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

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

# Science A
**Unit Physics P1b (Radiation and the Universe)**

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

**PHY1BP**

**F&H**

**Wednesday 3 March 2010 Morning Session**

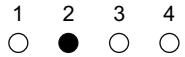
**For this paper you must have:**
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

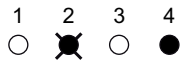
**Time allowed**
- 30 minutes

**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.

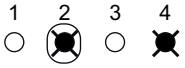
**Instructions for recording answers**
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown.




- 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

Different types of electromagnetic radiation have different hazards.

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

**A** microwaves

**B** ultraviolet rays

**C** visible light

**D** X-rays

| | **Possible hazard** |
|---|---|
| **1** | could cause skin cancer during sunbathing |
| **2** | could cause blindness if you look directly at the Sun |
| **3** | could kill cells deep inside your body |
| **4** | could damage your brain while using a mobile phone |

## QUESTION TWO

The table shows part of the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gamma | | Ultraviolet | | Infra red | | Radio |

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

**A** gamma

**B** infra red

**C** radio

**D** ultraviolet

The part of the electromagnetic spectrum with the longest wavelengths is . . . **1** . . . .

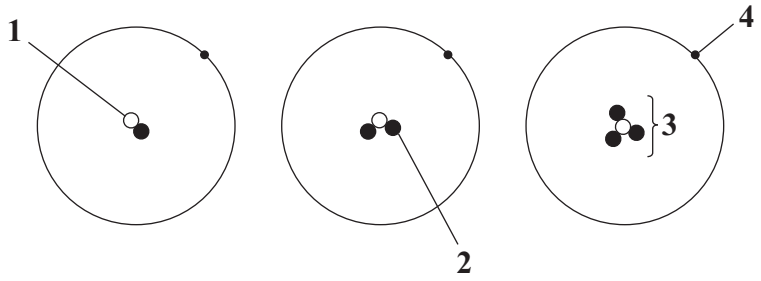
Between X-rays and visible light in the electromagnetic spectrum is . . . **2** . . . radiation.

Some radioactive isotopes emit . . . **3** . . . radiation.

Signals can be sent from remote controls to a television by . . . **4** . . . radiation.

## QUESTION THREE

The diagrams show three isotopes of hydrogen.




Match words, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagrams.

**A** electron

**B** neutron

**C** nucleus

**D** proton

## QUESTION FOUR

This question is about types of radiation.

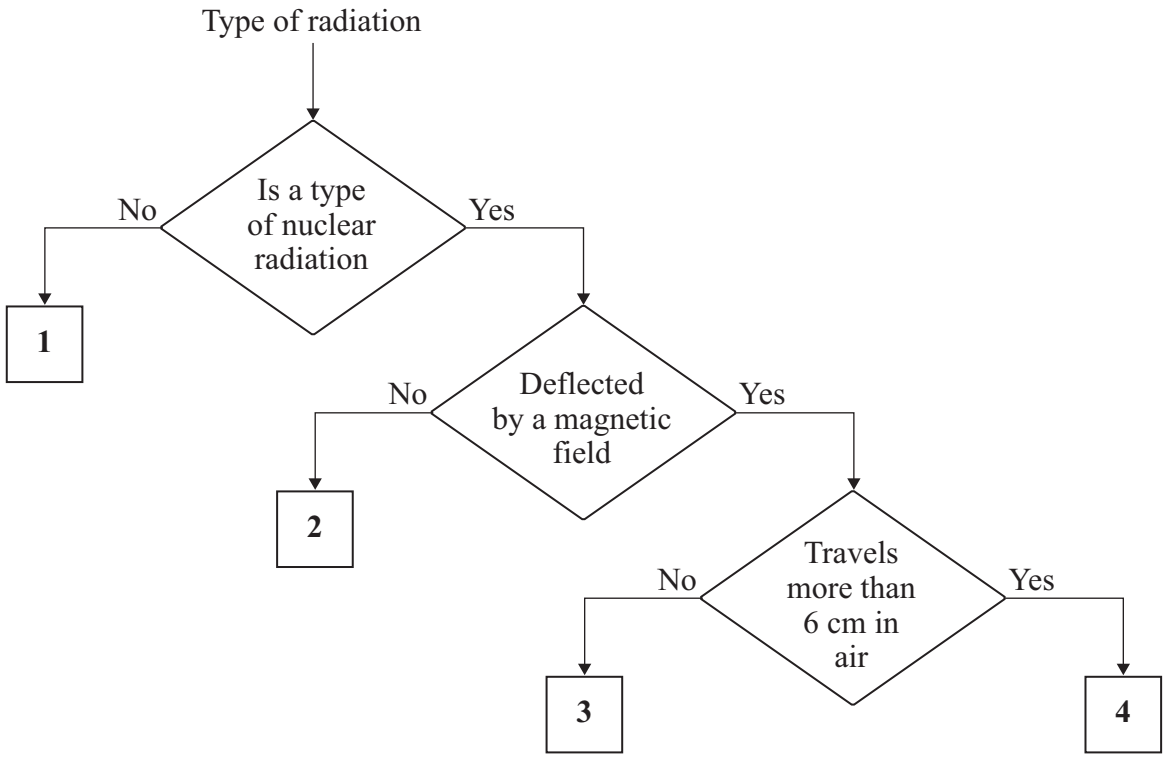
Match radiations, **A**, **B**, **C** and **D**, with the boxes **1–4** on the flow diagram.

