

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Secondary Education
Foundation Tier and Higher Tier
November 2010

Science A

Unit Physics P1b (Radiation and the Universe)

Physics

Unit Physics P1b (Radiation and the Universe)

PHY1BP
F&H

Thursday 11 November 2010 Afternoon Session

For this paper you must have:

- a black ball-point pen
 - an objective test answer sheet.
- You may use a calculator.

Time allowed

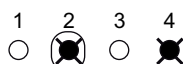
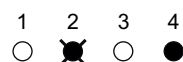
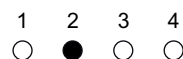
- 30 minutes

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

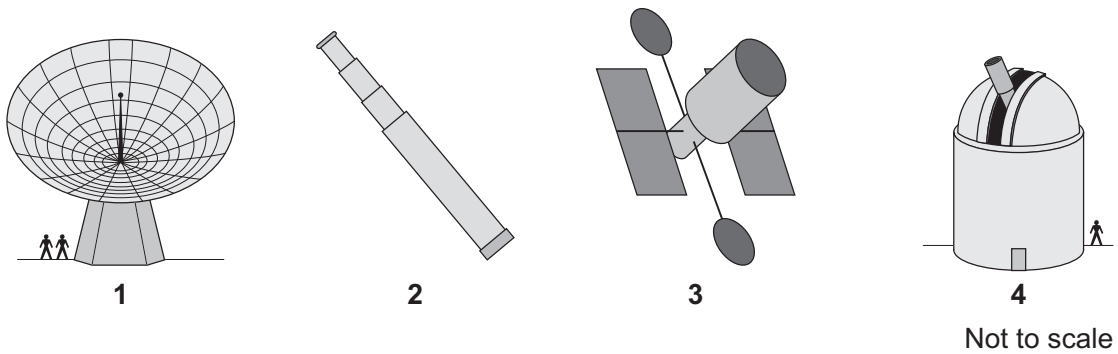
Match types of radiation, **A**, **B**, **C** and **D**, with the descriptions **1–4** in the table.

- A** infra red
- B** ultraviolet
- C** visible light
- D** X-rays

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

QUESTION TWO

The drawings show different types of telescope. They are not drawn to scale.



Match descriptions, **A**, **B**, **C** and **D**, with the telescopes **1–4**.

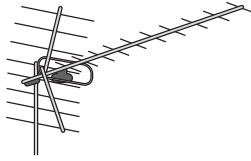
- A** can be used by anyone to view the surface of the Moon
- B** in orbit around the Earth
- C** built on the top of a mountain and can be used to view planets
- D** used by scientists to detect radio waves from space

Turn over for the next question

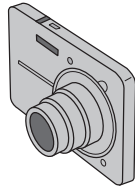
Turn over ►

QUESTION THREE

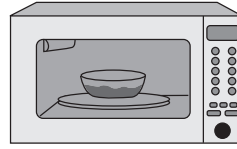
The drawings show devices that use electromagnetic waves.



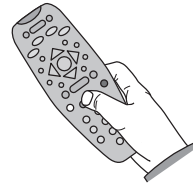
1



2



3



4

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

- A** infra red
- B** microwaves
- C** radio waves
- D** visible light

QUESTION FOUR

The diagram shows part of the electromagnetic spectrum.

1	X-rays	2	Visible light	3	Microwaves	4
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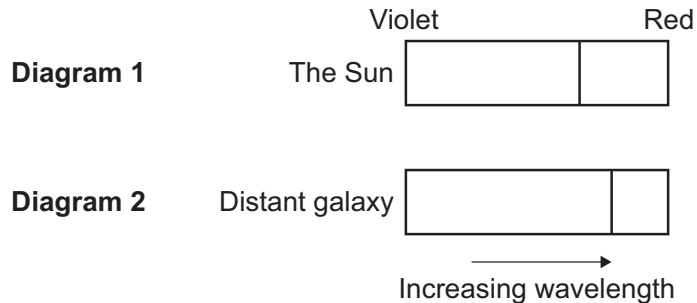
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** on the diagram.

- A** gamma
- B** infra red
- C** radio
- D** ultraviolet

QUESTION FIVE

Diagram 1 shows the spectrum of light from the Sun. There is a black line in the spectrum.

Diagram 2 shows the spectrum of light from a distant galaxy. This spectrum has the same black line.



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

- A** decreased
- B** increased
- C** shifted
- D** not changed

Edwin Hubble compared the spectrum of light from this distant galaxy to the spectrum of light from the Sun.

Hubble found that the position of the black line had . . . **1**

This was because the wavelength of the observed light had . . . **2**

The frequency of the observed light had . . . **3**

The speed of the light had . . . **4**

Turn over for the next question

Turn over ►

Section TwoQuestions **SIX** to **NINE**.

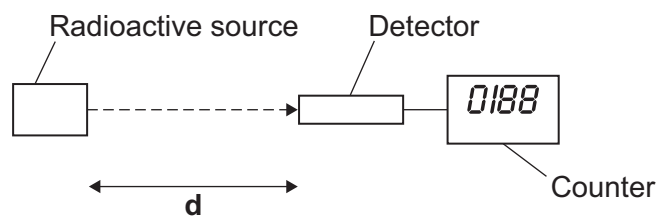
Each of these questions has four parts.

