Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

General Certificate of Secondary Education
June 2007

SCIENCE A **PHY1B**
Unit Physics P1b (Radiation and the Universe)

PHYSICS
Unit Physics P1b (Radiation and the Universe)

Monday 25 June 2007 Morning Session

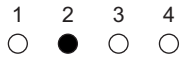
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

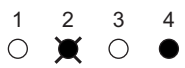
Time allowed: 30 minutes

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 'Radiation and the Universe' 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.

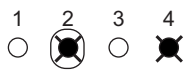
Instructions for recording answers
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown:



- 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 **SIX**.

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

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

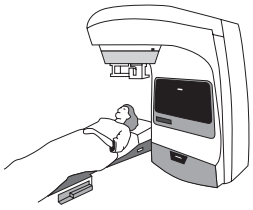
Mark your choices on the answer sheet.

QUESTION ONE

Each of these applications uses electromagnetic radiation.

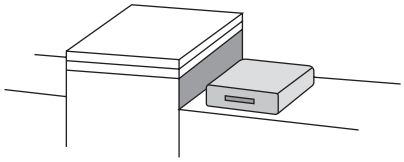
1

Killing cancer cells



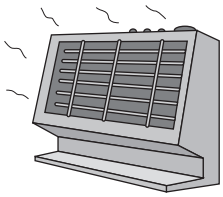
2

Checking bags at an airport



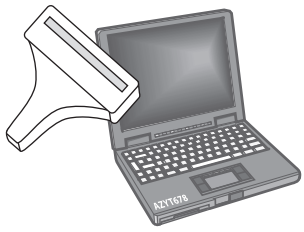
3

In radiant heaters



4

Seeing security markings



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

A gamma rays

B infra red rays

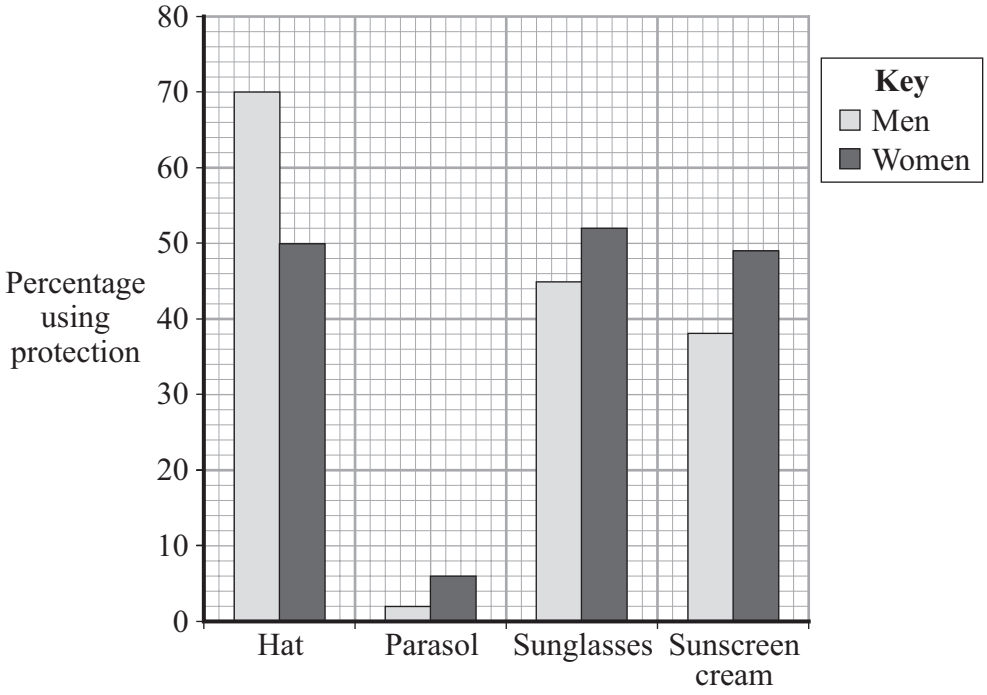
C ultraviolet rays

D X-rays

QUESTION TWO

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

The bar chart shows how men and women in Australia protect themselves against 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 parasol

