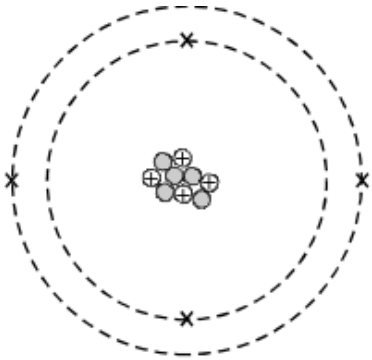
Q1. The diagram shows an atom.

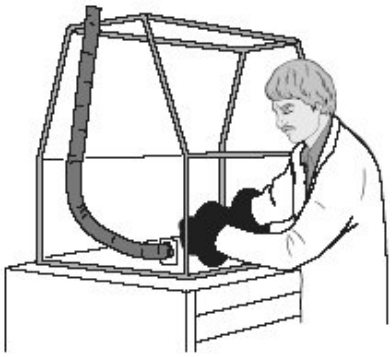


How many protons are there in the nucleus of the atom? .....

What is the mass number of the atom? .....

(Total 2 marks)

Q2. The picture shows a man at work in a factory that uses radioactive materials.



The radioactive material is kept behind glass shields. The man wears gloves so that he cannot touch the radioactive material directly.

Explain, as fully as you can, why these precautions are taken.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

.....

(Total 4 marks)

Q3. In some areas of the U.K. people are worried because their houses are built on rocks that release radon.

Read the information about radon.

- It is a gas.
- It is formed by the breakdown of radium.
- It emits alpha radiation.
- Each radon atom has 86 protons.
- Each radon atom has 136 neutrons.

Explain why it may be dangerous to live near rocks that release radon.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

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.....

(Total 3 marks)

Q4. In some areas of the U.K. people are worried because their houses are built on rocks that release radon.

Read the information about radon.

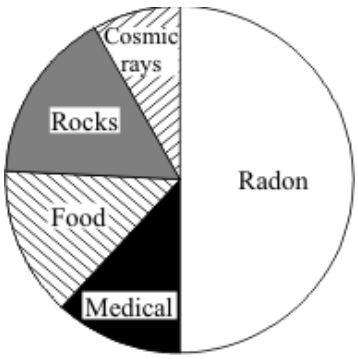
- It is a gas.
- It is formed by the breakdown of radium.
- It emits alpha radiation.
- Each radon atom has 86 protons.
- Each radon atom has 136 neutrons.

(i) How many electrons has each atom of radon? .....

(ii) What is the mass (nucleon) number of radon? .....

(Total 2 marks)

Q5. (a) The pie-chart shows the main sources of background radiation.



(i) Which source in the pie-chart adds the smallest amount of radiation to background levels?

.....

(1)

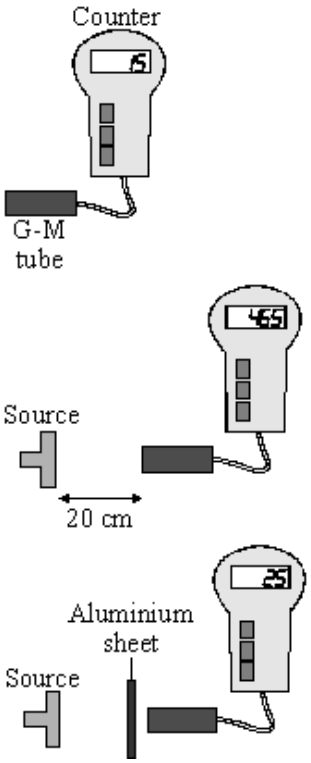
(ii) Name **two** natural sources of background radiation in the pie-chart.

1. .....

2. .....

(2)

(b) The diagrams show how a radiation detector and counter can be used to measure radiation levels. In each case the numbers show the count one minute after the counter is switched on.



(i) How many counts are just from background radiation?

.....

(ii) How many counts are just from the source?

.....

(iii) What type of radiation did the source give out?

.....

Give a reason for your answer.

.....

.....

.....

.....

(4)
(Total 7 marks)

Q6. (a) The diagram shows a hazard sign.

What type of hazard does this sign warn you about?

.....

(1)

(b) The names of three types of radiation are given in the box.

alpha (α)	beta (β)	gamma (γ)

Complete each sentence by choosing the correct type of radiation from those given in the box. Each type of radiation should be used once or not at all.

(i) The type of radiation that travels at the speed of light is .....

(1)

(ii) The type of radiation that is stopped by thick paper is .....

(1)

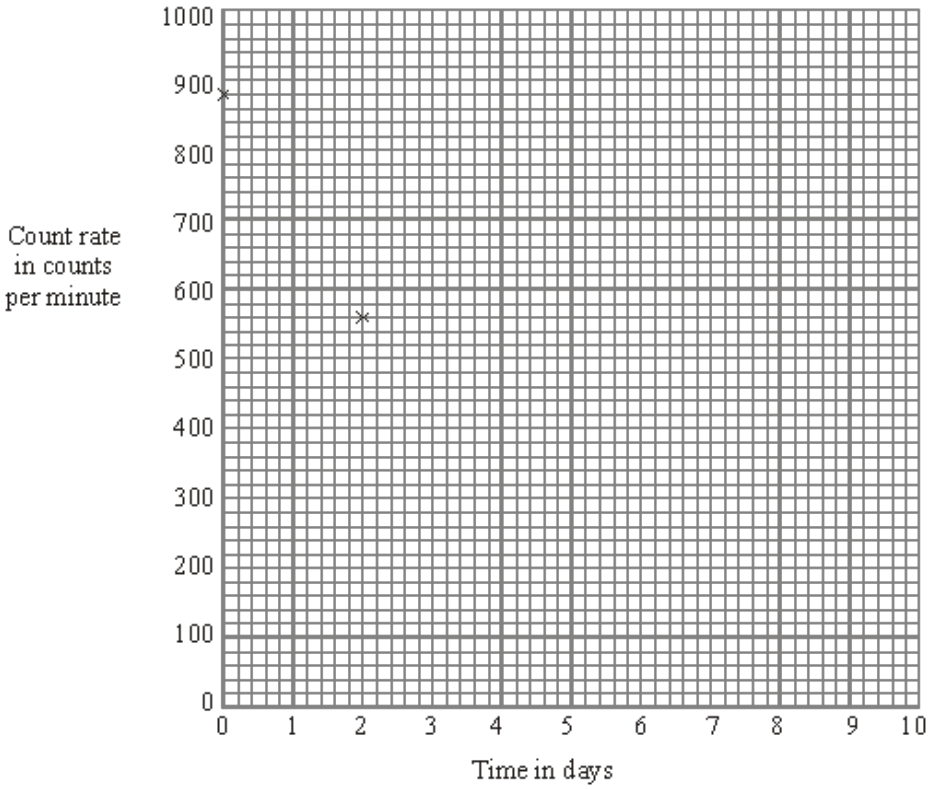
(Total 3 marks)

Q7. 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)

(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)

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

Half-life = ... days

(1)

(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?

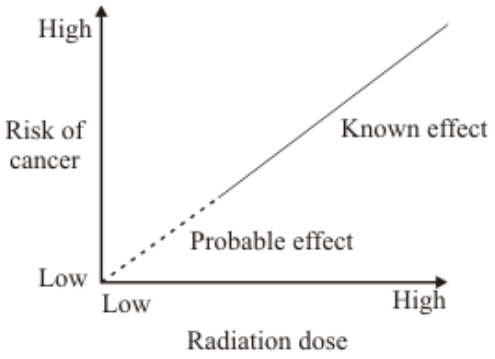
.....

Give a reason for your answer.

.....

(2)
(Total 7 marks)

Q8. (a) Radiation can cause cancer. The graph shows that the risk of cancer depends on the radiation dose a person is exposed to.

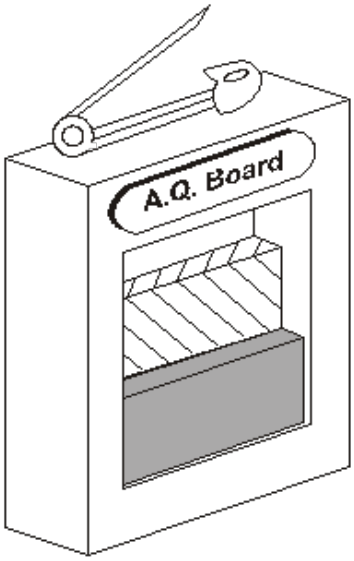


Complete the following sentence.

The ..... the dose of radiation a person gets, the greater the risk of cancer.

(1)

(b) A worker in a nuclear power station wears a special badge (diagram **1**). Diagram **2** shows what is inside the badge. When the film inside the badge is developed, it will be dark in the places where it has absorbed radiation.



