Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Secondary Education
Foundation Tier and Higher Tier
November 2009

Science A

Unit Physics P1b (Radiation and the Universe)

Physics

Unit Physics P1b (Radiation and the Universe)

PHY1BP

F&H

Thursday 19 November 2009 Morning Session

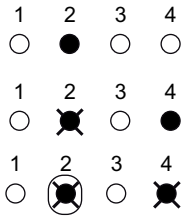
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

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 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

This question is about the uses of some types of electromagnetic radiation.

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

A infra red

B microwaves

C ultraviolet

D X-rays

	Use
1	sending signals in mobile phone networks
2	sending signals along optical fibres
3	photographing people's bones in hospital
4	reading 'invisible' security markings on property

QUESTION TWO

This question is about four types of electromagnetic radiation.

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

A gamma

B infra red

C radio

D visible light

The type of electromagnetic radiation with the longest wavelength is . . . **1** . . . .

The type of electromagnetic radiation with the highest frequency is . . . **2** . . . .

The type of electromagnetic radiation that is used to cook food is . . . **3** . . . .

The type of electromagnetic radiation that allows us to see is . . . **4** . . . .

Turn over for the next question

QUESTION THREE

This question is about a radioactive isotope that emits alpha particles.

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

A count rate

B half-life

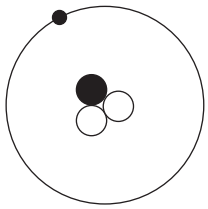
C penetrating power

D range

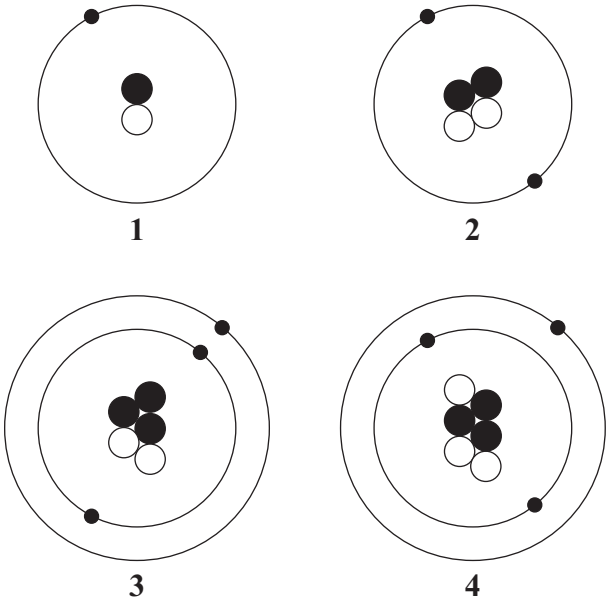
	Description
1	the number of alpha particles detected per second
2	the distance the alpha particles travel before being fully absorbed
3	the time it takes for half of the nuclei of the isotope to decay
4	the ability of the alpha particles to pass through matter

QUESTION FOUR

The diagram shows an isotope of hydrogen. It contains one electron, one proton and two neutrons.



Four other atoms are labelled **1–4**.



Match statements, **A**, **B**, **C** and **D**, with the atoms labelled **1–4**.

