Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Secondary Education
Foundation Tier and Higher Tier
November 2012

Science A

Unit Physics P1b (Radiation and the Universe)

Physics

Unit Physics P1b (Radiation and the Universe)

PHY1BP

F&H

Tuesday 6 November 2012 Afternoon Session

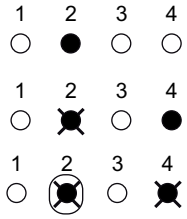
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

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 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**.

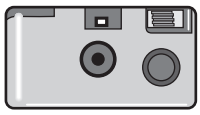
Mark your choices on the answer sheet.

QUESTION ONE

Each of these devices uses electromagnetic radiation.

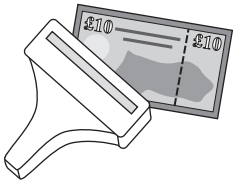
1

Camera



2

Forgery detector

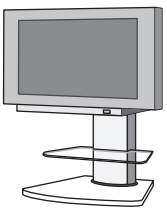


3

Toaster

4

Television



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

A infra red

B radio waves

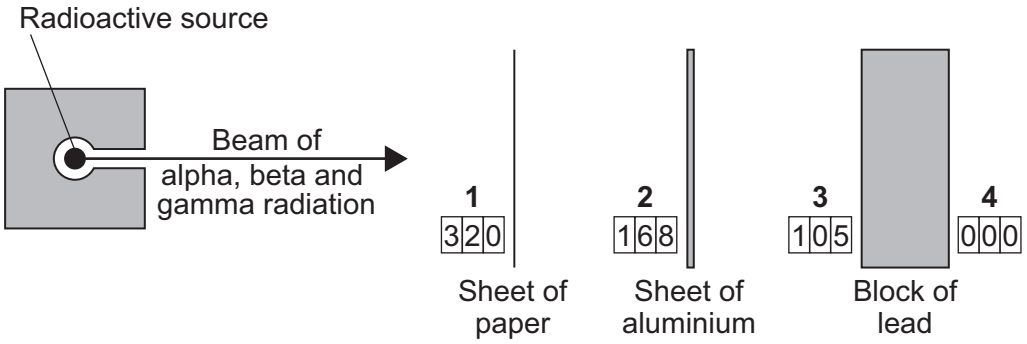
C ultraviolet

D visible light

QUESTION TWO

A radioactive source gives out a beam of alpha, beta and gamma radiation.

The diagram shows three different absorbers in the path of the beam. The diagram also shows the readings, in counts per second, on radiation detectors at positions **1**, **2**, **3** and **4**.



Match the radiation detected, **A**, **B**, **C** and **D**, with the positions **1**–**4** in the diagram.

A gamma only

B gamma and beta only

C gamma, beta and alpha

D no radiation

Turn over for the next question

QUESTION THREE

The Earth's atmosphere absorbs almost all electromagnetic waves but not waves with wavelengths longer than ultraviolet radiation.

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

A microwaves

B radio waves

C visible light

D X-rays

Three hundred years ago, many objects in the night sky were discovered by looking through hand-held telescopes. These telescopes detect . . . **1** . . . .

In the last century, distant galaxies were discovered by using large dishes and aerials on Earth which detected . . . **2** . . . .

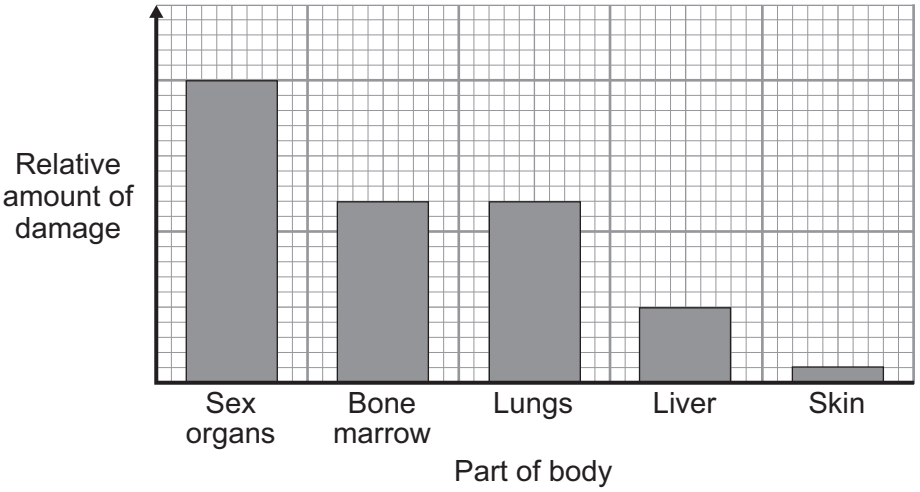
In recent years, many discoveries have been made using telescopes fixed to satellites in space. Unlike telescopes on Earth, telescopes fixed to satellites can detect . . . **3** . . . .

The satellites send images back to Earth using . . . **4** . . . .

