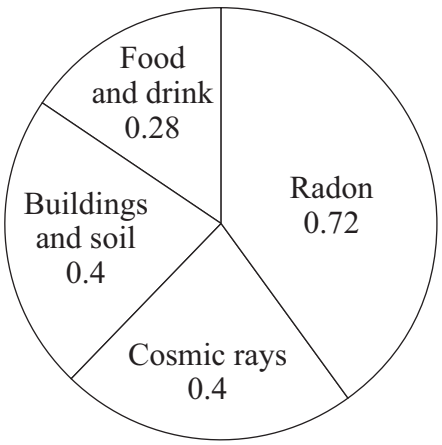
An alpha particle consists of 2 protons and 2 neutrons.

How is the structure of the nucleus of a polonium-218 atom different from the structure of the nucleus of a radon-222 atom?

.....

(1 mark)

6 (b) The pie chart shows the average radiation dose that a person in the UK receives each year from natural background radiation.
The doses are measured in millisieverts (mSv).



4.6.2.3 Properties of electromagnetic waves 2

Question 19 · continued

for mark

6 (b) (i) Calculate the proportion of natural background radiation that comes from radon. Show clearly how you work out your answer.

.....

.....

Proportion of radon = ...

(2 marks)

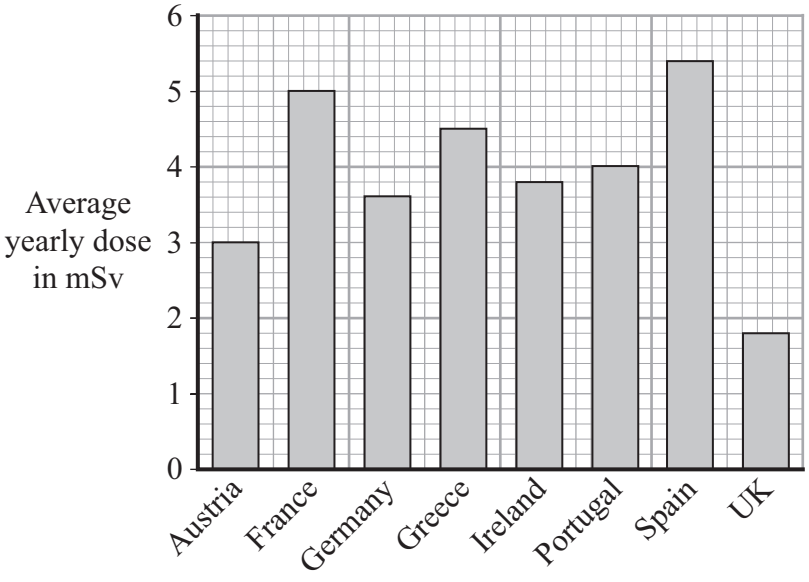
6 (b) (ii) Not all background radiation is from natural sources.

Name **one** source of background radiation that is not natural.

.....

(1 mark)

6 (c) The bar chart shows the average yearly dose from natural background radiation in different European countries.



6 (c) (i) How many times bigger is the average annual background dose in Germany compared to the UK?

.....

(1 mark)

Question 6 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 19 · continued

for mark

6 (c) (ii) The following table gives the effects of different radiation doses on the human body.

Radiation dose in mSv	Effects
10 000	Immediate illness; death within a few weeks
1 000	Radiation sickness; unlikely to cause death
50	Lowest dose with evidence of causing cancer

A family goes to Germany for a two-week holiday. Should they be concerned about the higher level of background radiation in Germany?

Draw a ring around your answer.

Yes **No**

Explain your answer.

.....

.....

.....

.....

(2 marks)

10

4.6.2.3 Properties of electromagnetic waves 2

Question 20

November 2008 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The diagram shows parts of the electromagnetic spectrum.

1	X-rays	**2**	**3**	Infra red rays	Microwaves	**4**

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

A gamma rays

B radio waves

C ultraviolet rays

D visible light

4.6.2.3 Properties of electromagnetic waves 2

Question 21

January 2009 | PHY1F | Original Q1 | Legacy

1 The table shows the electromagnetic spectrum.
Three types of wave have been missed out.

Gamma rays		Ultraviolet rays	Visible light		Micro-waves	

Shortest wavelength ⟷ Longest wavelength

1 (a) (i) Use words from the box to complete the table.

infra red rays	**radio waves**	**X-rays**

(2 marks)

1 (a) (ii) Which **one** of the following gives a use of gamma rays?

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

to communicate with satellites ☐

to see objects ☐

to kill cancer cells ☐

(1 mark)

1 (a) (iii) Complete the following sentence by drawing a ring around the correct word in the box.

All electromagnetic waves move [energy / gases / particles] from one place to another.

(1 mark)

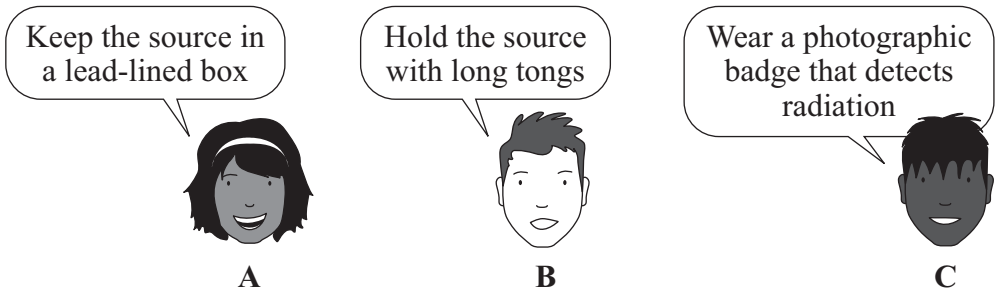
4

4.6.2.3 Properties of electromagnetic waves 2

Question 22

January 2009 | PHY1F | Original Q4 | Legacy

4 Before using a radioactive source, a teacher asked her students to suggest safety procedures that would reduce her exposure to the radiation. The students made the following suggestions.



A **B** **C**

4 (a) Which suggestion, **A**, **B** or **C**, would **not** reduce the exposure of the teacher to radiation?

.....

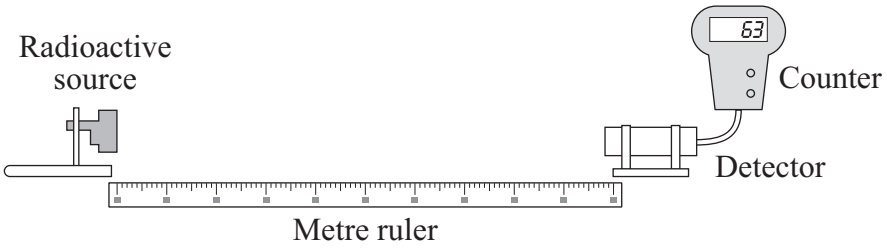
(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 22 · continued

for mark

4 (b) The diagram shows how the teacher measured the distance that the radiation travelled from the source. The count-rate at different distances from the source was measured and recorded in the table.



Distance from source to detector in cm	Count-rate in counts per minute
20	85
40	81
60	58
80	53
100	23

What type of radiation was the source emitting, alpha, beta or gamma?

.....

Explain the reasons for your choice.

.....

.....

.....

.....

(3 marks)

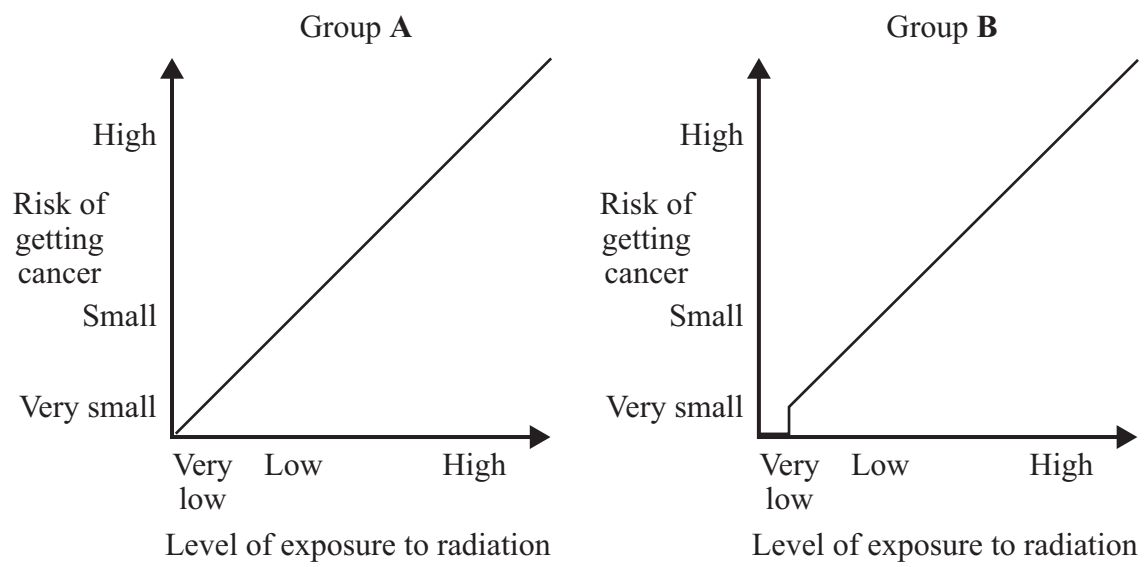
Question 4 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 22 · continued

for mark

4 (c) The graphs show how two groups of scientists, **A** and **B**, link exposure to radiation and the risk of getting cancer.



