Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

General Certificate of Secondary Education
June 2009

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

PHYSICS
Unit Physics P1b (Radiation and the Universe)

Monday 22 June 2009 Morning Session

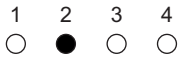
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

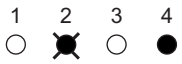
Time allowed: 30 minutes

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

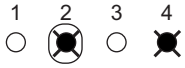
Instructions for recording answers
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown:



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



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



Information
- The maximum mark for this paper is 36.

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

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

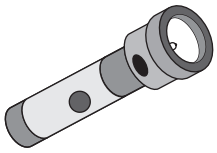
Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

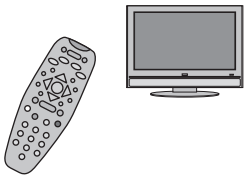
Many everyday devices use electromagnetic waves.

Torch



1

Remote control

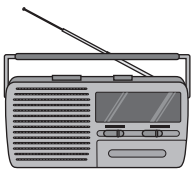


2

Mobile phone

3

Radio



4

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

A infra red

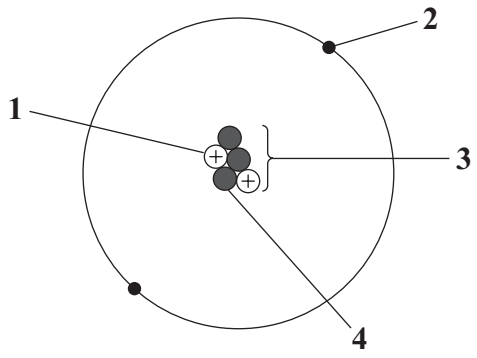
B microwaves

C radio waves

D visible light

QUESTION TWO

The diagram shows an atom.



Match parts of the atom, **A**, **B**, **C** and **D**, with the labels **1**–**4** on the diagram.

A electron

B neutron

C nucleus

D proton

QUESTION THREE

Electromagnetic waves can be dangerous.

There are different ways of protecting ourselves from the radiation.

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

A wearing thick, insulating gloves

B leaving the room

C looking through blackened glass

D using sun cream

When a dentist takes an X-ray of a patient's mouth, he protects himself by . . . **1** . . . .

A windsurfer protects herself from harmful ultraviolet rays by . . . **2** . . . .

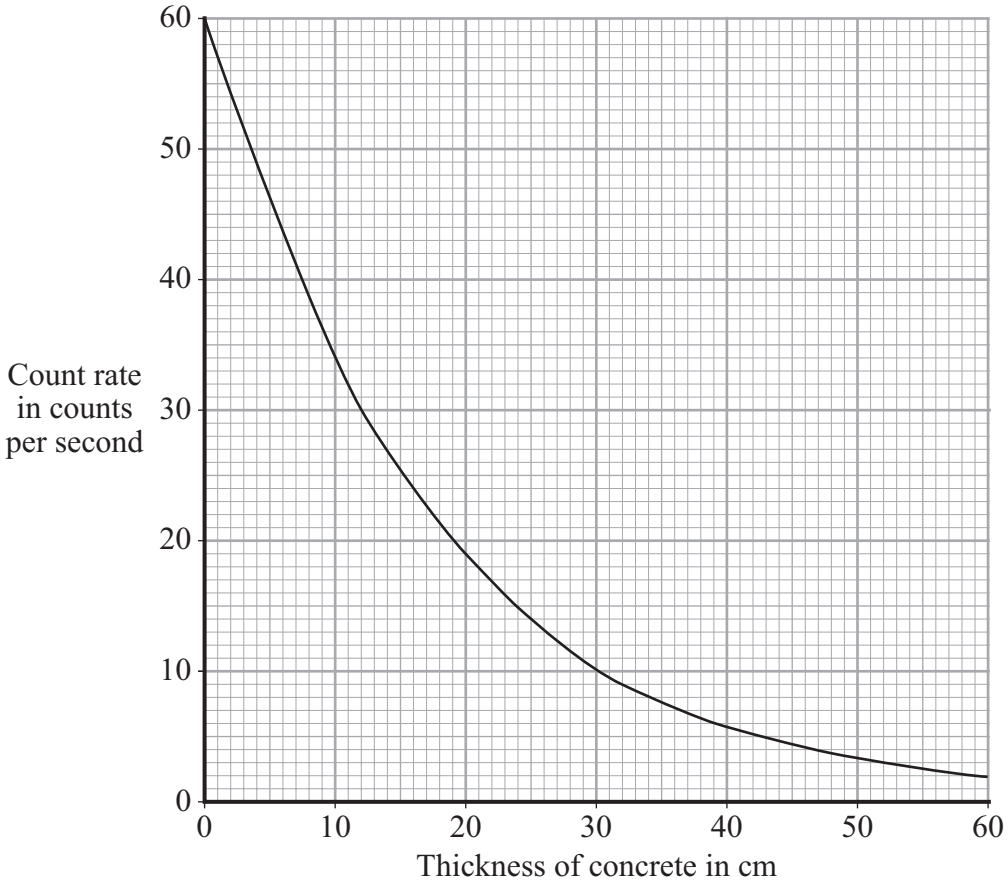
Someone watching an eclipse of the Sun protects her eyes by . . . **3** . . . .

