Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

General Certificate of Secondary Education
March 2009

SCIENCE A **PHY1BP**
Unit Physics P1b (Radiation and the Universe)

PHYSICS
Unit Physics P1b (Radiation and the Universe)

Wednesday 4 March 2009 Morning Session

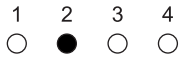
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

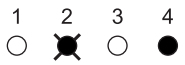
Time allowed: 30 minutes

Instructions
- Fill in the boxes at the top of this page.
- Check that your name, candidate number and centre number are printed on the separate answer sheet.
- Check that the separate answer sheet has the title 'Physics Unit 1b' printed on it.
- Attempt **one Tier only, either** the Foundation Tier **or** the Higher Tier.
- Make sure that you use the correct side of the separate answer sheet; the Foundation Tier is printed on one side and the Higher Tier on the other.
- Answer **all** the questions for the Tier you are attempting.
- Record your answers on the separate answer sheet only.
- Do all rough work in this book, **not** on your answer sheet.

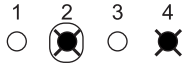
Instructions for recording answers
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown:



- Do **not** extend beyond the circles.
- If you want to change your answer, **you must** cross out your original answer, as shown:



- If you change your mind about an answer you have crossed out and now want to choose it, draw a ring around the cross as shown:



Information
- The maximum mark for this paper is 36.

Advice
- Do **not** choose more responses than you are asked to. You will lose marks if you do.
- Make sure that you hand in both your answer sheet and this question paper at the end of the test.
- If you start to answer on the wrong side of the answer sheet by mistake, make sure that you cross out **completely** the work that is not to be marked.

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Higher Tier starts on page 16 of this booklet.

FOUNDATION TIER

SECTION ONE

Questions **ONE** to **FIVE**.

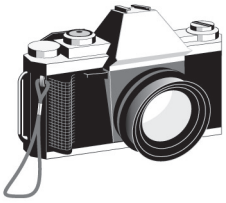
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

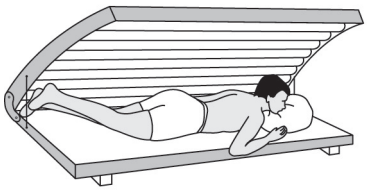
QUESTION ONE

Different devices use different types of electromagnetic waves.

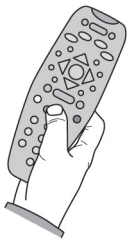


1
Camera

2
Hospital scanner



3
Sunbed



4
TV remote control

Match types of electromagnetic waves, **A**, **B**, **C** and **D**, with the diagrams **1–4**.

A infra red

B visible light

C ultraviolet

D X-rays

QUESTION TWO

A radioactive material gives out radiation all the time.

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

A alpha

B beta

C electron

D gamma

The radiation that is most penetrating is . . . **1** . . . .

The radiation that is stopped by a sheet of paper is . . . **2** . . . .

The radiation that passes through a sheet of paper but is stopped by aluminium foil is . . . **3** . . . .

A beta particle is an . . . **4** . . . .

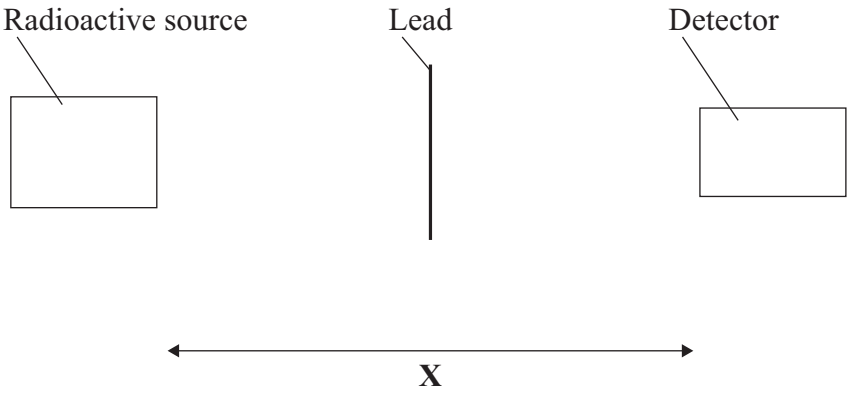
Turn over for the next question

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.