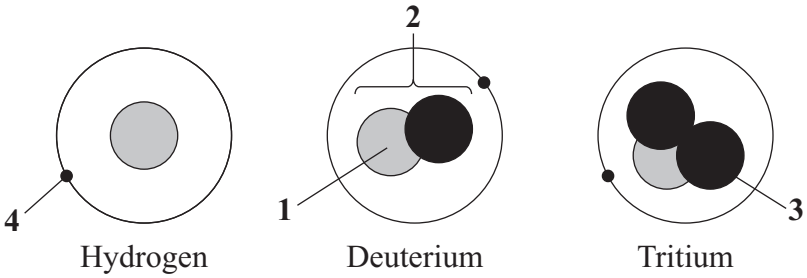
C sunglasses

D sunscreen cream

Statement	
used more by men than by women	**1**
used by 38 % of men	**2**
would give the best protection to the whole body	**3**
would probably be used by 26 women in a sample of 50	**4**

QUESTION THREE

The diagrams show three isotopes of hydrogen.



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

A electron

B neutron

C nucleus

D proton

QUESTION FOUR

Optical telescopes are used to observe space. They operate both from Earth and from satellites in space.

Match the features, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table to indicate whether the feature is an advantage or a disadvantage.

A It can contain large, very heavy components.

B Maintenance is very difficult to carry out.

C The quality of data obtained from it is not affected by atmospheric gases.

D It cannot be used during the day.

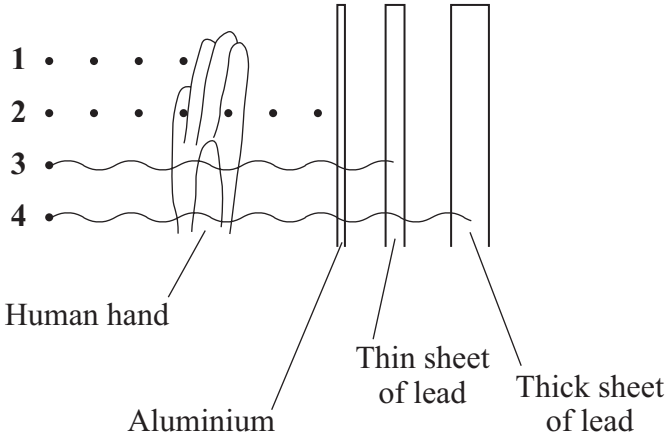
Position of telescope	Advantage	Disadvantage
on Earth	**1**	**2**
on satellite in space	**3**	**4**

QUESTION FIVE

Technicians in hospitals may be exposed to various types of electromagnetic or nuclear radiation.

The penetrating power of four types of radiation is shown in the diagram.

Technicians in the X-ray department wear aprons containing a thin sheet of lead for protection.



Match the types of nuclear and electromagnetic radiation, **A**, **B**, **C**, and **D**, with the labels **1–4** on the diagram.

A gamma radiation

B X-ray radiation

C alpha radiation

D beta radiation

Turn over for the next question

QUESTION SIX

Society must decide how to dispose of nuclear waste. Every disposal method has disadvantages.

Match the methods of disposing of nuclear waste, **A**, **B**, **C** and **D**, with the disadvantages **1 – 4** in the table.

A storing the waste in mineshafts

B storing the waste in metal tanks

C dumping the waste at sea

D launching the waste into space

Disadvantage	
too expensive for large quantities of material	**1**
likely to pollute fresh water supplies in a short time	**2**
leakage caused by corrosion may occur in the long term	**3**
most likely to cause damage to living organisms in the short term	**4**

Turn over for the next question

SECTION TWO

Questions **SEVEN** to **NINE**.

Each of these questions has four parts.

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

Mark your choices on the answer sheet.

QUESTION SEVEN

The solar system is part of the Milky Way galaxy.

7A Astronomers measure the wavelengths of light from distant galaxies.

The unit for wavelength is . . .

1 Hz

2 m/s

3 m

4 °C

7B Visible light from distant galaxies shows an increase in . . .

1 frequency.

2 intensity.

3 speed.

4 wavelength.

7C There is a red-shift in light observed from most distant galaxies.

This has led scientists to the belief that . . .

1 galaxies are moving away from each other.

2 galaxies are moving towards each other.

3 galaxies are moving towards the Milky Way.

4 galaxies are moving towards each other, but some are moving apart.

7D Scientists who have studied electromagnetic radiation from distant galaxies support the 'big bang' theory, which states that the Universe began . . .

1 in many places at the same time.

2 from a very small point.

3 as one very big galaxy.

4 as one very big solar system.

Turn over for the next question

QUESTION EIGHT

Pills are often kept in bottles made from brown plastic. The brown plastic absorbs ultraviolet (UV) radiation which may cause chemical changes to take place 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.

