AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.1.2

# Mass number, atomic number and isotopes

## Past-paper questions

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **43** |
| Available paper years | **2004–2025** |

## 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:** _____

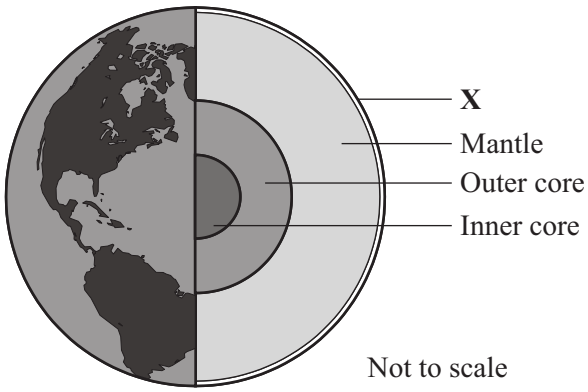
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 01**

June 2004 | 3451F | Original Q5 | Legacy

**5** (a) The diagram gives information about some of the layers that make up the Earth.




(i) What name is given to the outer layer of the Earth labelled **X**?

.....

*(1 mark)*

(ii) What is the difference between the inner core and the outer core?

.....

.....

*(2 marks)*

(b) Which of the following is used to detect the waves produced by an earthquake?

Draw a ring around your answer.

**barograph** **seismograph** **tachograph**

*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 01 · continued**





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(c) Most earthquakes happen where tectonic plates meet. Tectonic plates are large pieces of the Earth's outer layer that move very slowly. Sometimes the plates slide against each other. Earthquakes happen when the force built up in the rock below the Earth's surface is large enough to make the plates move suddenly.

Suggest why it is difficult to accurately predict when an earthquake will happen.

.....

.....

.....

.....

*(2 marks)*

(d) In some parts of the world heat from the rock in the Earth's outer layer produces high pressure steam. The steam is used to generate electricity.

Which **one** of the following words is used to describe this type of energy resource?

Draw a ring around your answer.

**geometric** **geostationary** **geothermal**

*(1 mark)*

(e) A rock sample contains 10 000 atoms of a radioactive uranium isotope. The half-life of this isotope is 4500 million years.

(i) How many atoms of the uranium isotope will be in the rock sample after 4500 million years?

.....

*(1 mark)*

(ii) How many atoms of the uranium isotope will be in the rock sample after 9000 million years?

.....

*(1 mark)*

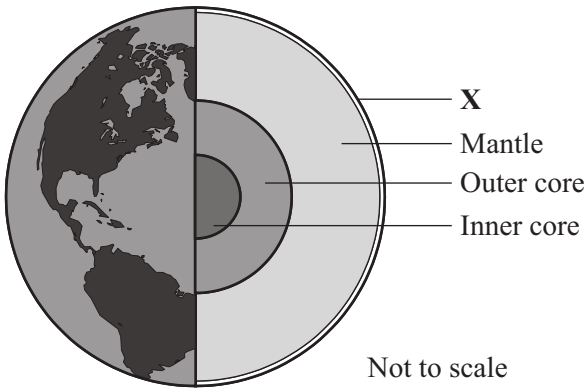
9

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 02**

June 2004 | 3462F3 | Original Q5 | Legacy

**5** (a) The diagram gives information about some of the layers that make up the Earth.




(i) What name is given to the outer layer of the Earth labelled **X**?

.....

*(1 mark)*

(ii) What is the difference between the inner core and the outer core?

.....

.....

*(2 marks)*

(b) Which of the following is used to detect the waves produced by an earthquake?

Draw a ring around your answer.

**barograph** **seismograph** **tachograph**

*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 02 · continued**





MARGIN BLANK

(c) Most earthquakes happen where tectonic plates meet. Tectonic plates are large pieces of the Earth's outer layer that move very slowly. Sometimes the plates slide against each other. Earthquakes happen when the force built up in the rock below the Earth's surface is large enough to make the plates move suddenly.

Suggest why it is difficult to accurately predict when an earthquake will happen.

.....

.....

.....

.....

*(2 marks)*

(d) In some parts of the world heat from the rock in the Earth's outer layer produces high pressure steam. The steam is used to generate electricity.

Which **one** of the following words is used to describe this type of energy resource?

Draw a ring around your answer.

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*(1 mark)*

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(i) How many atoms of the uranium isotope will be in the rock sample after 4500 million years?

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*(1 mark)*

(ii) How many atoms of the uranium isotope will be in the rock sample after 9000 million years?

.....

*(1 mark)*

9

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 03**

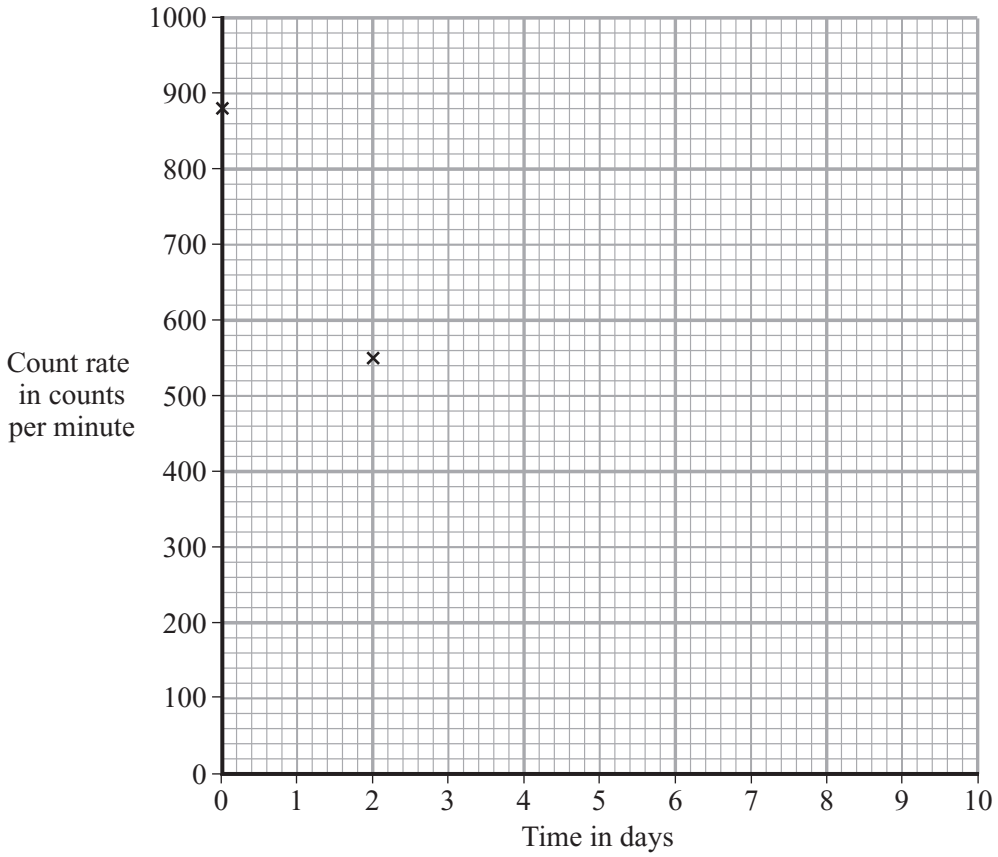
June 2005 | 3451 | Original Q7 | Legacy

**7** The table shows how the count rate from a radioactive substance changes in 10 days.

| Time in days | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Count rate in counts per minute | 880 | 555 | 350 | 220 | 140 | 90 |

(a) Draw a graph of count rate against time.

The first two points have been plotted for you.




*(3 marks)*

(b) (i) Use your graph to find out how long it takes for the count rate to fall from 880 counts per minute to 440 counts per minute.

Time = ..... days
*(1 mark)*

(ii) What is the half-life of this substance?

Half-life = ..... days
*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 03 · continued**





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(c) The table gives the half-life and type of radiation given out by four different radioactive isotopes.

| Radioactive isotope | Half-life in days | Radiation given out |
|---|---|---|
| bismuth-210 | 5.0 | beta |
| polonium-210 | 138.0 | alpha and gamma |
| radon-222 | 3.8 | alpha |
| thorium-234 | 24.1 | beta and gamma |

Some samples of each isotope have the same count rate today. Which sample will have the lowest count rate one month from today?

.....

Give a reason for your answer.

.....

*(2 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 04**

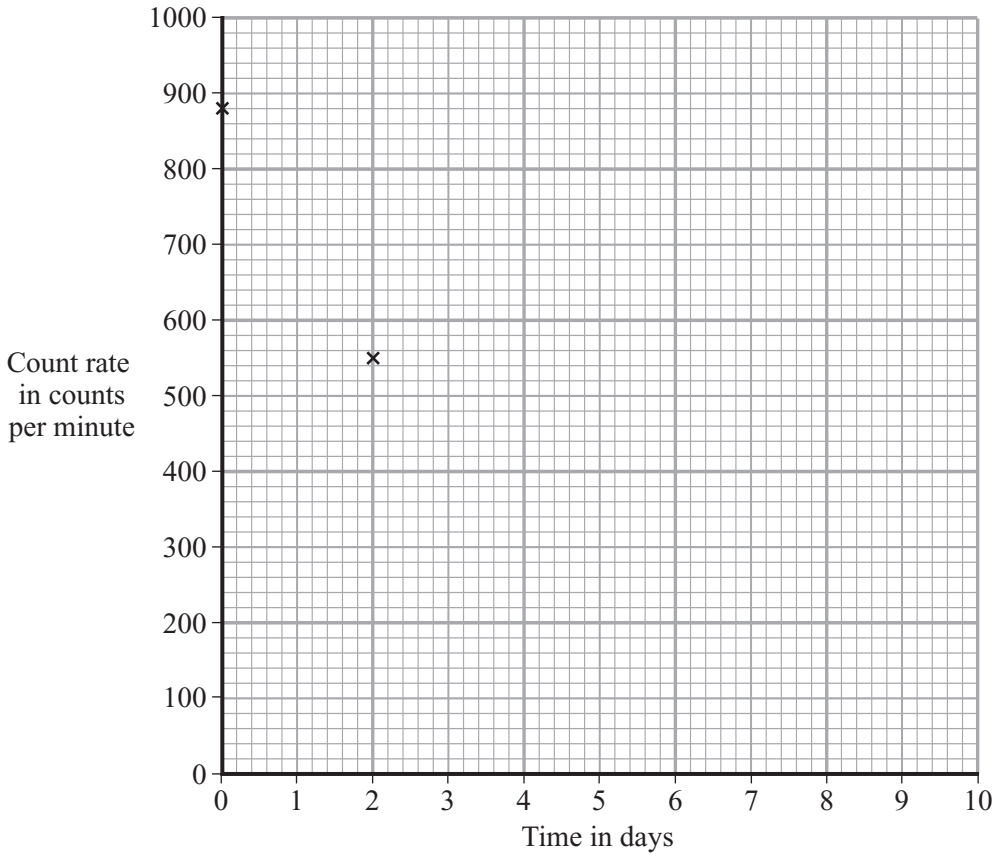
June 2005 | 3462 | Original Q7 | Legacy

**7** The table shows how the count rate from a radioactive substance changes in 10 days.

| Time in days | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Count rate in counts per minute | 880 | 555 | 350 | 220 | 140 | 90 |

(a) Draw a graph of count rate against time.

The first two points have been plotted for you.




*(3 marks)*

(b) (i) Use your graph to find out how long it takes for the count rate to fall from 880 counts per minute to 440 counts per minute.

Time = ..... days
*(1 mark)*

(ii) What is the half-life of this substance?

Half-life = ..... days
*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 04 · continued**





MARGIN
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| bismuth-210 | 5.0 | beta |
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| radon-222 | 3.8 | alpha |
| thorium-234 | 24.1 | beta and gamma |

Some samples of each isotope have the same count rate today. Which sample will have the lowest count rate one month from today?

.....

Give a reason for your answer.

.....

*(2 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 05**

June 2006 | 3451 | Original Q4 | Legacy

**4** (a) The diagrams, **A**, **B** and **C**, represent three different nuclei.

**Diagram A**



2 protons ⊕
4 neutrons ○

**Diagram B**



3 protons ⊕
3 neutrons ○

**Diagram C**



2 protons ⊕
2 neutrons ○

(i) Which **two** nuclei are isotopes of the same element?

..... and .....

*(1 mark)*

(ii) Which **two** nuclei have the same mass number?

..... and .....

*(1 mark)*

(iii) Give a reason for your choice of answer to part (a)(ii).

.....

.....

*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 05 · continued**



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(b) The tables below give examples of some stable nuclei and some unstable nuclei.

| Stable nuclei |
|---|
| boron-11 |
| carbon-12 |
| oxygen-16 |
| lead-207 |

| Unstable nuclei |
|---|
| boron-12 |
| carbon-14 |
| oxygen-15 |
| lead-209 |

(i) Write down, from the tables, the names of **two** radioactive nuclei.

..... and .....

*(1 mark)*

(ii) Write down, from the tables, the names of **two** non-radioactive nuclei.

..... and .....

*(1 mark)*

(c) Complete the following sentence by crossing out the **two** words in the box that are wrong.

