1 **(a)** An iodine isotope $^{131}_{53}\mathrm{I}$ decays by β-emission to an isotope of xenon (Xe).

(i) State the number of each type of particle in a neutral atom of $^{131}_{53}\mathrm{I}$.

protons .... neutrons .... electrons .... [2]

(ii) State the symbol, in nuclide notation, for the xenon nucleus.

....[2]

(b) The background count rate of radioactivity in a laboratory is 30 counts / min.

A radioactive sample has a half-life of 50 minutes. The sample is placed at a fixed distance from a detector. The detector measures an initial count rate from the sample, including background, of 310 counts / min.

On Fig. 10.1, plot suitable points and draw a graph of the count rate from the sample, **corrected for background**, as it changes with time.

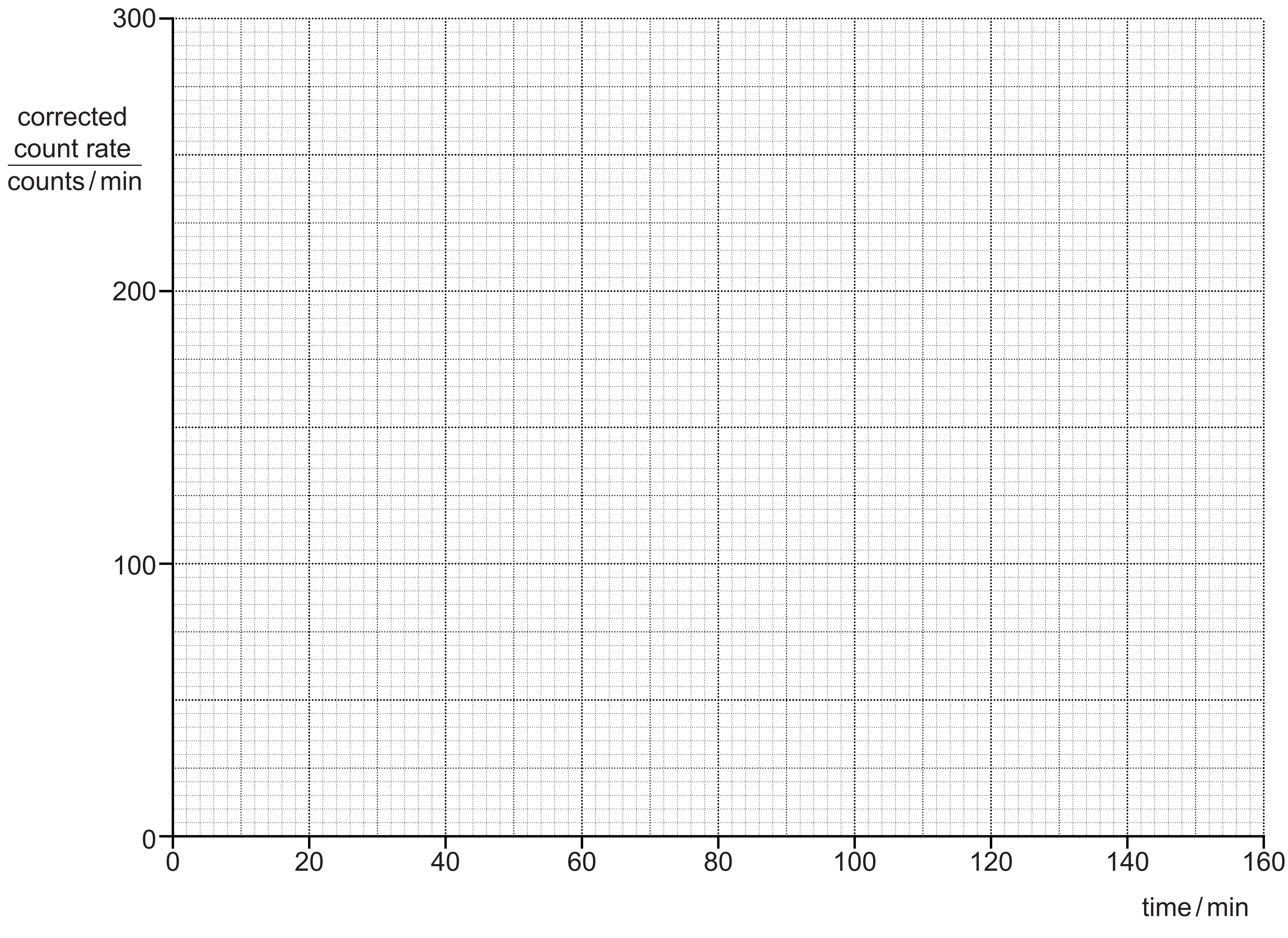

Fig. 10.1

[3]

[Total: 7]

2 Emissions from a radioactive source pass through a hole in a lead screen and into a magnetic field, as shown in Fig. 10.1. The experiment is carried out in a vacuum.

