AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.2.4

Uses and applications of electromagnetic waves

Past-paper questions

Tier	**Foundation**
Question groups	**13**
Available paper years	**2018–2025**

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.

6.6.2.4 Uses and applications of electromagnetic waves

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

6.6.2.4 Uses and applications of electromagnetic waves

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. ☐

6.6.2.4 Uses and applications of electromagnetic waves

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

6.6.2.4 Uses and applications of electromagnetic waves

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]

_____

6.6.2.4 Uses and applications of electromagnetic waves

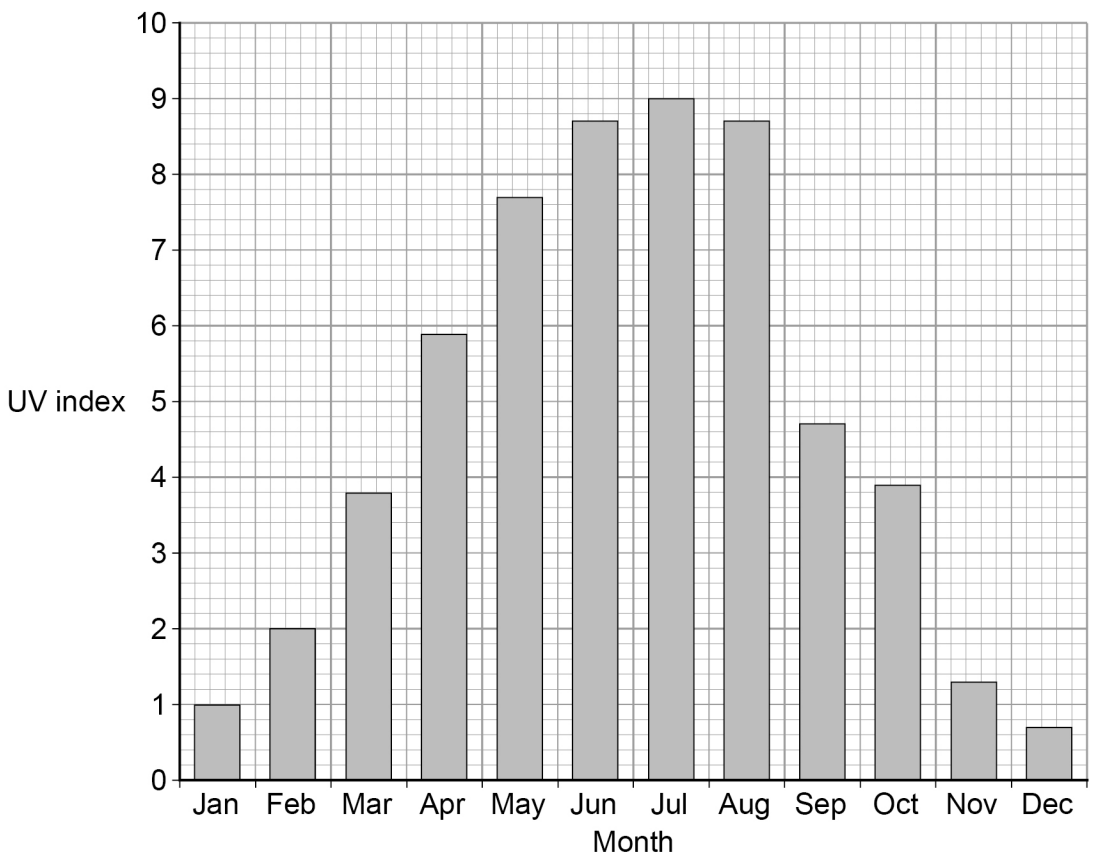
Question 03 · continued

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]

6.6.2.4 Uses and applications of electromagnetic waves

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

6.6.2.4 Uses and applications of electromagnetic waves

Question 04

November 2020 | 8464/P/1F | Original Q6

0 6 Different radioactive isotopes emit different types of nuclear radiation.