The lungs of a person who has breathed in a radioactive gas will be most damaged if the gas gives out

| alpha |
|---|
| beta |
| gamma |

radiation.

*(1 mark)*

**6**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 06**

June 2006 | 3462 | Original Q4 | Legacy

**4** (a) The diagrams, **A**, **B** and **C**, represent three different nuclei.

**Diagram A**



2 protons ⊕
4 neutrons ○

**Diagram B**



3 protons ⊕
3 neutrons ○

**Diagram C**



2 protons ⊕
2 neutrons ○

(i) Which **two** nuclei are isotopes of the same element?

..... and .....

*(1 mark)*

(ii) Which **two** nuclei have the same mass number?

..... and .....

*(1 mark)*

(iii) Give a reason for your choice of answer to part (a)(ii).

.....

.....

*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 06 · continued**



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(b) The tables below give examples of some stable nuclei and some unstable nuclei.

| Stable nuclei |
|---|
| boron-11 |
| carbon-12 |
| oxygen-16 |
| lead-207 |

| Unstable nuclei |
|---|
| boron-12 |
| carbon-14 |
| oxygen-15 |
| lead-209 |

(i) Write down, from the tables, the names of **two** radioactive nuclei.

..... and .....

*(1 mark)*

(ii) Write down, from the tables, the names of **two** non-radioactive nuclei.

..... and .....

*(1 mark)*

(c) Complete the following sentence by crossing out the **two** words in the box that are wrong.

The lungs of a person who has breathed in a radioactive gas will be most damaged if the gas gives out

| alpha |
|---|
| beta |
| gamma |

radiation.

*(1 mark)*

**6**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 07**

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

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 07 · 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.

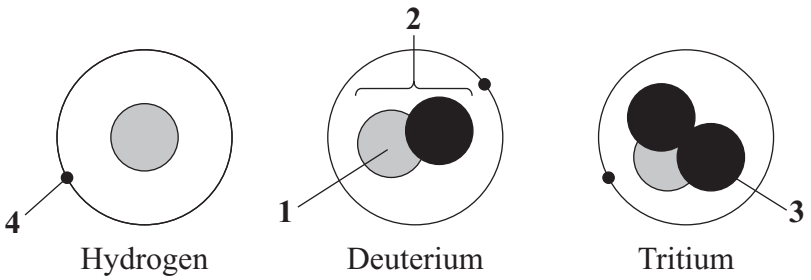
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 08**

June 2007 | PHY1B | Original Q3 | Legacy

**QUESTION THREE**

The diagrams show three isotopes of hydrogen.




Match the parts of atoms, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagrams.

**A** electron

**B** neutron

**C** nucleus

**D** proton

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 09**

June 2007 | PHY1F | Original Q6 | Legacy

**6** Some types of food are treated with *gamma* radiation. Low doses of radiation slow down the ripening of fresh fruit and vegetables while higher doses of radiation kill the bacteria that make the food go off.

(a) (i) What is *gamma* radiation?

.....

*(1 mark)*

(ii) Food packed in crates or boxes can be treated using this method.

Why must a source that emits *gamma* radiation be used?

.....

.....

*(1 mark)*

(iii) A suitable source of gamma radiation is the isotope caesium 137.

Complete the following sentence by choosing the correct word from the box.

| **electrons** | **neutrons** | **protons** |
|---|---|---|

An atom of caesium 137 has two more ..... than an atom of caesium 135.

*(1 mark)*

**Question 6 continues on the next page**

**Question 09 · continued**



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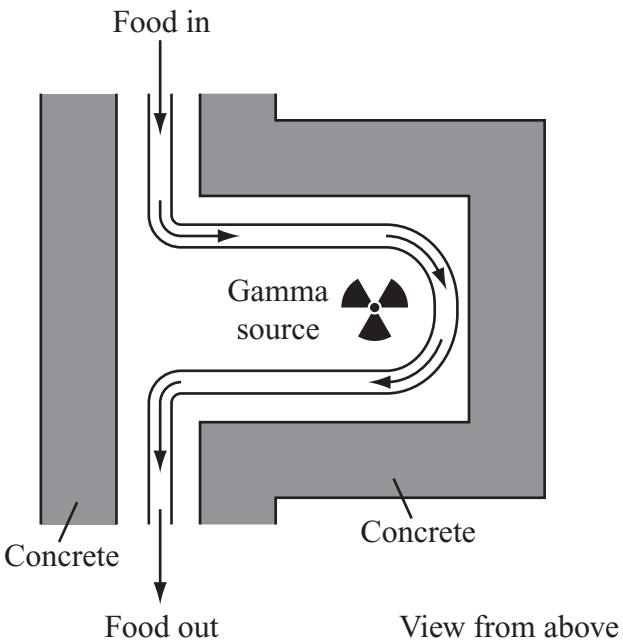
(b) The diagram shows how a conveyor belt can be used to move food past the radioactive source.




(i) How do the concrete walls reduce the radiation hazard to workers outside the food treatment area?

.....

.....

*(1 mark)*

(ii) Suggest **one** way that the dose of radiation received by the food could be increased other than by changing the radioactive source.

.....

.....

*(1 mark)*

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 09 · continued**



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(c) Some people may not like the idea of eating food treated with radiation.

(i) What evidence could a food scientist produce to show that food treated with radiation is safe to eat?

.....

.....

.....

.....

*(2 marks)*

(ii) The diagram shows the sign displayed on food treated with radiation.



Why is it important for people to know which foods have been treated with radiation?

.....

.....

*(1 mark)*

8

**4.4.1.2 Mass number, atomic number and isotopes**

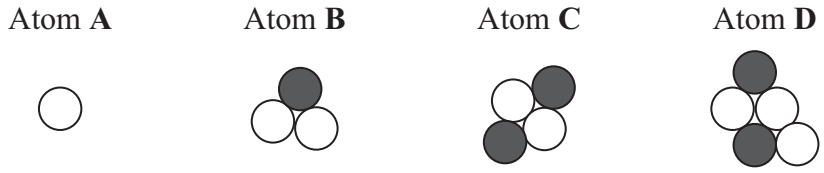
**Question 10**

November 2007 | PHY1B | Original Q4 | Legacy

## QUESTION FOUR

The diagram shows the nuclei of four different atoms, **A**, **B**, **C** and **D**. The protons and neutrons are shaded differently.

Two of the atoms are isotopes of the same element.




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

| | |
|---|---|
| **1** | the nucleus contains one proton |
| **2** | the nucleus contains three protons |
| **3** | the nucleus is an alpha particle |
| **4** | the atom is an isotope of atom **C** |

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 11**

June 2008 | PHY1BP | Original Q3 | Legacy

## QUESTION THREE

This question is about the particles that make up an atom.

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

**A** electrons

**B** neutrons

**C** protons and electrons

**D** protons and neutrons

| | |
|---|---|
| are outside the nucleus | **1** |
| are present in different numbers in isotopes of the same element | **2** |
| are the only particles in the nucleus | **3** |
| their numbers tell you to which element an atom belongs | **4** |

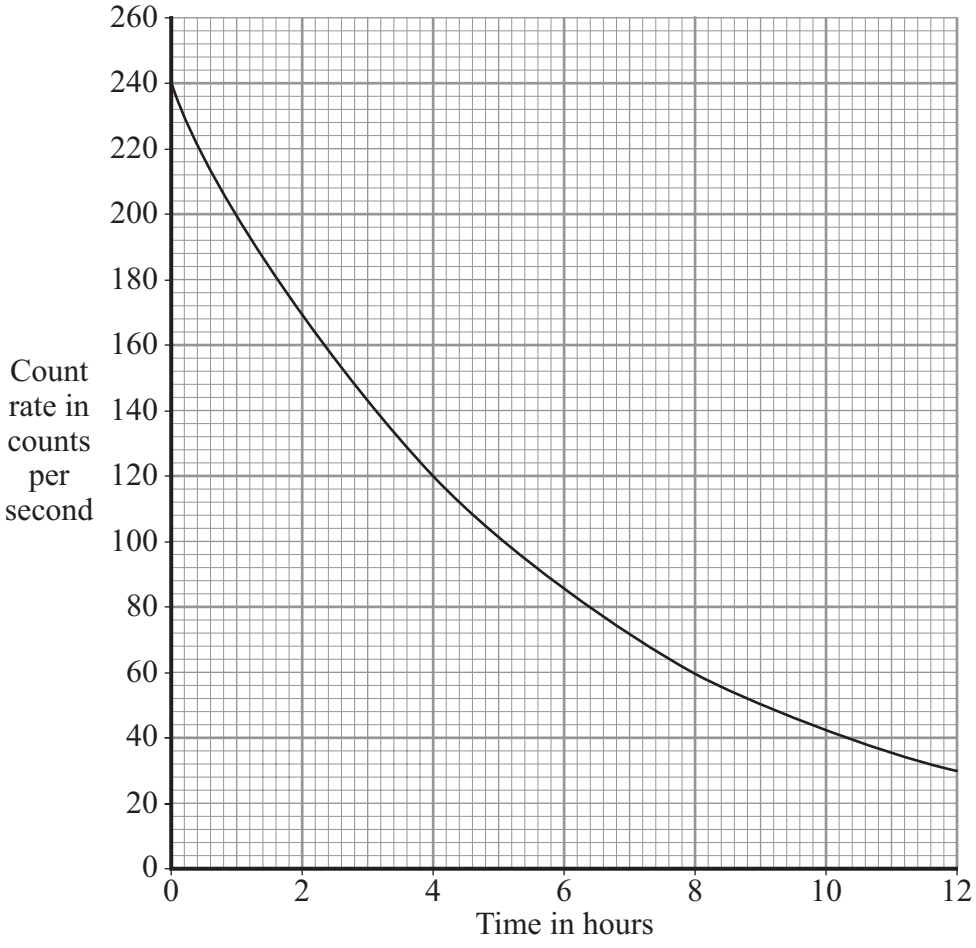
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 12**

June 2008 | PHY1BP | Original Q5 | Legacy

## QUESTION FIVE

The graph shows the count rate of a radioactive isotope over 12 hours.




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

**A** 4

**B** 12

**C** 60

**D** 90

| | |
|---|---|
| the count rate at 8 hours | **1** |
| the number of hours it took the count rate to fall to 30 | **2** |
| the decrease in count rate between 4 and 12 hours | **3** |
| the number of hours it took for the count rate to halve | **4** |

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 13**

June 2008 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

The table gives some information about four radioactive isotopes, **P**, **Q**, **R** and **S**.

| Radioactive isotope | | Type of radiation emitted | Half-life |
|---|---|---|---|
| **P** | americium-237 | alpha | 78 minutes |
| **Q** | americium-241 | alpha | 432 years |
| **R** | technetium-99 | gamma | 6 hours |
| **S** | krypton-78 | beta | 10.7 years |

**9A** Which isotope emits an electron from the nucleus?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**9B** Which isotope emits radiation with the longest range in air?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**9C** Which isotope would be the most suitable for use in a system for controlling paper thickness in a paper factory?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

4.4.1.2 Mass number, atomic number and isotopes

Question 13 · continued



**9D** Which isotope would be most suitable for monitoring the flow of blood through the heart?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**END OF TEST**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 14**

June 2008 | PHY2F | Original Q6 | Legacy

**6** (a) The table gives information about the radioactive isotope, radon-222.

| | |
|---|---|
| mass number | 222 |
| atomic number | 86 |
| radiation emitted | alpha particle |

**6** (a) (i) Complete the following sentence.

The mass number is the total number of..... and

..... inside an atom.

*(2 marks)*

**6** (a) (ii) Radon-222 is an isotope of radon.

How many protons are there in an atom of radon-222?

..... *(1 mark)*

**6** (a) (iii) When an atom of radon-222 emits an alpha particle, the radon-222 changes into an atom of polonium-218.

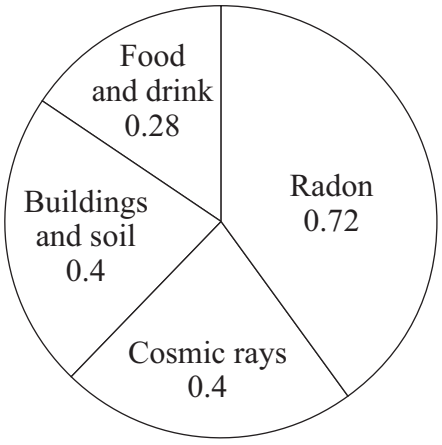
An alpha particle consists of 2 protons and 2 neutrons.

How is the structure of the nucleus of a polonium-218 atom different from the structure of the nucleus of a radon-222 atom?

.....

*(1 mark)*

**6** (b) The pie chart shows the average radiation dose that a person in the UK receives each year from natural background radiation.
The doses are measured in millisieverts (mSv).



Question 14 · continued



*for mark*

**6** (b) (i) Calculate the proportion of natural background radiation that comes from radon. Show clearly how you work out your answer.

.....

.....

Proportion of radon = .....

