Name: _____

Radioactivity

GCSE 9-1

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

Figure 4 shows a Geiger-Müller (GM) tube used for measuring radioactivity.

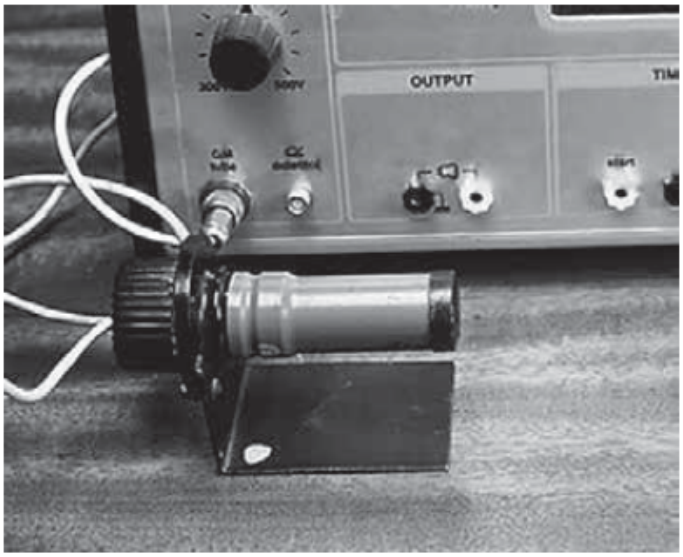

Figure 4

One radioactive source used in hospitals is technetium (Tc).

Technetium is produced from the radioactive decay of molybdenum (Mo).

Complete the following nuclear equation.

(1)

$$^{99}_{42}\text{Mo} \rightarrow \text{\_\_\_\_\_} + {}^{0}_{-1}\beta$$

(Total for question = 1 mark)

Q2.

Carbon-13 and carbon-14 are isotopes of carbon.

Nuclei of carbon-13 and carbon-14 can be represented by these symbols

$$^{13}_{6}\text{C} \quad \text{and} \quad ^{14}_{6}\text{C}$$

Complete the table for an atom of carbon-13 and an atom of carbon-14.

(2)

	number of neutrons in the nucleus	number of electrons in orbit around the nucleus
carbon-13		
carbon-14		

(Total for question = 2 marks)

Q3.

Carbon–14 is radioactive and has a half-life of 5 700 years.

The number of radioactive carbon–14 atoms in a very old piece of wood is found to have decreased from 1 000 000 to 125 000.

Determine the age of the piece of wood.

(2)

age of wood = ... years

(Total for question = 2 marks)

Q4.

Carbon-14 decays into nitrogen-14.

The symbol for nitrogen-14 is $^{14}_{7}N$

Explain what happens in a carbon-14 nucleus when it decays to a nitrogen-14 nucleus.

(2)

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(Total for question = 2 marks)

Q5.

Some rocks contained uranium when they were formed.

Radioactive decay in these rocks produces radon gas.

Explain why people living near these rocks have an increased health risk from background radiation.

(3)

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Q6.

Figure 4 shows a Geiger-Müller (GM) tube used for measuring radioactivity.

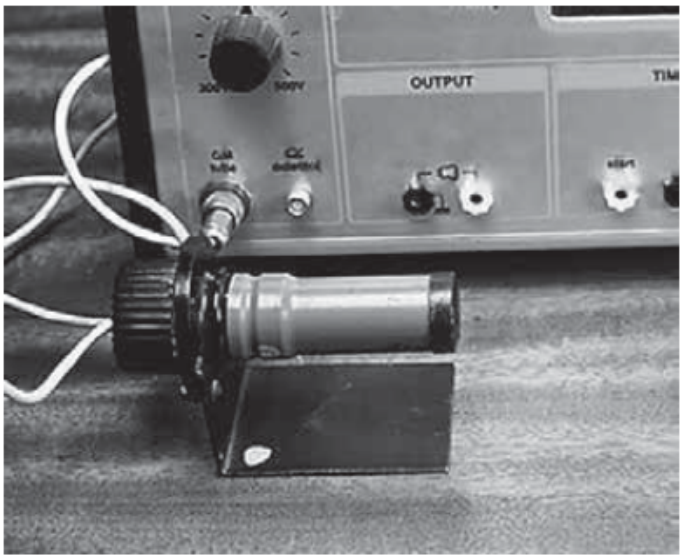

Figure 4

A hospital uses a radioactive isotope with a half-life of 6 hours.

