AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.3

Properties of electromagnetic waves 2

Past-paper questions

Tier	**Higher**
Question groups	**40**
Available paper years	**2004–2024**

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 01

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;

.....

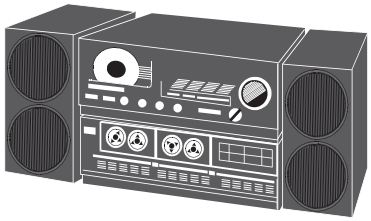
(1 mark)

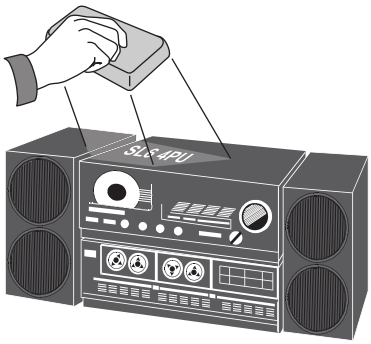
(ii) to send a signal to a TV from a remote control.

.....

(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 01 · 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 02

June 2004 | 3451H | Original Q17 | Legacy

17 (a) A beta particle is a high-energy electron.

(i) Which part of an atom emits a beta particle?

.....

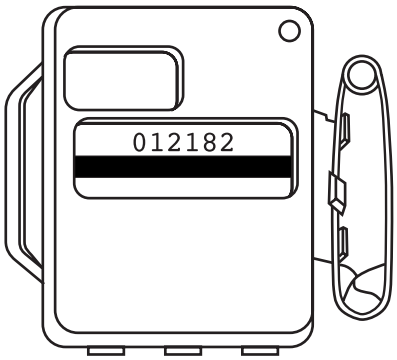
(1 mark)

(ii) How does the composition of an atom change when it emits a beta particle?

.....

(1 mark)

(b) The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

.....

(1 mark)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

.....

.....

(1 mark)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

.....

.....

(1 mark)

5

4.6.2.3 Properties of electromagnetic waves 2

Question 03

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;

.....

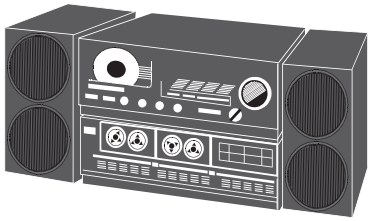
(1 mark)

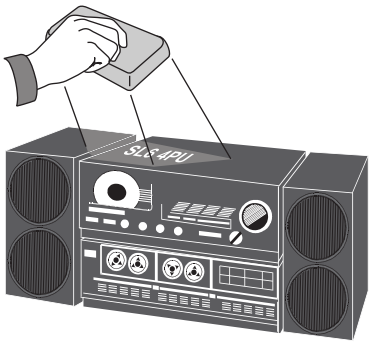
(ii) to send a signal to a TV from a remote control.

.....

(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.

.....

.....

.....

.....

(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 2004 | 3462H3 | Original Q13 | Legacy

13 (a) A beta particle is a high-energy electron.

(i) Which part of an atom emits a beta particle?

.....

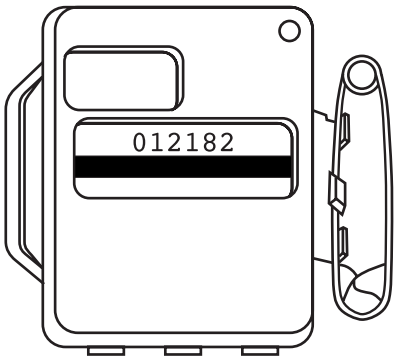
(1 mark)

(ii) How does the composition of an atom change when it emits a beta particle?

.....

(1 mark)

(b) The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

.....

(1 mark)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

.....

.....

(1 mark)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

.....

.....

(1 mark)

5

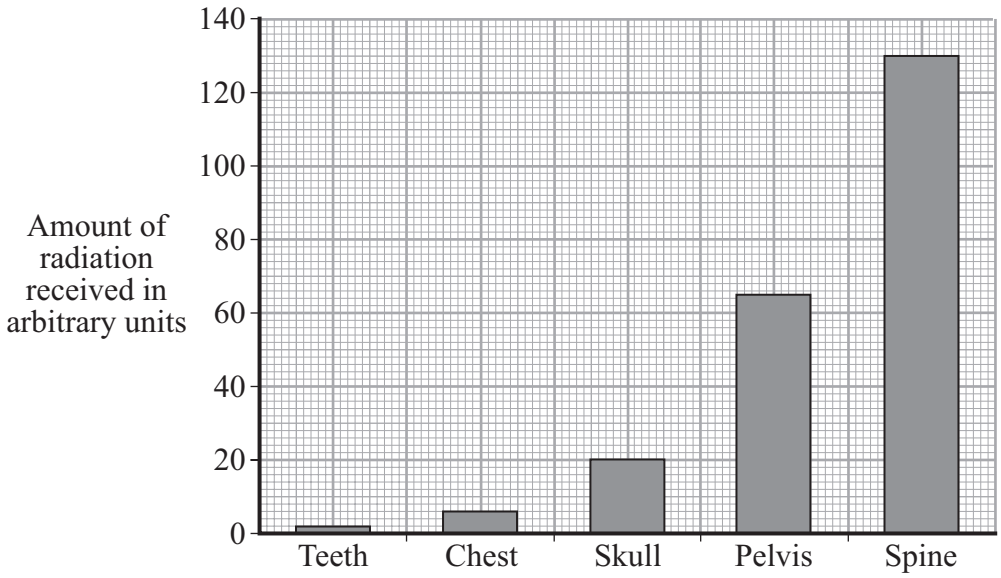
4.6.2.3 Properties of electromagnetic waves 2

Question 05

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** . . . .

4.6.2.3 Properties of electromagnetic waves 2

Question 06

November 2006 | PHY1B | Original Q2 | Legacy

QUESTION TWO

Electromagnetic radiation is often absorbed.

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

A current

B energy

C frequency

D substance

When electromagnetic radiation is absorbed, the . . . **1** . . . which absorbs it becomes hotter. This is because the radiation carries . . . **2** . . . . The radiation may create an alternating . . . **3** . . . with the same . . . **4** . . . as the radiation itself.

Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

Question 07

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 07 · 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.

