

Radioactivity

Question Paper

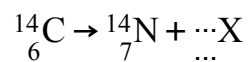
Course	CIE IGCSE Physics
Section	5. Nuclear Physics
Topic	Radioactivity
Difficulty	Hard

Time Allowed	50
Score	/36
Percentage	/100

Question 1a**Extended tier only**

A radioactive nucleus of carbon decays to a nucleus of nitrogen by emitting a particle.

Complete the nuclide equation and state the name of the particle.

**[3 marks]**

Question 1b**Extended tier only**

A radiation detector in a laboratory records a reading of 10 counts/min. There are no radioactive samples in the laboratory.

- (i) Explain why the radiation detector records a reading and suggest a possible source. [2]
- (ii) Carbon-14 has a half-life of 5700 years. There are atoms of carbon-14 in all living organisms.

An archaeologist digs up some ancient wood. In the same laboratory as in **(b)(i)**, a sample of this ancient wood gives a reading of 20 counts/min. An equivalent sample of living wood gives a reading of 80 counts/min. It is suggested that the age of the ancient sample is 11 400 years.

Do a calculation to check whether this suggestion is correct.

[4]

[2 marks]

Question 2

Fig.12.1 shows a radioactive source placed close to a radiation detector and counter. The detector can detect α , β and γ radiation.

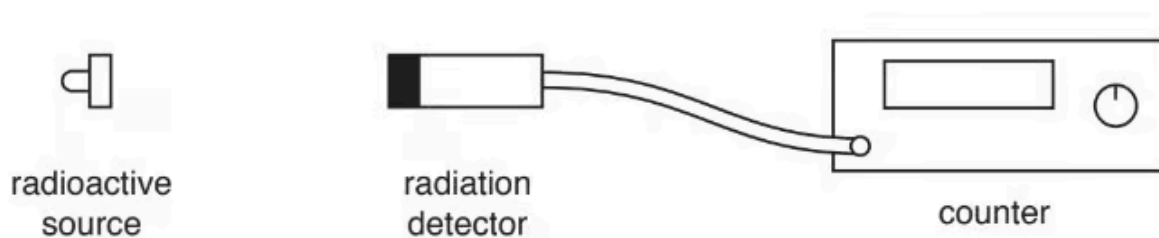


Fig. 12.1

The radioactive source emits β -particles only.

Describe how you could show that the source emits β -particles only.

As part of your answer, you may draw on Fig.12.1 and add any other apparatus you may need.

[4 marks]

Question 3a

A teacher carries out two experiments at the same time.

In the first experiment the count rate for a sample of a radioactive isotope is measured every 30 seconds for 6 minutes.

The results are shown in Table 12.1.

Table 12.1

time / minutes	<u>count rate</u> counts/second
0.0	1246
0.5	1036
1.0	941
1.5	810
2.0	686
2.5	621
3.0	550
3.5	468
4.0	421
4.5	368
5.0	318
5.5	280
6.0	242

Estimate the half-life of the radioactive isotope. Use the information in the table.

half-life = minutes

[1 mark]

Question 3b

In the second experiment the teacher repeats the procedure with another sample of the same radioactive isotope. The mass of the second sample is greater than that of the first sample.

Suggest a value for the count rate for this sample at the start of the experiment.

count rate = counts/second

[1 mark]

Question 3c

One type of particle emitted during radioactive decay is an α -particle (alpha particle).

Describe:

(i) the nature of an α -particle

[1]

(ii) the ionising ability of an α -particle

[1]

(iii) the penetrating ability of an α -particle.

[1]

[3 marks]

Question 4a

A radioactive substance decays by emitting an α -particle.

The nuclide notation for an α -particle is



- (i) State the term given to the number 4, written in the nuclide notation.

[1]

- (ii) State the term given to the number 2, written in the nuclide notation.

[1]

[2 marks]

Question 4b

Fig. 12.1 shows the decay curve for a radioactive material.