A technician measures a count rate of 80 counts per minute (cpm) from this isotope.

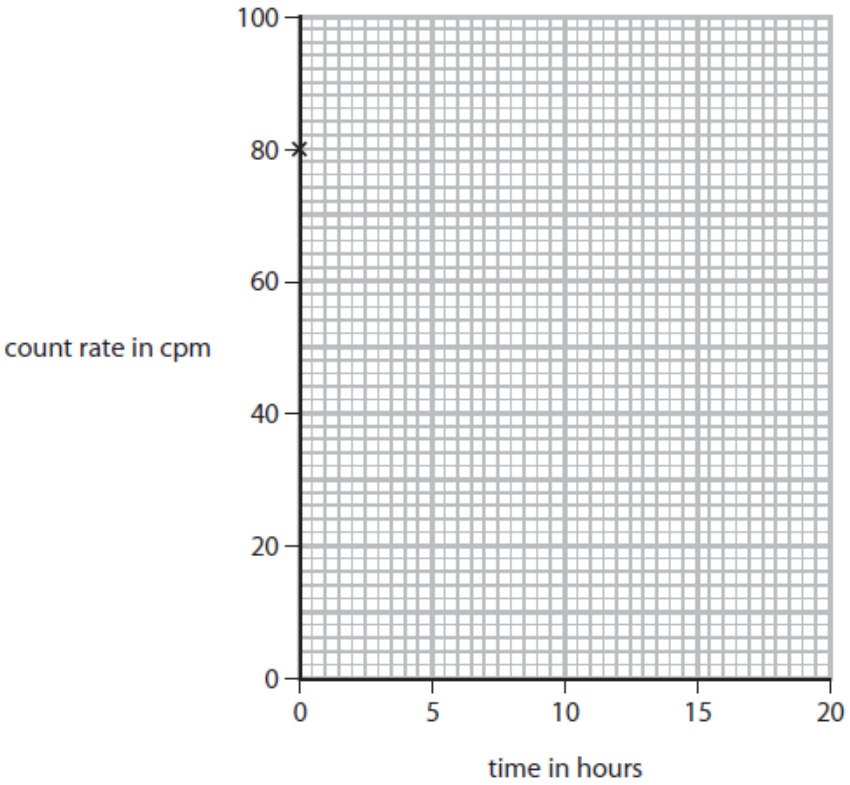

Figure 5

Complete the graph on Figure 5, as accurately as possible, to show how the count-rate from this isotope will change from the time of the first measurement.

The first point is already drawn in Figure 5.

(3)

(Total for question = 3 marks)

Q7.

Some rocks contained uranium when they were formed.

Radioactive decay in these rocks produces radon gas.

Explain why people living near these rocks have an increased health risk from background radiation.

(3)

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Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(i) In a controlled chain reaction of uranium-235, which of these could cause a

uranium-235 nucleus to undergo fission?

(1)

☒ **A** an alpha particle

☒ **B** a beta particle

☒ **C** a neutron

☒ **D** a proton

(ii) The kinetic energy of one of the particles released in a fission reaction is 1.2 × 10–11 J.

The mass of the particle is 1.4×10^{-25} kg.

Calculate the velocity of the particle.

(3)

velocity of the particle = ... m/s

(Total for question = 4 marks)

