Using radiation in hospitals

1 Hospitals use ionising radiation for many purposes.

(a) State **one** use of ionising radiation in a hospital.

(1)

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(b) An isotope of technicium, technicium-99, has a half-life of 6 hours.

A hospital has a sample which contains 40 mg of technicium-99.

Calculate how much technicium-99 will be in this sample after 12 hours.

(2)

amount remaining = ... mg

(c) Every hospital radiographer who works with radiation wears a radiation badge.

The badge is used to monitor the amount of radiation the radiographer absorbs each month.

(i) Explain why it is important to monitor the amount of radiation a radiographer absorbs each month.

(2)

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(ii) Radiographers are restricted to a smaller annual dose of radiation nowadays compared to 50 years ago.

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

This is because nowadays,

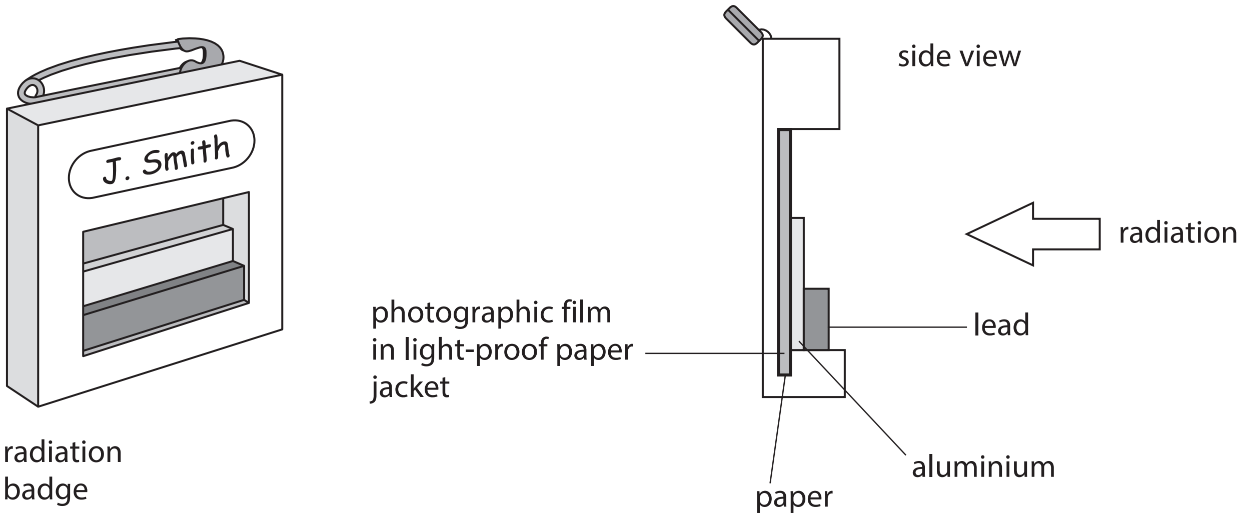
(1)

☒ **A** the radioactive sources have decayed

☒ **B** we can measure radiation more accurately

☒ **C** we have a better understanding of the risks from radiation

☒ **D** we have more effective ways of shielding against radiation *(iii) The radiation badge contains a photographic film which is sensitive to radiation.



The radiation badge is sent to a laboratory after a month and the film is checked.

Explain how the badge shows the amount of different types of radiation that the radiographer has been exposed to.

(6)

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(Total for Question 6 = 12 marks)

Nuclear power

2 Many countries generate electricity using nuclear fission.

(a) The decay products from nuclear fission emit different types of ionising radiation.

Draw **one** line from each type of radiation to its correct description.

(2)

type of radiation	**description**
alpha	electromagnetic wave
beta	electron
gamma	helium nucleus

(b) There are both fuel rods and control rods inside each fission reactor.

Explain how pushing control rods between the fuel rods changes the rate of nuclear fission in the reactor.

(2)

(c) Engineers are trying to generate electricity using the energy from nuclear fusion reactions.

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

High temperatures and pressures are needed in a nuclear fusion reactor.
This is to overcome

(1)

☐ **A** the kinetic energy of nuclei

☐ **B** the electrostatic repulsion of protons

☐ **C** the magnetic repulsion of neutrons

☐ **D** nuclear fission

(ii) Describe what happens to nuclei in a nuclear fusion reaction.

(2)

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(Total for Question 1 = 7 marks)