QUESTION FOUR

This question is about the structure of the atom.

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

A electrons

B neutrons

C nuclei

D protons

The central part of the atom is surrounded by a number of . . . **1** . . . .

In the central part of the atom, there are positive particles called . . . **2** . . . .

The central parts of atoms are called . . . **3** . . . .

Isotopes of the same element contain different numbers of . . . **4** . . . .

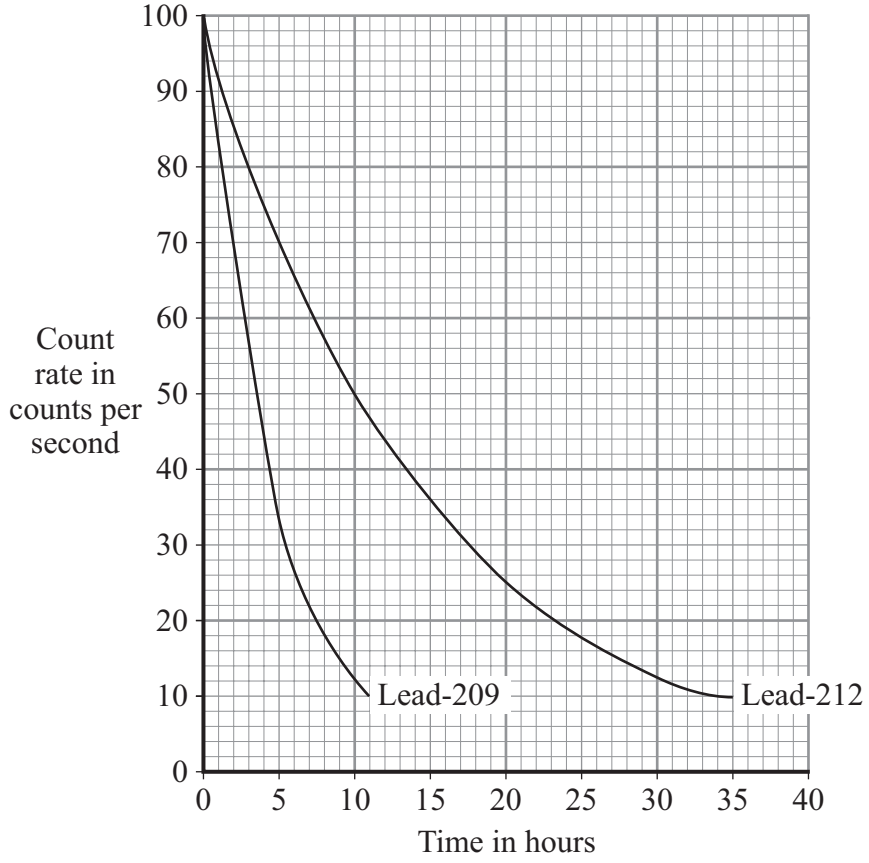
Turn over for the next question

QUESTION FIVE

The graph shows the radioactive decay of two isotopes of lead.

In lead-209, the total number of protons and neutrons is 209.

In lead-212, the total number of protons and neutrons is 212.



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

A 3

B 10

C 12

D 60

The half-life of lead-212 is . . . **1** . . . hours.

After 10 hours, the count rate of lead-209 is . . . **2** . . . counts per second.

When the count rate of lead-209 has dropped to 20 counts per second, the count rate of lead-212 has dropped to . . . **3** . . . counts per second.

Lead-212 has . . . **4** . . . more neutrons than lead-209.

Turn over for the next question

SECTION TWO

Questions **SIX** to **NINE**.

Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

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

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

QUESTION SEVEN

The radiation from stars produces spectra. By studying these spectra, scientists can learn a lot about the behaviour and history of stars.

Sometimes, lines in a spectrum appear to be shifted towards the longer wavelength end of the spectrum.

