AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.3.3

Uses of nuclear radiation

Past-paper questions

Tier	**Foundation**
Question groups	**14**
Available paper years	**2004–2018**

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.

4.4.3.3 Uses of nuclear radiation

Question 01

June 2004 | 3451F | Original Q2 | Legacy

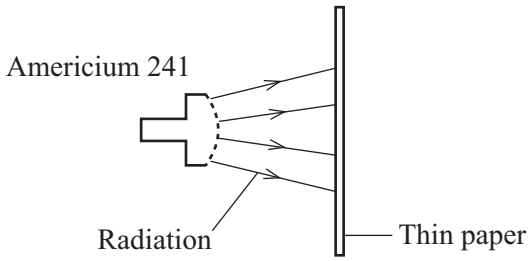
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.



Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

(1 mark)

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

(2 marks)

(d) Complete the sentence by choosing an answer from the box.

less than	**more than**	**the same as**

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

(1 mark)

5

4.4.3.3 Uses of nuclear radiation

Question 02

June 2004 | 3462F3 | Original Q2 | Legacy

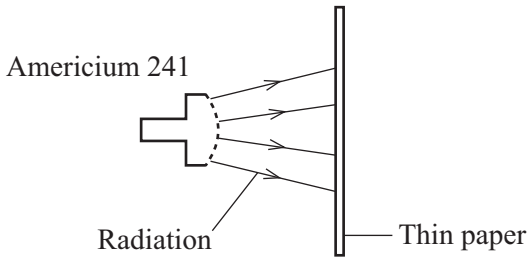
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.



Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

(1 mark)

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

(2 marks)

(d) Complete the sentence by choosing an answer from the box.

less than	**more than**	**the same as**

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

(1 mark)

5

4.4.3.3 Uses of nuclear radiation

Question 03

November 2006 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

Hospital patients are sometimes injected with radioactive tracers.



7A The purpose of a radioactive tracer is . . .

1 to identify the patient's blood group.

2 to sedate the patient before an operation.

3 to track the movement of substances in the patient's body.

4 to track the patient's movements in the hospital.

7B Which of the following is the most suitable radioactive substance to use as a tracer?

1 a gamma emitter with a long half-life

2 a gamma emitter with a short half-life

3 an alpha emitter with a long half-life

4 an alpha emitter with a short half-life

4.4.3.3 Uses of nuclear radiation

Question 03 · continued

7C Which of the following statements is correct for gamma radiation?

1 It is a stream of electrons.

2 It is a stream of protons.

3 It is deflected by an electric field.

4 It is **not** deflected by a magnetic field.

7D Which description is correct for the nucleus of a medium-sized atom?

It is a group of . . .

1 electrons and neutrons.

2 electrons, neutrons and protons.

3 electrons and protons.

4 neutrons and protons.

4.4.3.3 Uses of nuclear radiation

Question 04

June 2008 | PHY1F | Original Q3 | Legacy

3 (a) The names of three types of nuclear radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**. Draw only **three** lines.

List A Type of nuclear radiation	**List B** Property of radiation
alpha	not deflected by an electric field
beta	stopped by thin metal but not paper
gamma	the most strongly ionising
	will not harm living cells

(3 marks)

4.4.3.3 Uses of nuclear radiation

for mark

3 (b) Nuclear radiation is given out from the centre of some types of atom.

What name is given to the centre of an atom? .....

(1 mark)

3 (c) One of the substances in the table is used as a radioactive tracer. A hospital patient breathes in air containing the tracer. The radiation given out is measured by a doctor using a detector outside the patient's body.

Substance	Radiation given out	Solid, liquid or gas
X	alpha	gas
Y	gamma	gas
Z	gamma	solid

Which **one** of the substances, **X**, **Y** or **Z**, should be used as the tracer? .....

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

(3 marks)

3 (d) Radiation can also be used to kill the bacteria on fresh food.

Give **one** reason why farmers, shop owners or consumers may want food to be treated with radiation.

.....

.....

(1 mark)

8

4.4.3.3 Uses of nuclear radiation

Question 05

March 2009 | PHY1AP | Original Q3 | Legacy

QUESTION THREE

Some people feel strongly about the environment. They can use posters to protest against the location of new power stations.



