Nuclear reactions

1 (a) The nucleus of an atom of cobalt-60 can be represented by the symbol

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

(i) Use numbers from the box to complete the following sentences.

(2)

27	33	60	87

The number of protons in an atom of cobalt-60 is .....

The number of neutrons in an atom of cobalt-60 is .....

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

Atoms are neutral. An atom can become an ion by losing

(1)

☐ **A** an electron

☐ **B** a neutron

☐ **C** a gamma ray

☐ **D** an X-ray

(iii) Cobalt-60 is radioactive.
It emits beta radiation and gamma radiation.

Describe the differences between beta radiation and gamma radiation.

(3)

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*(b) Fission and fusion are two different types of nuclear reaction.

Describe the similarities and differences between nuclear fission reactions and nuclear fusion reactions.

(6)

(Total for Question 5 = 12 marks)

2 (a) (i) One source of background radiation is radon gas.

State another source of background radiation.

(1)

.....

(ii) Which of these two statements about background radiation are correct?

1 Radon gas from nuclear power stations is the main cause of background radiation.

2 Background radiation can be detected during radioactive experiments.

(1)

☒ **A** statement 1 only

☒ **B** statement 2 only

☒ **C** both statement 1 and statement 2

☒ **D** neither statement 1 nor statement 2

(iii) Background radiation from radon gas is different from place to place in the UK.

Explain these differences in background radiation.

(2)

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(b) Scientists have changed their ideas about the hazards from radioactive sources.

Describe how their ideas have changed since radioactivity was first discovered.

(2)

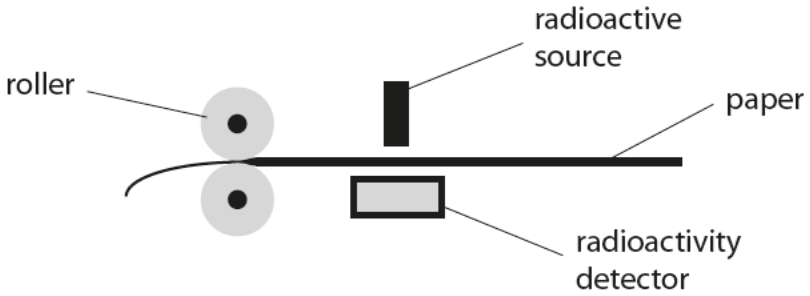
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*(c) The diagram shows how rollers can change the thickness of paper in a factory.
A thickness gauge controls the rollers.
The thickness gauge contains a radioactive source and a detector.
If the paper is too thick, the reading on the detector goes down.
This causes the rollers to be pushed closer together.



The radioactive source used must be chosen carefully to be effective and used in a way that is not a hazard to workers.

Discuss the factors to consider when choosing and using this radioactive source.

(6)

(Total for Question 6 = 12 marks)

Radioactivity and health

3 (a) Radioactive materials can be a risk to health.
Some food contains radioactive material.

Explain why people can eat this food without serious risk.

(2)

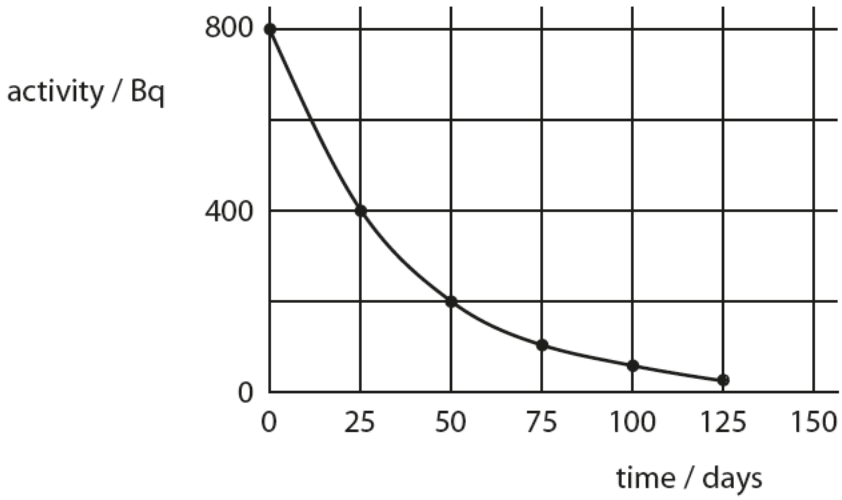
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(b) A radioactive material can be used to help diagnose heart disease.
The graph shows the decay curve for this material.



(i) A scientist measures the activity of a sample of this material as 400 Bq.
Some time later, he measures the activity as 100 Bq.

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

The time between the two measurements is about

(1)

☐ **A** 25 days

☐ **B** 50 days

☐ **C** 75 days

☐ **D** 100 days

(ii) Estimate the activity that should appear on the graph for a time of 150 days.

(1)

activity at 150 days = ... Bq

(c) Half-life is an important factor to consider when choosing isotopes for medical treatments.

Explain what **half-life** means.