**A** alpha

**B** beta

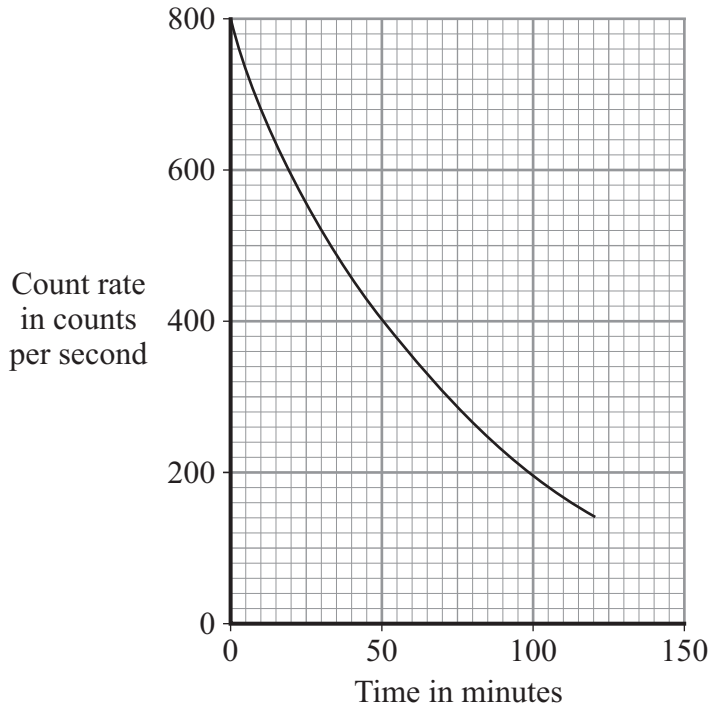
**C** gamma

**D** X-rays



**QUESTION FIVE**

The graph shows how the count rate of a radioactive substance changes with time.




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

**A** 50

**B** 100

**C** 400

**D** 800

| | |
|---|---|
| **1** | the initial count rate of the substance |
| **2** | the count rate after one half-life |
| **3** | the half-life of the substance in minutes |
| **4** | the count rate after three half-lives |

## SECTION TWO

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

Each of these questions has four parts.

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

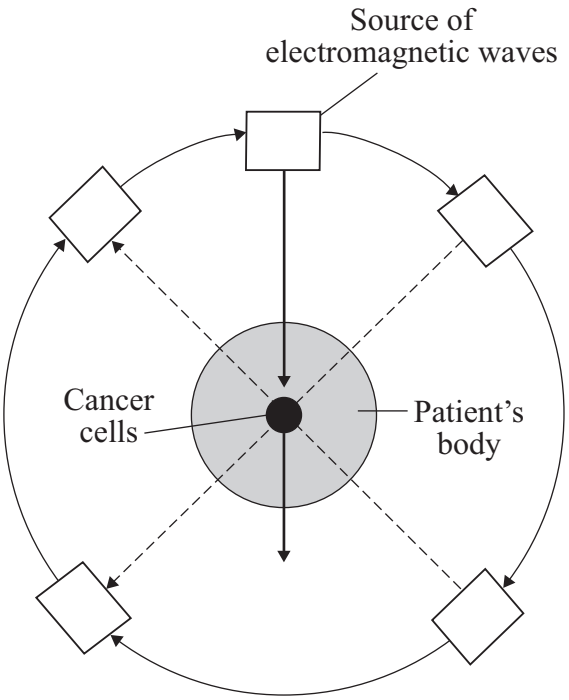
Mark your choices on the answer sheet.

## QUESTION SIX

Cancer cells can be killed using some types of electromagnetic waves.

One treatment concentrates a beam of electromagnetic waves onto the cancer cells.

The source of the waves rotates around the patient's body.




**6A** The electromagnetic waves deliver energy to kill cancer cells.

What type of electromagnetic waves can be used to kill cancer cells?

**1** gamma

**2** microwave

**3** radio

**4** ultraviolet

**6B** This treatment is effective because . . .

**1** the energy is spread evenly over the whole body.

**2** the energy is concentrated on the cancer cells.

**3** the waves all have the same wavelength.

**4** the waves all travel at the same speed.

**6C** The electromagnetic waves used do not cause as much damage to the surrounding cells as they do to the cancer cells.

This is because . . .

**1** electromagnetic waves do not affect normal cells.

**2** only the cancer cells receive the maximum amount of energy.

**3** the normal cells are first treated to protect them.

**4** the waves pass through gaps between the normal cells.

**6D** This type of treatment is not always available to cancer patients. One of the reasons for this is the high cost of the equipment.

