| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surname | | | | | | | | | | |
| Other Names | | | | | | | | | | |
| Candidate Signature | | | | | | | | | | |

General Certificate of Secondary Education
Foundation Tier and Higher Tier
March 2011

# Science A

**Unit Physics P1b (Radiation and the Universe)**

# Physics

**Unit Physics P1b (Radiation and the Universe)**

**PHY1BP**

**F&H**

**Wednesday 2 March 2011 Morning Session**

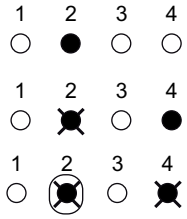
**For this paper you must have:**
- a black ball-point pen
- an objective test answer sheet.

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 14 of this booklet.

## FOUNDATION TIER

### Section One

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

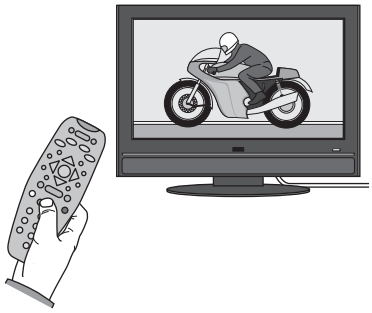
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1**–**4**.

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

Mark your choices on the answer sheet.

### QUESTION ONE

This question is about electromagnetic radiation and television.



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

**A** infra red

**B** microwaves

**C** radio waves

**D** visible light

Television signals from a transmitter on Earth are carried by . . . **1** . . . .

Television signals from a satellite are carried by . . . **2** . . . .

A television remote control uses . . . **3** . . . .

A television screen is designed to produce . . . **4** . . . .

**QUESTION TWO**

Electromagnetic radiation can be absorbed, reflected and transmitted.

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

**A** infra red

**B** microwaves

**C** visible light

**D** X-rays

A mirror is designed to reflect . . . **1** . . . .

Mobile phone masts are designed to transmit . . . **2** . . . .

The metal surface inside an oven is designed to reflect . . . **3** . . . .

Lead-lined aprons used in hospitals are designed to absorb . . . **4** . . . .

**QUESTION THREE**

This question is about gamma radiation.

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

**A** bacteria

**B** cells

**C** isotopes

**D** particles

Gamma radiation is emitted by the nuclei of radioactive . . . **1** . . . .

Gamma radiation can be used by doctors to kill cancer . . . **2** . . . .

Gamma radiation can be used to kill . . . **3** . . . that cause food to rot.

Unlike alpha and beta radiation, gamma radiation does not consist of . . . **4** . . . .

**QUESTION FOUR**

The waves in the electromagnetic spectrum can be grouped in order of wavelength.

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

**A** gamma rays

**B** infra red rays

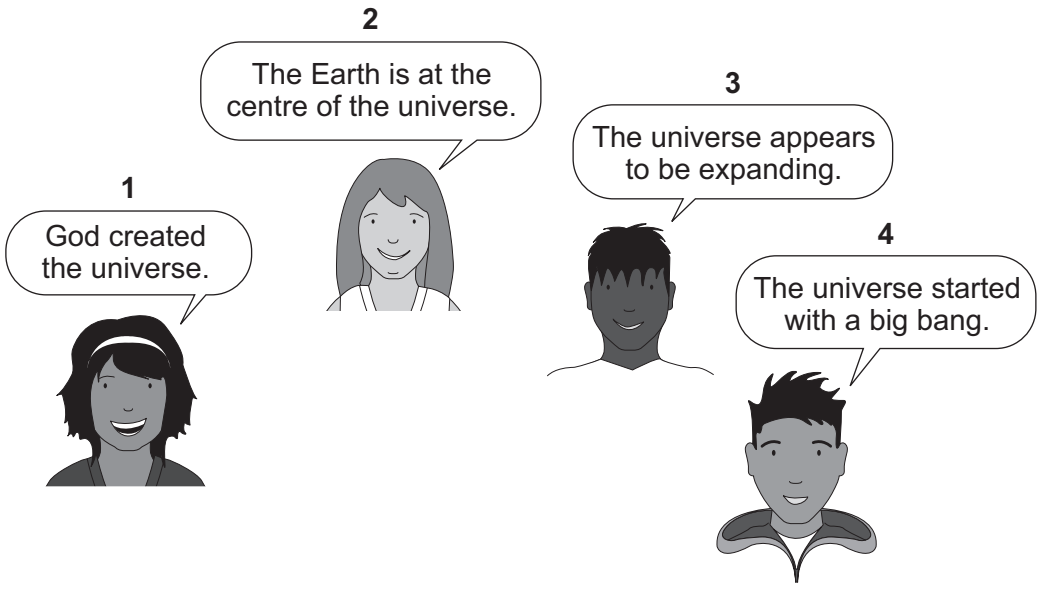
**C** radio waves

**D** ultraviolet rays

| |
|---|
| . . . **1** . . . |
| X-rays |
| . . . **2** . . . |
| visible light |
| . . . **3** . . . |
| microwaves |
| . . . **4** . . . |

**QUESTION FIVE**

Some students are talking about the universe.