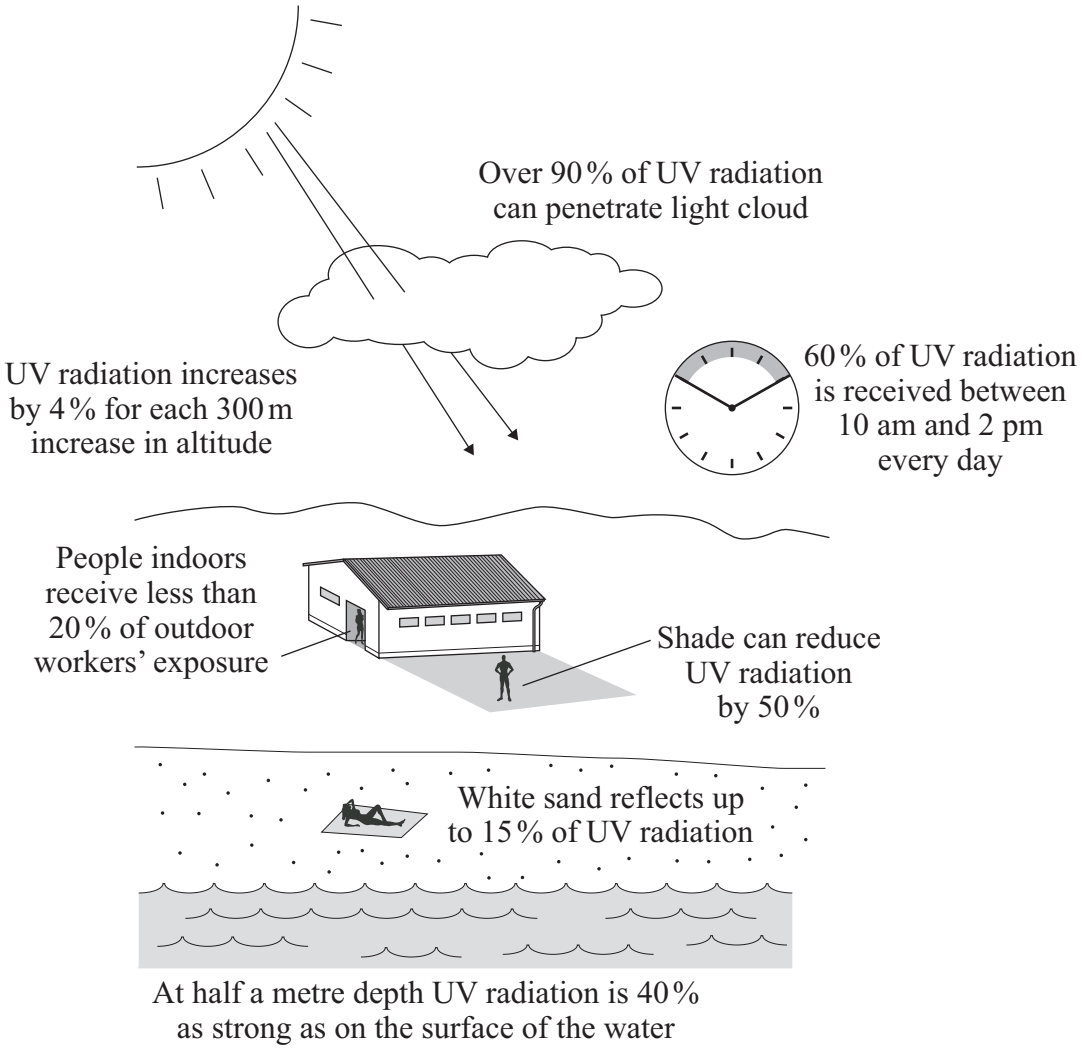
4.6.2.3 Properties of electromagnetic waves 2

Question 08

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 %

4.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

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.

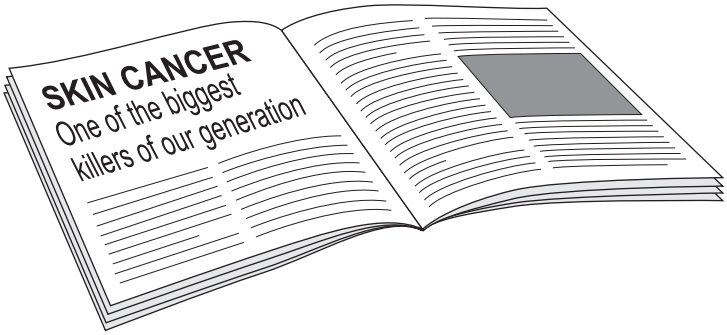
END OF TEST

4.6.2.3 Properties of electromagnetic waves 2

Question 09

January 2007 | PHY1H | Original Q2 | Legacy

2 A headline from a recent magazine article is shown below.



(a) Complete the following sentence.

Skin cancer can be caused by exposure to excess ..... rays from the Sun.

(1 mark)

4.6.2.3 Properties of electromagnetic waves 2

Question 09 · continued

BLANK

(b) Sunscreen should be used to protect your skin from the damaging effects of the Sun. A thick layer of sunscreen should be applied 30 minutes before sunbathing and re-applied every hour.
The protection factor of a sunscreen lets you work out roughly how long you can stay in the Sun without causing damage to your skin. For example, a 'factor 10' sunscreen lets you stay in the Sun for up to ten times longer than if you were not using the sunscreen.

(i) Without sunscreen, a person with fair skin has found that she gets sunburn after 12 minutes of sunbathing.

What is the maximum time that she could sunbathe without burning if she used 'factor 30' sunscreen on her skin?

.....

Maximum time = ...
(1 mark)

(ii) Why does the protection factor give only a rough idea of how long you can sunbathe without getting sunburn?

.....

.....
(1 mark)

(iii) Another person has naturally dark skin.

Suggest why he can sunbathe with less risk of getting skin cancer than a fair-skinned person.

.....

.....

.....

.....
(2 marks)

(c) Most people know that sunbathing can cause skin cancer. But most holidaymakers still like to come home with a suntan.

Why is it important that people understand that there are dangers involved in sunbathing?

.....

.....
(1 mark)

6

4.6.2.3 Properties of electromagnetic waves 2

Question 10

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?

.....

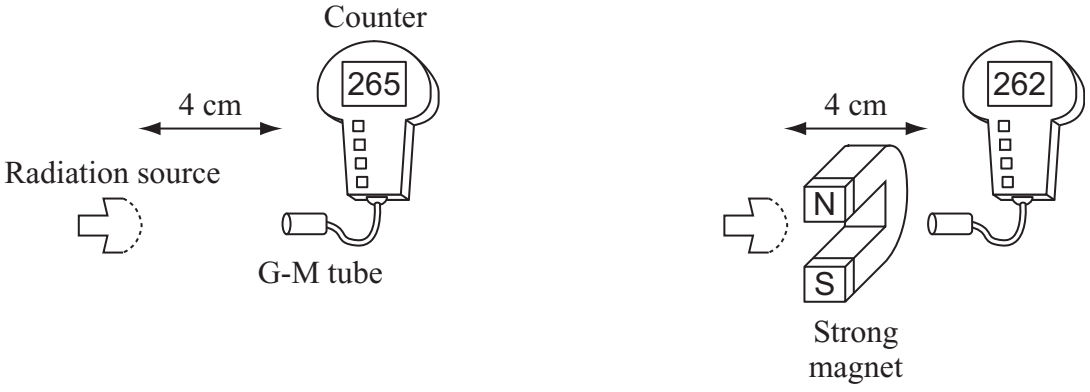
(1 mark)

(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)

4.6.2.3 Properties of electromagnetic waves 2

Question 10 · continued

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(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