What type of issue is this?

**1** economic

**2** environmental

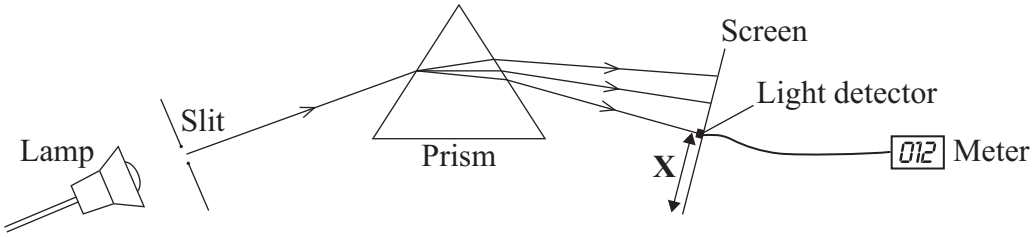
**3** scientific

**4** social

**Turn over for the next question**

## QUESTION SEVEN

The diagram shows apparatus used by some students investigating the light given out by a lamp.




The students used a prism to split the light into the colours of the spectrum.
They used a light detector and meter to measure the amount of light.
They measured the amount of light detected for different colours of the spectrum.

The only light in the room was from the lamp.

**7A** Which was a control variable in the experiment?

**1** amount of light detected

**2** the distance from the screen to the meter

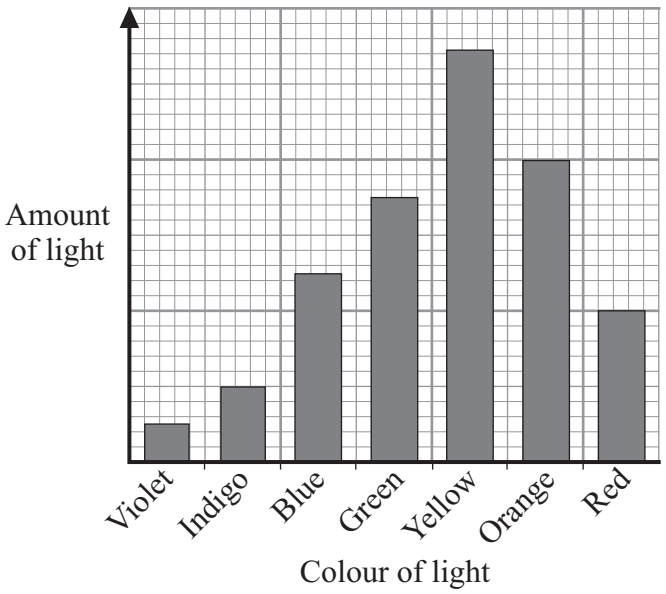
**3** the distance from the slit to the screen

**4** the distance **X** from the end of the screen to the detector

**7B** Which row in the table gives a correct description of variables?

| | **Independent variable** | **Dependent variable** |
|---|---|---|
| **1** | amount of light | colour of light |
| **2** | colour of light | amount of light |
| **3** | amount of light | distance from screen to prism |
| **4** | colour of light | distance from the slit to the screen |

The students displayed their results.




**7C** The students plotted a bar chart because . . .

**1** both variables were categoric.

**2** the amount of light was a continuous variable and the colour was a categoric variable.

**3** the amount of light was a categoric variable and the colour was a continuous variable.

**4** both variables were continuous.

**7D** From the graph we can conclude that the amount of light . . .

**1** decreases steadily from violet to red.

**2** increases steadily from violet to red.

**3** is the same for all colours.

**4** is bigger for one colour than for any of the others.

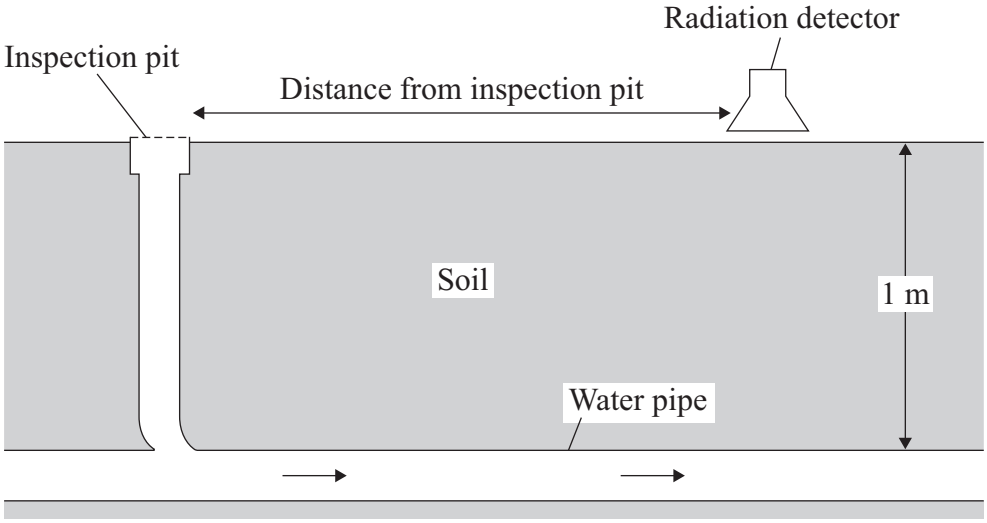
**Turn over for the next question**

## QUESTION EIGHT

Some engineers investigated a problem with the flow of water through an underground pipe.
The pipe was 1 metre below the ground.