*(2 marks)*

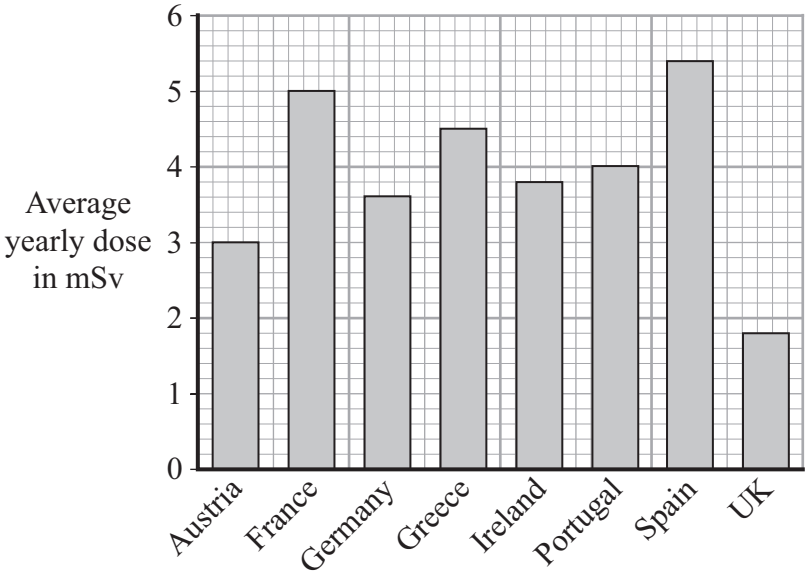
**6** (b) (ii) Not all background radiation is from natural sources.

Name **one** source of background radiation that is not natural.

.....

*(1 mark)*

**6** (c) The bar chart shows the average yearly dose from natural background radiation in different European countries.




**6** (c) (i) How many times bigger is the average annual background dose in Germany compared to the UK?

.....

*(1 mark)*

**Question 6 continues on the next page**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 14 · continued**



*for mark*

**6** (c) (ii) The following table gives the effects of different radiation doses on the human body.

| Radiation dose in mSv | Effects |
|---|---|
| 10 000 | Immediate illness; death within a few weeks |
| 1 000 | Radiation sickness; unlikely to cause death |
| 50 | Lowest dose with evidence of causing cancer |

A family goes to Germany for a two-week holiday. Should they be concerned about the higher level of background radiation in Germany?

Draw a ring around your answer.

**Yes** **No**

Explain your answer.

.....

.....

.....

.....

*(2 marks)*

10

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 15**

November 2008 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

Atoms are made up of different parts.

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

**A** electrons

**B** neutrons

**C** nuclei

**D** protons

All atoms of an element have the same number of positive particles called . . . **1** . . . .

These are located in their . . . **2** . . . .

The central part of an atom is surrounded by . . . **3** . . . .

The atoms of isotopes of the same element have a different number of . . . **4** . . . .

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 16**

March 2009 | PHY1BP | Original Q4 | Legacy

**QUESTION FOUR**

This question is about the structure of the atom.

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

**A** electrons

**B** neutrons

**C** nuclei

**D** protons

The central part of the atom is surrounded by a number of . . . **1** . . . .

In the central part of the atom, there are positive particles called . . . **2** . . . .

The central parts of atoms are called . . . **3** . . . .

Isotopes of the same element contain different numbers of . . . **4** . . . .

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 17**

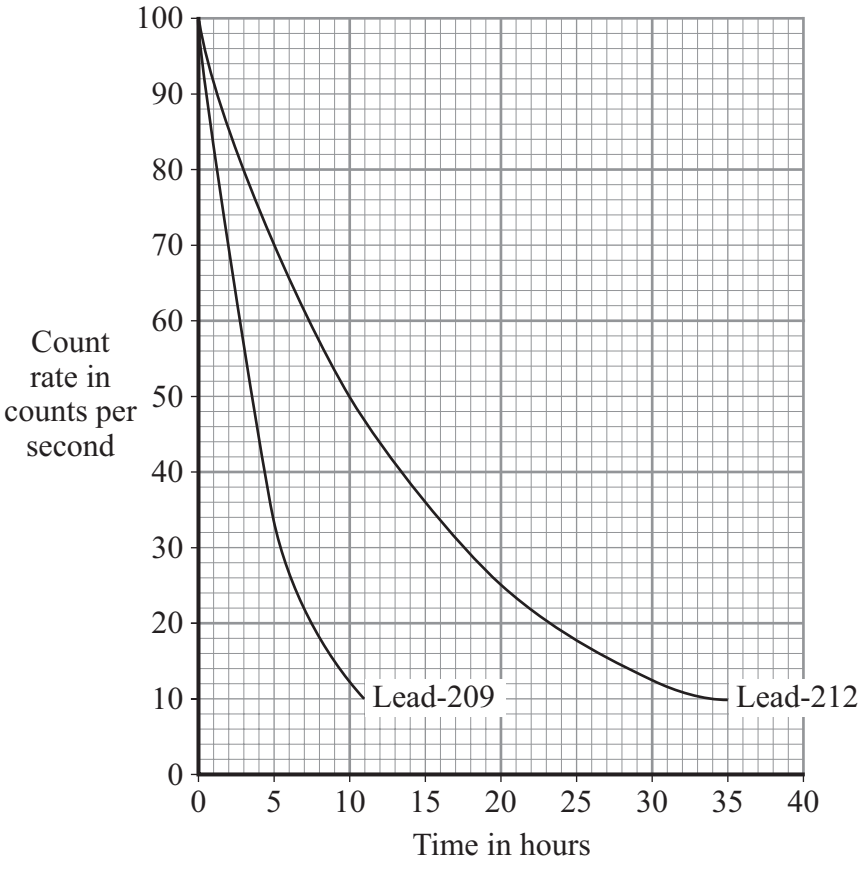
March 2009 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

The graph shows the radioactive decay of two isotopes of lead.

In lead-209, the total number of protons and neutrons is 209.

In lead-212, the total number of protons and neutrons is 212.




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

**A** 3

**B** 10

**C** 12

**D** 60

The half-life of lead-212 is . . . **1** . . . hours.

After 10 hours, the count rate of lead-209 is . . . **2** . . . counts per second.

When the count rate of lead-209 has dropped to 20 counts per second, the count rate of lead-212 has dropped to . . . **3** . . . counts per second.

Lead-212 has . . . **4** . . . more neutrons than lead-209.

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 18**

June 2009 | PHY1BP | Original Q6 | Legacy

## QUESTION SIX

The radioactive isotope phosphorus-32 emits beta particles.

Scientists use phosphorus-32 to help them to understand how plants use phosphorus to grow.

**6A** A material is described as radioactive if it gives out . . .

**1** radio waves all the time.

**2** nuclear radiation all the time.

**3** radio waves when heated.

**4** nuclear radiation when heated.

**6B** Phosphorus-32 is one of the isotopes of phosphorus.

Atoms of the other isotopes of phosphorus have different numbers of . . .

**1** electrons.

**2** neutrons.

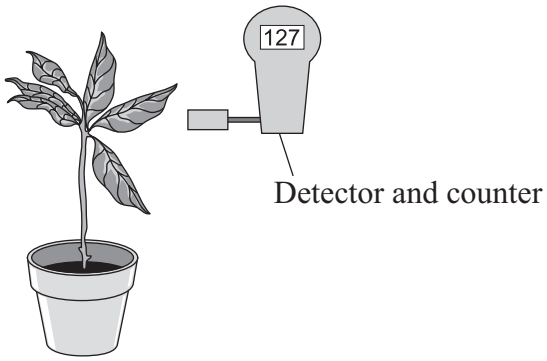
**3** nuclei.

**4** protons.

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 18 · continued**






**6C** The path of the phosphorus in the plant can be traced because the detector can detect . . .

**1** beta particles.

**2** phosphorus atoms.

**3** phosphorus nuclei.

**4** ultraviolet radiation.

**6D** Phosphorus-32 has a half-life of 14 days.

This means that the number of phosphorus-32 nuclei will . . .

**1** fall to zero in 14 days.

**2** halve in 14 days.

**3** double in 14 days.

**4** be unchanged in 14 days.

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 19**

June 2009 | PHY2F | Original Q7 | Legacy

**7** The table gives information about the three types of particle that make up an atom.

| Particle | Relative mass | Relative charge |
|---|---|---|
| Proton | | +1 |
| Neutron | 1 | |
| Electron | very small | –1 |

**7** (a) Complete the table by adding the **two** missing values. *(2 marks)*

**7** (b) Use the information in the table to explain why an atom has no overall electrical charge.

.....

.....

.....

.....

*(2 marks)*

**7** (c) Uranium has two natural isotopes, uranium-235 and uranium-238.
Uranium-235 is used as a fuel inside a nuclear reactor.
Inside the reactor, atoms of uranium-235 are split and energy is released.

**7** (c) (i) How is the structure of an atom of uranium-235 different from the structure of an atom of uranium-238?

.....

.....

*(1 mark)*

**7** (c) (ii) The nucleus of a uranium-235 atom must absorb a particle before the atom is able to split.

What type of particle is absorbed?

.....

*(1 mark)*

**7** (c) (iii) The nucleus of an atom splits into smaller parts in a reactor.

What name is given to this process?

.....

*(1 mark)*

7

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 20**

November 2009 | PHY1BP | Original Q3 | Legacy

## QUESTION THREE

This question is about a radioactive isotope that emits alpha particles.

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

**A** count rate

**B** half-life

**C** penetrating power

**D** range

| | **Description** |
|---|---|
| **1** | the number of alpha particles detected per second |
| **2** | the distance the alpha particles travel before being fully absorbed |
| **3** | the time it takes for half of the nuclei of the isotope to decay |
| **4** | the ability of the alpha particles to pass through matter |

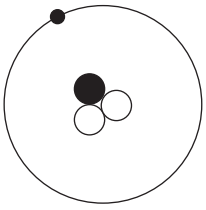
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 21**

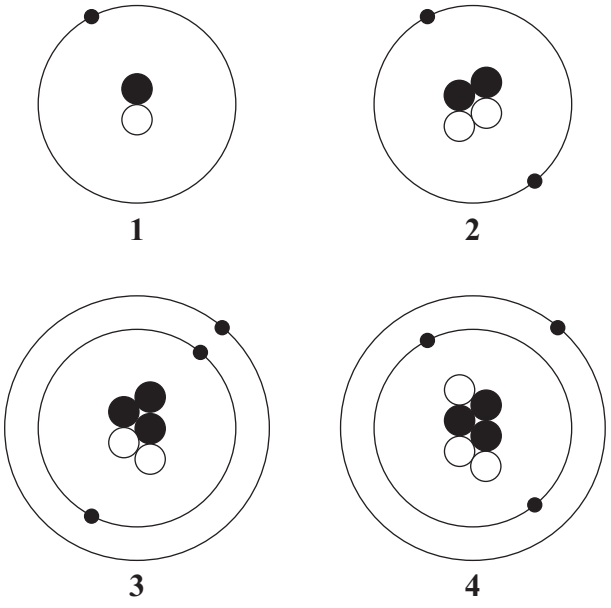
November 2009 | PHY1BP | Original Q4 | Legacy

## QUESTION FOUR

The diagram shows an isotope of hydrogen. It contains one electron, one proton and two neutrons.



Four other atoms are labelled **1–4**.




Match statements, **A**, **B**, **C** and **D**, with the atoms labelled **1–4**.

**A** contains 5 particles in its nucleus

**B** has a nucleus that is identical in structure to an alpha particle

**C** has the same number of electrons as atom **3**

**D** is a different isotope of hydrogen

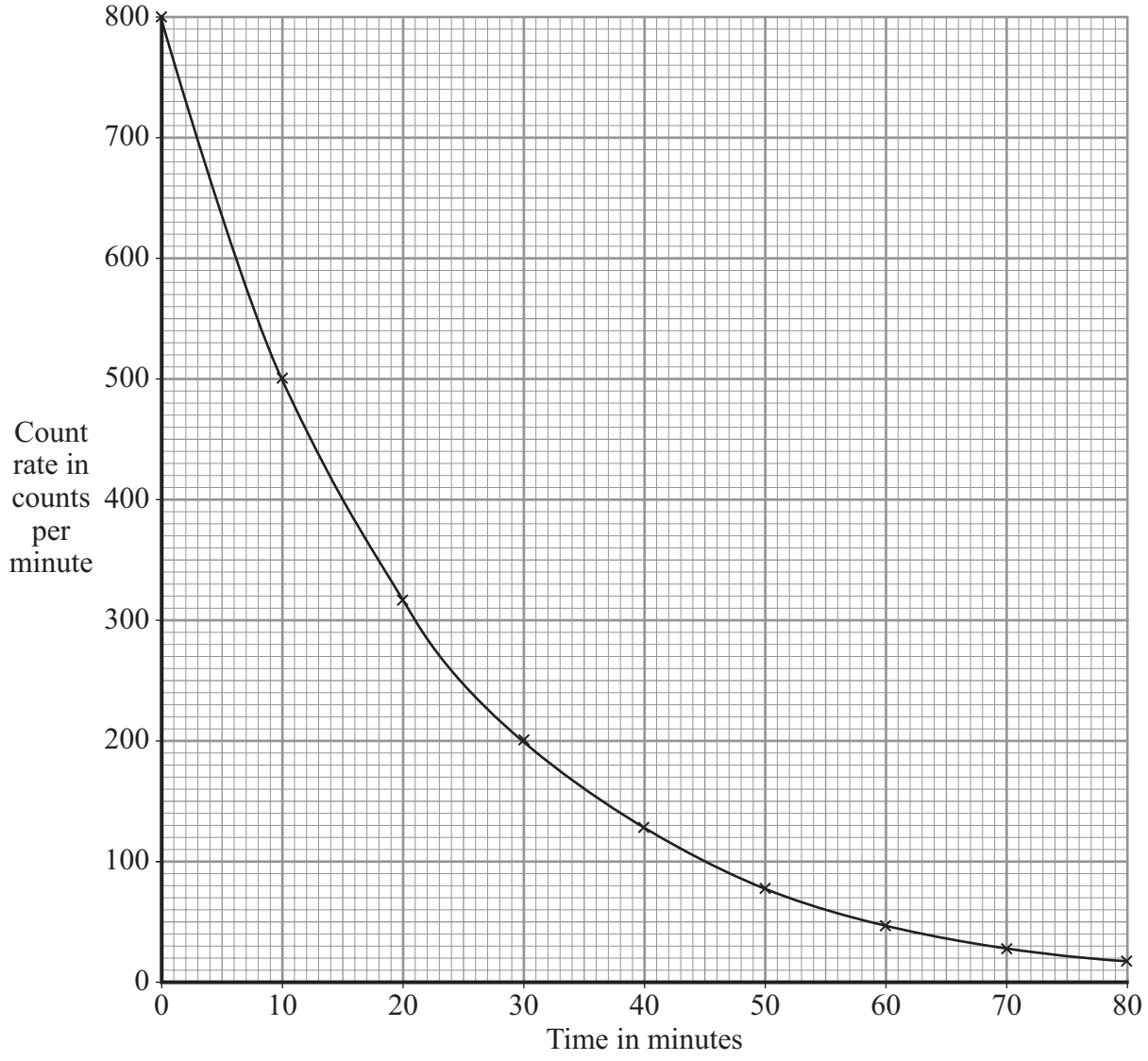
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 22**

November 2009 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

The graph shows how the count rate of a radioactive isotope varies with time.