4 (c) (i) Complete the following sentence using a word or phrase from the box.

decreases	**has no effect on**	**increases**

Both groups of scientists agree that a high level of exposure to radiation

..... the risk of getting cancer.

(1 mark)

4 (c) (ii) Use the graphs to describe carefully how the two groups of scientists disagree when the level of exposure to radiation is very low.

.....

.....

.....

.....

(2 marks)

7

4.6.2.3 Properties of electromagnetic waves 2

Question 23

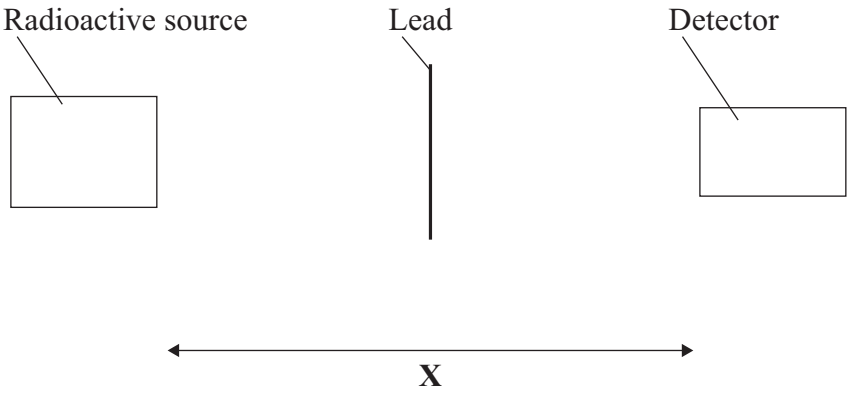
March 2009 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

A student investigated how much gamma radiation was absorbed by lead.

She used different thicknesses of lead.

She plotted a graph of her results.



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

A conclusion

B control variable

C prediction

D independent variable

1	She thought that the amount of radiation absorbed would decrease with thickness.
2	She kept the distance **X** the same.
3	She changed the thickness of the lead.
4	From her graph, she decided that the amount of radiation absorbed increased with thickness.

4.6.2.3 Properties of electromagnetic waves 2

Question 24

March 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

The table shows part of the electromagnetic spectrum.

gamma rays	X-rays	ultraviolet	visible light	infra red	microwaves

6A Which one of the following parts of the electromagnetic spectrum has the longest wavelength?

1 gamma rays

2 microwaves

3 ultraviolet

4 visible light

6B Which one of the following parts of the electromagnetic spectrum has the highest frequency?

1 gamma rays

2 microwaves

3 ultraviolet

4 visible light

6C Which part of the electromagnetic spectrum is used to show up invisible security marking on valuable equipment?

1 microwaves

2 ultraviolet

3 visible light

4 X-rays

4.6.2.3 Properties of electromagnetic waves 2

Question 24 · continued March 2009 | PHY1BP | Original Q6 | Legacy

6D Which part of the electromagnetic spectrum is emitted by mobile phone transmitters?

1 microwaves

2 ultraviolet

3 visible light

4 X-rays

Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

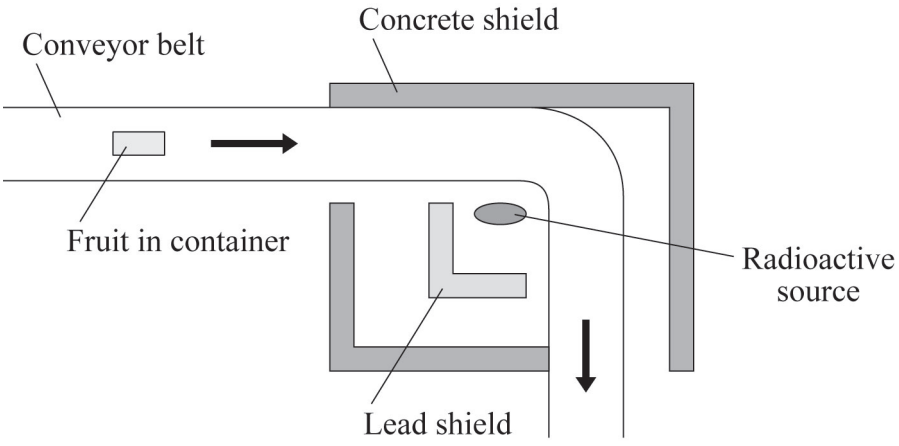
Question 25

March 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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.



8A 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.

8B 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.

4.6.2.3 Properties of electromagnetic waves 2

Question 25 · continued

8C 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.

8D 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

4.6.2.3 Properties of electromagnetic waves 2

Question 26

March 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

This question is about electromagnetic waves.

9A 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

9B 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.

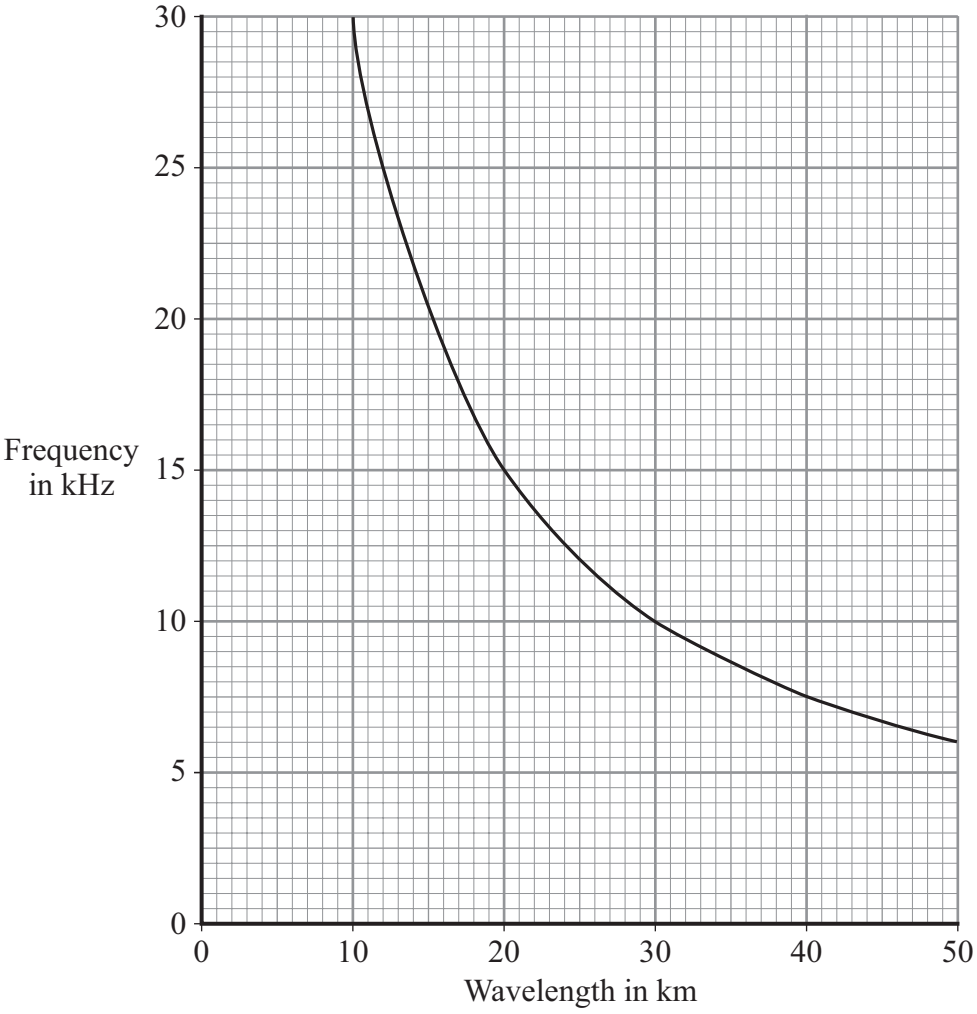
3 reflected by the atmosphere.

4 stopped by the atmosphere.

4.6.2.3 Properties of electromagnetic waves 2

Question 26 · continued

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



9C The graph shows that when the wavelength doubles, the frequency . . .

1 doubles.

2 halves.

3 quadruples.

4 stays the same.

9D 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

END OF TEST

4.6.2.3 Properties of electromagnetic waves 2

Question 27

June 2009 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

Electromagnetic waves can be dangerous.

There are different ways of protecting ourselves from the radiation.

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

A wearing thick, insulating gloves

B leaving the room

C looking through blackened glass

D using sun cream

When a dentist takes an X-ray of a patient's mouth, he protects himself by . . . **1** . . . .

A windsurfer protects herself from harmful ultraviolet rays by . . . **2** . . . .

Someone watching an eclipse of the Sun protects her eyes by . . . **3** . . . .

A man taking a metal bar out of a furnace protects himself by . . . **4** . . . .

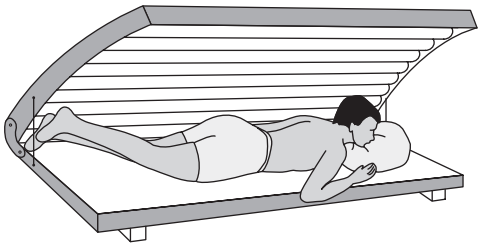
4.6.2.3 Properties of electromagnetic waves 2

Question 28

June 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

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

9A 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.

9B Repeating the investigation with another group of people would make the results more . . .

1 reliable.

2 precise.

3 biased.

4 random.