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

**A** a belief that science cannot disprove

**B** a conclusion based on observations of red-shift

**C** a theory supported by scientific evidence but not direct observations

**D** a theory that science has disproved

**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.

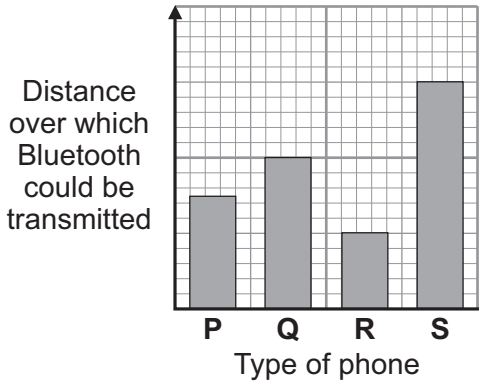
Mark your choices on the answer sheet.

**QUESTION SIX**

'Bluetooth' is a type of radio communication that can be used between mobile phones over short distances.

A group of students investigated the distance over which four different types of mobile phone could transmit *Bluetooth*.

Their results are shown below.




**6A** The data is displayed as a bar chart because one of the variables is . . .

**1** a categoric variable.

**2** a control variable.

**3** a continuous variable.

**4** an independent variable.

**6B** What was the independent variable in the students' investigation?

**1** distance over which the signal could be transmitted

**2** length of time for which the signal was sent

**3** strength of signal used

**4** type of phone used

**6C** Which phone could transmit *Bluetooth* over the biggest distance?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**6D** Most mobile phones use digital signals rather than analogue signals.

Why is this?

**1** Digital signals are less prone to interference.

**2** Digital signals travel faster.

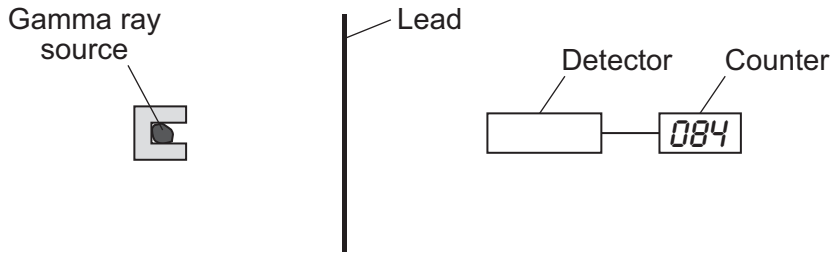
**3** Digital signals can travel further.

**4** Digital signals vary continuously.

**Turn over for the next question**

## QUESTION SEVEN

A student investigated the absorption of gamma rays. He used lead of different thicknesses.




He increased the thickness of the lead by 1 mm each time and measured the count rate.

His results are shown in the table.

| Thickness of lead in mm | Count rate in counts per second |
|---|---|
| 0 | 100 |
| 1 | 84 |
| 2 | 70 |
| 3 | 60 |
| 4 | 50 |
| 5 | 44 |
| 6 | 35 |
| 7 | 30 |
| 8 | 25 |

**7A** What was the interval used in the thickness of the lead sheets?

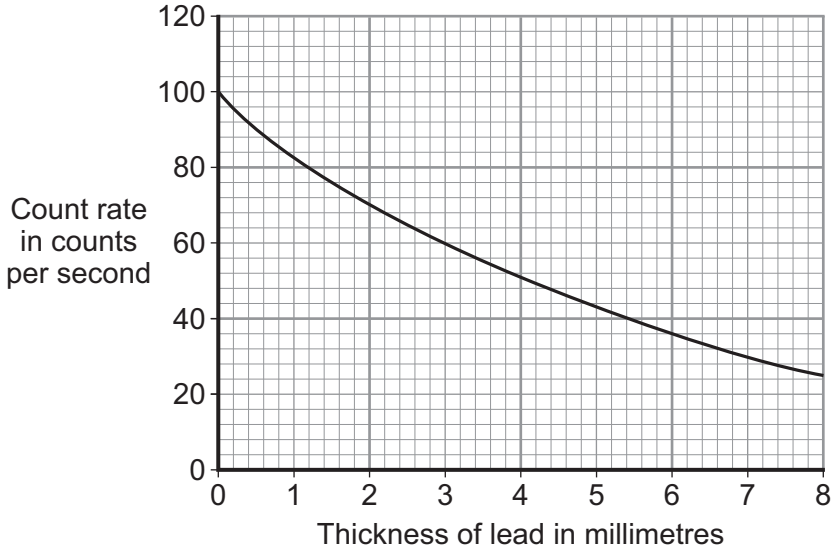
**1** 1 mm

**2** 2 mm

**3** 5 mm

**4** 10 mm

The graph shows the results.