(2)

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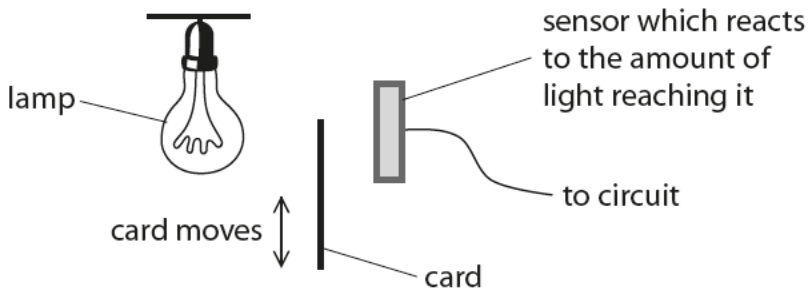
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*(d) A teacher decides to model how a machine checks the level of the liquid in medicine bottles.
The machine uses a radioactive source to sound an alarm when the level of liquid becomes too low.

He sets up the arrangement shown.



The piece of card can be moved up and down between the lamp and the detector.
Each part of the teacher's arrangement corresponds to a part of the machine.

By comparing the parts of the teacher's arrangement to the parts of the machine, discuss how effective this model is.

(6)

(Total for Question 6 = 12 marks)

Living with radioactivity

4 Everyone is exposed to background radiation. Some of this radiation comes from natural sources.

(a) (i) One example of a source of background radiation that does not occur naturally is radiotherapy.

State **one** other source of background radiation that does not occur naturally.

(1)

.....

.....

(ii) Radon gas is a natural source of background radiation.

In some parts of the country, a lot of the background radiation comes from radon gas.

Explain why there is no radon gas in some other parts of the country.

(2)

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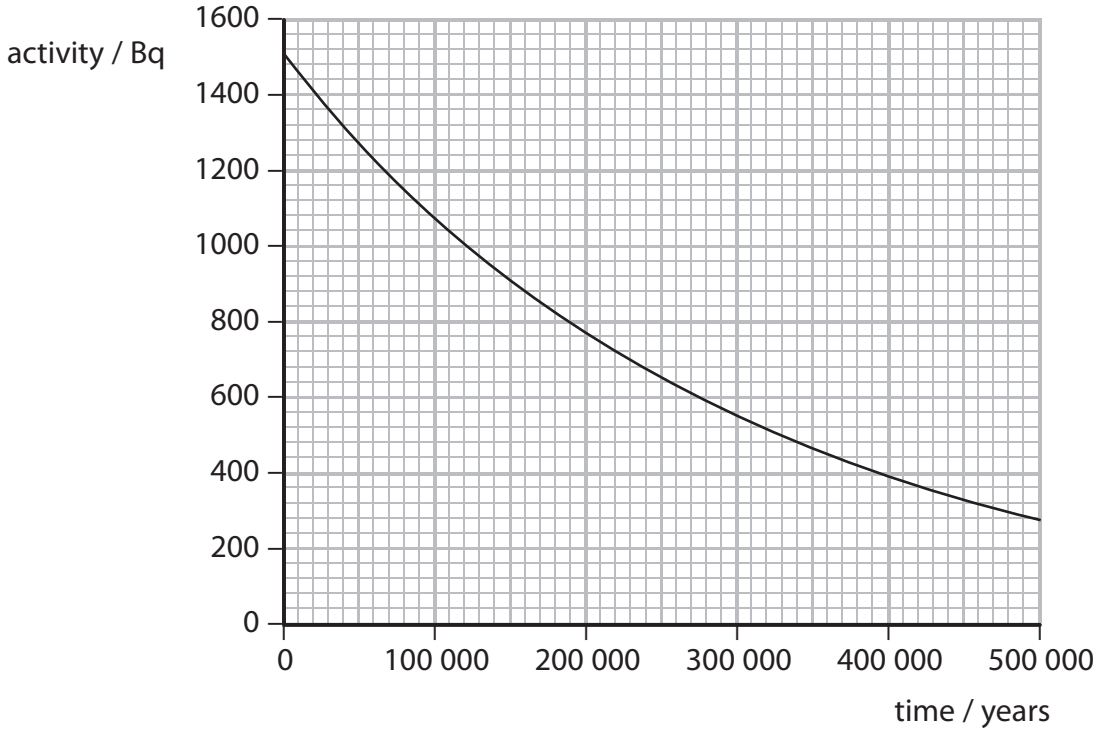
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(b) Technetium-99 is one of the radioactive isotopes in nuclear waste.

The graph shows the decay curve for technetium-99.



(i) Use the graph to show that the half-life of technetium-99 is about 200 000 years.

(2)

(ii) Technetium-99 emits beta particles.

Give **one** reason that beta particles can cause harm to people.

(1)

.....

.....

*(c) There are many radioactive isotopes in nuclear waste.

Technetium-99 is just one of these isotopes.

People are worried about how we should deal with nuclear waste.

Explain why it is difficult to deal with nuclear waste safely.

(6)

(Total for Question 5 = 12 marks)