Match energy sources, **A**, **B**, **C**, and **D**, with the protesters' posters **1–4**.

A fossil fuels

B nuclear

C tides

D wind

4.4.3.3 Uses of nuclear radiation

Question 06

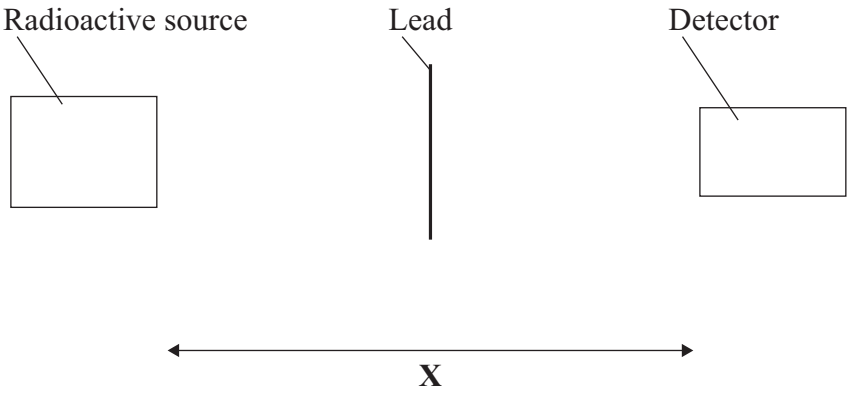
March 2009 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

A student investigated how much gamma radiation was absorbed by lead.

She used different thicknesses of lead.

She plotted a graph of her results.



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

A conclusion

B control variable

C prediction

D independent variable

1	She thought that the amount of radiation absorbed would decrease with thickness.
2	She kept the distance **X** the same.
3	She changed the thickness of the lead.
4	From her graph, she decided that the amount of radiation absorbed increased with thickness.

4.4.3.3 Uses of nuclear radiation

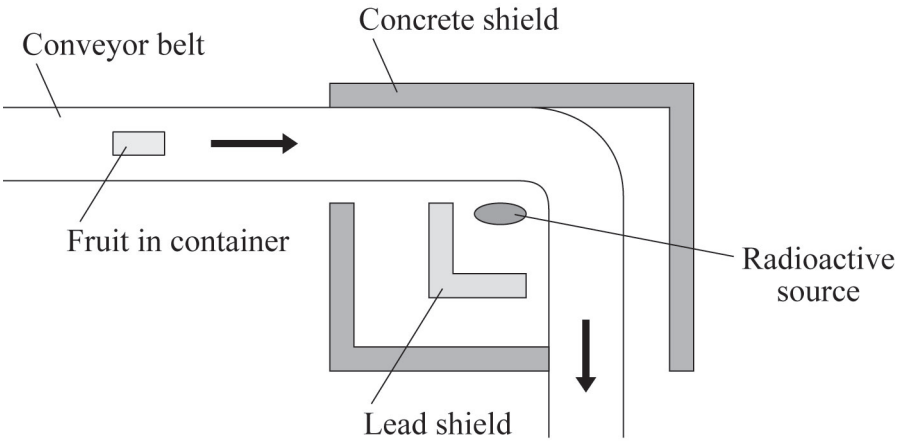
Question 07

March 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

In some countries, fruit is passed in front of a radioactive source. The gamma radiation from the source kills bacteria. This keeps the fruit fresh for longer.

The main process is shown in the diagram.



8A Gamma radiation is used because it is . . .

1 able to penetrate the container and fruit.

2 stopped by the lead shield.

3 not harmful to people.

4 the only radiation that can kill bacteria.

8B The amount of radiation absorbed by the fruit can be increased by . . .

1 moving the source further from the fruit.

2 packing the fruit in thicker containers.

3 slowing down the conveyor belt.

4 speeding up the conveyor belt.

4.4.3.3 Uses of nuclear radiation

Question 07 · continued March 2009 | PHY1BP | Original Q8 | Legacy

8C Some fruit growers use X-ray machines instead of gamma ray sources.

The X-rays are safer to work with because . . .

1 gamma ray sources are used in hospitals.