7A What name is given to the shift towards the longer wavelength end of the spectrum?

1 blue-shift

2 green-shift

3 yellow-shift

4 red-shift

7B What information can this shift give scientists about the star that is producing it?

1 the diameter of the star

2 the distance the star is from Earth

3 the mass of the star

4 the temperature of the star

7C What theory about the universe does observation of this shift support?

1 the universe is contracting

2 the universe is expanding

3 the universe is not changing

4 the universe is expanding and contracting

7D A scientist making measurements with a telescope complains that his observations lack precision.

What type of instrument would give more precision?

1 one that has been better calibrated

2 one that has been less well calibrated

3 one with a larger scale division

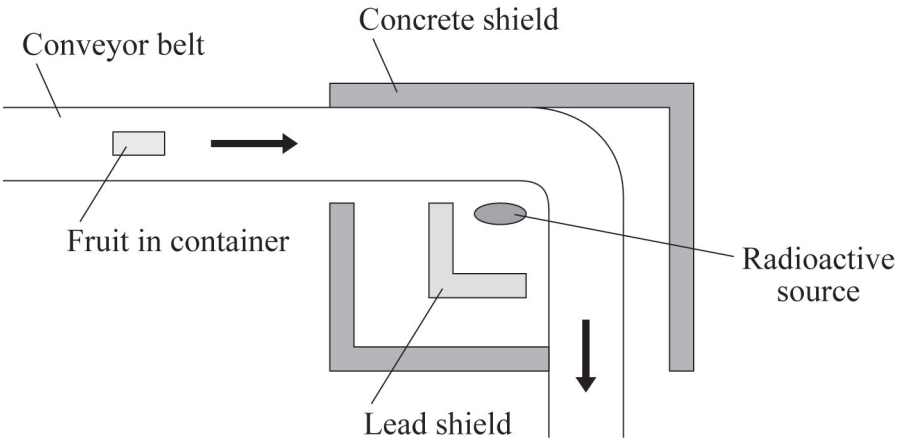
4 one with a smaller scale division

Turn over for the next question

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.

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

Turn over for the next question

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 . . .

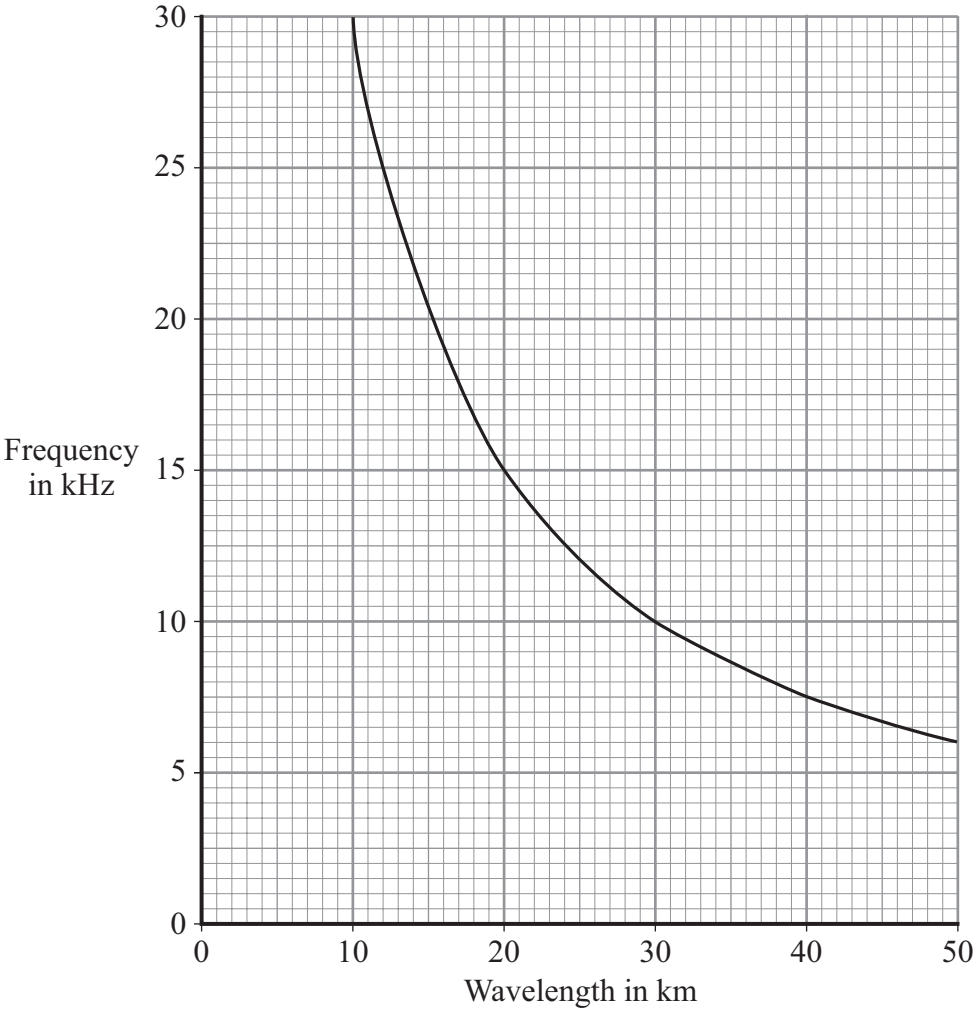
1 absorbed by the atmosphere.

