

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



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

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

PHY1BP
F&H

Friday 22 June 2012 Afternoon Session

For this paper you must have:

- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

Time allowed

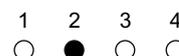
- 30 minutes

Instructions

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

Instructions for recording answers

- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown.
- Do **not** extend beyond the circles.
- If you want to change your answer, **you must** cross out your original answer, as shown.
- If you change your mind about an answer you have crossed out and now want to choose it, draw a ring around the cross as shown.



Information

- The maximum mark for this paper is 36.

Advice

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

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

Some types of radiation are more penetrating than other types.

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

- A** alpha
- B** beta
- C** gamma
- D** X-rays

	Penetrating power
1	stopped by a thin sheet of paper
2	passes through a sheet of paper but stopped by aluminium
3	stopped by bone but not by flesh
4	only stopped by many centimetres of lead

QUESTION TWO

Nuclear radiation and electromagnetic radiation have many different uses.

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

- A** alpha
- B** gamma
- C** infra red
- D** ultraviolet

	Use
1	in smoke detectors
2	for heat-sensitive photography
3	in sunbeds
4	for sterilising medical equipment

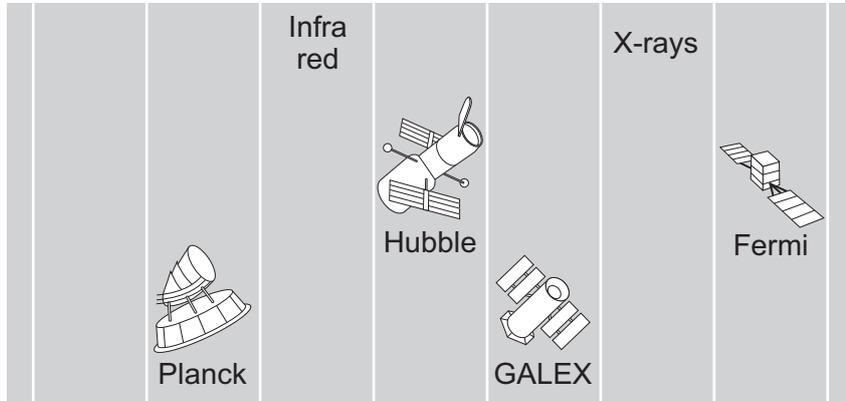
Turn over for the next question

Turn over ►

QUESTION THREE

Different space telescopes are designed to detect different types of electromagnetic radiation.

The diagram shows part of the electromagnetic spectrum and four different telescopes.



Match telescopes, **A**, **B**, **C** and **D**, with the types of electromagnetic radiation **1–4** in the table that each telescope is designed to detect.

- A** Fermi
- B** GALEX
- C** Hubble
- D** Planck

	Type of electromagnetic radiation
1	gamma radiation
2	microwave
3	ultraviolet
4	visible light

QUESTION FOUR

Read this extract from a magazine article.

X-rays and health

Doctors studied the health records of hospital patients who had been X-rayed in the previous three years. The patients were compared to a similar group who had not been X-rayed in the same three years.

The doctors found that there was no significant difference in the health of the two groups.

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

- A** conclusion
B confidentiality
C control
D evidence

The group that had not been X-rayed is the . . . **1**

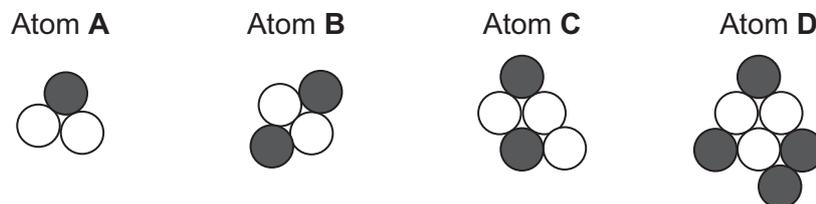
The data in the health records is the . . . **2**

What the doctors found out helps them to reach their . . . **3**

The ethical issue in such a study is the issue of . . . **4**

QUESTION FIVE

The diagram shows the nuclei of four different atoms, **A**, **B**, **C** and **D**. The protons and neutrons are shaded differently.



