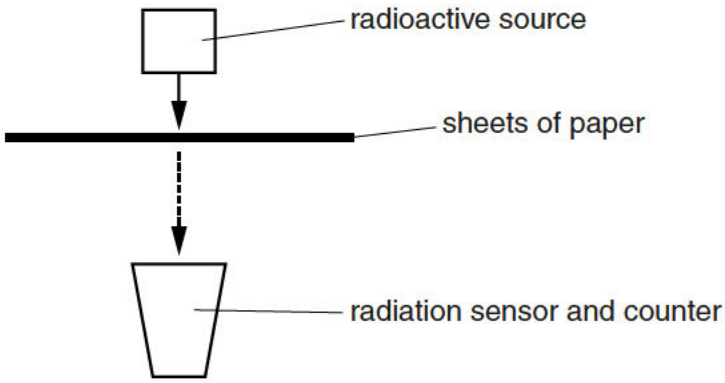
1 Dr Williams shows her class an experiment with radioactivity.

She uses three different radioactive sources

- an alpha emitter
- a beta emitter
- a gamma emitter.

She uses different thicknesses of sheets of paper between the source and the sensor.

Look at the diagram.



Dr Williams measures the nuclear radiation from each source using the sensor.
Each radioactive source emits only one type of radiation.
This can be alpha, beta or gamma.
Look at her results for each source.

Thickness of sheets of paper in mm	Average count rate in counts per second		
	Radioactive source X	Radioactive source Y	Radioactive source Z
0	30	68	65
0.2	32	36	60
0.4	31	21	57
0.6	33	5	52
0.8	34	1	48
1.0	29	0	45
1.2	31	1	41
1.4	30	0	39
1.6	31	0	38
1.8	30	2	35
2.0	31	1	33

Use the data to identify and explain which radiation comes from sources X, Y and Z. Comment on how useful each source is for detecting the thickness of sheets of paper up to 2 mm.

The quality of written communication will be assessed in your answer to the question.

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.... **[6]**

2 Radiation comes from the nucleus of an atom that is unstable.

(a) An alpha particle is a helium nucleus.

What is a beta particle?

Choose the **best** answer from

an electron

a fast moving electron

a proton

a fast moving proton

..... **[1]**

(b) What happens to a nucleus when a beta particle is emitted?

Put ticks (✓) next to the **two** correct statements.

mass number is unchanged	☐
nucleus has one more neutron	☐
nucleus has one more proton	☐
atomic number decreases by one	☐

[1]

(c) Radioactive americium (Am) is used in smoke alarms.

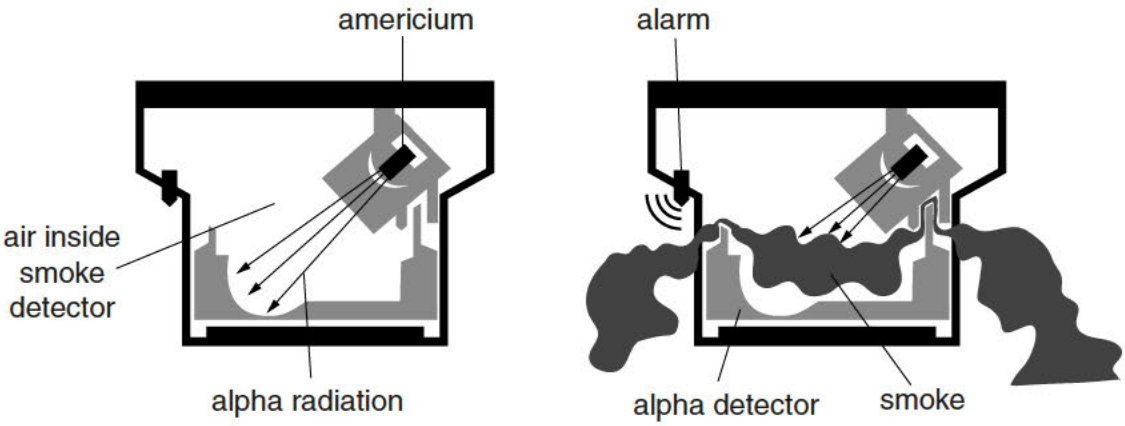
(i) Complete the equation for alpha decay.