**7B** The graph shows that . . .

**1** doubling the thickness of lead doubles the count rate.

**2** there is no relationship between thickness and count rate.

**3** doubling the thickness of lead makes the count rate three times bigger.

**4** the thicker the lead, the lower the count rate.

**7C** A thickness of 2 mm of lead will reduce the count rate by . . .

**1** 30 counts per second.

**2** 40 counts per second.

**3** 50 counts per second.

**4** 70 counts per second.

**7D** What thickness of lead reduced the count rate to half of its original value?

**1** 1 mm

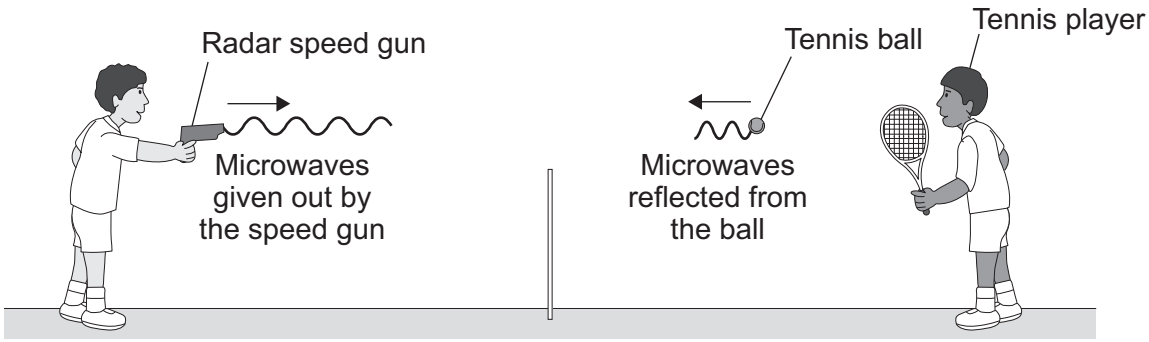
**2** 4 mm

**3** 9 mm

**4** 10 mm

## QUESTION EIGHT

The picture shows a radar speed gun being used to measure how fast a tennis player hits the ball.




Some of the microwaves from the radar speed gun are absorbed by the ball and some are reflected by the ball.

**8A** What effect will the absorbed microwaves have on the ball?

**1** The temperature of the ball will increase slightly.

**2** The ball will go faster.

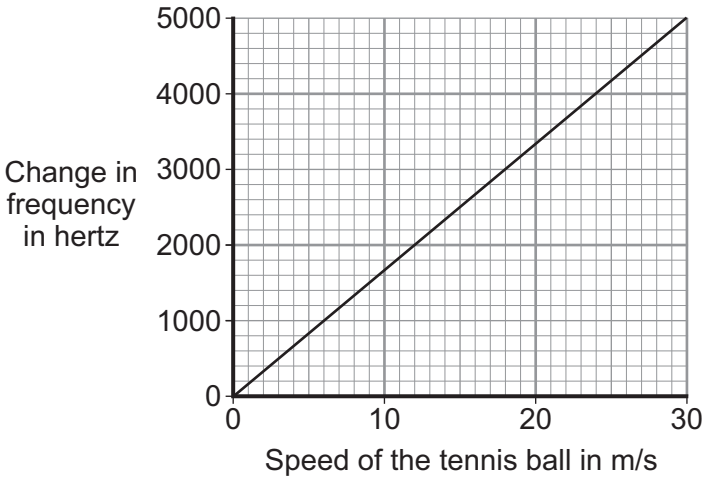
**3** The temperature of the ball will decrease slightly.

**4** The ball will go slower.

**8B** Which row in the table describes how the frequency and wavelength of the reflected microwaves are different from the microwaves given out by the speed gun?

| | **Frequency of reflected waves** | **Wavelength of reflected waves** |
|---|---|---|
| **1** | higher | longer |
| **2** | lower | shorter |
| **3** | higher | shorter |
| **4** | lower | longer |

The graph shows how the change in frequency of the microwaves depends on the speed of the ball.




**8C** The data has been drawn as a line graph because . . .

**1** frequency and speed are both categoric variables.

**2** frequency and speed are both continuous variables.

**3** frequency is a categoric variable and speed is a continuous variable.

**4** frequency is a continuous variable and speed is a categoric variable.

**8D** The speed gun measures the change in frequency as 3000 Hz.

What is the speed of the ball?