Instead of pills, she used UV-sensitive beads. 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 placed the bottles at equal distances from a UV lamp.
- She then measured the time it took for all of the beads in each bottle to change from white to red.

The table shows her results.

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

8A What kind of variable was the type of pill bottle?

1 categoric

2 continuous

3 discrete

4 ordered

8B 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

8C Which bottle would be best for storing pills?

1 **W**

2 **X**

3 **Y**

4 **Z**

8D The best way of displaying the data from this investigation would be in the form of a . . .

1 bar chart.

2 line graph.

3 pie chart.

4 scattergram.

Turn over for the next question

QUESTION NINE

There was an accident at the Chernobyl nuclear power station in April 1986. This resulted in the release of radioactive materials into the environment. Some of these materials may cause cancer of the thyroid gland in children.

The table shows the number of cases of thyroid cancer in children in two regions near the Chernobyl power station. It also shows the number of cases per 100 000 children in those regions.

		Childhood thyroid cancer cases per year, 1986–1998												
Region \ **Year**		**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
Belarus	Number of cases	3	4	6	5	31	62	62	87	77	82	67	73	48
	Number of cases per 100 000 children	0.2	0.3	0.4	0.3	1.9	3.9	3.9	5.5	5.1	5.6	4.8	5.6	3.9
Ukraine	Number of cases	8	7	8	11	26	22	49	44	44	47	56	36	44
	Number of cases per 100 000 children	0.2	0.1	0.1	0.1	0.2	0.2	0.5	0.4	0.4	0.5	0.6	0.4	0.5

9A By how many did the number of cases of childhood thyroid cancer per year increase in the Belarus region between the year of the Chernobyl accident and 1995?

1 2

2 3

3 79

4 82

9B A city in Ukraine has 200 000 children.

How many cases of childhood thyroid cancer would be expected in the city in 1992?

1 1

2 2

3 5

4 49

One of the radioactive materials responsible for producing childhood thyroid cancer is iodine-131. Children may take in iodine-131 in contaminated food. The iodine-131 is accumulated by the thyroid gland.

9C The half-life of iodine-131 is 8 days. 100 atoms of iodine-131 are taken into the thyroid gland.

How many of these radioactive iodine-131 atoms will there be after 16 days?

1 25

2 50

3 75

4 100

9D Which type of radiation is most likely to cause damage by ionisation once inside the body?

1 alpha radiation

2 beta radiation

3 gamma radiation

4 ultraviolet radiation

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

Society must decide how to dispose of nuclear waste. Every disposal method has disadvantages.

Match the methods of disposing of nuclear waste, **A**, **B**, **C** and **D**, with the disadvantages **1–4** in the table.

A storing the waste in mineshafts

B storing the waste in metal tanks

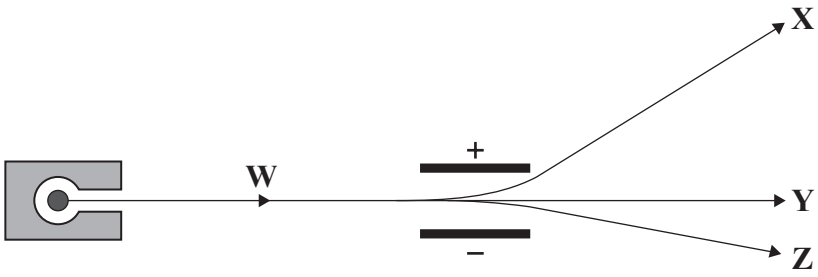
C dumping the waste at sea

D launching the waste into space

Disadvantage	
too expensive for large quantities of material	**1**
likely to pollute fresh water supplies in a short time	**2**
leakage caused by corrosion may occur in the long term	**3**
most likely to cause damage to living organisms in the short term	**4**

QUESTION TWO

A source emits nuclear radiation. In front of it there is a gap in a powerful electrical field.



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

A alpha (α)

B beta (β)

C gamma (γ)

D alpha (α), beta (β) and gamma (γ)

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

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

Pills are often kept in bottles made from brown plastic. The brown plastic absorbs ultraviolet (UV) radiation which may cause chemical changes to take place 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.

Instead of pills, she used UV-sensitive beads. 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 placed the bottles at equal distances from a UV lamp.
- She then measured the time it took for all of the beads in each bottle to change from white to red.

The table shows her results.

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

3A What kind of variable was the type of pill bottle?