Radiation from rocks

3 (a) 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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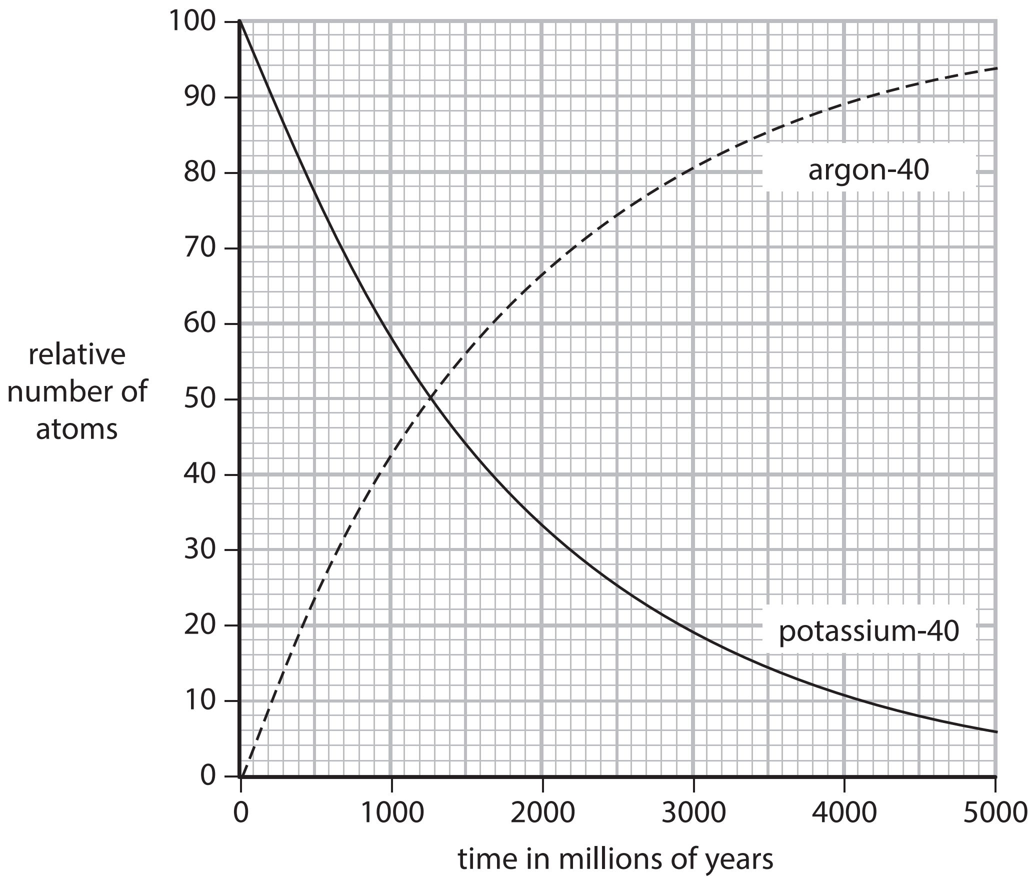
(b) Some rocks co   go.

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

(c) Some other 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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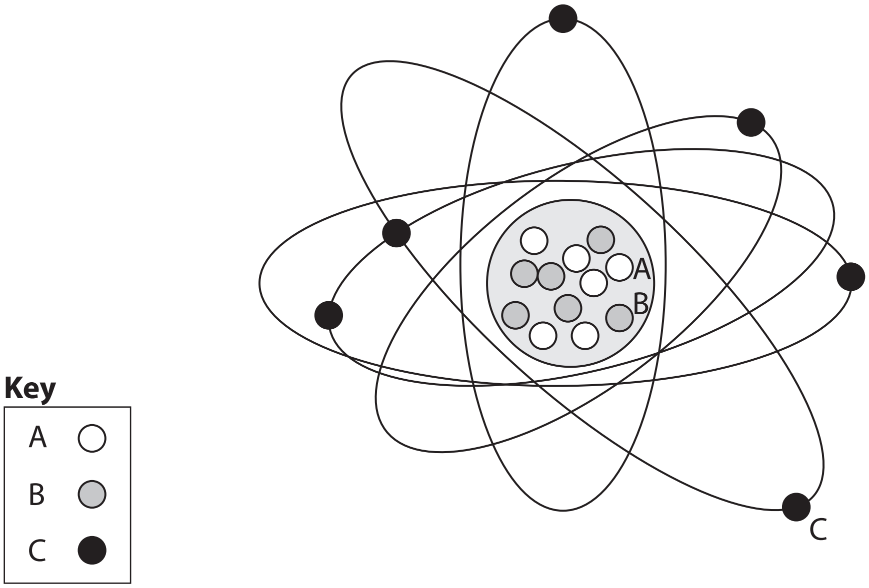
(Total for Question 4 = 10 marks)

Radioactivity and atoms

4 The diagram shows an atom of carbon.

A, B and C are three different particles.



Not to scale

(a) (i) Name the three different particles shown.

(3)

A = ...

B = ...

C = ...

(ii) What is the mass (nucleon) number of this carbon atom?

(1)

....

(b) Which **one** of these statements about alpha radiation is correct?

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

(1)

☒ **A** Alpha radiation has no charge.

☒ **B** Alpha radiation is very ionising.

☒ **C** Alpha radiation travels very far in air.

☒ **D** Alpha radiation is an electromagnetic wave.

(c) Choose words from the box to complete the following sentences.

Words may be used once, more than once or not at all.

alpha	b	on

The radiation that is a wave is ....

(1)

The particle that is negatively charged is ....

(1)

(d) When an atom emits an alpha particle its nucleus changes.

Which describes the changes in the nucleus?

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

(1)

	proton number	**mass number**
☒ **A**	decreases by 2	decreases by 4
☒ **B**	increases by 2	decreases by 4
☒ **C**	decreases by 2	increases by 4
☒ **D**	increases by 2	increases by 4

(Total for Question 1 = 8 marks)

Radiation in medicine

5 (a) Many different types of radiation are used by doctors.

Which type of radiation comes from radioactive sources?

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

(1)

☐ **A** gamma rays

☐ **B** ultrasound

☐ **C** ultraviolet

☐ **D** X-rays

(b) Explain how radiation from radioactive sources can be dangerous to people.

(2)

....

....

....

(c) Medical staff who use radioactive materials need more protection than their patients.

Describe some precautions that medical staff can take to ensure their safety from radioactive materials.

(3)

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*(d) Describe how radioactive materials can be used in the diagnosis and treatment of some illnesses.

(6)

(Total for Question 6 = 12 marks)