**1** 18 m/s

**2** 20 m/s

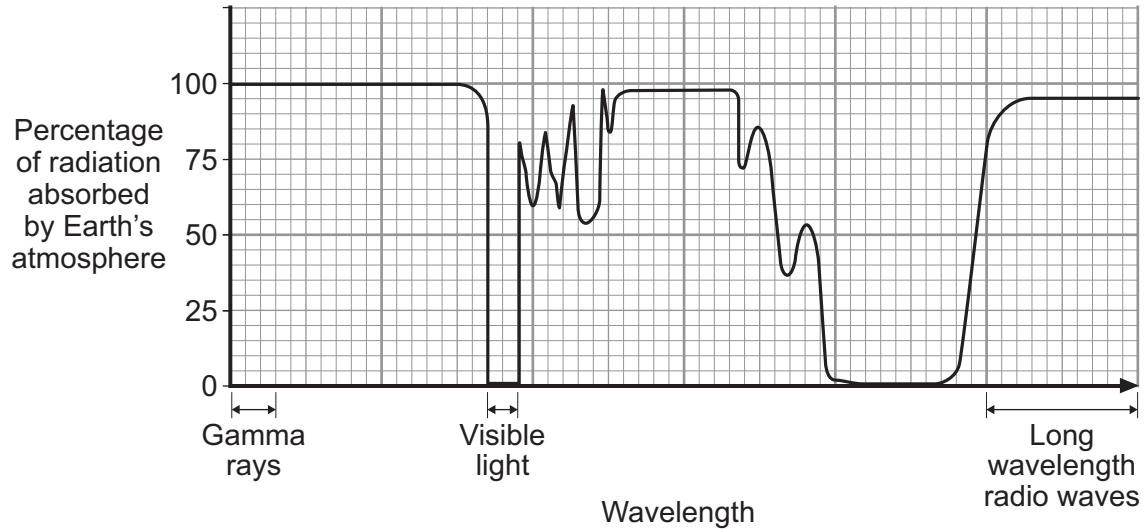
**3** 21 m/s

**4** 22 m/s

**Turn over for the next question**

## QUESTION NINE

The diagram shows the absorption of electromagnetic radiation by the Earth's atmosphere.




**9A** The diagram shows that . . .

**1** all wavelengths of gamma radiation reach the Earth's surface.

**2** all wavelengths of radio waves reach the Earth's surface.

**3** all wavelengths of ultraviolet radiation reach the Earth's surface.

**4** all wavelengths of visible light reach the Earth's surface.

**9B** Some objects in space emit X-rays.

Where would you put a telescope to detect these X-rays?

**1** above the Earth's atmosphere

**2** at the top of a hill

**3** at ground level in a hot desert

**4** at ground level in the Antarctic

The table gives information about some space telescopes.

| **Name** | Hubble | Compton | Chandra | Spitzer |
|---|---|---|---|---|
| **Launched in** | 1990 | 1991 | 1999 | 2003 |
| **Detects** | infra red rays<br>ultraviolet rays<br>visible light | gamma rays | X-rays | infra red rays |

**9C** Which statement about these space telescopes can be deduced from the information in the table?

**1** They all collect data using mirrors.

**2** They all detect electromagnetic radiation.

**3** They are all in space at present.

**4** They were all used to study the Earth.

**9D** From the information in the table, which one of the following emissions could be detected by one of these space telescopes?

**1** alpha particles

**2** nuclear radiation

**3** radio waves

**4** sound waves

**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** to **TWO**.

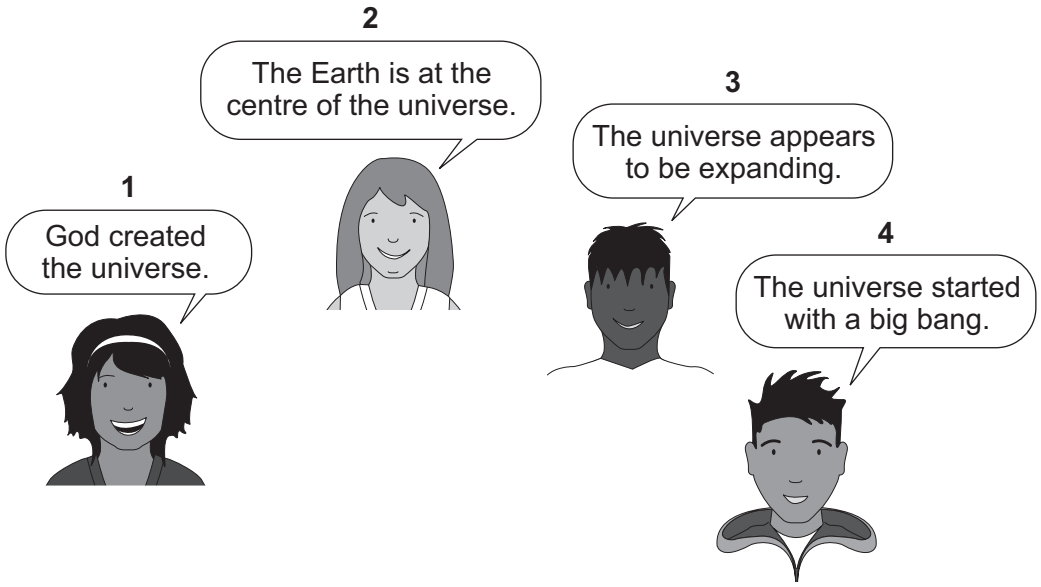
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1**–**4**.

