1 In a research laboratory, a radioactive sample is placed close to a radiation detector. The graph in Fig. 11.1 shows the decay of the sample.

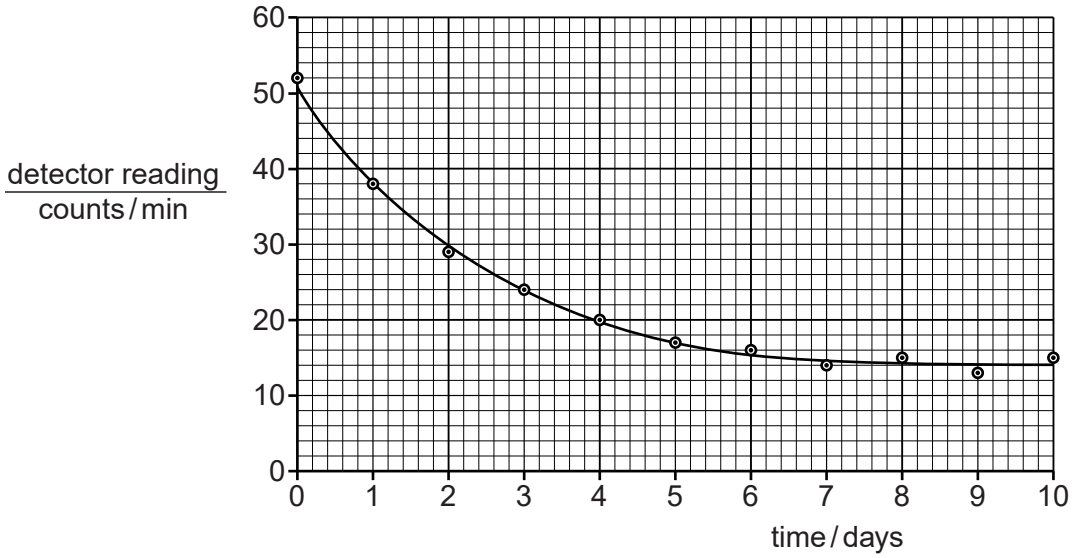

Fig. 11.1

(a) After 6 days the count rate hardly decreases and, in fact, increases a little at times. Explain these observations.

.....

.....

.....

..... [2]

(b) Use the graph to determine the half-life of the sample. Explain your working carefully.

half-life = ... [4]

(c) Another radioactive sample is a strong emitter of α-particles and γ-rays. A junior researcher suggests that a sufficient safety precaution, when working with this sample, would be to hold the sample with long forceps. Explain why this suggestion, although helpful, may be insufficient.

.....

.....

.....

..... [2]

[Total: 8]

2 **(a)** A radioactive source emits α-, β- and γ-radiation.

Which of these radiations

(i) has the shortest range in air, ...

(ii) has a negative charge, ...

(iii) is not deflected in a magnetic field? .....

[2]

(b) In a famous experiment, carried out in a vacuum, a very thin sheet of gold was placed in the path of alpha particles.

It was found that a large number of the alpha particles passed through the sheet with little or no deflection from their original path. A very small number of the alpha particles were reflected back towards the source.

(i) Explain, in terms of the force acting, why the direction of motion of an alpha particle changes when it comes close to the nucleus of a gold atom.

.....

.....

..... [2]

(ii) State **two** conclusions, about the nuclei of atoms, that were made from the results of this experiment.

1. .....

.....

2. .....

.....

[2]

[Total: 6]

3 **(a)** Six different nuclides have nucleon and proton numbers as follows:

nuclide	nucleon number	proton number
A	214	84
B	214	85
C	211	84
D	211	86
E	210	82
F	210	83

State which two nuclides are isotopes of the same element. ..... and ..... [1]

(b) Thorium-232 has a half-life of 1.4×10^{10} years.

At a particular instant, the activity of a sample of thorium-232 is 120 Bq.

(i) Calculate the time taken for the activity of this sample to fall to 15 Bq.

time taken .....[1]

(ii) Explain why, when the activity has become 15 Bq, much of the sample will no longer be thorium-232.

.....

.....

.....[1]

(iii) The sample of thorium-232 is used in an experiment in a laboratory.

Explain why its activity may be regarded as constant.

.....

.....

.....[1]

[Total: 4]

4 **(a)** An atom consists of a nucleus made up of protons and neutrons, surrounded by orbiting electrons.

(i) Which of these particles has a positive charge? .....[1]

(ii) Which two of these particles have almost equal mass?

..... and ..... [1]

(b) A silver nucleus is denoted by $^{107}_{47}Ag$. State the number of protons and the number of neutrons in this nucleus.

number of protons = ... number of neutrons = ... [2]

(c) The graph in Fig. 11.1 shows part of the decay curve of a radioactive nuclide. The count rate is plotted against time.