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

1	The nucleus contains one neutron.
2	The nucleus contains four neutrons.
3	The nucleus is the same as an alpha particle.
4	The atom is an isotope of atom D .

Turn over ►

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

A report on the safety of mobile phones was published. It suggested that people who use a mobile phone for an hour every day are twice as likely to get brain cancer as people who do not use a mobile phone.

6A Which type of electromagnetic radiation is used to send messages between mobile phones?

- 1 gamma rays
- 2 microwaves
- 3 ultraviolet rays
- 4 visible light

6B A student, concerned about brain cancer, read some other reports on the safety of mobile phones.

The most reliable reports on the safety of mobile phones will be produced by . . .

- 1 advertising companies.
- 2 other students of his age.
- 3 independent scientists.
- 4 mobile phone makers.

6C Mobile phones use digital signals rather than analogue signals.

Which row in the table correctly describes the two types of signal?

	Analogue	Digital
1	Easily processed by computers	Less prone to interference
2	Not easily processed by computers	More prone to interference
3	Less prone to interference	Not easily processed by computers
4	More prone to interference	Easily processed by computers

6D In the UK, mobile phone companies use three different frequencies.

Frequency	900 MHz	1800 MHz	2100 MHz
Name used for frequency	GSM 900	GSM 1800	IMT 2000

What physical property is shared by all three frequencies?

- 1 They have the same wavelength.
- 2 They have the same speed in a vacuum.
- 3 Their name shows the frequency.
- 4 They cannot travel through a vacuum.

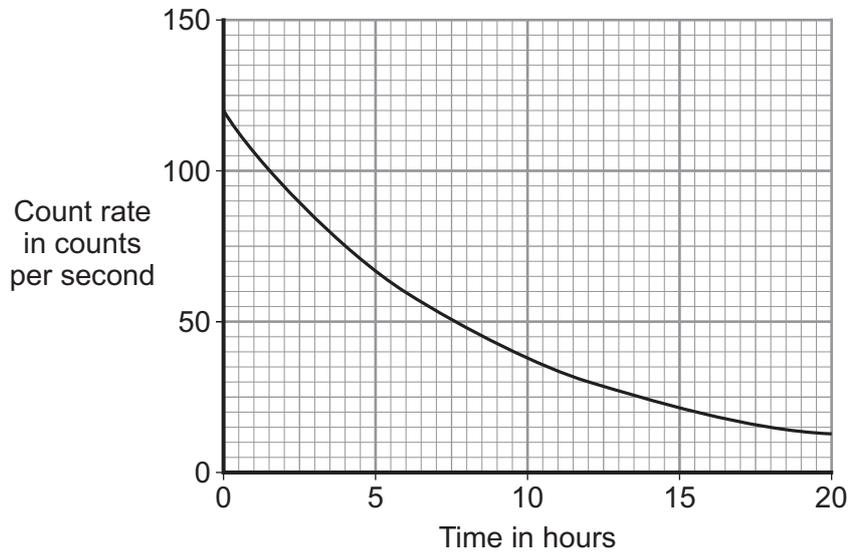
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QUESTION SEVEN

Technetium-99 is a radioactive isotope. A scientist investigated how the count rate of technetium-99 changes with time.

The graph shows her results.



7A Which row in the table correctly describes the variables in the investigation?

	Count rate	Time
1	control	independent
2	control	dependent
3	dependent	independent
4	independent	dependent

7B The results have been displayed as a line graph because both variables are . . .

- 1 categoric variables.
- 2 continuous variables.
- 3 control variables.
- 4 dependent variables.

7C After three hours the count rate of the technetium-99 is . . .

1 70

2 80

3 85

4 90

7D The half-life of the technetium-99 is . . .

1 6.0 hours.

2 7.5 hours.

3 9.0 hours.

4 18.0 hours.