4.6.2.3 Properties of electromagnetic waves 2

Question 11

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

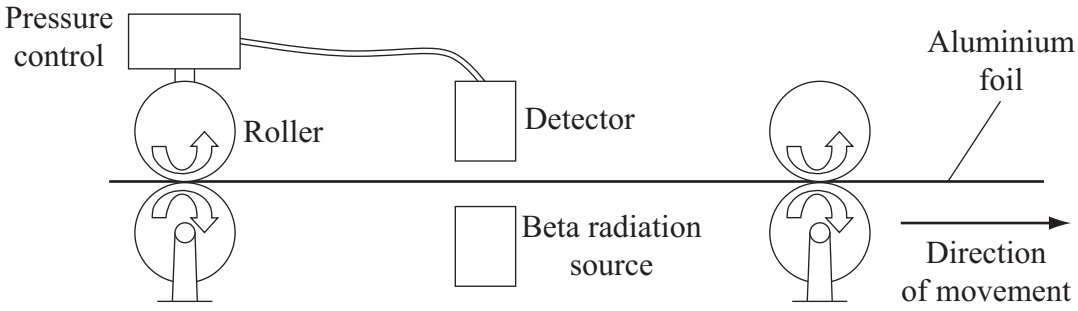
4.6.2.3 Properties of electromagnetic waves 2

Question 12

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.

4.6.2.3 Properties of electromagnetic waves 2

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.

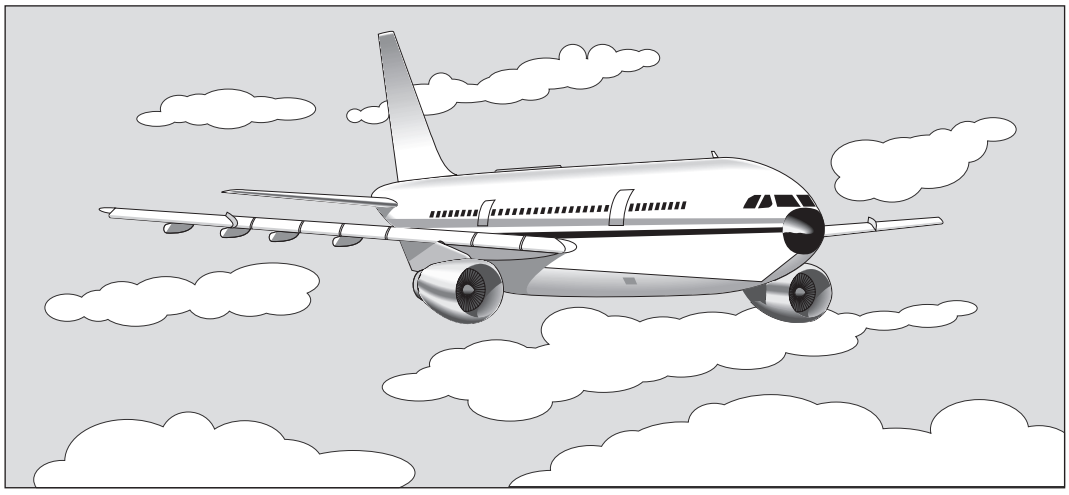
Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

Question 13

March 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE



Everyone is exposed to some nuclear radiation.

Aircrews are exposed to extra nuclear radiation because they spend long periods of time at high altitudes. The doses they receive can be measured in millisieverts (mSv).

The average dose of extra nuclear radiation for cabin crew is 2 mSv per year. A pregnant member of crew will be given a flight schedule of work to avoid a dose higher than 1 mSv per year.

Here is a table of doses per flight from London to various destinations.

Destination	Flight time (h)	Dose (mSv)
Kiev	4	0.018
Los Angeles	13	0.069
Madrid	2	0.010
New York	7	0.042
Paris	1	0.004
Rome	3	0.014
Tokyo	14	0.078

4.6.2.3 Properties of electromagnetic waves 2

Question 13 · continued

9A In order to compare the flight data, it must have been collected under controlled conditions.

Which is the most important factor to control?

1 air temperature

2 altitude

3 wind speed

4 colour of the aircraft

9B The connection, in the given data, between flight time and dose is . . .

1 longer flight, higher dose.

2 longer flight, lower dose.

3 shorter flight, higher dose.

4 that there is no connection.

9C The flight time to Dallas is 10 hours.

The most likely dose of radiation which a member of the air crew receives is . . .

1 0.045 mSv

2 0.050 mSv

3 0.055 mSv

4 0.065 mSv

9D How many times can a pregnant crew member fly **return** from London to Madrid before she has received 1 mSv of radiation?

1 20 times

2 40 times

3 50 times

4 100 times

END OF TEST

4.6.2.3 Properties of electromagnetic waves 2

Question 14

June 2007 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

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

4A 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

4B 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 14 · continued June 2007 | PHY1B | Original Q4 | Legacy

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.

4C 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

4D 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

4.6.2.3 Properties of electromagnetic waves 2

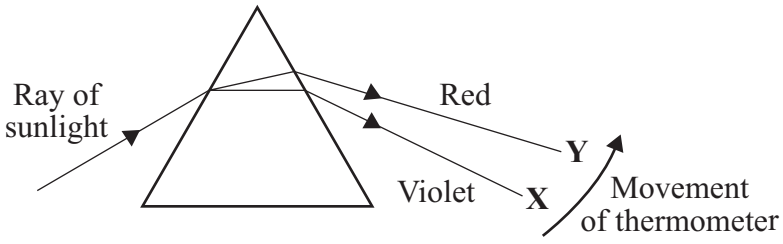
Question 15

June 2007 | PHY1B | Original Q6 | Legacy

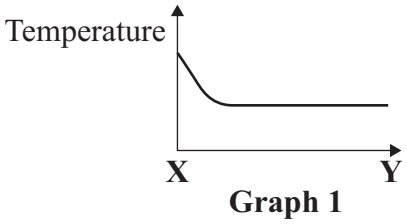
QUESTION SIX

When electromagnetic radiation is absorbed, the energy it carries makes the substance which absorbs it hotter and may create an alternating current of electricity.

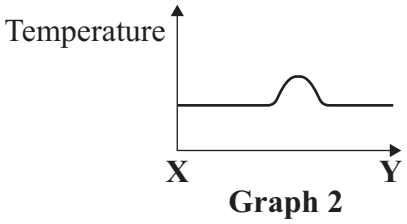
6A When sunlight passes through a prism, a visible spectrum forms. A thermometer is moved slowly from **X** to **Y**.



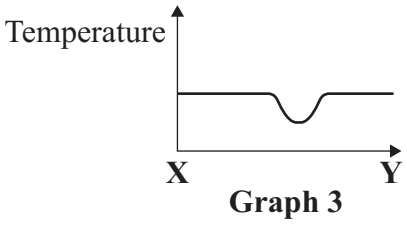
Which sketch graph shows the temperature change as the thermometer moves from **X** to **Y**?



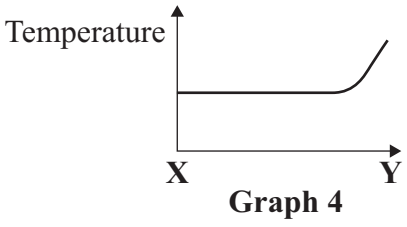
Graph 1



Graph 2



Graph 3



Graph 4

6B The absorption of electromagnetic radiation can create an alternating current in a wire.