A man taking a metal bar out of a furnace protects himself by . . . **4** . . . .

QUESTION FOUR

Concrete is sometimes used to protect people from the harmful effects of gamma radiation.

The graph shows the count rate from a source of gamma radiation after it has passed through different thicknesses of concrete.



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

A 8

B 12

C 30

D 60

The count rate when there is no concrete = . . . **1** . . . counts per second.

The thickness of the concrete when the count rate is 10 counts per second = . . . **2** . . . cm.

The thickness of concrete needed to reduce the count rate by half = . . . **3** . . . cm.

The reduction in count rate when the thickness of concrete is increased from 30 cm to 60 cm = . . . **4** . . . counts per second.

QUESTION FIVE

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

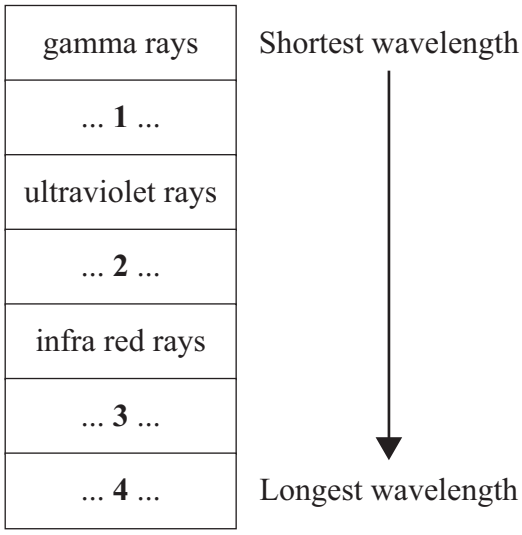
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A microwaves

B X-rays

C visible light

D radio waves



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.

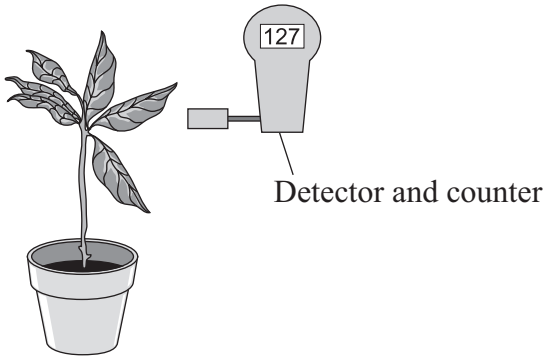
Atoms of the other isotopes of phosphorus have different numbers of . . .

1 electrons.

2 neutrons.

3 nuclei.

4 protons.



6C The path of the phosphorus 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 studying distant galaxies have noticed that light from them appears 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 It is expanding.