2 X-ray machines can be switched on and off.

3 gamma rays have a lower frequency than X-rays.

4 X-rays have a shorter wavelength than gamma rays.

8D Some scientists investigated the effect of radiation on the vitamin C content of fruit.

They measured the amount of radiation absorbed by some fruit.

They also measured the amount of vitamin C in the fruit before and after the radiation treatment.

Which row of the table describes the variables for a fair test?

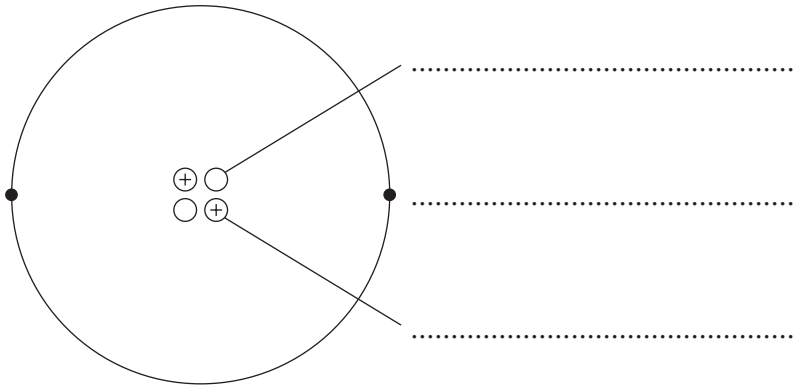
	Amount of radiation absorbed	Amount of vitamin C lost during irradiation	Size and type of fruit
1	independent	dependent	control
2	independent	control	dependent
3	dependent	independent	control
4	control	independent	dependent

4.4.3.3 Uses of nuclear radiation

Question 08

June 2009 | PHY1F | Original Q3 | Legacy

3 The diagram shows a helium atom.



3 (a) (i) Use the words in the box to label the diagram.

electron	**neutron**	**proton**

(2 marks)

3 (a) (ii) An alpha particle is the same as the nucleus of a helium atom.

How is an alpha particle different from a helium atom?

.....

.....

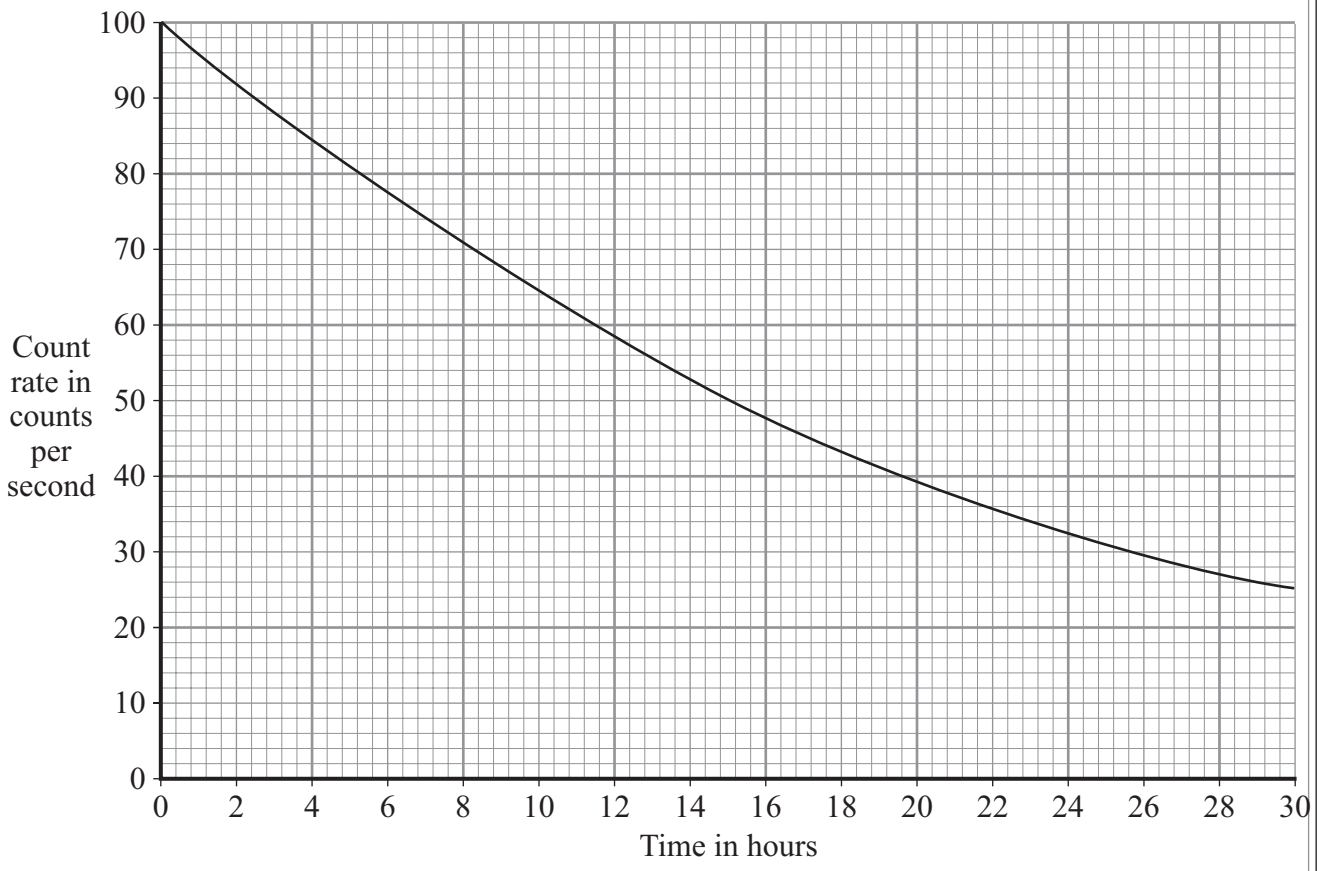
(1 mark)