This alternating current will have . . .

1 the same frequency as the electromagnetic radiation.

2 the same ionising power as the electromagnetic radiation.

3 the same speed as the electromagnetic radiation.

4 the same wavelength as the electromagnetic radiation.

4.6.2.3 Properties of electromagnetic waves 2

Question 15 · continued

6C Which factors most affect the absorption of electromagnetic radiation by living cells?

1 speed and wavelength

2 speed, wavelength and size of dose

3 wavelength and size of dose

4 size of dose

6D During the solar eclipse of 2001, four students shared their observations.

Which student's observation was correct?

Student	Observation
1	"It went both cold and dark at the same time."
2	"It went cold, then it went dark."
3	"It went cold, then warm again, then dark."
4	"It went dark, then light again, then cold."

4.6.2.3 Properties of electromagnetic waves 2

Question 16

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

4.6.2.3 Properties of electromagnetic waves 2

Question 17

November 2007 | PHY1B | Original Q8 | Legacy

QUESTION EIGHT

A former spy was poisoned with the radioactive isotope polonium-210.

8A Some of the spy's friends were found to be contaminated with polonium-210. They were safe from the radiation unless they had taken some of the polonium-210 into their bodies.

This is because the radiation given off by polonium-210 is . . .

1 alpha particles.

2 beta particles.

3 gamma rays.

4 X-rays.

8B It is difficult to detect the radiation given off by polonium-210 using a detector outside the body because the radiation has . . .

1 high penetrating power.

2 a long range in air.

3 low ionising power.

4 low penetrating power.

8C Scientists carried out many tests at restaurants, hotels and airports. This caused much public anxiety.

Which one of the following statements is true?

1 The particles emitted by polonium-210 are radioactive.

2 Anyone too close to a polonium-210 source will become radioactive.

3 If you swallow polonium-210, it will damage cells in the body.

4 The radiation from polonium-210 makes clothes glow in the dark.

4.6.2.3 Properties of electromagnetic waves 2

Question 17 · continued

8D Another isotope of polonium is polonium-208.

Compared with polonium-210, polonium-208 has . . .

1 more neutrons.

2 fewer neutrons.

3 more protons.

4 fewer protons.

Turn over for the next question

4.6.2.3 Properties of electromagnetic waves 2

Question 18

January 2008 | PHY1H | Original Q5 | Legacy

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)

4.6.2.3 Properties of electromagnetic waves 2

Question 18 · 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

4.6.2.3 Properties of electromagnetic waves 2

Question 19

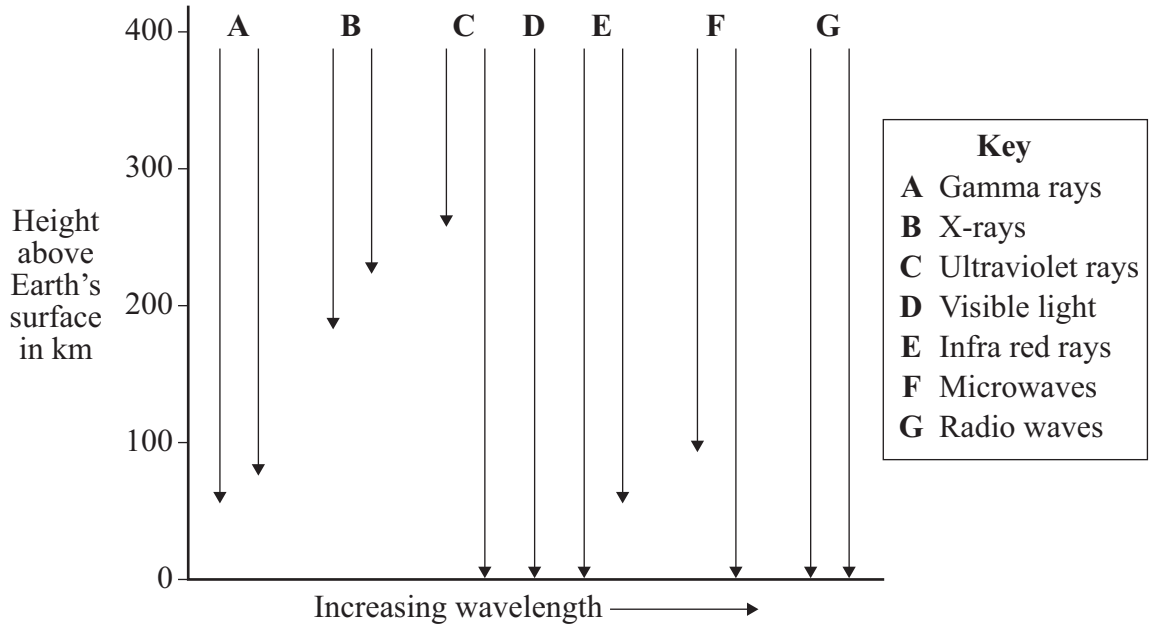
March 2008 | PHY1BP | Original Q9 | Legacy

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

4.6.2.3 Properties of electromagnetic waves 2

Question 19 · continued

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

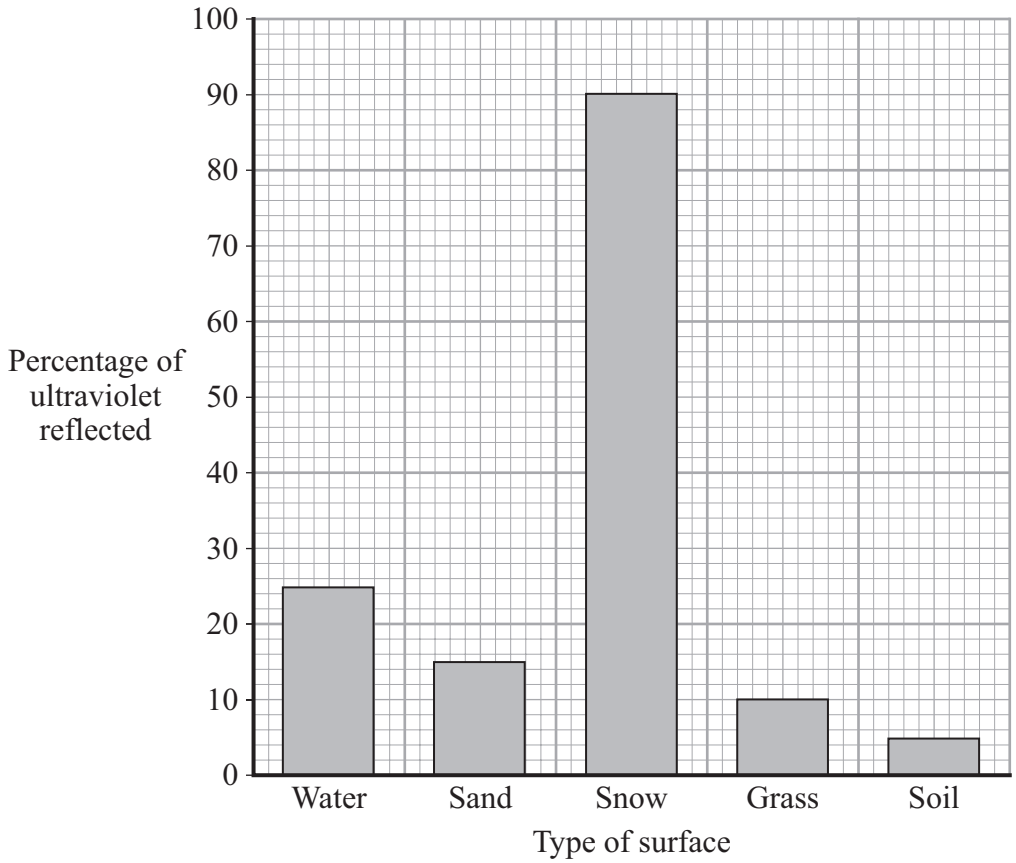
4.6.2.3 Properties of electromagnetic waves 2