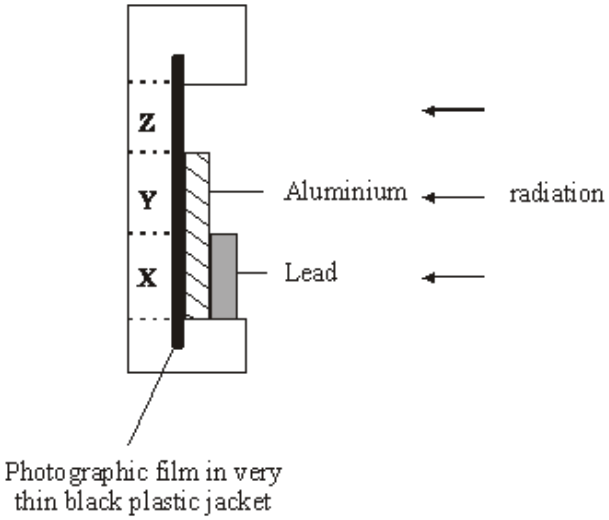


Diagram 1 **Diagram 2**

Which part of the film, **X**, **Y** or **Z,** would darken if the worker had received a dose of alpha radiation?

.....

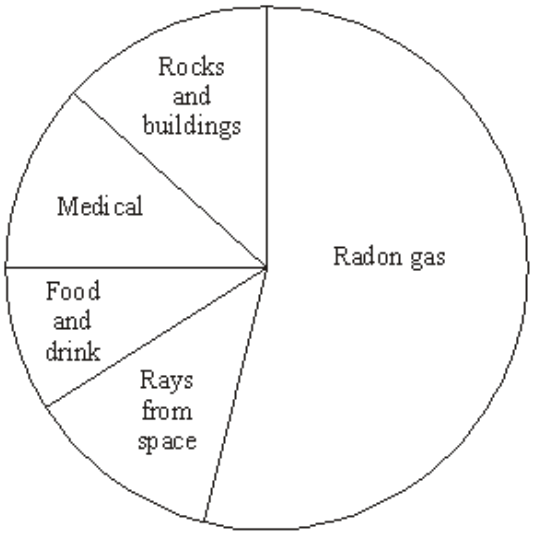
Give a reason for your answer.

.....

.....

(2)
(Total 3 marks)

Q9. Radiation is around us all of the time. The pie chart shows the sources of this radiation.



(i) What is the main source of this radiation?

.....

(1)

(ii) What name is given to the radiation that is around us all of the time?

.....

(1)
(Total 2 marks)

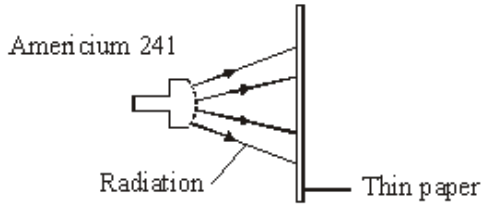
Q10. A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

Number of neutrons	146
Number of protons	95
Number of electrons	

(1)

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.



Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

(1)

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

(2)

(d) Complete the sentence by choosing an answer from the box.

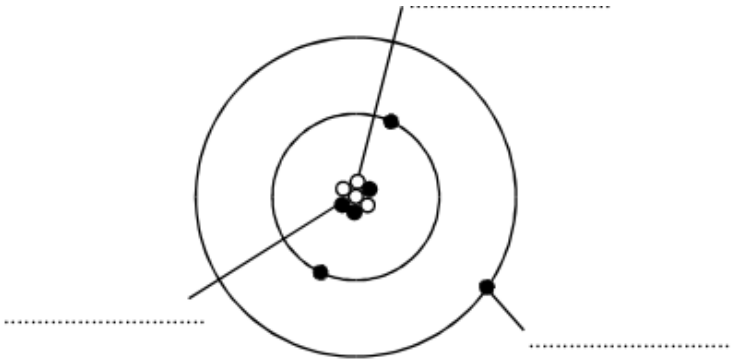
less than	**more than**	**the same as**

After many years the radiation emitted by americium 241 will be .....

when the smoke detector was new.

(1)
(Total 5 marks)

Q11. The diagram represents an atom of lithium.



(i) Complete the diagram by writing in the spaces the name of each type of particle. Use only words given in the box. Each word may be used once or not at all.

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

(3)

(ii) Which type of particle found inside the atom is uncharged?

.....

(1)

(iii) What is the mass number of this atom, 3, 4, 7 or 10?

.....

Give a reason for your choice.

.....

.....

(2)
(Total 6 marks)

Q12. (a) The names of three types of radiation are given in **List A**. Various properties of these three types of radiation are given in **List B**.

Draw a line to link each type of radiation in **List A** to its correct property in **List B**. Draw only **three** lines.

List A **Type of radiation**	**List B** **Property of radiation**
	not dangerous
alpha (α)	
	stopped by paper
beta (β)	
	travels at 300 000 000 m/s
gamma (γ)	
	travels up to 1 metre in air

(3)

(b) This sign warns people that a radioactive source is being used in a laboratory.

Why is it important to warn people that a radioactive source is being used?

.....

.....

(1)

(c) To study the blood flow in a patient's lungs, a doctor injects some technetium-99 compound into the patient. The gamma radiation given out by the technetium-99 atoms is detected using a gamma camera outside the patient's body.

Which statement gives the reason why gamma radiation is used? Put a tick (✓) in the box next to your choice.

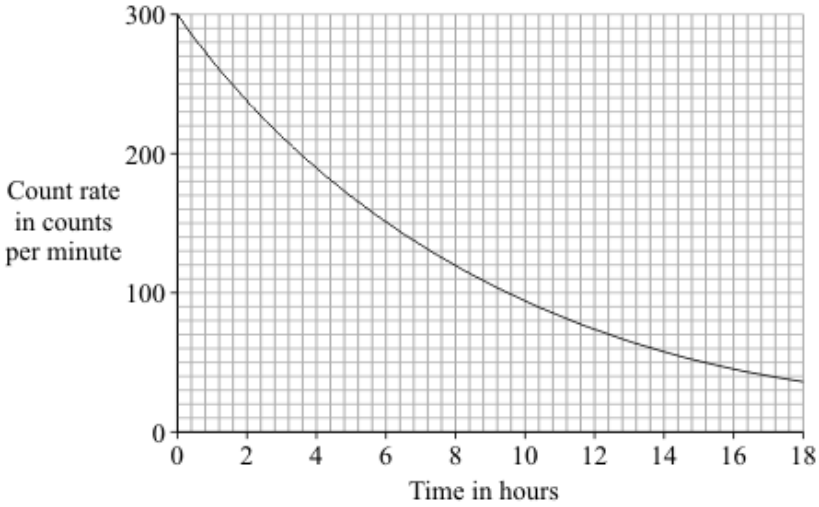
It can travel through a vacuum. ☐

It is not affected by a magnet. ☐

It can pass through the human body. ☐

(1)

(d) The graph shows how the count rate from a sample of technetium-99 changes with time.



Q13. (a) The names of three types of nuclear radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**. Draw only three lines.

List A Type of nuclear radiation	**List B** Property of radiation
	not deflected by an electric field
alpha	
	stopped by thin metal but not paper
beta	
	the most strongly ionising
gamma	
	will not harm living cells

(3)

(b) Nuclear radiation is given out from the centre of some types of atom.

What name is given to the centre of an atom? .....

(1)

(c) One of the substances in the table is used as a radioactive tracer. A hospital patient breathes in air containing the tracer. The radiation given out is measured by a doctor using a detector outside the patient's body.

Substance	**Radiation given out**	**Solid, liquid or gas**
X	alpha	gas
Y	gamma	gas
Z	gamma	solid

Which **one** of the substances, **X**, **Y** or **Z**, should be used as the tracer? .....

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

(3)

(d) Radiation can also be used to kill the bacteria on fresh food.

Give **one** reason why farmers, shop owners or consumers may want food to be treated with radiation.

.....

.....

(1)

(Total 8 marks)

##

The table shows the average background radiation dose from various sources that a person living in Britain receives in one year.

Source of background radiation	Average amount each year in dose units
Buildings	50
Food and drink	300
Medical treatments (including X-rays)	300
Radon gas	1250
Rocks	360
Space (cosmic rays)	240
TOTAL	2500

(a) Only **two** of the following statements are true.

Tick (✓) the boxes next to the true statements.

Half the average background radiation dose comes from radon gas. ☐

Everyone receives the same background radiation dose. ☐

Cosmic rays produce less background radiation than food and drink. ☐

(1)

(b) Most sources of background radiation are natural but some are artificial (man-made).

Which source of background radiation given in the table is artificial?

.....

(1)

(c) Each time a dental X-ray is taken, the patient receives about 20 units of radiation.

How many dental X-rays would give the yearly average dose for medical treatments?

.....

.....