1 categoric

2 continuous

3 discrete

4 ordered

3B 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

3C Which bottle would be best for storing pills?

1 **W**

2 **X**

3 **Y**

4 **Z**

3D The best way of displaying the data from this investigation would be in the form of a . . .

1 bar chart.

2 line graph.

3 pie chart.

4 scattergram.

Turn over for the next question

QUESTION FOUR

There was an accident at the Chernobyl nuclear power station in April 1986. This resulted in the release of radioactive materials into the environment. Some of these materials may cause cancer of the thyroid gland in children.

The table shows the number of cases of thyroid cancer in children in two regions near the Chernobyl power station. It also shows the number of cases per 100 000 children in those regions.

		Childhood thyroid cancer cases per year, 1986–1998												
Region \ **Year**		**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
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	Number of cases per 100 000 children	0.2	0.3	0.4	0.3	1.9	3.9	3.9	5.5	5.1	5.6	4.8	5.6	3.9
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	Number of cases per 100 000 children	0.2	0.1	0.1	0.1	0.2	0.2	0.5	0.4	0.4	0.5	0.6	0.4	0.5

4A By how many did the number of cases of childhood thyroid cancer per year increase in the Belarus region between the year of the Chernobyl accident and 1995?

1 2

2 3

3 79

4 82

4B A city in Ukraine has 200 000 children.

How many cases of childhood thyroid cancer would be expected in the city in 1992?

1 1

2 2

3 5

4 49

One of the radioactive materials responsible for producing childhood thyroid cancer is iodine-131. Children may take in iodine-131 in contaminated food. The iodine-131 is accumulated by the thyroid gland.

4C The half-life of iodine-131 is 8 days. 100 atoms of iodine-131 are taken into the thyroid gland.

How many of these radioactive iodine-131 atoms will there be after 16 days?

1 25

2 50

3 75

4 100

4D Which type of radiation is most likely to cause damage by ionisation once inside the body?