Question 20

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

4.6.2.3 Properties of electromagnetic waves 2

Question 20 · continued

for mark

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

.....

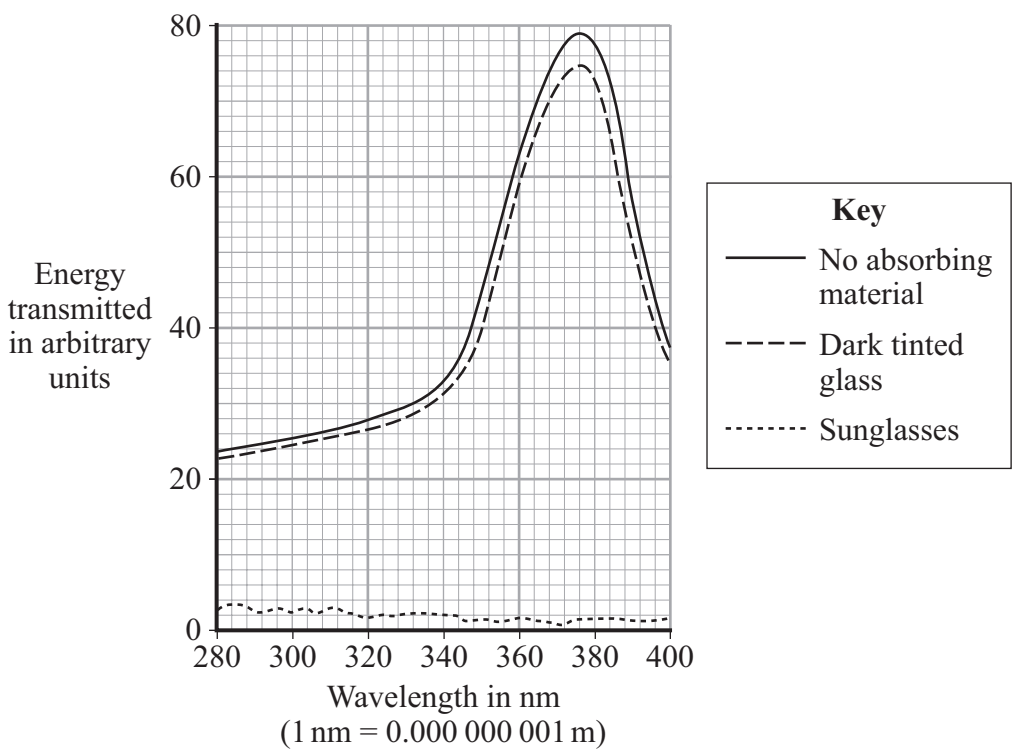
(1 mark)

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.



4.6.2.3 Properties of electromagnetic waves 2

Question 20 · 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

4.6.2.3 Properties of electromagnetic waves 2

Question 21

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

mass number	222
atomic number	86
radiation emitted	alpha particle

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

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

..... inside an atom.

(2 marks)

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

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

..... *(1 mark)*

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

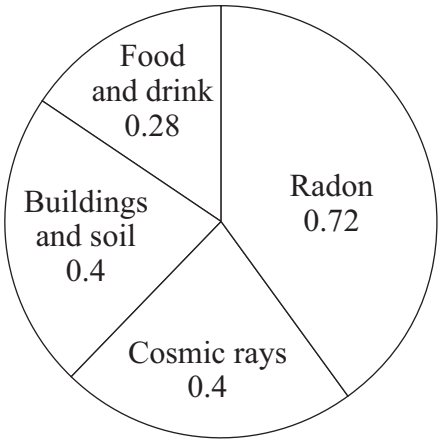
An alpha particle consists of 2 protons and 2 neutrons.

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)

2 (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 21 · continued

for mark

2 (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)

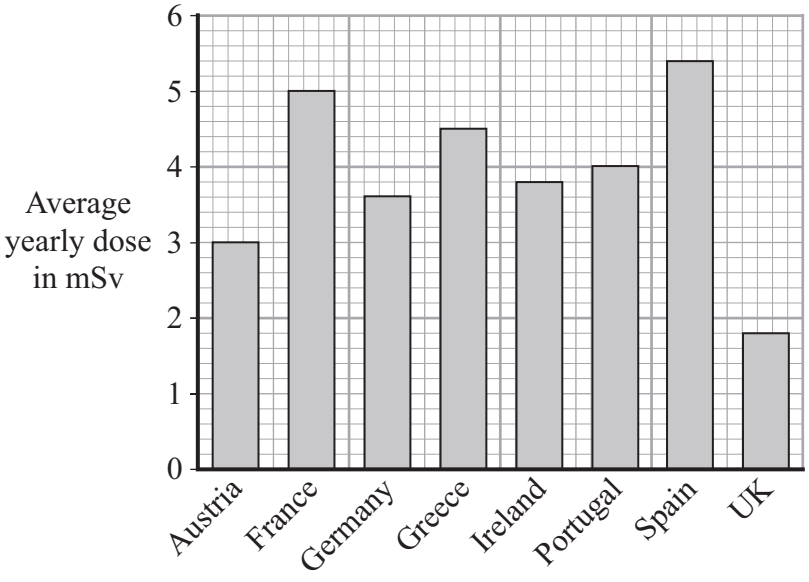
2 (b) (ii) Not all background radiation is from natural sources.

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

.....

(1 mark)

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



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

.....