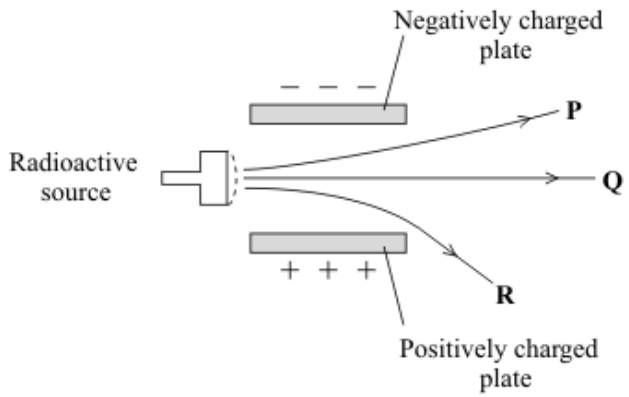
Number of X-rays = ...

(2)

(Total 4 marks)

Q15. A radioactive source emits alpha (α), beta (β) and gamma (γ) radiation. The diagram shows what happens to the radiation as it passes between two charged metal plates.

Diagram 1



(a) Which line **P**, **Q** or **R** shows the path taken by:

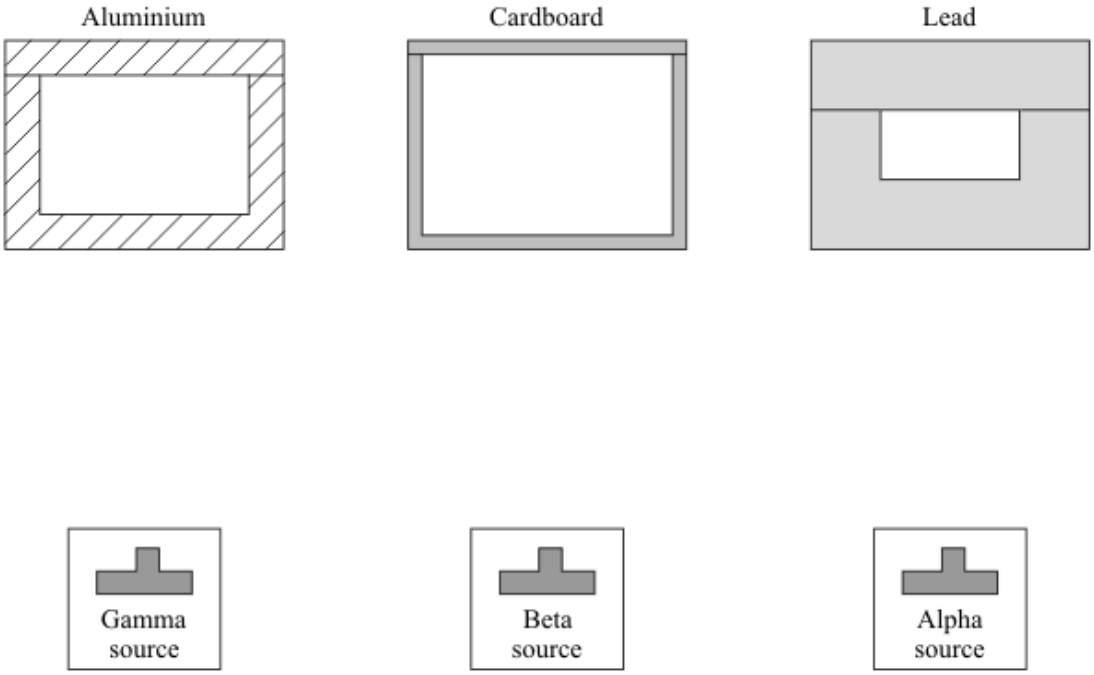
(i) alpha radiation .....

(1)

(ii) gamma radiation? .....

(1)

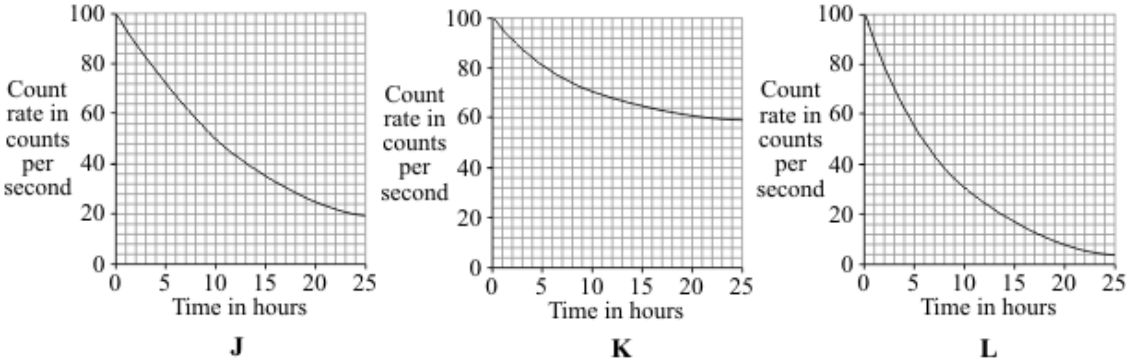
(b) The diagram shows three different boxes and three radioactive sources. Each source emits only one type of radiation and is stored in a different box. The box reduces the amount of radiation getting into the air.



Draw **three** lines to show which source should be stored in which box so that the minimum amount of radiation gets into the air.

(2)

(c) The graphs show how the count rates from three different radioactive sources, **J**, **K**, and **L**, change with time.



(i) Which source, **J, K**, or **L**, has the highest count rate after 24 hours? .....

(1)

(ii) For source **L**, what is the count rate after 5 hours?

..... counts per second

(1)

(iii) Which source, **J, K,** or **L**, has the longest half-life? .....

(1)

(iv) A radioactive source has a half-life of 6 hours.

What might this source be used for?

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

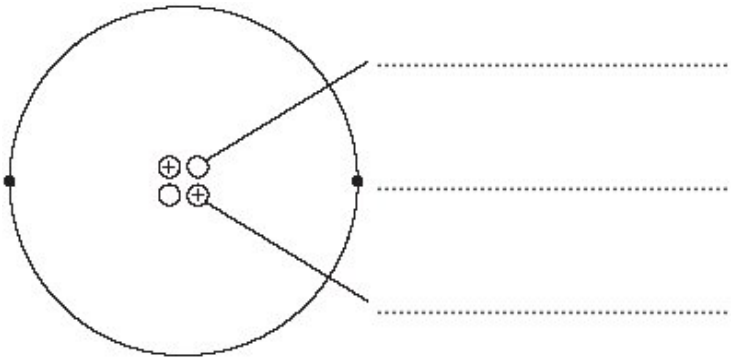
To monitor the thickness of paper as it is made in a factory ☐

To inject into a person as a medical tracer ☐

To make a smoke alarm work ☐

(1)
(Total 8 marks)

Q16. The diagram shows a helium atom.



(a) (i) Use the words in the box to label the diagram.

electron	**neutron**	**proton**

(2)

(ii) An alpha particle is the same as the nucleus of a helium atom.

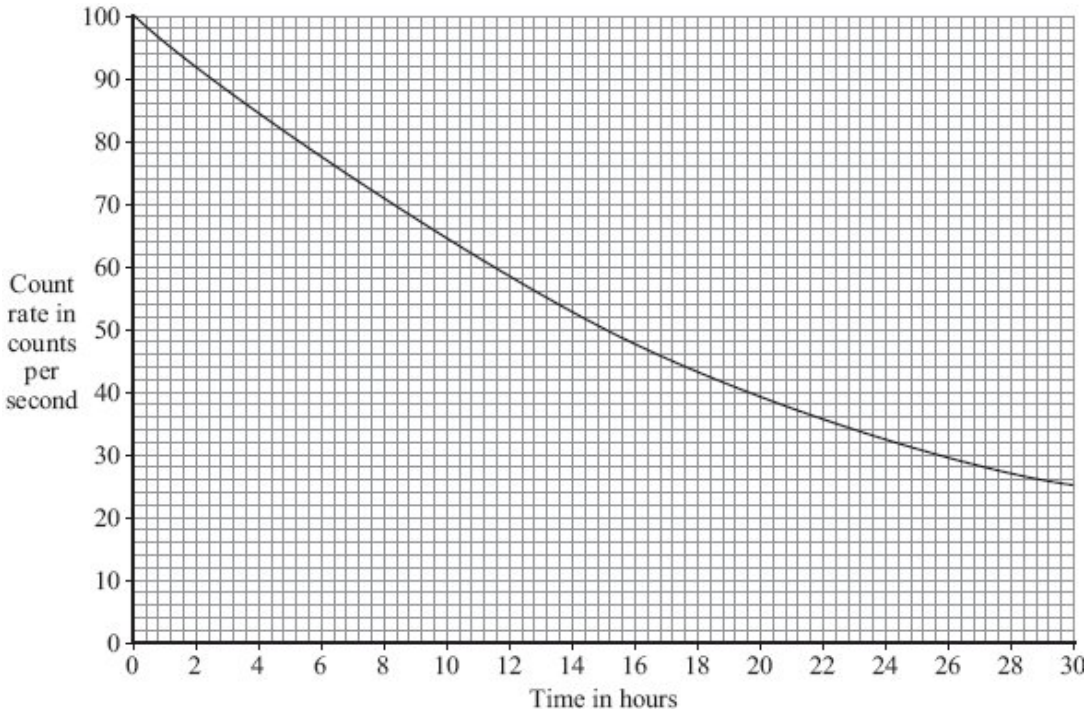
How is an alpha particle different from a helium atom?