A polonium-210 (Po) nucleus emits an alpha particle (α) and turns into a lead (Pb) nucleus.

This can be represented by the equation:

$$^{210}_{84}Po \longrightarrow {}^{A}_{Z}Pb + \alpha$$

0 6 . 1 What is the value of A in the equation?

[1 mark]

Tick (✓) **one** box.

A = 206 ☐ A = 208 ☐ A = 210 ☐ A = 211 ☐

0 6 . 2 What is the value of Z in the equation?

[1 mark]

Tick (✓) **one** box.

Z = 80 ☐ Z = 82 ☐ Z = 85 ☐ Z = 86 ☐

Question 6 continues on the next page

6.6.2.4 Uses and applications of electromagnetic waves

Question 04 · continued

0 6 . 3 A strontium-89 nucleus (Sr) emits a beta particle (β) and turns into an yttrium nucleus (Y).

This can be represented by the equation:

$$^{89}_{38}\text{Sr} \longrightarrow {}^{A}_{Z}\text{Y} + \beta$$

What are the values of A and Z in the equation?

[2 marks]

A = _____

Z = _____

0 6 . 4 Gamma radiation is another type of nuclear radiation.

What does gamma radiation consist of?

[1 mark]

Tick (✓) **one** box.

- High energy neutrons ☐
- Electromagnetic waves ☐
- Particles with no charge ☐
- Positively charged ions ☐

6.6.2.4 Uses and applications of electromagnetic waves

Question 04 · continued

0 6 . 5 Explain the differences between the properties of alpha, beta and gamma radiations.

[6 marks]

11

6.6.2.4 Uses and applications of electromagnetic waves

Question 05

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]

6.6.2.4 Uses and applications of electromagnetic waves

Question 05 · 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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6.6.2.4 Uses and applications of electromagnetic waves

Question 06

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

6.6.2.4 Uses and applications of electromagnetic waves

Question 06 · 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]

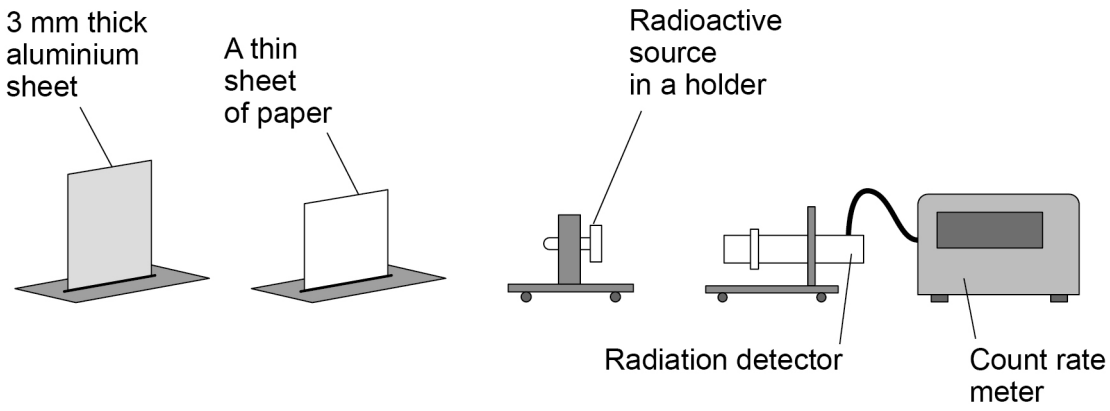
6.6.2.4 Uses and applications of electromagnetic waves

Question 06 · 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

6.6.2.4 Uses and applications of electromagnetic waves

Question 07

0 1 There are different types of electromagnetic waves.

0 1 . 1 What do all electromagnetic waves transfer?

[1 mark]

Tick (✓) **one** box.

Charge ☐

Energy ☐

Matter ☐

Sound ☐

0 1 . 2 Complete the sentence.

Choose answers from the box.

[2 marks]

charge	**frequency**	**speed**	**wavelength**

Different types of electromagnetic waves have a different _____

and a different _____ .