QUESTION FOUR

In 1920, scientists investigated the effect of radiation on different parts of the body. They found that radiation affects some parts of the body more than it affects other parts of the body.

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



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

A categoric

B control

C dependent

D reliable

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

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

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

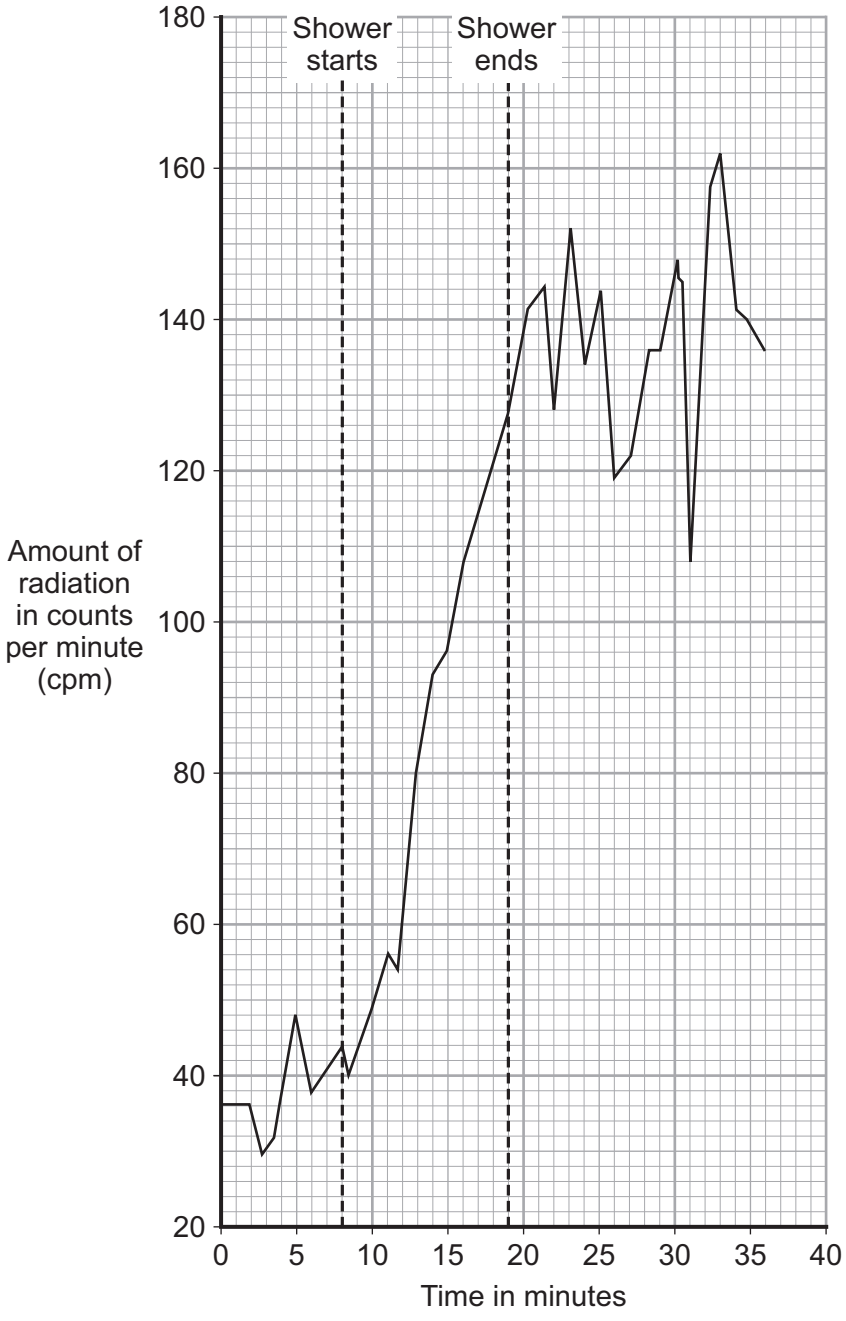
If this investigation was repeated, giving similar results, this would show that the original data was . . . **4** . . . .

Turn over for the next question

QUESTION FIVE

The graph shows how the amount of radiation from radon varies in the bathroom of a house.

The data is recorded before, during and after someone having a shower.



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

A 11

B 33

C 44

D 84

1	the time the shower took in minutes
2	the amount of radiation at the start of the shower in cpm
3	the time when the radiation in the bathroom reached a maximum in minutes
4	the increase in the amount of radiation during the shower in cpm

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 radioactive isotope phosphorus-32 emits beta particles.

Scientists use phosphorus-32 to help them to understand how plants use phosphorus to grow.

6A A material is described as radioactive if it gives out . . .

1 radio waves all the time.

2 nuclear radiation all the time.

3 radio waves when heated.

4 nuclear radiation when heated.

6B Phosphorus-32 is one of the isotopes of phosphorus.