The engineers put a small amount of radioactive liquid into the pipe through an inspection pit.
The radioactive liquid had a half-life of two days.

A radiation detector was used to measure the count rate at different distances from the inspection pit.




The results are shown below.

| Distance from the inspection pit in metres | Count rate in counts per minute |
|---|---|
| 1 | 23 |
| 2 | 21 |
| 3 | 23 |
| 4 | 28 |
| 5 | 32 |
| 6 | 27 |
| 7 | 20 |
| 8 | 18 |
| 9 | 19 |
| 10 | 20 |

**8A** The engineers would use a radioactive liquid that emits . . .

**1** alpha radiation.

**2** beta radiation.

**3** gamma radiation.

**4** X-radiation.

**8B** The readings suggest that . . .

**1** the pipe was clear and water was flowing normally.

**2** the pipe was not level.

**3** the pipe had a leak.

**4** the pipe had a blockage.

**8C** To improve the reliability of the data, the engineers should . . .

**1** use a more sensitive counter.

**2** re-calibrate the counter.

**3** repeat their investigation and calculate the means.

**4** decide whether the variables are continuous or discrete.

**8D** To fix the problem, workmen were asked to dig a hole down to the pipe.

The best place for the workmen to dig the hole is . . .

**1** 3 m from the inspection pit.

**2** 5 m from the inspection pit.

**3** 7 m from the inspection pit.

**4** 9 m from the inspection pit.

## QUESTION NINE

There are two types of communication signal: analogue and digital.

**9A** Which pair of diagrams correctly shows the patterns for digital and analogue signals?

| | Digital signal pattern | Analogue signal pattern |
|---|---|---|
| **1** |  |  |
| **2** |  |  |
| **3** |  |  |
| **4** |  |  |

**9B** One reason for using digital signals rather than analogue signals for communication is that . . .

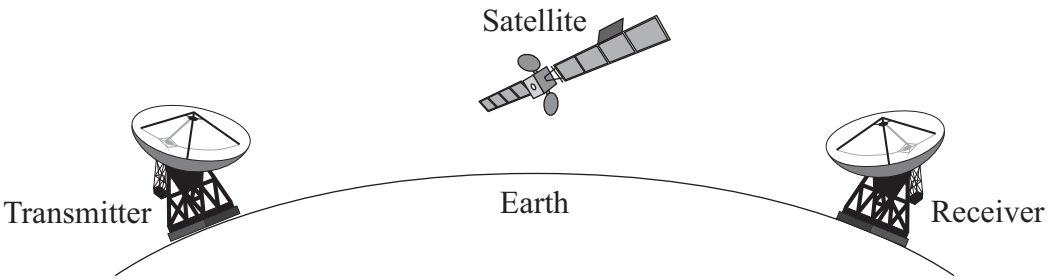
**1** analogue signals are less prone to interference.

**2** analogue signals can have only two values.

**3** digital signals are continuously variable.

**4** digital signals can be easily processed by computers.

**9C** Satellites in orbit around the Earth receive and transmit microwave signals for international telephone communication.




Microwaves are used because . . .

**1** they are the only type of electromagnetic wave that can travel through a vacuum.

**2** they are not absorbed by the Earth's atmosphere.

**3** they follow the curvature of the Earth.

**4** they travel faster than radio waves.

**9D** Properties of waves are often demonstrated in schools using waves on water.

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

A wave generator with a frequency of 50 Hz produces water waves with a wavelength of 2 cm.

At what speed do the waves travel?

