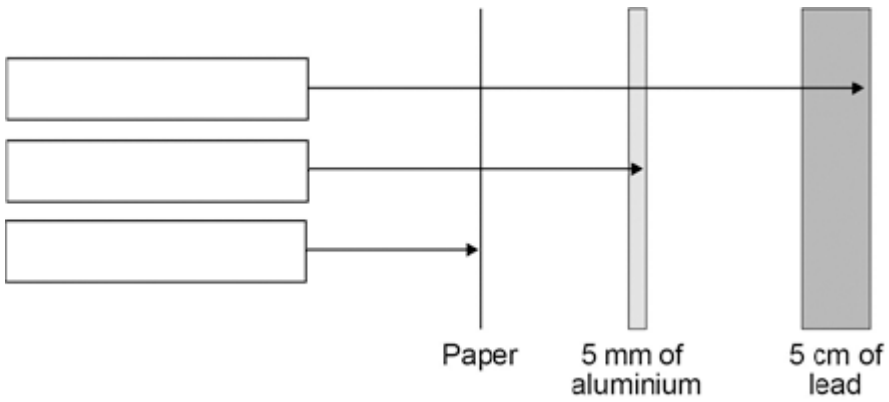
(a) Draw **one** line from each type of radiation to what the radiation consists of.

Type of radiation	**What radiation consists of**
Alpha	Electron from the nucleus
Beta	Two protons and two neutrons
Gamma	Electromagnetic radiation
	Neutron from the nucleus

(3)

(b) A teacher demonstrates the penetration of alpha, beta and gamma radiation through different materials.

The demonstration is shown in the figure below.



Complete the figure above by writing the name of the correct radiation in each box.

(2)

(c) Give **two** safety precautions the teacher should have taken in the demonstration.

1 .....

.....

2 .....

.....

(2)

(d) The table below shows how the count rate from a radioactive source changes with time.

Time in seconds	0	40	80	120	160
Count rate in counts / second	400	283	200	141	100

Use the table to calculate the count rate after 200 seconds.

.....

.....

(2)

(e) The half-life of the radioactive source used was very short.

Give **one** reason why this radioactive source would be much less hazardous after 800 seconds.

.....

.....

(1)
(Total 10 marks)

Q2. 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.

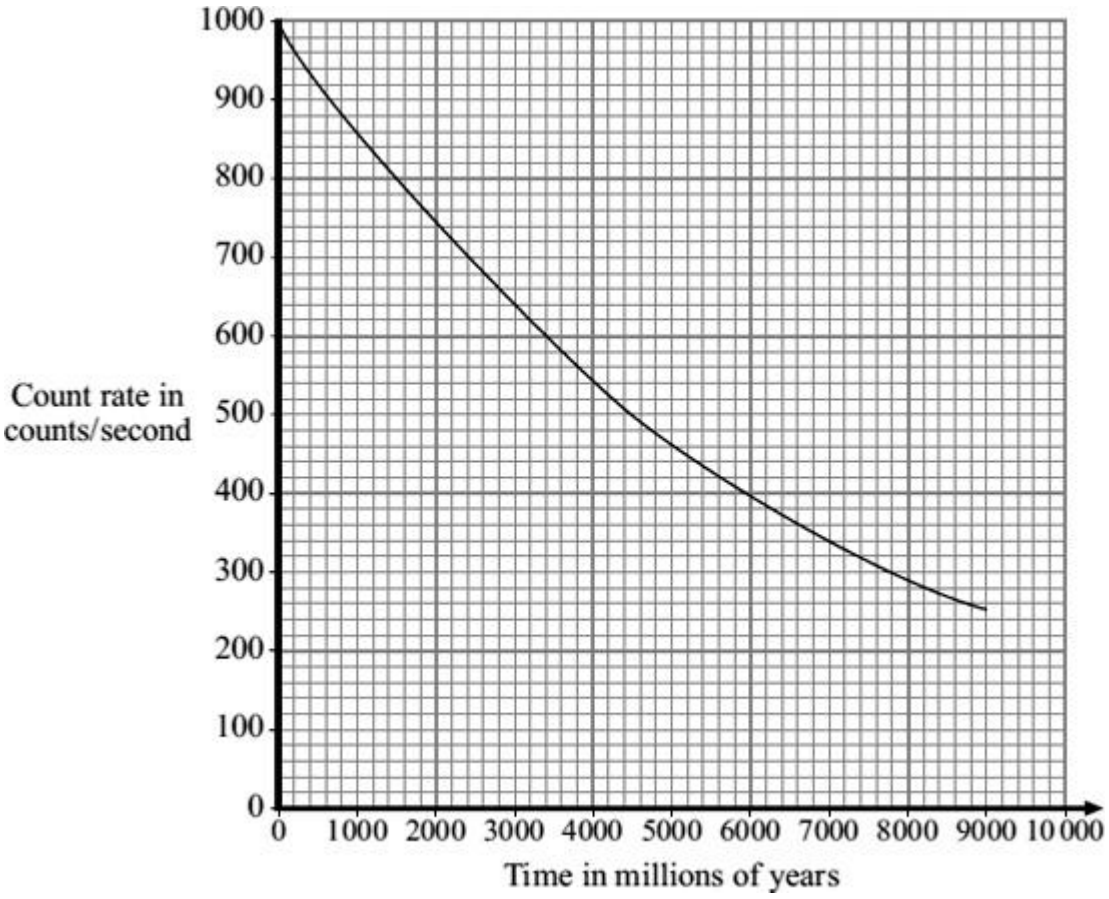
Write down your **new** statement.