A contains 5 particles in its nucleus

B has a nucleus that is identical in structure to an alpha particle

C has the same number of electrons as atom **3**

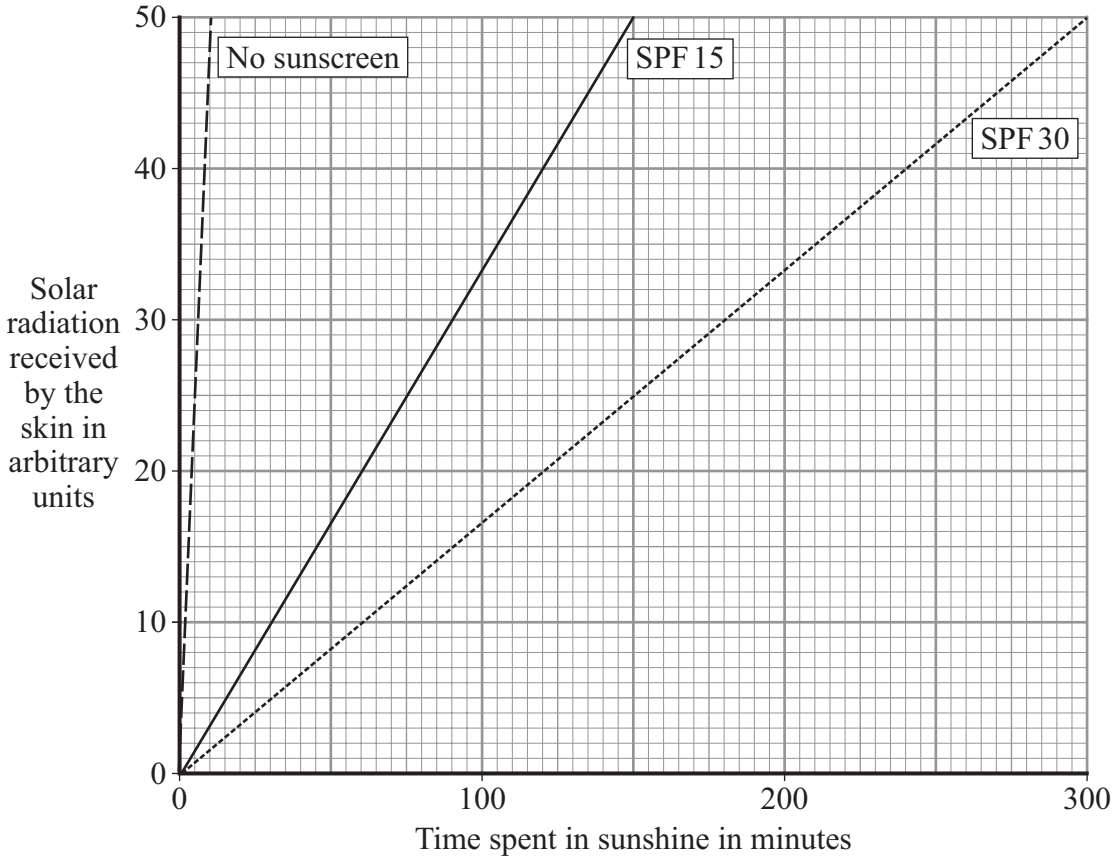
D is a different isotope of hydrogen

QUESTION FIVE

The longer you sunbathe, the more solar radiation your skin receives. Sunscreen lotions absorb some of this radiation. The lotions are given a skin protection factor (SPF) number.

The graph shows how the amount of radiation received by a person's skin is related to how long they are outside on a sunny day.

The skin gets sunburnt if it receives 50 units of solar radiation.



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

A 10

B 15

C 25

D 200

After 150 minutes, the skin protected by SPF 30 sunscreen lotion has received . . . **1** . . . units of solar radiation.

Without sunscreen lotion, it takes . . . **2** . . . minutes to get sunburnt.

If you protect your skin with SPF 15 sunscreen lotion, you can stay . . . **3** . . . times longer in sunshine without getting sunburnt than you can with unprotected skin.

If you put on SPF 20 sunscreen lotion, it would be . . . **4** . . . minutes before you got sunburnt.

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

Diagram 1 shows a transmitter used to send information to a satellite. The transmitter has a microwave source in front of the dish.

Diagram 2 gives more detail of the dish and the microwave source. The dish is made of metal coated with plastic. The plastic coating prevents corrosion of the metal.

Diagram 1

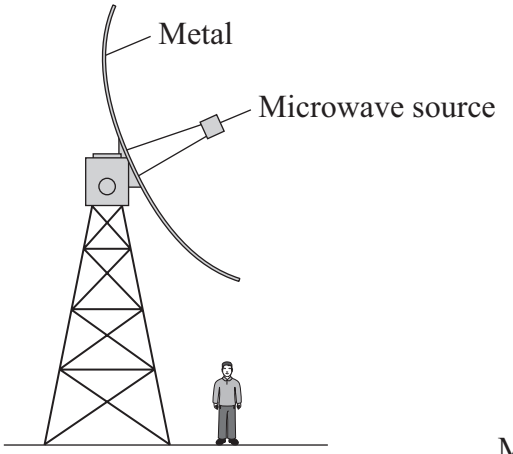
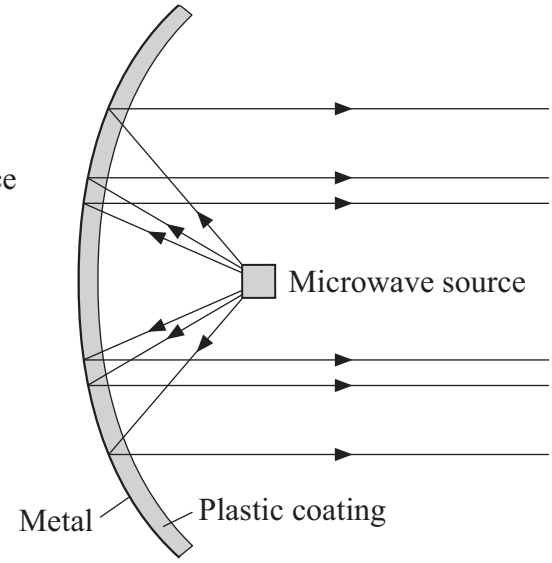


Diagram 2



6A The coating is made of plastic because microwaves are . . .

1 absorbed by plastic.

2 changed to an alternating current by plastic.

3 reflected by plastic.

4 able to pass through plastic.

6B The dish is made of metal because microwaves . . .

1 are absorbed by metals.

2 are reflected by metal.

3 give an alternating current with a different frequency.

4 interfere with the digital signals produced.

6C The microwave source is turned off when maintenance work is done in the dish.

This is to prevent the maintenance workers from . . .

1 becoming deaf from the analogue signals used.

2 causing interference to the digital signals used.

3 having their bodies heated by the microwaves.

4 receiving an electric shock from the alternating current, which is more dangerous than direct current.

6D Which of the following statements is correct about all microwaves?

1 As the frequency decreases, the wavelength decreases.

2 As the frequency decreases, the wavelength increases.

3 As the frequency increases, the wavelength does not change.

4 As the frequency increases, the wavelength increases.

Turn over for the next question

QUESTION SEVEN

Astronomers studying light from distant galaxies notice that the light from them seems to increase in wavelength.

7A The increase in wavelength is known as . . .

1 blue-shift.

2 contraction.

3 expansion.

4 red-shift.

7B The increase in wavelength . . .

1 is smaller the further away the galaxy is.

2 is larger the further away the galaxy is.

3 becomes zero for very distant galaxies.

4 is the same whether galaxies are moving towards us or away from us.

7C The unit of wavelength is the . . .

1 hertz.