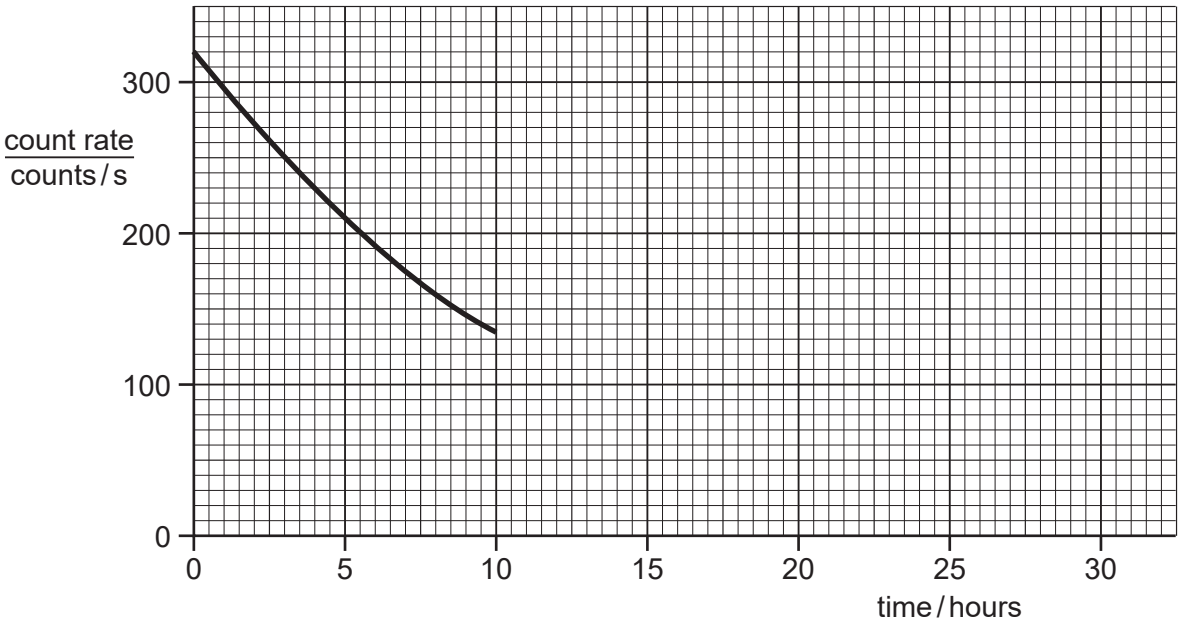

Fig. 11.1

(i) Use the graph to find the half-life of this nuclide.

half-life = ...[1]

(ii) Plot two more points on Fig. 11.1 at times greater than 10 hours. Use a dot in a circle to indicate each point. [2]

[Total: 7]

5 Emissions from a radioactive source pass through a hole in a lead screen and into a magnetic field, as shown in Fig. 10.1.

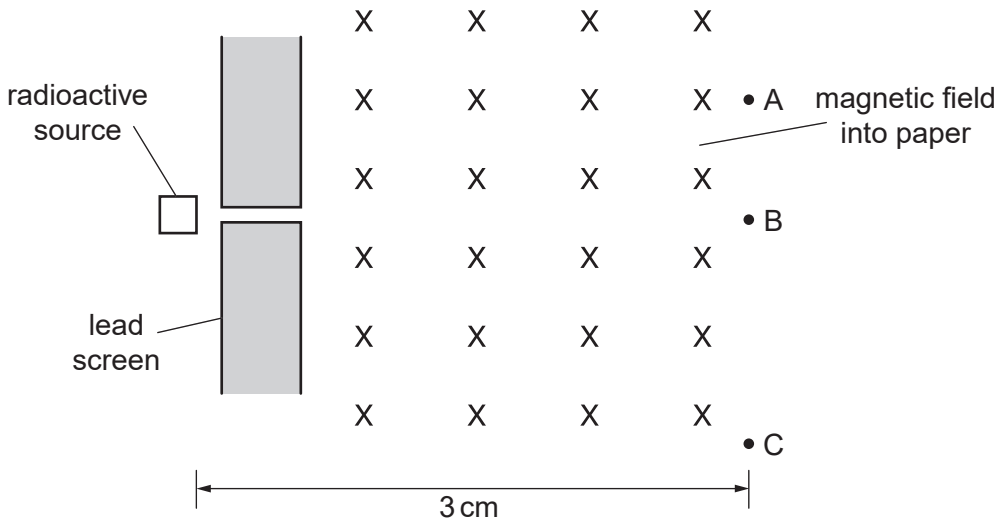

Fig. 10.1

Radiation detectors are placed at A, B and C. They give the following readings:

A	B	C
32 counts / min	543 counts / min	396 counts / min

The radioactive source is then completely removed, and the readings become:

A	B	C
33 counts / min	30 counts / min	31 counts / min

(a) Explain why there are still counts being recorded at A, B and C, even when the radioactive source has been removed, and give the reason for them being slightly different.

.....

.....

.....

..... [2]

(b) From the data given, deduce the type of emission being detected, if any, at A, at B and at C when the radiation source is present.

State the reasons for your answers.

detector at A .....

.....

..... [2]

detector at B .....

.....

..... [3]

detector at C .....

.....

..... [3]

[Total: 10]