.....

.....

(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)

Q3. Atoms contain three types of particle.

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

The particles in the nucleus of the atom are

electrons and neutrons.
electrons and protons.
neutrons and protons.

(1)

(b) Complete the table to show the relative charges of the atomic particles.

Particle	Relative charge
Electron	–1
Neutron	
Proton	

(2)

(c) (i) A neutral atom has no overall charge.

Explain this in terms of its particles.

.....

.....

.....

.....

(2)

(ii) Complete the sentence.

An atom that loses an electron is called an .....

and has an overall ..... charge.

(2)

(d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Some substances are radioactive. They may emit alpha or beta particles.

Describe the characteristics of alpha particles and beta particles in terms of their:

- structure
- penetration through air and other materials
- deflection in an electric field.

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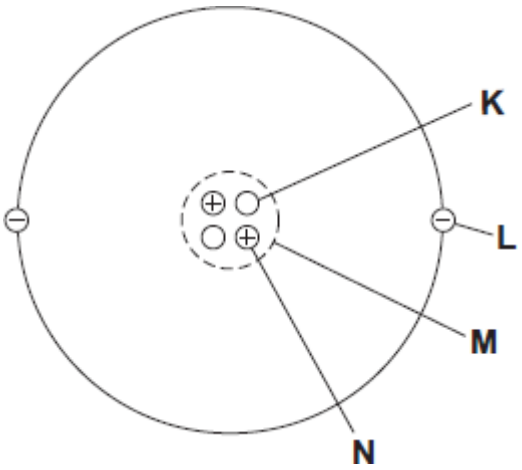
(6)
(Total 13 Marks)

Q4. (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.