2 It is contracting.

3 It was expanding but is now contracting.

4 It was contracting but is now expanding.

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

1 It all started from one small point.

2 It was formed by gravity pulling material together.

3 It was formed by two galaxies colliding.

4 It 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

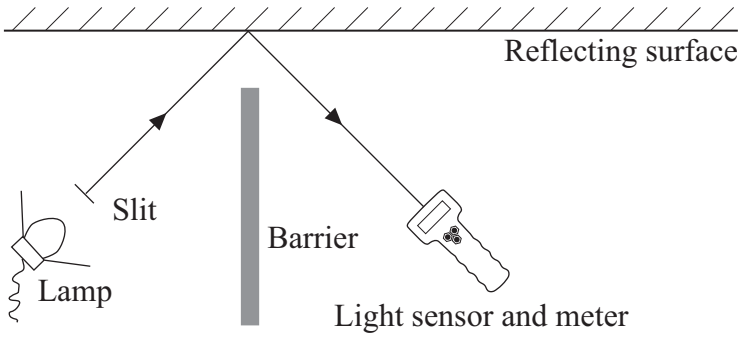
Turn over for the next question

QUESTION EIGHT

A student investigated how different surfaces reflect light.

The student set up the apparatus shown below.

She did the experiment in a darkroom where the only light was from the lamp.



She used different reflecting surfaces. They were:

- shiny black
- shiny white
- matt white
- matt black.

For each surface, she took the meter reading.

8A What type of variable was the reflecting surface?

1 continuous

2 control

3 dependent

4 independent

8B What type of variable was the meter reading?

1 control

2 dependent

3 categoric

4 independent

8C The student noticed that when she switched off the lamp, the meter reading did not return to zero.

This caused her meter readings to be different from the true meter readings.

This is called . . .

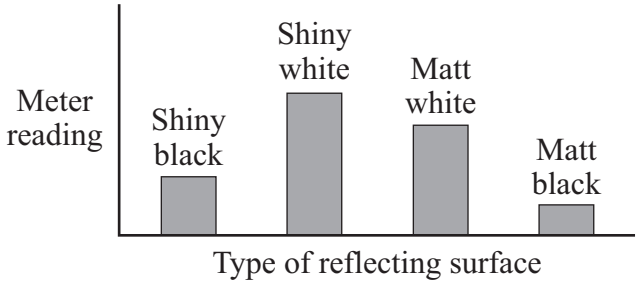
1 an anomalous result.

2 a best fit.

3 a random error.

4 a systematic error.

8D The bar chart shows her results.



She displayed her results as a bar chart because the type of reflecting surface was a . . .

1 continuous variable and so was the meter reading.

2 continuous variable and the meter reading was a categoric variable.

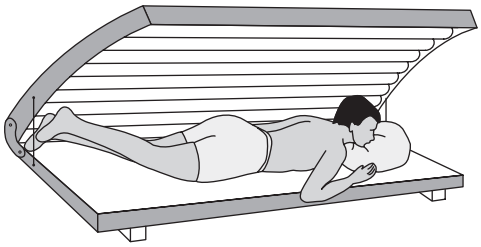
3 categoric variable and the meter reading was a continuous variable.

4 categoric variable and so was the meter reading.

Turn over for the next question

QUESTION NINE

Some people use sunbeds to get a suntan. Sunbeds emit ultraviolet radiation which causes the skin to tan. Exposure to too much ultraviolet radiation can lead to the development of skin cancer.



Scientists investigated the risk of cancer developing in people who regularly used sunbeds.

The table gives their results.

	Regular users of sunbeds	**Non-users of sunbeds**
Number of people	1000	1000
Number of people with skin cancer in 1985	4	4
Number of people with skin cancer in 2005	13	5

9A The group that did not use sunbeds . . .

1 acted as the control group.

2 ensured that the results were reliable.

3 acted as the independent variable.

4 ensured that the results were accurate.

9B Repeating the investigation with another group of people would make the results more . . .

1 reliable.

2 precise.

3 biased.

4 random.

9C These results show that . . .

1 regular use of sunbeds always leads to the development of skin cancers.

2 regular use of sunbeds can reduce the development of skin cancers.