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

Mark your choices on the answer sheet.

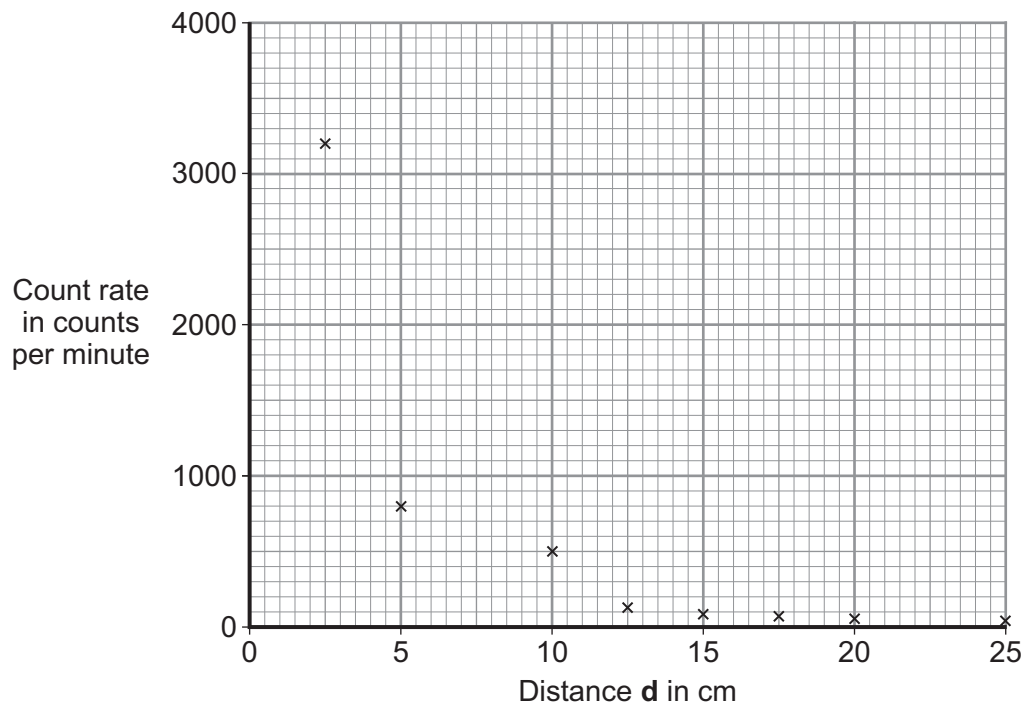
QUESTION SIX

A radioactive source gives out gamma radiation. A student wanted to know how the count rate from the source changes as the distance from the source increases. The following apparatus was set up.



The count rate was measured for a number of different distances, **d**.

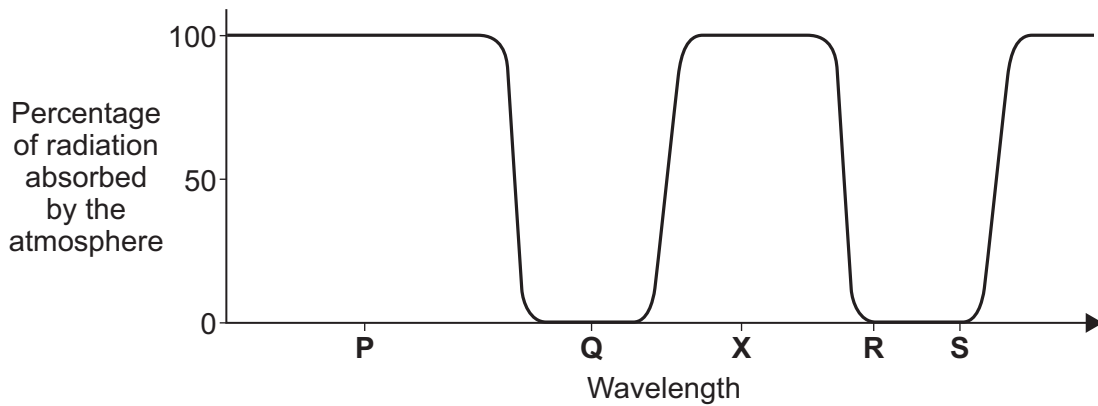
The student plotted the results on graph paper.



-
- 6A** A line graph should be drawn because . . .
- 1 both variables are categoric.
 - 2 both variables are continuous.
 - 3 both variables are ordered.
 - 4 one variable is categoric and the other variable is continuous.
- 6B** The range of distance measurements is . . .
- 1 2.5–5.0 cm
 - 2 2.5–10.0 cm
 - 3 2.5–20.0 cm
 - 4 2.5–25.0 cm
- 6C** Each reading was repeated twice and the mean calculated.
- This made the data more . . .
- 1 accurate.
 - 2 discrete.
 - 3 reliable.
 - 4 sensitive.
- 6D** The result shown at 10 cm is anomalous and . . .
- 1 the graph line should be drawn to pass through this result.
 - 2 was caused by a systematic error in the ruler.
 - 3 was caused by a systematic error in the counter.
 - 4 should be ignored when drawing the graph line.