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

Mark your choices on the answer sheet.

## QUESTION ONE

Some students are talking about the universe.




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

**A** a belief that science cannot disprove

**B** a conclusion based on observations of red-shift

**C** a theory supported by scientific evidence but not direct observations

**D** a theory that science has disproved

**QUESTION TWO**

Radioactive isotopes have many uses.

The table gives the types of radiation emitted and the half-lives of four radioactive isotopes, **A**, **B**, **C** and **D**.

| Isotope | Radiation emitted | Half-life |
|---|---|---|
| **A** | alpha | 432 years |
| **B** | beta | 29 years |
| **C** | gamma | 6 hours |
| **D** | gamma | 5 years |

Match isotopes, **A**, **B**, **C** and **D**, with the most appropriate uses **1**–**4** in the table below.

| | Use |
|---|---|
| **1** | controlling the thickness of aluminium foil as it is produced |
| **2** | sterilising medical instruments used in an operating theatre |
| **3** | injecting into a patient as a medical tracer |
| **4** | used inside a smoke detector |

**Turn over for the next question**

**Section Two**

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

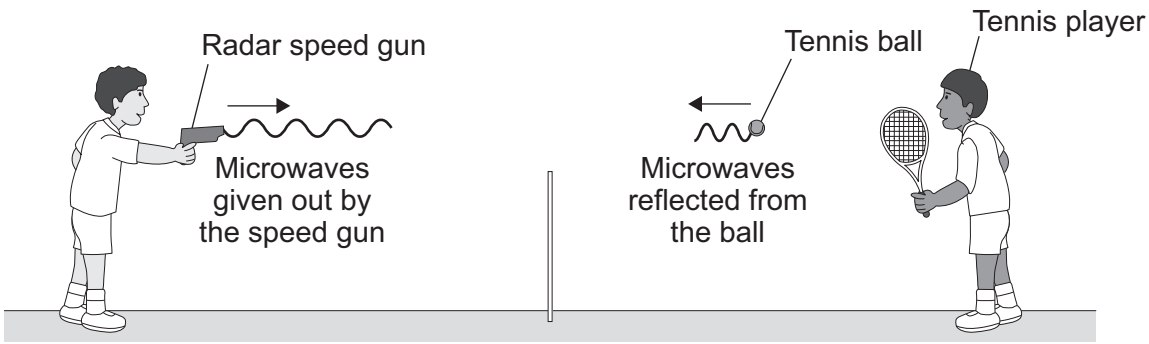
Each of these questions has four parts.

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

Mark your choices on the answer sheet.

## QUESTION THREE

The picture shows a radar speed gun being used to measure how fast a tennis player hits the ball.




Some of the microwaves from the radar speed gun are absorbed by the ball and some are reflected by the ball.

**3A** What effect will the absorbed microwaves have on the ball?

**1** The temperature of the ball will increase slightly.

**2** The ball will go faster.

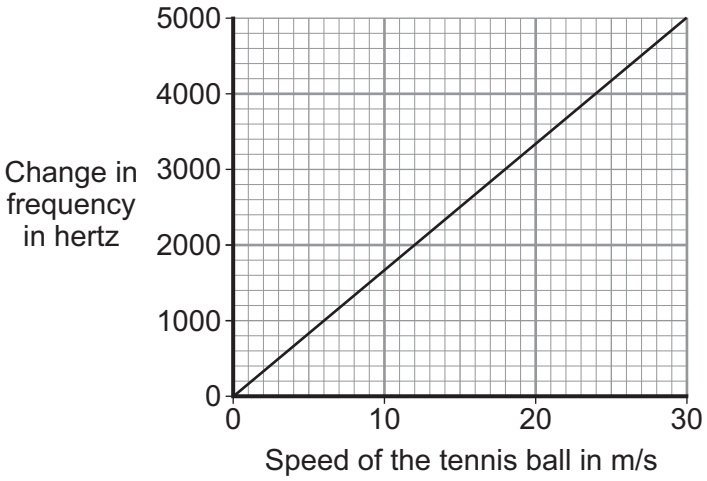
**3** The temperature of the ball will decrease slightly.