2 interfered with by the atmosphere.

3 reflected by the atmosphere.

4 stopped by the atmosphere.

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

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Foundation Tier is earlier in this booklet.

HIGHER TIER

SECTION ONE

Questions **ONE** and **TWO**.

In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

Use **each** answer only **once**.

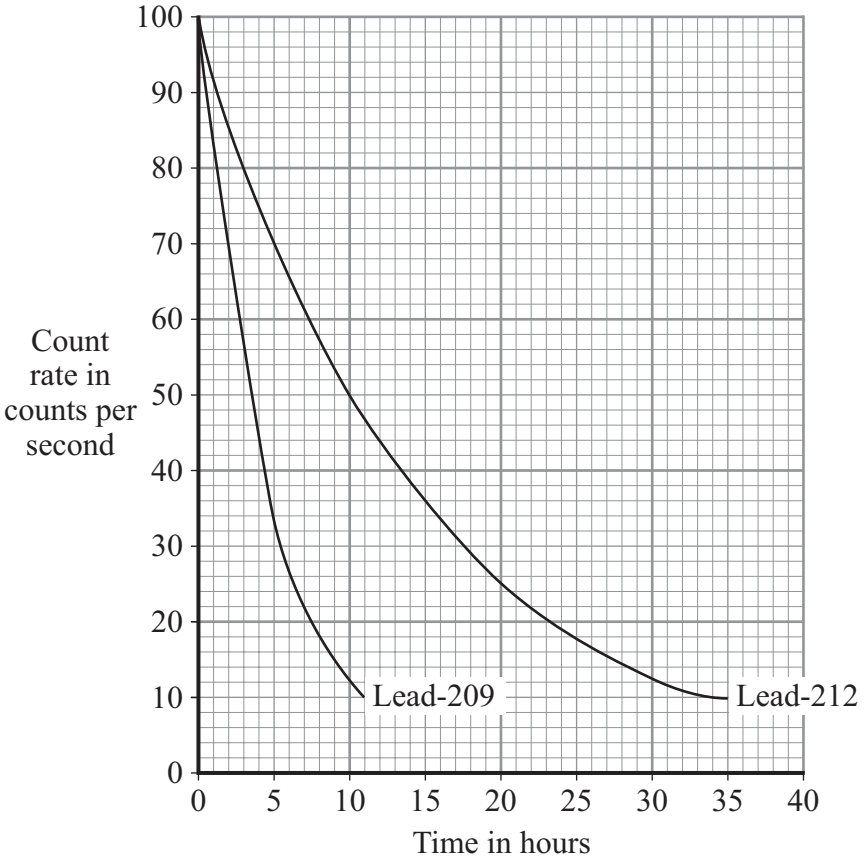
Mark your choices on the answer sheet.