0 1 . 3 **Figure 1** shows the electromagnetic spectrum.

Figure 1

Radio waves	Microwaves	Infrared	**A**	Ultraviolet	X-rays	**B**

Give the names of parts **A** and **B** of the electromagnetic spectrum.

[2 marks]

A _____

B _____

6.6.2.4 Uses and applications of electromagnetic waves

Question 07 · continued

0 1 . 4 Different types of electromagnetic waves have different uses.

Draw **one** line from each type of electromagnetic wave to its use.

[3 marks]

Type of electromagnetic wave	Use
Microwaves	Electrical heaters
Ultraviolet	Energy efficient lamps
X-rays	Imaging bones
	Satellite communications

8

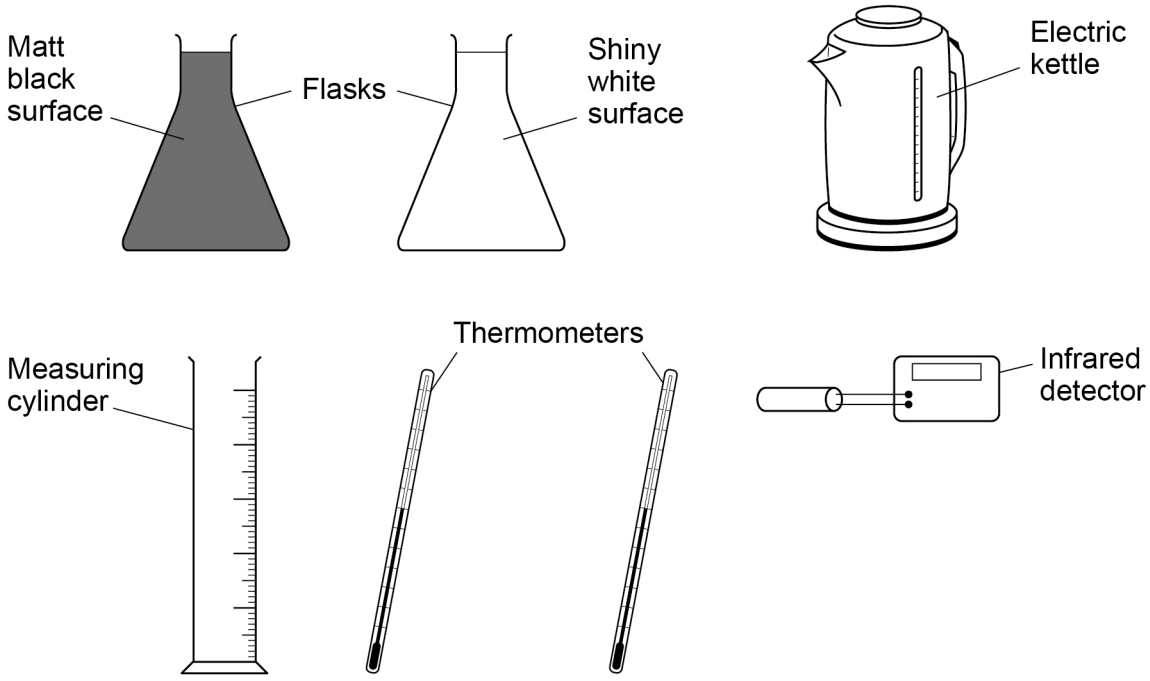
6.6.2.4 Uses and applications of electromagnetic waves

Question 08

0 2 A student investigated how the colour of a surface affects the power of the infrared radiation emitted by the surface.

Figure 2 shows the equipment used.

Figure 2



6.6.2.4 Uses and applications of electromagnetic waves

Question 08 · continued

The infrared detector measures the power of the infrared radiation emitted by the flasks.

0 2 . 1 The student poured hot water into each flask.

What should the student do to reduce the risk of burning herself with the hot water?

[1 mark]

0 2 . 2 Describe how the student should use the equipment in **Figure 2** to compare the power of the infrared radiation emitted by each surface.