4.4.3.3 Uses of nuclear radiation

Question 08 · continued

for mark

3 (b) The graph shows how the count rate from a sample of radioactive sodium-24 changes with time.



3 (b) (i) How many hours does it take for the count rate to fall from 100 counts per second to 50 counts per second?

Time = ... hours
(1 mark)

3 (b) (ii) What is the half-life of sodium-24?

Half-life = ... hours
(1 mark)

Question 3 continues on the next page

4.4.3.3 Uses of nuclear radiation

Question 08 · continued

for mark

3 (c) A smoke detector contains a small amount of americium-241.

Americium-241 is a radioactive substance which emits alpha particles. It has a half-life of 432 years.

3 (c) (i) Which **one** of the following statements gives a reason why the americium-241 inside the smoke detector will **not** need replacing?

Put a tick (✓) in the box next to your answer.

The alpha particles have a low energy. ☐

People replace smoke detectors every few years. ☐

Americium-241 has a long half-life. ☐

(1 mark)

3 (c) (ii) The diagram shows the label on the back of the smoke detector.



Why do people need to know that the smoke detector contains a radioactive material?

.....

.....

(1 mark)

7

4.4.3.3 Uses of nuclear radiation

Question 09

June 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The table gives uses for four types of radiation.

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

A alpha

B beta

C gamma

D X-rays

	Use
1	in medical tracers
2	in smoke detectors
3	to control the thickness of paper during manufacture
4	usually used to take shadow photographs of bones

4.4.3.3 Uses of nuclear radiation

Question 10

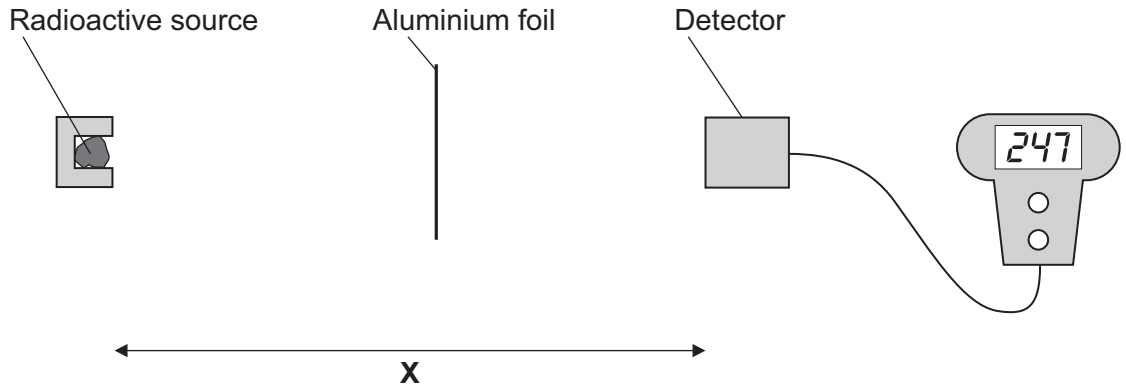
November 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