QUESTION ONE

The graph shows the radioactive decay of two isotopes of lead.

In lead-209, the total number of protons and neutrons is 209.

In lead-212, the total number of protons and neutrons is 212.



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

A 3

B 10

C 12

D 60

The half-life of lead-212 is . . . **1** . . . hours.

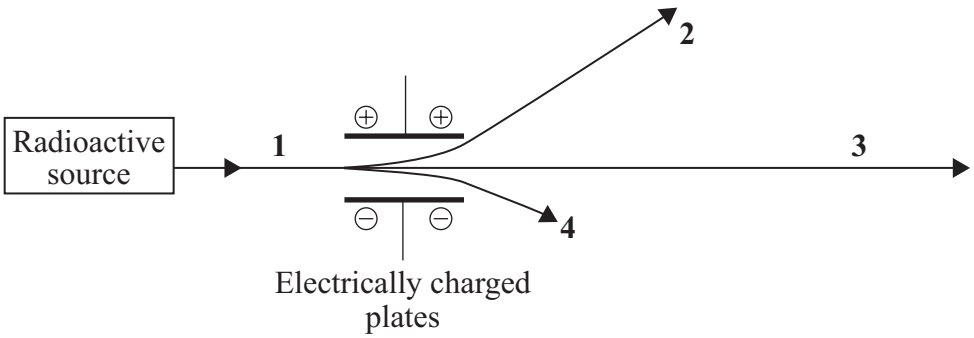
After 10 hours, the count rate of lead-209 is . . . **2** . . . counts per second.

When the count rate of lead-209 has dropped to 20 counts per second, the count rate of lead-212 has dropped to . . . **3** . . . counts per second.

Lead-212 has . . . **4** . . . more neutrons than lead-209.

QUESTION TWO

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



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

A alpha particles

B beta particles

C gamma rays

D alpha, beta and gamma radiation

SECTION TWO

Questions **THREE** to **NINE**.

Each of these questions has four parts.

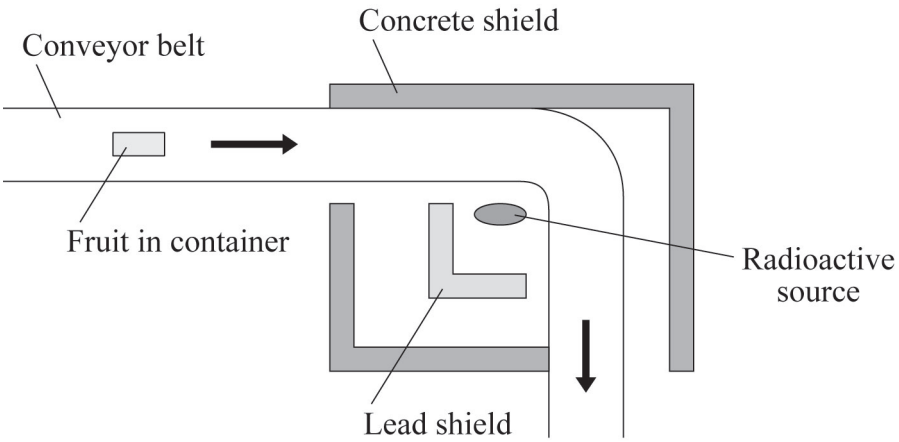
In each part choose only **one** answer.

Mark your choices on the answer sheet.

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.

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

Turn over for the next question

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 . . .