3 regular use of sunbeds increases the risk of developing skin cancers.

4 non-users of sunbeds have a greater risk of developing skin cancers than regular users of sunbeds.

9D The government is concerned about the health of regular users of sunbeds because . . .

1 the sunbed industry is not regulated properly.

2 sunbeds contain cancer-producing chemicals.

3 there are no health benefits from using sunbeds.

4 treatment for skin cancers is an expensive burden on the Health Service.

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

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

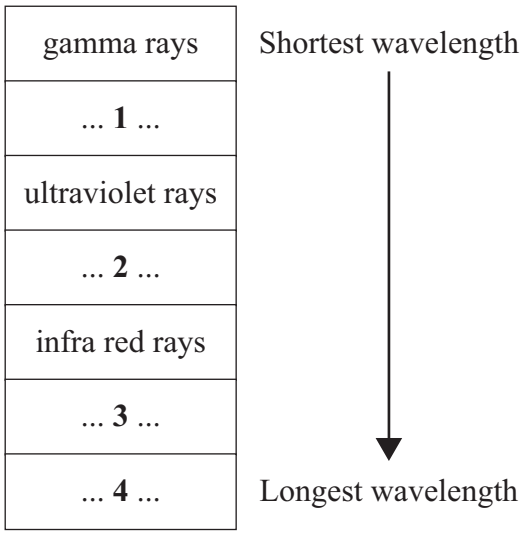
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A microwaves

B X-rays

C visible light

D radio waves



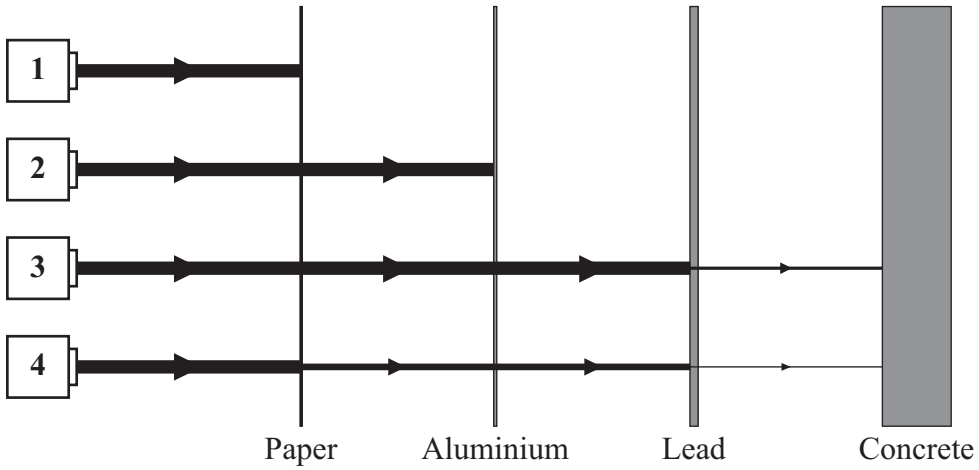
QUESTION TWO

The diagram shows four radioactive sources, **1**, **2**, **3** and **4**, each producing different types of nuclear radiation.

The thicker the horizontal lines in the diagram, the greater the intensity of the radiation.

Match the types of radiation, **A**, **B**, **C** and **D**, with the radioactive sources **1–4**.

Radioactive sources



A alpha only

B beta only

C gamma only

D alpha and gamma

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.

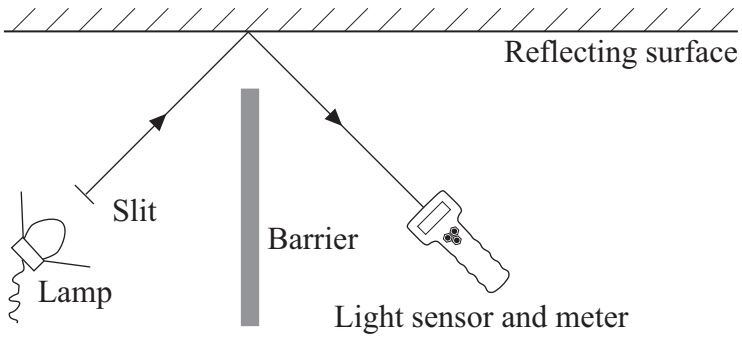
Mark your choices on the answer sheet.