1 alpha radiation

2 beta radiation

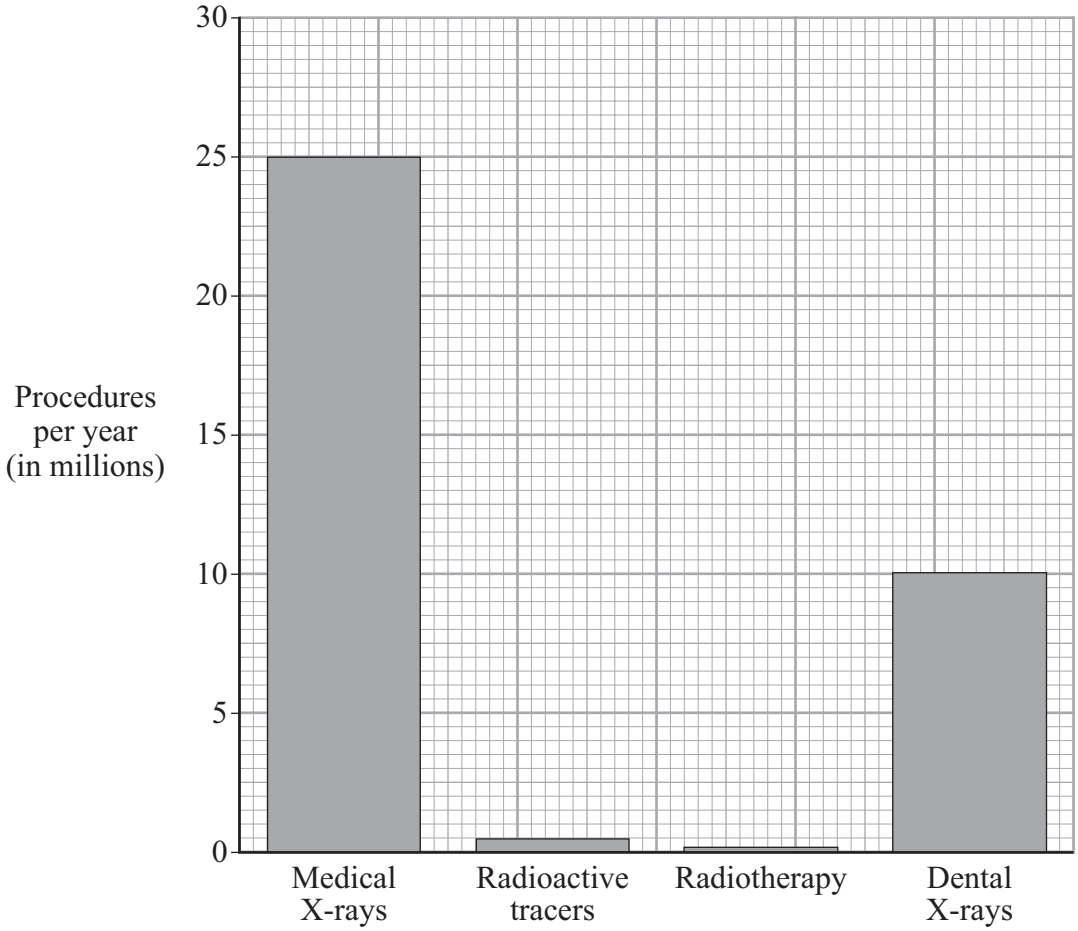
3 gamma radiation

4 ultraviolet radiation

Turn over for the next question

QUESTION FIVE

The bar chart shows the number of medical procedures per year in the UK that involve exposure to electromagnetic and nuclear radiation.



5A In how many procedures were radioactive tracers used?

1 100 000

2 500 000

3 1 000 000

4 2 000 000

5B Which type of procedure is used to treat patients?

1 dental X-rays

2 medical X-rays

3 radioactive tracers

4 radiotherapy

5C What is the approximate total number of X-rays taken in the UK each year?

1 10 000

2 25 000

3 35 000

4 35 000 000

5D Medical X-rays are dangerous because . . .

1 they can pass through the body.

2 they cause burns to the skin.

3 they cause water inside cells to heat up.

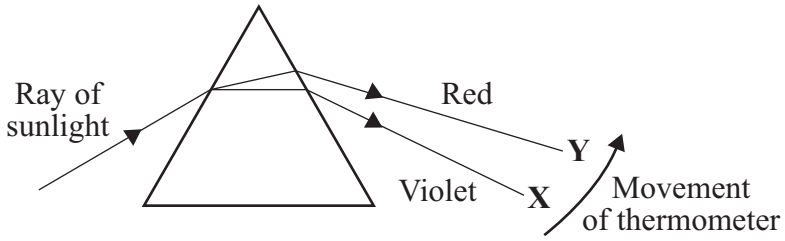
4 they cause ionisation inside cells.

Turn over for the next question

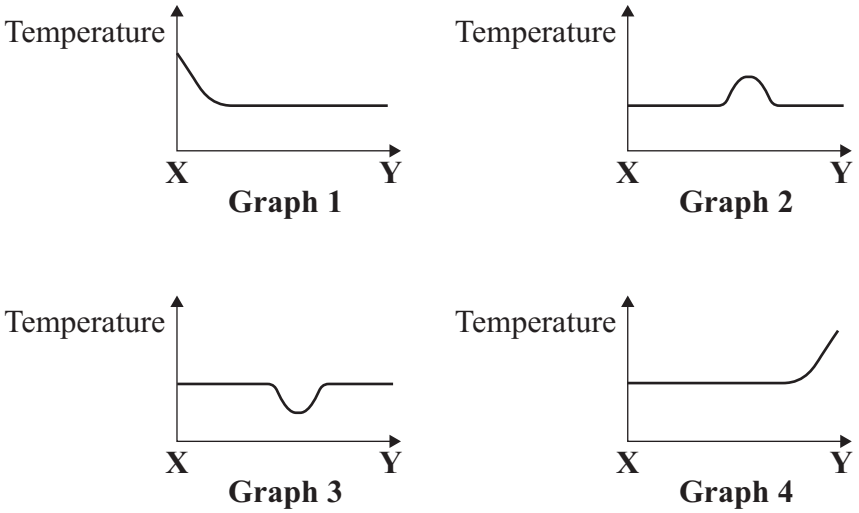
QUESTION SIX

When electromagnetic radiation is absorbed, the energy it carries makes the substance which absorbs it hotter and may create an alternating current of electricity.

6A When sunlight passes through a prism, a visible spectrum forms. A thermometer is moved slowly from **X** to **Y**.



Which sketch graph shows the temperature change as the thermometer moves from **X** to **Y**?



6B The absorption of electromagnetic radiation can create an alternating current in a wire.

This alternating current will have . . .

1 the same frequency as the electromagnetic radiation.

2 the same ionising power as the electromagnetic radiation.

3 the same speed as the electromagnetic radiation.

4 the same wavelength as the electromagnetic radiation.