**1** 1 m/s

**2** 25 m/s

**3** 100 m/s

**4** 2500 m/s

**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**.

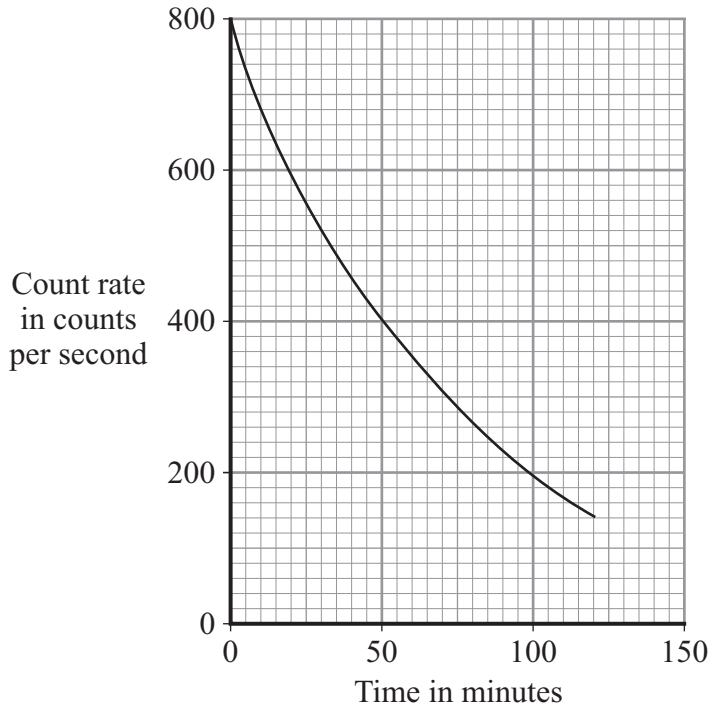
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1– 4**.

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

Mark your choices on the answer sheet.

## QUESTION ONE

The graph shows how the count rate of a radioactive substance changes with time.



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

**A** 50

**B** 100

**C** 400

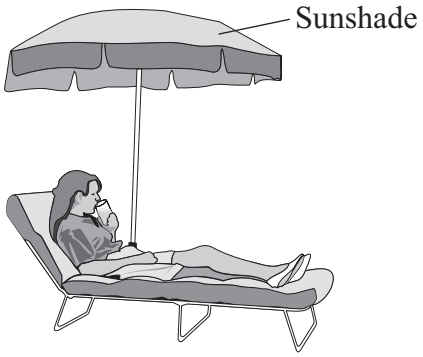
**D** 800

| | |
|---|---|
| **1** | the initial count rate of the substance |
| **2** | the count rate after one half-life |
| **3** | the half-life of the substance in minutes |
| **4** | the count rate after three half-lives |

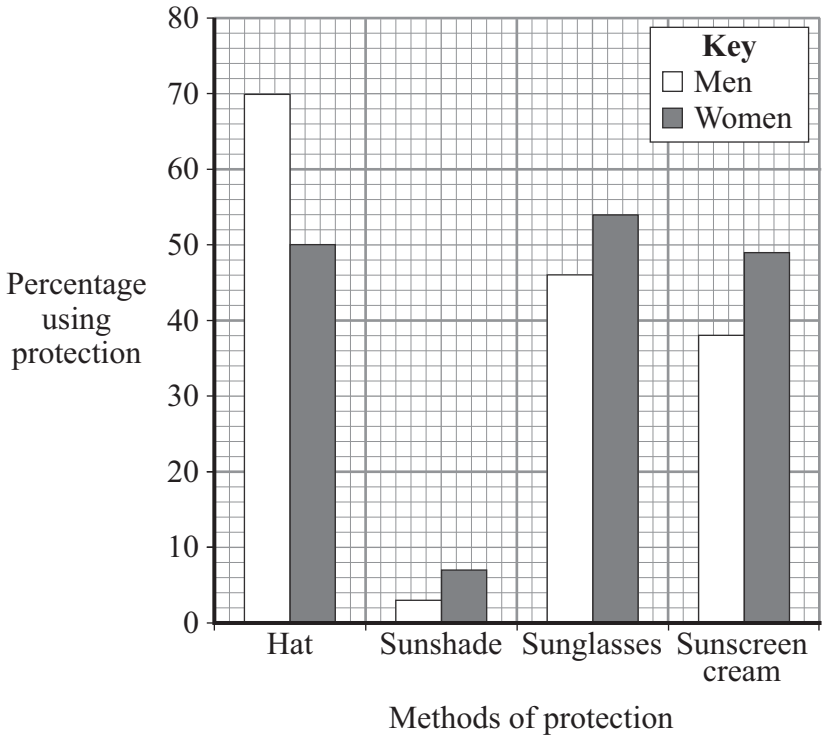
**Turn over for the next question**

**QUESTION TWO**

There are several ways of protecting ourselves from the Sun's radiation.




The bar chart shows how men and women in Australia protect themselves from the Sun's radiation.



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

**A** hat

**B** sunshade

**C** sunglasses

**D** sunscreen cream

| | |
|---|---|
| **1** | used by more men than women |
| **2** | would be used by 27 women in a sample of 50 |
| **3** | used by 49% of women |
| **4** | would give protection to the whole body |