[4 marks]

Question 2 continues on the next page

Question 08 · continued

A student investigated how the power of the infrared radiation emitted from a flask changed with time.

Table 1 shows the results.

Table 1

Time in seconds	Power in watts
0	8.0
60	7.2
120	6.5
180	5.9
240	5.4
300	5.0
360	4.7
420	4.5

0 2 . 3 Describe the pattern shown by the data in **Table 1**.

[2 marks]

0 2 . 4 What is the most likely value for the power of the infrared radiation emitted after 480 seconds?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

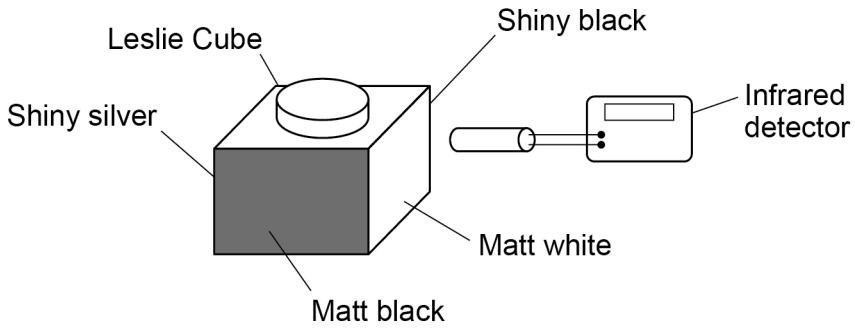
4.0 W ☐ 4.2 W ☐ 4.4 W ☐ 4.6 W ☐

Question 08 · continued

A Leslie Cube is used to demonstrate that different surfaces emit different amounts of infrared radiation.

Figure 3 shows an infrared detector and a Leslie Cube filled with hot water.

Figure 3



0 2 . 5 Give **one** advantage of using a Leslie Cube rather than the equipment in **Figure 2** on page 4.

[1 mark]

0 2 . 6 The teacher improved the demonstration by using four infrared detectors connected to a data logger and computer. Each detector was pointed at a different surface of the Leslie Cube.

The distance between the surface and the detector was the same in each case.

Give **two** reasons why this improved the demonstration.

[2 marks]

1

2

11

6.6.2.4 Uses and applications of electromagnetic waves

Question 09

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 ☐

6.6.2.4 Uses and applications of electromagnetic waves

Question 09 · 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

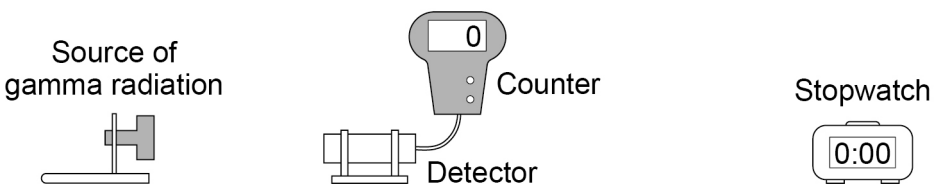
was _____ Bq.

Question 1 continues on the next page

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

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

6.6.2.4 Uses and applications of electromagnetic waves

Question 09 · 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]

_____

_____

11

6.6.2.4 Uses and applications of electromagnetic waves

Question 10

June 2023 | 8464/P/2F | Original Q6

0 6 The Sun emits a continuous spectrum of electromagnetic waves.

Figure 14 names some of the groups of waves in the electromagnetic spectrum.

Figure 14

A	**B**	Infrared	Visible light	Ultraviolet	**C**	Gamma rays

0 6 . 1 Name groups **A**, **B** and **C** in **Figure 14**.

[2 marks]

A _____

B _____

C _____

0 6 . 2 Give **one** similarity and **one** difference between the properties of ultraviolet waves and gamma rays.