Turn over for the next question

Turn over ►

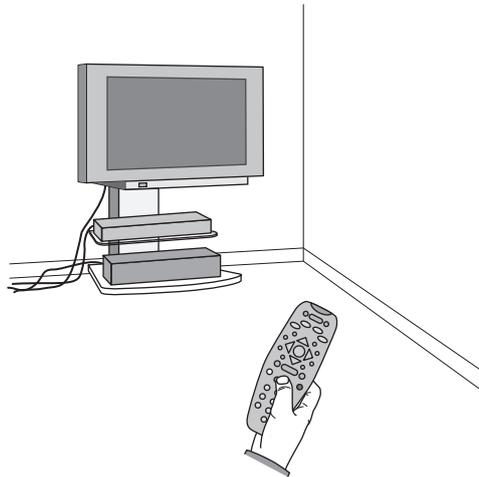
QUESTION EIGHT

This question is about electromagnetic waves.

8A Which type of electromagnetic wave is used in a handheld remote control for a television?

- 1 infra red
- 2 radio
- 3 visible light
- 4 X-rays

8B The diagram shows a handheld remote control unit being used to change a television channel. The unit is pointing at a surface and not directly at the television.



The signal from the remote control unit reaches the television because the surface . . .

- 1 absorbs the signal.
- 2 refracts the signal.
- 3 reflects the signal.
- 4 transmits the signal.

8C Television signals can be transmitted using cable networks. These networks usually contain optical fibres.

Which of the following two types of electromagnetic radiation can be transmitted through optical fibres?

- 1 infra red and microwaves
- 2 infra red and visible light
- 3 radio waves and microwaves
- 4 visible light and radio waves

8D The behaviour of waves is often demonstrated using waves on water. In one demonstration, waves of wavelength 5 cm were produced by a vibrating piece of wood. The frequency of the waves was 10 Hz.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)
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What was the wave speed, in m/s?

- 1 0.5
- 2 2.0
- 3 15.0
- 4 50.0

Turn over for the next question

Turn over ►

QUESTION NINE

Early in the twentieth century, astronomers first observed an apparent change in wavelength of light from distant galaxies. This observation led to the suggestion that the universe began with an explosion.

It was then predicted that if the universe began with an explosion there should be background microwave radiation in space, left over from the explosion.

Background microwave radiation from space was discovered in 1964.

- 9A** What is the apparent change in wavelength of light from distant galaxies?
- 1 an increase in the wavelength caused by a galaxy moving away from the Earth
 - 2 an increase in the wavelength caused by a galaxy moving towards the Earth
 - 3 a decrease in the wavelength caused by a galaxy being a long way from the Earth
 - 4 a decrease in the wavelength caused by a galaxy moving away from the Earth
- 9B** The suggestion that the universe began with an explosion is called . . .
- 1 a fact.
 - 2 an investigation.
 - 3 an observation.
 - 4 a theory.
- 9C** Compared to visible light, microwave radiation has . . .
- 1 the same wavelength and a lower frequency.
 - 2 a longer wavelength and a lower frequency.
 - 3 a shorter wavelength and the same frequency.
 - 4 a shorter wavelength and a higher frequency.
- 9D** The discovery of background microwave radiation from space . . .
- 1 proves that the universe is expanding.
 - 2 proves that the universe began with an explosion.
 - 3 does not support the suggestion that the universe is expanding.
 - 4 supports the suggestion that the universe began with an explosion.

END OF TEST

There are no questions on this page

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 diagram shows the nuclei of four different atoms, **A**, **B**, **C** and **D**. The protons and neutrons are shaded differently.