QUESTION SEVEN

The graph shows how the Earth's atmosphere absorbs different wavelengths of electromagnetic waves.



7A Which wavelength, **P**, **Q**, **R** or **S**, does not reach the Earth's surface?

- 1 **P**
- 2 **Q**
- 3 **R**
- 4 **S**

7B The wavelength labelled **X** is in the infra red region.

Some objects in space emit infra red radiation.

Where would you put a telescope to collect infra red radiation from objects in space?

- 1 above the Earth's atmosphere
- 2 on a high mountain
- 3 at ground level in a hot desert
- 4 at ground level in the Antarctic

-
- The Hubble Space Telescope (HST) is in orbit around the Earth.
 - Astronauts from a space shuttle can repair the HST if it breaks down.
 - In 2003, a space shuttle returning to Earth exploded.
 - After this explosion it was decided to stop sending astronauts to repair the HST.

7C This decision was later changed and in 2009 it was decided to send another space mission to repair the HST.

What is the most likely reason for this?

- 1 Space missions are now completely safe.
- 2 Astronomers want to keep using the HST.
- 3 The HST has never sent data back to Earth.
- 4 To give jobs to engineers.

7D The HST sends data back to Earth.

Electromagnetic waves labelled **R** on the graph are used to send the data.

The waves labelled **R** are used because the . . .

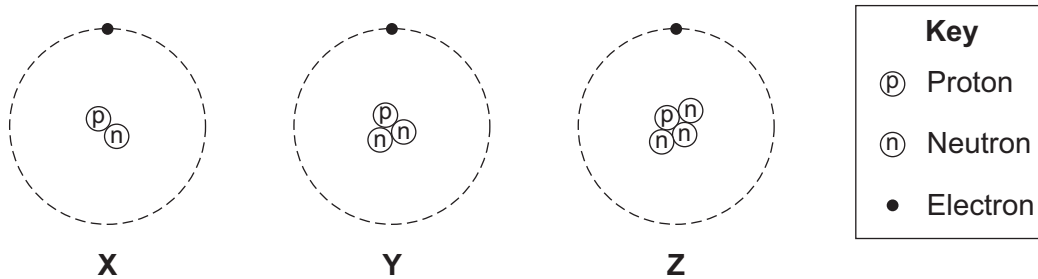
- 1 waves have a shorter wavelength than infra red.
- 2 atmosphere absorbs the waves.
- 3 atmosphere does not absorb the waves.
- 4 waves are in the visible light region.

Turn over for the next question

Turn over ►

QUESTION EIGHT

The diagram shows three atoms, **X**, **Y** and **Z**.



8A Which of these atoms are isotopes of the same element?

- 1 X, Y and Z
- 2 X and Y only
- 3 X and Z only
- 4 Y and Z only

8B Some substances are radioactive.

What does this mean?

- 1 Radio signals make these substances emit radiation.
- 2 These substances can take part in chemical reactions.
- 3 These substances emit radiation from the nuclei of their atoms.
- 4 These substances glow in the dark.

8C Some substances emit beta radiation.

What is beta radiation?

- 1 a helium nucleus
- 2 an electron from outside the nucleus
- 3 an electron from inside the nucleus
- 4 an electromagnetic wave

8D The warning label is from a smoke detector.

Warning!
This device contains a source
that emits alpha radiation.
Do not take this device apart.

What is the reason for this warning?

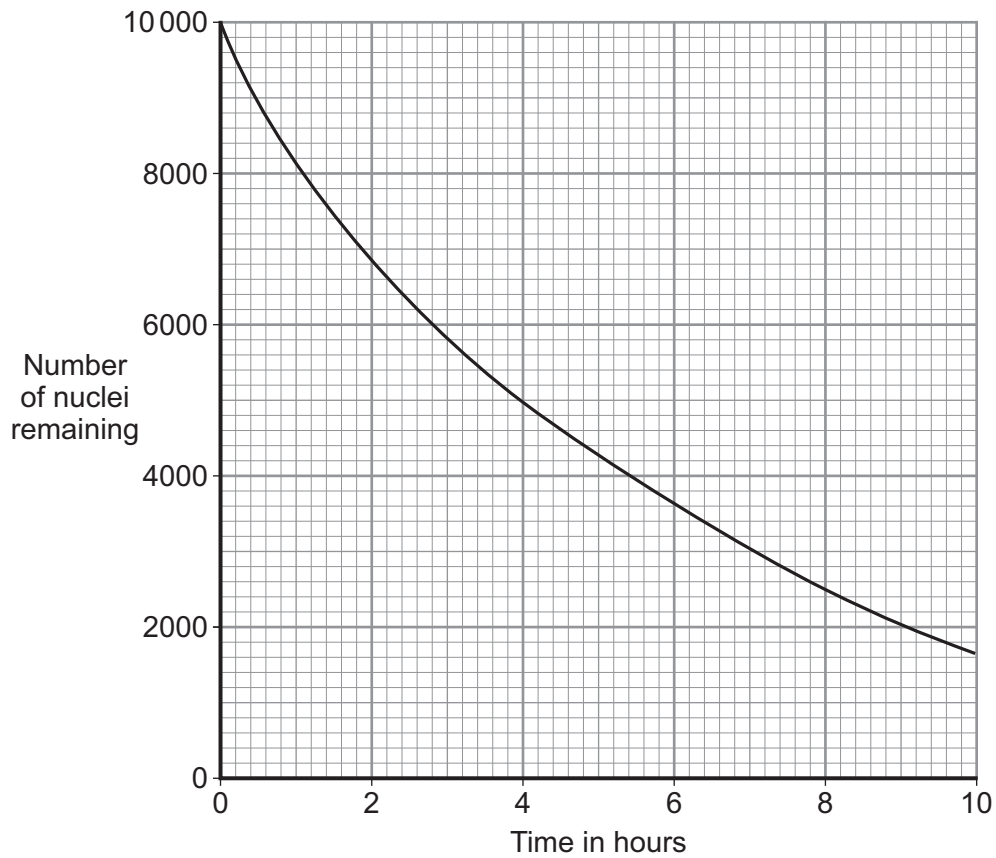
- 1 Alpha radiation is very dangerous if the source gets inside the body.
- 2 Alpha radiation can travel very long distances in the air.
- 3 Alpha radiation has the longest half-life.
- 4 Alpha radiation is the most penetrating of all radiations.