**9A** What is the half-life of the isotope?

**1** 10 minutes

**2** 15 minutes

**3** 20 minutes

**4** 80 minutes

Question 22 · continued



**9B** The person who plotted the graph has drawn a line graph rather than a bar chart.

What is the reason for this?

**1** Both the count rate and time are continuous variables.

**2** Time is a discrete variable and count rate is a continuous variable.

**3** Time is a continuous variable and count rate is a categoric variable.

**4** Both the count rate and time are discrete variables.

**9C** The government recommends that all homes are fitted with smoke alarms. Americium-241 is used in these alarms. Americium-241 emits alpha particles and has a half-life of 460 years.

The americium-241 is safe to use in homes because . . .

**1** it has a long half-life.

**2** alpha particles travel only a few centimetres in air.

**3** smoke alarm batteries are replaced regularly.

**4** its nucleus has 146 neutrons.

**9D** This information is about the isotope technetium-99.

- It emits gamma radiation.
- Its half-life is 6 hours.
- It decays to a stable isotope of rubidium.
- It is used for diagnostic medical studies.
- It is put into the body.

A doctor wants to convince a patient that technetium-99 is safe to use to diagnose a medical problem.

Which of the following should he use to reassure the patient?

**1** Rubidium is a rare metallic element.

**2** Gamma radiation is part of the electromagnetic spectrum.

**3** The half-life of the technetium-99 isotope is relatively short.

**4** There is no risk in using radioactive materials.

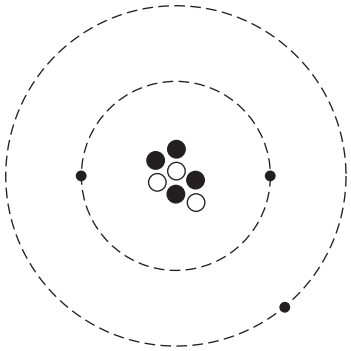
**END OF TEST**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 23**

January 2010 | PHY2F | Original Q4 | Legacy

**4** The diagram represents an atom of lithium.



**4** (a) (i) Complete the following table of information for an atom of lithium.

| | |
|---|---|
| Number of protons | |
| Number of electrons | |
| Number of neutrons | |

*(2 marks)*

**4** (a) (ii) What is the mass number of a lithium atom?

Draw a ring around your answer.

| | | | |
|---|---|---|---|
| **3** | **4** | **7** | **10** |

Give a reason for your answer.

.....

.....

*(2 marks)*

**4** (b) Complete the following sentence by drawing a ring around the correct line in the box.

An atom that has lost an electron is called

| |
|---|
| an ion |
| an isotope |
| a positive atom |

.

*(1 mark)*

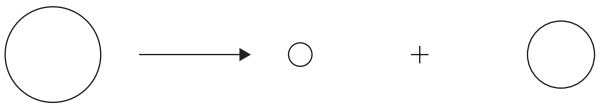
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 23 · continued**



*for mark*

**4** (c) When an alpha particle is emitted from the nucleus of a radon atom, the radon changes into polonium.



Radon — Alpha particle — Polonium

**Not to scale**

An alpha particle consists of 2 protons and 2 neutrons.

**4** (c) (i) Complete the following sentence by drawing a ring around the correct line in the box.

The mass of a polonium atom is

| |
|---|
| greater than |
| the same as |
| smaller than |

the mass of a radon atom.

*(1 mark)*

**4** (c) (ii) Give a reason for your answer to part (c)(i).

.....

.....

*(1 mark)*

7

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 24**

March 2010 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

The table shows part of the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gamma | | Ultraviolet | | Infra red | | Radio |

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

**A** gamma

**B** infra red

**C** radio

**D** ultraviolet

The part of the electromagnetic spectrum with the longest wavelengths is . . . **1** . . . .

Between X-rays and visible light in the electromagnetic spectrum is . . . **2** . . . radiation.

Some radioactive isotopes emit . . . **3** . . . radiation.

Signals can be sent from remote controls to a television by . . . **4** . . . radiation.

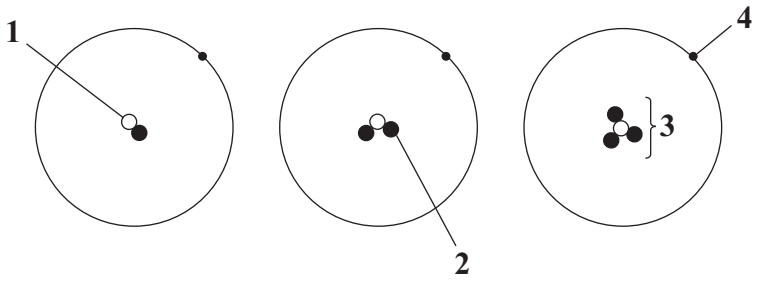
### 4.4.1.2 Mass number, atomic number and isotopes

**Question 25**

March 2010 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

The diagrams show three isotopes of hydrogen.




Match words, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagrams.

**A** electron

**B** neutron

**C** nucleus

**D** proton

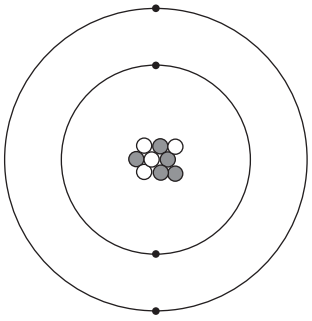
### 4.4.1.2 Mass number, atomic number and isotopes

**Question 26**

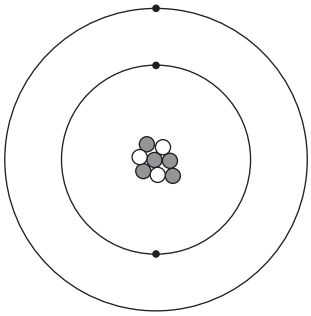
June 2010 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

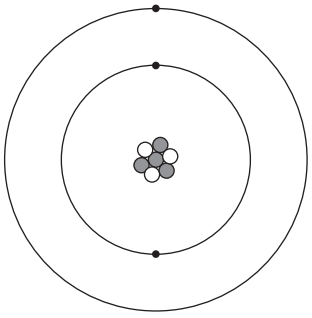
The diagram shows four atoms, **W**, **X**, **Y** and **Z**.



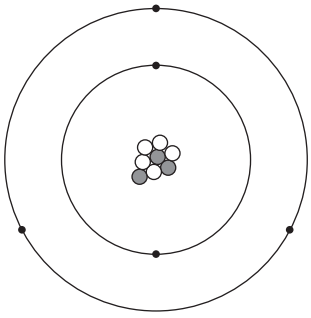
Atom **W**



Atom **X**



Atom **Y**



Atom **Z**

Atoms **X** and **Y** are isotopes of the same element.

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

**A** three

**B** four

**C** five

**D** eight

Atom **W** contains . . . **1** . . . electrons.

Atom **X** contains . . . **2** . . . neutrons.

Atom **Y** contains . . . **3** . . . protons.

Atom **Z**'s nucleus contains . . . **4** . . . particles.

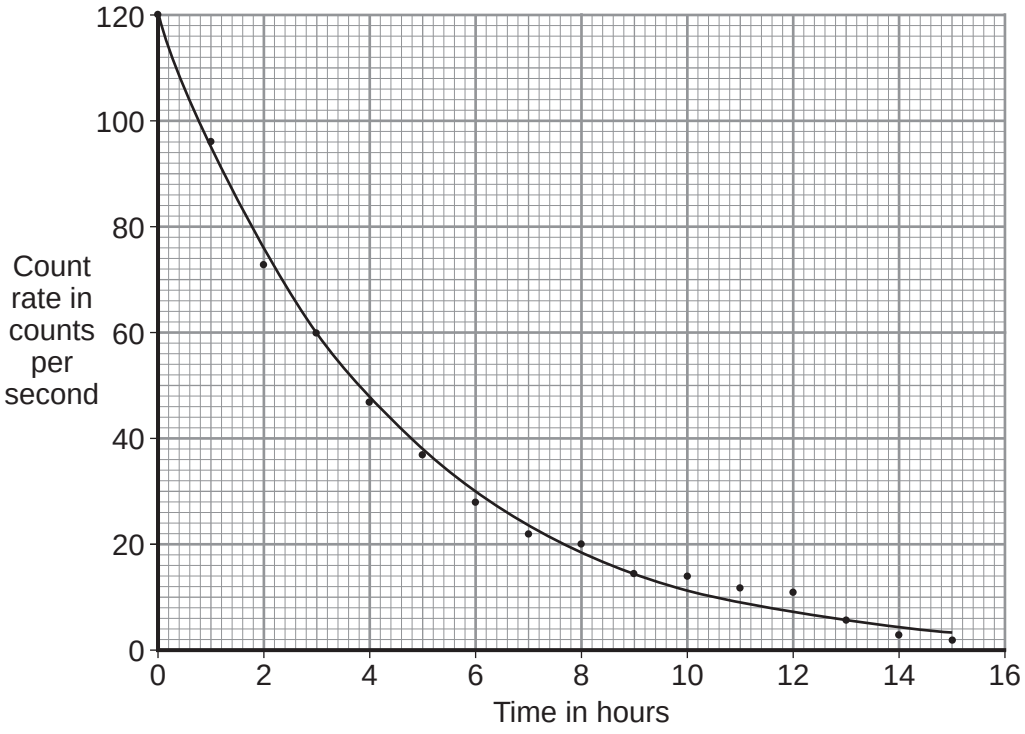
### 4.4.1.2 Mass number, atomic number and isotopes

**Question 27**

June 2010 | PHY1BP | Original Q9 | Legacy

**QUESTION NINE**

The graph shows the count rate of a radioactive isotope over 15 hours.




**9A** Which row in the table describes correctly the types of variable?

| | Count rate | Time |
|---|---|---|
| **1** | categoric | categoric |
| **2** | categoric | continuous |
| **3** | continuous | categoric |
| **4** | continuous | continuous |

**9B** Not all the points of the graph lie on the drawn curve.

The line drawn is called . . .

**1** a discrete line.

**2** a line of best fit.

**3** a line of least resistance.

**4** an error line.

4.4.1.2 Mass number, atomic number and isotopes

Question 27 · continued



**9C** The half-life of the radioactive isotope is . . .

**1** 2 hours.

**2** 3 hours.

**3** 5 hours.

**4** 7 hours.

**9D** A different radioactive isotope has a half-life of 10 hours.

What fraction of the original mass of isotope will be left after 30 hours?

**1** $\frac{1}{3}$

**2** $\frac{1}{8}$

**3** $\frac{1}{30}$

**4** $\frac{7}{8}$

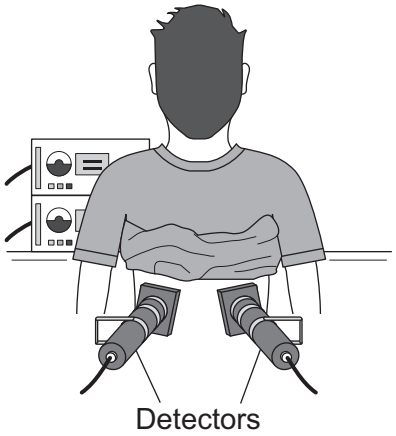
**END OF TEST**

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 28**

June 2010 | PHY1F | Original Q7 | Legacy

**7 (a)** A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.




The doctor injects a small amount of technetium-99 into the patient's bloodstream.