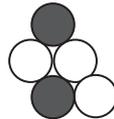
Atom **A**



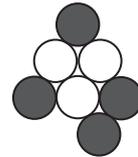
Atom **B**



Atom **C**



Atom **D**



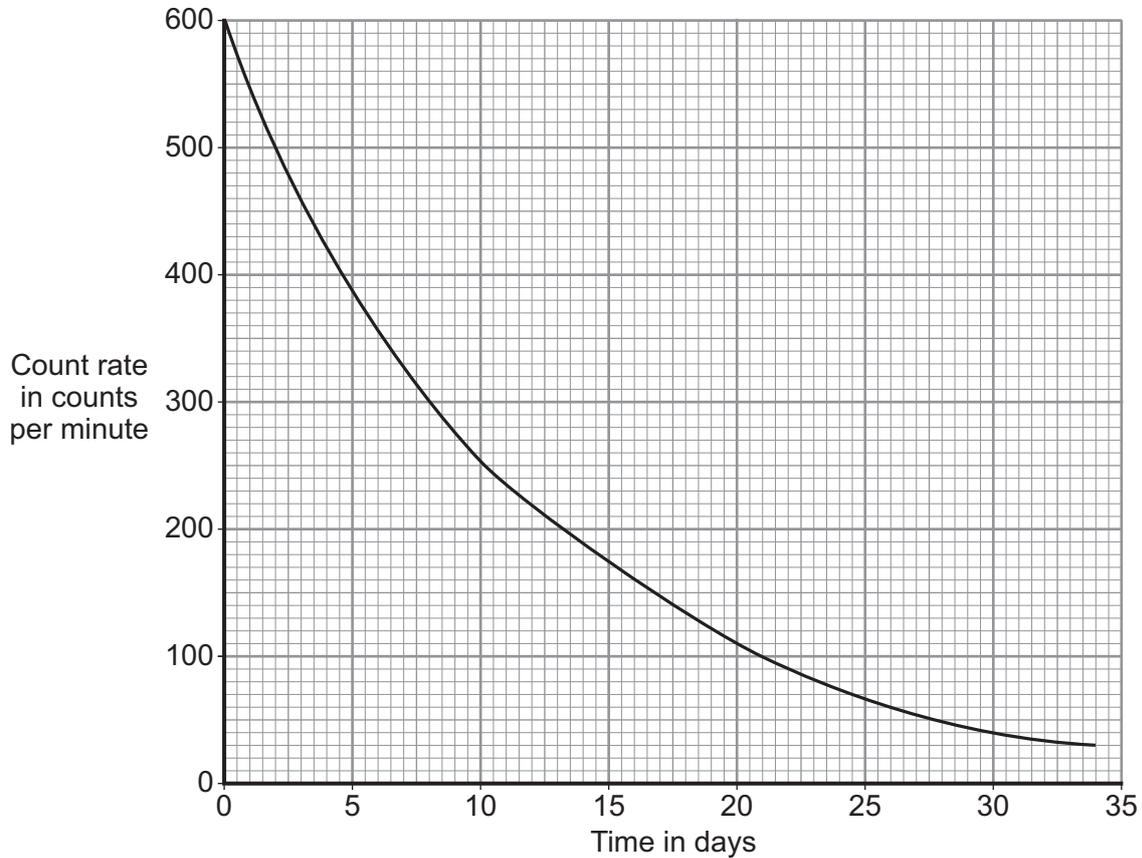
Match atoms, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

1	The nucleus contains one neutron.
2	The nucleus contains four neutrons.
3	The nucleus is the same as an alpha particle.
4	The atom is an isotope of atom D .

QUESTION TWO

Iodine-131 is a radioactive isotope. It is used in hospitals.

The graph shows how the count rate of a sample of iodine-131 changes with time.



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

A 3

B 8

C 21

D 252

The count rate after 10 days is . . . **1** . . . counts per minute.

The time taken for the count rate to fall from 600 to 100 counts per minute is . . . **2** . . . days.

The half-life of the iodine-131 is . . . **3** . . . days.

A patient is given 32 mg of iodine-131. This will decay to 4 mg in . . . **4** . . . half-lives.

Turn over ►

Section TwoQuestions **THREE** to **NINE**.

Each of these questions has four parts.