[2 marks]

Similarity _____

_____

Difference _____

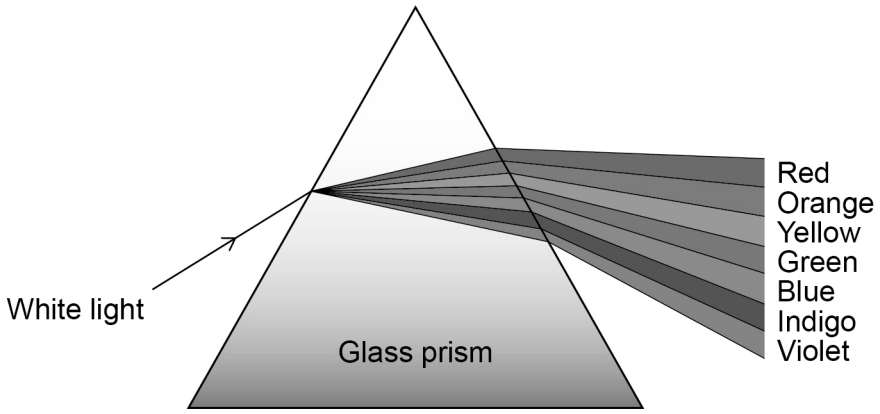
_____

6.6.2.4 Uses and applications of electromagnetic waves

Question 10 · continued

Figure 15 shows white light split into a spectrum of different colours by a glass prism.

Figure 15



0 6 . 3 Light changes direction when it enters the glass prism.

What name is given to this process?

[1 mark]

Question 6 continues on the next page

6.6.2.4 Uses and applications of electromagnetic waves

Question 10 · continued

Use the Physics Equations Sheet to answer questions **06.4** and **06.5**.

0 6 . 4 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 6 . 5 The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^{8} m/s

Calculate the frequency of the wave.

[3 marks]

Frequency = _____ Hz

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6.6.2.4 Uses and applications of electromagnetic waves

Question 11

June 2025 | 8464/P/1F | Original Q1

0 1 There are different isotopes of the element lead.

0 1 . 1 What is the difference between the atoms of different isotopes of lead?

[1 mark]

Tick (✓) **one** box.

- The number of electrons ☐
- The number of neutrons ☐
- The number of protons ☐

0 1 . 2 The isotope lead-210 is radioactive.

What is meant by 'lead-210 is radioactive'?

[1 mark]

Tick (✓) **one** box.

- Lead-210 forms many different compounds. ☐
- Lead-210 has unstable nuclei. ☐
- Lead-210 melts at a low temperature. ☐

6.6.2.4 Uses and applications of electromagnetic waves

Question 11 · continued

0 1 . 3 The isotope lead-210 emits beta radiation.

What is beta radiation?

[1 mark]

Tick (✓) **one** box.

