Medical uses of radiation

1 (a) 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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(b) Radiotherapy is often used for palliative care when cancers are incurable.

Explain how using radiotherapy in this way is helpful to patients.

(2)

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(c) 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	20 000
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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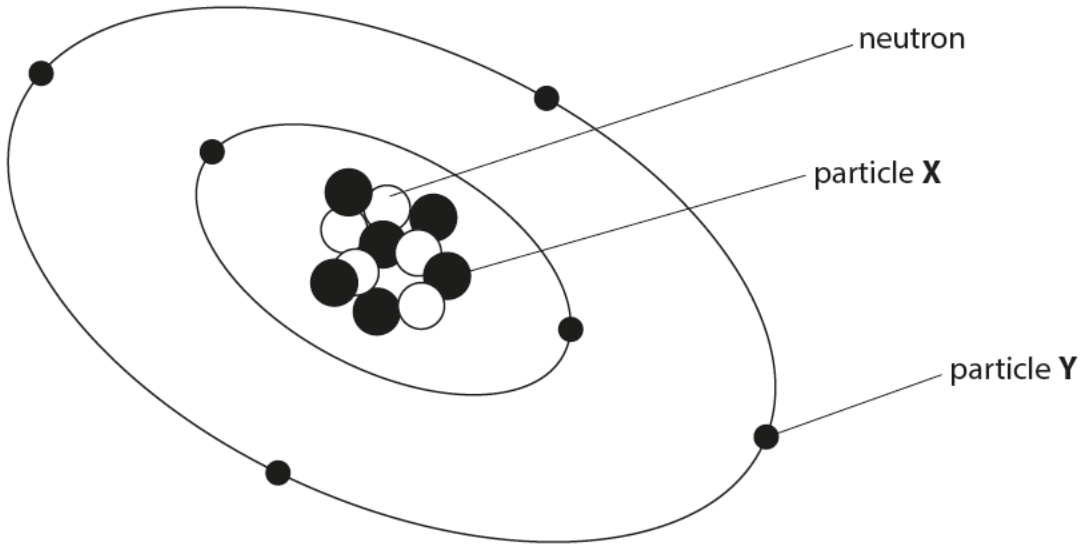
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(Total for Question 4 = 10 marks)

Radioactive material

2 (a) The diagram represents an atom of carbon.



NOT to scale

(i) State the name of particle **X**.

(1)

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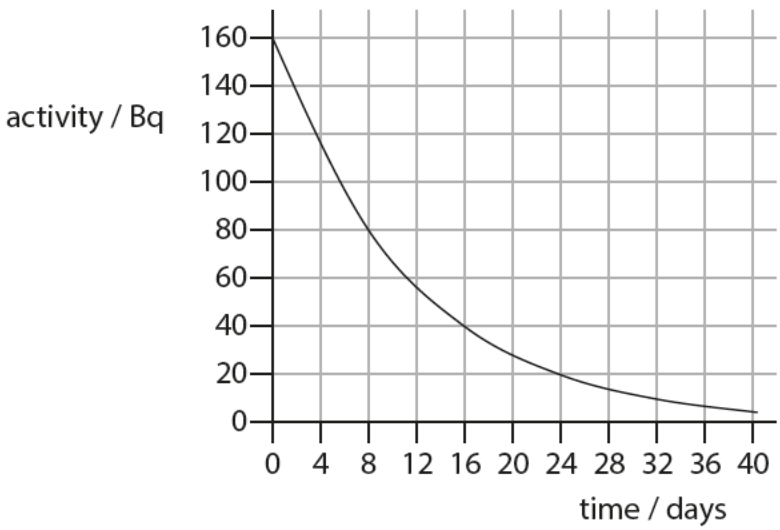
(ii) State the name of particle **Y**.

(1)

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(b) Iodine-131 is a radioactive isotope of iodine.

The graph shows how the activity of a sample of iodine-131 decreases with time.



(i) Use the graph to calculate the half-life of iodine-131.

(2)

half-life = ... days

(ii) Another sample of iodine-131 has an activity of 800 Bq.

Calculate how long it will take before its activity decreases to 200 Bq.

(2)

time = ... days

*(c) There are plans to build more nuclear power stations to supply electricity to the National Grid.