QUESTION THREE

A student investigated how different surfaces reflect light.

The student set up the apparatus shown below.

She did the experiment in a darkroom where the only light was from the lamp.



She used different reflecting surfaces. They were:

- shiny black
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- matt white
- matt black.

For each surface, she took the meter reading.

3A What type of variable was the reflecting surface?

1 continuous

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4 independent

3B What type of variable was the meter reading?

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2 dependent

3 categoric

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3C The student noticed that when she switched off the lamp, the meter reading did not return to zero.

This caused her meter readings to be different from the true meter readings.

This is called . . .

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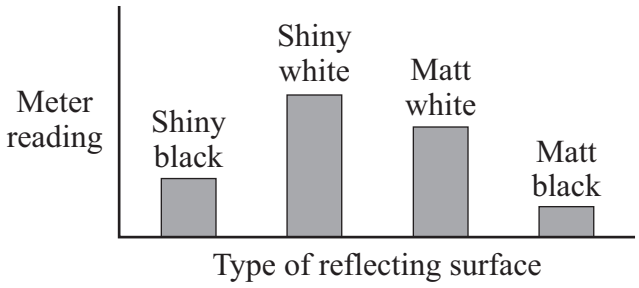


She displayed her results as a bar chart because the type of reflecting surface was a . . .

1 continuous variable and so was the meter reading.

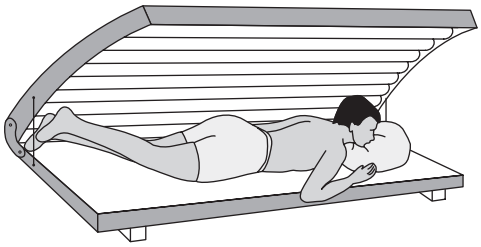
2 continuous variable and the meter reading was a categoric variable.

3 categoric variable and the meter reading was a continuous variable.

4 categoric variable and so was the meter reading.

QUESTION FOUR

Some people use sunbeds to get a suntan. Sunbeds emit ultraviolet radiation which causes the skin to tan. Exposure to too much ultraviolet radiation can lead to the development of skin cancer.



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The table gives their results.

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Number of people with skin cancer in 1985	4	4
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4A The group that did not use sunbeds . . .

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2 ensured that the results were reliable.

3 acted as the independent variable.

4 ensured that the results were accurate.

4B Repeating the investigation with another group of people would make the results more . . .

1 reliable.

2 precise.

3 biased.

4 random.

4C These results show that . . .

1 regular use of sunbeds always leads to the development of skin cancers.

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3 regular use of sunbeds increases the risk of developing skin cancers.

4 non-users of sunbeds have a greater risk of developing skin cancers than regular users of sunbeds.

4D The government is concerned about the health of regular users of sunbeds because . . .

1 the sunbed industry is not regulated properly.

2 sunbeds contain cancer-producing chemicals.

3 there are no health benefits from using sunbeds.

4 treatment for skin cancers is an expensive burden on the Health Service.