A student investigated how much beta radiation was absorbed by aluminium foil.

He used several different thicknesses of aluminium foil.

He plotted a graph of his results.



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

A conclusion

B control variable

C independent variable

D prediction

1	He thought that the amount of radiation absorbed would decrease with increasing thickness.
2	From his graph, he decided that the amount of radiation absorbed increased with increasing thickness.
3	He changed the thickness of the aluminium foil.
4	He kept the distance **X** the same.

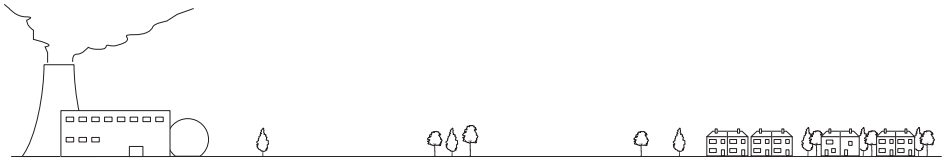
4.4.3.3 Uses of nuclear radiation

Question 11

November 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

A nuclear power station is built a few miles away from a village.



The nuclear power station uses radioactive uranium as its fuel. After a few years, there are more cases of cancer than usual occurring in the village. The villagers think that this is because of radiation from the power station.

9A Any radiation reaching the village directly from the power station will be . . .

1 alpha radiation only.

2 beta radiation only.

3 gamma radiation only.

4 alpha, beta and gamma radiation.

9B The increased number of cancer cases near the power station . . .

1 proves that the power station is the only cause of these cancers.

2 proves that the power station is one possible cause of these cancers.

3 suggests that the power station is the only cause of these cancers.

4 suggests that the power station is one possible cause of these cancers.

9C Checks are to be made for any link between the power station and the increased number of cancer cases in the village.

This is most likely to be done by . . .

1 shutting down the power station to see if the number of cases decreases.

2 re-housing the villagers away from the power station to see if the number of cancer cases decreases.

3 re-housing the villagers closer to the power station to see if the number of cancer cases increases.

4 comparing the villagers' health records with those of people who do not live near nuclear power stations.

4.4.3.3 Uses of nuclear radiation

9D Exposure to radiation from radioactive sources used in schools must be kept to a minimum.

The best way to do this is to store the source in a box lined with . . .

1 aluminium.

2 glass.

3 lead.

4 wood.

END OF TEST

4.4.3.3 Uses of nuclear radiation

Question 12

June 2015 | PH2FP | Original Q6 | Legacy

6 (a) Radioactive sources that emit alpha, beta or gamma radiation can be dangerous.

What is a possible risk to health caused by using a radioactive source?

[1 mark]

.....

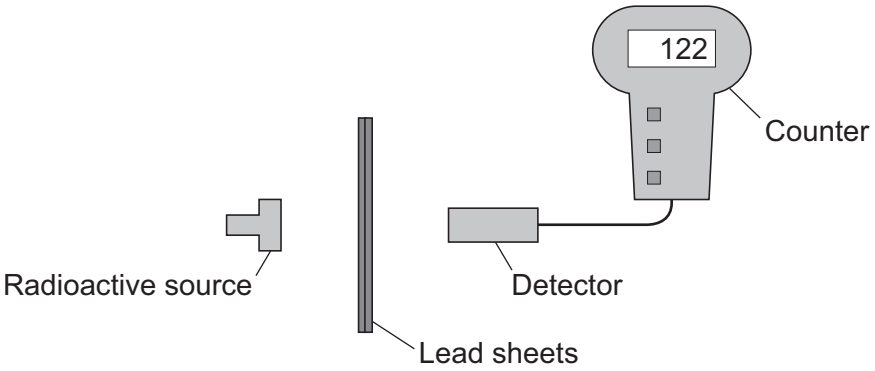
.....