Technetium-99 emits *gamma radiation*.

Give **two** reasons why an isotope that emits gamma radiation is injected into the patient rather than an isotope that emits alpha radiation.

1 .....

.....

2 .....

.....

*(2 marks)*

4.4.1.2 Mass number, atomic number and isotopes

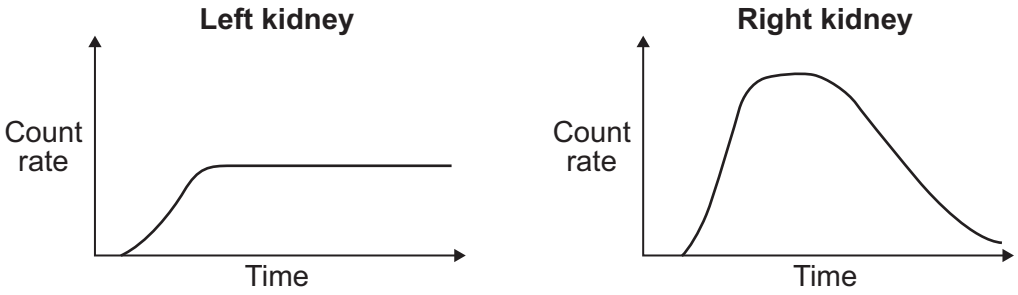
Question 28 · continued



**7 (b)** If the patient's kidneys are working correctly, the technetium-99 will pass from the bloodstream into the kidneys and then into the patient's urine.

Detectors are used to measure the radiation emitted from the kidneys.

The level of radiation emitted from each kidney is recorded on a graph.




**7 (b) (i)** How do the graphs show that technetium-99 is passing from the bloodstream into each kidney?

.....

.....

*(1 mark)*

**7 (b) (ii)** By looking at the graphs, the doctor is able to tell if there is a problem with the patient's kidneys.

Which **one** of the following statements is correct?

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

Only the right kidney is working correctly. ☐

Only the left kidney is working correctly. ☐

Both kidneys are working correctly. ☐

Explain the reason for your answer.

.....

.....

.....

.....

*(3 marks)*

**Question 7 continues on the next page**

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 28 · continued**



**7 (c)** The patient was worried about having a radioactive isotope injected into their body. The doctor explained that the risk to the patient's health was very small as technetium-99 has a short *half-life*.

**7 (c) (i)** What does the term *half-life* mean?

.....

.....

*(1 mark)*

**7 (c) (ii)** Explain why it is important that the doctor uses an isotope with a short half-life rather than an isotope with a long half-life.

.....

.....

.....

.....

*(2 marks)*

9

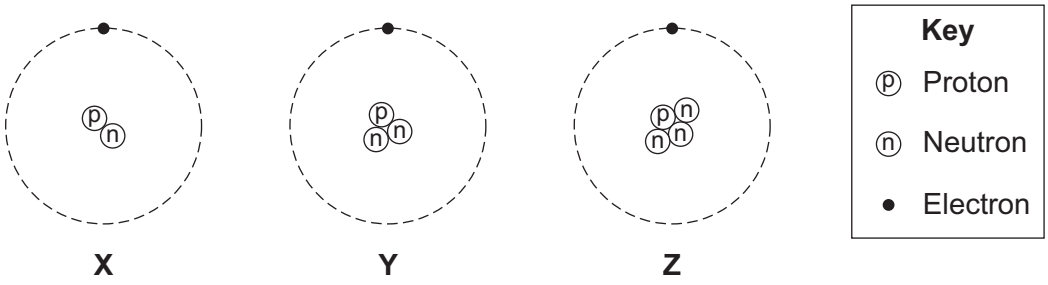
### 4.4.1.2 Mass number, atomic number and isotopes

Question 29

November 2010 | PHY1BP | Original Q8 | Legacy

**QUESTION EIGHT**

The diagram shows three atoms, **X**, **Y** and **Z**.




**8A** Which of these atoms are isotopes of the same element?

**1** **X**, **Y** and **Z**

**2** **X** and **Y** only

**3** **X** and **Z** only

**4** **Y** and **Z** only

**8B** Some substances are radioactive.

What does this mean?

**1** Radio signals make these substances emit radiation.

**2** These substances can take part in chemical reactions.

**3** These substances emit radiation from the nuclei of their atoms.

**4** These substances glow in the dark.

**8C** Some substances emit beta radiation.

What is beta radiation?

**1** a helium nucleus

**2** an electron from outside the nucleus

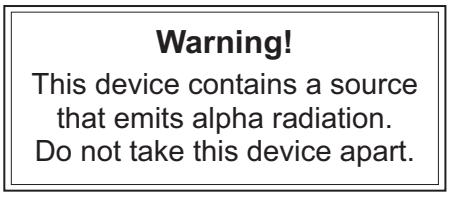
**3** an electron from inside the nucleus

**4** an electromagnetic wave

Question 29 · continued



**8D** The warning label is from a smoke detector.




What is the reason for this warning?

**1** Alpha radiation is very dangerous if the source gets inside the body.

**2** Alpha radiation can travel very long distances in the air.

**3** Alpha radiation has the longest half-life.

**4** Alpha radiation is the most penetrating of all radiations.

**Turn over for the next question**

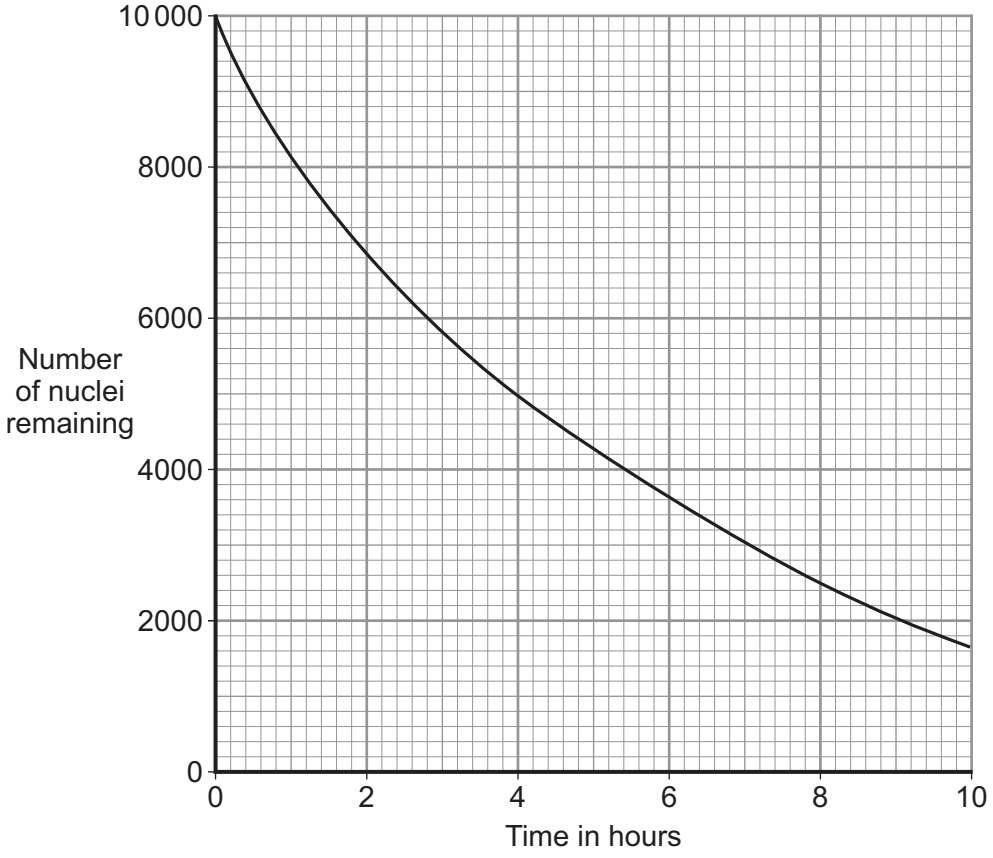
**4.4.1.2 Mass number, atomic number and isotopes**

**Question 30**

November 2010 | PHY1BP | Original Q9 | Legacy

**QUESTION NINE**

The graph shows the decay of a small sample of radioactive isotope. At the start, the sample contains 10 000 nuclei.




**9A** What is the half-life of the isotope shown in the graph?

**1** 2 hours

**2** 4 hours

**3** 6 hours

**4** 8 hours

**9B** How many of the original nuclei would remain after three half-lives?

**1** 1250

**2** 2500

**3** 3333

**4** none

Question 30 · continued



**9C** This radioactive isotope may be suitable . . .

**1** as a source of radiation in a smoke alarm.

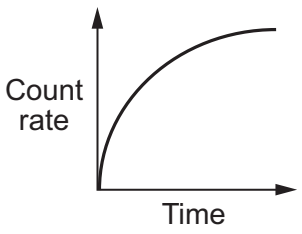
**2** as a source of radiation to monitor the thickness of paper in a paper mill.

**3** as a medical tracer in the human body.

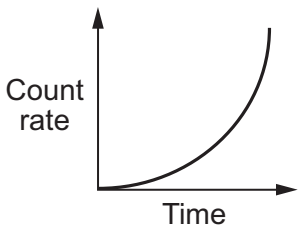
**4** to use in finding the age of an ancient bone.

**9D** Which one of the following graphs would show how the count rate for this isotope changes with time?

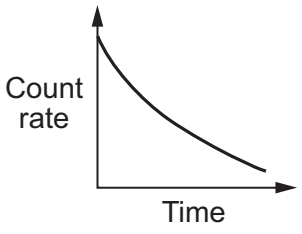
**1**



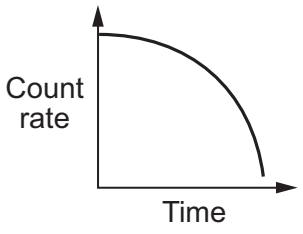

**2**




**3**




**4**




**END OF TEST**

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 31**

March 2011 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

This question is about gamma radiation.

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

**A** bacteria

**B** cells

**C** isotopes

**D** particles

Gamma radiation is emitted by the nuclei of radioactive . . . **1** . . . .

Gamma radiation can be used by doctors to kill cancer . . . **2** . . . .

Gamma radiation can be used to kill . . . **3** . . . that cause food to rot.

Unlike alpha and beta radiation, gamma radiation does not consist of . . . **4** . . . .

4.4.1.2 Mass number, atomic number and isotopes

Question 32

June 2011 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

The following article appeared in a newspaper.

### Radioactive Fruit!

Some supermarkets sell fresh fruit that has been exposed to radiation.

A spokesperson for the supermarkets explained: "The radiation kills bacteria on the surface and inside the fruit. This means that the fruit stays fresh for longer. Scientists have done tests on the treated fruit and are sure that it is safe to eat."

He added: "Fruit that has been treated in this way will be clearly labelled."

A consumer group has said: "We do not believe that fruit treated with radioactivity is safe. We are trying to stop supermarkets from selling it."

**8A** To reassure customers that the treated fruit is safe to eat, the supermarket should . . .

**1** explain that the treated fruit will stay fresh for longer.

**2** sell the treated fruit at a lower price than the untreated fruit.

**3** show that the scientists who did the tests were not biased.

**4** tell customers that the taste of the fruit has not changed.

**8B** The government has said that all fruit should be clearly labelled to show if it has been treated with radiation.

This is because . . .

**1** people can then decide whether or not they want to eat fruit treated with radiation.

**2** the government knows that treated fruit is dangerous to eat.

**3** the government wants to encourage people to eat more fruit.

**4** the labels can make the fruit more attractive.

4.4.1.2 Mass number, atomic number and isotopes

Question 32 · continued



**8C** The headline of the newspaper says that the fruit is radioactive.

What should scientists do to test if this is true?

**1** measure the time it takes for the fruit to go rotten

**2** put the fruit close to a radiation detector and see if the count rate goes up

**3** put the fruit close to a radiation detector and see if the count rate goes down

**4** see if the fruit glows when placed in a dark room

**8D** The radiation used to treat the fruit kills bacteria both on the surface and inside the fruit.

The radioactive isotope used must emit the right type of radiation. It must also have a suitable half-life.

Which row in the table describes the most suitable radioactive isotope to use?

| Isotope | Radiation emitted | Half-life |
|---|---|---|
| **1** | alpha | 6 hours |
| **2** | alpha | 60 years |
| **3** | gamma | 5 hours |
| **4** | gamma | 5 years |

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 33**

June 2011 | PHY1F | Original Q8 | Legacy

**8 (a)** By 2023, nearly all of the existing nuclear power stations in the UK will be closed down.

**8 (a) (i)** Before a nuclear power station can be demolished, the remaining nuclear fuel, radioactive waste materials and reactor must be carefully removed.

What is this process called?

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

decommissioning ☐

decontaminating ☐

dismantling ☐

*(1 mark)*

**8 (a) (ii)** The workers are exposed to radiation as they remove the reactor. One of the biggest risks is from the isotope cobalt-60, which has a half-life of 5.3 years.

Explain the advantage of waiting 11 years after a nuclear power station has closed down before starting to remove the reactor.

.....

.....

.....

.....

