AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.2.3

Properties of electromagnetic waves 2

Past-paper questions

Tier	**Foundation**
Question groups	**8**
Available paper years	**2018–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.6.2.3 Properties of electromagnetic waves 2

Question 01

June 2018 | 8464/P/1F | Original Q5

0 5 Radioactive nuclei can emit alpha, beta or gamma radiation.

0 5 . 1 Which type of radiation is the most penetrating?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

0 5 . 2 Which type of radiation is the most ionising?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

0 5 . 3 Which type of radiation has the longest range in air?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

Question 5 continues on the next page

Question 01 · continued

When radioactive isotopes in the Earth's crust decay they release energy.

The decay causes the heating of rocks in the crust.

0 5 . 4 **Figure 8** shows the decay of uranium–238 (U–238) into thorium–234 (Th–234).

Figure 8

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

Complete **Table 2** to show the number of neutrons and protons in the nuclei.

[2 marks]

Table 2

Isotope	Number of neutrons	Number of protons
uranium–238	146	
thorium–234		90

0 5 . 5 Geothermal power stations pump water through heated rocks.

The temperature of the water increases from 20 °C to its boiling point of 100 °C

Calculate the change in thermal energy when the mass of water heated is 150 kg

Specific heat capacity = 4 200 J/kg °C

Use the Physics Equations Sheet.

[3 marks]

Change in thermal energy = _____ J

8

6.6.2.3 Properties of electromagnetic waves 2

Question 02

June 2018 | 8464/P/2F | Original Q4

0 4 **Figure 5** shows types of waves within the electromagnetic spectrum.

Some of the types of waves are represented by letters.

Figure 5



0 4 . 1 Which letter shows the position of ultraviolet (UV) radiation within the electromagnetic spectrum?

[1 mark]

Tick **one** box.

P ☐ **Q** ☐ **R** ☐ **S** ☐

0 4 . 2 A special lamp can produce UV radiation.

Which **two** statements describe the electromagnetic waves emitted by a UV lamp?

[2 marks]

Tick **two** boxes.

They have a higher frequency than X-rays. ☐

They have the same wave speed as visible light. ☐

They have a longer wavelength than microwaves. ☐

They have a lower frequency than gamma rays. ☐

They have a greater wave speed than radio waves. ☐

6.6.2.3 Properties of electromagnetic waves 2

Question 02 · continued

0 4 . 3 UV radiation is used to treat a vitamin D deficiency.

People should **not** use a UV lamp for long periods of time.

State **two** risks of exposure to high levels of UV radiation.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 4 Ionising radiation is used for some medical imaging.

Name **two** types of electromagnetic waves that are used.

[2 marks]

1 _____

2 _____

7

6.6.2.3 Properties of electromagnetic waves 2

Question 03

June 2019 | 8464/P/2F | Original Q5

0 5 The Sun emits all types of electromagnetic waves.

Figure 7 shows the electromagnetic spectrum.

Figure 7

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

0 5 . 1 Complete the sentences.

Choose answers from the box.

[3 marks]

frequency	**mass**	**power**
velocity		**wavelength**

In a vacuum, all electromagnetic waves travel at the same _____ .

Gamma waves have the greatest _____ .

Radio waves have the greatest _____ .

0 5 . 2 Explain why it is important that the Earth's atmosphere absorbs gamma rays emitted by the Sun.

[2 marks]

_____

_____

_____

_____

0 5 . 3 Some microwaves are **not** absorbed by the Earth's atmosphere.

Why is this useful?