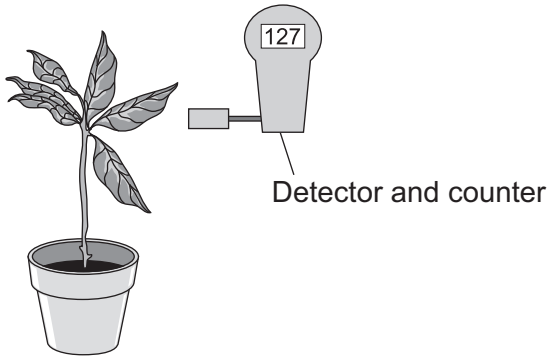
Atoms of the other isotopes of phosphorus have different numbers of . . .

1 electrons.

2 neutrons.

3 nuclei.

4 protons.



6C The path of the phosphorus-32 in the plant can be traced because the detector can detect . . .

1 beta particles.

2 phosphorus atoms.

3 phosphorus nuclei.

4 ultraviolet radiation.

6D Phosphorus-32 has a half-life of 14 days.

This means that the number of phosphorus-32 nuclei will . . .

1 fall to zero in 14 days.

2 halve in 14 days.

3 double in 14 days.

4 be unchanged in 14 days.

Turn over for the next question

QUESTION SEVEN

Scientists have observed that light from distant galaxies seems to have increased in wavelength.

7A What is this apparent increase in wavelength called?

1 black hole formation

2 blue-shift

3 red-shift

4 the Hubble effect

7B What does the apparent increase in wavelength suggest about the universe?

1 The universe is expanding.

2 The universe is contracting.

3 The universe was expanding but is now contracting.

4 The universe was contracting but is now expanding.

7C What does the apparent increase in wavelength suggest about the origin of the universe?

1 The universe started from one small point.

2 The universe was formed by gravity pulling material together.

3 The universe was formed by two galaxies colliding.

4 The universe had no starting point; it has always existed.

7D What name is given to the theory about the origin of the universe that has been developed from these observations?

1 big bang theory

2 steady state theory

3 relativity theory

4 gravitational theory

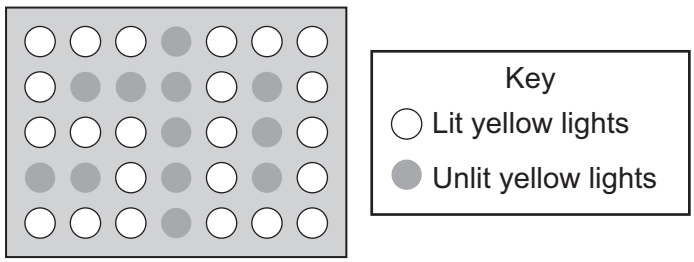
Turn over for the next question

QUESTION EIGHT

It is important that warning signs on motorways are very clear, because vehicles on motorways often travel at high speed.

Tests were done to find the most suitable colour for the lights in a warning sign.

The diagram shows a sign with yellow lights.



8A Which of the following is the most likely reason that yellow light is used for the sign?

1 Yellow light has a higher frequency than all other colours.

2 Yellow light has a longer wavelength than all other colours.

3 Yellow light is easier to see than all other colours.

4 Yellow light travels faster than all other colours.

8B What determines the colour of the light from the display?

1 its brightness

2 its frequency

3 its power

4 its speed in a vacuum

8C The wavelength of red light is 700 nm and the wavelength of violet light is 300 nm.

Which of the following could be the value of the wavelength of the yellow light from the sign?

1 250 nm

2 350 nm

3 600 nm

4 750 nm

8D A radio signal is used to switch on the warning sign. The frequency of the radio signal is 2 000 000 hertz and the wavelength is 150 metres.

What is the wave speed of the radio signal in metres per second?

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

1 13 333 m/s

2 1 333 333 m/s

3 300 000 000 m/s

4 3 000 000 000 m/s

Turn over for the next question

QUESTION NINE

Pills are often kept in bottles made from brown plastic. The brown plastic absorbs ultraviolet (UV) radiation. The UV radiation may cause chemical changes in the pills.

A scientist carried out an investigation to compare the amount of UV radiation absorbed by four different pill bottles. Each bottle was made from a different type of plastic.

She used UV-sensitive beads instead of pills. The beads were white when kept in the dark. They changed to a red colour when exposed to UV radiation.

- She put twenty beads into each of the bottles.
- She then put the bottles at equal distances from a UV lamp.
- She then measured the time taken for all the beads in each bottle to change from white to red.

9A Which of these was **not** a control variable in this investigation?

1 the number of beads

2 the distance of the bottle from the UV radiation

3 the intensity of the UV lamp

4 the type of plastic used for the bottle

The table shows her results.

Bottle	Time taken for all the beads to turn red in minutes
W	19
X	37
Y	56
Z	24

9B Which bottle would be best for storing pills?

1 W

2 X

3 Y

4 Z

9C The clock that she used did not go back to zero when RESET was pressed.

This produced an error that was . . .

1 caused by a faulty technique.

2 caused by human error.