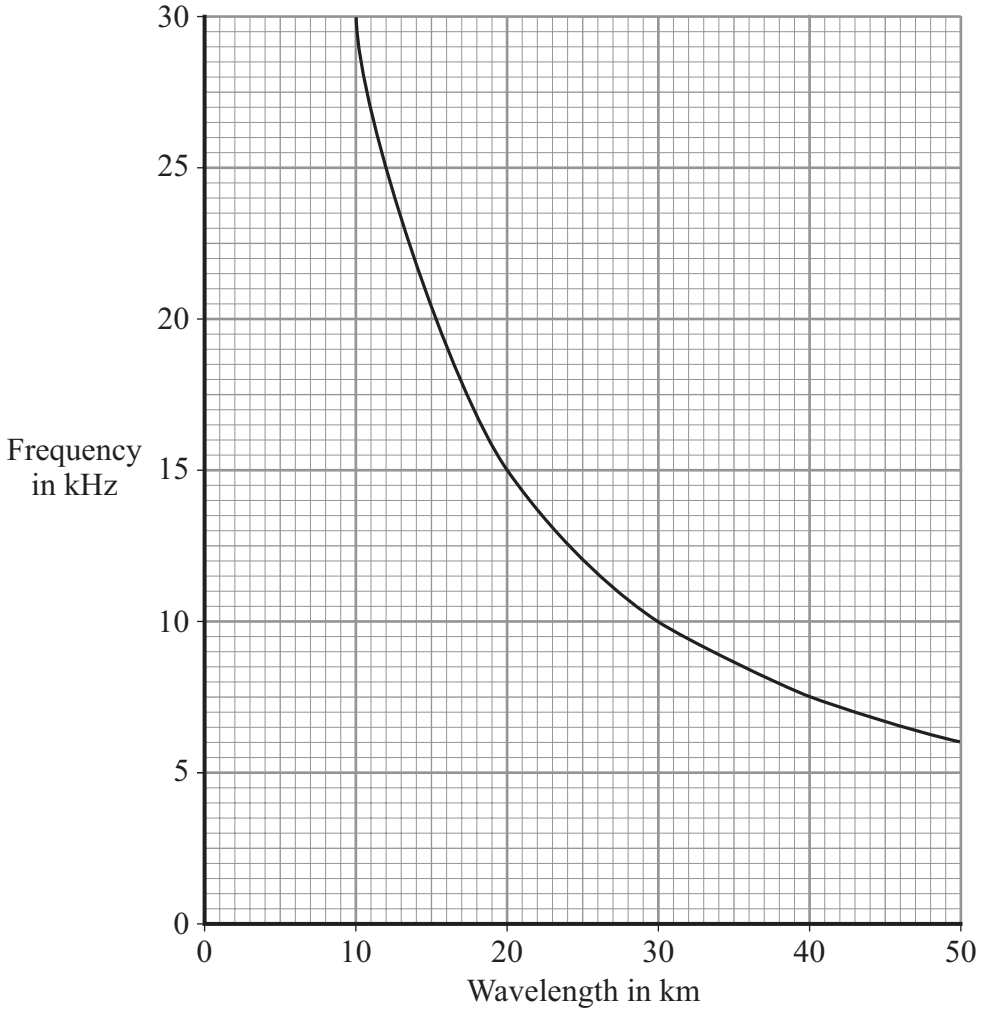
1 absorbed by the atmosphere.

2 interfered with by the atmosphere.

3 reflected by the atmosphere.

4 stopped by the atmosphere.

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

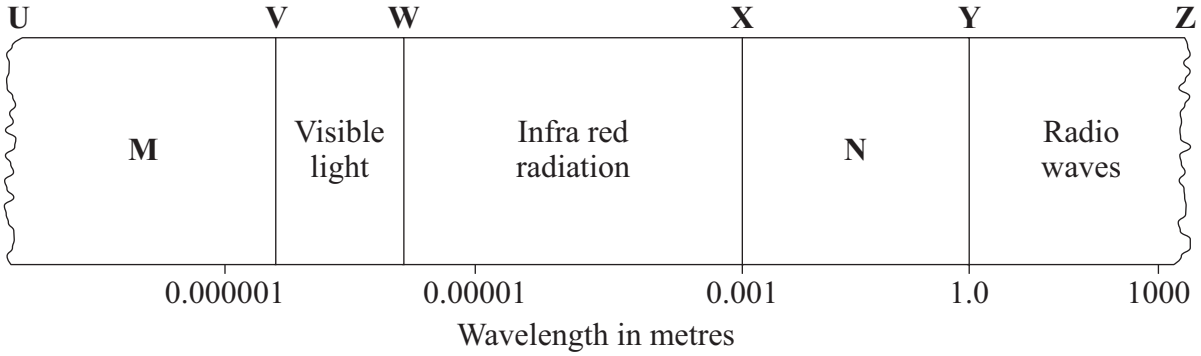
2 1.4 kHz

3 12 kHz

4 14 kHz

QUESTION FIVE

The diagram shows part of the electromagnetic spectrum.