[1 mark]

_____

6.6.2.3 Properties of electromagnetic waves 2

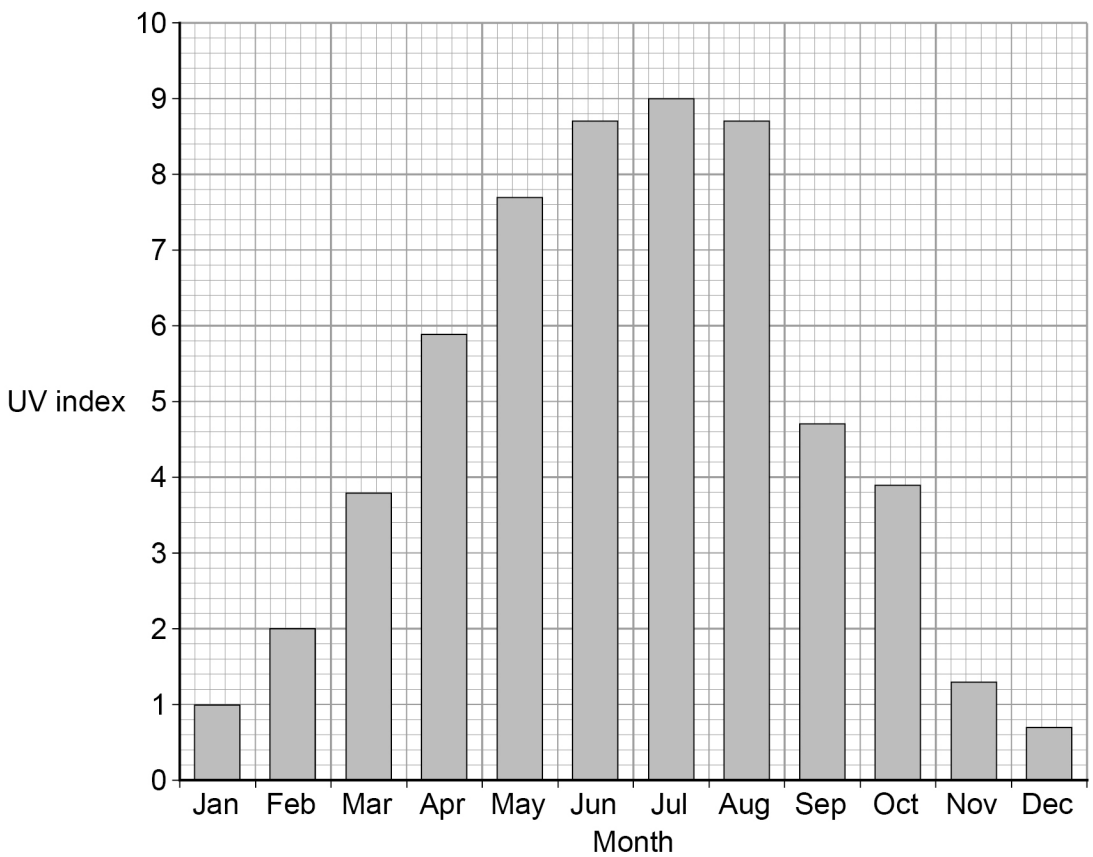
Question 03 · continued

Some ultraviolet (UV) radiation from the Sun passes through the atmosphere and reaches the surface of the Earth.

The amount of UV radiation that reaches the surface of the Earth can be measured on a scale called the UV index.

Figure 8 shows the average midday UV index in the UK for 1 year.

Figure 8



0 5 . 4 Why is exposure to UV radiation harmful to humans?

[1 mark]

6.6.2.3 Properties of electromagnetic waves 2

Question 03 · continued

0 5 . 5 Compare the risk from UV radiation at different times of year in the UK.

Use data from **Figure 8**.

[2 marks]

9

Turn over for the next question

6.6.2.3 Properties of electromagnetic waves 2

Question 04

November 2020 | 8464/P/2F | Original Q3

0 3 X-rays and gamma rays are types of electromagnetic waves.

X-rays are used for medical imaging.

0 3 . 1 Which substance will **not** absorb X-rays?

[1 mark]

Tick (✓) **one** box.

Bone ☐ Metal ☐ Skin ☐

Table 1 shows the effect of exposure to different doses of radiation.

Table 1

Dose in mSv	Effect on the human body
100	slightly increased risk of cancer
1000	5% increased risk of cancer
5000	high risk of death

0 3 . 2 During one X-ray a person receives a dose of 0.100 mSv

Why is this dose unlikely to harm the person?