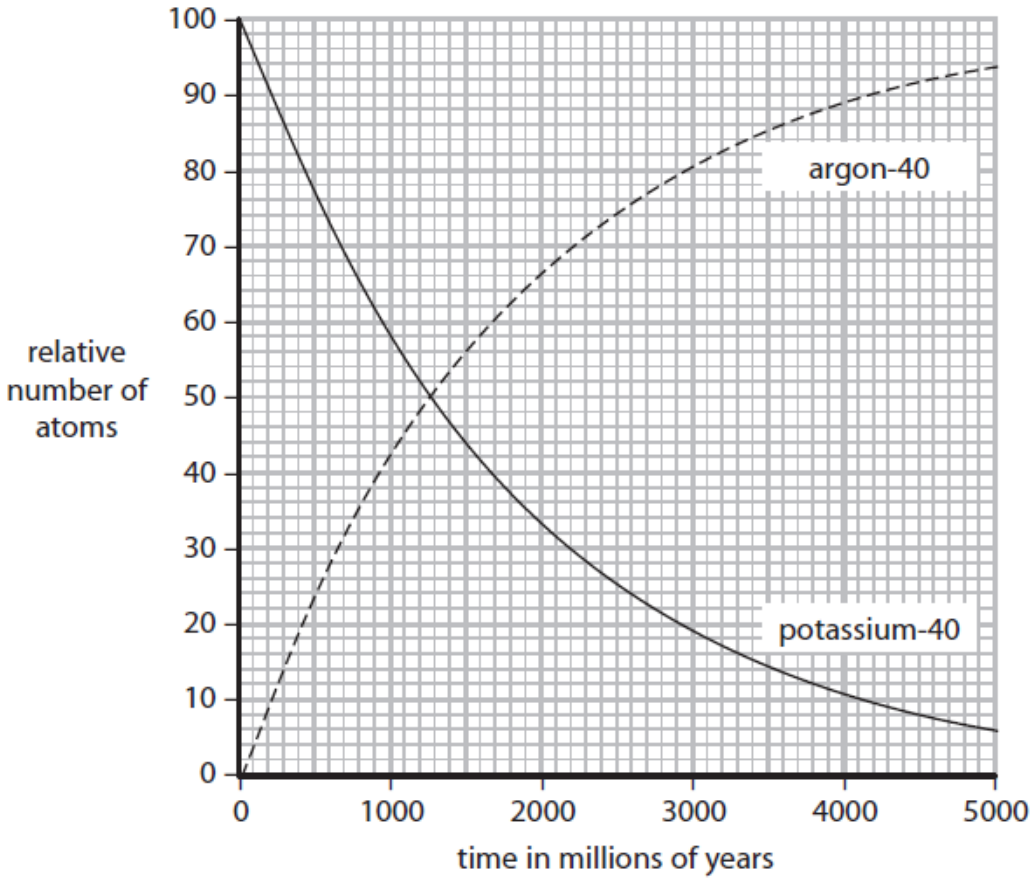
Q9.

Some rocks containing potassium were formed many millions of years ago.

There was no argon-40 in the rocks when they were formed.

When scientists analyse samples of these rocks, they find small amounts of argon-40 trapped inside.

The graph shows how the relative amounts of potassium-40 and argon-40 change over time.



(i) Use the graph to find the half-life of potassium-40.

(1)

half-life = ... million years

(ii) Scientists analyse a sample taken from inside a rock.

They find that there is exactly 3 times as much argon-40 as there is potassium-40.

Use the graph to find the age of the rock.

(2)

age of rock = ... million years

Q10.

Many different types of radioactive isotope are used for the diagnosis and treatment of medical conditions.

(i) Iodine-123 is used as a radioactive tracer to diagnose thyroid problems.

Complete the sentence by putting a cross (☒) in the box next to your answer.

This tracer must have a half-life of

(1)

☒ **A** a few days

☒ **B** a few hours

☒ **C** less than a second

☒ **D** several weeks

(ii) Pellets which contain radium-223 can be put inside the body to treat cancers.

Radium-223 has a half-life of 11.4 days and emits alpha radiation.

Explain why radium-223 is suitable for use inside the body to treat cancers.

(3)

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Q11.

The table gives the average dose of radiation a person received from various sources.

radiation source	average radiation dose (arbitrary units)
average yearly background	3000
one chest X-ray	20
one CT scan of the chest	6000
one whole body CT scan	20000
one PET scan	6000

(i) Explain why a CT scan of the chest gives a much higher dose of radiation than a chest X-ray.

(2)

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(ii) Justify the use of medical procedures which give patients large doses of radiation.

(2)

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Q12.

Figure 4 shows a Geiger-Müller (GM) tube used for measuring radioactivity.