(1 mark)

Question 2 continues on the next page

4.6.2.3 Properties of electromagnetic waves 2

Question 21 · continued

for mark

2 (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

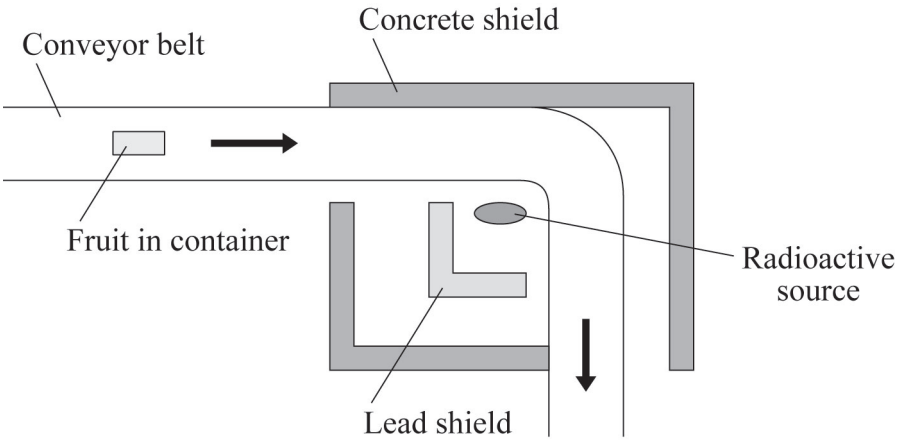
Question 22

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 22 · continued March 2009 | PHY1BP | Original Q3 | Legacy

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

4.6.2.3 Properties of electromagnetic waves 2

Question 23

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.

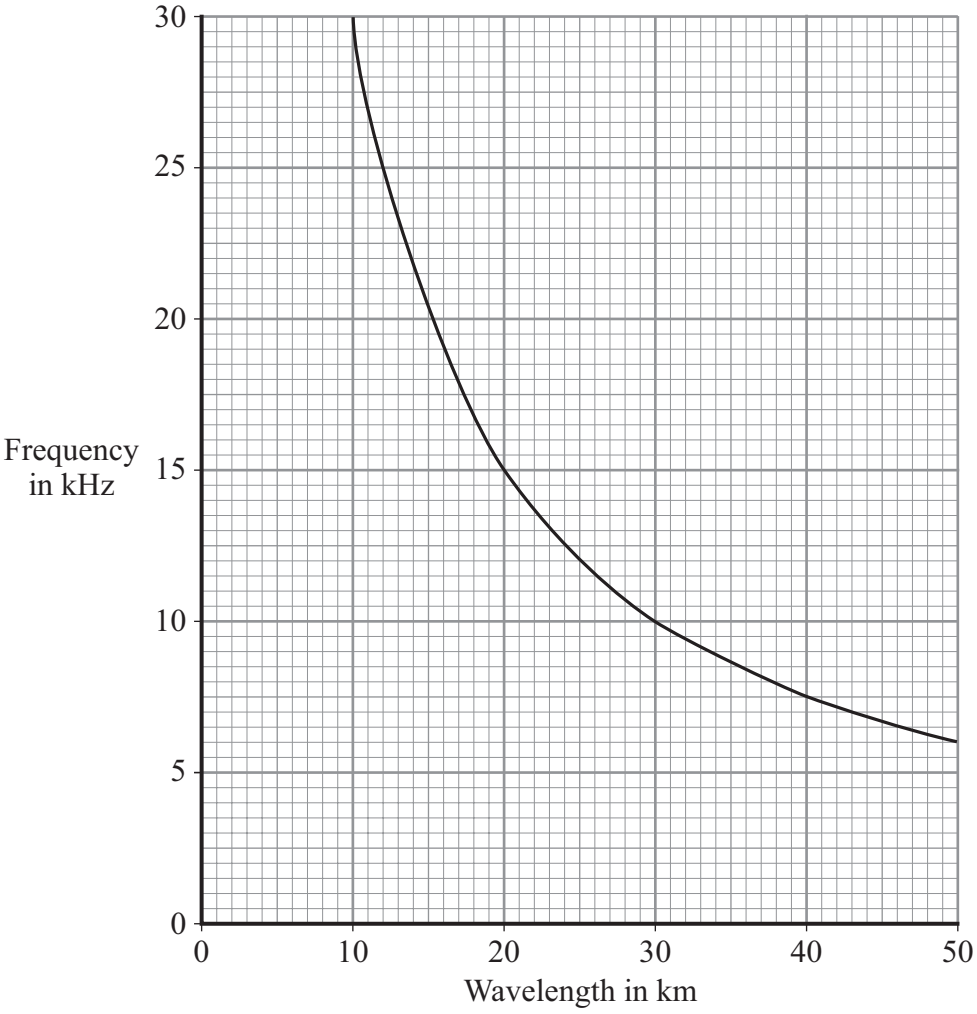
3 reflected by the atmosphere.

4 stopped by the atmosphere.

4.6.2.3 Properties of electromagnetic waves 2

Question 23 · 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

4.6.2.3 Properties of electromagnetic waves 2

Question 24

March 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Airline pilots and people who live at high altitude have an increased exposure to radiation from space.

Scientists measured the annual radiation dose received by people who lived at different altitudes. They repeated the experiment two more times and obtained the following results.

	Annual radiation dose in mSv		
Height above sea level in metres	**First time**	**Second time**	**Third time**
1000	2.9	3.0	2.9
2000	4.44	4.54	4.57
3000	5.90	5.78	6.01
4000	7.46	7.49	7.51

1 millisievert (mSv) is a unit of radiation dose

The scientists also investigated the exposure due to air travel. They found that pilots receive a radiation dose of 0.10 mSv for every 100 hours of flight.

8A Which is the least precise set of results?

1 1000 m

2 2000 m

3 3000 m

4 4000 m

8B Airline pilots should not receive an annual radiation dose of more than 6 mSv.

A pilot should restrict his flying hours because an annual exposure to radiation of more than 6 mSv produces . . .

1 a reduced level of long-term concentration.

2 an increased risk of developing visual impairments.

3 reduced levels of oxygen to the brain.

4 an increased risk of damage to body tissues.

4.6.2.3 Properties of electromagnetic waves 2

Question 24 · continued

8C A pilot who lives in Switzerland at a height of 2000 m should restrict his annual flying hours to about . . .

1 500 hours.

2 1500 hours.

3 2500 hours.

4 6000 hours.

8D A pilot averages 1000 hours of flying a year.

The maximum altitude at which he could safely live is . . .

1 1000 m.

2 2000 m.

3 3000 m.

4 4000 m.