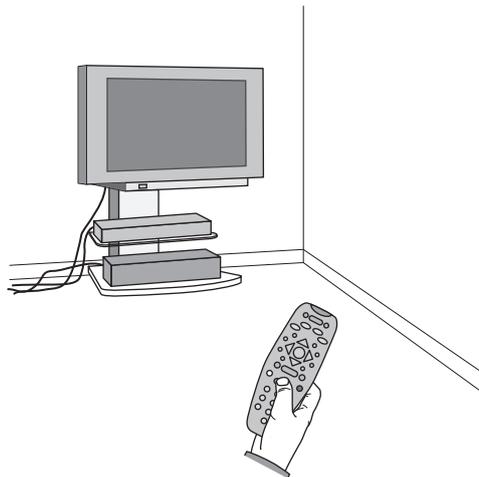
In each part choose only **one** answer.Mark your choices on the answer sheet.

QUESTION THREE

This question is about electromagnetic waves.

3A Which type of electromagnetic wave is used in a handheld remote control for a television?

- 1 infra red
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- 3 visible light
- 4 X-rays

3B The diagram shows a handheld remote control unit being used to change a television channel. The unit is pointing at a surface and not directly at the television.

The signal from the remote control unit reaches the television because the surface . . .

- 1 absorbs the signal.
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3C Television signals can be transmitted using cable networks. These networks usually contain optical fibres.

Which of the following two types of electromagnetic radiation can be transmitted through optical fibres?

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3D The behaviour of waves is often demonstrated using waves on water. In one demonstration, waves of wavelength 5 cm were produced by a vibrating piece of wood. The frequency of the waves was 10 Hz.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)
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What was the wave speed, in m/s?

- 1 0.5
- 2 2.0
- 3 15.0
- 4 50.0

Turn over for the next question

Turn over ►

QUESTION FOUR

Early in the twentieth century, astronomers first observed an apparent change in wavelength of light from distant galaxies. This observation led to the suggestion that the universe began with an explosion.

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Background microwave radiation from space was discovered in 1964.

- 4A** What is the apparent change in wavelength of light from distant galaxies?
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- 4B** The suggestion that the universe began with an explosion is called . . .
- 1 a fact.
 - 2 an investigation.
 - 3 an observation.
 - 4 a theory.
- 4C** Compared to visible light, microwave radiation has . . .
- 1 the same wavelength and a lower frequency.
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 - 3 a shorter wavelength and the same frequency.
 - 4 a shorter wavelength and a higher frequency.
- 4D** The discovery of background microwave radiation from space . . .
- 1 proves that the universe is expanding.
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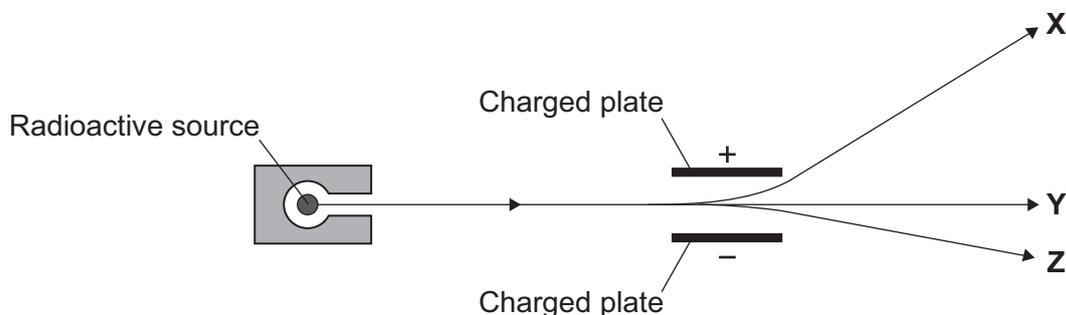
Turn over for the next question

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QUESTION FIVE

A radioactive source emits alpha, beta and gamma radiation.

The diagram shows the radiation passing through a powerful electric field.



5A Compared to **X**, which row in the table shows the charges on **Y** and **Z**?

	Y	Z
1	no charge	opposite
2	no charge	same
3	opposite	no charge
4	same	no charge

5B Which row of the table correctly identifies the radiations **X**, **Y** and **Z**?