Electromagnetic radiation emitted from nuclei ☐

High speed electrons ejected from nuclei ☐

Particles that consist of two neutrons and two protons ☐

Question 1 continues on the next page

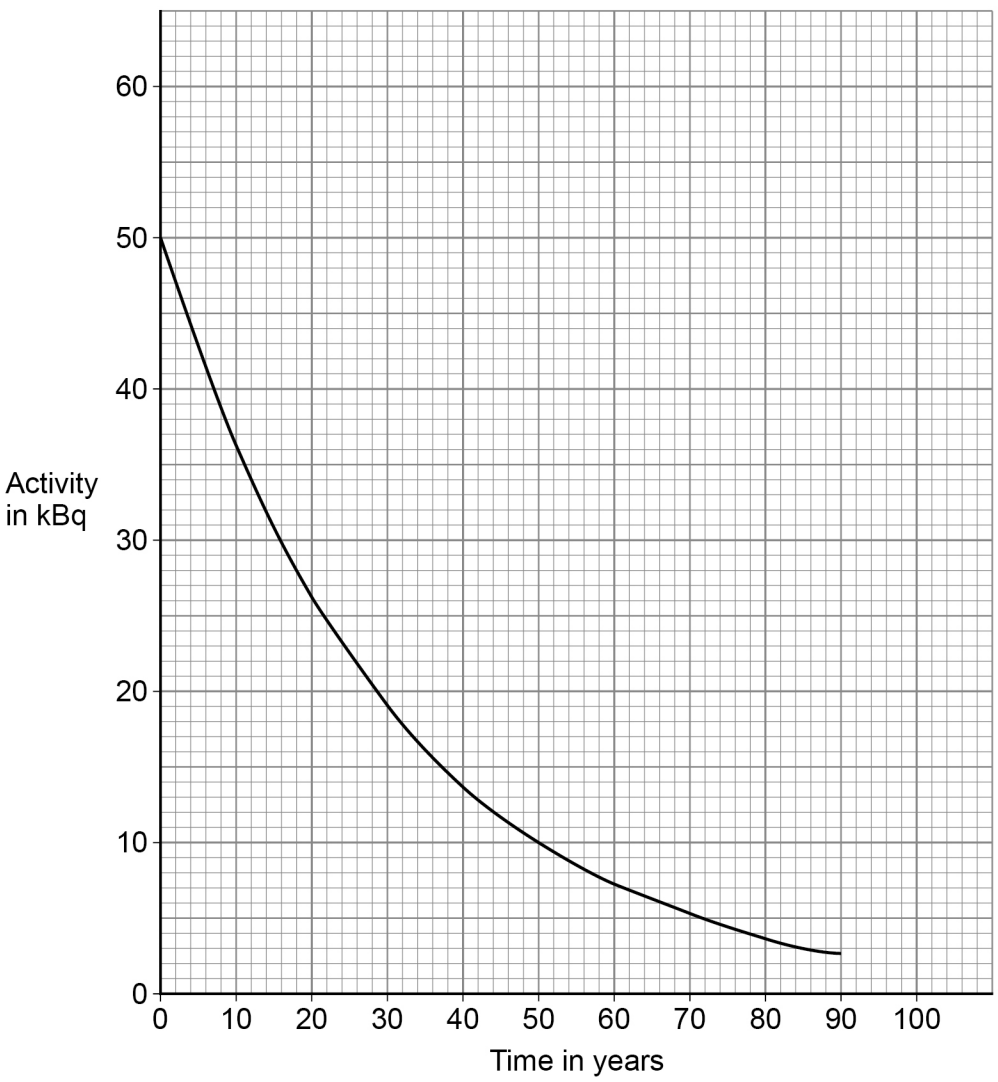
Question 11 · continued

The paint in an old painting contains the isotope lead-210.

The lead-210 in the paint can be used to estimate the age of the painting.

Figure 1 shows how the activity of the lead-210 in the paint changes with time.

Figure 1



0 1 . 4 What was the initial activity of the lead-210 in the paint?

Use **Figure 1**.

[1 mark]

Activity = _____ kBq

Question 11 · continued

0 1 . 5 Calculate the activity of the lead-210 in the paint after one half-life.

[1 mark]

Activity = _____ kBq

0 1 . 6 What was the estimated age of the painting when the activity was 10 kBq?

Use **Figure 1**.

[1 mark]

Age = _____ years

The paint also contains other radioactive substances.

0 1 . 7 A scientist removed the other radioactive substances before measuring the activity.

The activity would be greater if the other radioactive substances were **not** removed.

How would the estimate of the age of the painting be different if the activity was greater?

Use **Figure 1**.

[1 mark]

Tick (✓) **one** box.

The estimated age would be lower ☐

The estimated age would be the same ☐

The estimated age would be greater ☐

6.6.2.4 Uses and applications of electromagnetic waves

Question 11 · continued

The other radioactive substances in the paint emit different types of radiation.

0 1 . 8 Complete the sentence.

Choose the answer from the box.

[1 mark]

alpha	**beta**	**gamma**

The type of radiation with the greatest range in air is _____.

0 1 . 9 Complete the sentence.

Choose the answer from the box.

[1 mark]

alpha	**beta**	**gamma**

The type of radiation that is the least penetrating is _____.