*(2 marks)*

4.4.1.2 Mass number, atomic number and isotopes

Question 33 · continued



**8 (b)** It is almost certain that new nuclear power stations will be built in the UK.

The table shows the results of surveys asking people in the UK whether they were in favour of, or against, the building of new nuclear power stations.

| | 2001 | 2005 | 2007 |
|---|---|---|---|
| **Percentage (%) in favour** | 20 | 41 | 65 |
| **Percentage (%) against** | 60 | 28 | 20 |
| **Percentage (%) not sure** | 20 | 31 | 15 |

**8 (b) (i)** From these surveys, how did public opinion on the building of new nuclear power stations change between 2001 and 2007?

.....

.....

*(1 mark)*

**8 (b) (ii)** Suggest a reason why some people may think that the results from these surveys are unreliable.

.....

.....

*(1 mark)*

**8 (b) (iii)** Give **one** reason in favour of building new nuclear power stations.

.....

.....

*(1 mark)*

**Question 8 continues on the next page**

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 33 · continued**



**8 (c)** The government of one Middle Eastern country has decided to build its first nuclear power station. The oil that would have been used to generate electricity can then be sold to other countries.

On what is this decision based?

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

economic issues ☐

ethical issues ☐

social issues ☐

*(1 mark)*

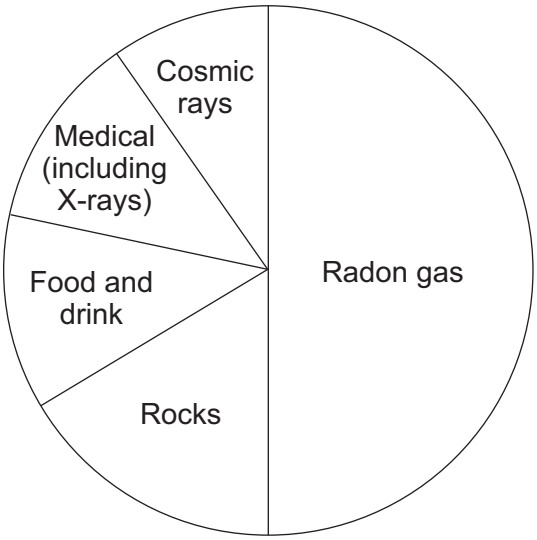
7

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 34**

June 2011 | PHY2F | Original Q1 | Legacy

**1** The pie chart shows the average proportions of background radiation from various sources in the UK.




Three sources of background radiation are given in **List A**.
Statements about sources of background radiation are given in **List B**.

Draw **one** line to link each source of background radiation in **List A** to the statement about that source given in **List B**.

Draw only **three** lines.

| List A | List B |
|---|---|
| X-rays | Are used to show broken bones. |
| Cosmic rays | The radiation comes from outer space. |
| Radon gas | Comes from soil containing a radioactive isotope of potassium. |
| | Gives about 50% of all background radiation. |

*(3 marks)*

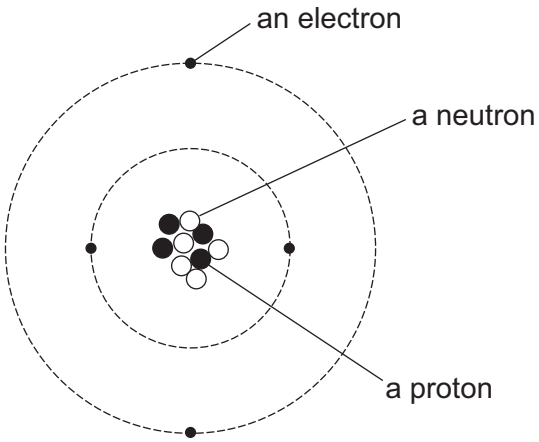
3

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 35**

June 2011 | PHY2F | Original Q2 | Legacy

**2** The diagram represents an atom of beryllium. The three types of particle that make up the atom have been labelled.




**2 (a)** Use the labels from the diagram to complete the following statements.

Each label should be used once.

The particle with a positive charge is ..... .

The particle with the smallest mass is ..... .

The particle with no charge is ..... .

*(2 marks)*

**2 (b)** What is the atomic number of a beryllium atom?

Draw a ring around your answer.

| 4 | 5 | 9 | 13 |
|---|---|---|---|

Give a reason for your answer.

.....

.....

*(2 marks)*

4.4.1.2 Mass number, atomic number and isotopes

Question 35 · continued



**2 (c)** Which **one** of the following statements describes what can happen to an atom to change it into an ion?

Tick (✓) **one** box.

The atom loses a neutron. ☐

The atom loses an electron. ☐

The atom loses a proton. ☐

*(1 mark)*

5

**Turn over for the next question**

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 36**

June 2013 | PH2FP | Original Q1 | Legacy

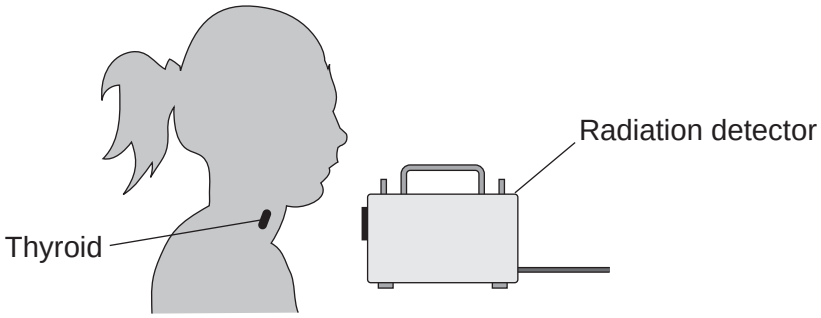
**1 (a)** The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B.**

Draw **one** line from each type of radiation in **List A** to its correct property in **List B**.

| List A<br>Type of radiation | List B<br>Property of radiation |
|---|---|
| | will pass through paper but is stopped by thin metal |
| alpha | |
| | has the shortest range in air |
| beta | |
| | will not harm human cells |
| gamma | |
| | is very weakly ionising |

*(3 marks)*

**1 (b)** The radioactive isotope iodine-123 can be used by a doctor to examine the thyroid gland of a patient. The iodine, taken as a tablet, is absorbed by the thyroid gland. The gamma radiation emitted as the iodine atoms decay is detected outside the body.




The doctor uses an isotope emitting gamma radiation to examine the thyroid gland rather than an isotope emitting alpha or beta radiation.

Which **one** of the following gives a reason why gamma radiation is used?

Tick (✓) **one** box.

Gamma radiation will pass through the body. ☐

Gamma radiation is not deflected by a magnet. ☐

Gamma radiation has a long range in air. ☐

*(1 mark)*

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 36 · continued**



**1 (c)** Iodine-123 has a half-life of 13 hours.

Use a word from the box to complete the sentence.

| all | half | most |
|---|---|---|

After 13 hours ..... of the iodine-123 atoms the thyroid absorbed have decayed.

*(1 mark)*

**1 (d)** Iodine-123 and iodine-131 are two of the isotopes of iodine.

Draw a ring around the correct answer to complete the sentence.

The nucleus of an iodine-123 atom has the same number of | electrons / neutrons / protons | as the

nucleus of an iodine-131 atom.

*(1 mark)*

6

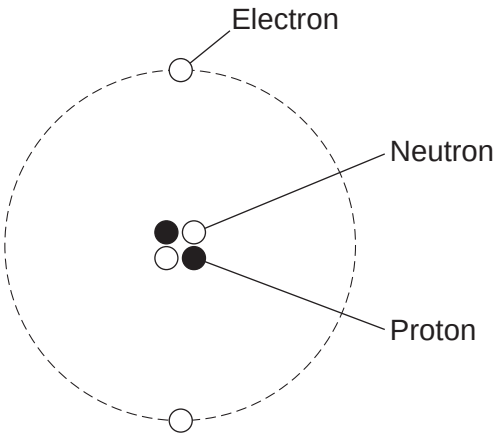
### 4.4.1.2 Mass number, atomic number and isotopes

**Question 37**

June 2014 | PH2FP | Original Q5 | Legacy

**5 (a)** **Figure 9** shows a helium atom.

**Figure 9**




**5 (a) (i)** Which **one** of the particles in the atom is **not** charged?

Draw a ring around the correct answer.

**[1 mark]**

**electron** **neutron** **proton**

**5 (a) (ii)** Which **two** types of particle in the atom have the same mass?

**[1 mark]**

..... and .....

**5 (a) (iii)** What is the atomic number of a helium atom?

Draw a ring around the correct answer.

**[2 marks]**

**2** **4** **6**

Give a reason for your answer.

.....

.....

4.4.1.2 Mass number, atomic number and isotopes

Question 37 · continued

June 2014 | PH2FP | Original Q5 | Legacy

**5 (b)** Alpha particles are one type of nuclear radiation.

**5 (b) (i)** Name **one** other type of nuclear radiation.

**[1 mark]**

.....

**5 (b) (ii)** Use the correct answer from the box to complete the sentence.

**[1 mark]**

| | | |
|---|---|---|
| **electrons** | **neutrons** | **protons** |

The difference between an alpha particle and a helium atom is that the alpha particle does **not** have any ..... .

**5 (b) (iii)** Which **one** of the following is a property of alpha particles?

Tick (✓) **one** box.

**[1 mark]**

Have a long range in air ☐

Are highly ionising ☐

Will pass through metals ☐

**Question 5 continues on the next page**

4.4.1.2 Mass number, atomic number and isotopes

Question 37 · continued



**5 (c)** Doctors may use nuclear radiation to treat certain types of illness.

Treating an illness with radiation may also harm a patient.

**5 (c) (i)** Complete the following sentence.

**[1 mark]**

The risk from treating a patient with radiation is that the radiation may

..... healthy body cells.

**5 (c) (ii)** Draw a ring around the correct answer to complete the sentence.

**[1 mark]**

Radiation may be used to treat a patient if the risk from the

radiation is

- much bigger than
- about the same as
- much smaller than

the possible benefit of having the treatment.

9

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 38**

June 2016 | PH2FP | Original Q4 | Legacy

**4 (a)** Uranium has two natural isotopes, uranium-235 and uranium-238.

Use the correct answer from the box to complete the sentence.

**[1 mark]**

| electrons | neutrons | protons |
|---|---|---|

The nucleus of a uranium-238 atom has three more _____ than the nucleus of a uranium-235 atom.

**4 (b)** Uranium-235 is used as a fuel inside a nuclear reactor.
Energy is released from nuclear fuels by the process of nuclear fission.

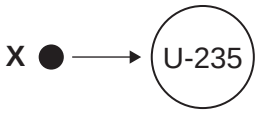
What is the energy released from nuclear fuels inside a nuclear reactor used for?

**[1 mark]**

_____

**4 (c)** **Figure 6** shows the nucleus of an atom of uranium-235 (U-235) about to undergo nuclear fission.

**Figure 6**




**4 (c) (i)** Before nuclear fission can happen the nucleus of a uranium atom has to absorb the particle labelled **X**.

What is particle **X**?

**[1 mark]**

Tick (✓) **one** box.

an electron ☐ a neutron ☐ a proton ☐

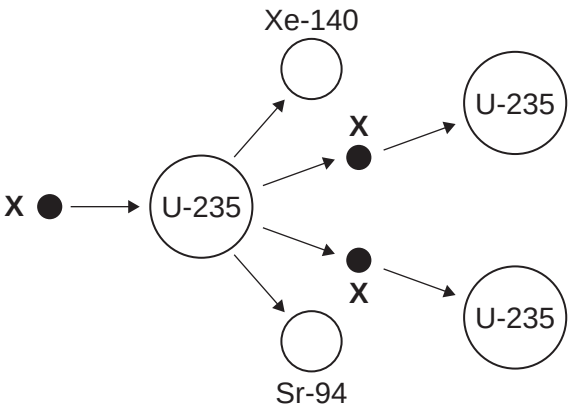
4.4.1.2 Mass number, atomic number and isotopes

Question 38 · continued



**4 (c) (ii)** The process of nuclear fission, shown in **Figure 7**, causes the nucleus of the uranium-235 (U-235) atom to split apart and release two of the particles **X**.

**Figure 7**




Complete **Figure 7** to show how the particles **X start** a chain reaction.

**[2 marks]**

5

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 39**

June 2018 | 8463/1F | Original Q5

**0 5** Americium-241 ($^{241}_{95}Am$) is an isotope of americium.

**0 5 . 1** Which of the isotopes given in **Table 1** is **not** an isotope of americium?

**[2 marks]**

**Table 1**

| Isotope | Mass number | Atomic number |
|---|---|---|
| A | 243 | 95 |
| B | 243 | 94 |
| C | 242 | 95 |

Isotope _____

Give a reason for your answer.