6 (b) In an experiment, a teacher put a 2 mm thick lead sheet in front of a radioactive source. She used a detector and counter to measure the radiation passing through the lead sheet in one minute.

She then put different numbers of lead sheets, each 2 mm thick, in front of the radioactive source and measured the radiation passing through in one minute.

The apparatus the teacher used is shown in **Figure 7**.

Figure 7



6 (b) (i) When using a radioactive source in an experiment, how could the teacher reduce the risk to her health?

Suggest **one** way.

[1 mark]

.....

.....

Question 6 continues on the next page

4.4.3.3 Uses of nuclear radiation

Question 12 · continued

6 (b) (ii) The number recorded on the counter is actually higher than the amount of radiation detected from the source.

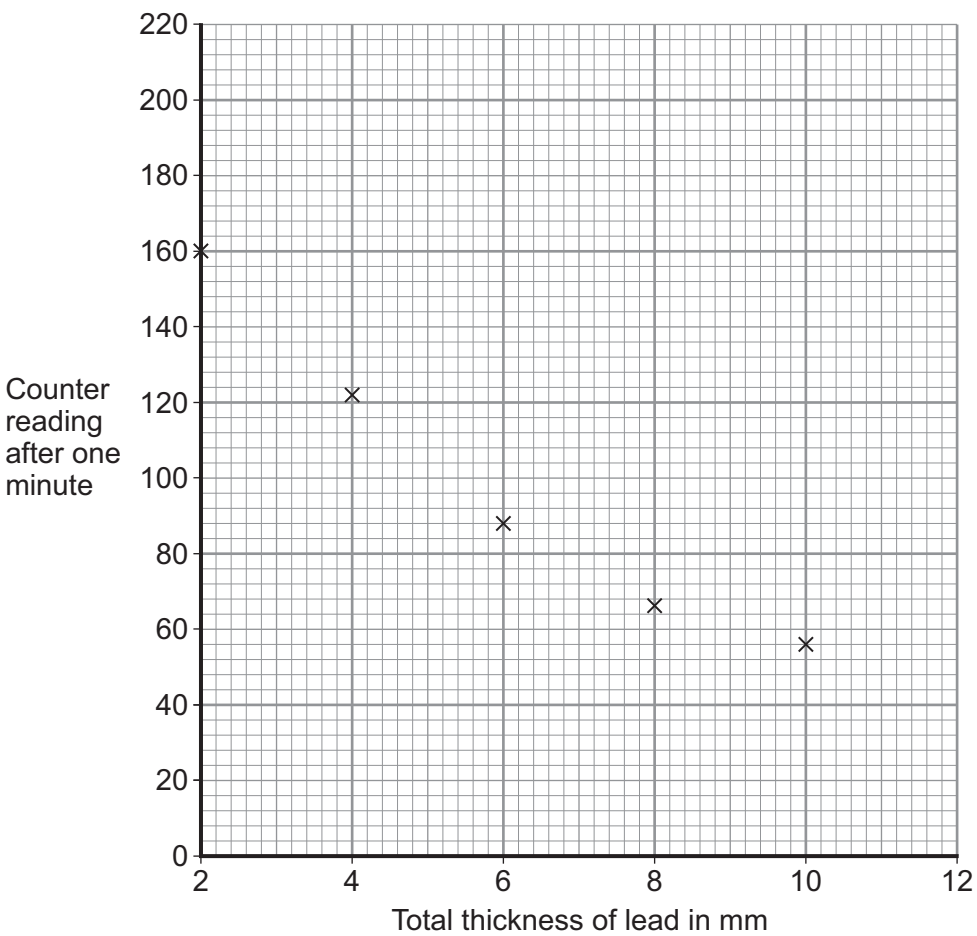
Complete the following word equation.

[1 mark]

The number recorded on the counter	=	The amount of radiation detected from the source	+	..... radiation

6 (c) The readings taken by the teacher are plotted in **Figure 8**.