[1 mark]

0 3 . 3 A doctor takes an X-ray photograph of a person.

When taking the X-ray photograph, the doctor stands behind a screen.

Suggest why.

[1 mark]

6.6.2.3 Properties of electromagnetic waves 2

Question 04 · continued

0 3 . 4 Which of the following are gamma rays used for?

[1 mark]

Tick (✓) **one** box.

Cooking food ☐

Energy-efficient lamps ☐

Sterilising medical equipment ☐

0 3 . 5 Why are gamma rays and X-rays harmful to humans?

[1 mark]

Tick (✓) **one** box.

They are ionising ☐

They are radioactive ☐

They travel at the speed of light ☐

0 3 . 6 Electromagnetic waves are also used in communications.

Describe how microwaves and visible light are used in communications.

[4 marks]

Microwaves _____

_____

_____

_____

Visible light _____

_____

_____

_____

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6.6.2.3 Properties of electromagnetic waves 2

Question 05

November 2021 | 8464/P/1F | Original Q6

0 6 A radioactive source emits alpha, beta and gamma radiation.

0 6 . 1 An alpha particle is the same as a helium nucleus.

How many times bigger is the radius of a helium atom than the radius of an alpha particle?

[1 mark]

Tick (✓) **one** box.

Less than 100 times bigger ☐

Exactly 5000 times bigger ☐

More than 10 000 times bigger ☐

0 6 . 2 Alpha particles can ionise atoms in the air.

What happens to an atom when it is ionised by an alpha particle?

[2 marks]

Tick (✓) **two** boxes.

A neutron in the atom becomes a proton. ☐

The atom becomes a positive ion. ☐

The atom gains a neutron. ☐

The atom gains a proton. ☐

The atom loses an electron. ☐

Question 6 continues on the next page

6.6.2.3 Properties of electromagnetic waves 2

Question 05 · continued

0 6 . 3 A spark detector is a device that can be used to detect alpha radiation.

A spark detector works by alpha particles ionising atoms in the air near a wire mesh.

A large potential difference creates a spark when the air near the wire mesh is ionised.

Suggest why a spark detector **cannot** detect beta radiation.

[1 mark]

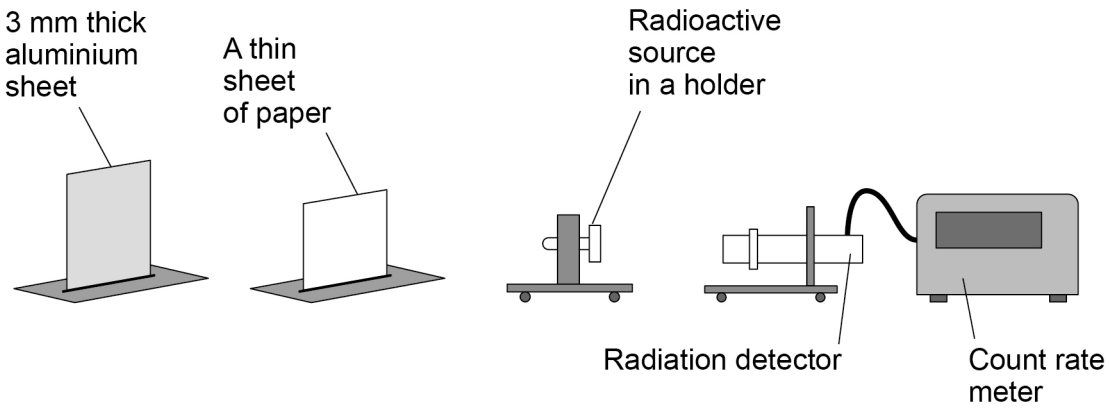
6.6.2.3 Properties of electromagnetic waves 2

Question 05 · continued

0 6 . 4 A teacher wants to demonstrate that the radioactive source emits alpha, beta and gamma radiation.

Figure 11 shows the equipment the teacher has.

Figure 11



Describe a method the teacher could use.