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6.6.2.4 Uses and applications of electromagnetic waves

Question 12

June 2025 | 8464/P/2F | Original Q2

0 2 Food colouring can be used to change the colour of water.

A student investigated how the colour of water affects the time taken for the water to cool.

This is the method used.

1. Put 200 cm^3 of hot water into a conical flask.

2. Add four drops of food colouring to the water.

3. Place a digital thermometer in the water.

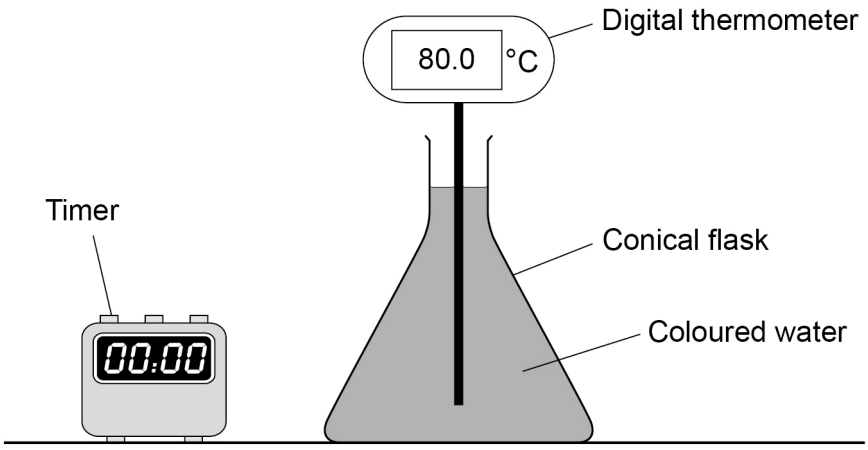
4. Start a timer when the temperature of the water is 80.0 °C.

5. Record the time taken for the water to cool to 65.0 °C.

6. Repeat steps 1 to 5 using different colours of food colouring.

Figure 3 shows the apparatus.

Figure 3



0 2 . 1 What was the independent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Colour of water ☐

Final temperature of water ☐

Volume of water ☐

6.6.2.4 Uses and applications of electromagnetic waves

Question 12 · continued

0 2 . 2 Which of the following was a control variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Initial temperature of water ☐

Time taken for water to cool ☐

Type of thermometer used ☐

0 2 . 3 What equipment should have been used to make sure 200 cm^3 of water was put in the conical flask?

[1 mark]

Tick (✓) **one** box.

Beaker ☐

Measuring cylinder ☐

Metre rule ☐

0 2 . 4 The student also tested water with no food colouring.

The temperature of the water changed from 80.0 °C to 65.0 °C in a time of 5.0 minutes.

Calculate the average rate of change of temperature of the water.

Use the equation:

$$\text{average rate of change of temperature} = \frac{\text{change in temperature}}{\text{time taken}}$$

[2 marks]

Average rate of change of temperature = _____ °C/minute

Question 12 · continued

Table 1 shows the results for the different coloured water.

Table 1

Colour of water	Rate of change of temperature in °C/minute
Red	6.1
Yellow	5.0
Green	4.3
Blue	4.0
Violet	3.7