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

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

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

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

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

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

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

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

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

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

What is the frequency of these waves?

1 0.000 005 Hz

2 0.005 Hz

3 200 kHz

4 450 000 000 kHz

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

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

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

1 the gamma ray part of the electromagnetic spectrum.

2 the microwave part of the electromagnetic spectrum.

3 the radio wave part of the electromagnetic spectrum.

4 the ultraviolet part of the electromagnetic spectrum.

Turn over for the next question

QUESTION SIX

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

6A Alpha radiation is . . .

1 a very fast electron from the nucleus.

2 an electromagnetic wave of very high frequency.

3 a particle containing protons and neutrons.

4 a particle containing only neutrons.

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

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

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

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

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

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

6C Gamma radiation is not electrically charged.

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

1 deflected in magnetic fields but not in electric fields.

2 deflected in electric fields but not in magnetic fields.

3 deflected in both electric and magnetic fields.

4 not deflected in either electric or magnetic fields.

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

After 26 seconds, . . .

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

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

3 only 2 g of radium-211 will remain.

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

Turn over for the next question

QUESTION SEVEN

This question is about the behaviour of waves as the source of the wave moves, and what this can tell us about the universe.

7A At an air show, an aircraft flies at a steady speed in a straight line over the crowd of spectators.

As the aircraft approaches, how do the wavelength and frequency of the sound wave heard by the spectators differ from the sound emitted by the aircraft?

	Wavelength	**Frequency**
1	shorter	higher
2	longer	lower
3	longer	the same
4	the same	lower

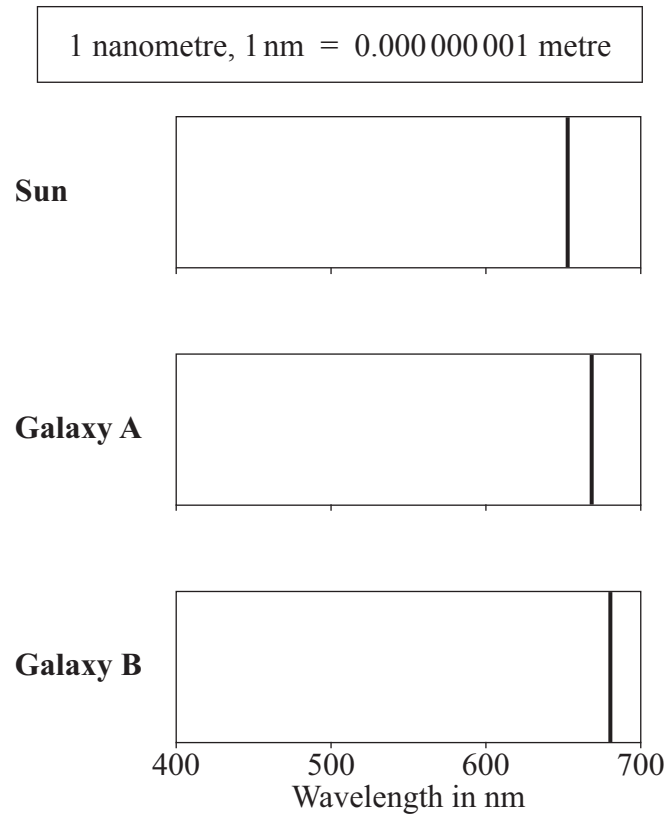
7B Scientists observing the Andromeda galaxy see that its light is undergoing a blue-shift.

What does this tell them about the wavelength of light arriving on Earth from this galaxy and the movement of Andromeda relative to Earth?