	X	Y	Z
1	alpha	beta	gamma
2	beta	gamma	alpha
3	beta	alpha	gamma
4	alpha	gamma	beta

5C **X** is deflected more than **Z** because **X** has . . .

- 1** a higher charge than **Z**.
- 2** a higher mass than **Z**.
- 3** a lower charge than **Z**.
- 4** a lower mass than **Z**.

5D Which row in the table shows the correct order of ionising power?

	Least ionising	→	Most ionising
1	alpha	beta	gamma
2	gamma	alpha	beta
3	beta	alpha	gamma
4	gamma	beta	alpha

Turn over for the next question

Turn over ►

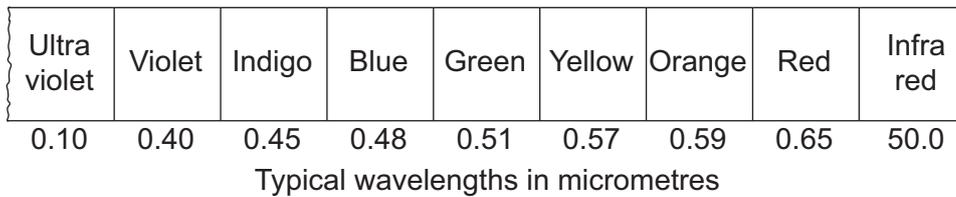
QUESTION SIX

When the James Webb space telescope (JWST) is launched, it will orbit the Earth at a distance of about 1.5 million kilometres.

It will detect wavelengths from 0.6 to 27 micrometres.

One micrometre = one millionth of a metre

The diagram shows part of the electromagnetic spectrum with some typical wavelengths.



6A Which two regions of the electromagnetic spectrum is the JWST designed to detect?

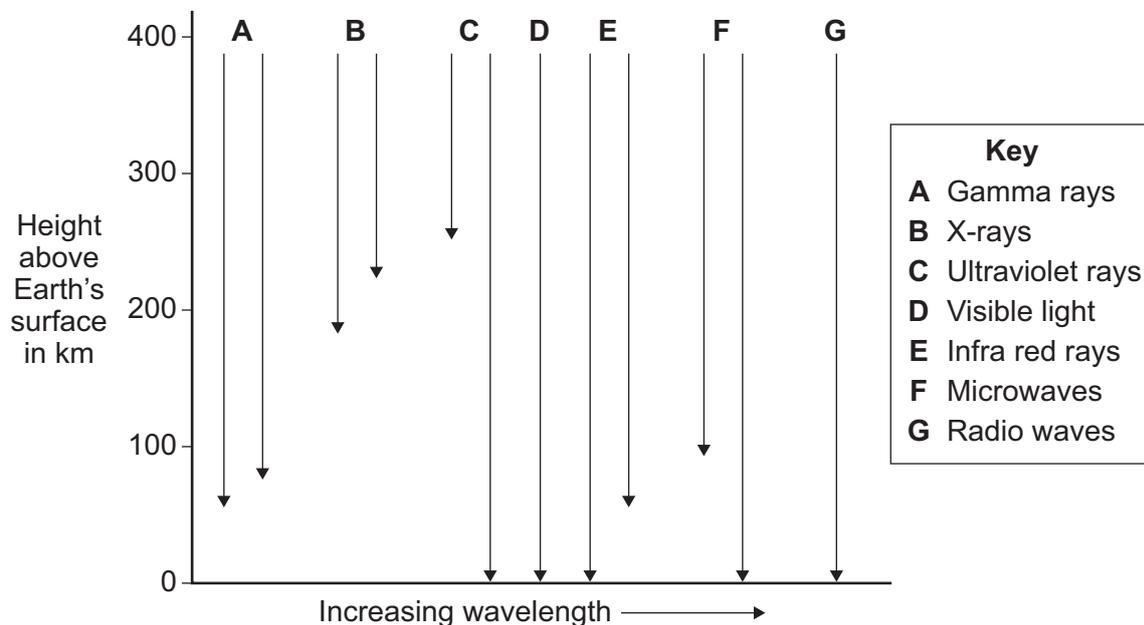
- 1 blue and indigo
- 2 green and yellow
- 3 red and infra red
- 4 violet and ultraviolet

6B Which one of the following is **not** an advantage of the JWST being in such a high orbit?