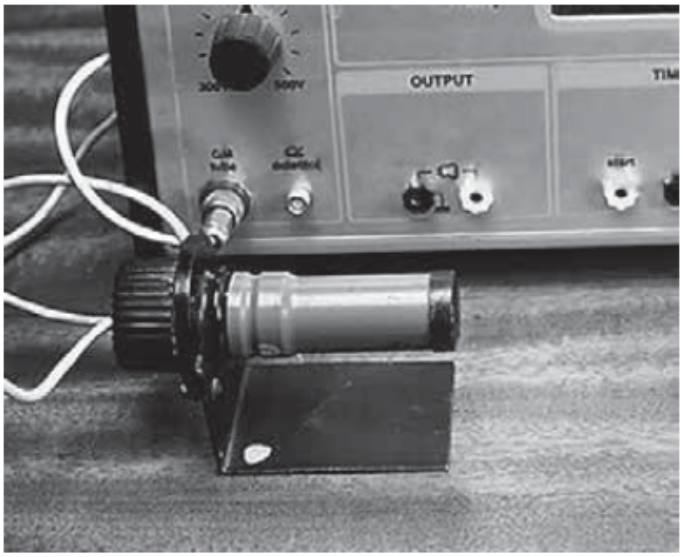

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Figure 4

Describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks.

(4)

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(Total for question = 4 marks)

Q13.

(i) State the name of an instrument that can be used to measure radioactivity.

(1)

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(ii) State **two** sources of background radiation.

(2)

1 .....

2 .....

(Total for question = 3 marks)

Q14.

One isotope of the element potassium is potassium-40.

A nucleus of potassium-40 is represented by:

$$^{40}_{19}K$$

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The number of neutrons in a nucleus of potassium-40 is

(1)

☒ **A** 19

☒ **B** 21

☒ **C** 40

☒ **D** 59

(ii) Which of these symbols is correct for the nucleus of a different isotope of potassium?

Put a cross (☒) in the box next to your answer.

(1)

$^{39}_{19}K$ $^{40}_{20}K$ $^{19}_{40}K$ $^{39}_{20}K$

☒ A ☒ B ☒ C ☒ D

(iii) A sample of potassium-40 is left for a long time.

Some of the potassium-40 nuclei will emit gamma radiation as they turn into argon-40 nuclei.

Argon-40 nuclei never change.

Describe what information this gives about the isotope potassium-40.

(2)

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Q15.

Energy from the nuclei of atoms can be used in medical diagnosis and treatment.

(i) Fluorine-18 is a radioactive isotope used in PET scanners for medical diagnosis.

Explain why fluorine-18 must be produced close to the hospital where it is used.

(2)

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(ii) Some tumours inside the body can be treated by using either alpha radiation or gamma radiation.

Explain why the source of alpha radiation is usually inside the body but the source of gamma radiation can be outside the body.

(4)