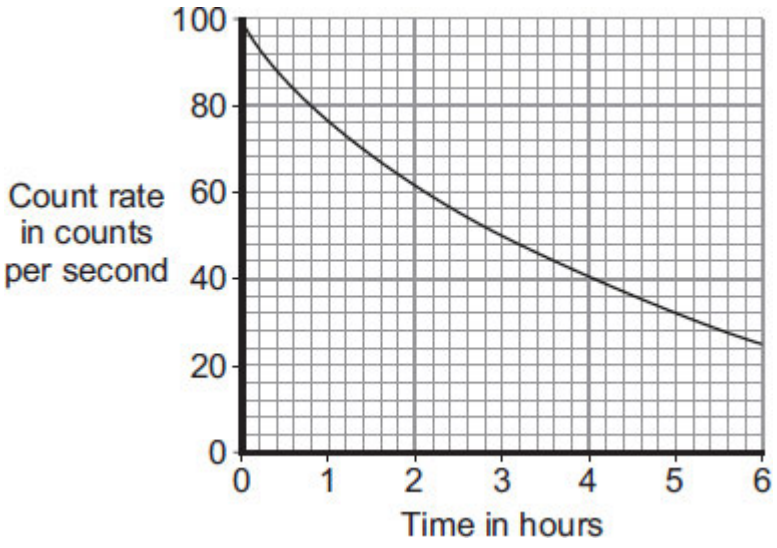
to monitor the thickness of aluminium foil as it is made in a factory ☐

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)

Q5. (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**.

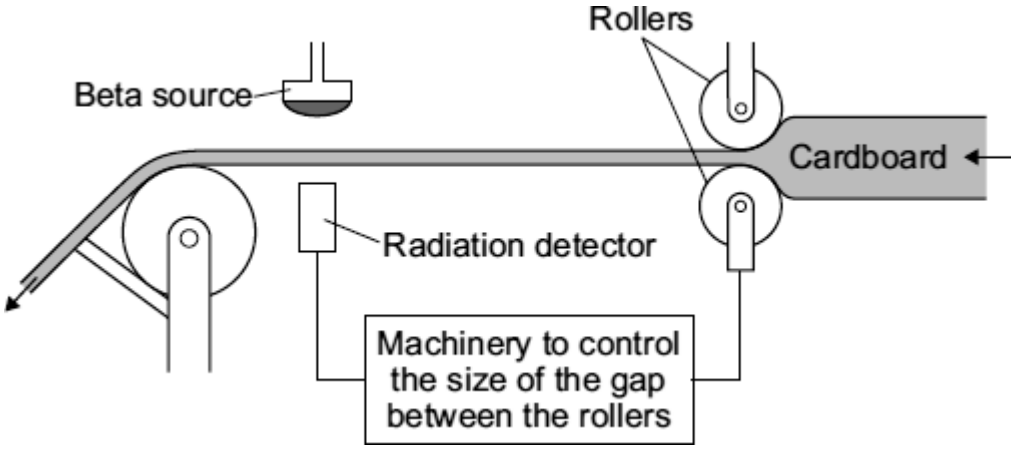
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

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)

Q6. 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.

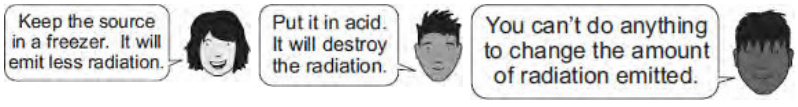
Why is it important to warn people that a radiation source is being used?

.....

.....

(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.



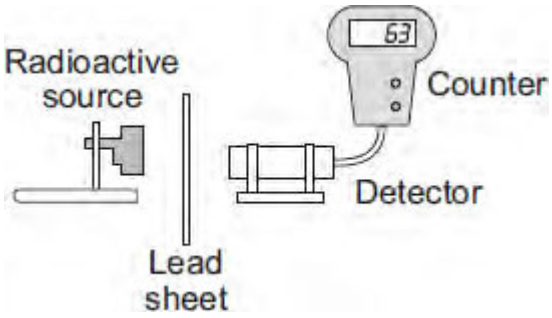
A **B** **C**

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.

.....