Turn over for the next question

Turn over ►

QUESTION NINE

The graph shows the decay of a small sample of radioactive isotope. At the start, the sample contains 10 000 nuclei.



9A What is the half-life of the isotope shown in the graph?

- 1 2 hours
- 2 4 hours
- 3 6 hours
- 4 8 hours

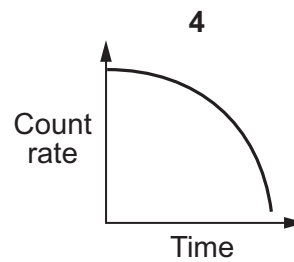
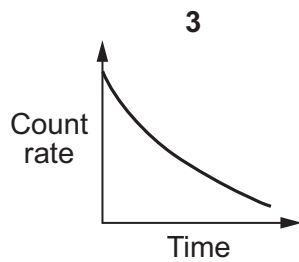
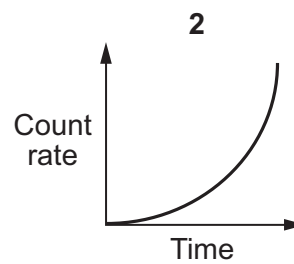
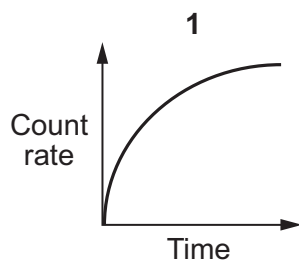
9B How many of the original nuclei would remain after three half-lives?

- 1 1250
- 2 2500
- 3 3333
- 4 none

9C This radioactive isotope may be suitable . . .

- 1 as a source of radiation in a smoke alarm.
- 2 as a source of radiation to monitor the thickness of paper in a paper mill.
- 3 as a medical tracer in the human body.
- 4 to use in finding the age of an ancient bone.

9D Which one of the following graphs would show how the count rate for this isotope changes with time?



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**.

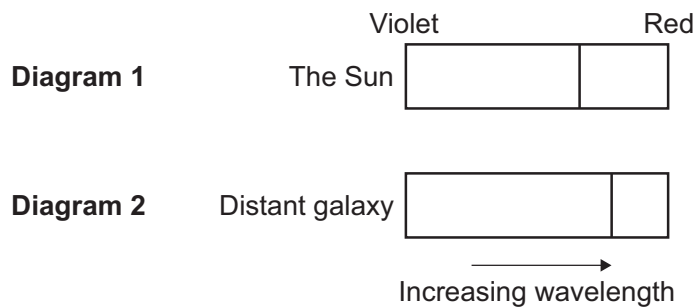
Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

Diagram 1 shows the spectrum of light from the Sun. There is a black line in the spectrum.

Diagram 2 shows the spectrum of light from a distant galaxy. This spectrum has the same black line.



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

- A** decreased
- B** increased
- C** shifted
- D** not changed

Edwin Hubble compared the spectrum of light from this distant galaxy to the spectrum of light from the Sun.