.....

.....

(1)

(b) The graph shows how the count rate from a sample of radioactive sodium-24 changes with time.



(i) How many hours does it take for the count rate to fall from 100 counts per second to 50 counts per second?

Time = ... hours

(1)

(ii) What is the half-life of sodium-24?

Half-life = ... hours

(1)

(c) A smoke detector contains a small amount of americium-241.

Americium-241 is a radioactive substance which emits alpha particles. It has a half-life of 432 years.

(i) Which **one** of the following statements gives a reason why the americium-241 inside the smoke detector will **not** need replacing?

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

The alpha particles have a low energy. ☐

People replace smoke detectors every few years. ☐

Americium-241 has a long half-life. ☐

(1)

(ii) The diagram shows the label on the back of the smoke detector.

Why do people need to know that the smoke detector contains a radioactive material?

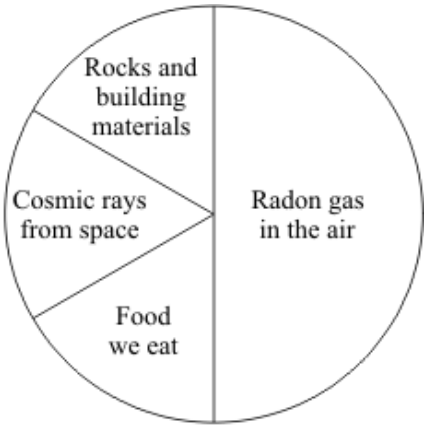
.....

.....

(1)

(Total 7 marks)

Q17. (a) The pie chart shows the average proportions of natural background radiation from various sources in one part of the UK.



(i) What proportion of the background radiation comes from radon gas?

.....

(1)

(ii) Suggest why our bodies are slightly radioactive.

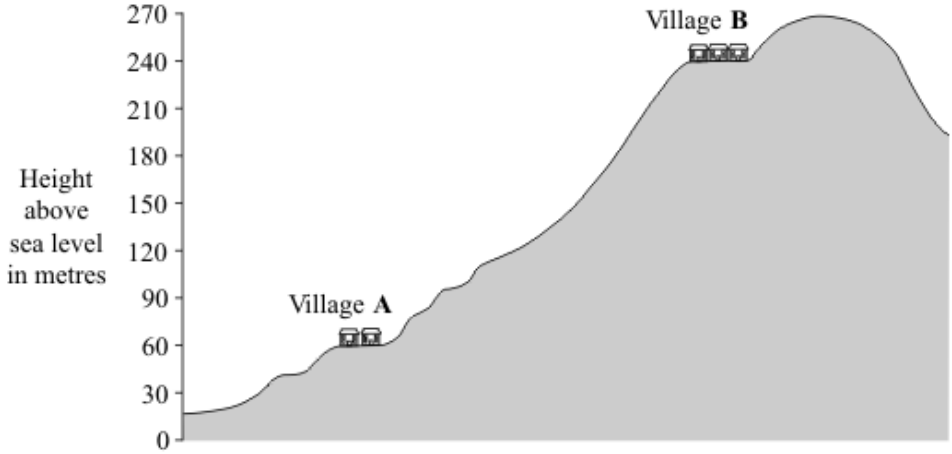
.....

.....

(1)

(b) The level of background radiation from cosmic rays is not the same everywhere. For every 30 metres above sea level, the amount of background radiation increases by one unit.

The diagram shows the position of two villages, **A** and **B**, built on a hill.



How is the amount of background radiation from cosmic rays different in village **A** compared to village **B**?

To obtain full marks you must include a calculation in your answer.

.....

.....

.....

.....

.....

.....

(3)
(Total 5 marks)

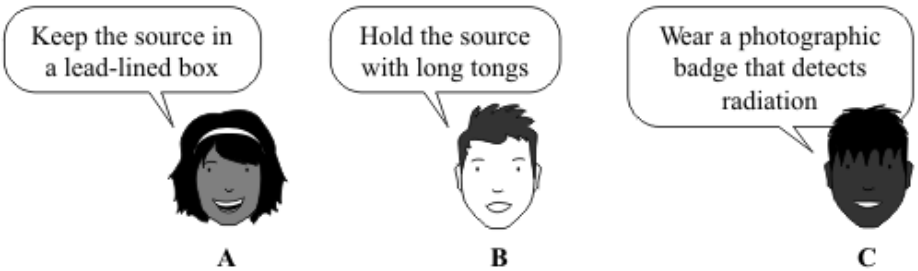
Q18. Four different processes are described in **List A**. The names of these processes are given in **List B**.

Draw a line to link each description in **List A** to its correct name in **List B**.
Draw only **four** lines.

List A	**List B**
the nuclei of two atoms joining together	gamma emission
the nucleus of an atom splitting into several pieces	electric current
an atom losing an electron	ionisation
an electric charge moving through a metal	nuclear fission
	nuclear fusion

(Total 4 marks)

Q19. Before using a radioactive source, a teacher asked her students to suggest safety procedures that would reduce her exposure to the radiation. The students made the following

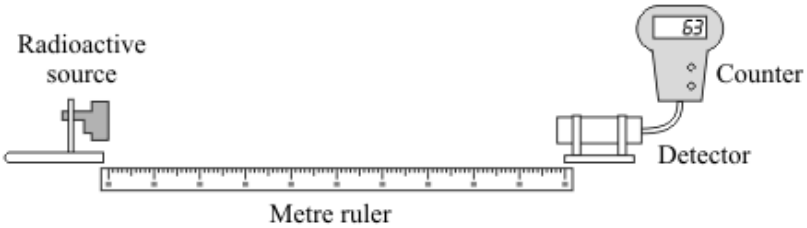


(a) Which suggestion, **A**, **B** or **C**, would **not** reduce the exposure of the teacher to radiation?

.....

(1)

(b) The diagram shows how the teacher measured the distance that the radiation traveled from the source. The count-rate at different distances from the source was measured and recorded in the table.



Distance from source to detector in cm	Count-rate in counts per minute
20	85
40	81
60	58
80	53
100	23

What type of radiation was the source emitting, alpha, beta or gamma?

.....

Explain the reasons for your choice.

.....

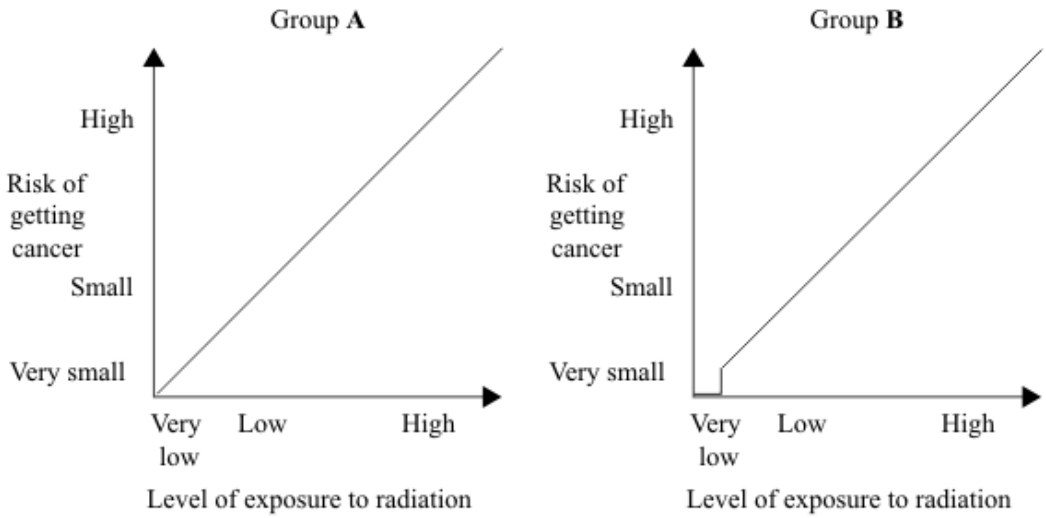
.....

.....

.....

(3)

(c) The graphs show how two groups of scientists, **A** and **B**, link exposure to radiation and the risk of getting cancer.



(i) Complete the following sentence using a word or phrase from the box.

decreases	**has no effect on**	**increases**

Both groups of scientists agree that a high level of exposure to radiation

..... the risk of getting cancer.

(1)

(ii) Use the graphs to describe carefully how the two groups of scientists disagree when the level of exposure to radiation is very low.

.....