2 metre.

3 metre per second.

4 second.

7D Most astronomers think that the universe began from a very small initial point.

Since then, the universe has . . .

1 been contracting.

2 been contracting then expanding.

3 been expanding.

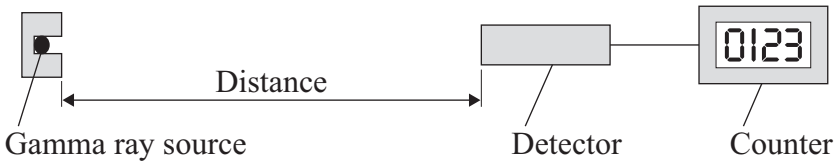
4 stayed unchanged.

Turn over for the next question

QUESTION EIGHT

Harmful Gamma Radiation? .... Keep safe, keep away!

A sixth form student decided to test the truth of the newspaper headline. She used a gamma ray source and a detector to measure the amount of radiation reaching the detector per second. She repeated the experiment and calculated the mean count rates. She then moved the detector further away from the source and repeated the procedure.



Her results are shown in the table.

Distance from source in metres	Count rate in counts per second		
	Test 1	Test 2	Mean
0.2	480	484	482
0.4	121	127	124
0.6	55	55	55
0.8	30	32	31
1.0	20	18	19

8A The results with the greatest range of count rate occur at a distance from the source of . . .

1 0.2 m

2 0.4 m

3 0.8 m

4 1.0 m

8B She repeated the experiment and calculated the mean to make her results more . . .

1 accurate.

2 controlled.

3 varied.

4 reliable.

8C A valid conclusion based on her results would be that . . .

1 1.0 m is a safe distance to be from the source.

2 the count rate decreases as the distance from the source increases.

3 the count rate will be almost zero at a distance of 1.2 m from the source.

4 there is no such thing as a safe distance from a gamma source.

8D Another way in which the count rate could be reduced would be to . . .

1 reduce the air temperature between the source and detector.

2 place a thick sheet of lead between the source and detector.

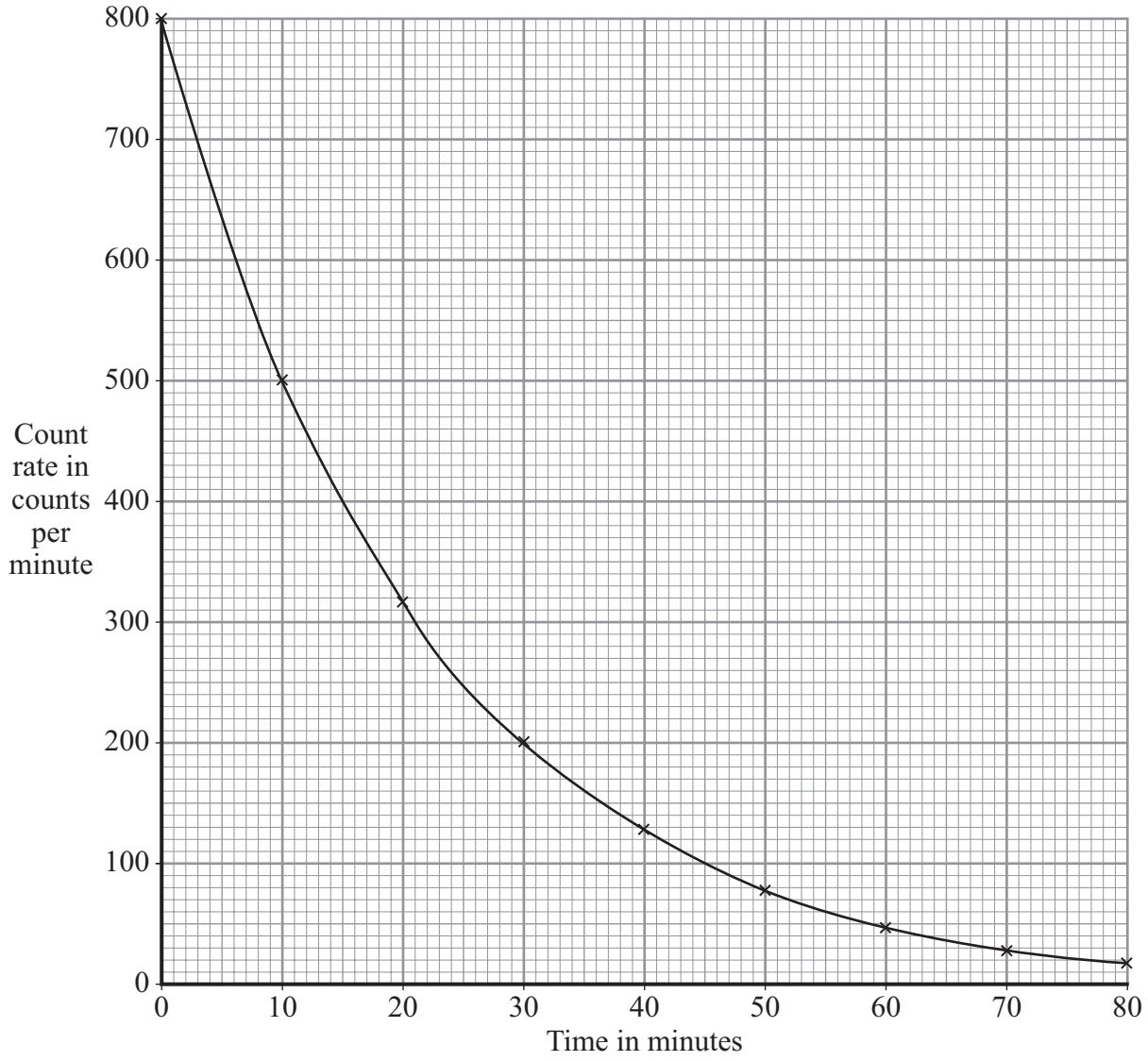
3 produce a strong electric field between the source and detector.