**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.

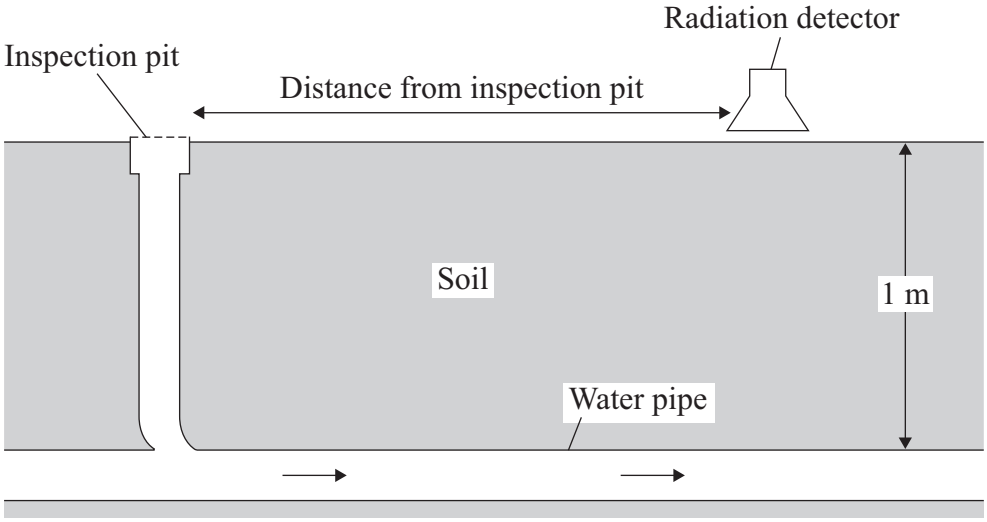
Mark your choices on the answer sheet.

## QUESTION THREE

Some engineers investigated a problem with the flow of water through an underground pipe.
The pipe was 1 metre below the ground.

The engineers put a small amount of radioactive liquid into the pipe through an inspection pit.
The radioactive liquid had a half-life of two days.

A radiation detector was used to measure the count rate at different distances from the inspection pit.




The results are shown below.

| Distance from the inspection pit in metres | Count rate in counts per minute |
|---|---|
| 1 | 23 |
| 2 | 21 |
| 3 | 23 |
| 4 | 28 |
| 5 | 32 |
| 6 | 27 |
| 7 | 20 |
| 8 | 18 |
| 9 | 19 |
| 10 | 20 |

**3A** The engineers would use a radioactive liquid that emits . . .

**1** alpha radiation.

**2** beta radiation.

**3** gamma radiation.

**4** X-radiation.

**3B** The readings suggest that . . .

**1** the pipe was clear and water was flowing normally.

**2** the pipe was not level.

**3** the pipe had a leak.

**4** the pipe had a blockage.

**3C** To improve the reliability of the data, the engineers should . . .

**1** use a more sensitive counter.

**2** re-calibrate the counter.

**3** repeat their investigation and calculate the means.

**4** decide whether the variables are continuous or discrete.

**3D** To fix the problem, workmen were asked to dig a hole down to the pipe.

The best place for the workmen to dig the hole is . . .

**1** 3 m from the inspection pit.

**2** 5 m from the inspection pit.

**3** 7 m from the inspection pit.

**4** 9 m from the inspection pit.

## QUESTION FOUR

There are two types of communication signal: analogue and digital.

**4A** Which pair of diagrams correctly shows the patterns for digital and analogue signals?

| | Digital signal pattern | Analogue signal pattern |
|---|---|---|
| **1** |  |  |
| **2** |  |  |
| **3** |  |  |
| **4** |  |  |

**4B** One reason for using digital signals rather than analogue signals for communication is that . . .

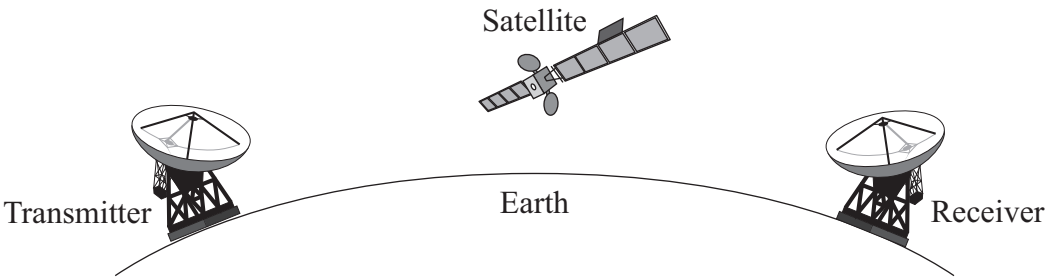
**1** analogue signals are less prone to interference.

**2** analogue signals can have only two values.

**3** digital signals are continuously variable.

**4** digital signals can be easily processed by computers.

**4C** Satellites in orbit around the Earth receive and transmit microwave signals for international telephone communication.




Microwaves are used because . . .

**1** they are the only type of electromagnetic wave that can travel through a vacuum.

**2** they are not absorbed by the Earth's atmosphere.

**3** they follow the curvature of the Earth.

**4** they travel faster than radio waves.

**4D** Properties of waves are often demonstrated in schools using waves on water.

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

A wave generator with a frequency of 50 Hz produces water waves with a wavelength of 2 cm.

At what speed do the waves travel?