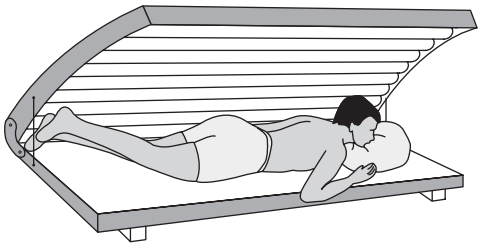
4.6.2.3 Properties of electromagnetic waves 2

Question 25

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 25 · continued

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 26

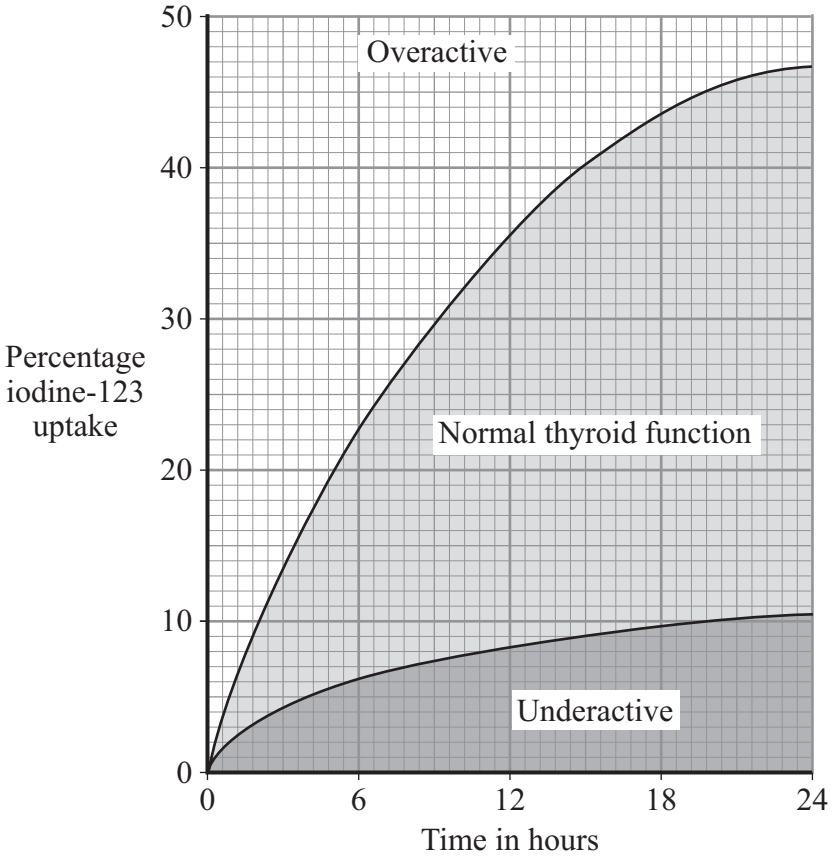
June 2009 | PHY1BP | Original Q5 | Legacy

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.

4.6.2.3 Properties of electromagnetic waves 2

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

4.6.2.3 Properties of electromagnetic waves 2

Question 27

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

4.6.2.3 Properties of electromagnetic waves 2

Question 27 · 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.

4.6.2.3 Properties of electromagnetic waves 2

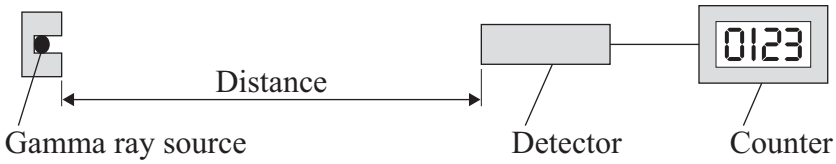
Question 28

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

4.6.2.3 Properties of electromagnetic waves 2

Question 28 · continued November 2009 | PHY1BP | Original Q3 | Legacy

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 29

March 2010 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

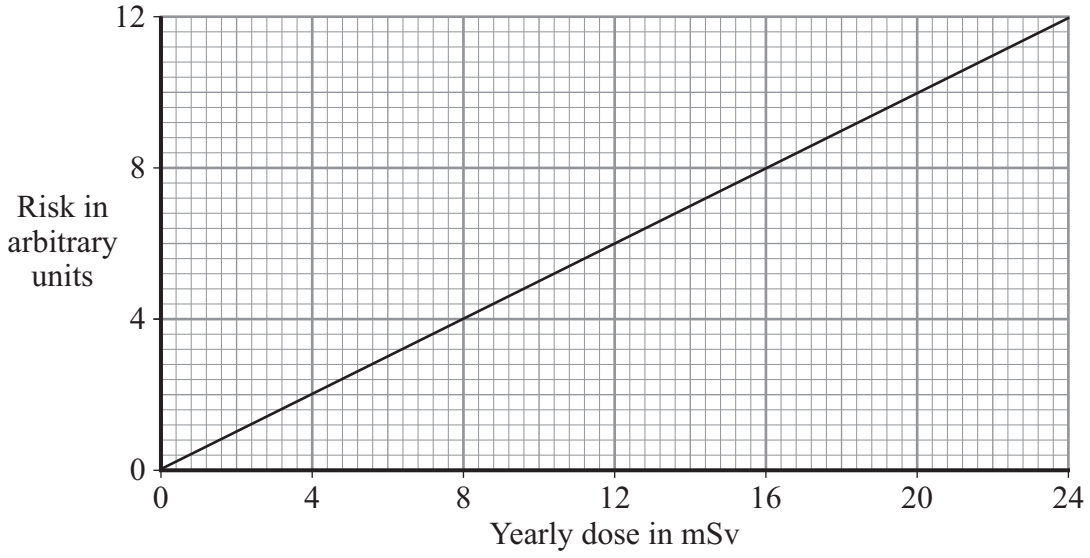
Workers in industries that use radioactive materials have the amount of radiation they receive carefully monitored. The amount of radiation received is called the dose. The industries set dose limits.

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 29 · 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.

4.6.2.3 Properties of electromagnetic waves 2

Question 30

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

4.6.2.3 Properties of electromagnetic waves 2

Question 31

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 31 · continued

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

4.6.2.3 Properties of electromagnetic waves 2

Question 32

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.

4.6.2.3 Properties of electromagnetic waves 2

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

4.6.2.3 Properties of electromagnetic waves 2

Question 33

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

4.6.2.3 Properties of electromagnetic waves 2

Question 33 · 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)

4.6.2.3 Properties of electromagnetic waves 2

Question 33 · 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

4.6.2.3 Properties of electromagnetic waves 2

Question 33 · 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

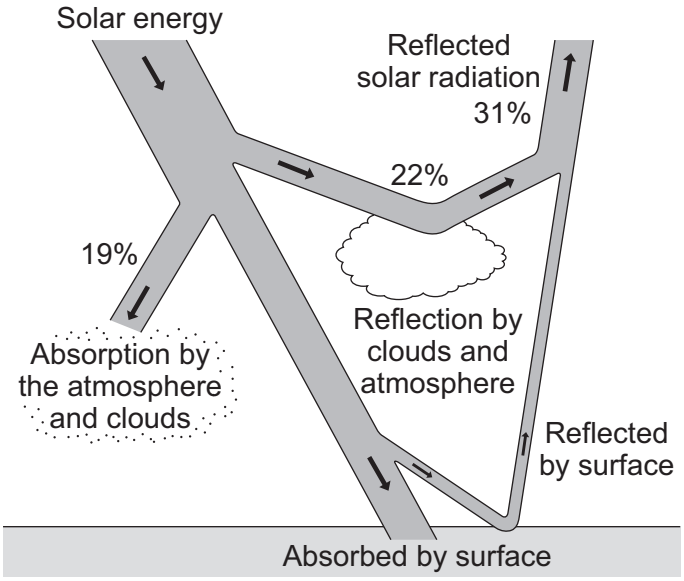
4.6.2.3 Properties of electromagnetic waves 2

Question 34

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.

4.6.2.3 Properties of electromagnetic waves 2

Question 34 · continued

March 2011 | PHY1BP | Original Q9 | Legacy

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

4.6.2.3 Properties of electromagnetic waves 2

Question 35

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

4.6.2.3 Properties of electromagnetic waves 2

Question 35 · continued

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.