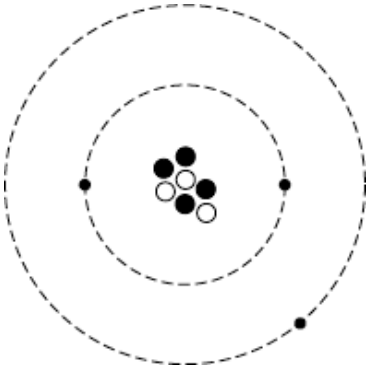
.....

.....

.....

(2)
(Total 7 marks)

Q20. The diagram represents an atom of lithium.



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

Number of protons	
Number of electrons	
Number of neutrons	

(2)

(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)

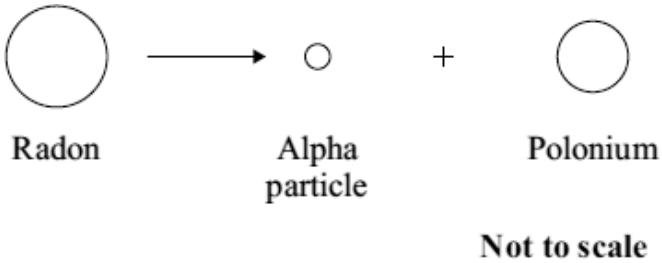
(b) Complete the following sentence by drawing a ring around the correct line in the box.

An atom that has lost an electron is called

an ion
an isotope
a positive atom

(1)

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



An alpha particle consists of 2 protons and 2 neutrons.

(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)

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

.....

.....

(1)
(Total 7 marks)

Q21. Some rocks inside the Earth contain a radioactive element, uranium-238. When an atom of uranium-238 decays, it gives out an alpha particle.

(a) The following statement about alpha particles was written by a student.
The statement is **not** correct.

Alpha particles can pass through a very thin sheet of lead.

Change **one** word in the statement to make it correct.

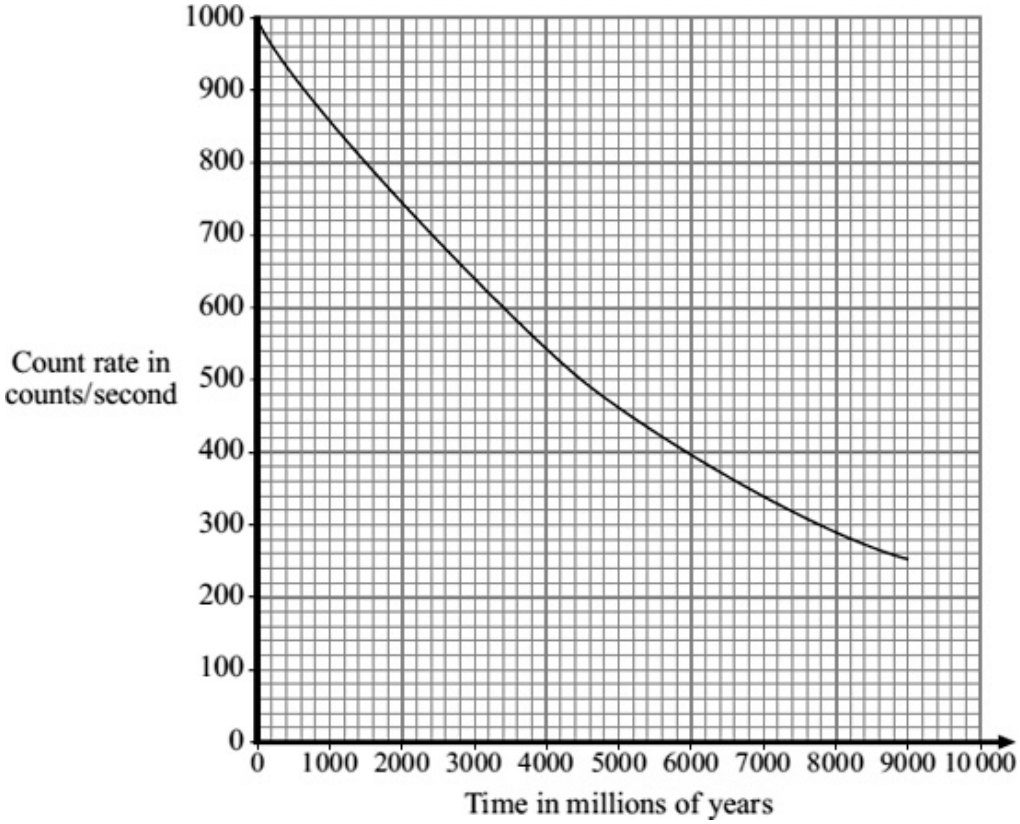
Write down your **new** statement.

.....

.....

(1)

(b) The graph shows how the count rate from a sample of uranium-238 changes with time.



The graph can be used to find the half-life of uranium-238. The half-life is 4 500 million years.

(i) Draw on the graph to show how it can be used to find the half-life of uranium -238.

(1)

(ii) There is now half as much uranium-238 in the rocks as there was when the Earth was formed.

How old is the Earth?

Draw a ring around your answer.

2250 million years **4500 million years** **9000 million years**

(1)

(iii) If a sample of uranium-238 were available, it would not be possible to measure the half-life in a school experiment.

Explain why.

.....

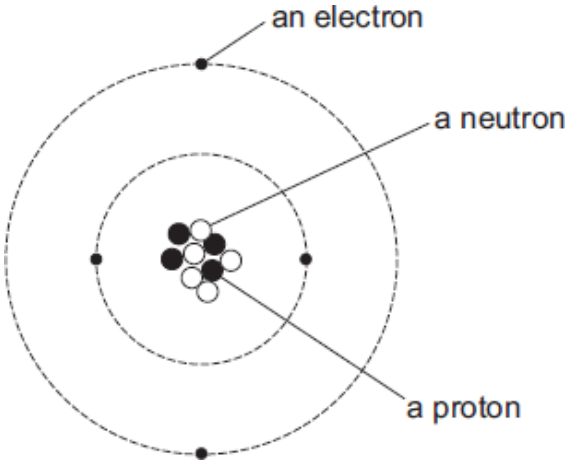
.....

.....

.....

(2)
(Total 5 marks)

Q22. The diagram represents an atom of beryllium. The three types of particle that make up the atom have been labelled.



(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)

(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)

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

Tick (✓) **one** box.

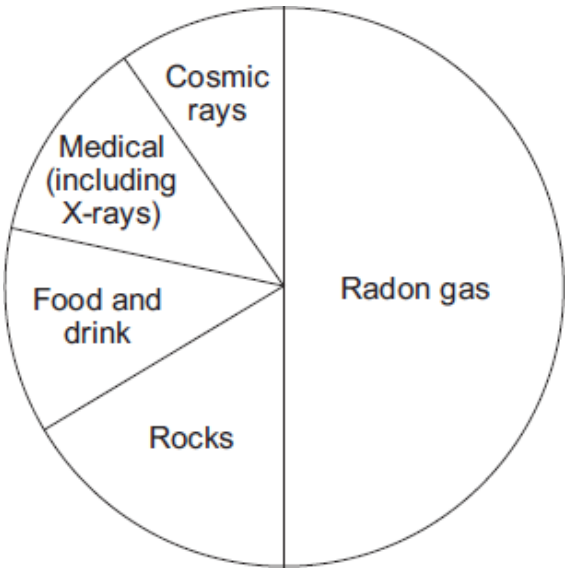
The atom loses a neutron. ☐

The atom loses an electron. ☐

The atom loses a proton. ☐

(1)
(Total 5 marks)

Q23. 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**.

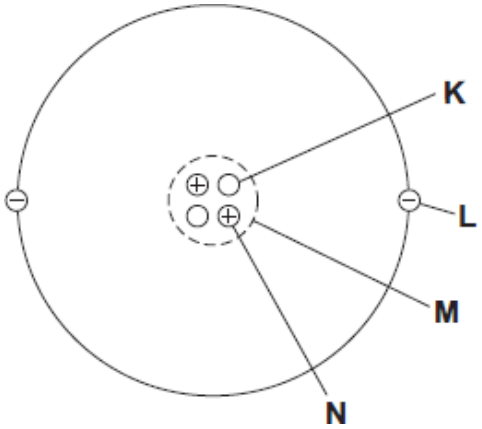
Draw **one** line to link each source of background radiation in **List A** to the statement about that source given in **List B**.

Draw only **three** lines.

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

(Total 3 marks)

Q24. (a) The diagram represents a helium atom.



(i) Which part of the atom, **K**, **L**, **M** or **N**, is an electron?

Part ☐

(1)

(ii) Which part of the atom, **K**, **L**, **M** or **N**, is the same as an alpha particle?

Part ☐

(1)

(b) A radioactive source emits alpha particles.

What might this source be used for?