4.6.2.3 Properties of electromagnetic waves 2

Question 28 · continued June 2009 | PHY1BP | Original Q9 | Legacy

9C 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.

9D 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.

END OF TEST

4.6.2.3 Properties of electromagnetic waves 2

Question 29

November 2009 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about the uses of some types of electromagnetic radiation.

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

A infra red

B microwaves

C ultraviolet

D X-rays

	Use
1	sending signals in mobile phone networks
2	sending signals along optical fibres
3	photographing people's bones in hospital
4	reading 'invisible' security markings on property

4.6.2.3 Properties of electromagnetic waves 2

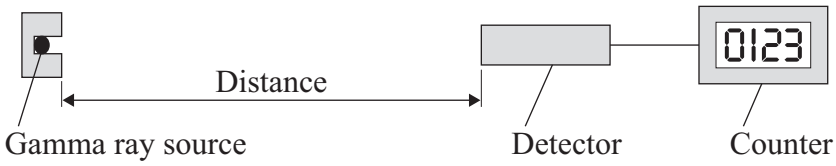
Question 30

November 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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

8A 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

4.6.2.3 Properties of electromagnetic waves 2

Question 30 · continued

8B She repeated the experiment and calculated the mean to make her results more . . .

1 accurate.

2 controlled.

3 varied.

4 reliable.

8C 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.

8D 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.

4.6.2.3 Properties of electromagnetic waves 2

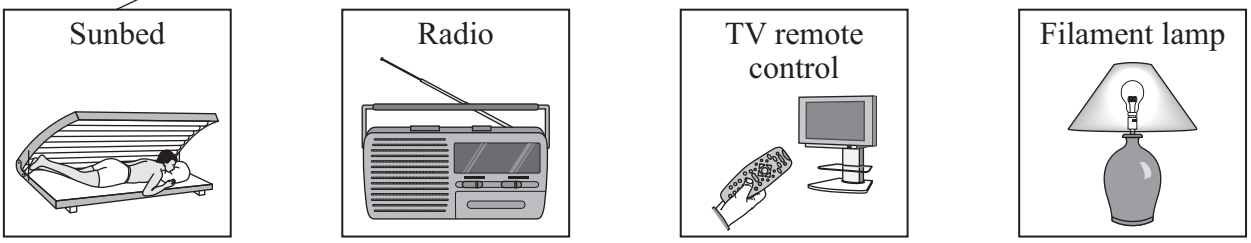
Question 31

January 2010 | PHY1F | Original Q1 | Legacy

1 (a) The diagram shows the electromagnetic spectrum.
The pictures show four devices that use electromagnetic waves. Each device uses a different type of electromagnetic wave.

Draw a line from each device to the type of electromagnetic wave that it uses.
One has been done for you.

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



(3 marks)

1 (b) A headline from a recent newspaper article is shown below.



1 (b) (i) What serious health problem may be caused by using a sunbed too much?

.....

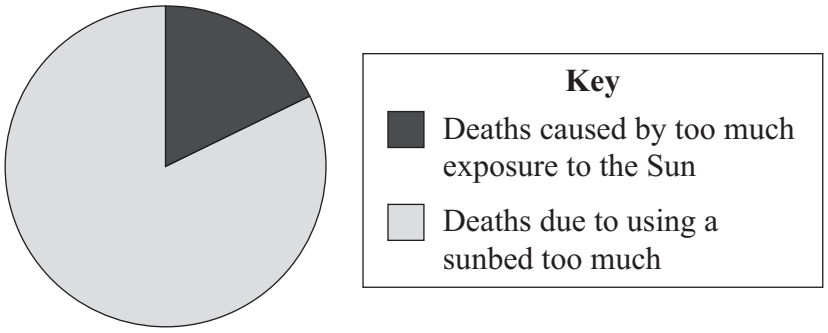
(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 31 · continued

for mark

1 (b) (ii) The pie chart compares the number of deaths in Britain each year, which may have been caused by using sunbeds too much, with those which may have been caused by too much exposure to the Sun.



It is difficult for a doctor to be certain that a person has died because of using a sunbed too much.

Suggest why.

.....

.....

(1 mark)

1 (b) (iii) A spokesperson for a leading cancer charity said:

> 'We want people, especially young people, to know the possible dangers of using a sunbed.'

Why is it important that you know the possible dangers of using a sunbed?

.....

.....

(1 mark)

6

4.6.2.3 Properties of electromagnetic waves 2

Question 32

March 2010 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Different types of electromagnetic radiation have different hazards.

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

A microwaves

B ultraviolet rays

C visible light

D X-rays

	Possible hazard
1	could cause skin cancer during sunbathing
2	could cause blindness if you look directly at the Sun
3	could kill cells deep inside your body
4	could damage your brain while using a mobile phone

4.6.2.3 Properties of electromagnetic waves 2

Question 33

March 2010 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The table shows part of the electromagnetic spectrum.

Gamma		Ultraviolet		Infra red		Radio

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

A gamma

B infra red

C radio

D ultraviolet

The part of the electromagnetic spectrum with the longest wavelengths is . . . **1** . . . .

Between X-rays and visible light in the electromagnetic spectrum is . . . **2** . . . radiation.

Some radioactive isotopes emit . . . **3** . . . radiation.

Signals can be sent from remote controls to a television by . . . **4** . . . radiation.

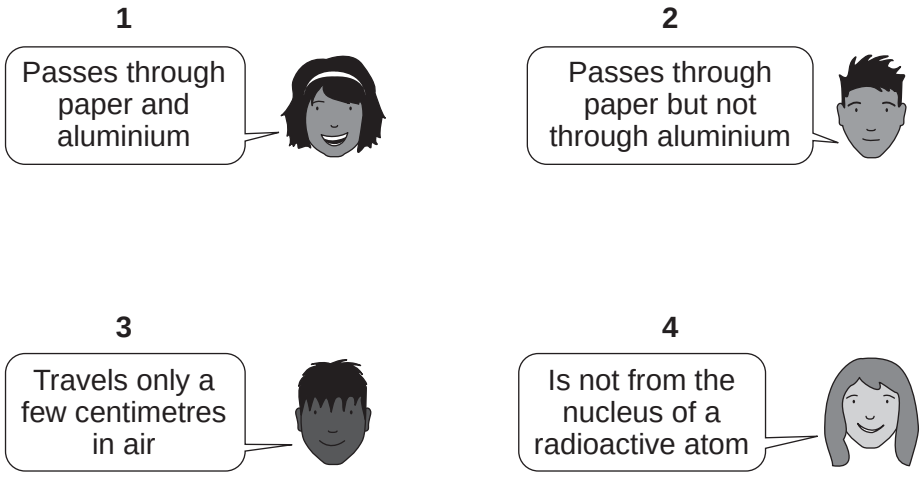
4.6.2.3 Properties of electromagnetic waves 2

Question 34

June 2010 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

Four students are describing the properties of different types of radiation.



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

A alpha

B beta

C gamma

D X-rays

4.6.2.3 Properties of electromagnetic waves 2

Question 35

June 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The table gives uses for four types of radiation.

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

A alpha

B beta

C gamma

D X-rays

	Use
1	in medical tracers
2	in smoke detectors
3	to control the thickness of paper during manufacture
4	usually used to take shadow photographs of bones

4.6.2.3 Properties of electromagnetic waves 2

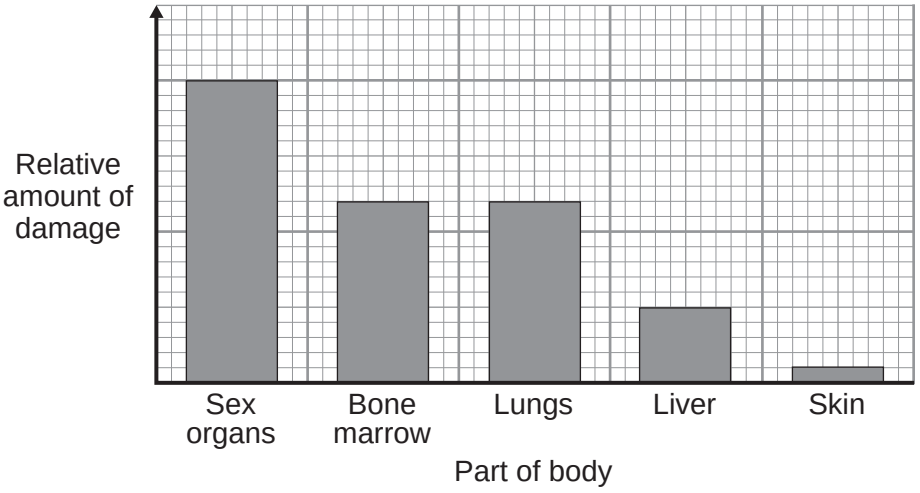
Question 36

June 2010 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

In 1920, scientists investigated the effect of radiation on different parts of the body. They found that some parts of the body were more affected by radiation than others.

The bar chart compares the relative amounts of damage to different parts of the body when they were exposed to the same radiation dose.



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

A categoric

B control

C dependent

D reliable

The radiation dose to which the body is exposed is the . . . **1** . . . variable.

The data is shown as a bar chart because one of the variables is . . . **2** . . . .

The relative amount of damage is the . . . **3** . . . variable.

If scientists repeated the investigation today and got similar results, this would show that the original data was . . . **4** . . . .

4.6.2.3 Properties of electromagnetic waves 2

Question 37

November 2010 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Different types of electromagnetic radiation affect living tissue and cells in different ways.