Figure 8



6 (c) (i) Draw a line of best fit to complete **Figure 8**.

[1 mark]

4.4.3.3 Uses of nuclear radiation

Question 12 · continued

6 (c) (ii) How does the amount of radiation **absorbed** by the lead change as the total thickness of the lead is increased?

[1 mark]

.....

.....

6 (c) (iii) Use **Figure 8** to estimate the reading on the counter when the total thickness of the lead is increased to 12 mm.

[1 mark]

Estimated counter reading = ...

6 (d) What type of radiation was emitted from the radioactive source?

[2 marks]

Draw a ring around the correct answer.

alpha **beta** **gamma**

Give a reason for your answer.

.....

.....

8

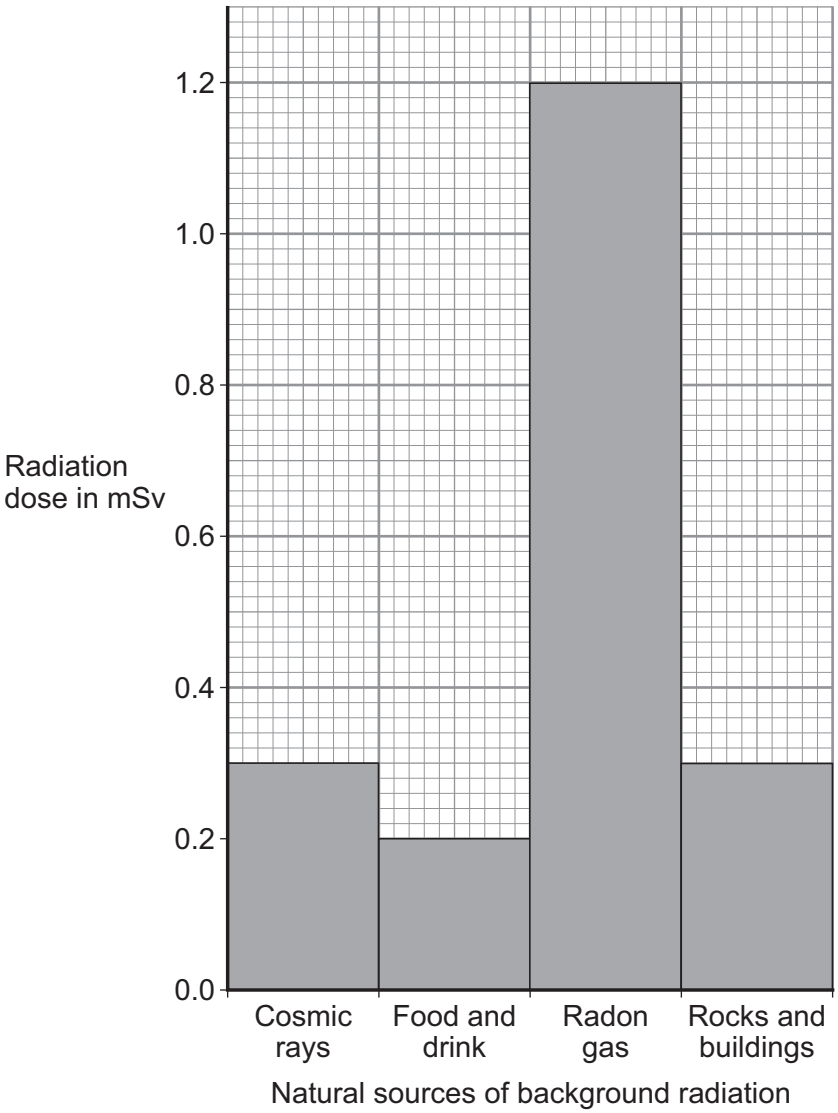
4.4.3.3 Uses of nuclear radiation

Question 13

June 2017 | PH2FP | Original Q7 | Legacy

7 **Figure 13** shows the total radiation dose that the average person in the UK gets from natural background radiation sources in one year.

Figure 13



7 (a) (i) Calculate the percentage of the total radiation dose the average person in the UK receives from cosmic rays.