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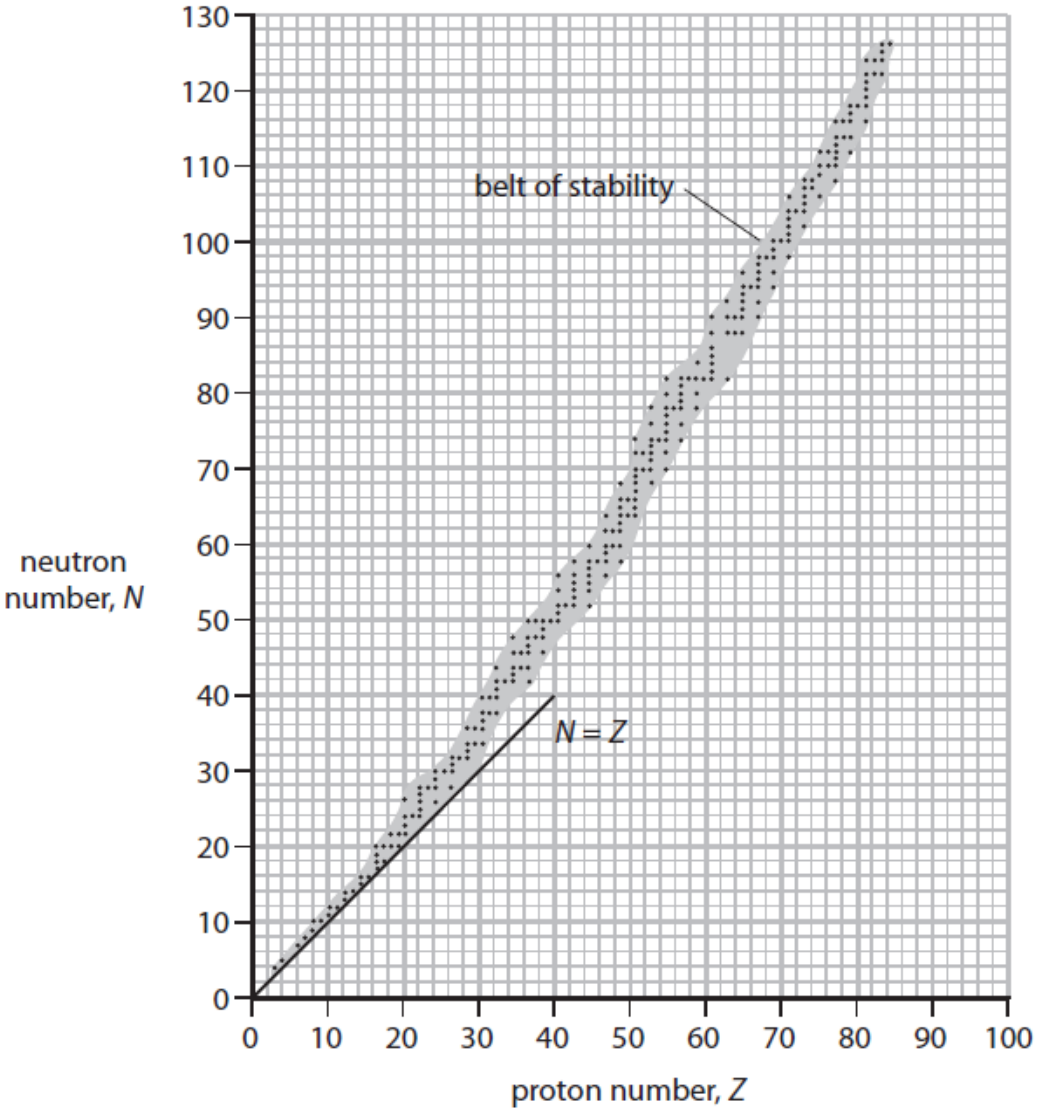
(Total for question = 6 marks)

Q16.

(a) The diagram shows the stability curve for nuclear isotopes.



Complete the sentence by putting a cross (☒) in the box next to your answer.

An isotope above the curve will undergo β^- decay because it has

(1)

☒ **A** too few protons

☒ **B** too many protons

☒ **C** too few neutrons

☒ **D** too many neutrons

(b) Which statement is correct for β^+ and β^- particles?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** a β^+ is positively charged and a β^- is negatively charged

☒ **B** the mass of a β^+ is 1800 times the mass of a β^-

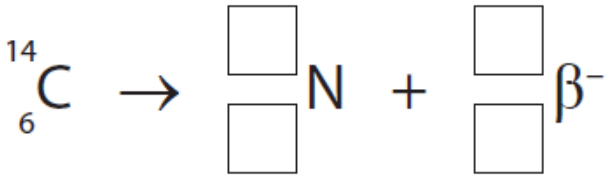
☒ **C** the charge on a β^+ is twice the charge on a β^-

☒ **D** a β^+ is a proton and a β^- is an electron

(c) Carbon-14 decays by emitting a β^- particle to form an isotope of nitrogen.

Complete the nuclear equation for this decay by filling in the boxes.

(2)



(d) Protons and neutrons both contain quarks.

Describe the arrangement of quarks in a proton.

(2)

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(e) Explain what happens to a nucleus during β^+ decay.

(2)

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Q17.

(a) In some countries food is sold with this label.

This food has been deliberately exposed to gamma radiation.

Complete the sentence by putting a cross (☒) in the box next to your answer.