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

A infra red

B ultraviolet

C visible light

D X-rays

	The radiation . . .
1	can be felt by the skin as heat.
2	can pass through fleshy tissue but is absorbed by bone.
3	can be detected by special cells in the eye.
4	can be absorbed by the skin and cause a suntan.

4.6.2.3 Properties of electromagnetic waves 2

Question 38

3 (a) The names of the three types of nuclear radiation are given in **List A**.
Some properties of these types of radiation are given in **List B**.

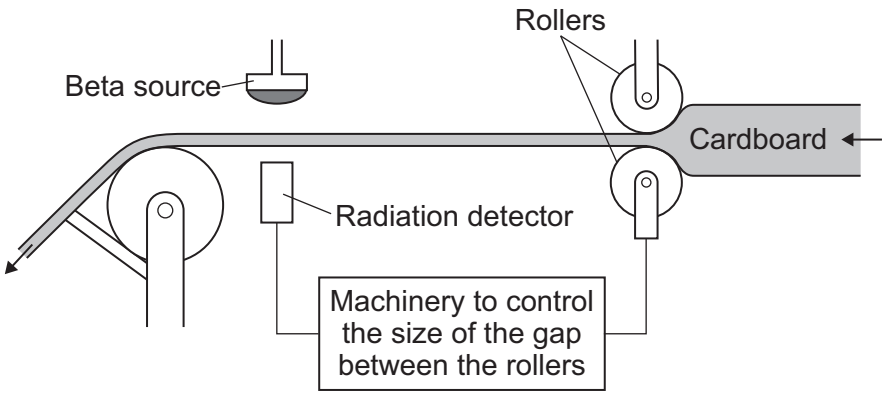
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

Draw only **three** lines.

List A **Type of nuclear radiation**	**List B** **Property of radiation**
Alpha	Has the same mass as an electron
Beta	Very strongly ionising
Gamma	Passes through 10 cm of aluminium
	Deflected by a magnetic field but not deflected by an electric field

(3 marks)

3 (b) The diagram shows a system used to control the thickness of cardboard as it is made.



4.6.2.3 Properties of electromagnetic waves 2

Question 38 · continued January 2011 | PHY1F | Original Q3 | Legacy

The cardboard passes through a narrow gap between a beta radiation source and a radiation detector.

The table gives the detector readings over 1 hour.

Time	Detector reading
08:00	150
08:15	148
08:30	151
08:45	101
09:00	149

3 (b) (i) Between 08:00 and 08:30, the cardboard is produced at the usual, correct thickness.

Explain how you can tell from the detector readings that the cardboard produced at 08:45 is thicker than usual.

.....

.....

.....

.....

(2 marks)

3 (b) (ii) Which would be the most suitable half-life for the beta source?

Draw a ring around your answer.

six days **six months** **six years**

(1 mark)

3 (b) (iii) This control system would **not** work if the beta radiation source was replaced by an alpha radiation source.

Why not?

.....

.....

(1 mark)

7

4.6.2.3 Properties of electromagnetic waves 2

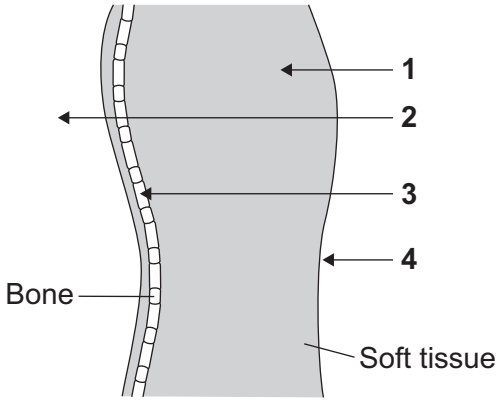
Question 39

June 2011 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The human body can be exposed to different types of radiation.

The arrows on the diagram show how far four types of radiation would penetrate.



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

A alpha

B beta

C gamma

D X-rays

4.6.2.3 Properties of electromagnetic waves 2

Question 40

QUESTION THREE

Electromagnetic waves can be dangerous.

People using electromagnetic waves have to protect themselves.

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

A leaving the room to switch on the equipment

B looking through blackened glass

C wearing thick, insulating gloves

D using remotely controlled equipment

An astronomer watching an eclipse of the Sun protects his eyes by . . . **1** . . . .

A radiographer taking X-rays of patients protects herself by . . . **2** . . . .

A steelworker opening the door of a furnace protects himself by . . . **3** . . . .

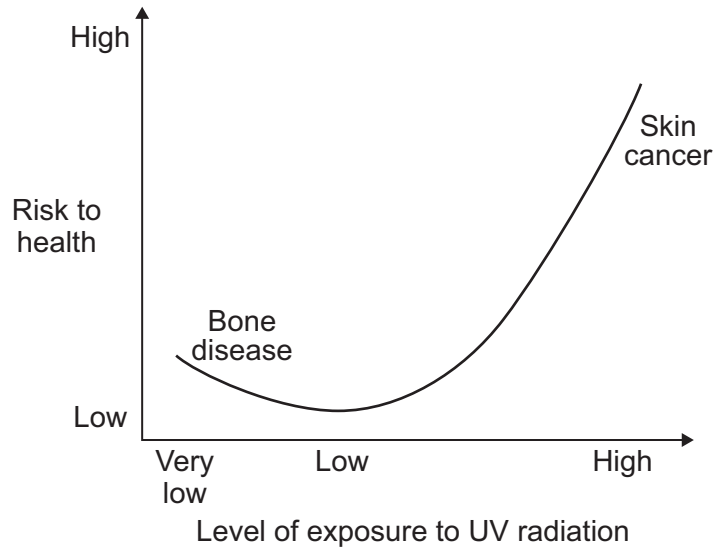
A scientist working with radioactive materials protects himself by . . . **4** . . . .

4.6.2.3 Properties of electromagnetic waves 2

Question 41

3 Exposure to ultraviolet (UV) radiation can harm a person's health.

The graph shows how the risk to health depends on the level of exposure to UV.



3 (a) What level of exposure to UV radiation gives the highest health risk?

Draw a ring around your answer.

very low **low** **high**

(1 mark)

3 (b) The body needs vitamin D to prevent bone disease. The ultraviolet radiation in sunlight enables the body to produce vitamin D. Some people hardly ever go outside into direct sunlight.

3 (b) (i) Complete the following sentence by drawing a ring around the line in the box that is correct.

Staying inside will

reduce
not affect
increase

the risk of developing skin cancer.

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 41 · continued

3 (b) (ii) How will staying inside affect the risk of developing bone disease?

.....

Give a reason for your answer.

.....

.....

(2 marks)

4

Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

Question 42

November 2011 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about nuclear and electromagnetic radiation.

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

A alpha particle

B beta particle

C gamma ray

D X-rays

1	an electromagnetic wave emitted from the nucleus of an atom
2	an electron from the nucleus of an atom
3	absorbed by bone but not absorbed by soft tissue
4	very good at ionising the atoms of a gas

4.6.2.3 Properties of electromagnetic waves 2

Question 43

November 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

X-rays are useful for obtaining images of internal parts of the body. However, there are dangers from exposure to X-rays.

8A 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.

8B 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

8C 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 %

4.6.2.3 Properties of electromagnetic waves 2

Question 43 · continued

8D 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.

Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

Question 44

June 2012 | PH2FP | Original Q6 | Legacy

6 The table shows the average background radiation dose from various sources that a person living in the UK receives in one year.

Source of background radiation	Average radiation dose received each year in dose units
Cosmic rays (from space)	300
Food and drink	250
Medical treatments (including X-rays)	350
Radon gas	1250
Rocks	350
TOTAL	2500

6 (a) (i) A student looked at the data in the table and then wrote down four statements.

Only **two** of the statements are true.

Put a tick (✓) in the boxes next to the **two** true statements.

More than half of the average radiation dose comes from radon gas. ☐

On average, cosmic rays produce less background radiation than rocks. ☐

Everyone living in the UK receives the same background radiation dose. ☐

Having no X-rays reduces a person's radiation dose. ☐

(2 marks)

6 (a) (ii) Each time a chest X-ray is taken, the patient receives about 100 units of radiation.

How many chest X-rays would just exceed the yearly average dose for medical treatments?

.....

Number of chest X-rays = ...

(2 marks)

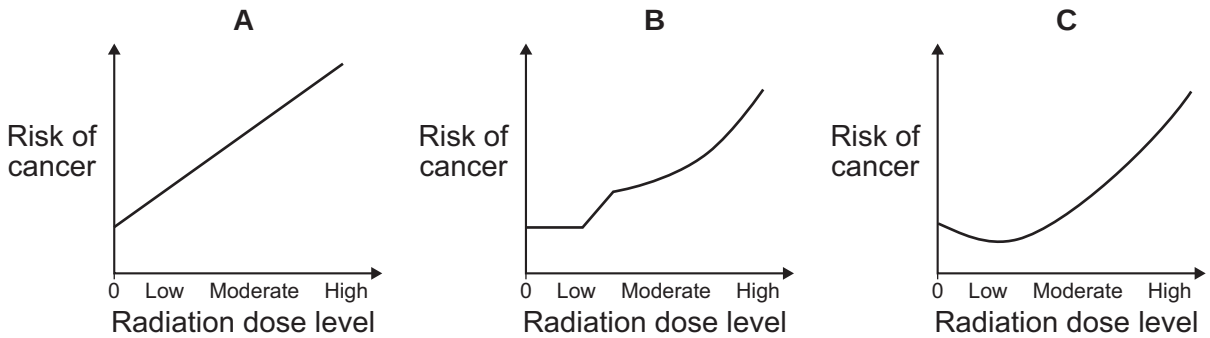
Question 6 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 44 · continued

6 (b) Exposure to radiation can cause cancer.