**4** The ball will go slower.

**3B** Which row in the table describes how the frequency and wavelength of the reflected microwaves are different from the microwaves given out by the speed gun?

| | **Frequency of reflected waves** | **Wavelength of reflected waves** |
|---|---|---|
| **1** | higher | longer |
| **2** | lower | shorter |
| **3** | higher | shorter |
| **4** | lower | longer |

The graph shows how the change in frequency of the microwaves depends on the speed of the ball.




**3C** The data has been drawn as a line graph because . . .

**1** frequency and speed are both categoric variables.

**2** frequency and speed are both continuous variables.

**3** frequency is a categoric variable and speed is a continuous variable.

**4** frequency is a continuous variable and speed is a categoric variable.

**3D** The speed gun measures the change in frequency as 3000 Hz.

What is the speed of the ball?

**1** 18 m/s

**2** 20 m/s

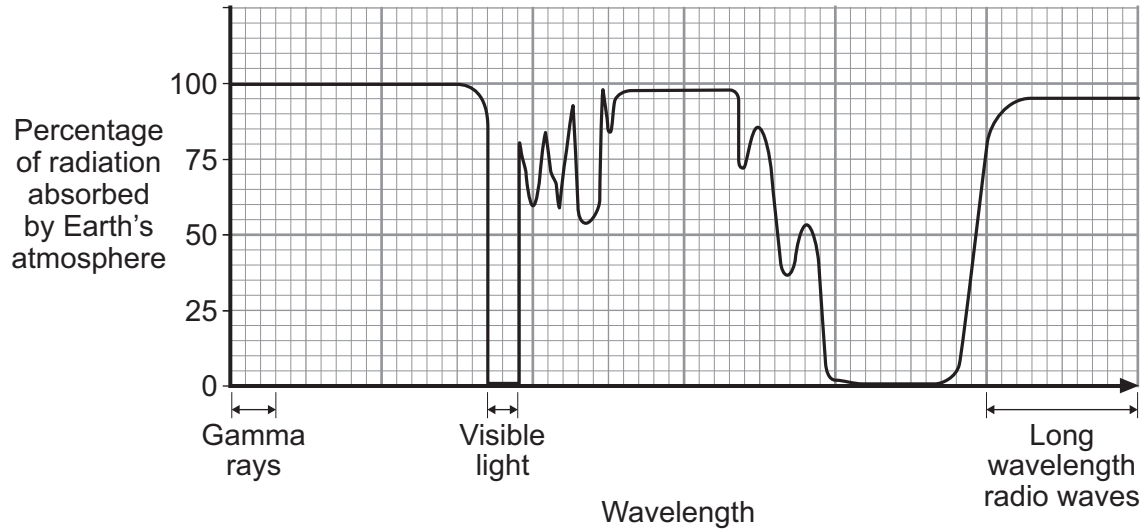
**3** 21 m/s

**4** 22 m/s

**Turn over for the next question**

## QUESTION FOUR

The diagram shows the absorption of electromagnetic radiation by the Earth's atmosphere.




**4A** The diagram shows that . . .

**1** all wavelengths of gamma radiation reach the Earth's surface.

**2** all wavelengths of radio waves reach the Earth's surface.

**3** all wavelengths of ultraviolet radiation reach the Earth's surface.

**4** all wavelengths of visible light reach the Earth's surface.

**4B** Some objects in space emit X-rays.

Where would you put a telescope to detect these X-rays?

**1** above the Earth's atmosphere

**2** at the top of a hill

**3** at ground level in a hot desert

**4** at ground level in the Antarctic

The table gives information about some space telescopes.

| **Name** | Hubble | Compton | Chandra | Spitzer |
|---|---|---|---|---|
| **Launched in** | 1990 | 1991 | 1999 | 2003 |
| **Detects** | infra red rays<br>ultraviolet rays<br>visible light | gamma rays | X-rays | infra red rays |

**4C** Which statement about these space telescopes can be deduced from the information in the table?

**1** They all collect data using mirrors.

**2** They all detect electromagnetic radiation.

**3** They are all in space at present.

**4** They were all used to study the Earth.

**4D** From the information in the table, which one of the following emissions could be detected by one of these space telescopes?