**1** 1 m/s

**2** 25 m/s

**3** 100 m/s

**4** 2500 m/s

**Turn over for the next question**

## QUESTION FIVE

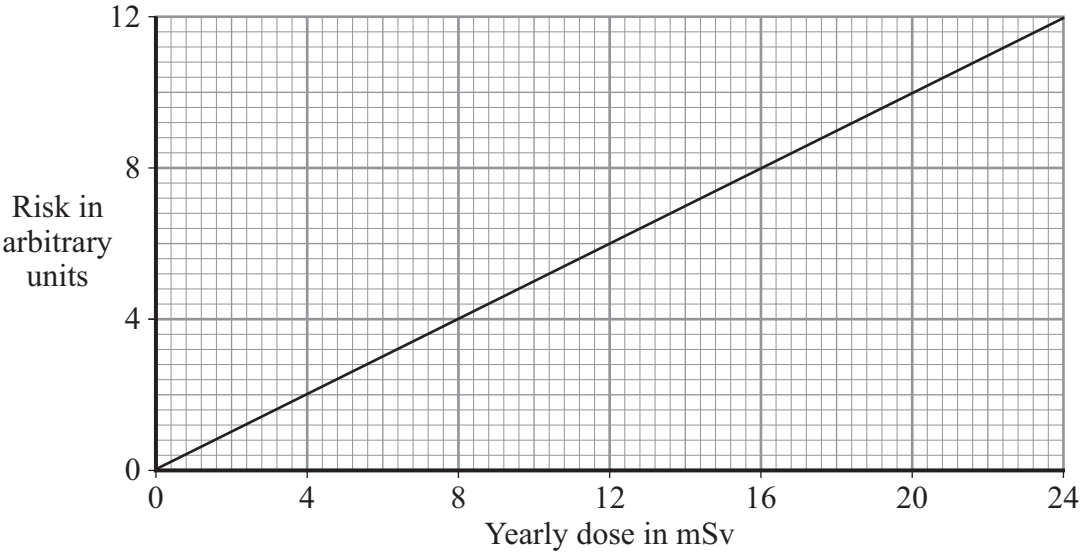
Workers in industries that use radioactive materials have the amount of radiation they receive carefully monitored. The amount of radiation received is called the dose. The industries set dose limits.

The table shows the maximum yearly dose that is allowed for three groups of people. The higher the dose of radiation received, the greater the risk of developing cancer.

| Description | Yearly dose limit in millisieverts (mSv) |
|---|---|
| Member of the public | 1 |
| Worker under 18 years | 6 |
| Pregnant adult worker | 4 |

A millisievert is a unit of radiation dose.

**5A** The graph shows how the risk changes with the yearly dose.




The graph shows that the risk . . .

**1** does not depend on the yearly dose.

**2** is 2 arbitrary units for a member of the public.

**3** is inversely proportional to the yearly dose.

**4** is directly proportional to the yearly dose.

**5B** The yearly dose limit for an adult worker is five times that of a pregnant adult worker.

What is the risk (in arbitrary units) for an adult worker?

**1** 3

**2** 10

**3** 15

**4** 20

**5C** Nuclear power stations produce radiation.

Which one of the following does **not** reduce the risk to power station workers?

**1** building power stations far from centres of population

**2** giving the workers protective clothing

**3** monitoring the dose each worker receives to ensure that radiation limits are not exceeded

**4** shielding the workers from the source of radiation

**5D** Workers may be subjected to alpha, beta or gamma radiation.

Outside the body, alpha is less dangerous to workers than beta because alpha radiation . . .

**1** cannot penetrate the skin.

**2** is deflected by electric fields.

**3** is much less strongly ionising.

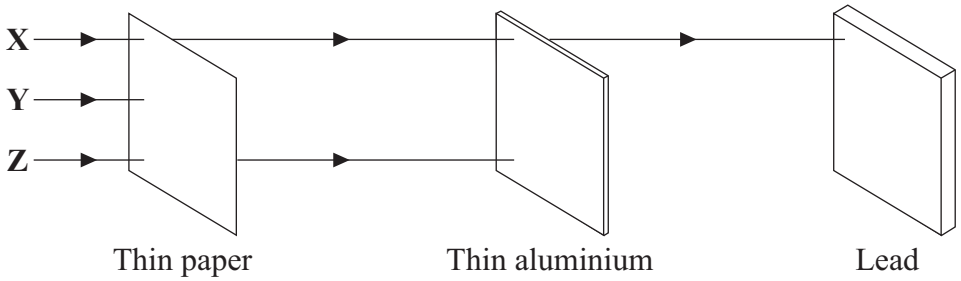
**4** has a much longer range.

**Turn over for the next question**

## QUESTION SIX

This question is about radioactive substances and the radiation they emit.

The diagram shows how each type of radiation, **X**, **Y** and **Z**, is absorbed by different materials.