An alpha particle is a helium nucleus.

$$^{241}_{95}\text{Am} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\text{Np} + {}^{\ldots\ldots}_{\ldots\ldots}\text{He}$$

[2]

(ii) Here are two diagrams showing how a smoke detector works.



Use the diagrams to describe how a smoke detector works.

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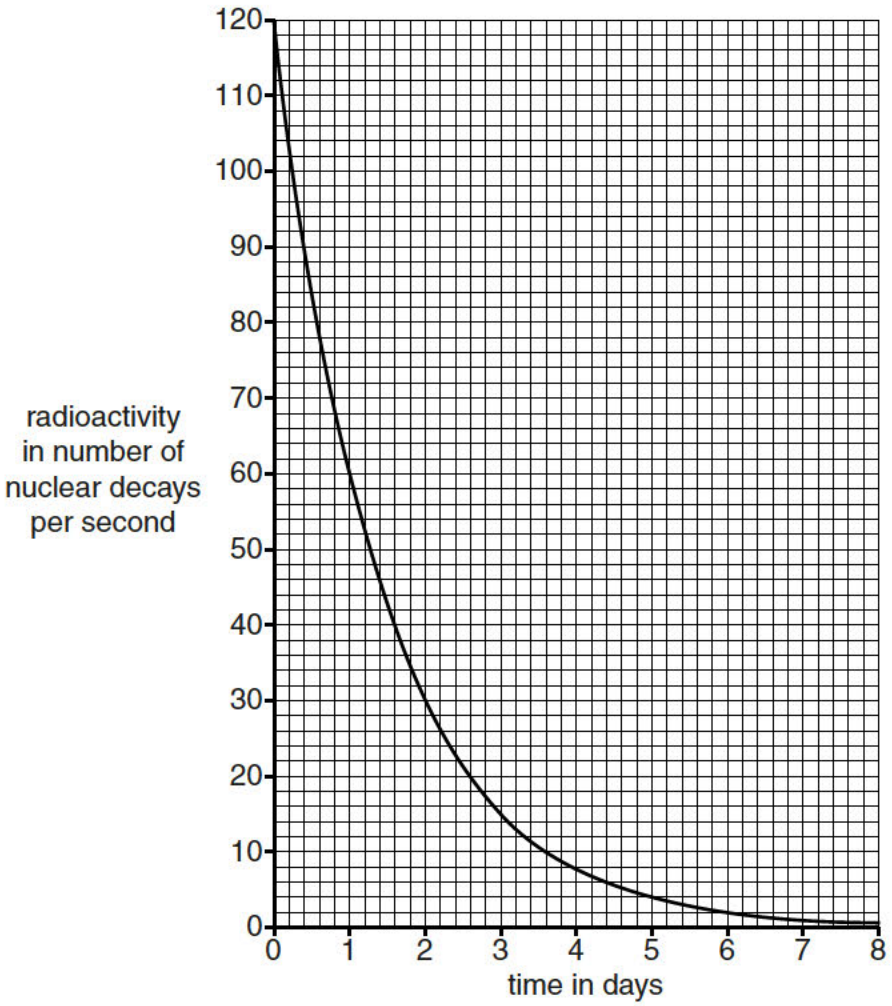
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..... **[2]**

3 Medical radioisotopes use radioactive elements.

Radioactivity is measured by the number of nuclear decays per second.

Look at the graph showing the radioactive decay of element **A**.



(a) (i) What happens to the radioactivity of element **A** between day 1 and day 2?

.....

..... **[2]**

(ii) Doctor Hanif compares radioactive element **A** with radioactive element **B**.

Both elements start with the same radioactivity of 120 nuclear decays per second.