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

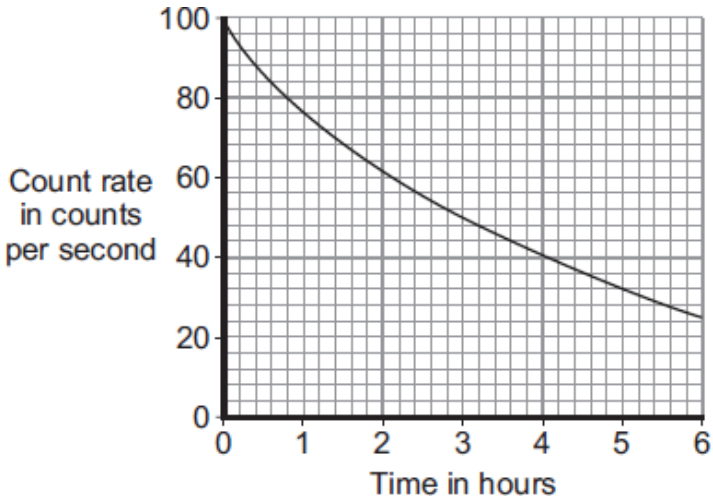
to monitor the thickness of aluminium foil as it is made in a factory ☐

to make a smoke detector work ☐

to inject into a person as a medical tracer ☐

(1)

(c) The graph shows how the count rate from a source of alpha radiation changes with time.



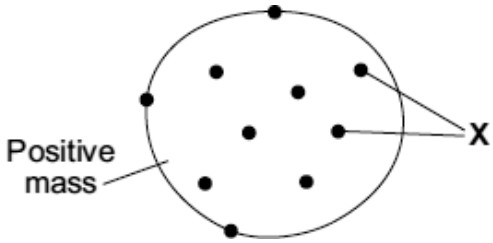
What is the count rate after 4 hours?

..... counts per second

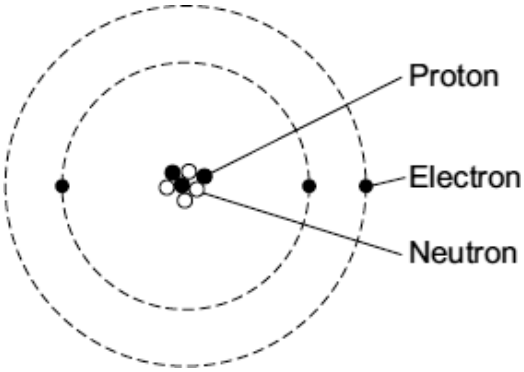
(1)

(Total 4 marks)

Q25. The diagrams show two different models of an atom.



'Plum pudding' model



Model used today

(a) The particles labelled '**X**' in the plum pudding model are also included in the model of the atom used today.

What are the particles labelled '**X**' ?

.....

(1)

(b) Scientists decided that the ‘plum pudding’ model was wrong and needed replacing.

Which **one** of the following statements gives a reason for deciding that a scientific model needs replacing?

Tick (✓) **one** box.

The model is too simple. ☐

The model has been used by scientists for a long time. ☐

The model cannot explain the results from a new experiment. ☐

(1)

(c) The table gives information about the three types of particle that are in the model of the atom used today.

Particle	Relative mass	Relative charge
	1	+1
	very small	–1
	1	0

Complete the table by adding the names of the particles.

(2)
(Total 4 marks)

Q26. The names of three different processes are given in **List A**.
Where these processes happen is given in **List B**.

Draw a line to link each process in **List A** to where the process happens in **List B**.

Draw only **three** lines.

List A **Process**	**List B** **Where it happens**
	in a star
fusion	
	in a nuclear reactor
chain reaction	
	in a smoke precipitator
alpha decay	
	in the nucleus of an atom

(Total 3 marks)

Q27. (a) The names of the three types of nuclear radiation are given in **List A**.
Some properties of these types of radiation are given in **List B**.

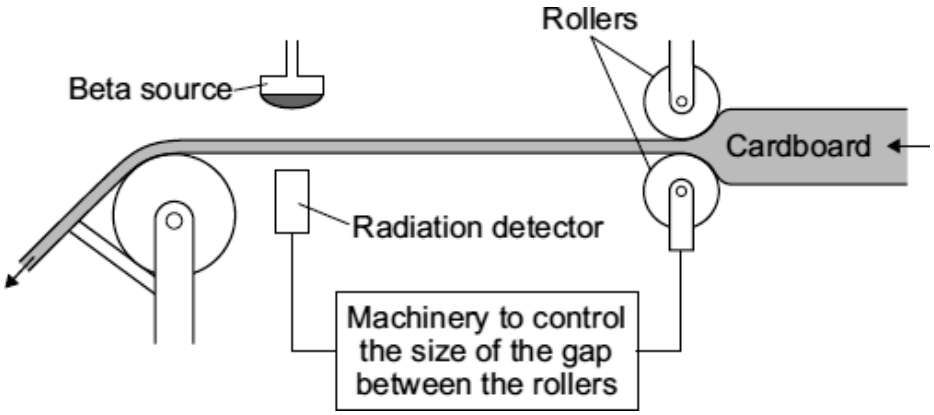
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

Draw only **three** lines.

List A **Type of nuclear radiation**	**List B** **Property of radiation**
	Has the same mass as an electron
Alpha	
	Very strongly ionising
Beta	
	Passes through 10 cm of aluminium
Gamma	
	Deflected by a magnetic field but not deflected by an electric field

(3)

(b) The diagram shows a system used to control the thickness of cardboard as it is made.



The cardboard passes through a narrow gap between a beta radiation source and a radiation detector.

The table gives the detector readings over 1 hour.

Time	Detector reading
08:00	150
08:15	148
08:30	151
08:45	101
09:00	149

(i) Between 08:00 and 08:30, the cardboard is produced at the usual, correct thickness.

Explain how you can tell from the detector readings that the cardboard produced at 08:45 is thicker than usual.

.....

.....

.....

.....

(2)

(ii) Which would be the most suitable half-life for the beta source?

Draw a ring around your answer.

six days **six months** **six years**

(1)

(iii) This control system would **not** work if the beta radiation source was replaced by an alpha radiation source.

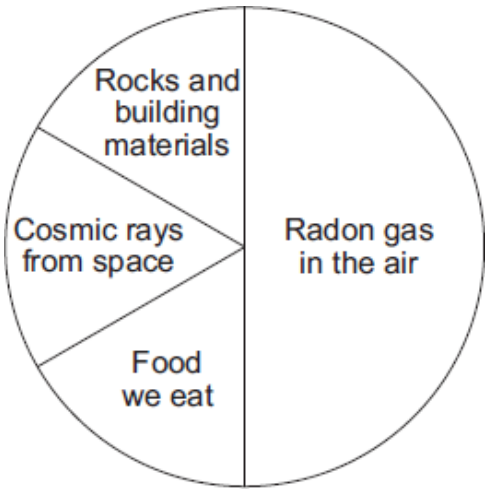
Why not?

.....

.....

(1)
(Total 7 marks)

Q28. The pie chart shows the average proportions of natural background radiation from various sources in the UK.



(a) (i) Complete the following sentence.

On average, ... of the natural background radiation in the UK comes from radon gas.

(1)

(ii) Radon gas is found inside homes.

The table shows the results from measuring the level of radon gas inside four homes in one area of the UK.

Home	**Level of radon gas in Bq per m^3 of air**
1	25
2	75
3	210
4	46
Mean	89

One of the homes has a much higher level of radon gas than the other three homes.

What should be done to give a more reliable mean for the homes in this area of the UK?

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

ignore the data for home number 3 ☐

measure the radon gas level in more homes in this area ☐

include data for homes from different areas of the UK ☐

(1)

(b) Each atom of radon has 86 protons and 136 neutrons.

(i) How many electrons does each atom of radon have?

Draw a ring around your answer.

50 **86** **136** **222**

(1)

(ii) How many particles are there in the nucleus of a radon atom?

Draw a ring around your answer.

50 **86** **136** **222**

(1)
(Total 4 marks)

Q29. The table shows the average background radiation dose from various sources that a person living in the UK receives in one year.

Source of background radiation	**Average radiation dose received each year in dose units**
Cosmic rays (from space)	300
Food and drink	250
Medical treatments (including X-rays)	350
Radon gas	1250
Rocks	350
TOTAL	2500

(a) (i) A student looked at the data in the table and then wrote down four statements.

Only **two** of the statements are true.

Put a tick (✓) in the boxes next to the **two** true statements.

More than half of the average radiation dose comes from radon gas. ☐

On average, cosmic rays produce less background radiation than rocks. ☐

Everyone living in the UK receives the same background radiation dose. ☐

Having no X-rays reduces a person's radiation dose. ☐

(2)

(ii) Each time a chest X-ray is taken, the patient receives about 100 units of radiation.

How many chest X-rays would just exceed the yearly average dose for medical treatments?