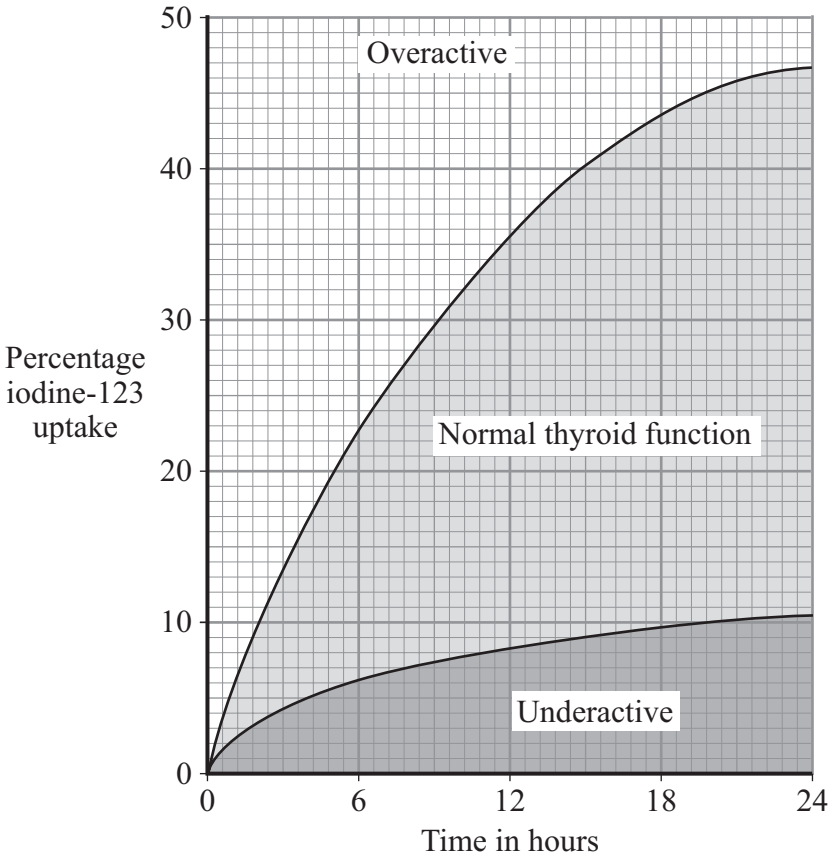
Turn over for the next question

QUESTION FIVE

The thyroid gland uses iodine to produce hormones (chemicals) which help to control the body's functions. If too much iodine is absorbed, the thyroid becomes overactive. If too little iodine is absorbed, the thyroid becomes underactive.

A radioactive isotope, iodine-123, is used as a tracer in the diagnosis of thyroid disease. Iodine-123 is a gamma emitter.

A patient having a diagnostic test is given a drink of sodium iodide which contains a small amount of iodine-123. A detector measures the gamma emission from the thyroid. The iodine uptake by the thyroid is measured and displayed, as shown in the graph.



5A A gamma emitter is used because gamma rays . . .

1 are not affected by electric fields.

2 can pass through body tissue easily.

3 travel at the speed of light.

4 have very long wavelengths.

5B A patient is worried about drinking the radioactive liquid. The doctor tells him that the half-life of iodine-123 is 13 hours.

She explains that after 48 hours . . .

1 there will be no iodine-123 left in the body.

2 there will be less than 1/16 of the iodine-123 left in the body.

3 there will be less than 1/8 of the iodine-123 left in the body.

4 there will be no gamma radiation left in the body.

5C Three patients, **P**, **Q** and **R**, undergo the same diagnostic test. Their results are shown in the table.

Patient	Percentage of iodine-123 uptake after 6 hours	Percentage of iodine-123 uptake after 24 hours
P	1.0	5.0
Q	10.0	25.0
R	25.0	50.0

Using the graph, which one of the following statements is a correct conclusion?

1 All three patients are normal.

2 **P** and **Q** are normal; **R** is 'overactive'.

3 **P** and **R** are normal; **Q** is 'underactive'.

4 Only **Q** is normal.

5D Some medical students suggest that the rate of gamma emission from the iodine-123 is affected by different factors.

Which student is correct?

Student	Factor affecting rate of gamma emission
1	body temperature
2	age and sex of patient
3	length of time after the drink is taken
4	chemical composition of sodium iodide

QUESTION SIX

Mobile phones make use of microwaves.

Microwave ovens use microwaves of a similar wavelength. These microwaves are absorbed by the water molecules in food.

Human and animal body tissues contain a lot of water molecules. Some people are worried that using mobile phones for long periods of time could lead to some form of brain damage.

Scientists have investigated this worry by exposing laboratory mice to mobile phone radiation and monitoring the mice for signs of brain abnormality.

6A Electromagnetic waves travel at a speed of 300 000 km/s. Some microwaves have a wavelength of 10 cm.