The graphs, **A**, **B** and **C**, show three different ways that the exposure to radiation and the risk of getting cancer could be linked.



6 (b) (i) What do all three of these graphs suggest happens to the risk of getting cancer when the radiation dose goes from moderate to high?

.....

.....

(1 mark)

6 (b) (ii) Some scientists believe that exposure to **low** radiation doses reduces the chance that a person will get cancer. This effect is called 'radiation hormesis'.

Which **one** of the graphs, **A**, **B** or **C**, shows 'radiation hormesis'?

Write your answer in the box. ☐

Give a reason for your answer.

.....

.....

.....

(2 marks)

4.6.2.3 Properties of electromagnetic waves 2

Question 44 · continued June 2012 | PH2FP | Original Q6 | Legacy

6 (c) Scientists did an experiment in which mice were exposed to different doses of radiation.

The results from the experiment are given in the table.

Description of exposure	Percentage of mice getting cancer
Mice exposed to a low dose of radiation and then a high dose of radiation.	16%
Mice exposed to a high dose of radiation only.	46%

6 (c) (i) Do the results from this experiment provide evidence to support 'radiation hormesis'?

Draw a ring around your answer. NO YES

Explain the reason for your answer.

.....

.....

.....

.....

.....

(2 marks)

6 (c) (ii) Complete the following sentence by drawing a ring around the correct word in the box.

Using animals in scientific experiments raises | environmental / ethical / social | issues.

(1 mark)

10

4.6.2.3 Properties of electromagnetic waves 2

Question 45

June 2013 | PH2FP | Original Q1 | Legacy

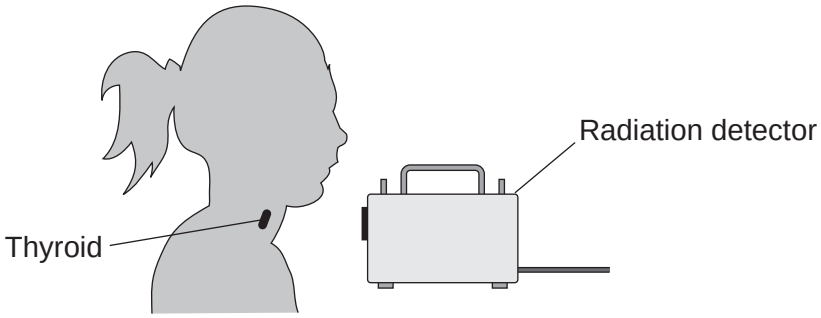
1 (a) The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B.**

Draw **one** line from each type of radiation in **List A** to its correct property in **List B**.

List A Type of radiation	List B Property of radiation
	will pass through paper but is stopped by thin metal
alpha	
	has the shortest range in air
beta	
	will not harm human cells
gamma	
	is very weakly ionising

(3 marks)

1 (b) The radioactive isotope iodine-123 can be used by a doctor to examine the thyroid gland of a patient. The iodine, taken as a tablet, is absorbed by the thyroid gland. The gamma radiation emitted as the iodine atoms decay is detected outside the body.



The doctor uses an isotope emitting gamma radiation to examine the thyroid gland rather than an isotope emitting alpha or beta radiation.

Which **one** of the following gives a reason why gamma radiation is used?

Tick (✓) **one** box.

Gamma radiation will pass through the body. ☐

Gamma radiation is not deflected by a magnet. ☐

Gamma radiation has a long range in air. ☐

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 45 · continued

1 (c) Iodine-123 has a half-life of 13 hours.

Use a word from the box to complete the sentence.

all	half	most

After 13 hours ..... of the iodine-123 atoms the thyroid absorbed have decayed.

(1 mark)

1 (d) Iodine-123 and iodine-131 are two of the isotopes of iodine.

Draw a ring around the correct answer to complete the sentence.

The nucleus of an iodine-123 atom has the same number of | electrons / neutrons / protons | as the

nucleus of an iodine-131 atom.

(1 mark)

6

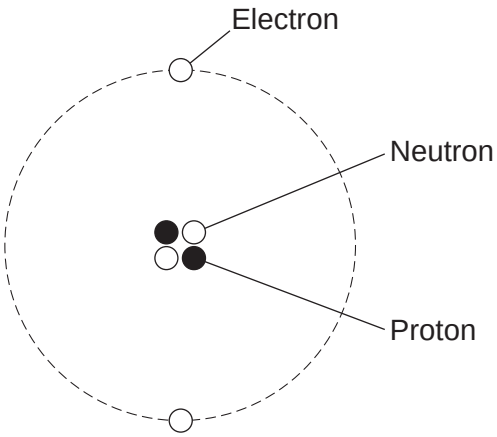
4.6.2.3 Properties of electromagnetic waves 2

Question 46

June 2014 | PH2FP | Original Q5 | Legacy

5 (a) **Figure 9** shows a helium atom.

Figure 9



5 (a) (i) Which **one** of the particles in the atom is **not** charged?

Draw a ring around the correct answer.

[1 mark]

electron **neutron** **proton**

5 (a) (ii) Which **two** types of particle in the atom have the same mass?

[1 mark]

..... and .....

5 (a) (iii) What is the atomic number of a helium atom?

Draw a ring around the correct answer.

[2 marks]

2 **4** **6**

Give a reason for your answer.

.....

.....

4.6.2.3 Properties of electromagnetic waves 2

Question 46 · continued

5 (b) Alpha particles are one type of nuclear radiation.

5 (b) (i) Name **one** other type of nuclear radiation.

[1 mark]

.....

5 (b) (ii) Use the correct answer from the box to complete the sentence.

[1 mark]

electrons	**neutrons**	**protons**

The difference between an alpha particle and a helium atom is that the alpha particle does **not** have any ..... .

5 (b) (iii) Which **one** of the following is a property of alpha particles?

Tick (✓) **one** box.

[1 mark]

Have a long range in air ☐

Are highly ionising ☐

Will pass through metals ☐

Question 5 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 46 · continued

5 (c) Doctors may use nuclear radiation to treat certain types of illness.

Treating an illness with radiation may also harm a patient.

5 (c) (i) Complete the following sentence.

[1 mark]

The risk from treating a patient with radiation is that the radiation may

..... healthy body cells.

5 (c) (ii) Draw a ring around the correct answer to complete the sentence.

[1 mark]

Radiation may be used to treat a patient if the risk from the

radiation is

much bigger than
about the same as
much smaller than

the possible benefit of having the treatment.

9

4.6.2.3 Properties of electromagnetic waves 2

Question 47

June 2015 | PH2FP | Original Q6 | Legacy

6 (a) Radioactive sources that emit alpha, beta or gamma radiation can be dangerous.

What is a possible risk to health caused by using a radioactive source?

[1 mark]

.....

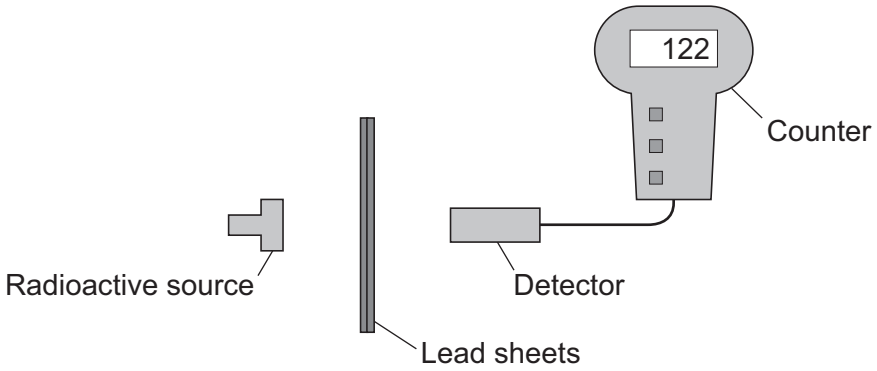
.....

6 (b) In an experiment, a teacher put a 2 mm thick lead sheet in front of a radioactive source. She used a detector and counter to measure the radiation passing through the lead sheet in one minute.

She then put different numbers of lead sheets, each 2 mm thick, in front of the radioactive source and measured the radiation passing through in one minute.

The apparatus the teacher used is shown in **Figure 7**.

Figure 7



6 (b) (i) When using a radioactive source in an experiment, how could the teacher reduce the risk to her health?

Suggest **one** way.

[1 mark]

.....

.....

Question 6 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 47 · continued

6 (b) (ii) The number recorded on the counter is actually higher than the amount of radiation detected from the source.