4 produce a strong magnetic field between the source and detector.

Turn over for the next question

QUESTION NINE

The graph shows how the count rate of a radioactive isotope varies with time.



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

1 10 minutes

2 15 minutes

3 20 minutes

4 80 minutes

9B The person who plotted the graph has drawn a line graph rather than a bar chart.

What is the reason for this?

1 Both the count rate and time are continuous variables.

2 Time is a discrete variable and count rate is a continuous variable.

3 Time is a continuous variable and count rate is a categoric variable.

4 Both the count rate and time are discrete variables.

9C The government recommends that all homes are fitted with smoke alarms. Americium-241 is used in these alarms. Americium-241 emits alpha particles and has a half-life of 460 years.

The americium-241 is safe to use in homes because . . .

1 it has a long half-life.

2 alpha particles travel only a few centimetres in air.

3 smoke alarm batteries are replaced regularly.

4 its nucleus has 146 neutrons.

9D This information is about the isotope technetium-99.

- It emits gamma radiation.
- Its half-life is 6 hours.
- It decays to a stable isotope of rubidium.
- It is used for diagnostic medical studies.
- It is put into the body.

A doctor wants to convince a patient that technetium-99 is safe to use to diagnose a medical problem.

Which of the following should he use to reassure the patient?

1 Rubidium is a rare metallic element.

2 Gamma radiation is part of the electromagnetic spectrum.

3 The half-life of the technetium-99 isotope is relatively short.

4 There is no risk in using radioactive materials.

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 longer you sunbathe, the more solar radiation your skin receives. Sunscreen lotions absorb some of this radiation. The lotions are given a skin protection factor (SPF) number.

The graph shows how the amount of radiation received by a person's skin is related to how long they are outside on a sunny day.

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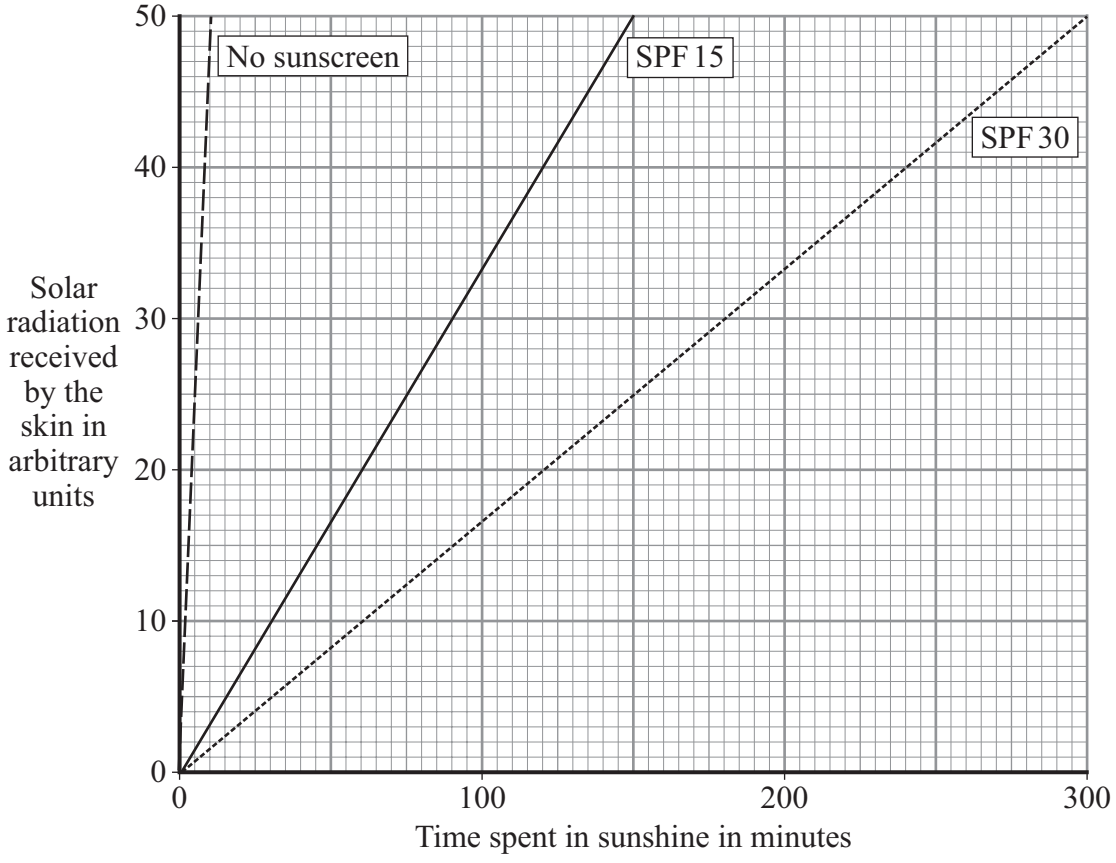

Match figures, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A 10

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After 150 minutes, the skin protected by SPF 30 sunscreen lotion has received . . . **1** . . . units of solar radiation.