Hubble found that the position of the black line had . . . **1**

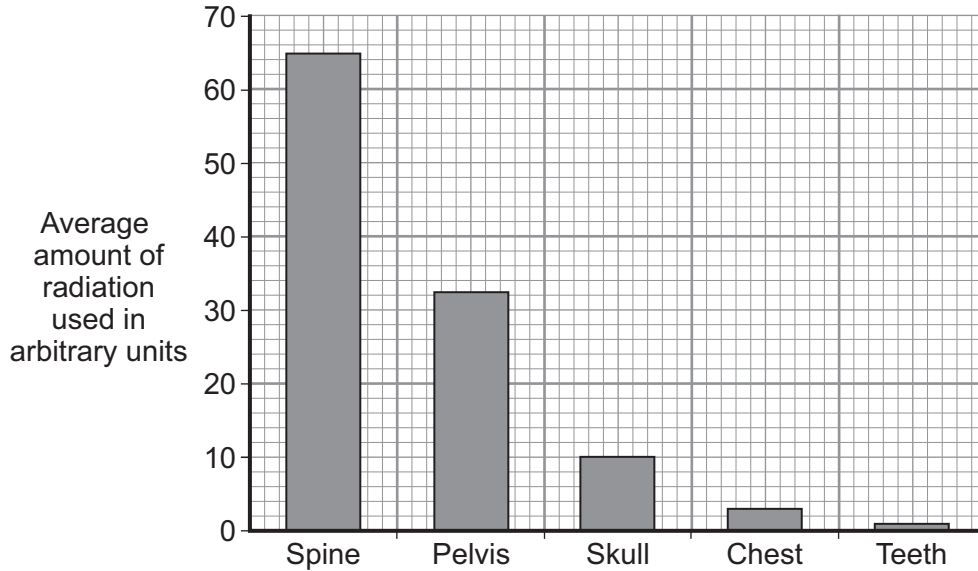
This was because the wavelength of the observed light had . . . **2**

The frequency of the observed light had . . . **3**

The speed of the light had . . . **4**

QUESTION TWO

A survey was carried out on patients having X-rays taken at a hospital. The graph shows the average amount of radiation used when X-rays were taken of different parts of the body.



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

- A** categoric
- B** continuous
- C** dependent
- D** reliable

The data is **not** shown as a line graph because only one variable is . . . **1**

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

The part of the body of which an X-ray is taken is a . . . **3** . . . variable.

Surveying more patients would make the data more . . . **4**

Turn over for the next question

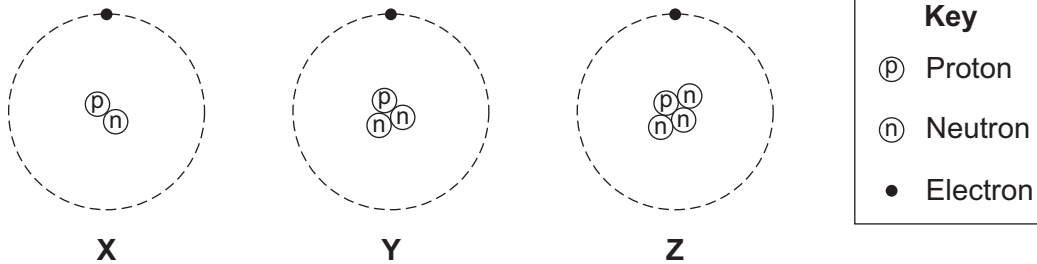
Turn over ►

Section TwoQuestions **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 THREEThe diagram shows three atoms, **X**, **Y** and **Z**.**3A** Which of these atoms are isotopes of the same element?

- 1 X, Y and Z
- 2 X and Y only
- 3 X and Z only
- 4 Y and Z only

3B Some substances are radioactive.

What does this mean?

- 1 Radio signals make these substances emit radiation.
- 2 These substances can take part in chemical reactions.
- 3 These substances emit radiation from the nuclei of their atoms.
- 4 These substances glow in the dark.

3C Some substances emit beta radiation.

What is beta radiation?

- 1 a helium nucleus
- 2 an electron from outside the nucleus
- 3 an electron from inside the nucleus
- 4 an electromagnetic wave

3D The warning label is from a smoke detector.

Warning!
This device contains a source
that emits alpha radiation.
Do not take this device apart.

What is the reason for this warning?