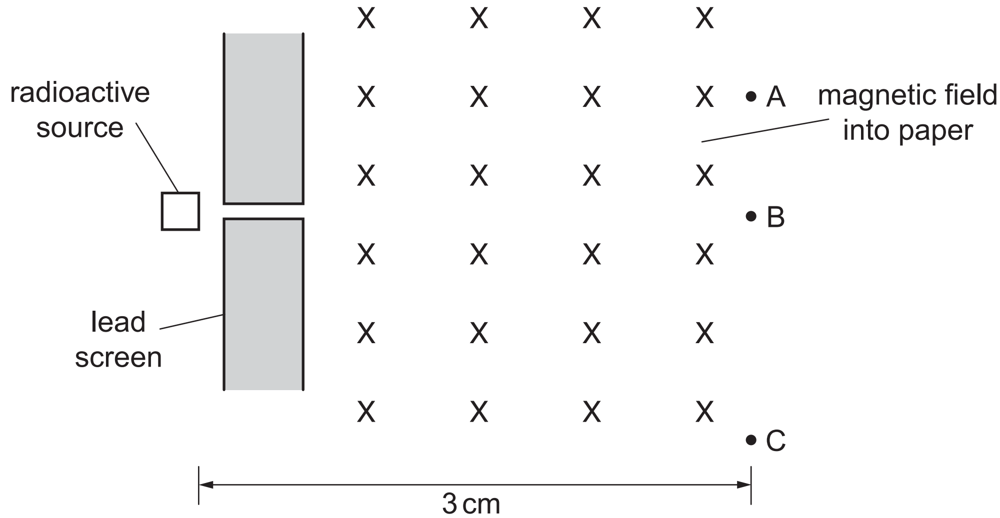

Fig. 10.1

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

A		C
32 counts / min	5 counts / min	3 counts / min

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

A		C
33 counts / min	counts / min	counts / min

From the data given for positions A, B and C, deduce the type of emissions coming from the radioactive source. Explain your reasoning.

....

....

....

....

....

....

....

....

.... [7]

[Total: 7]

3 **(a)** State the nature of γ-rays.

....

.... [1]

(b) A beam of α-particles and β-particles passes, in a vacuum, between the poles of a strong magnet.

Compare the deflections of the paths of the two types of particle.

....

....

.... [2]

(c) A beam of β-particles passes, in a vacuum, through the electric field between a pair of oppositely charged metal plates.

Describe the path of the particles.

....

....

.... [2]

(d) The nuclear equation shows the decay of an isotope of polonium.

$$^{A}_{Z}\text{Po} \rightarrow {}^{206}_{82}\text{Pb} + {}^{4}_{2}\text{X}$$

(i) State the nature of X.

....

.... [1]

(ii) Calculate the values of A and Z.

A = ... Z = ... [1]

[Total: 7]

4 (a) State the nature of an α-particle.

....

....[1]

(b) Describe how an electric field between two charged plates could be used to determine whether a beam of particles consists of α- or β-particles.

....

....

....[2]

(c) Describe the path of γ-rays in a magnetic field.

....

....[1]

(d) State what is meant by the term *isotopes*. Use the terms proton number and nucleon number in your explanation.

....

....

....

....

....[3]

[Total: 7]

5 **(a)** An underground water pipe has cracked and water is leaking into the surrounding ground.

Fig. 11.1 shows a technician locating the position of the leak.

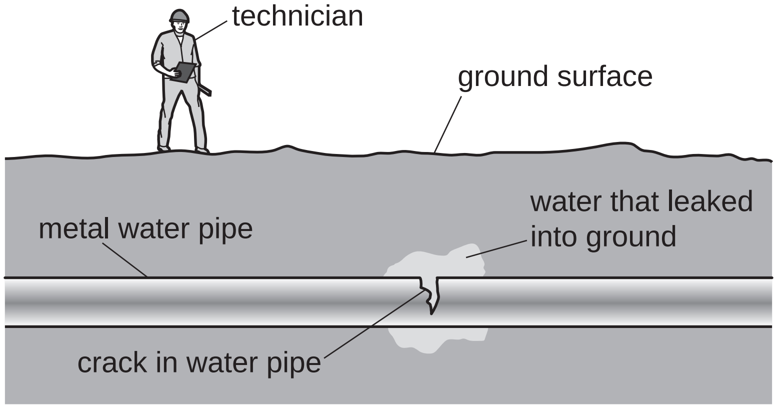

Fig. 11.1

A radioactive isotope is introduced into the water supply and the water that leaks from the crack is radioactive.