3 random.

4 systematic.

9D If the scientist had used a clock measuring to the nearest second, instead of to the nearest minute, her results would have been more . . .

1 accurate.

2 precise.

3 systematic.

4 valid.

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**.

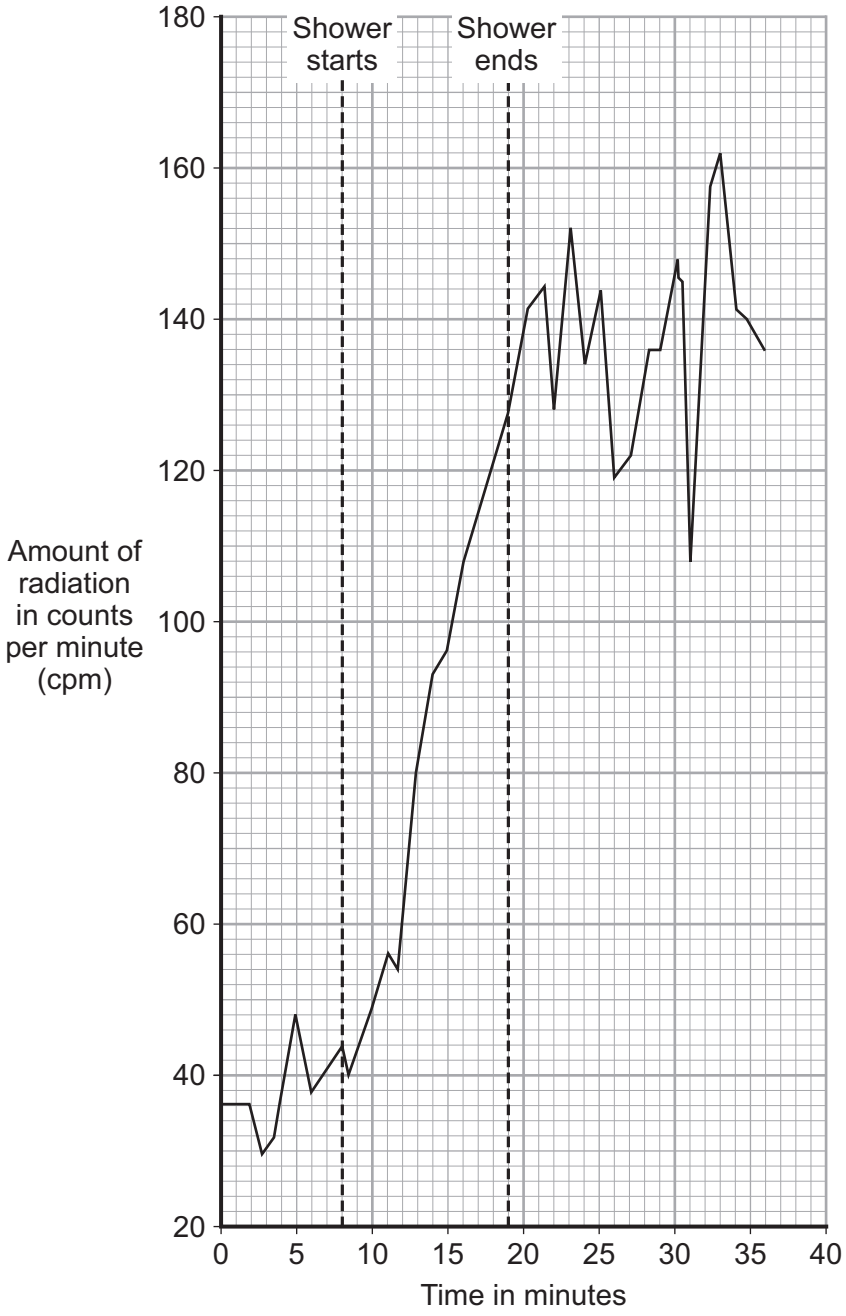
Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

The graph shows how the amount of radiation from radon varies in the bathroom of a house.

The data is recorded before, during and after someone having a shower.



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

A 11

B 33

C 44

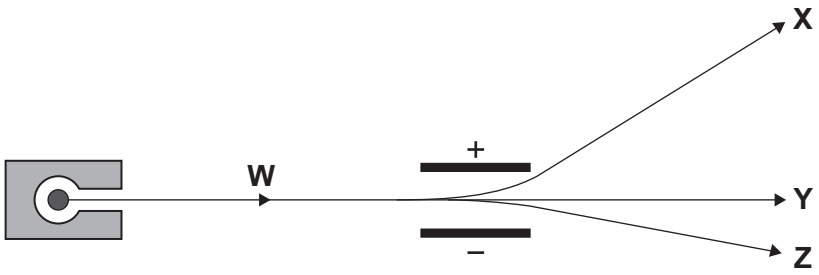
D 84

1	the time the shower took in minutes
2	the amount of radiation at the start of the shower in cpm
3	the time when the radiation in the bathroom reached a maximum in minutes
4	the increase in the amount of radiation during the shower in cpm

Turn over for the next question

QUESTION TWO

A source emits nuclear radiation. This radiation passes through an electric field.