[6 marks]

10

6.6.2.3 Properties of electromagnetic waves 2

Question 06

November 2021 | 8464/P/2F | Original Q5

0 5 Scientists are developing a rocket aeroplane designed to travel much faster than jet aeroplanes.

0 5 . 1 The rocket aeroplane must accelerate along a runway to take off.

What would happen to the air resistance acting on the rocket aeroplane as it accelerates?

[1 mark]

0 5 . 2 An upward force called lift will act on the wings of the rocket aeroplane when it moves.

Complete the sentence.

Choose the answer from the box.

[1 mark]

less than	**the same as**	**greater than**

As the rocket aeroplane starts to accelerate along the runway, the lift force on the wings will be _____ the weight of the rocket aeroplane.

Question 5 continues on the next page

6.6.2.3 Properties of electromagnetic waves 2

Question 06 · continued

0 5 . 3 During the first 14 seconds the average speed of the rocket aeroplane on the runway will be 35 m/s.

Calculate the distance that the rocket aeroplane will travel during the first 14 seconds.

Use the equation:

distance travelled = average speed × time

[2 marks]

Distance travelled = _____ m

0 5 . 4 Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 5 . 5 When the rocket aeroplane travels a distance of 270 m on the runway the engines will do 54 000 000 J of work.

Calculate the average force exerted by the engines.

[3 marks]

Average force = _____ N

6.6.2.3 Properties of electromagnetic waves 2

Question 06 · continued

0 5 . 6 The rocket aeroplane will fly at a greater height than a jet aeroplane.

The height that an aeroplane flies at affects the radiation dose a passenger will receive each hour.

Table 2 shows the speed of each aeroplane and the radiation dose a passenger will receive each hour.

Table 2

Aeroplane	Speed in metres per second	Radiation dose each hour in millisieverts
Rocket aeroplane	8000	0.006
Jet aeroplane	250	0.003

Exposure to ionising radiation has risks and possible consequences.

Evaluate the risks and possible consequences of flying in a rocket aeroplane and in a jet aeroplane.

Assume the same journey is made in each aeroplane.

Use values from **Table 2**.

[6 marks]

14

6.6.2.3 Properties of electromagnetic waves 2

Question 07

June 2023 | 8464/P/1F | Original Q1

0 1 A scientist investigated the radiation emitted by different radioactive isotopes.

The scientist had a sample of polonium-210.

The radiation emitted by polonium-210 can be represented by the symbol $^{4}_{2}\text{He}$.

0 1 . 1 Which type of radiation can be represented by the symbol $^{4}_{2}\text{He}$?

[1 mark]

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Gamma ☐

0 1 . 2 How many protons are there in a particle of radiation represented by $^{4}_{2}\text{He}$?

[1 mark]

Tick (✓) **one** box.

2 ☐ 4 ☐ 6 ☐ 8 ☐

0 1 . 3 A polonium-210 (Po) nucleus changes into a lead (Pb) nucleus by emitting a $^{4}_{2}\text{He}$ particle. This is shown by the following nuclear equation.

$$^{210}_{84}\text{Po} \rightarrow {}^{206}_{\mathbf{X}}\text{Pb} + {}^{4}_{2}\text{He}$$

What is the value of **X**?

[1 mark]

Tick (✓) **one** box.

80 ☐ 82 ☐ 84 ☐ 86 ☐

6.6.2.3 Properties of electromagnetic waves 2

Question 07 · continued

0 1 . 4 The sample of polonium-210 had an activity of 100 Bq.

Complete the sentence.

Choose the answer from the box.

[1 mark]

25	**50**	**100**	**200**

After one half-life, the activity of polonium-210 in the sample

was _____ Bq.

Question 1 continues on the next page

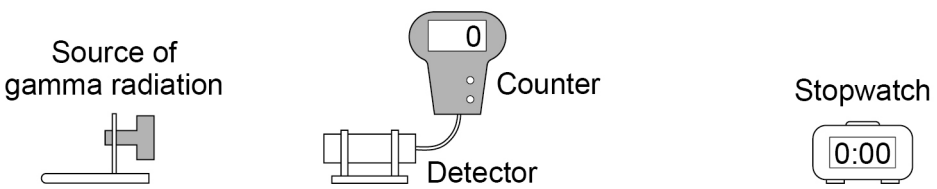
6.6.2.3 Properties of electromagnetic waves 2

Question 07 · continued

The scientist investigated another radioactive isotope that is a source of gamma radiation.