Element **B** has a **longer** half-life.

Draw a line on the graph to show the decay of element **B**. **[1]**

(b) Technetium-99 can be used to make a medical radioisotope.

When technetium-99 decays it emits beta radiation.

Complete the nuclear equation for this decay.

$$^{99}_{43}\mathrm{Tc} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{Ru} + {}^{\ldots\ldots}_{\ldots\ldots}\beta$$

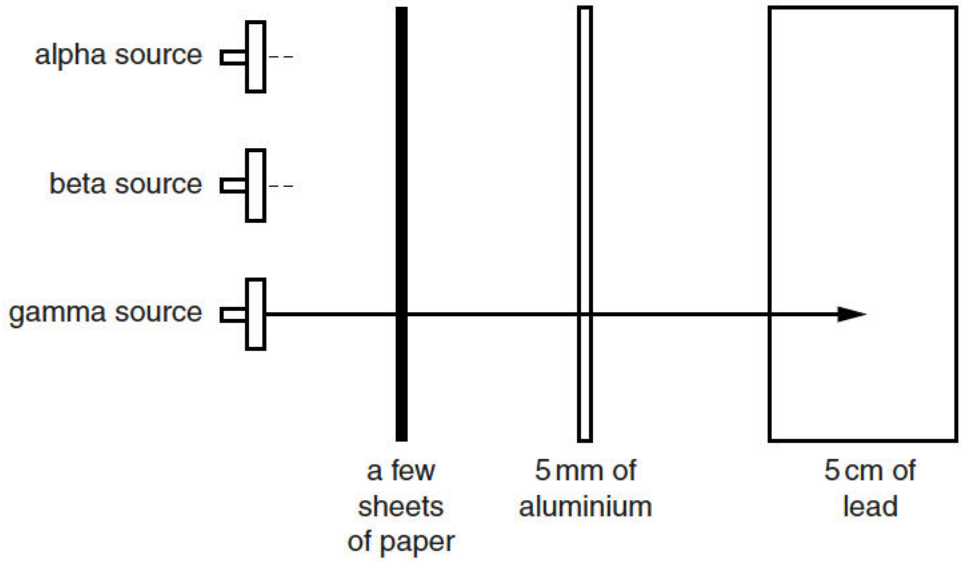
[2]

[Total: 5]

4 This question is about nuclear radiation.

(a) Complete the diagram to show the penetrating power of alpha **and** beta radiation.

Gamma radiation has been completed for you.



[1]

(b) Write down **two** examples of beneficial uses of gamma radiation.

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..... **[2]**

(c) Explain the problems of dealing with radioactive waste.

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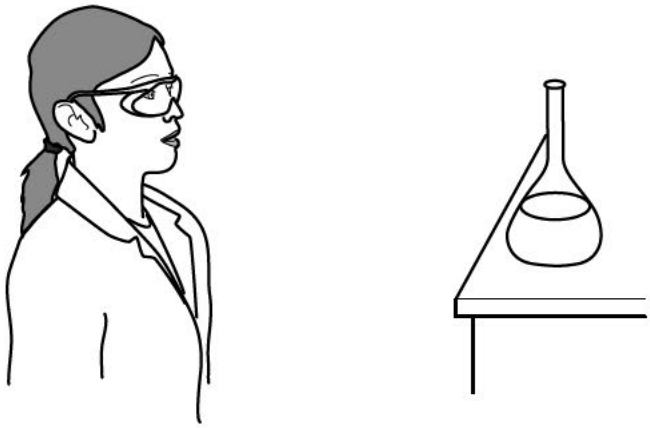
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..... **[2]**

[Total: 5]

5 Tricia is a scientist investigating the **radioactivity** of a liquid.



(a) Tricia wants to measure the penetrating power of the radiation emitted.

(i) Alpha, beta and gamma radiation can be stopped by different materials.

Which material would be the best material to show that alpha radiation is emitted?