**6A** Which row in **Table 1** shows the correct radiation types?

**Table 1**

| | **X** | **Y** | **Z** |
|---|---|---|---|
| **1** | beta | alpha | gamma |
| **2** | gamma | alpha | beta |
| **3** | beta | gamma | alpha |
| **4** | gamma | beta | alpha |

**6B** When gamma radiation is absorbed, . . .

**1** the absorber increases in mass.

**2** the absorber shows a rise in temperature.

**3** the radiation will become helium gas.

**4** the radiation will transform into light.

**6C** Which row in **Table 2** correctly describes the three types of radiation?

**Table 2**

| | Alpha | Beta | Gamma |
|---|---|---|---|
| **1** | an electron from outside the nucleus | a helium nucleus | a short wavelength electromagnetic wave |
| **2** | a short wavelength electromagnetic wave | an electron from outside the nucleus | a helium nucleus |
| **3** | a helium nucleus | an electron from inside the nucleus | a high frequency electromagnetic wave |
| **4** | a helium nucleus | a short wavelength electromagnetic wave | an electron from inside the nucleus |

**6D** The radioactive gas thoron, which has a half-life of 50 seconds, is used in an experiment. At the end of the experiment, the count rate had fallen to $\frac{1}{32}$ of the count rate at the beginning.

The time taken to carry out the experiment was . . .

**1** 200 seconds.

**2** 250 seconds.

**3** 300 seconds.

**4** 1600 seconds.

**Turn over for the next question**

## QUESTION SEVEN

Some of the world's best telescopes are placed on the tops of mountains. These telescopes detect infra red and visible light waves from distant stars and galaxies.

Some space telescopes detect X-rays from these galaxies. These telescopes are placed above the Earth's atmosphere.

**7A** The Hubble Space Telescope (HST) has been in orbit around the Earth since 1990. The HST is an optical telescope.

What is the advantage of placing the HST in orbit around the Earth?

**1** Light, gathered by the HST, has not been distorted by the atmosphere.

**2** Once the HST goes into orbit, it costs nothing to run.

**3** The HST can observe the whole sky in one orbit.

**4** The HST picks up clearer pictures because it is nearer to space.

**7B** A ground-based telescope could not detect X-rays from space because . . .

**1** there are no X-rays in space.

**2** the Earth's atmosphere absorbs X-rays.

**3** X-rays are harmful to people.

**4** X-rays are digital signals.

**7C** The longer the wavelength of the radiation being received, the larger the diameter of the receiving dish of the telescope needs to be.

The telescopes with the largest dishes are those detecting . . .

**1** gamma rays.

**2** radio waves.

**3** visible light.

**4** X-rays.

**7D** Images of distant galaxies produced by the Hubble telescope provide evidence to support the idea that the universe . . .

**1** has a definite edge.

**2** is contracting.

**3** is expanding.

**4** is neither expanding nor contracting.

**Turn over for the next question**

## QUESTION EIGHT

For many years, scientists have been investigating the universe and how it continues to change.

**8A** Why is the 'Big Bang' theory currently the most widely accepted theory of the origin of the universe?

**1** It has been proved correct by using mathematical models.

**2** It has not been revised or changed by scientists for many years.

**3** It is based on a combination of scientific and religious facts.

**4** It is the best explanation of the current scientific data.

**8B** Red-shift of light provides evidence about how the universe is changing.

When red-shift is detected, it means that . . .

**1** galaxies are moving rapidly away from Earth.

**2** galaxies furthest away from Earth are expanding.

**3** some galaxies are approaching the Earth.

**4** stars in the nearest galaxies are becoming red giants.

**8C** Red-shift involves a change in frequency and wavelength.

Which row in the table correctly describes these changes?

| | **Frequency** | **Wavelength** |
|---|---|---|
| **1** | decreases | decreases |
| **2** | decreases | increases |
| **3** | increases | decreases |
| **4** | increases | increases |

**8D** Which one of the following is a similar effect to red-shift?

**1** Red light from a lamp being reflected by a mirror.

**2** As a police car moves away from you, the sound from the siren seems lower in frequency than it really is.

**3** As a train approaches a station, the sound of the train gets louder.

**4** Light from the setting Sun becomes increasingly redder.

**Turn over for the next question**

## QUESTION NINE

This question is about electromagnetic radiation.

**9A** Electromagnetic radiations are . . .

**1** disturbances in an electric field.

**2** disturbances of the air between source and receiver.

**3** waves caused by pressure changes in a vacuum.

**4** waves of very high frequency.

**9B** When electromagnetic radiation reaches a substance, . . .

**1** all wavelengths will be absorbed by the substance.

**2** all wavelengths will be reflected by the substance.

**3** all wavelengths will be transmitted through the substance.

**4** some wavelengths may be absorbed, some reflected and some transmitted.

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

All electromagnetic waves travel at 300 000 km/s.

**9C** Most schools have microwave generators that produce microwaves with a wavelength of 3 cm.

What is the frequency of these microwaves?

**1** 900 kHz

**2** 10 000 kHz

**3** 900 000 kHz

**4** 10 000 000 kHz

**9D** BBC Radio 4 transmits radio waves at a frequency of 200 kHz.

What is the wavelength of Radio 4?

**1** 1.5 m

**2** 600 m

**3** 1500 m

**4** 60 km

**END OF TEST**

**There are no questions printed on this page**

**There are no questions printed on this page**