Figure 1 shows the equipment used.

Figure 1



0 1 . 5 The count-rate is the number of counts detected each second.

In 30 seconds the number of counts detected was 1500.

Calculate the count-rate.

[2 marks]

Count-rate = _____ counts per second

6.6.2.3 Properties of electromagnetic waves 2

Question 07 · continued

The scientist placed a thick sheet of lead between the source of gamma radiation and the detector.

0 1 . 6 What was the effect of the sheet of lead on the count-rate?

Give a reason for your answer.

[2 marks]

Effect _____

_____

Reason _____

_____

0 1 . 7 The lead was irradiated by the gamma radiation.

What happened to the lead when it was irradiated by the gamma radiation?

[1 mark]

Tick (✓) **one** box.

The lead atoms became radioactive. ☐

The lead gained atoms from the radioactive source. ☐

The lead was exposed to gamma radiation. ☐

Question 1 continues on the next page

6.6.2.3 Properties of electromagnetic waves 2

Question 07 · continued

0 1 . 8 Gamma radiation is emitted from the nucleus of an atom.

Complete the sentence.

Choose the answer from the box.

[1 mark]

electromagnetic waves	**high speed electrons**
neutrons	**positively charged ions**

Gamma radiation consists of _____.

0 1 . 9 **Figure 2** shows the scientist holding the radioactive source using tongs.

Figure 2



Suggest **one** reason why using long tongs rather than short tongs was safer for the scientist.

[1 mark]

_____

_____

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6.6.2.3 Properties of electromagnetic waves 2

Question 08

June 2024 | 8464/P/1F | Original Q3

0 3 Some people used to think that radioactive substances had health benefits.

100 years ago, a company made toothpaste containing the radioactive isotopes radium-228 and radium-226.

Figure 3 shows the symbols for these isotopes.

Figure 3

$^{228}_{88}Ra$ $^{226}_{88}Ra$

0 3 . 1 How are atoms of radium-228 different from atoms of radium-226?

[1 mark]

Tick (✓) **one** box.

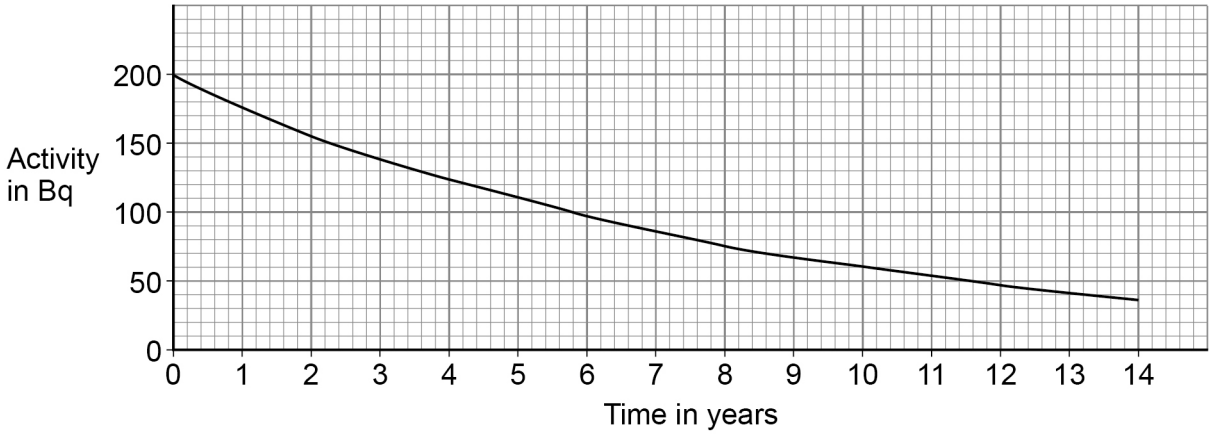
- Radium-228 atoms have one more neutron and one more proton. ☐
- Radium-228 atoms have two more neutrons and two more protons. ☐
- Radium-228 atoms have two more neutrons. ☐
- Radium-228 atoms have two more protons. ☐

6.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

0 3 . 2 **Figure 4** shows how the activity of a sample of radium-228 changed over time.