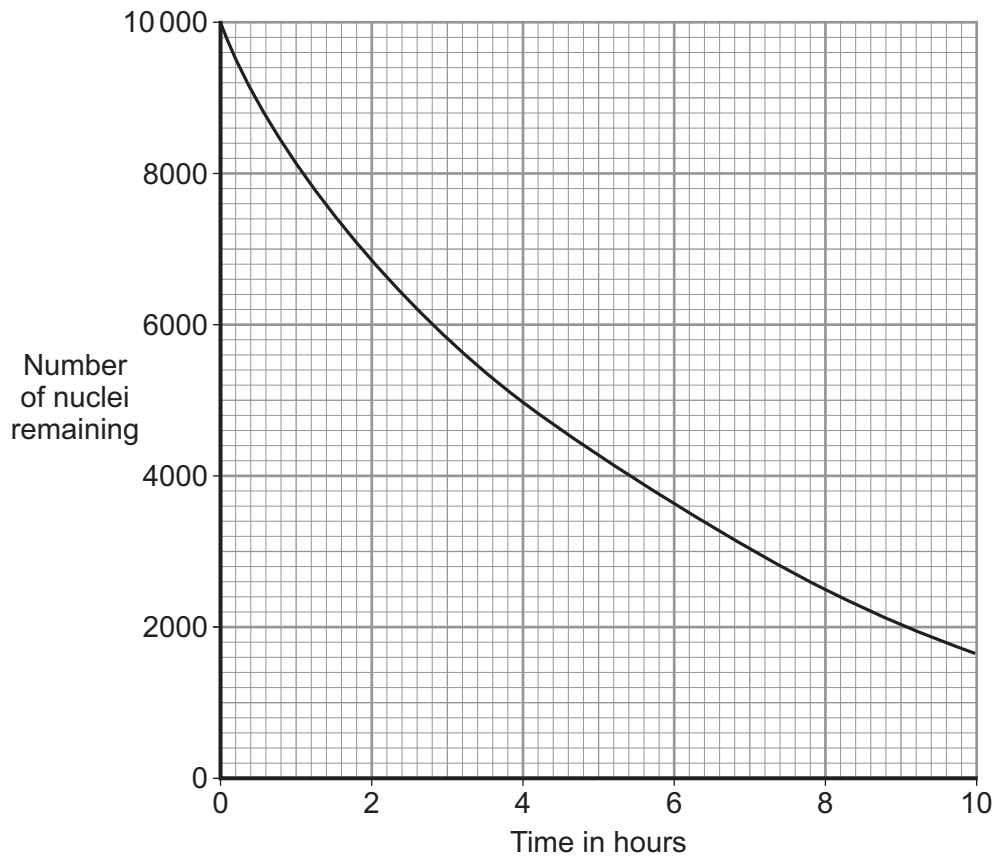
- 1 Alpha radiation is very dangerous if the source gets inside the body.
- 2 Alpha radiation can travel very long distances in the air.
- 3 Alpha radiation has the longest half-life.
- 4 Alpha radiation is the most penetrating of all radiations.

Turn over for the next question

Turn over ►

QUESTION FOUR

The graph shows the decay of a small sample of radioactive isotope. At the start, the sample contains 10 000 nuclei.



4A What is the half-life of the isotope shown in the graph?

- 1 2 hours
- 2 4 hours
- 3 6 hours
- 4 8 hours

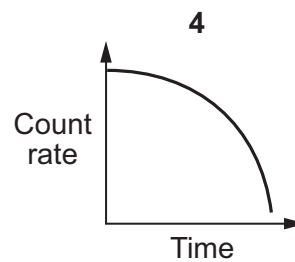
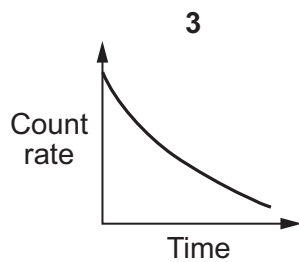
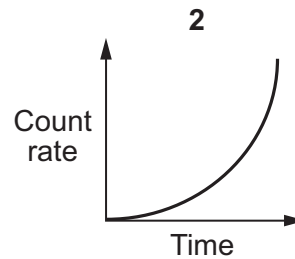
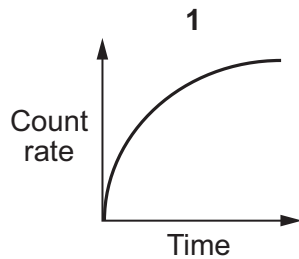
4B How many of the original nuclei would remain after three half-lives?

- 1 1250
- 2 2500
- 3 3333
- 4 none

4C This radioactive isotope may be suitable . . .

- 1 as a source of radiation in a smoke alarm.
- 2 as a source of radiation to monitor the thickness of paper in a paper mill.
- 3 as a medical tracer in the human body.
- 4 to use in finding the age of an ancient bone.

4D Which one of the following graphs would show how the count rate for this isotope changes with time?



Turn over for the next question

Turn over ►

QUESTION FIVE

Fluorescers are substances that are used to make objects look brighter. Fluorescers absorb ultraviolet radiation and re-emit it as visible light. This makes the object glow when exposed to ultraviolet radiation.

- Laundry detergents contain fluorescers to make 'white look even whiter'.
- Dental compounds contain fluorescers to make teeth look brighter.
- Since 1950, fluorescers have been added to white paper to brighten it.

5A A white shirt has been washed in detergent containing a fluorescer.

The white shirt will . . .

- 1 be much cleaner.
- 2 glow in the dark.
- 3 look cleaner.
- 4 stay cleaner for longer.

5B A dentist paints someone's teeth with enamel containing a fluorescer.

The enamel absorbs ultraviolet radiation from sunlight and then emits light with . . .

- 1 a higher frequency and a longer wavelength.
- 2 a higher frequency and a shorter wavelength.
- 3 a lower frequency and a longer wavelength.
- 4 a lower frequency and a shorter wavelength.

5C A document is dated 1805. The document glows when it is viewed in ultraviolet light.

The document is likely to . . .

- 1 be a forgery.
- 2 have been printed before 1805.
- 3 have a dull surface.
- 4 have a shiny surface.

5D The ultraviolet radiation used to view the document has a wavelength of 0.000 000 1 metres.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	x	wavelength (metre, m)
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Speed of electromagnetic waves = 300 000 000 m/s

What is the frequency of ultraviolet radiation of wavelength 0.000 000 1 metres?