**1** alpha particles

**2** nuclear radiation

**3** radio waves

**4** sound waves

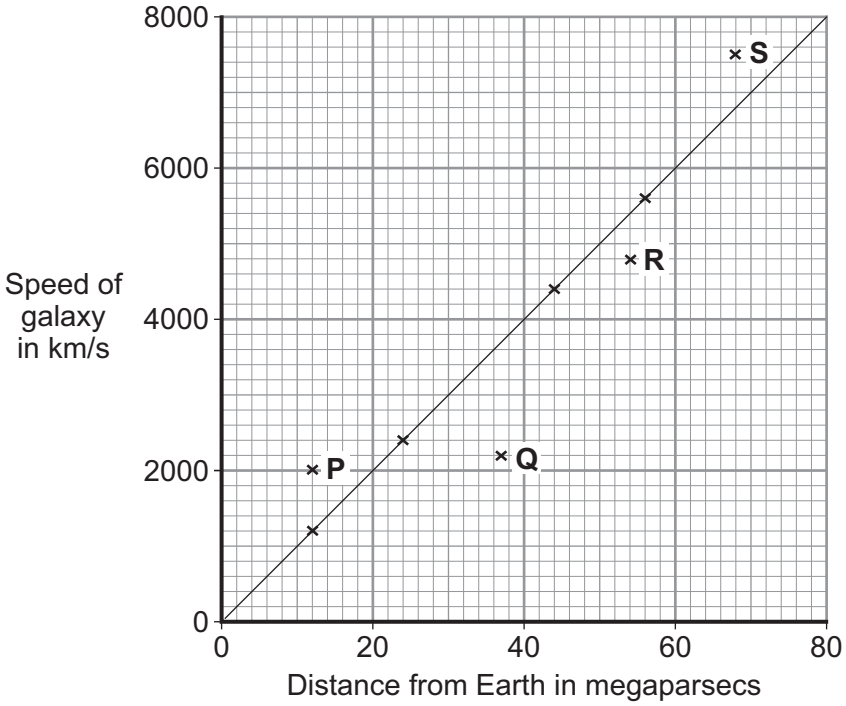
**Turn over for the next question**

**QUESTION FIVE**

In the early part of the twentieth century, Edwin Hubble made the discovery that distant galaxies are moving away from Earth.

He calculated the speeds at which the galaxies are moving away from Earth and their distances from Earth.

The graph shows Hubble's results.




A megaparsec is a unit of distance

**5A** Which one of the following statements describes what the graph shows?

**1** All galaxies have different but constant speeds.

**2** Galaxies will eventually reach a maximum speed.

**3** Nearer galaxies have the highest speeds.

**4** The speed of a galaxy is directly proportional to its distance from Earth.

**5B** What is the approximate speed, in km/s, of a galaxy 120 megaparsecs away from Earth?

**1** 10 000

**2** 11 000

**3** 12 000

**4** 13 000

**5C** The light from four galaxies, **P**, **Q**, **R** and **S**, is examined for red-shift.

Which one of the following statements about the amount of red-shift is correct?

**1** **P** produces the biggest red-shift.

**2** **P**, **Q**, **R** and **S** produce the same red-shift.

**3** **Q** and **R** produce the smallest red-shift.

**4** **S** produces the biggest red-shift.

**5D** Some galaxies show a blue-shift.

These galaxies . . .

**1** are the most distant galaxies from the Earth.

**2** are stationary.

**3** are moving towards the Earth.

**4** have only just been formed.

**Turn over for the next question**

## QUESTION SIX

Some radioactive substances emit beta particles.

**6A** What is a beta particle?

**1** an electron from outside the nucleus

**2** an electron from inside the nucleus

**3** a neutron from inside the nucleus

**4** a proton from inside the nucleus

**6B** Which row in the table correctly describes the properties of beta particles?

| | Range in air | Penetration through materials |
|---|---|---|
| **1** | a few centimetres | stopped by thin paper |
| **2** | about a metre | stopped by thin paper |
| **3** | about a metre | stopped by thin aluminium |
| **4** | several kilometres | stopped by thick lead |

**6C** Beta particles cause ionisation.

What does this mean?

**1** They make non-radioactive sources become radioactive.

**2** They produce charged particles when they collide with atoms.

**3** They remove charged particles from the air.

**4** They stop other radioactive sources from emitting radiation.

**6D** How is a beta particle different from an alpha particle?

**1** Alpha particles do not cause ionisation but beta particles do.

**2** Alpha particles are deflected by magnetic fields and beta particles are not.

**3** Beta particles are deflected by electric fields and alpha particles are not.

**4** Beta particles have a much smaller mass than alpha particles.

**Turn over for the next question**

## QUESTION SEVEN

In 2009, the European Space Agency launched two space telescopes: the Herschel and the Planck.

Also in 2009, the US space shuttle Atlantis was launched. Atlantis carried seven astronauts to service the Hubble space telescope.