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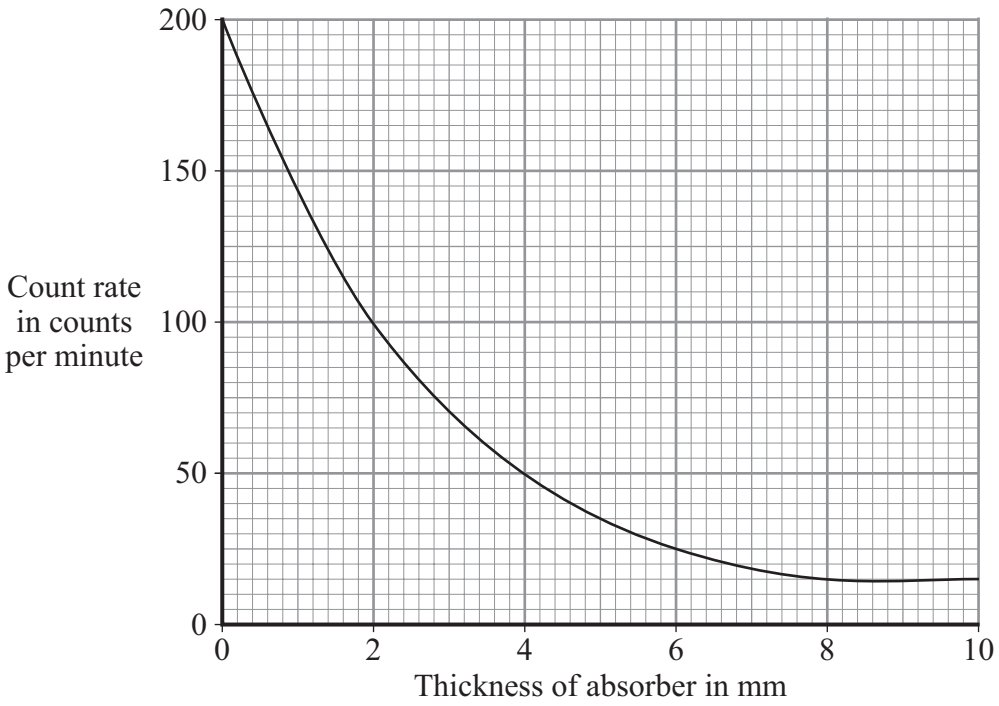
If you put on SPF 20 sunscreen lotion, it would be . . . **4** . . . minutes before you got sunburnt.

Turn over for the next question

QUESTION TWO

A source of beta radiation is placed in front of a detector. Pieces of aluminium of different thicknesses are placed between the source and the detector. The thickness of the absorber and the count rate are measured.

The results are shown on the graph.



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

A 2

B 9

C 70

D 200

The count rate with no absorber is . . . **1** . . . counts per minute.

The count rate when the absorber is 3 mm thick is . . . **2** . . . counts per minute.

The thickness needed to reduce the count rate by half is . . . . **3** . . . mm.

The thickness needed to absorb all the radiation from the source is . . . **4** . . . mm.

Turn over for the next question

SECTION TWO

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

Each of these questions has four parts.

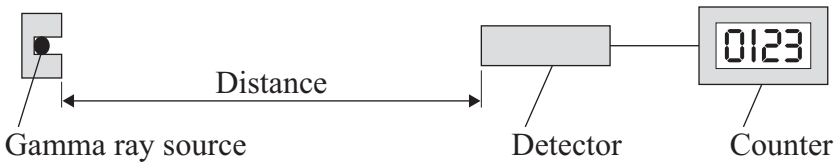
In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION THREE

Harmful Gamma Radiation? .... Keep safe, keep away!

A sixth form student decided to test the truth of the newspaper headline. She used a gamma ray source and a detector to measure the amount of radiation reaching the detector per second. She repeated the experiment and calculated the mean count rates. She then moved the detector further away from the source and repeated the procedure.



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3A The results with the greatest range of count rate occur at a distance from the source of . . .

1 0.2 m

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3B She repeated the experiment and calculated the mean to make her results more . . .

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3D Another way in which the count rate could be reduced would be to . . .

1 reduce the air temperature between the source and detector.