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

A alpha

B beta

C gamma

D alpha, beta and gamma

Path **W** is the path of . . . **1** . . . radiation.

Path **X** is the path of . . . **2** . . . radiation.

Path **Y** is the path of . . . **3** . . . radiation.

Path **Z** is the path of . . . **4** . . . radiation.

Turn over for the next question

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.

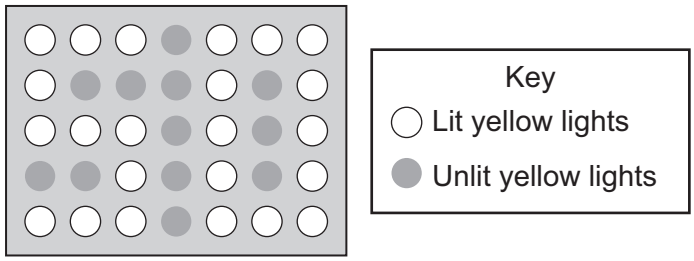
Mark your choices on the answer sheet.

QUESTION THREE

It is important that warning signs on motorways are very clear, because vehicles on motorways often travel at high speed.

Tests were done to find the most suitable colour for the lights in a warning sign.

The diagram shows a sign with yellow lights.



3A Which of the following is the most likely reason that yellow light is used for the sign?

1 Yellow light has a higher frequency than all other colours.

2 Yellow light has a longer wavelength than all other colours.

3 Yellow light is easier to see than all other colours.

4 Yellow light travels faster than all other colours.

3B What determines the colour of the light from the display?

1 its brightness

2 its frequency

3 its power

4 its speed in a vacuum

3C The wavelength of red light is 700 nm and the wavelength of violet light is 300 nm.

Which of the following could be the value of the wavelength of the yellow light from the sign?

1 250 nm

2 350 nm

3 600 nm

4 750 nm

3D A radio signal is used to switch on the warning sign. The frequency of the radio signal is 2 000 000 hertz and the wavelength is 150 metres.

What is the wave speed of the radio signal in metres per second?

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

1 13 333 m/s

2 1 333 333 m/s

3 300 000 000 m/s

4 3 000 000 000 m/s

Turn over for the next question

QUESTION FOUR

Pills are often kept in bottles made from brown plastic. The brown plastic absorbs ultraviolet (UV) radiation. The UV radiation may cause chemical changes in the pills.

A scientist carried out an investigation to compare the amount of UV radiation absorbed by four different pill bottles. Each bottle was made from a different type of plastic.

She used UV-sensitive beads instead of pills. The beads were white when kept in the dark. They changed to a red colour when exposed to UV radiation.

- She put twenty beads into each of the bottles.
- She then put the bottles at equal distances from a UV lamp.
- She then measured the time taken for all the beads in each bottle to change from white to red.

4A Which of these was **not** a control variable in this investigation?

1 the number of beads

2 the distance of the bottle from the UV radiation

3 the intensity of the UV lamp

4 the type of plastic used for the bottle

The table shows her results.

Bottle	Time taken for all the beads to turn red in minutes
W	19
X	37
Y	56
Z	24

4B Which bottle would be best for storing pills?

1 **W**

2 **X**

3 **Y**

4 **Z**

4C The clock that she used did not go back to zero when RESET was pressed.

This produced an error that was . . .

1 caused by a faulty technique.

2 caused by human error.

3 random.

4 systematic.

4D If the scientist had used a clock measuring to the nearest second, instead of to the nearest minute, her results would have been more . . .

1 accurate.

2 precise.

3 systematic.

4 valid.

Turn over for the next question

QUESTION FIVE

Nitrogen-16 is a radioactive isotope of nitrogen. This isotope decays to stable oxygen-16 by beta emission.

5A A beta particle is . . .

1 a helium nucleus.

2 a neutron.

3 a proton.

4 an electron.

5B The rate of emission of beta particles from the nitrogen-16 would . . .