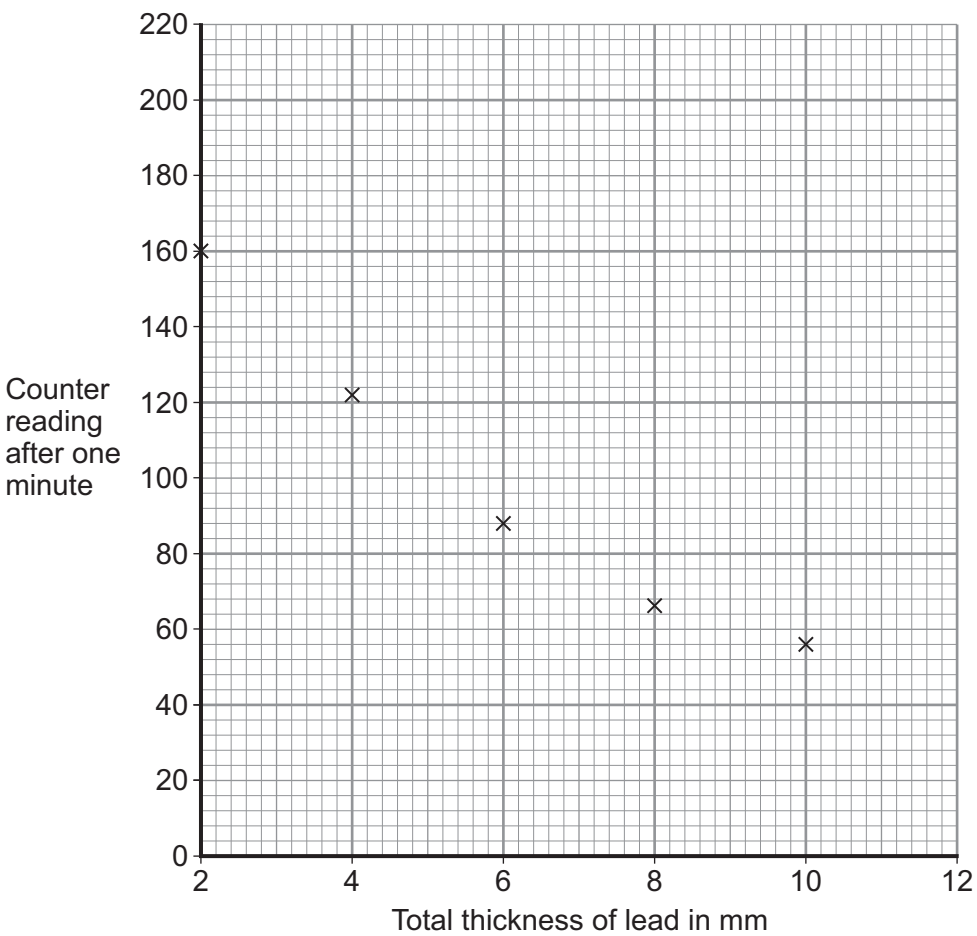
Complete the following word equation.

[1 mark]

The number recorded on the counter	=	The amount of radiation detected from the source	+	..... radiation

6 (c) The readings taken by the teacher are plotted in **Figure 8**.

Figure 8



6 (c) (i) Draw a line of best fit to complete **Figure 8**.

[1 mark]

4.6.2.3 Properties of electromagnetic waves 2

Question 47 · continued

6 (c) (ii) How does the amount of radiation **absorbed** by the lead change as the total thickness of the lead is increased?

[1 mark]

.....

.....

6 (c) (iii) Use **Figure 8** to estimate the reading on the counter when the total thickness of the lead is increased to 12 mm.

[1 mark]

Estimated counter reading = ...

6 (d) What type of radiation was emitted from the radioactive source?

[2 marks]

Draw a ring around the correct answer.

alpha **beta** **gamma**

Give a reason for your answer.

.....

.....

8

4.6.2.3 Properties of electromagnetic waves 2

Question 48

June 2015 | PH3FP | Original Q9 | Legacy

9 (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 ..... .

9 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Figure 17 shows one medical use of ultrasound and one medical use of X-rays.

Figure 17





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]

.....

.....

.....

.....

.....

.....

.....

.....

4.6.2.3 Properties of electromagnetic waves 2

Question 49

June 2016 | PH2FP | Original Q9 | Legacy

9 Alpha particles, beta particles and gamma rays are types of nuclear radiation.

9 (a) Describe the structure of an alpha particle.

[1 mark]

_____

_____

9 (b) Nuclear radiation can change atoms into ions by the process of ionisation.

9 (b) (i) Which type of nuclear radiation is the least ionising?

[1 mark]

Tick (✓) **one** box.

alpha particles ☐ beta particles ☐ gamma rays ☐

9 (b) (ii) What happens to the structure of an atom when the atom is ionised?

[1 mark]

_____

_____

9 (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]

_____

_____

4.6.2.3 Properties of electromagnetic waves 2

Question 49 · continued

9 (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

4.6.2.3 Properties of electromagnetic waves 2

Question 50

June 2016 | PH3FP | Original Q2 | Legacy

2 **Figure 2** shows an X-ray of an arm with a broken bone.

Figure 2



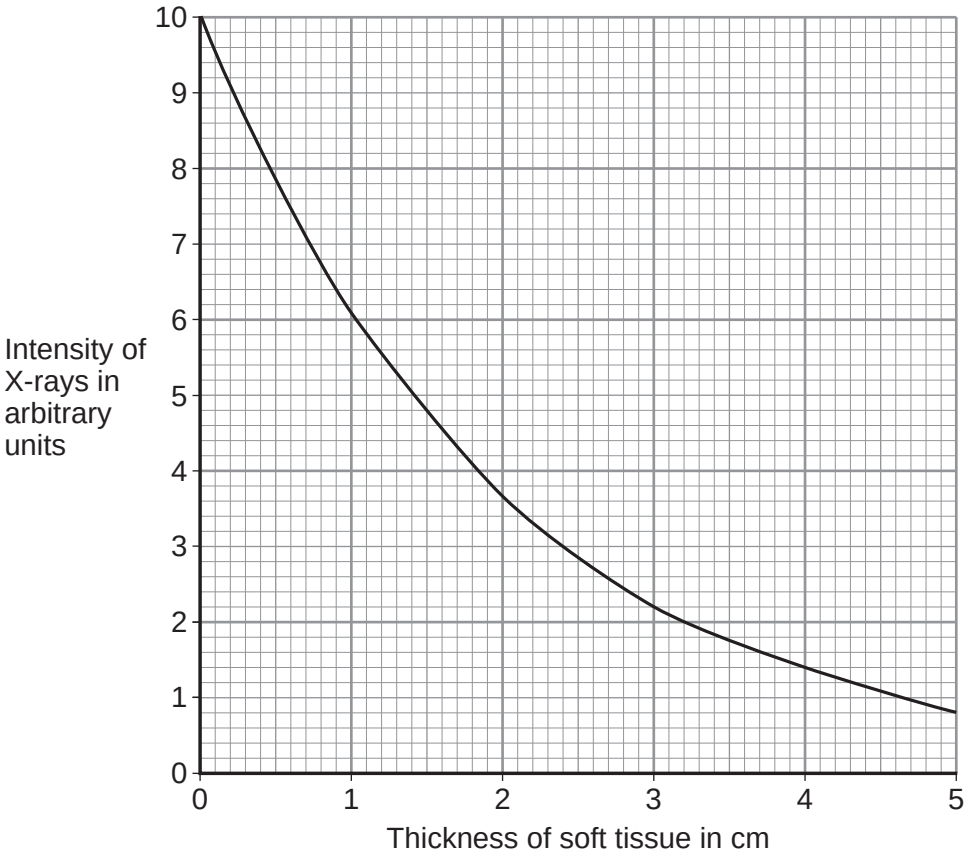
2 (a) Complete the following sentence.

[1 mark]

X-rays are part of the _____ spectrum.

2 (b) **Figure 3** shows how the intensity of the X-rays changes as they pass through soft tissue and reach a detector.

Figure 3



4.6.2.3 Properties of electromagnetic waves 2

Question 50 · continued

2 (b) (i) Use **Figure 3** to determine the intensity of X-rays reaching the detector for a 3 cm thickness of soft tissue.

[1 mark]

Intensity of X-rays = _____ arbitrary units

2 (b) (ii) Describe how the thickness of soft tissue affects the intensity of the X-rays.

[2 marks]

_____

_____

_____

_____

2 (b) (iii) The data in **Figure 3** are shown as a line graph and not as a bar chart.

Choose the reason why.

[1 mark]

Tick (✓) **one** box.

Both variables are categoric ☐

Both variables are continuous ☐

One variable is continuous and one is categoric ☐

2 (c) What happens to X-rays when they enter a bone?

[1 mark]

_____

_____

Question 2 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 50 · continued

2 (d) How are images formed electronically in a modern X-ray machine?

[1 mark]

Tick (✓) **one** box.

With a charge-coupled device (CCD) ☐

With an oscilloscope ☐

With photographic film ☐

2 (e) Radiographers who take X-ray photographs may be exposed to X-rays.

2 (e) (i) X-rays can increase the risk of the radiographer getting cancer.

Why can X-rays increase the risk of getting cancer?

[1 mark]

Tick (✓) **one** box.

X-rays travel at the speed of light ☐

X-rays can travel through a vacuum ☐

X-rays are ionising ☐

2 (e) (ii) What should the radiographer do to reduce the risk from X-rays?

[1 mark]

_____

_____

9

4.6.2.3 Properties of electromagnetic waves 2

Question 51

June 2018 | 8463/1F | Original Q11

1 1 A teacher used a Geiger-Muller tube and counter to measure the number of counts in 60 seconds for a radioactive rock.

1 1 . 1 The counter recorded 819 counts in 60 seconds. The background radiation count rate was 0.30 counts per second.

Calculate the count rate for the rock.

[3 marks]

Count rate = _____ per second

1 1 . 2 A householder is worried about the radiation emitted by the granite worktop in his kitchen.

1 kg of granite has an activity of 1250 Bq. The kitchen worktop has a mass of 180 kg.

Calculate the activity of the kitchen worktop in Bq.