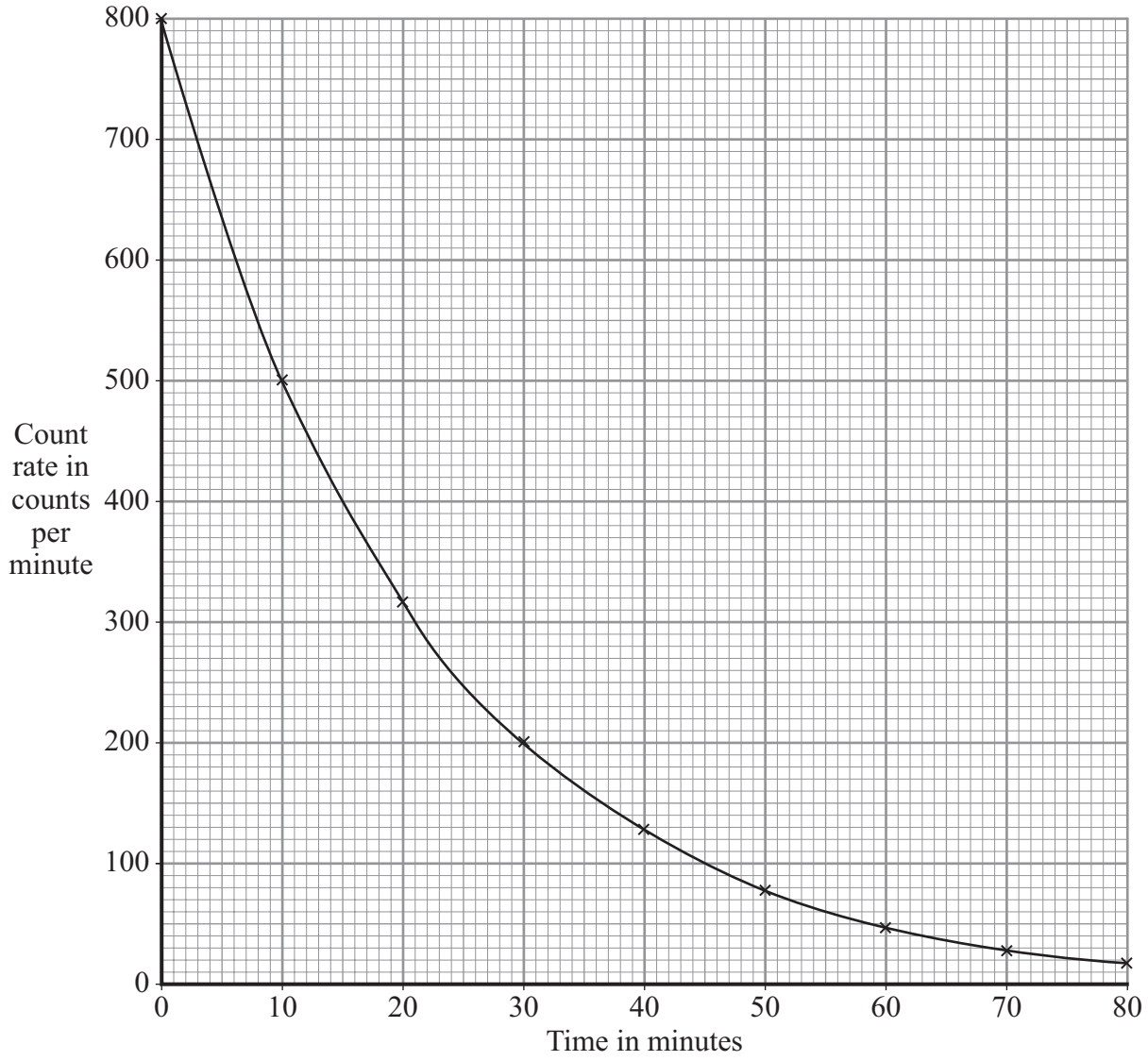
2 place a thick sheet of lead between the source and detector.

3 produce a strong electric field between the source and detector.

4 produce a strong magnetic field between the source and detector.

QUESTION FOUR

The graph shows how the count rate of a radioactive isotope varies with time.



4A What is the half-life of the isotope?

1 10 minutes

2 15 minutes

3 20 minutes

4 80 minutes

4B The person who plotted the graph has drawn a line graph rather than a bar chart.

What is the reason for this?

1 Both the count rate and time are continuous variables.

2 Time is a discrete variable and count rate is a continuous variable.

3 Time is a continuous variable and count rate is a categoric variable.

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4C The government recommends that all homes are fitted with smoke alarms. Americium-241 is used in these alarms. Americium-241 emits alpha particles and has a half-life of 460 years.

The americium-241 is safe to use in homes because . . .

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1 Rubidium is a rare metallic element.

2 Gamma radiation is part of the electromagnetic spectrum.

3 The half-life of the technetium-99 isotope is relatively short.

4 There is no risk in using radioactive materials.

QUESTION FIVE

The Sun emits different types of radiation. These types of radiation travel from the Sun until they reach the Earth's atmosphere. In the atmosphere, some types of radiation are reflected, some are absorbed and some are transmitted to the Earth's surface, where they cause the Earth to warm up.

Human activity has produced large amounts of carbon dioxide gas which has increased the amount of carbon dioxide in the atmosphere. The carbon dioxide helps to trap the Earth's heat and so contributes to the 'greenhouse' effect, which results in the Earth becoming hotter.

5A On their journey from the Sun to the Earth, all the types of radiation travel with the same . . .

1 energy.

2 frequency.

3 speed.

4 wavelength.

5B The ozone layer in the Earth's atmosphere absorbs some of the Sun's ultraviolet radiation.

Ultraviolet radiation can . . .

1 be detected by your eyes.

2 give your skin a suntan.

3 cool your skin.

4 pass through flesh but not bone.

5C Most of the Sun's infra red radiation is emitted with a wavelength of about 0.5 micrometres. Most of the Earth's infra red radiation is emitted with a wavelength of about 10 micrometres.

Carbon dioxide molecules in the atmosphere can absorb infra red radiation with wavelengths between 2 micrometres and 17 micrometres.

1 micrometre = 1 millionth of a metre

Therefore, the carbon dioxide will . . .

1 absorb the Sun's infra red radiation and absorb the Earth's infra red radiation.

2 absorb the Sun's infra red radiation and transmit the Earth's infra red radiation.

3 transmit the Sun's infra red radiation and absorb the Earth's infra red radiation.

4 transmit the Sun's infra red radiation and transmit the Earth's infra red radiation.

5D As an object gets hotter, its main infra red emission wavelength gets shorter.