4.6.2.3 Properties of electromagnetic waves 2

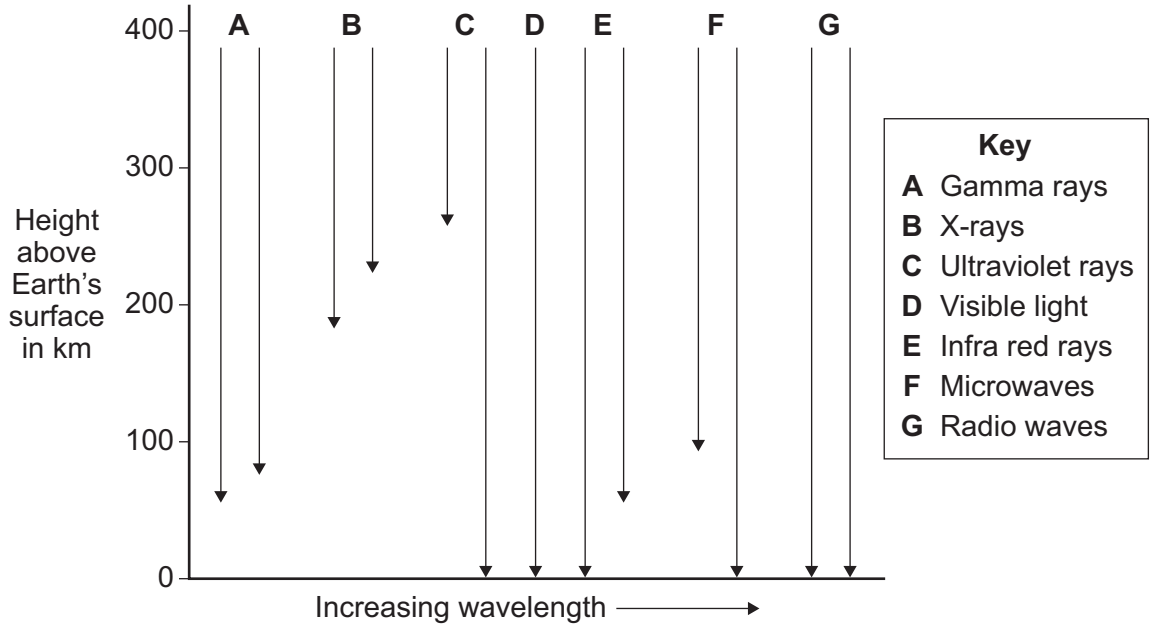
Question 36

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

4.6.2.3 Properties of electromagnetic waves 2

Question 36 · 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

4.6.2.3 Properties of electromagnetic waves 2

Question 37

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]

.....

.....

.....

.....

.....

.....

.....

.....

4.6.2.3 Properties of electromagnetic waves 2

Question 38

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]

4.6.2.3 Properties of electromagnetic waves 2

Question 38 · 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

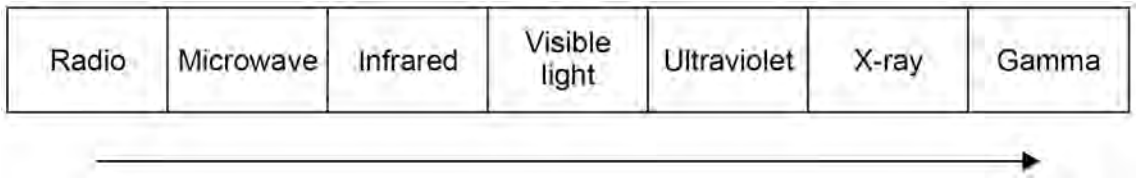
4.6.2.3 Properties of electromagnetic waves 2

Question 39

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

4.6.2.3 Properties of electromagnetic waves 2

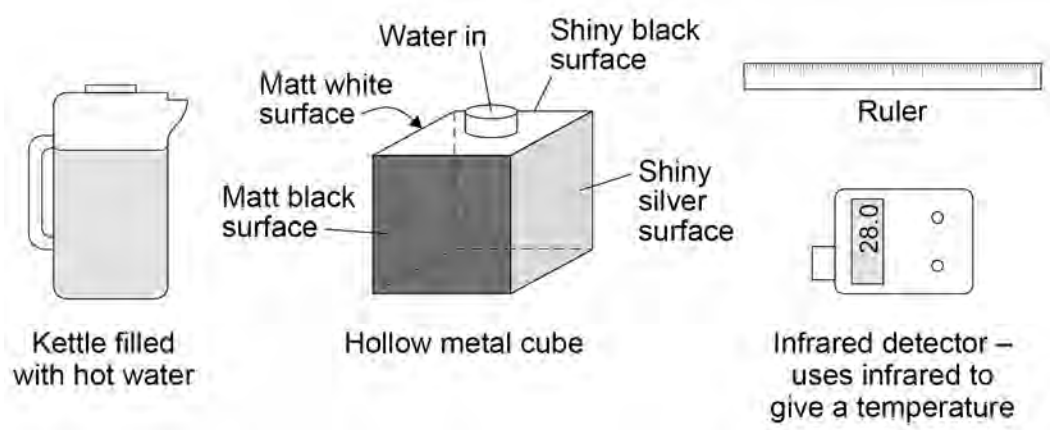
Question 39 · continued

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]

4.6.2.3 Properties of electromagnetic waves 2

Question 39 · continued

June 2019 | 8463/2H | Original Q7

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]

4.6.2.3 Properties of electromagnetic waves 2

Question 39 · 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.

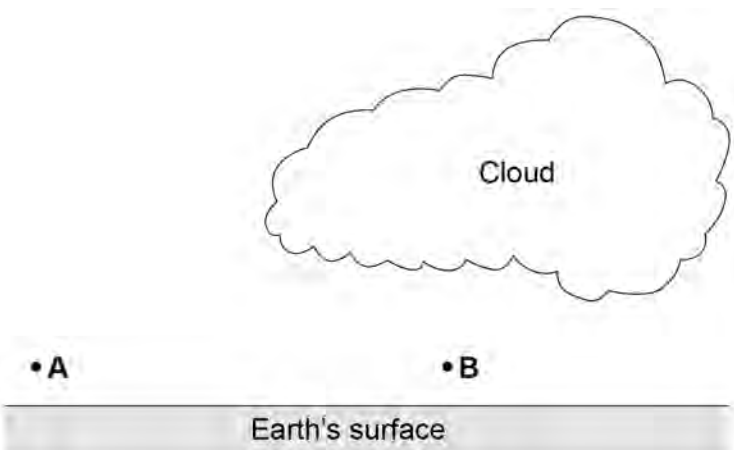
A perfect reflector has an Albedo value of 1.0
A perfect absorber has an Albedo value of 0.0

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

4.6.2.3 Properties of electromagnetic waves 2

Question 40

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 _____

_____

4.6.2.3 Properties of electromagnetic waves 2

Question 40 · continued

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