	Wavelength	**Movement relative to Earth**
1	decreasing	moving away
2	decreasing	moving towards
3	increasing	moving away
4	increasing	moving towards

The visible part of the electromagnetic spectrum from stars includes dark lines. They correspond to chemical elements in the stars and occur at specific wavelengths.

The line in the spectra shown below, from three different sources, represents hydrogen which is found in the Sun's spectrum at a wavelength of 656.3 nm.



7C What does this indicate about galaxies **A** and **B**?

1 Galaxy **A** is colder than galaxy **B**.

2 Galaxy **A** is further away from Earth than galaxy **B**.

3 Galaxy **B** is colder than galaxy **A**.

4 Galaxy **B** is further away from Earth than galaxy **A**.

7D Which of the following theories about the universe does red-shift information support?

1 The universe began from a small initial point and has been expanding ever since.

2 The universe expanded initially, but is now contracting.

3 The universe has always been the size it is now.

4 The universe will eventually run out of energy and collapse.

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.

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.

Turn over for the next question

QUESTION NINE

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

	UVA	UVB	UVC	X-rays	

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

In what wavelength region will violet light be found?

1 nanometre, 1 nm = 0.000 000 001 metre

1 360 – 400 nm

2 400 – 430 nm

3 620 – 700 nm

4 700 – 760 nm

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

This is surprising because gamma rays . . .

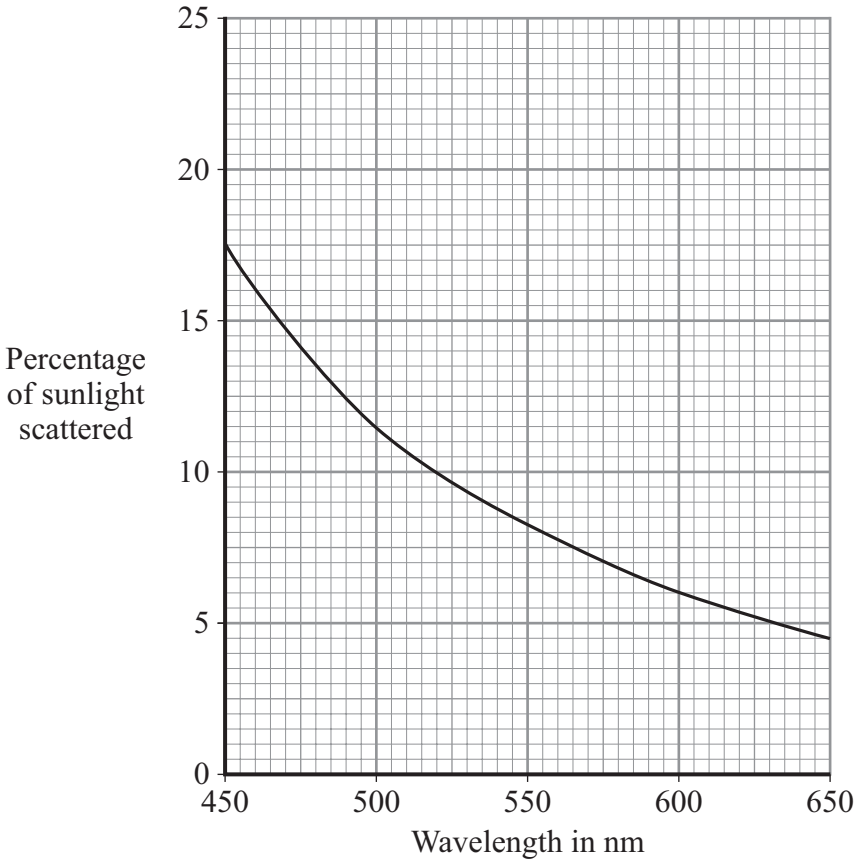
1 penetrate less than X-rays and have a lower frequency than X-rays.

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

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

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

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



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

1 11.5 %

2 37.5 %

3 62.5 %

4 88.5 %

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

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

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

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

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

END OF TEST

There are no questions printed on this page