If human activity continues to increase the amount of carbon dioxide gas in the atmosphere, then the Earth will emit . . .

1 more energy, with a shorter main emission wavelength.

2 more energy, with the same main emission wavelength.

3 the same energy, with a shorter main emission wavelength.

4 the same energy, with the same main emission wavelength.

Turn over for the next question

QUESTION SIX

Astronomers have observed many distant galaxies and found that the radiation from the galaxies shows a red-shift.

6A What happens to the radiation in red-shift?

1 The observed wavelength decreases and the frequency increases.

2 The observed wavelength increases and the frequency decreases.

3 The observed wavelength increases and the frequency increases.

4 The observed wavelengths merge together to form red light.

6B The astronomers realised that these galaxies are moving away from us.

This led them to produce a theory in which . . .

1 the galaxies are contracting towards a small point.

2 the galaxies are moving towards each other.

3 the universe is contracting towards a small point.

4 the universe is expanding from an initial small point.

6C The data in the table below shows the red-shift of different galaxies. (They are all for the same spectral line.)

Name of galaxy	Red shift in nm
M60	18.8
M99	32.1
NGC 2366	1.3
NGC 2976	0.04

Which galaxy is furthest from Earth?

1 M60

2 M99

3 NGC 2366

4 NGC 2976

6D Astronomers have found that the light from the Sun shows an increase in frequency on one edge and a decrease in frequency on the opposite edge.

What does this suggest is happening to the Sun?

1 It is gradually expanding.

2 It is moving away from us.

3 It is moving towards us.

4 It is rotating.

Turn over for the next question

QUESTION SEVEN

There are two types of radio wave that carry television signals, VHF and UHF.

7A Some UHF waves have a frequency that is ten times bigger than some VHF waves.

The wavelength of these UHF waves, in comparison to the VHF ones, is . . .

1 ten times as big because they travel faster.

2 one tenth as big because they travel faster.

3 ten times as big because they travel at the same speed.

4 one tenth as big because they travel at the same speed.

7B One television channel transmits using waves of frequency 1000 MHz.

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

Speed of electromagnetic waves in a vacuum = 300 000 km/s

1 MHz = 1 million hertz

What is the wavelength of these waves?

1 0.3 m

2 3.0 m

3 0.3 km

4 3.0 km

7C All television transmitters in the UK are going to be switched from analogue to digital signals.

Which row in the table is correct?

	Analogue signals	**Digital signals**
1	continuously varying	more prone to interference and cannot be processed by a computer
2	less prone to interference and can be easily processed by a computer	discrete values only, generally on and off
3	continuously varying	less prone to interference and can be easily processed by a computer
4	discrete values only, generally on and off	continuously varying

7D An aerial receives television signals.

The energy transferred by an electromagnetic wave carrying the television signal . . .

1 makes the aerial hotter so that it can detect the signal.

2 makes the aerial colder so that it can detect the signal.

3 creates an alternating current in the aerial with the same frequency as the wave.

4 creates a direct current in the aerial with the same frequency as the wave.

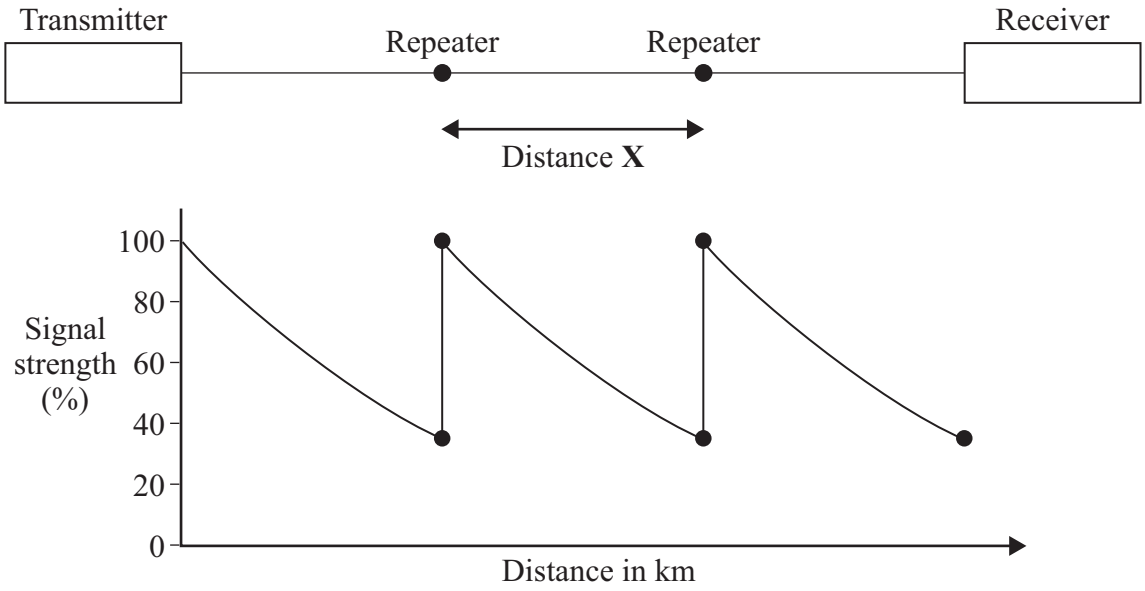
Turn over for the next question

QUESTION EIGHT

Information can be sent along optical fibres in the form of pulses. These pulses become weaker as they pass along the fibre.