[2 marks]

Activity = _____ Bq

4.6.2.3 Properties of electromagnetic waves 2

Question 51 · continued

1 1 . 3 The average total radiation dose per year in the UK is 2.0 millisieverts.

Table 2 shows the effects of radiation dose on the human body.

Table 2

Radiation dose in millisieverts	Effects
10 000	Immediate illness; death within a few weeks
1000	Radiation sickness; unlikely to cause death
100	Lowest dose with evidence of causing cancer

The average radiation dose from the granite worktop is 0.003 millisieverts per day.

Explain why the householder should **not** be concerned about his yearly radiation dose from the granite worktop.

One year is 365 days.

[2 marks]

1 1 . 4 Bananas are a source of background radiation. Some people think that the unit of radiation dose should be changed from sieverts to Banana Equivalent Dose.

Suggest **one** reason why the Banana Equivalent Dose may help the public be more aware of radiation risks.

[1 mark]

8

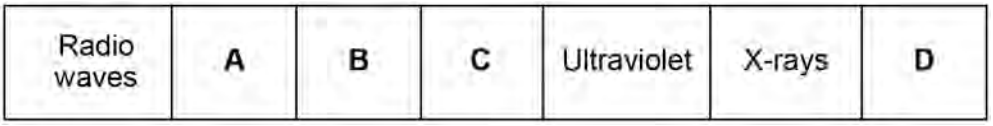
4.6.2.3 Properties of electromagnetic waves 2

Question 52

June 2018 | 8463/2F | Original Q8

0 8 **Figure 10** shows the position of three types of wave in the electromagnetic spectrum.

Figure 10



0 8 . 1 Which position shows where visible light is in the spectrum?

Tick **one** box.

[1 mark]

A ☐ **B** ☐ **C** ☐ **D** ☐

0 8 . 2 Which **one** of the statements about electromagnetic waves is correct?

Tick **one** box.

[1 mark]

Radio waves have a higher frequency than X-rays. ☐

Radio waves have a longer wavelength than ultraviolet. ☐

X-rays have a longer wavelength than radio waves. ☐

X-rays travel faster through the air than ultraviolet. ☐

0 8 . 3 Give **one** possible danger of exposing your skin to ultraviolet radiation.

[1 mark]

4.6.2.3 Properties of electromagnetic waves 2

Question 52 · continued

0 8 . 4 Having an X-ray taken exposes a person to ionising radiation.

Table 3 gives the average radiation dose for an X-ray of the chest and an X-ray of the upper digestive system.

Table 3

Part of the body	Radiation dose in millisieverts (mSv)
Upper digestive system	5.0
Chest	0.1

The risk of an X-ray causing cancer is about 1 in 20 000 for each mSv of radiation received.

Compare the risk of developing cancer from having an X-ray of the upper digestive system with the risk from having an X-ray of the chest.

Use the data in **Table 3**.

[2 marks]

5

4.6.2.3 Properties of electromagnetic waves 2

Question 53

June 2019 | 8463/1F | Original Q2

0 2 Polonium-210 ($^{210}_{84}Po$) is a radioactive isotope that decays by emitting alpha radiation.

0 2 . 1 Which is the correct decay equation for polonium-210?

[1 mark]

Tick (✓) **one** box.

$^{210}_{84}Po \rightarrow {}^{214}_{86}X + {}^{4}_{2}He$ ☐

$^{210}_{84}Po \rightarrow {}^{206}_{86}X + {}^{4}_{2}He$ ☐

$^{210}_{84}Po \rightarrow {}^{206}_{82}X + {}^{4}_{2}He$ ☐

0 2 . 2 Why is alpha radiation dangerous inside the human body?

[1 mark]

Tick (✓) **one** box.

Alpha radiation is electromagnetic radiation. ☐

Alpha radiation is highly ionising. ☐

Alpha radiation is very penetrating. ☐

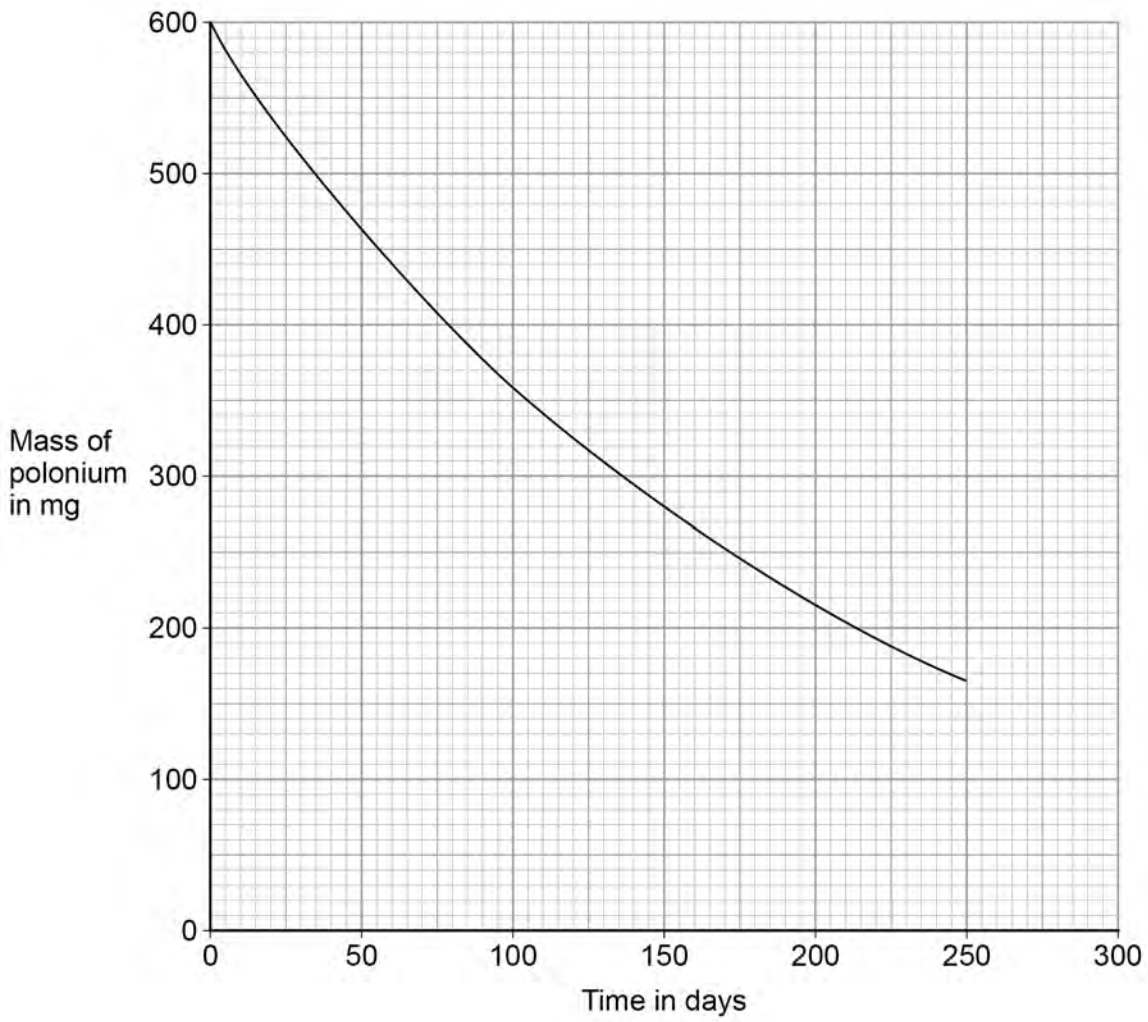
Question 2 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 53 · continued

Figure 3 shows how the mass of a sample of polonium-210 changes with time.

Figure 3



0 2 . 3 Determine the change in mass of the sample of polonium-210 between 50 and 150 days.

[2 marks]

Change in mass = _____ mg

4.6.2.3 Properties of electromagnetic waves 2

Question 53 · continued

0 2 . 4 Estimate the mass of polonium-210 remaining after 300 days.

[1 mark]

Mass = _____ mg

0 2 . 5 Nuclear radiation can cause ionisation.

Complete the sentences.

Choose answers from the box.

[2 marks]

a negative	**an electron**	**a neutron**	**a positive**	**a proton**	**a zero**

An atom becomes an ion when it loses _____.

The resulting ion has _____ charge.

7

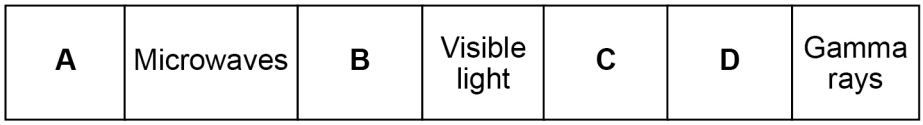
4.6.2.3 Properties of electromagnetic waves 2

Question 54

November 2020 | 8463/2F | Original Q6

0 6 . 1 **Figure 10** shows the position of three types of wave in the electromagnetic spectrum.

Figure 10



Which letter represents the position of X-rays in the electromagnetic spectrum?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Question 6 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 54 · continued

A doctor needs to obtain an image of a bone in a patient's injured arm.

The doctor takes an X-ray of the arm.

0 6 . 2 Give **one** possible harmful consequence of receiving a dose of X-ray radiation.

[1 mark]

Table 3 gives information about two methods of bone imaging.

Table 3

Method	Radiation dose in millisieverts
X-ray of arm	0.1
CT scan of arm	6.0

0 6 . 3 Compare the risk of harm to the patient of having an X-ray rather than a CT scan.