6C Which factors most affect the absorption of electromagnetic radiation by living cells?

1 speed and wavelength

2 speed, wavelength and size of dose

3 wavelength and size of dose

4 size of dose

6D During the solar eclipse of 2001, four students shared their observations.

Which student's observation was correct?

Student	Observation
1	"It went both cold and dark at the same time."
2	"It went cold, then it went dark."
3	"It went cold, then warm again, then dark."
4	"It went dark, then light again, then cold."

Turn over for the next question

QUESTION SEVEN

This question is about the transmission of light by optical fibres.

7A Optical fibres can bend light around corners without loss of signal.

This is because . . .

1 absorption of the signal occurs in the optical fibre.

2 following signals push the signals around the corners.

3 reflection of the signal occurs inside the optical fibre.

4 light signals are digital signals.

7B Infra red and visible light are used to send signals along optical fibres.

Compared with other electromagnetic radiations, infra red and visible light . . .

1 have similar frequencies and wavelengths.

2 have very high frequencies and very high wavelengths.

3 have very low frequencies and very low wavelengths.

4 travel at different speeds.

7C Communication by electromagnetic radiation may be by analogue signals.

Which row of the table correctly describes the characteristics of these analogue signals?

	Speed	**Signal type**
1	constant	continuously varying
2	constant	only on or off
3	varies	continuously varying
4	varies	only on or off

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

7D An infra red wave has a wavelength of 0.001 m and a wave speed of 300 000 000 m/s.

The frequency of this wave is:

1 3 Hz

2 30 Hz

3 30 000 Hz

4 300 000 000 000 Hz

Turn over for the next question

QUESTION EIGHT

Americium-241 has a half-life of 432 years. A smoke detector uses the radiation from about 0.0002 g of americium-241 oxide. This substance emits alpha radiation. The alpha radiation ionises molecules in the air inside the smoke detector and this allows an electric current to flow. However, particles of smoke will absorb the radiation. This stops the electric current and causes the alarm to switch on.

8A When used as intended, a smoke detector is **not** a health hazard to humans.

This is because . . .

1 alpha particles are harmless.

2 alpha particles are the least harmful type of radiation.

3 alpha particles do **not** travel beyond the smoke alarm.

4 americium-241 has a long half-life.

8B Alpha particle emission is the most effective type of radiation for use in smoke detectors because . . .

1 alpha particles are heavier than beta particles.

2 alpha particles travel only short distances.

3 it is cheap to produce.

4 it is the most ionising type of radiation.

8C When an americium-241 atom emits an alpha particle, the new atom which is formed will have . . .

1 fewer protons only.

2 fewer neutrons only.

3 fewer electrons only.

4 fewer protons and fewer neutrons.

8D The table shows the properties of four radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
Californium-241	alpha	4 minutes
Cobalt-60	gamma	5 years
Strontium-90	beta	28 years
Technetium-99	gamma	6 hours

Which isotope would be the best to use as a tracer in the human body?

1 californium-241

2 cobalt-60

3 strontium-90

4 technetium-99

Turn over for the next question

QUESTION NINE

Early last century, astronomers noticed that distant galaxies had peculiar light spectra. They noticed that the galaxies' light spectra were shifted towards the red end of the spectrum.

9A Evidence from this type of shift allows scientists to deduce the . . .

1 average density of a galaxy.

2 chemical composition of a galaxy.

3 distance of the galaxy from the Earth.

4 total mass of a galaxy.

9B Red-shift is caused by . . .

1 an observed decrease in frequencies of the electromagnetic radiation leaving the source.

2 electromagnetic waves changing velocity as they travel from more distant galaxies.

3 movement of the Earth along its orbit.

4 an observed decrease in wavelength of the electromagnetic radiation leaving the source.

9C The sequence of colour bands in the visible spectrum is:

red, orange, yellow, green, blue, indigo and violet.

A red-shift could cause . . .

1 the blue band to move towards violet.

2 the red band to move towards orange.

3 the violet band to move towards indigo.

4 the violet band to move towards ultraviolet light.

9D When the light from distant galaxies is analysed, the amount of red-shift is proportional to distance.

This suggests that . . .

1 light from a galaxy three times as far away will have three times the amount of red-shift.

2 light from a galaxy twice as far away will have half the amount of red-shift.

3 the frequency of light leaving a galaxy twice as far away will be doubled.

4 the speed of light reaching the Earth from a distant galaxy will decrease as time passes.

END OF TEST