- 1 Experiencing less gravity means that maintenance will be easier.
- 2 Heat from the Earth does not interfere with its detectors.
- 3 Radiation received is not distorted by the Earth's atmosphere.
- 4 Wavelengths, which are absorbed by the Earth's atmosphere, can be detected.

- 6C** The diagram shows how far different electromagnetic waves from space 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.



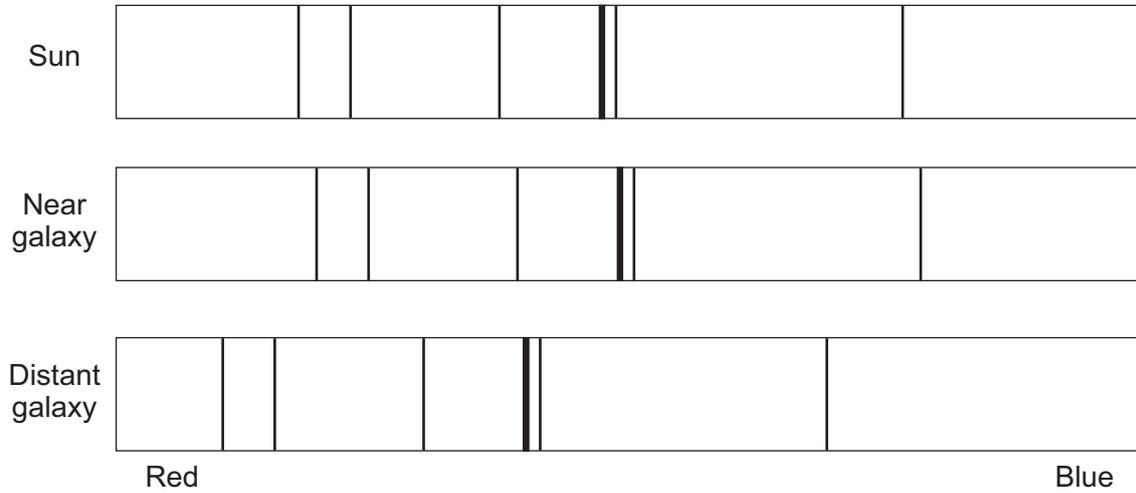
For which of the following types of radiation do all wavelengths reach the Earth's surface?

- 1 infra red and radio
 - 2 ultraviolet and X-rays
 - 3 visible and radio
 - 4 visible and X-ray
- 6D** What is the minimum height for a telescope which detects all wavelengths of ultraviolet radiation and X-rays?
- 1 75 km
 - 2 180 km
 - 3 230 km
 - 4 250 km

Turn over ►

QUESTION SEVEN

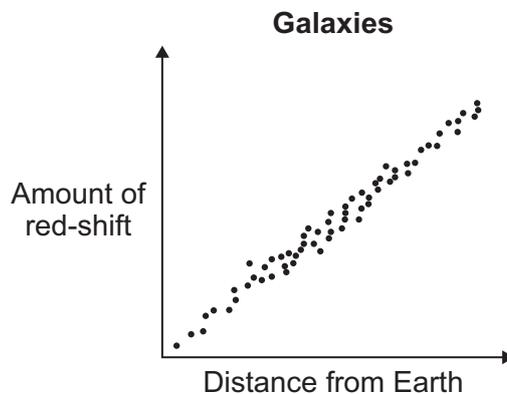
The diagrams show the spectra of light observed from two galaxies, compared with light from the Sun.



7A How do these diagrams show that red-shift has occurred in the light from the distant galaxy?

- 1 There is more red light in the spectrum from the near galaxy.
- 2 There are more dark lines in the spectrum from the distant galaxy.
- 3 The dark lines in the spectrum from the distant galaxy have moved towards the red end.
- 4 The dark lines in the spectrum from the near galaxy have moved towards the blue end.