_____

_____

_____

**Question 5 continues on the next page**

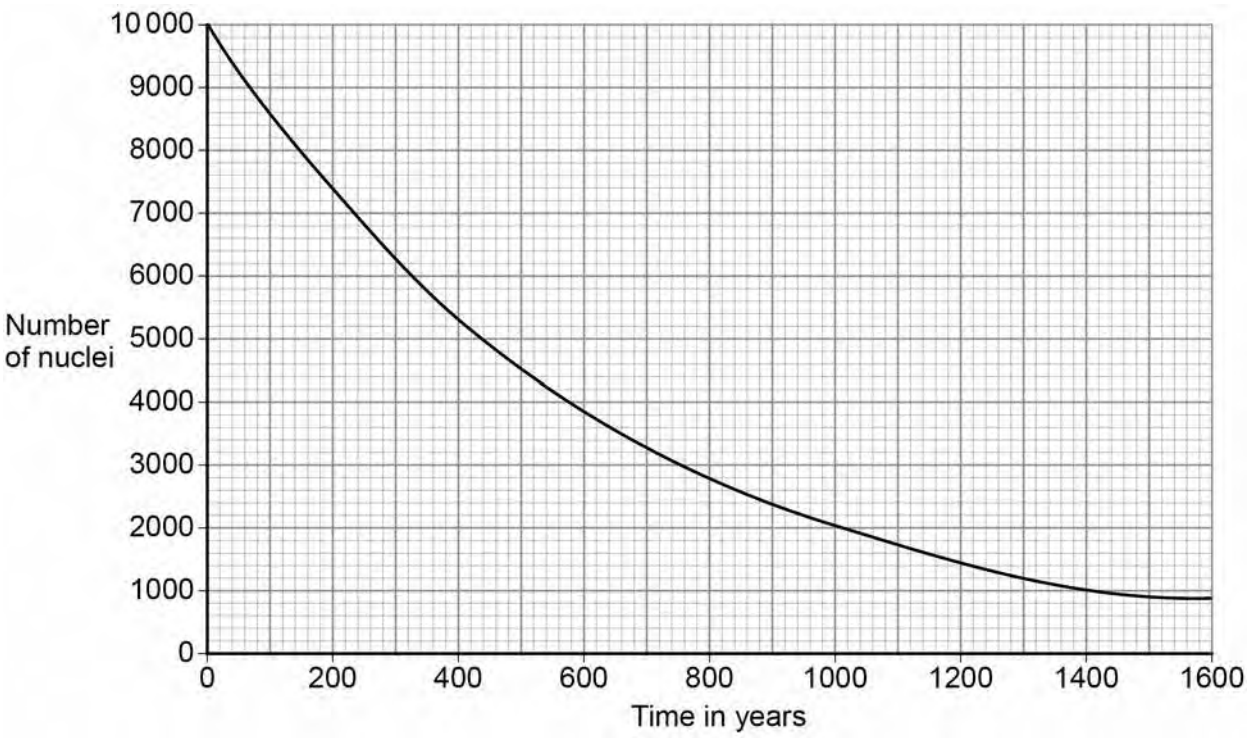
4.4.1.2 Mass number, atomic number and isotopes

Question 39 · continued

June 2018 | 8463/1F | Original Q5

**Figure 5** shows how the number of americium-241 nuclei in a sample changes with time.

**Figure 5**




**0 5 . 2** How many years does it take for the number of americium-241 nuclei to decrease from 10 000 to 5000?

**[1 mark]**

Time = _____ years

**0 5 . 3** What is the half-life of americium-241?

**[1 mark]**

Half-life = _____ years

4

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 40**

November 2021 | 8463/1F | Original Q5

**0 5** Atoms of different elements have different properties.

**0 5 . 1** Which of the following is the same for all atoms of the same element?

**[1 mark]**

Tick (✓) **one** box.

- Atomic number ☐
- Mass number ☐
- Neutron number ☐

**0 5 . 2** Which of the following is different for isotopes of the same element?

**[1 mark]**

Tick (✓) **one** box.

- Number of electrons ☐
- Number of neutrons ☐
- Number of protons ☐

**Question 5 continues on the next page**

4.4.1.2 Mass number, atomic number and isotopes

Question 40 · continued

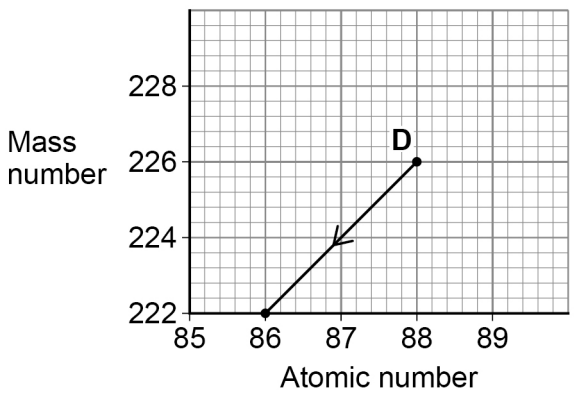


**0 5 . 3** A nucleus emits radiation.

**Figure 7** shows how the mass number and the atomic number change.

The nucleus is labelled **D**.

**Figure 7**




Which type of radiation is emitted when nucleus **D** decays?

**[1 mark]**

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

4.4.1.2 Mass number, atomic number and isotopes

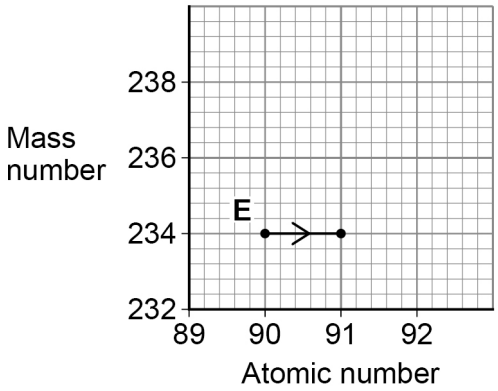
Question 40 · continued



**0 5 . 4** Nucleus **E** also emits radiation.

**Figure 8** shows how the mass number and the atomic number change for nucleus **E**.

**Figure 8**




Which type of radiation is emitted when nucleus **E** decays?

**[1 mark]**

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

**Question 5 continues on the next page**

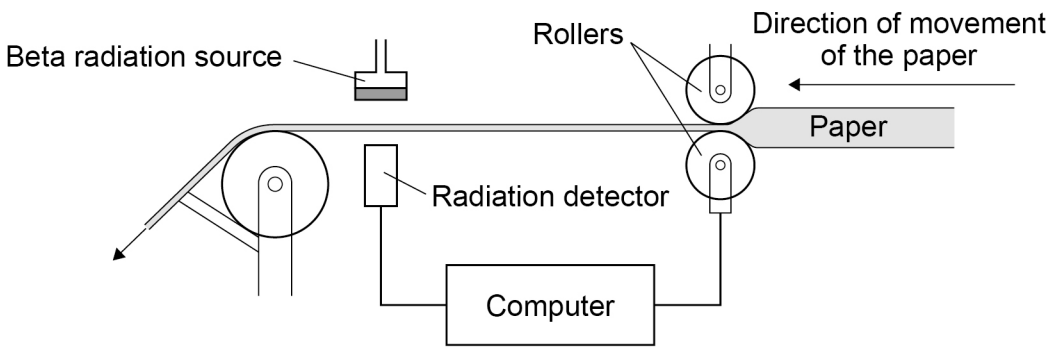
Question 40 · continued



Beta radiation can be used to monitor the thickness of paper during production.

**Figure 9** shows how the radiation is used.

**Figure 9**




The computer uses information from the radiation detector to change the size of the gap between the rollers.

**0 5 . 5** Complete the sentences.

Choose answers from the box.

Each answer can be used once, more than once or not at all.

| | | |
|---|---|---|
| **decrease** | **stay the same** | **increase** |

The thickness of the paper between the beta source and the detector increases.

**[2 marks]**

The reading on the detector will _____.

This is because the amount of radiation absorbed by the paper

will _____.

4.4.1.2 Mass number, atomic number and isotopes

Question 40 · continued



**0 5 . 6** All radioactive elements have a half-life.

What is meant by 'half-life'?

**[1 mark]**

Tick (✓) **one** box.

- The time it takes for all the nuclei in a radioactive sample to split in half. ☐
- The time it takes for the count rate of a radioactive sample to halve. ☐
- The time it takes for the radiation to travel half of its range in air. ☐

**0 5 . 7** Why should the radiation source used in **Figure 9** have a long half-life?

**[1 mark]**

Tick (✓) **one** box.

- So the activity of the source is approximately constant. ☐
- So the amount of radiation decreases quickly. ☐
- So the radiation has a long range in air. ☐

8

### 4.4.1.2 Mass number, atomic number and isotopes

**Question 41**

June 2022 | 8463/1F | Original Q4

**0 4** Radioactive isotopes emit different types of nuclear radiation.

**0 4 . 1** What does an alpha particle consist of?

**[1 mark]**

Tick (✓) **one** box.

- 2 protons and 2 electrons ☐
- 2 protons and 2 neutrons ☐
- 4 protons ☐
- 4 neutrons ☐

**0 4 . 2** What is a beta particle?

**[1 mark]**

Tick (✓) **one** box.

- An electron ☐
- A neutron ☐
- Electromagnetic radiation ☐

**0 4 . 3** A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

What is the correct equation for this decay?

**[1 mark]**

Tick (✓) **one** box.

- $^{85}_{36}Kr + {}^{0}_{-1}e \longrightarrow {}^{85}_{37}Rb$ ☐
- $^{85}_{36}Kr \longrightarrow {}^{85}_{37}Rb + {}^{0}_{-1}e$ ☐
- $^{85}_{37}Rb \longrightarrow {}^{85}_{36}Kr + {}^{0}_{-1}e$ ☐

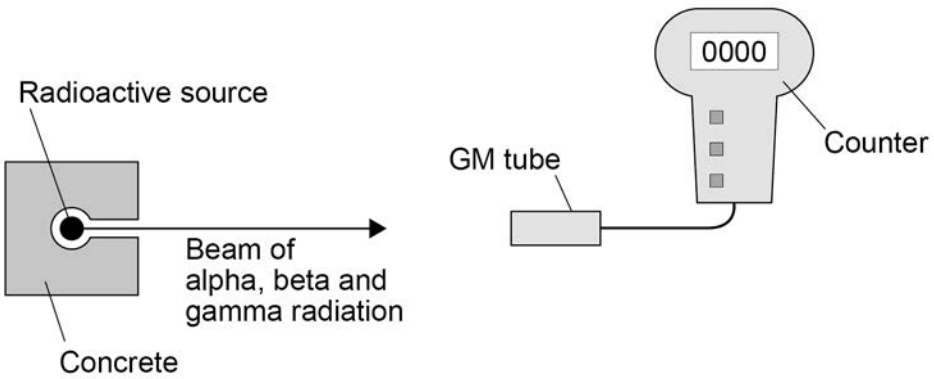
Question 41 · continued



**0 4 . 4** **Figure 5** shows an experiment to demonstrate how alpha, beta and gamma radiation penetrate different materials.

The experiment takes place in a vacuum.

**Figure 5**




Three different materials are used:

- a sheet of paper
- a 0.5 cm thick sheet of aluminium
- a 10 cm block of lead.

Each material is placed one at a time between the radioactive source and the GM tube.

The GM tube and counter show whether the material has stopped the radiation.

Complete **Table 1** to show how alpha, beta and gamma radiation penetrate the materials in **Figure 5**.

Use the words **Yes** and **No**.

Part of **Table 1** has been completed for you.

**[3 marks]**

**Table 1**

| Type of radiation | Most radiation is stopped by: | | |
|---|---|---|---|
| | the sheet of paper | the sheet of aluminium | the block of lead |
| Alpha | | | Yes |
| Beta | No | | |
| Gamma | | No | |

4.4.1.2 Mass number, atomic number and isotopes

Question 41 · continued



**0 4 . 5** Alpha, beta and gamma radiation have different ionising powers.

Draw **one** line from each radiation type to the correct ionising power.

**[3 marks]**

| Radiation type | Ionising power |
|---|---|
| Alpha | Zero |
| Beta | Low |
| Gamma | Medium |
| | High |

**0 4 . 6** Some sources of background radiation are natural and other sources are man-made.

Which of the following is a man-made source of background radiation?

**[1 mark]**

Tick (✓) **one** box.

Cosmic rays ☐

Nuclear accidents ☐

Rocks ☐

**0 4 . 7** The average background radiation dose per year in the UK is 2.0 millisieverts.

A dental X-ray gives a patient a radiation dose of 0.005 millisieverts.

Calculate how many dental X-rays would be the same as the average background radiation dose per year.

**[2 marks]**

Number of dental X-rays = _____

12

4.4.1.2 Mass number, atomic number and isotopes

Question 42

June 2023 | 8463/1F | Original Q3

**0 3** Some isotopes emit nuclear radiation.

**0 3 . 1** Carbon-12 and carbon-14 are both isotopes of carbon.

Complete the sentences.

Choose answers from the box.

**[2 marks]**

| | | | |
|---|---|---|---|
| **alpha particles** | **electrons** | **neutrons** | **protons** |

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have the **same** number of _____ .

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have a **different** number of _____ .

**0 3 . 2** Different radioactive isotopes have different half-lives.

What does 'half-life' mean?

**[1 mark]**

Tick (✓) **one** box.

- Half the time taken for all of the nuclei in a sample to decay. ☐
- The time taken for half the nuclei in a sample to decay. ☐
- The time taken for one nucleus to split in half. ☐

**Question 3 continues on the next page**

4.4.1.2 Mass number, atomic number and isotopes

Question 42 · continued



**0 3 . 3** **Table 2** shows the half-life of some different isotopes of carbon.

**Table 2**

| Isotope | Half-life in seconds |
|---|---|
| Carbon-15 | 2.45 |
| Carbon-16 | 0.75 |
| Carbon-17 | 0.19 |
| Carbon-18 | 0.09 |

Which isotope is the least stable?