The table gives information about the three space telescopes.

| | **Hubble** | **Herschel** | **Planck** |
|---|---|---|---|
| **Distance from Earth** | 560 km | 1.5 million km | 1.5 million km |
| **Radiation detected** | Visible light, ultraviolet | Infra red | Microwaves |
| **Cost of 2009 launch** | £1 billion (for servicing) | Total for the 2 telescopes - £1.7 billion | |
| **Objects observed** | Distant stars and galaxies | Early development of galaxies | Radiation left over from the 'Big Bang' |

**7A** The Hubble and Herschel telescopes both contain mirrors. The diameter of the mirror in the Herschel telescope is 50 % larger than the diameter of the main mirror in the Hubble telescope.

This means that the . . .

**1** Herschel mirror is capable of collecting more energy each second than the Hubble mirror.

**2** cost of the Herschel telescope is higher than the cost of the Hubble servicing mission.

**3** Herschel telescope is much lighter than the Hubble telescope.

**4** orbit of the Herschel telescope is much larger than the orbit of the Hubble telescope.

**7B** The larger the diameter of a telescope mirror, the longer the wavelength of radiation it can detect.

The order of increasing diameters for the space telescopes in the table is . . .

**1** Herschel; Hubble; Planck.

**2** Hubble; Herschel; Planck.

**3** Planck; Herschel; Hubble.

**4** Planck; Hubble; Herschel.

**7C** The table refers to radiation left over from the 'Big Bang'.

What is the 'Big Bang'?

**1** a theory that the light from distant galaxies shows a red-shift

**2** an observation that the universe is expanding

**3** a theory that the universe began from a very small initial point

**4** evidence that distant galaxies are moving away from the Earth

**7D** A survey showed that a lot of people living in the UK think that the money spent on the launches in 2009 would have been better spent on feeding starving people in the developing world.

The people in the survey are concerned about . . .

**1** political and scientific issues.

**2** political and environmental issues.

**3** economic and environmental issues.

**4** economic and ethical issues.

**Turn over for the next question**

## QUESTION EIGHT

An isotope, **X**, is radioactive and decays into isotope **Y**, which is not radioactive.

Rocks such as granite contain both of these isotopes.

The half-life of isotope **X** is 4 million years.

**8A** A sample of granite is found to contain one atom of **Y** for each atom of **X**.

The age of the rock is about . . .

**1** 1 million years.

**2** 2 million years.

**3** 4 million years.

**4** 6 million years.

**8B** Another sample of rock is known to be 8 million years old.

The ratio of the number of atoms of **X** to the number of atoms of **Y** would be . . .

**1** 1 : 2

**2** 1 : 3

**3** 1 : 4

**4** 2 : 1

**8C** A sample of rock contains atoms of isotope **X**, but no atoms of isotope **Y**.

This is because . . .

**1** all the atoms of **Y** have decayed.

**2** the atoms of **X** in this sample are not radioactive.

**3** the half-life of atoms of **X** in this sample is greater than 4 million years.

**4** the rock has only recently been formed.

**8D** Isotope **X** decays by emitting alpha particles.

An alpha particle consists of . . .

**1** 2 electrons only.

**2** 2 protons and 2 neutrons.

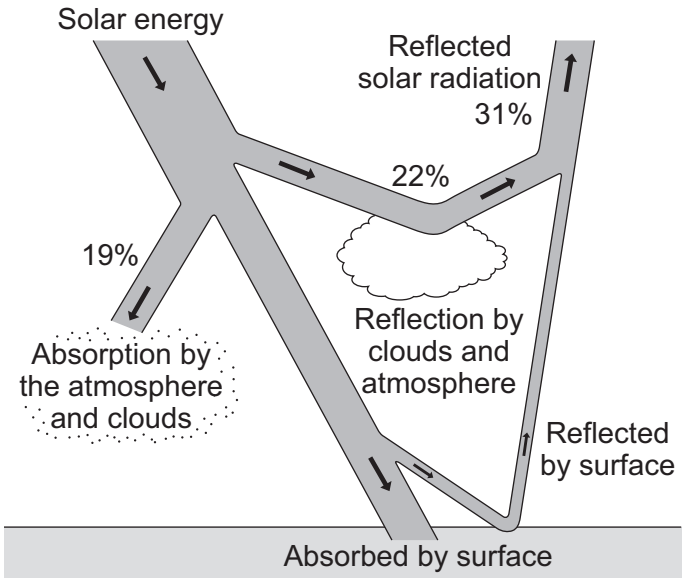
**3** 2 neutrons only.

**4** 2 protons and 2 electrons.

**Turn over for the next question**

**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.

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**

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