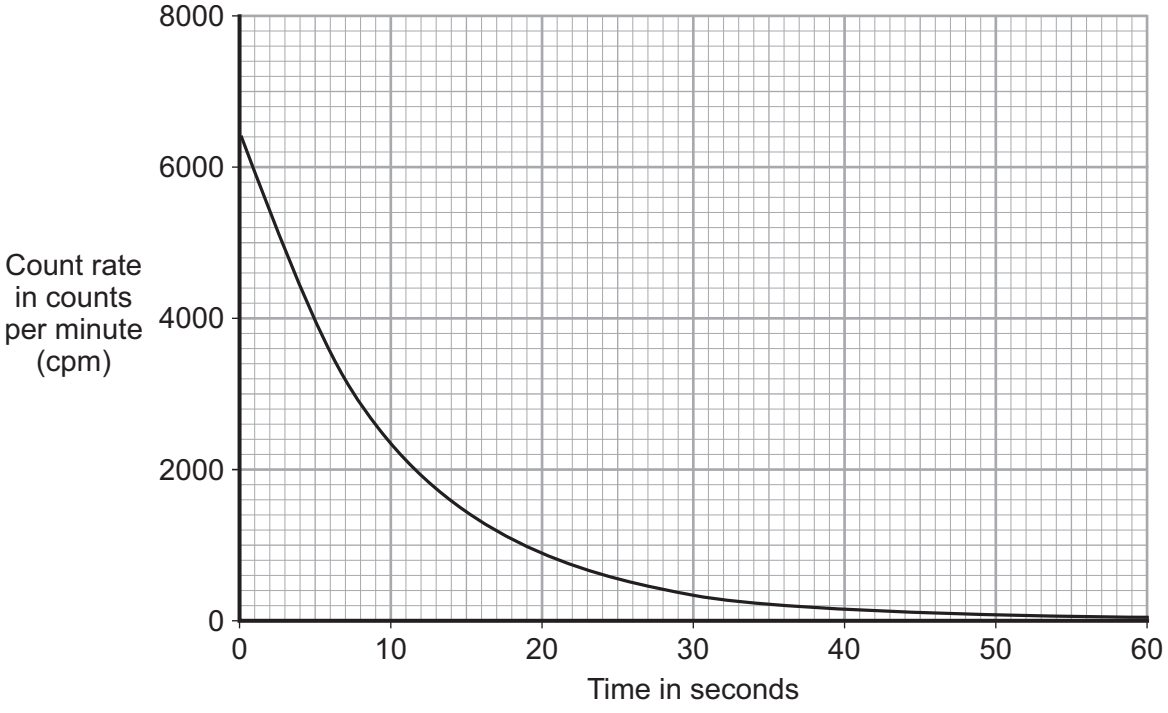
1 be increased by increasing the temperature.

2 be reduced by increasing the pressure of the surrounding air.

3 be reduced by liquefying the nitrogen-16.

4 be unaffected by changes in temperature, pressure or state.

The graph shows the radioactive decay curve for a sample of nitrogen-16.



5C Using information from the graph, what is the approximate half-life of nitrogen-16?

1 7 seconds

2 30 seconds

3 60 seconds

4 3200 seconds

5D The initial count rate of the nitrogen-16 sample is 6400 counts per minute.

What is the approximate value of the count rate after four half-lives?

1 3200 cpm

2 1600 cpm

3 800 cpm

4 400 cpm

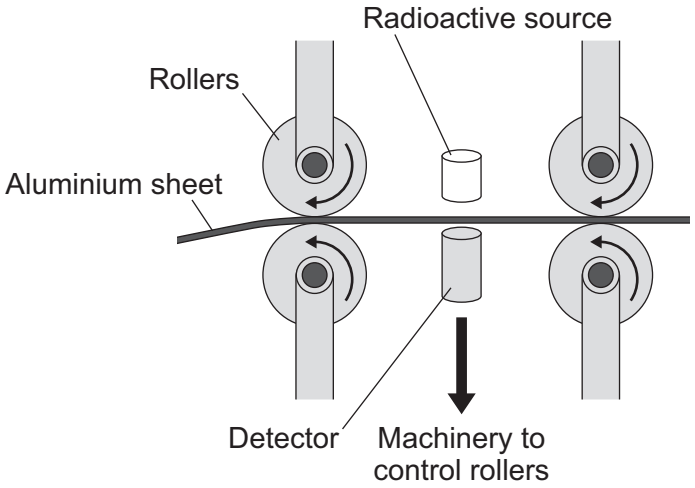
Turn over for the next question

QUESTION SIX

The table shows the type of radiation emitted by, and the half-life of four radioactive isotopes, **P**, **Q**, **R** and **S**.

Radioactive isotope	Radiation emitted	Half-life
P	beta	6000 years
Q	alpha	400 years
R	gamma	6 hours
S	beta	30 seconds

6A The diagram shows how a radioactive isotope is used to monitor the thickness of aluminium in the continuous manufacture of aluminium sheet.



Which of the isotopes should be used?

1 **P**

2 **Q**

3 **R**

4 **S**

6B A smoke alarm uses a small amount of a radioactive isotope. Isotope **Q** is used so that the smoke alarm can be used safely in a house.

This is because isotope **Q** is an alpha emitter . . .

1 with a short half-life and alpha particles have a short range in air.

2 with a short half-life and alpha particles have a long range in air.

3 with a long half-life and alpha particles have a short range in air.

4 with a long half-life and alpha particles have a long range in air.

6C Radioactive isotopes can be injected into the human body to act as tracers in medical diagnosis.

The isotope used is . . .

1 **P** because it has a very long half-life and beta particles can reach the detector.

2 **Q** because it has a long half-life and alpha particles are relatively safe outside the body.

3 **R** because it has a short half-life and gamma rays can reach the detector.