**[1 mark]**

Tick (✓) **one** box.

Carbon-15 ☐

Carbon-16 ☐

Carbon-17 ☐

Carbon-18 ☐

4.4.1.2 Mass number, atomic number and isotopes

Question 42 · continued



**0 3 . 4** Workers in nuclear power stations must be aware of nuclear irradiation and radioactive contamination.

Draw **one** line from each term to an example of the term.

**[2 marks]**

| Term | Example |
| --- | --- |
| | Exposure to a beam of gamma rays |
| Radioactive contamination | Exposure to ultraviolet radiation from the Sun |
| Nuclear irradiation | Accidental transfer of plutonium onto a human body |
| | Using a mobile phone |

**Question 3 continues on the next page**

Question 42 · continued



**0 3 . 5** Why are workers required to walk across a sticky floor before leaving the nuclear power station?

**[1 mark]**

Tick (✓) **one** box.

To remove alpha particles from their shoes. ☐

To remove gamma radiation from their shoes. ☐

To remove radioactive dust from their shoes. ☐

**0 3 . 6** The places where people work and live contribute to the nuclear radiation they are exposed to.

**Table 3** shows the mean daily dose of radiation caused by two different jobs.

**Table 3**

| Job | Mean daily dose in mSv |
|---|---|
| Aeroplane pilot | 0.072 |
| Nuclear power station worker | 0.00050 |

Calculate the number of days a nuclear power station worker must work before receiving the same dose that an aeroplane pilot receives in one day.

**[2 marks]**

Number of days = _____

4.4.1.2 Mass number, atomic number and isotopes

Question 42 · continued



**0 3 . 7** The process of nuclear fission takes place in nuclear power stations.

The process of nuclear fusion takes place in the Sun.

Draw **one** line from each process to its fuel.

**[2 marks]**

| Process | Fuel |
| --- | --- |
| | Hydrogen |
| Nuclear fission | Iron |
| Nuclear fusion | Lead |
| | Uranium |

11

**4.4.1.2 Mass number, atomic number and isotopes**

**Question 43**

June 2025 | 8463/1F | Original Q3

**0 3** Different radioactive isotopes emit different types of radiation.

**0 3 . 1** One isotope of uranium (U) decays into thorium (Th) by emitting an alpha particle (He).

Which nuclear equation shows the decay of this isotope of uranium?

**[1 mark]**

Tick (✓) **one** box.

$^{230}_{92}U \rightarrow {}^{226}_{90}Th + {}^{4}_{2}He$ ☐

$^{226}_{90}Th \rightarrow {}^{230}_{92}U + {}^{4}_{2}He$ ☐

$^{230}_{92}U + {}^{226}_{90}Th \rightarrow {}^{4}_{2}He$ ☐

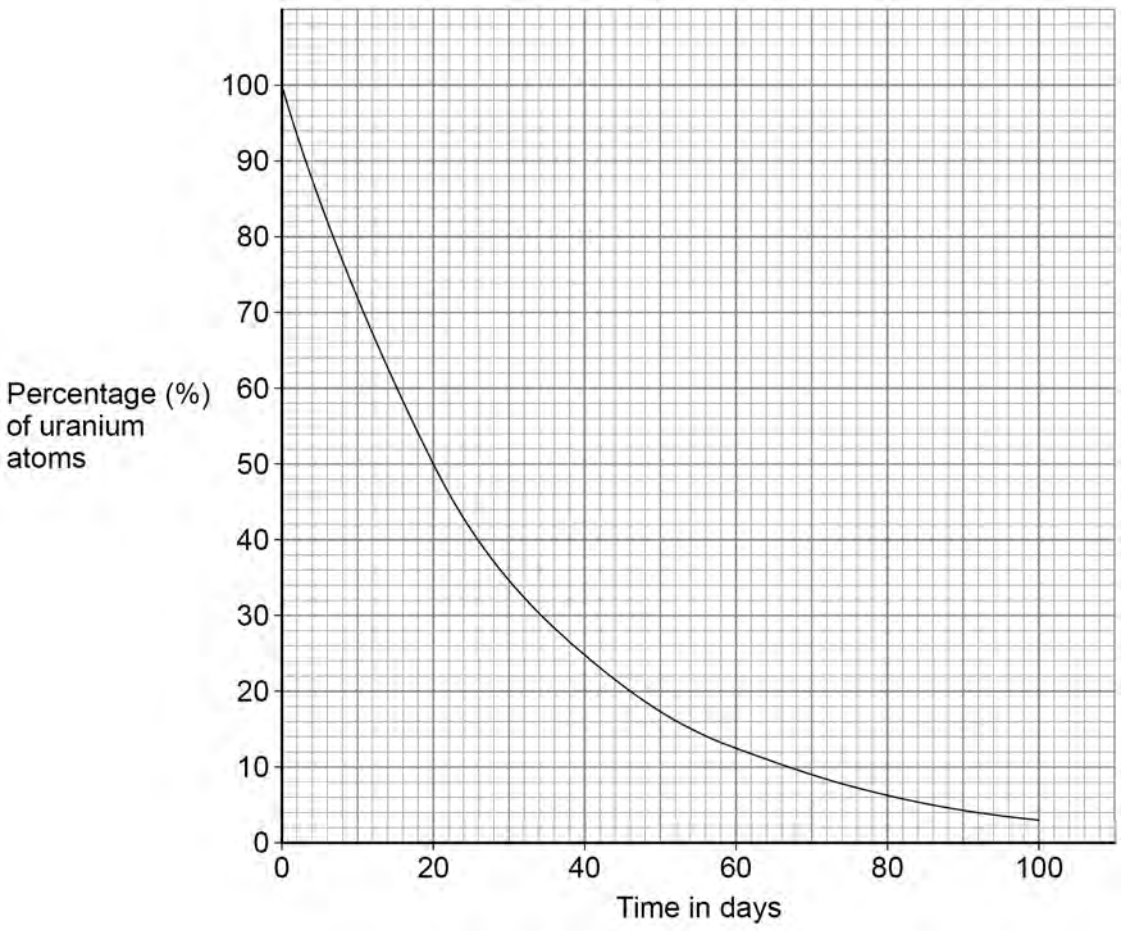
4.4.1.2 Mass number, atomic number and isotopes

Question 43 · continued



**Figure 4** shows how the percentage of uranium atoms in a sample of one uranium isotope varies with time.

**Figure 4**




**0 3 . 2** What is the time taken for 50% of the atoms of this uranium isotope to decay?

Use **Figure 4**.

**[1 mark]**

Time taken = _____ days

**0 3 . 3** What is the half-life of this uranium isotope?

**[1 mark]**

Half-life = _____ days

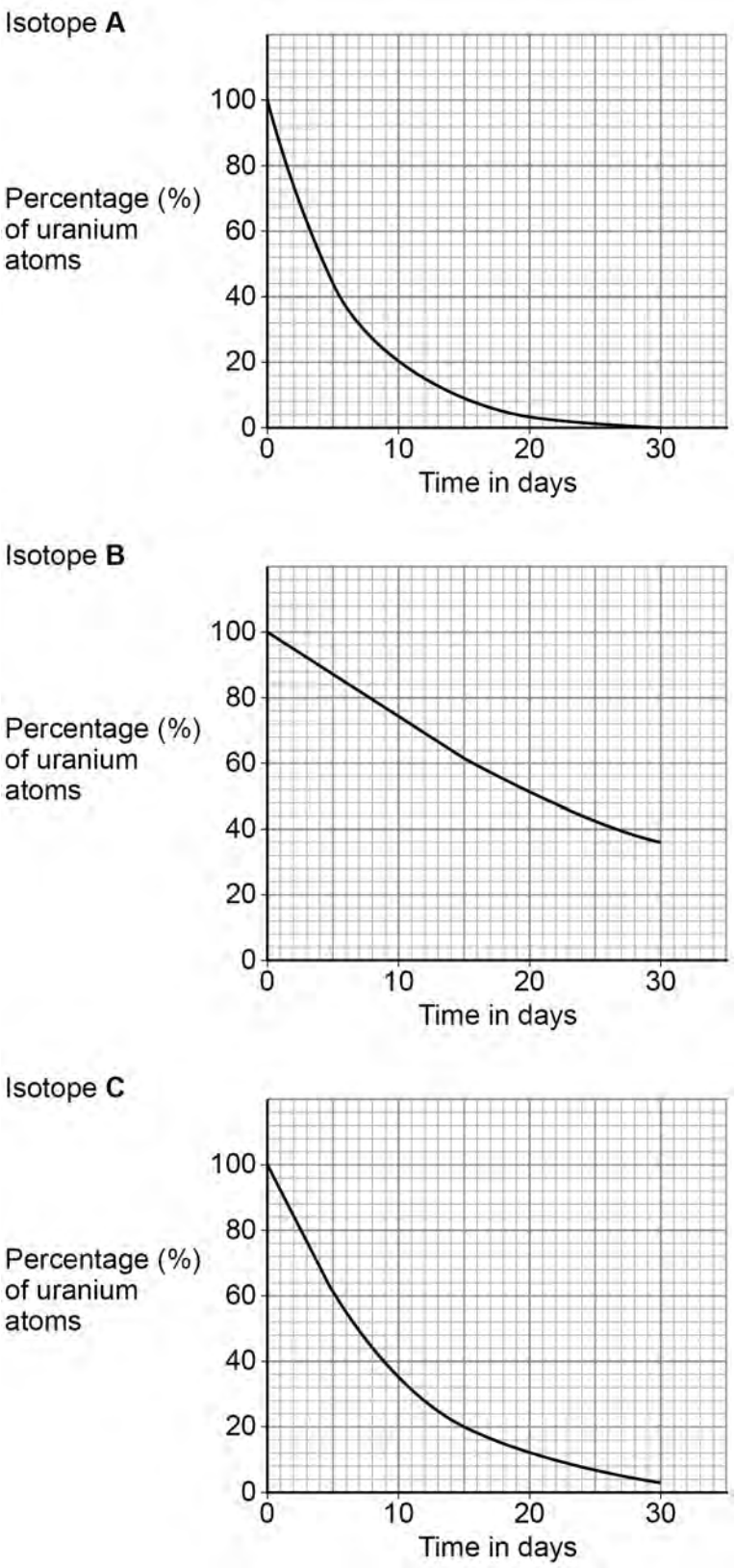
4.4.1.2 Mass number, atomic number and isotopes

Question 43 · continued



**0 3 . 4** **Figure 5** shows how the percentage of uranium atoms varies with time for three different isotopes of uranium, **A**, **B** and **C**.

**Figure 5**



4.4.1.2 Mass number, atomic number and isotopes

Question 43 · continued



Which isotope is the most unstable?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

Isotope **A** ☐

Isotope **B** ☐

Isotope **C** ☐

Reason _____

_____

_____

**Question 3 continues on the next page**

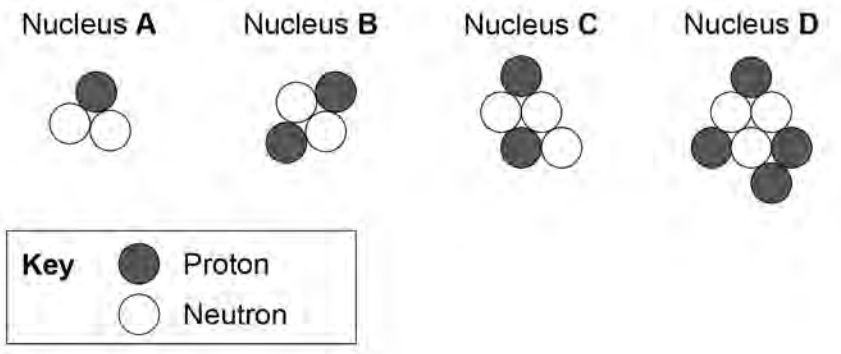
4.4.1.2 Mass number, atomic number and isotopes

Question 43 · continued



**Figure 6** shows the nuclei of four different atoms.

**Figure 6**




**0 3 . 5** Which nucleus in **Figure 6** has the smallest **mass** number?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 3 . 6** Which nucleus in **Figure 6** has an **atomic** number of 4?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

4.4.1.2 Mass number, atomic number and isotopes

Question 43 · continued



**0 3 . 7** Which **two** nuclei in **Figure 6** are isotopes of the same element?

Give a reason for your answer.

**[2 marks]**

Nucleus ☐ and nucleus ☐

Reason _____

_____

Scientists have replaced old models of the atom with newer models.

The nuclear model of the atom has a nucleus at the centre.

**0 3 . 8** Which model of the atom was replaced by the nuclear model?

**[1 mark]**

Tick (✓) **one** box.

Bohr model ☐

Plum pudding model ☐

Tiny spheres that cannot be divided ☐

**0 3 . 9** What does the nuclear model state about the mass of an atom?

**[1 mark]**

Tick (✓) **one** box.

The mass of the atom is concentrated in the electrons. ☐

The mass of the atom is concentrated in the nucleus. ☐

The mass of the atom is spread throughout the atom. ☐

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