- 1 30 Hz
- 2 3 000 000 Hz
- 3 3 000 000 000 Hz
- 4 3 000 000 000 000 000 Hz

Turn over for the next question

Turn over ►

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.

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

Turn over ►

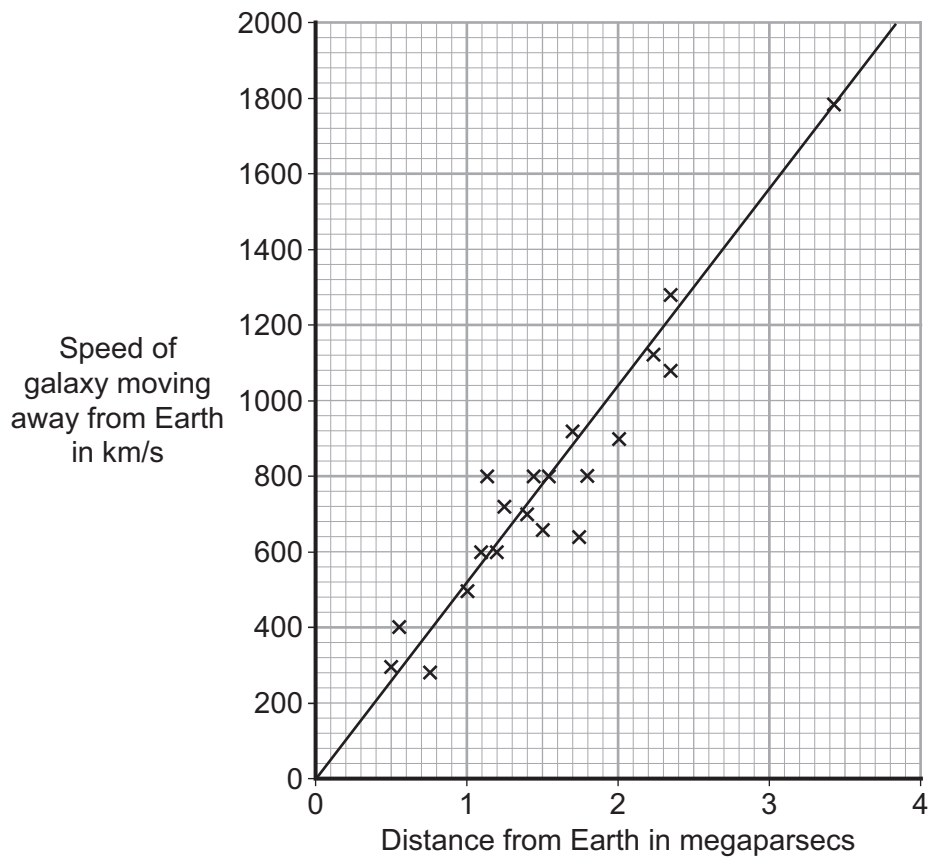
QUESTION SEVEN

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

7A Red-shift is an apparent . . .

- 1 decrease in wavelength of the light due to a galaxy moving away from the Earth.
- 2 increase in wavelength of the light due to a galaxy moving away from the Earth.
- 3 decrease in wavelength of the light due to a galaxy moving towards the Earth.
- 4 increase in the wavelength of the light due to a galaxy moving towards the Earth.

The graph shows the results of calculations made by the astronomer Edwin Hubble. He plotted the speed at which the galaxies are moving away from Earth against their distance from Earth. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 000 km.



7B Hubble's results suggest that . . .

- 1 more results are needed before we can say there is a relationship between the speed of a galaxy and the distance of the galaxy from Earth.
- 2 there is a negative relationship between the speed of a galaxy and the distance of the galaxy from Earth.
- 3 the speed of a galaxy is directly proportional to the distance of the galaxy from Earth.
- 4 the graph points are too scattered to give a meaningful relationship.

7C The gradient of the line of best fit on the graph is known as the Hubble constant. The Hubble constant can be used to estimate the age of the universe.

From this data, the approximate value of the Hubble constant in km/s per megaparsec is . . .

- 1 4
- 2 500
- 3 1000
- 4 2000

7D Hubble's calculations support the 'big bang' theory. The 'big bang' theory says that the universe is expanding.

In 1948, George Gamow predicted that there should be microwave radiation left over from the 'big bang'. This radiation was discovered in the 1960s, and was confirmed by the Cosmic Background Explorer satellite in the early 1990s.

This discovery . . .

- 1 disproves the involvement of a god in the origin of the universe.
- 2 gives information to help us know what happened before the 'big bang'.
- 3 provides evidence which eliminates all other theories of the origin of the universe.
- 4 provides evidence in support of the 'big bang' theory.