The gamma radiation is used to

(1)

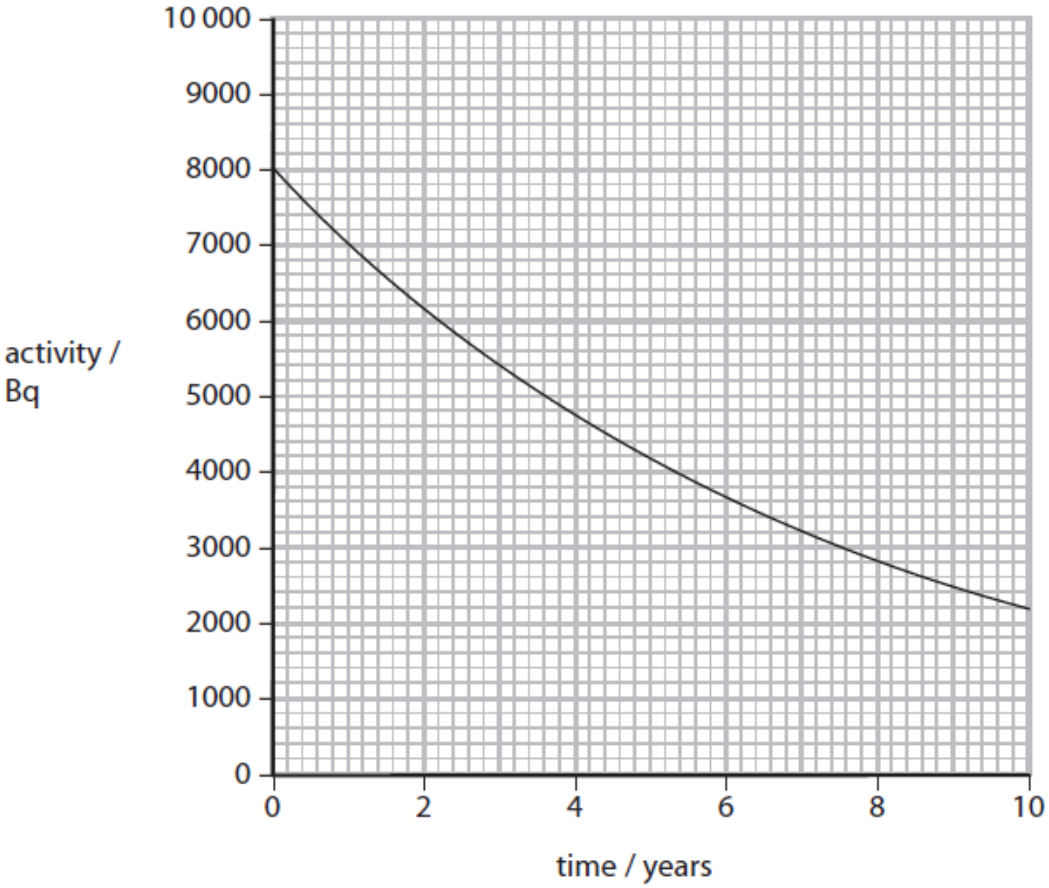
☒ **A** produce cancer cells in the food

☒ **B** kill cancer cells in the food

☒ **C** kill microbes in the food

☒ **D** make the food radioactive.

(b) Cobalt-60 is one source of gamma radiation used for food irradiation. This graph shows how the activity of a sample of cobalt-60 changes over 10 years.



(i) Use the graph to find the half-life of cobalt-60.

(2)

half-life = ... years

(ii) The cobalt-60 has to be replaced when its activity has fallen below 1000 Bq.

Estimate how long it takes for the activity to fall from 8000 Bq to 1000 Bq.

(1)

half-life = ... years

(c) The cobalt-60 sources used to irradiate the food are small metal rods about the size of a pencil. They are made from stable cobalt-59 which is put inside a nuclear reactor. Some of the cobalt-59 is turned into cobalt-60 by the radiation in the reactor.

(i) The nuclei of the two isotopes can be represented as

$^{60}_{27}Co$ $^{59}_{27}Co$

Compare these two isotopes of cobalt.

(2)

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*(ii) When it is time to replace the cobalt-60 rods there are two options.

- The rods can be disposed of.
- The rods can be transported to a nuclear reactor to turn more of the cobalt-59 into cobalt-60 so that they can be used again.

Discuss the hazards in these two options.

(6)

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(Total for Question = 12 marks)