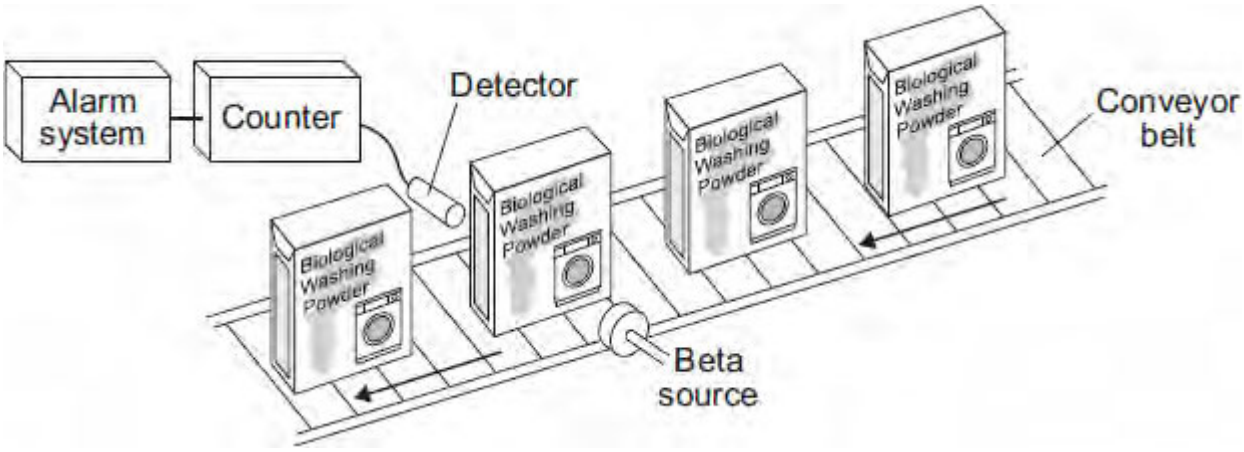
.....

.....

(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.



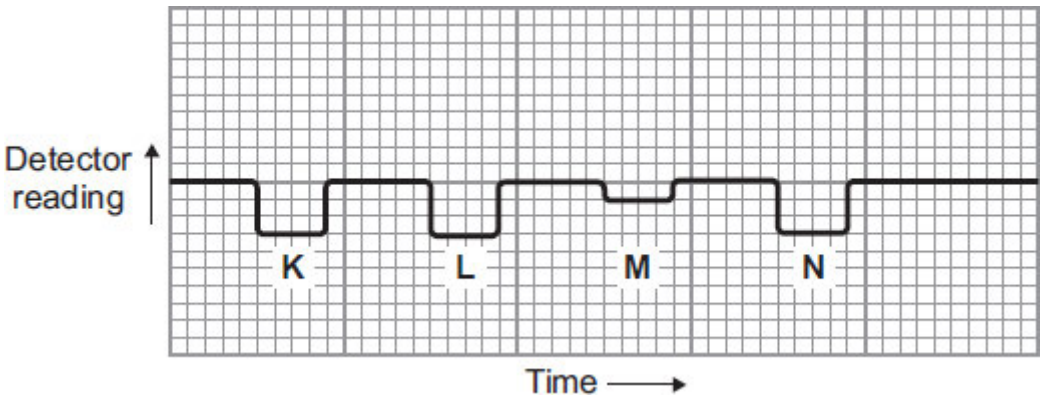
(i) Why would this system **not** work if an alpha source were used instead of the beta source?

.....

.....

(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)

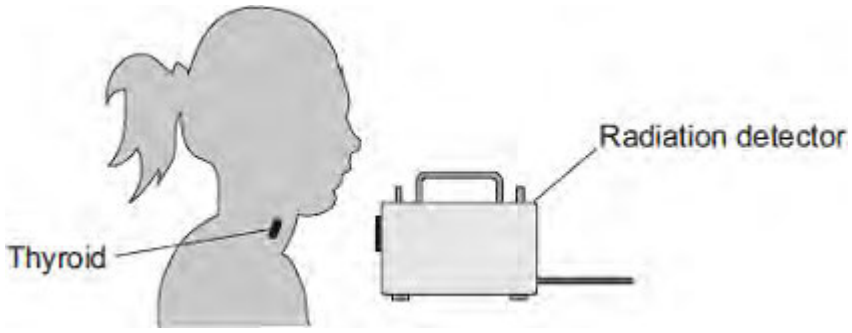
Q7.(a) The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

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	as the
protons	

nucleus of an iodine-131 atom.

(1)
(Total 6 marks)