7B The scattergram shows how the amount of red-shift is related to the distance from Earth for galaxies.



What conclusion could be made from the scattergram about the relationship between the amount of red-shift and the distance from Earth?

- 1 The amount of red-shift is inversely proportional to the distance from Earth.
- 2 The amount of red-shift is directly proportional to the distance from Earth.
- 3 Red-shift and distance from Earth are unrelated.
- 4 There is insufficient evidence to draw a conclusion.

7C Evidence from red-shift has led scientists to develop the 'Big Bang' theory.

What does the 'Big Bang' theory state?

- 1 The universe will end with a big bang.
- 2 The universe has expanded and then contracted since it was first formed.
- 3 The universe was created by a massive explosion of material.
- 4 The universe began from a very small initial point.

7D If some scientists discover evidence in the future that does not agree with the 'Big Bang' theory, what should they do?

- 1 completely reject the theory
- 2 ignore the new evidence
- 3 check the new evidence
- 4 alter the new evidence to match the old theory

Turn over for the next question

Turn over ►

QUESTION EIGHT

Television signals are now digital and not analogue.

8A Which row in the table correctly describes the two types of signal?

	Analogue	Digital
1	signal varies continuously and can be processed easily by computers	signal is ON/OFF and cannot be processed easily by computers
2	signal is ON/OFF and cannot be processed easily by computers	signal varies continuously and can be processed easily by computers
3	signal varies continuously and cannot be processed easily by computers	signal is ON/OFF and can be processed easily by computers
4	signal is ON/OFF and can be processed easily by computers	signal varies continuously and cannot be processed easily by computers

8B Many people bought new digital televisions to replace their old analogue televisions. Other people spent less money by buying a signal converter which lets them continue to use their analogue television. The old analogue televisions must be disposed of.

Buying new digital televisions rather than signal converters raises . . .

- 1 economic and political issues.
- 2 economic and environmental issues.
- 3 environmental and ethical issues.
- 4 ethical and political issues.

8C Microwaves are used for communication in satellite television networks and in digital mobile phone networks.

Which row in the table correctly explains the reasons?

	Why microwaves?	Why digital and not analogue?
1	can be converted to digital	carry more energy
2	can be converted to digital	experience less interference
3	can pass through the atmosphere	carry more energy
4	can pass through the atmosphere	experience less interference

- 8D** Some microwaves have a frequency of 3000 MHz. Electromagnetic waves travel at 300 000 km/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)
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1MHz = 1 million hertz

What is the wavelength of these microwaves?

- 1 10 cm
- 2 10 m
- 3 100 m
- 4 1 km

Turn over for the next question

Turn over ►

QUESTION NINE

This question is about radioactive isotopes technetium-99 (Tc-99) and lanthanum-142 (La-142).

The isotope Tc-99 has a half-life of 6 hours.

9A What fraction of Tc-99 will have decayed after 18 hours?

1 $\frac{1}{8}$

2 $\frac{1}{3}$

3 $\frac{2}{3}$

4 $\frac{7}{8}$

9B Depending on the type of radiation it emits, for which of the following applications might the radioactive isotope Tc-99 be suitable?

- 1 implanting close to a cancerous growth for several months
- 2 fitting inside smoke alarms
- 3 determining the date of an ancient wooden box
- 4 tracing the flow of blood through the body

9C The isotope La-142 emits beta particles and has a half-life of 1.5 hours.

Beta particles are . . .

- 1 electrons emitted from the nuclei of atoms.
- 2 part of the electromagnetic spectrum.
- 3 nuclei of helium atoms.
- 4 electrons from outside the nuclei of atoms.

9D The count rate of a sample of La-142 is measured. The count rate is 8000 counts per second.

The count rate of this isotope, 3 hours before the experiment began, was . . .

- 1 8000 counts per second.
- 2 16000 counts per second.
- 3 24000 counts per second.
- 4 32000 counts per second.

END OF TEST