The technician tries to locate an area above the pipe where the radioactive count rate is higher than in the surrounding area.

(i) State and explain the type of radiation that must be emitted by the isotope for the leak to be detected.

....

....

....[2]

(ii) The half-life of the isotope used is 6.0 hours.

Explain why an isotope with this half-life is suitable.

....

....

....

....[2]

(b) Caesium-133 is a stable isotope of the element caesium, but caesium-135 is radioactive.

A nucleus of caesium-133 contains 78 neutrons and a nucleus of caesium-135 contains 80 neutrons.

Put **one** tick in each row of the table to indicate how the number of particles in a neutral atom of caesium-133 compares with the number of particles in a neutral atom of caesium-135.

The first row has been completed already.

	particles in caesium-133				
	2 more than caesium-135	1 more than caesium-135	equal to caesium-135	1 fewer than caesium-135	2 fewer than caesium-135
number of neutrons					✓
number of protons					
number of nucleons					
number of electrons					

[2]

[Total: 6]

6 **(a)** The counter of a radiation detector placed close to a radioactive source gives a count rate of 1600 counts / s. The half-life of the source is 1 week.

Ignoring background radiation, calculate the count rate

(i) 1 week after the first measurement,

count rate = ...[1]

(ii) 3 weeks after the first measurement.

count rate = ...[1]

(b) Fig. 11.1 shows the arrangement for an experiment to investigate the shielding of radioactive sources.

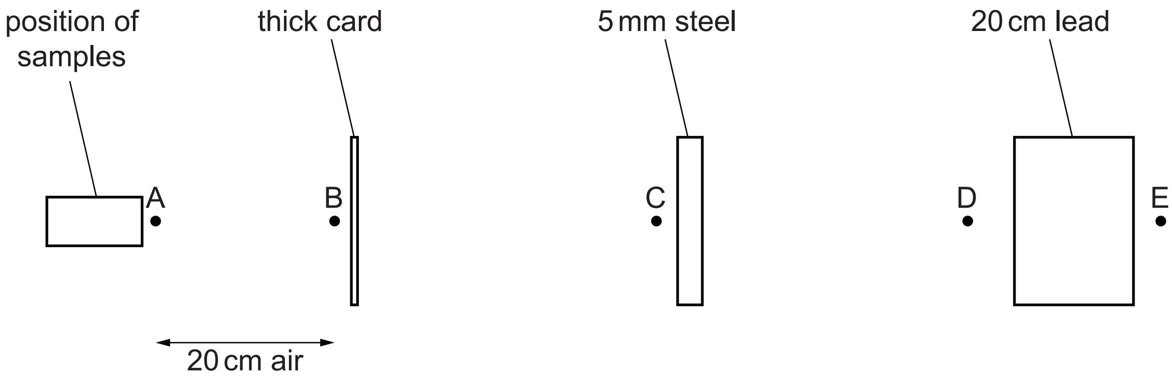

Fig. 11.1 (not to scale)

Samples containing three different radioactive sources are placed, one at a time, in the position shown.

The table shows the count rates when a radiation detector is placed at the positions A to E.

Complete the table to indicate whether α-particles, β-particles or γ-rays are emitted from each sample.

	A	B	C	D	E	type of radiation emitted
sample 1	high	high	high	high	low	
sample 2	high	high	low	0	0	
sample 3	high	0	0	0	0	

[3]

(c) State which type of radiation, α, β or γ, is the most strongly ionising.

....[1]

[Total: 6]

7 **(a)** Complete the table below for the three types of radiation.

radiation	nature	charge	stopped by
γ	electromagnetic radiation		
β		negative	
α			thick paper

[3]

(b) An isotope of strontium is represented in nuclide notation as $^{90}_{38}Sr$.

For a neutral atom of this isotope, state

(i) the proton number, ...

(ii) the nucleon number, ...

(iii) the number of neutrons, ...

(iv) the number of electrons. ....

[3]

(c) A sample of a radioactive material is placed near a radiation detector. A count-rate of 4800 counts / s is detected from the sample. After 36 hours the count-rate has fallen to 600 counts / s.

Calculate how many more hours must pass for the count-rate to become 150 counts / s.

number of hours = ... [3]

[Total: 9]