Figure 4



What is the approximate half-life of radium-228?

[1 mark]

Tick (✓) **one** box.

- 6 years ☐
- 7 years ☐
- 14 years ☐
- 100 years ☐

Question 3 continues on the next page

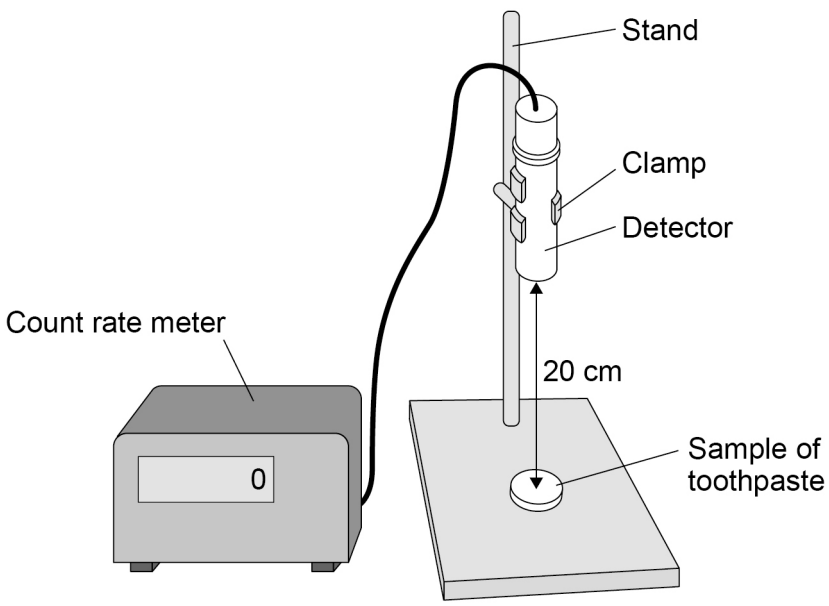
6.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

A scientist investigated whether the toothpaste in four tubes of the 100-year-old toothpaste is equally radioactive.

Figure 5 shows the equipment used.

Figure 5



0 3 . 3 When the equipment was arranged as shown in **Figure 5**, it was **not** possible to detect alpha particles from the toothpaste.

Suggest how the scientist adjusted the equipment to detect alpha particles from the toothpaste.

[1 mark]

6.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

0 3 . 4 The scientist adjusted the equipment and determined the activity of the toothpaste from each tube.

Table 1 shows the results.

Table 1

Tube	Activity in Bq
A	3150
B	2940
C	3180
D	3050

What was the range of activities shown in **Table 1**?

[1 mark]

From _____ Bq to _____ Bq

0 3 . 5 What was the independent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

The activity of the toothpaste ☐

The mass of toothpaste used ☐

The temperature of the toothpaste ☐

The tube of toothpaste used ☐

Question 3 continues on the next page

6.6.2.3 Properties of electromagnetic waves 2

Question 08 · continued

0 3 . 6 What was the dependent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

- The activity of the toothpaste ☐
- The mass of toothpaste used ☐
- The temperature of the toothpaste ☐
- The tube of toothpaste used ☐

0 3 . 7 When the toothpaste was new, it caused a risk to health because of the nuclear radiation emitted.

What happened to the risk to health from the toothpaste after 100 years?

[1 mark]

0 3 . 8 Which property makes nuclear radiation hazardous?

[1 mark]

Tick (✓) **one** box.

- Nuclear radiation is ionising. ☐
- Nuclear radiation is penetrating. ☐
- Nuclear radiation is too small to see. ☐
- Nuclear radiation makes objects radioactive. ☐

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