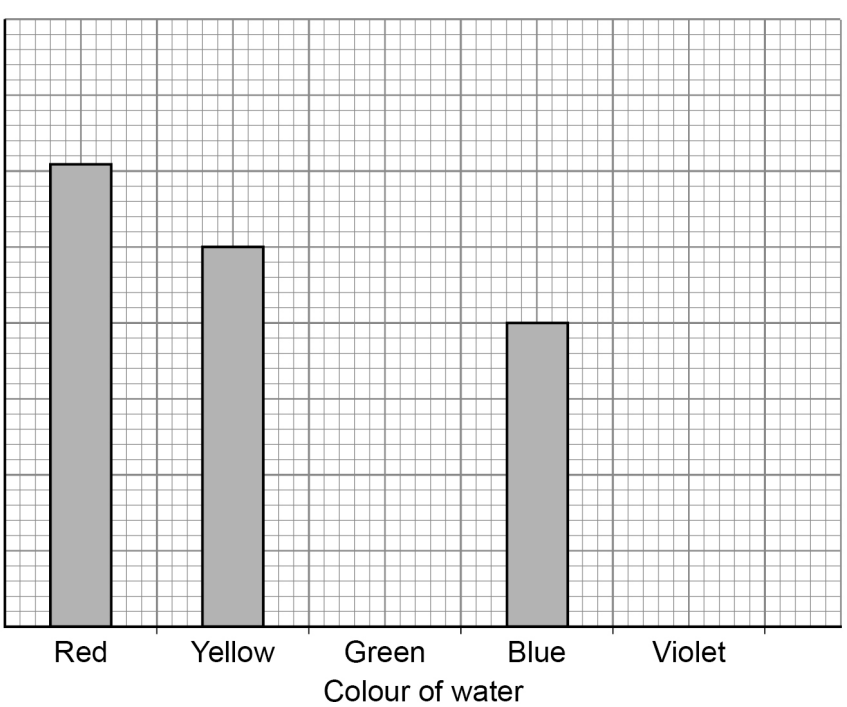
0 2 . 5 Complete **Figure 4**.

You should:

- label the *y*-axis
- add a scale to the *y*-axis
- draw bars for the green water and the violet water.

[3 marks]

Figure 4



6.6.2.4 Uses and applications of electromagnetic waves

Question 12 · continued

0 2 . 6 In the visible spectrum, orange light is between red light and yellow light.

Estimate the rate of change of temperature if orange food colouring was used.

Use **Table 1**.

[1 mark]

Estimated rate of change of temperature = _____ °C/minute

0 2 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

infrared	**ultraviolet**	**x-rays**

The results show that the colour of the water affects the rate at which the water emits _____.

0 2 . 8 Complete the sentence.

Choose the answer from the box.

[1 mark]

energy	**rarefactions**	**temperature**

The water in each conical flask cools down because the electromagnetic radiation emitted by the water transfers _____.

11

6.6.2.4 Uses and applications of electromagnetic waves

Question 13

June 2025 | 8464/P/2F | Original Q5

0 5 Some homes are connected to the internet using satellites.

Electromagnetic waves are used to transmit data between Earth and the satellites.

0 5 . 1 Which electromagnetic waves are used to transfer data between Earth and satellites?

[1 mark]

Tick (✓) **one** box.

- Gamma rays ☐
- Microwaves ☐
- Ultraviolet ☐
- Visible light ☐

0 5 . 2 Which of the following electromagnetic waves has the greatest frequency?

[1 mark]

Tick (✓) **one** box.

- Gamma rays ☐
- Microwaves ☐
- Ultraviolet ☐
- Visible light ☐

Question 5 continues on the next page

6.6.2.4 Uses and applications of electromagnetic waves

Question 13 · continued

0 5 . 3 What is meant by the 'period of a wave'?

[1 mark]

Tick (✓) **one** box.

The distance travelled by a wave in one second ☐

The number of waves passing a fixed point each second ☐

The time taken for one wave to pass a fixed point ☐

0 5 . 4 Data is transmitted to the satellites by electromagnetic waves with a frequency of 48 GHz.

Calculate the period of waves with a frequency of 48 GHz.

Use the Physics Equations Sheet.

Choose the unit from the box.

[4 marks]

J	N/kg	s

Period = _____ Unit _____

6.6.2.4 Uses and applications of electromagnetic waves

Question 13 · continued

0 5 . 5 The satellites receive and transmit data using electromagnetic waves with different frequencies.

Give **one** property that is the same for electromagnetic waves with different frequencies.

[1 mark]

0 5 . 6 Most homes are connected to the internet using cables.

Suggest **one** reason why homes in some areas of the UK are connected to the internet by satellites.

[1 mark]

9