4 **S** because it has a short half-life and beta particles can reach the detector.

6D Trees contain the radioactive isotope carbon-14. After a tree has been chopped down, the count rate from the carbon-14 it contains gradually decreases. By measuring the count rate and knowing the half-life of the isotope, the age of the dead wood can be estimated.

Which isotope could be used to estimate the age of a wooden box thought to be about 18000 years old?

1 **P** because its half-life is 6000 years so the box has existed for 3 half-lives.

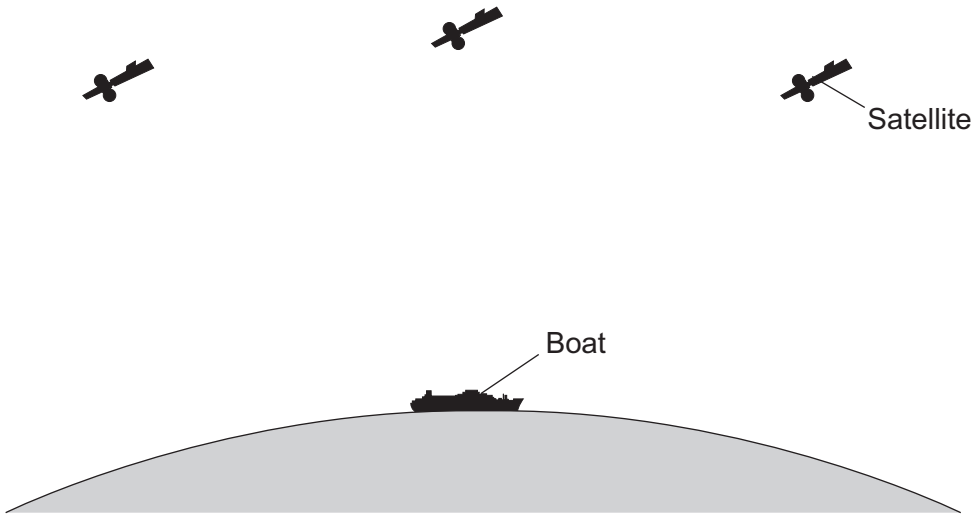
2 **Q** because its half-life is 400 years so the box has existed for 45 half-lives.

3 **R** because its half-life is 6 hours so it is safe to do the estimation.

4 **S** because its half-life is 30 seconds and this is enough time to do the estimation.

QUESTION SEVEN

Geostationary satellites can be used for navigation. These satellites stay in the same position above the Earth as the Earth spins on its axis. For navigation, the signals from three satellites are needed.



7A Electromagnetic radiation is used to communicate with the satellites.

Here are two statements about electromagnetic radiation.

X All electromagnetic radiation travels as waves.

Y All electromagnetic radiation travels at the same speed through space.

Which statements are correct?

1 **X** only

2 **Y** only

3 both **X** and **Y**

4 neither **X** nor **Y**

7B What effect will signals from the satellite have on the metal aerial on the boat?

1 heat up the metal and destroy some of its atoms

2 heat up the metal and set up an alternating electric current

3 produce microwaves which carry the information to be displayed

4 produce microwaves which set up an alternating electric current

7C The electromagnetic radiation used has a speed of 300 000 000 m/s and a wavelength of 20 cm.

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

What is its frequency?

1 15 000 000 Hz

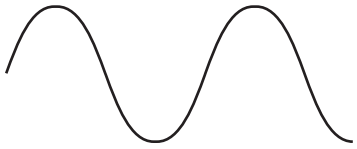
2 60 000 000 Hz

3 1 500 000 000 Hz

4 6 000 000 000 Hz

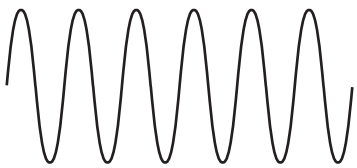
7D Which of these signals could a computer process easily?

1



2

3



4

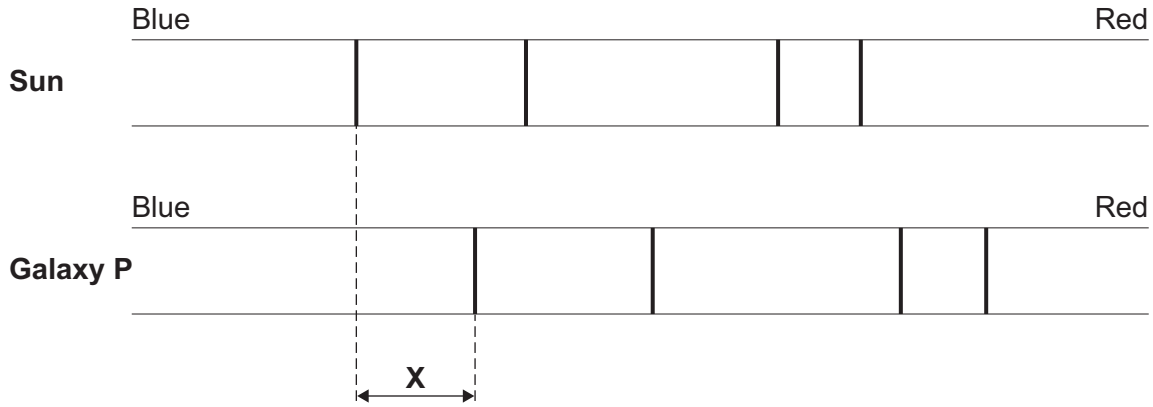
QUESTION EIGHT

The visible part of the electromagnetic spectrum from a galaxy includes dark lines. These lines are at specific wavelengths.