Turn over for the next question

Turn over ►

QUESTION EIGHT

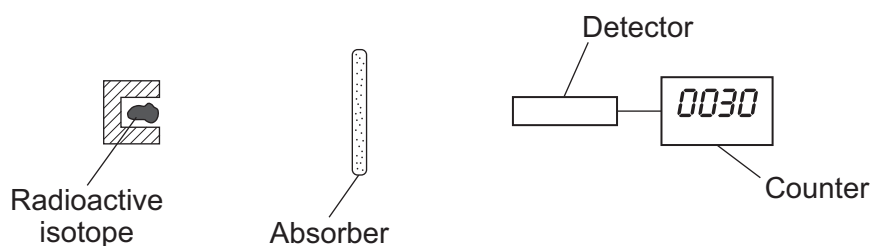
Radioactive isotopes may emit alpha, beta or gamma radiation.

A sixth-form student carried out experiments on different radioactive isotopes, **S**, **T** and **V**.

She was told that:

- all three types of radiation are emitted
- the experiments must be done in a vacuum.

In the first experiment, she put different absorbers in turn between each of the isotopes and a detector. She measured the count rate from each isotope.



The results are shown in **Table 1**.

Table 1

Isotope	Count rate in counts per second			
	No absorber	Sheet of paper	10 mm of aluminium	100 mm of lead
S	40	40	40	2
T	60	20	18	4
V	75	74	0	0

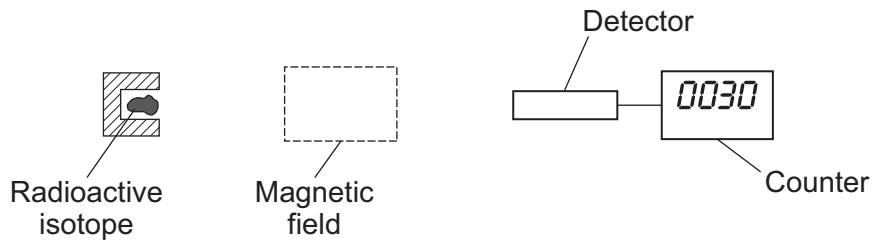
8A From these results, it can be concluded that isotope **V** emits . . .

- 1 alpha radiation only.
- 2 beta radiation only.
- 3 gamma radiation only.
- 4 alpha and gamma radiation.

8B Which source emits more than one type of radiation?

- 1 **S**
- 2 **T**
- 3 **V**
- 4 none of them

8C In a second experiment, the absorber was replaced by a magnetic field.



The results are shown in **Table 2**.

Table 2

Isotope	Count rate in counts per second	
	Without magnetic field	With magnetic field
S	40	40
T	60	20
V	75	0

Which one of the following conclusions from the experiment is correct?

- 1 **V** could be a gamma emitter and a beta emitter.
- 2 **V** and **T** both emit gamma radiation.
- 3 **S** is either an alpha emitter or a beta emitter.
- 4 **T** could be an alpha emitter and a gamma emitter.

8D Some types of radiation are deflected by a magnetic field.

This is because the radiation . . .

- 1 is like a wave.
- 2 has a positive charge or a negative charge.
- 3 has north poles and south poles.
- 4 has no mass.

Turn over ►

QUESTION NINE

Four hundred years ago, Galileo pointed his small, primitive telescope at the night sky.

His telescope had lenses to focus light from the stars.

Today, much larger optical telescopes use large curved mirrors to focus light. The largest single-piece mirror has a diameter of 8.4 m. If the diameter was made any larger, the mirror would deform under its own weight. Very large telescopes use smaller mirrors linked together.

The table gives the effective diameters of the mirrors in several large optical telescopes.

Telescope	Keck	Giant Magellan Telescope (GMT)	Thirty Metre Telescope(TMT)	Very Large Telescope (VLT)
Effective diameter of mirror in metres	10.0	27.0	30.0	32.8

9A The TMT has nine times the light-collecting power of the Keck telescope mirror.

This is because the light-collecting power of a telescope is . . .

- 1 directly proportional to the diameter of the mirror.
- 2 inversely proportional to the diameter of the mirror.
- 3 directly proportional to the square of the diameter of the mirror.
- 4 inversely proportional to the square of the diameter of the mirror.

9B The VLT is located in a desert high in the mountains of South America.

The VLT produces sharp images because . . .

- 1 the VLT is nearer to the stars than optical telescopes at sea level.
- 2 light rays are more easily reflected higher in the atmosphere.
- 3 the night sky in the desert is clear and dark.
- 4 at the top of a mountain the telescope weighs less.

9C Some telescopes are put into orbit round the Earth.

This is so that the telescopes . . .

- 1 can detect only visible light.
- 2 can detect only the electromagnetic waves that the Earth's atmosphere absorbs.
- 3 can detect visible light and sound waves.
- 4 can detect electromagnetic waves that do not reach the Earth's surface.

9D The smaller the diameter of a telescope, the higher the frequency of the waves that it can detect.

Pulsars are objects in space that emit radio waves. Pulsars were discovered using radio telescopes based on Earth.

The telescope that first detected the radiation from a pulsar had a diameter . . .

- 1 about the same size as the diameter of an optical telescope because the frequencies it detects are about the same.
- 2 smaller than the diameter of an optical telescope because the frequencies it detects are lower.
- 3 larger than the diameter of an optical telescope because the frequencies it detects are higher.
- 4 larger than the diameter of an optical telescope because the frequencies it detects are lower.

END OF TEST

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