In the early development of the fibres, the signal strength halved every 10 km. To overcome this, devices called 'repeaters' were inserted into the optical fibre system to boost the signal to its original strength.

The diagram shows one of the early systems. The graph shows how the signal strength changes with distance.



8A A signal is transmitted along the optical fibre. The power at the transmitter is 2 mW.

In the absence of any 'repeater', what would the power of the signal be after 30 km?

1 0.000 mW

2 0.125 mW

3 0.250 mW

4 0.333 mW

8B Using the graph, the distance **X** between the 'repeaters' is between . . .

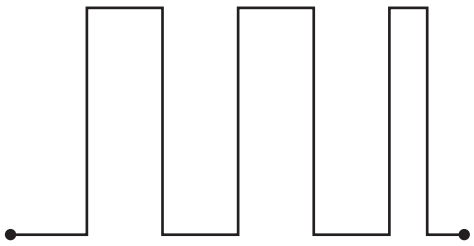
1 0 – 10 km

2 10 – 20 km

3 20 – 30 km

4 30 – 40 km

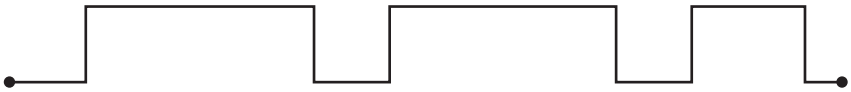
8C The transmitter sends out three pulses as shown. (All diagrams are drawn to the same scale.)



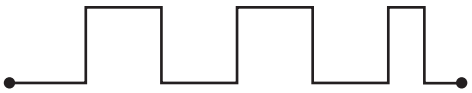
Just before the pulses reach the first 'repeater', they would look like . . .

1

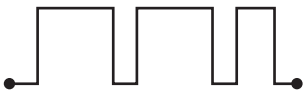
2



3



4



8D The use of optical fibres, between transmitter and receiver, has had a significant effect on the transmission of signals in . . .

1 landline phones.

2 mobile phones.

3 satellite communication.

4 wifi (wireless communication).

QUESTION NINE

Visible light from space can be gathered and focused by optical telescopes.

9A Optical telescopes used to observe objects in space are limited because they can only be used . . .

1 as ground-based telescopes.

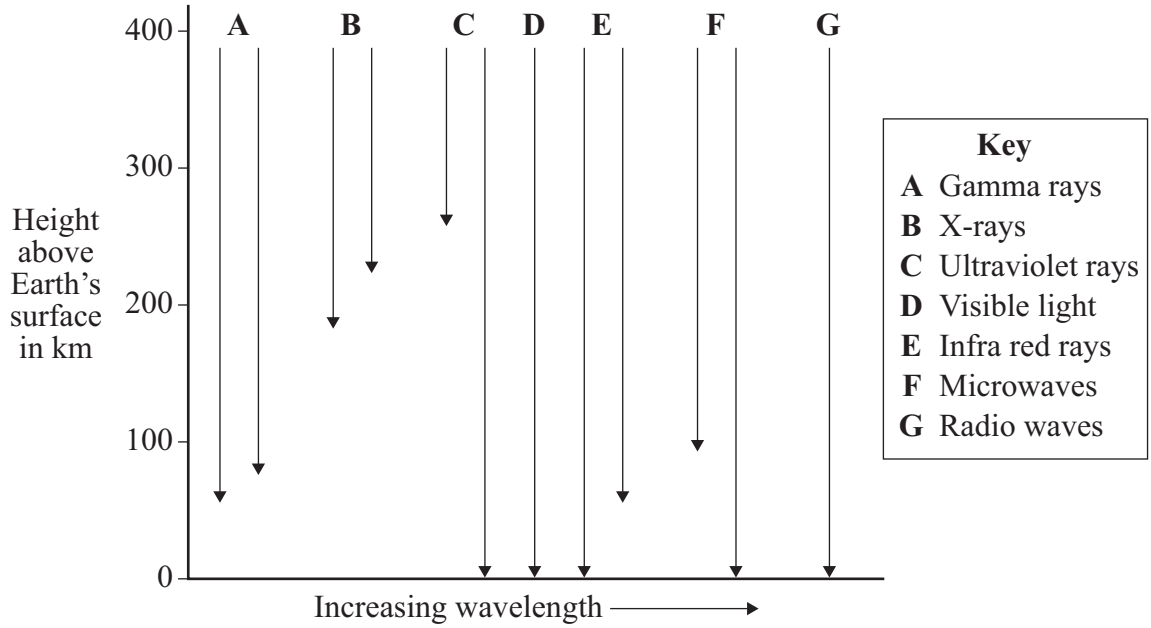
2 at night.

3 to observe a small region of the electromagnetic spectrum.

4 to observe one region of the sky.

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9B Radio telescopes are sited on the ground.

This is because radio waves . . .

1 are emitted by many stars.

2 can penetrate the atmosphere.

3 have a shorter wavelength than microwaves.

4 have more energy than infra red waves.

9C The types of radiation collected by four telescopes, **M**, **N**, **P** and **Q**, are given in the table.

Telescope	Radiation collected
M	infra red waves
N	gamma rays
P	X-rays
Q	microwaves

Which telescopes could be operated from an aircraft flying at an altitude of 12 km?

1 **M** and **N**

2 **N** and **P**

3 **P** and **Q**

4 **Q** and **M**

9D What is the minimum height above the Earth for a satellite to be able to use telescope **P**?

1 50 km

2 70 km

3 180 km

4 250 km

END OF TEST

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