What is the frequency of these microwaves?

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

1 30 000 000 Hz

2 300 000 000 Hz

3 3 000 000 000 Hz

4 30 000 000 000 Hz

6B Electromagnetic waves that ionise may cause cancer. The higher the frequency of a wave, the more ionising the radiation.

Which type of radiation is most likely to cause cancer?

1 microwaves

2 infra red

3 ultraviolet

4 X-rays

6C The power output of a microwave oven is at least 500 W.

The power output of mobile phones is limited to 2 W.

What is the most likely reason why this power limit was introduced?

1 to reduce interference between phones

2 to reduce heating effects on the brain

3 to allow phones to use the GPS (Global Positioning System)

4 to allow phones to use a digital signal

6D The tests on mice showed no evidence of brain abnormalities in the mice.

From this, the public can conclude that . . .

1 the results are not accurate because the tests were not carried out on humans.

2 as there is no evidence of danger to mice, there is probably no danger to humans.

3 as there is no evidence of danger to mice, there is no danger to humans.

4 the tests were not sensitive enough to record any evidence.

Turn over for the next question

QUESTION SEVEN

Some types of electromagnetic radiation from space are absorbed by the Earth's atmosphere.

	Short wavelength radio	Short wavelength microwaves	Infra red	Visible light	Ultraviolet	X-rays	Gamma rays
Percentage absorbed by atmosphere	0	95	96	5	98	100	100

Different objects or events in the universe emit different types of electromagnetic radiation.

	Gamma ray bursts	Nebulae	Pulsars	Stars	Universe background radiation
Radiation emitted	gamma rays	infra red	radio	all types	short wavelength microwaves

The planets and moons of the solar system reflect light from the Sun.

7A Early civilisations observed the sky with the naked eye.

Which objects did they see?

1 moons, nebulae and pulsars

2 gamma ray bursts, moons and planets

3 nebulae and pulsars

4 moons, planets and stars

7B Telescopes that could detect electromagnetic waves of the lowest frequency were built in the 20th century. These telescopes are on the surface of the Earth.

From the information in the tables, which of the following, which could not have been observed before, could then be easily observed from the Earth's surface?

1 pulsars

2 gamma ray bursts

3 nebulae

4 stars

7C In 1989, the background radiation from the universe was mapped from a telescope in space.

Why was this **not** done with telescopes based on Earth?

1 Because only 2% of ultraviolet radiation penetrates Earth's atmosphere.

2 Because only 4% of infra red radiation penetrates Earth's atmosphere.

3 Because only 5% of short wavelength microwave radiation penetrates Earth's atmosphere.

4 Because only 95% of visible radiation penetrates Earth's atmosphere.

7D The first table suggests that, with the exception of . . .

1 radio, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

2 radio, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

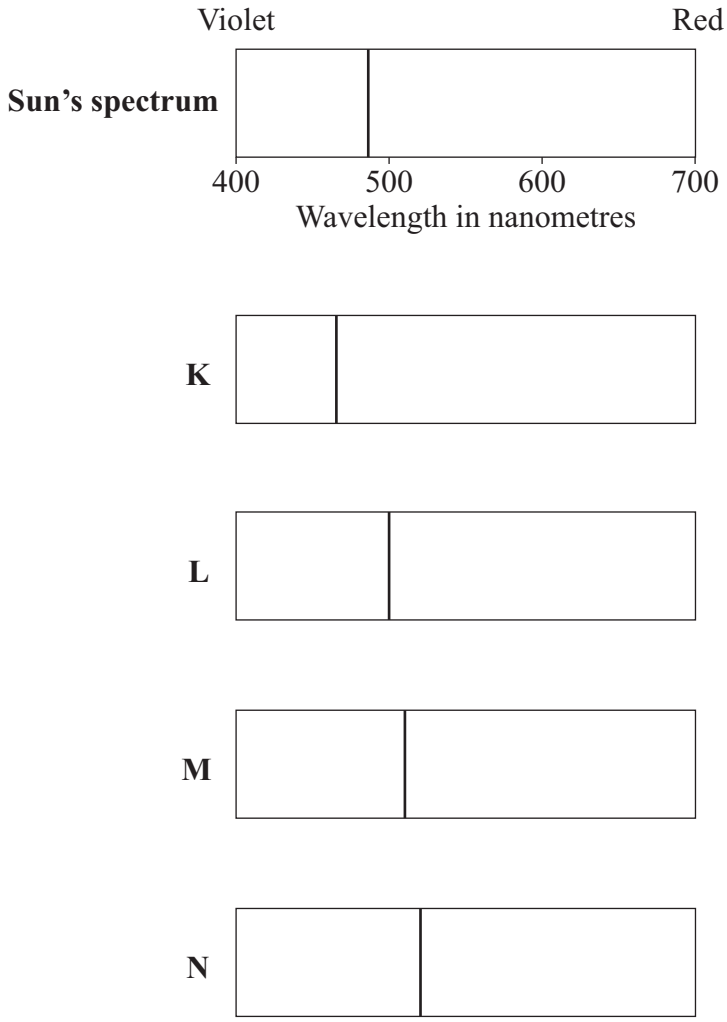
3 visible light, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