The diagrams show the positions of the dark lines in the spectrum from the Sun and in the spectrum from a distant galaxy, **P**.

Galaxy **P** is moving away from the observer.

The dark lines in **P**'s spectrum are shown to be displaced.



8A The displacement marked **X** in the diagram is called the red-shift.

What apparent change has occurred to the speed and frequency of the light to cause red-shift?

	Speed	Frequency
1	decreased	stayed the same
2	increased	stayed the same
3	stayed the same	decreased
4	stayed the same	increased

8B A different galaxy, **Q**, is nearer to the observer than galaxy **P** and is moving towards the observer.

The displacement in **Q**'s spectrum, compared with the displacement in **P**'s spectrum, is . . .

1 smaller and in the opposite direction.

2 bigger and in the opposite direction.

3 smaller and in the same direction.

4 bigger and in the same direction.

8C Edwin Hubble made measurements of the dark lines in the spectra from distant galaxies.

His observations led to the idea that the universe is expanding.

He observed that . . .

1 the further away the galaxy, the smaller the red-shift.

2 the further away the galaxy, the bigger the red-shift.

3 the most distant galaxies show a blue-shift.

4 the red-shift does not change with distance.

8D Scientists are interested in how the universe began.

Which one of the following statements is correct?

1 We now definitely know that the universe began with a 'big bang'.

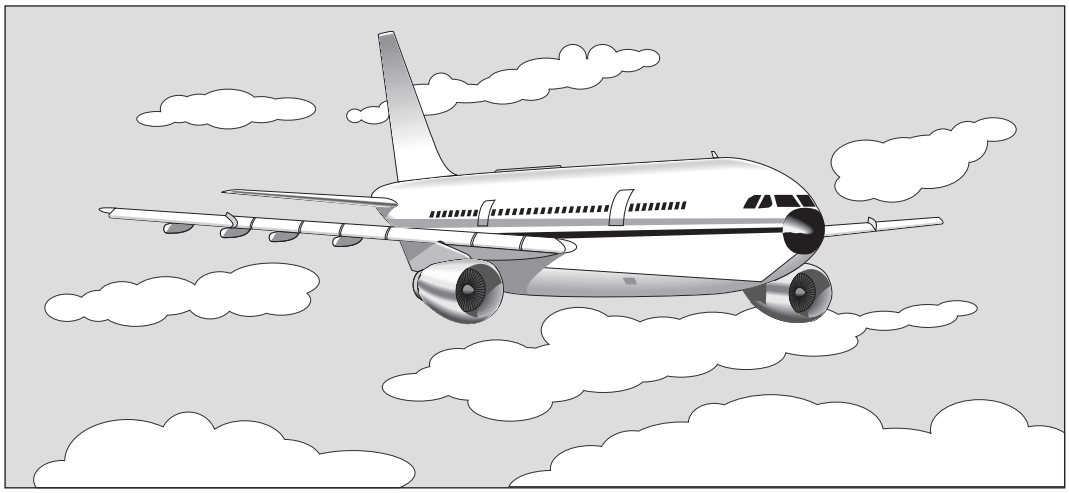
2 There is no evidence about how the universe began.

3 The evidence we have now suggests that the universe began at a small point.

4 We now know that the galaxies will continue to get further apart.

Turn over for the next question

QUESTION NINE



Everyone is exposed to some nuclear radiation.

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

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

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

Destination	Flight time (h)	Dose (mSv)
Kiev	4	0.020
Los Angeles	13	0.065
Madrid	2	0.010
New York	7	0.035
Paris	1	0.005
Rome	3	0.015
Tokyo	14	0.070

9A To be able 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 flight time from London to Dallas is 10 hours.

The most likely dose of radiation a member of the cabin crew receives on this flight is . . .

1 0.040 mSv

2 0.045 mSv

3 0.050 mSv

4 0.060 mSv

9C The data in the table shows that . . .

1 the dose is directly proportional to the flight time.

2 the dose is inversely proportional to the flight time.

3 the longer the flight, the lower the dose.

4 the shorter the flight, the higher the dose.

9D How many times can a pregnant member of the cabin crew fly from London to Madrid and back before she has received the maximum permitted dose of radiation?

1 20 times

2 40 times

3 50 times

4 100 times

END OF TEST

There are no questions printed on this page

There are no questions printed on this page

There are no questions printed on this page