Discuss the advantages and disadvantages of using nuclear power to generate electricity.

(6)

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(Total for Question 5 = 12 marks)

Using radioactive materials

3 (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)

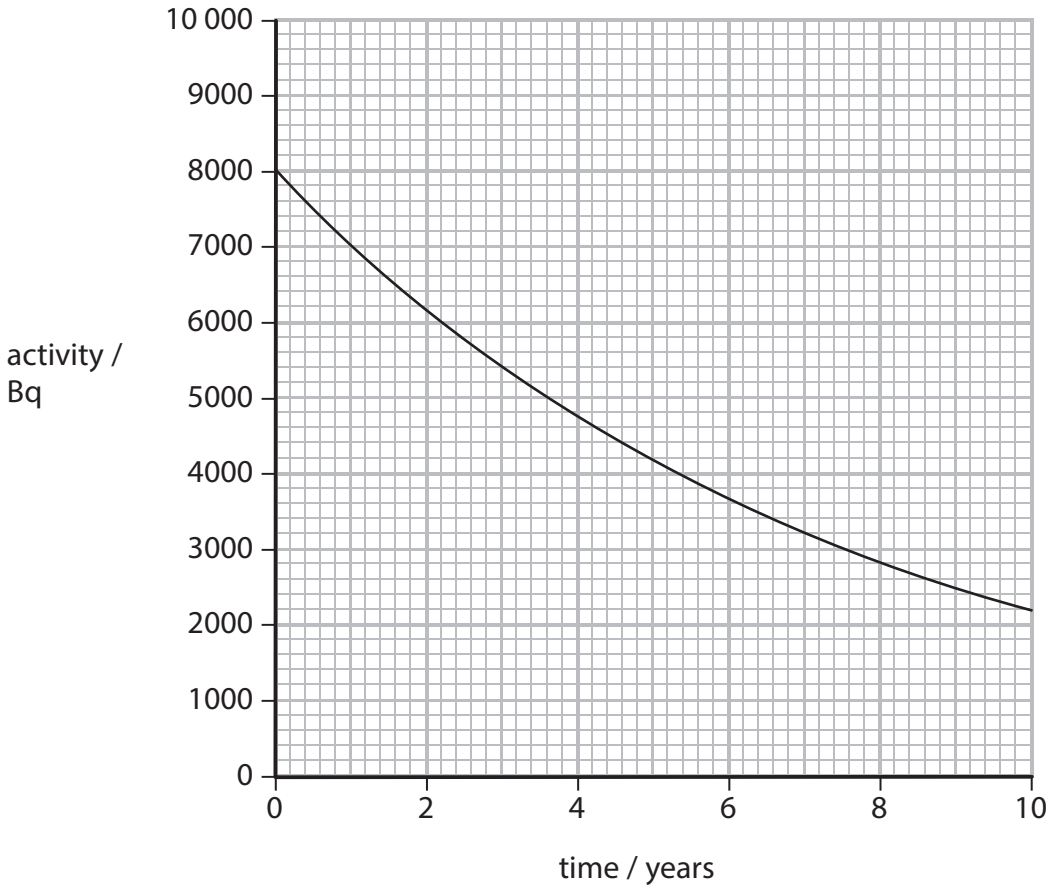
☐ **A** produce cancer cells in the food

☐ **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)

time taken = ... 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)

(Total for Question 6 = 12 marks)

Electromagnetic spectrum

4 The electromagnetic spectrum is continuous.
Different regions of the spectrum have different properties.

(a) (i) Name an electromagnetic wave that is also an ionising radiation.

(1)

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(ii) Genuine banknotes contain a special ink.
This ink is invisible under normal light.

Suggest why the ink glows when ultraviolet radiation is shone on it.

(2)

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(b) An electromagnetic wave has a frequency of 7×10^9 Hz.
The speed of the wave is 3×10^8 m/s.
Calculate the wavelength of the wave.

(3)

wavelength = ... m

*(c) Radiation from different regions of the electromagnetic spectrum can affect the human body in many ways.

Discuss the different ways in which excessive exposure to electromagnetic radiations of various frequencies may cause damage to the human body.

(6)

(Total for Question 5 = 12 marks)