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..... **[1]**

(ii) She may have difficulty measuring the penetrating power of **alpha** radiation **in a liquid**.

Suggest **one** of the problems she may have.

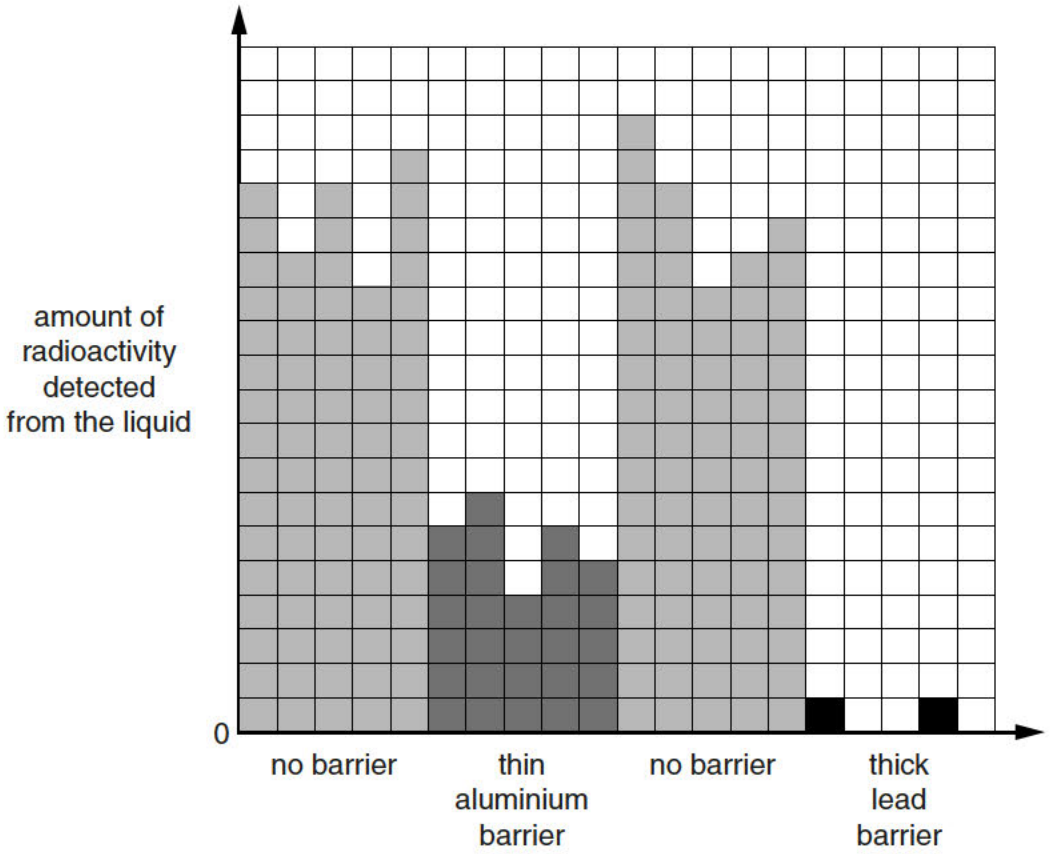
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..... **[1]**

(b) Here are her results.

She carried out each investigation five times.



(i) Explain why she carried out each investigation five times.

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..... **[1]**

(ii) Interpret her results to identify the types of radiation emitted.

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..... **[2]**

[Total: 5]

6 Nuclear radiation can be both useful and dangerous.

The three types of nuclear radiation are alpha, beta and gamma.

(a) Look at the table about nuclear radiation. It is incomplete.

Complete the table.

nuclear radiation	example of use	stopped by
alpha		a sheet of card
beta		
gamma	treating cancer	a few cm of lead

[3]

(b) Radioactive materials have to be disposed of safely.

Some high level nuclear waste from a power station is in liquid form.

The nuclear power company want to bury the liquid waste underground.

Explain the risks of doing this.

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..... **[2]**

[Total: 5]