4 visible light, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

Turn over for the next question

QUESTION EIGHT

Dark lines on the spectra of light from galaxies represent chemical elements. The lines occur at specific wavelengths.



The line shown on the Sun's spectrum represents hydrogen. **K**, **L**, **M** and **N** are spectra of light from distant galaxies showing the same line.

8A Which galaxy is furthest from the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

8B Which galaxy is moving towards the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

8C Observation and analysis of red-shift suggests that . . .

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

2 the universe contracted initially and then began to expand.

3 the universe expanded initially and then began to contract.

4 the universe has always existed as it is now.

8D What causes red-shift?

1 a decrease in the frequency of light due to the galaxies moving closer to the Earth

2 a decrease in the frequency of light due to the galaxies moving away from the Earth

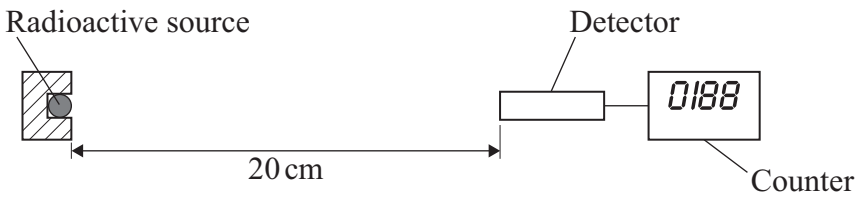
3 an increase in the frequency of light due to the galaxies moving closer to the Earth

4 an increase in the frequency of light due to the galaxies moving away from the Earth

Turn over for the next question

QUESTION NINE

A scientist investigated how the count rate of the nuclear radiation emitted by a particular radioactive source changed with time.



She placed a radiation detector 20 centimetres from the source.

She recorded the count rate every 10 minutes for 2 hours.

These are her results.

Time in min	10	20	30	40	50	60	70	80	90	100	110	120
Count rate in counts per minute	188	160	132	112	94	80	69	56	47	40	33	28

9A What is the half-life of the source?

1 30 minutes

2 40 minutes

3 50 minutes

4 60 minutes

9B The count rate at 70 minutes does not fit the same pattern as the other results.

Which one of the following is the most likely reason that this count rate does not fit the pattern?

1 The sensitivity of the detector is too low.

2 After 70 minutes, there was a rise in room temperature.

3 Radioactive decay is a random process.

4 After a certain time, the half-life of a source changes.

9C The scientist should have recorded the count rate at the beginning of the investigation at 0 minutes.

What was the count rate most likely to have been at 0 minutes?

1 192 counts per minute

2 188 counts per minute

3 224 counts per minute

4 376 counts per minute

9D Another radioactive material has a half-life of 6 years. A 64 g sample of the radioactive material is stored in a container.

What mass of this radioactive material will have decayed in 24 years?

1 4 g

2 16 g

3 48 g

4 60 g

END OF TEST

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