[2 marks]

4.6.2.3 Properties of electromagnetic waves 2

Question 54 · continued

November 2020 | 8463/2F | Original Q6

0 6 . 4 Which of the following is the same as 6.0 millisieverts?

[1 mark]

Tick (✓) **one** box.

- 0.60 sieverts ☐
- 0.060 sieverts ☐
- 0.0060 sieverts ☐
- 0.00060 sieverts ☐

0 6 . 5 The patient received a total radiation dose of 2.5 millisieverts during one year.

Calculate the percentage of this dose that came from one X-ray of the arm.

Use the data in **Table 3**.

[2 marks]

Percentage = _____ %

7

4.6.2.3 Properties of electromagnetic waves 2

Question 55

June 2022 | 8463/1F | Original Q4

0 4 Radioactive isotopes emit different types of nuclear radiation.

0 4 . 1 What does an alpha particle consist of?

[1 mark]

Tick (✓) **one** box.

- 2 protons and 2 electrons ☐
- 2 protons and 2 neutrons ☐
- 4 protons ☐
- 4 neutrons ☐

0 4 . 2 What is a beta particle?

[1 mark]

Tick (✓) **one** box.

- An electron ☐
- A neutron ☐
- Electromagnetic radiation ☐

0 4 . 3 A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

What is the correct equation for this decay?

[1 mark]

Tick (✓) **one** box.

- $^{85}_{36}Kr + {}^{0}_{-1}e \longrightarrow {}^{85}_{37}Rb$ ☐
- $^{85}_{36}Kr \longrightarrow {}^{85}_{37}Rb + {}^{0}_{-1}e$ ☐
- $^{85}_{37}Rb \longrightarrow {}^{85}_{36}Kr + {}^{0}_{-1}e$ ☐

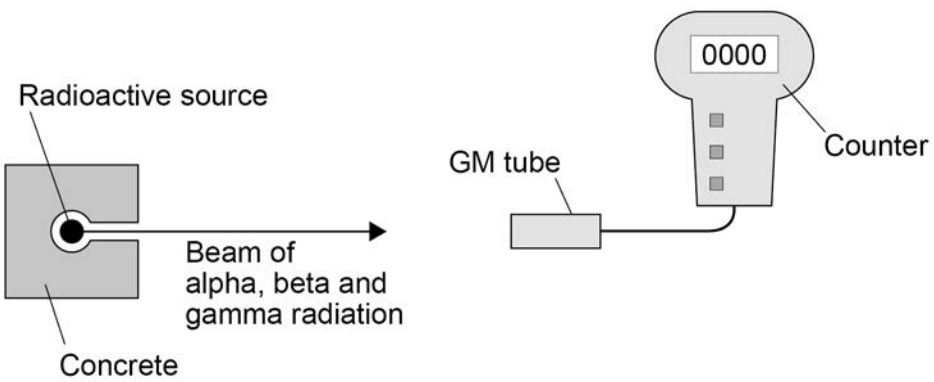
4.6.2.3 Properties of electromagnetic waves 2

Question 55 · continued

0 4 . 4 **Figure 5** shows an experiment to demonstrate how alpha, beta and gamma radiation penetrate different materials.

The experiment takes place in a vacuum.

Figure 5



Three different materials are used:

- a sheet of paper
- a 0.5 cm thick sheet of aluminium
- a 10 cm block of lead.

Each material is placed one at a time between the radioactive source and the GM tube.

The GM tube and counter show whether the material has stopped the radiation.

Complete **Table 1** to show how alpha, beta and gamma radiation penetrate the materials in **Figure 5**.

Use the words **Yes** and **No**.

Part of **Table 1** has been completed for you.

[3 marks]

Table 1

Type of radiation	Most radiation is stopped by:		
	the sheet of paper	the sheet of aluminium	the block of lead
Alpha			Yes
Beta	No		
Gamma		No	

4.6.2.3 Properties of electromagnetic waves 2

Question 55 · continued

0 4 . 5 Alpha, beta and gamma radiation have different ionising powers.

Draw **one** line from each radiation type to the correct ionising power.

[3 marks]

Radiation type	Ionising power
Alpha	Zero
Beta	Low
Gamma	Medium
	High

0 4 . 6 Some sources of background radiation are natural and other sources are man-made.

Which of the following is a man-made source of background radiation?

[1 mark]

Tick (✓) **one** box.

Cosmic rays ☐

Nuclear accidents ☐

Rocks ☐

0 4 . 7 The average background radiation dose per year in the UK is 2.0 millisieverts.

A dental X-ray gives a patient a radiation dose of 0.005 millisieverts.

Calculate how many dental X-rays would be the same as the average background radiation dose per year.

[2 marks]

Number of dental X-rays = _____

12

4.6.2.3 Properties of electromagnetic waves 2

Question 56

June 2022 | 8463/2F | Original Q5

0 5 Ultraviolet and visible light are both parts of the electromagnetic spectrum.

0 5 . 1 How does the speed of ultraviolet in a vacuum compare to the speed of visible light in a vacuum?

[1 mark]

Tick (✓) **one** box.

Ultraviolet travels at a faster speed than visible light. ☐

Ultraviolet travels at a slower speed than visible light. ☐

Ultraviolet travels at the same speed as visible light. ☐

0 5 . 2 **Figure 9** shows parts of the electromagnetic spectrum.

Figure 9

Radio waves	A	B	C	D	X-rays	Gamma rays

Which letters represent the positions of ultraviolet and visible light in the electromagnetic spectrum?

[2 marks]

Ultraviolet _____

Visible light _____

4.6.2.3 Properties of electromagnetic waves 2

Question 56 · continued

0 5 . 3 **Table 3** shows the range of wavelengths for different types of ultraviolet.

Table 3

Type	Range of wavelength in nanometres
Ultraviolet **A** (UVA)	315–400
Ultraviolet **B** (UVB)	280–315
Ultraviolet **C** (UVC)	100–280

Determine which type of ultraviolet shown in **Table 3** has the largest range of wavelengths.

To gain full marks you must calculate the range of wavelengths for each type of ultraviolet.

[3 marks]

Type of ultraviolet with the largest range of wavelengths _____

Question 5 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 56 · continued

Figure 10 shows how different types of ultraviolet are absorbed by the ozone layer in the Earth's atmosphere.

Table 4 shows the relative ionising power from each type of ultraviolet.

Figure 10

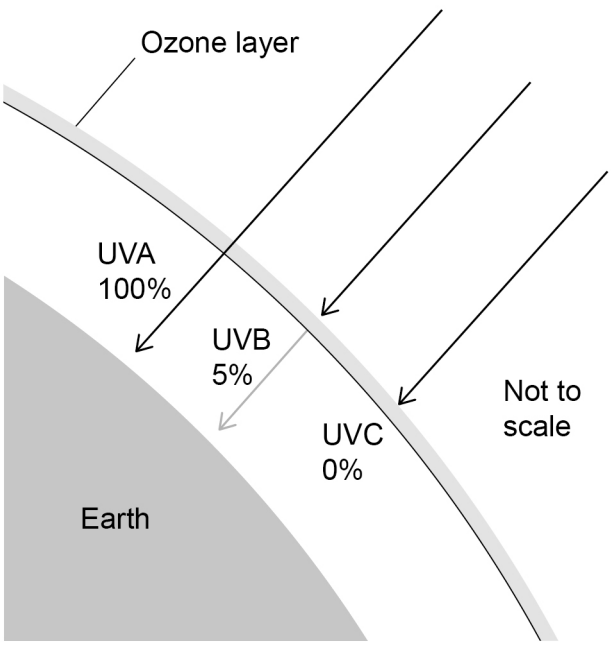


Table 4

Type	Relative ionising power
UVA	Low
UVB	Medium
UVC	High

0 5 . 4 Explain the importance of the ozone layer in reducing the risk to people from all types of ultraviolet.

Use **Figure 10** and **Table 4**.

[4 marks]

4.6.2.3 Properties of electromagnetic waves 2

Question 56 · continued

0 5 . 5 The Sun emits visible light.

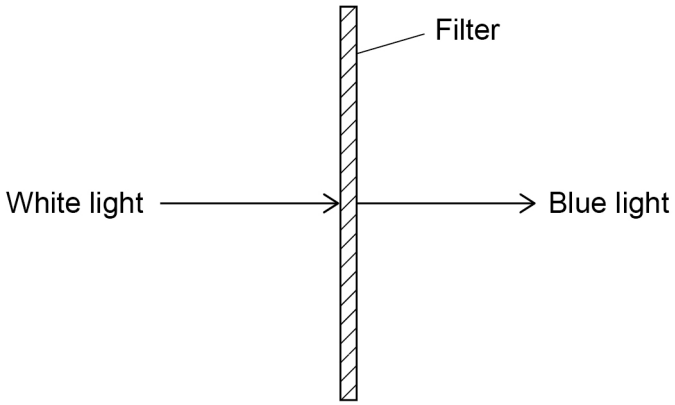
A student concludes that visible light is **not** absorbed by the ozone layer.

Give **one** piece of evidence that shows the student's conclusion is correct.

[1 mark]

0 5 . 6 **Figure 11** shows white light incident on a colour filter.

Figure 11



Complete the sentence.

Choose the answers from the box.

[2 marks]

absorbed	**radiated**	**reflected**	**refracted**	**transmitted**

When white light is incident on the filter, only blue light is _____

and all other colours of light are _____ .

13