[2 marks]

Percentage radiation dose from cosmic rays = _____ %

4.4.3.3 Uses of nuclear radiation

Question 13 · continued

7 (a) (ii) Over one year, a person may get a higher than average dose of radiation from cosmic rays.

Suggest **one** reason why.

[1 mark]

_____

_____

7 (a) (iii) Some sources of background radiation are man-made.

Name **one** man-made source of background radiation.

[1 mark]

_____

_____

7 (b) Before using a radioactive source a teacher measured the background radiation in her laboratory. She did this three times. The measurements were taken correctly but the three measurements were different.

Why were the three background measurements different?

[1 mark]

_____

_____

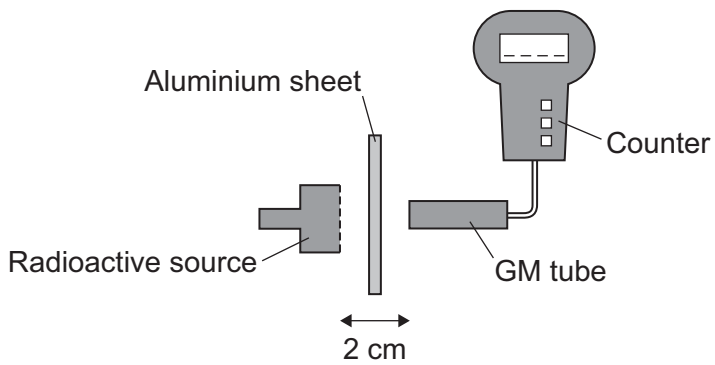
Question 7 continues on the next page

4.4.3.3 Uses of nuclear radiation

Question 13 · continued

7 (c) **Figure 14** shows the apparatus the teacher used to investigate the radiation emitted by a source.

Figure 14



The teacher changed the thickness of the aluminium between the source and the Geiger-Müller (GM) tube.

The number of counts recorded for each thickness is given in **Table 1**.
The mean background measurement was 20 counts in one minute.

Table 1

Thickness of aluminium in millimetres	Counts in one minute
2	350
4	68
6	20

7 (c) (i) A student concluded that the radioactive source emits beta radiation.

Explain how the information in **Table 1** supports this conclusion.

[2 marks]

4.4.3.3 Uses of nuclear radiation

Question 13 · continued

7 (c) (ii) The teacher said that the source also emits alpha radiation.

Describe how the investigation could be changed in order to show that the source emits alpha radiation.

[2 marks]

_____

_____

_____

_____

_____

_____

9

Turn over for the next question

4.4.3.3 Uses of nuclear radiation

Question 14

June 2018 | 8463/1F | Original Q11

1 1 A teacher used a Geiger-Muller tube and counter to measure the number of counts in 60 seconds for a radioactive rock.

1 1 . 1 The counter recorded 819 counts in 60 seconds. The background radiation count rate was 0.30 counts per second.

Calculate the count rate for the rock.

[3 marks]

Count rate = _____ per second

1 1 . 2 A householder is worried about the radiation emitted by the granite worktop in his kitchen.

1 kg of granite has an activity of 1250 Bq. The kitchen worktop has a mass of 180 kg.

Calculate the activity of the kitchen worktop in Bq.

[2 marks]

Activity = _____ Bq

4.4.3.3 Uses of nuclear radiation

Question 14 · continued

1 1 . 3 The average total radiation dose per year in the UK is 2.0 millisieverts.

Table 2 shows the effects of radiation dose on the human body.

Table 2

Radiation dose in millisieverts	Effects
10 000	Immediate illness; death within a few weeks
1000	Radiation sickness; unlikely to cause death
100	Lowest dose with evidence of causing cancer

The average radiation dose from the granite worktop is 0.003 millisieverts per day.

Explain why the householder should **not** be concerned about his yearly radiation dose from the granite worktop.

One year is 365 days.

[2 marks]

1 1 . 4 Bananas are a source of background radiation. Some people think that the unit of radiation dose should be changed from sieverts to Banana Equivalent Dose.

Suggest **one** reason why the Banana Equivalent Dose may help the public be more aware of radiation risks.

[1 mark]

8