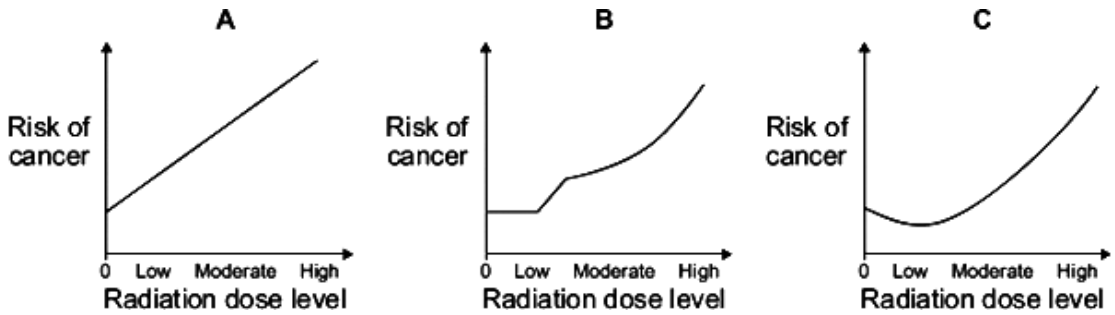
.....

Number of chest X-rays = ...

(2)

(b) Exposure to radiation can cause cancer.

The graphs, **A**, **B** and **C**, show three different ways that the exposure to radiation and the risk of getting cancer could be linked.



(i) What do all three of these graphs suggest happens to the risk of getting cancer when the radiation dose goes from moderate to high?

.....

.....

(1)

(ii) Some scientists believe that exposure to **low** radiation doses reduces the chance that a person will get cancer. This effect is called 'radiation hormesis'.

Which one of the graphs, **A**, **B** or **C**, shows 'radiation hormesis'?

Write your answer in the box. ☐

Give a reason for your answer.

.....

.....

.....

(2)

(c) Scientists did an experiment in which mice were exposed to different doses of radiation.

The results from the experiment are given in the table.

Description of exposure	Percentage of mice getting cancer
Mice exposed to a low dose of radiation and then a high dose of radiation.	16%
Mice exposed to a high dose of radiation only.	46%

(i) Do the results from this experiment provide evidence to support 'radiation hormesis'?

Draw a ring around your answer. NO YES

Explain the reason for your answer.

.....

.....

.....

.....

.....

(2)

(ii) Complete the following sentence by drawing a ring around the correct word in the box.

Using animals in scientific experiments raises

environmental
ethical
social

issues.

(1)
(Total 10 marks)

Q30. Certain types of atom emit alpha, beta or gamma radiation. The radiation is emitted from the centre of the atom.

(a) What name is given to the centre of an atom?

.....

(1)

(b) The sign below is used to warn people that a radiation source is being used in a laboratory.

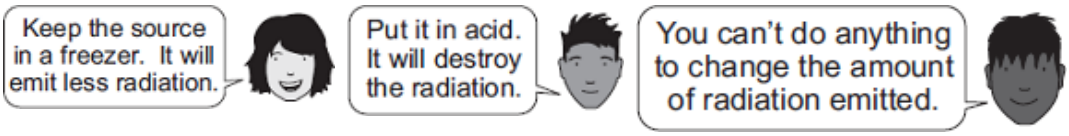
Why is it important to warn people that a radiation source is being used?

.....

.....

(1)

(c) Before using a radiation source, a teacher asked her class whether there was any way that she could reduce the amount of radiation that the source emitted. Three students each gave an answer to the teacher.



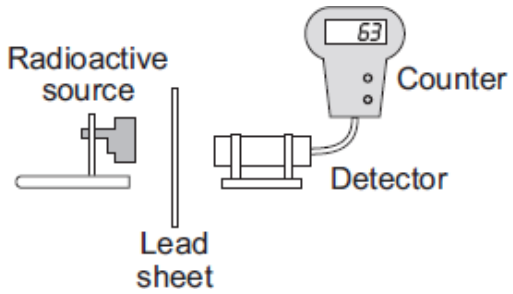
A **B** **C**

Which **one** of the students, **A**, **B** or **C**, is correct?

Write your answer in the box. ☐

(1)

(d) The diagram shows the apparatus used by the teacher to demonstrate how one type of radiation is able to pass through lead.



One lead sheet, 2 mm thick, was placed between the source and the detector and a count rate was taken. Extra lead sheets were added. For each extra lead sheet, a new count rate was taken and recorded in the table.

Number of lead sheets	Count rate in counts per minute
1	226
2	220
3	210
4	190
5	185

Which type of radiation was the source emitting: alpha, beta or gamma?

.....

Give the reason for your answer.

.....

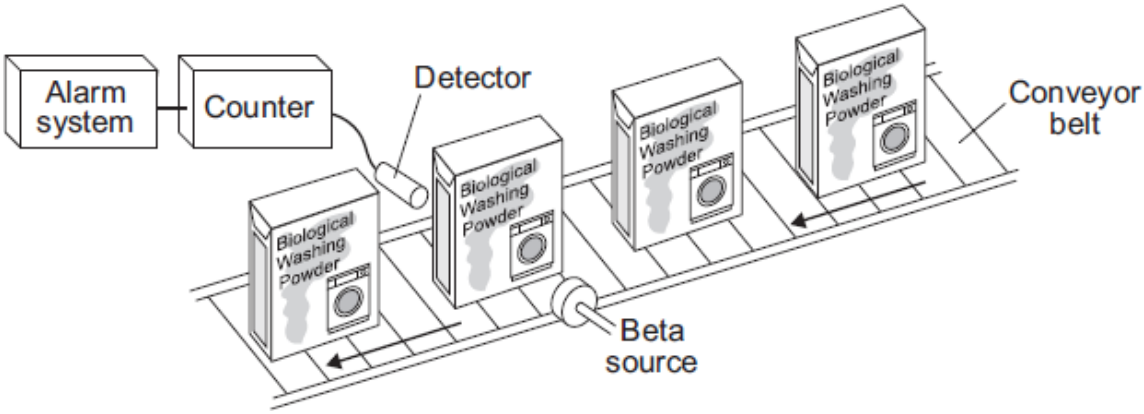
.....

.....

(2)

(e) The diagram shows how a company detects any boxes left empty by an automatic filler.

When an empty box passes between the beta source and the detector, a buzzer sounds. A worker then removes the box from the conveyor belt.



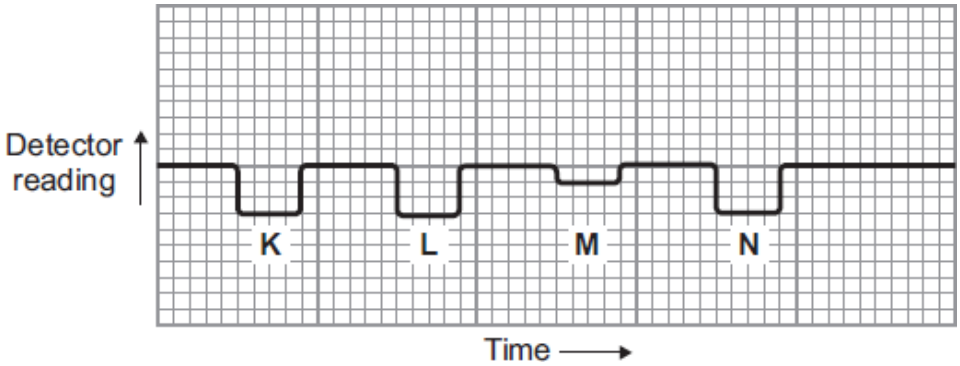
(i) Why would this system **not** work if an alpha source were used instead of the beta source?

.....

.....

(1)

(ii) The chart shows how the detector reading changes as boxes pass along the conveyor belt.



Which part of the chart, **K**, **L**, **M** or **N**, shows that an empty box is passing between the beta source and the detector?

.....

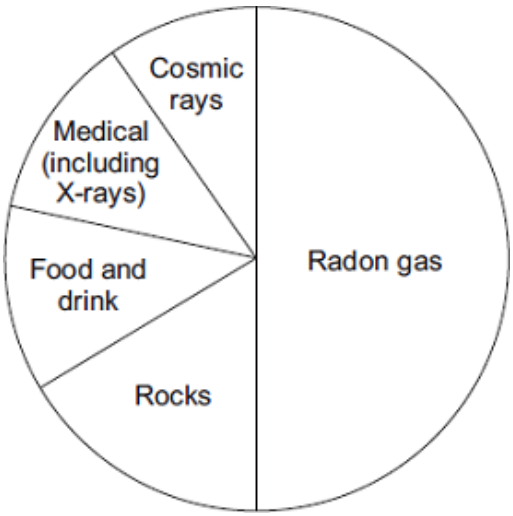
Give a reason for your answer.

.....

.....

(2)
(Total 8 marks)

Q31. The pie chart shows the average proportions of background radiation from various sources in the UK.



(a) 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**.

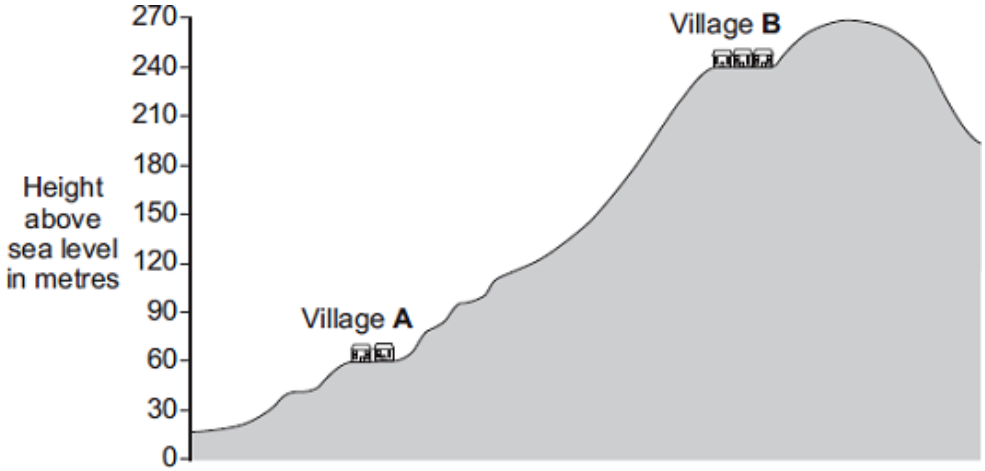
Draw only **three** lines.

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

(3)

(b) The level of background radiation from cosmic rays is not the same everywhere. For every 30 metres above sea level, the amount of background radiation increases by one unit.

The diagram shows the position of two villages, **A** and **B**, built on a hill.



How is the amount of background radiation from cosmic rays different in village **A** compared to village **B**?

To obtain full marks, you must include a calculation in your answer.

.....

.....

.....

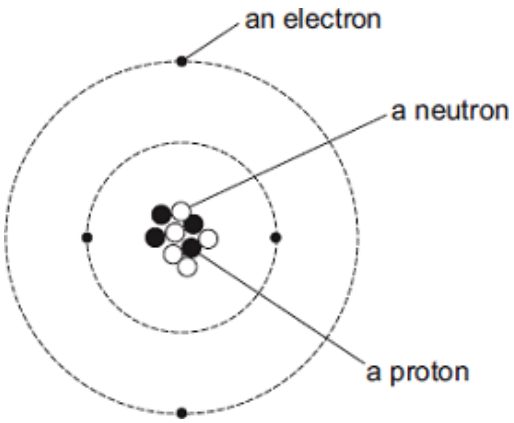
.....

.....

.....

(3)
(Total 6 marks)

Q32. The diagram represents an atom of beryllium. The three types of particle that make up the atom have been labelled.



(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)

(b) What is the mass number of a beryllium atom?

Draw a ring around your answer.

4	**5**	**9**	**13**

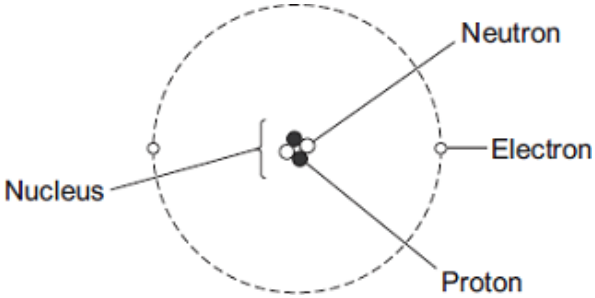
Give a reason for your answer.

.....

.....

(2)
(Total 4 marks)

Q33. The diagram shows the structure of an atom.



Not drawn to scale

(a) In 1931 scientists thought that atoms contained **only** protons and electrons.

Suggest what happened in 1932 to change the idea that atoms contained only protons and electrons.

.....

.....

(1)

(b) The table gives information about the particles in an atom.

Complete the table by adding the names of the particles.

Particle	Relative Mass	Relative Charge
	1	0
	very small	–1
	1	+1

(2)
(Total 3 marks)

Q34. (a) Sources of background radiation are either natural or man-made.

Which **two** of the sources listed in the box are *natural* sources of background radiation?

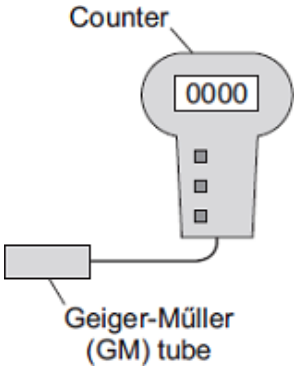
Draw a ring around each of your answers.

cosmic rays	**nuclear accidents**	**X-rays**	**radon gas**

(2)

(b) A teacher used a Geiger-Műller (GM) tube and counter to measure the background radiation in her laboratory. The teacher reset the counter to zero, waited one minute and then took the count reading. The teacher repeated this two more times.

The three readings taken by the teacher are given in the table.



Count
17
21
19

(i) The three readings are different.

What is the most likely reason for this?

Tick (✓) **one** box.

The teacher did not reset the counter to zero. ☐

Radioactive decay is a random process. ☐

The temperature in the laboratory changed. ☐

(1)

(ii) Calculate the mean (average) value of the three readings given in the table.

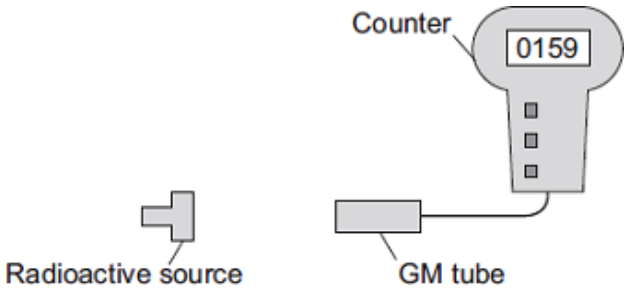
.....

Mean (average) value = ... counts

(1)

(iii) The diagram shows how the teacher used the GM tube and counter to measure the radiation emitted from a radioactive source.

The counter was reset to zero. The count after one minute was 159.



Calculate how many counts were due to the radiation from the radioactive source.

.....

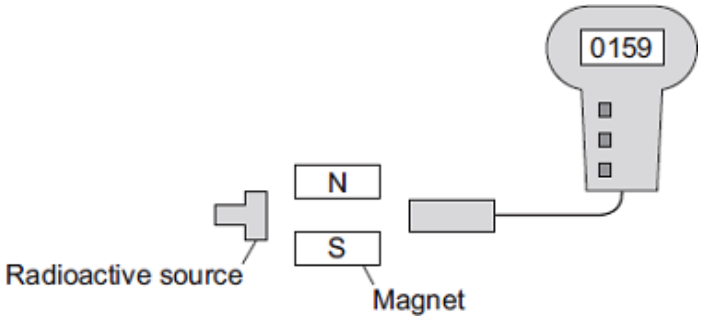
.....

Counts due to the radiation from the radioactive source = ...

(1)

(iv) The teacher then put a powerful magnet between the radioactive source and the GM tube.

The counter was reset to zero. The number on the counter shows the count after one minute.



What type of radiation was being emitted from the radioactive source?

Draw a ring around your answer.

alpha **beta** **gamma**

Explain the reason for your answer.

.....

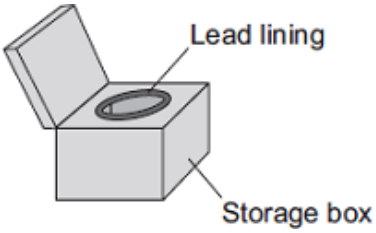
.....

.....

.....

(3)

(c) At the end of the lesson the teacher put the radioactive source back inside its storage box.



Why is the inside of the box lined with lead?

.....

.....

(1)

(d) Which **one** of the following questions **cannot** be answered by scientific study?

Tick (✓) **one** box.

Where does background radiation come from? ☐

What is meant by the half-life of a radioactive source? ☐

Should radioactive waste be dumped in the oceans? ☐

(1)
(Total 10 marks)

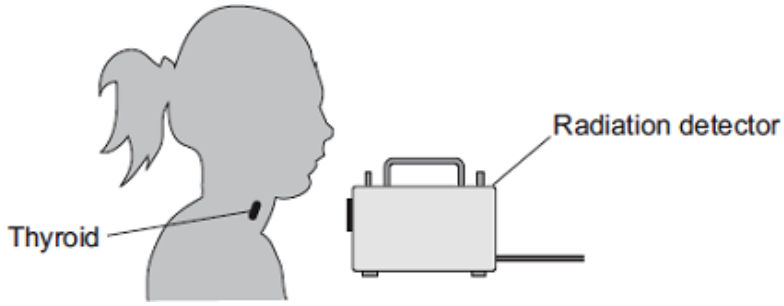
Q35. (a) The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

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

List A **Type of radiation**	**List B** **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)

(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)

(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)

(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)
(Total 6 marks)