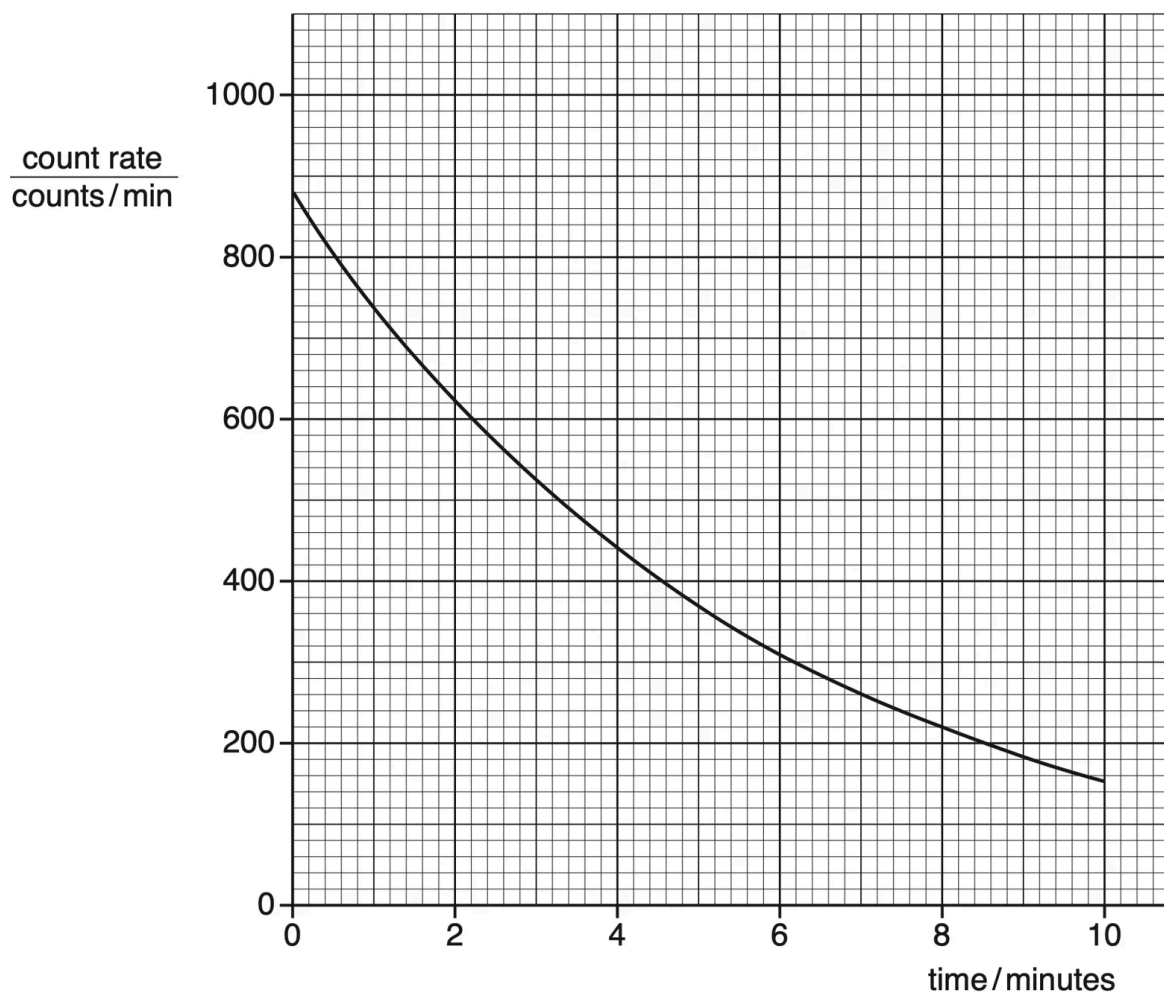


Fig. 12.1

- (i) Use information from the graph in Fig. 12.1 to determine the half-life of the material. Clearly show how you used the graph to obtain your answer.

half-life = minutes [3]

- (ii) Another radioactive material with the same half-life has an initial count rate of 600 counts/min. On Fig. 12.1 sketch the decay curve for this material.

[1]
[4 marks]

Question 5a

Astatine-210 is a radioactive material. The nucleus of astatine can be represented by the symbol shown.



Complete the table to describe the nucleus of astatine-210.

type of particle	number of particles	charge on particle
neutron		
		positive

[4 marks]

Question 5b

Astatine-210 has a half-life of 8 hours.

- (i) The count rate of a sample of astatine-210 is measured over 24 hours.

On Fig. 12.1, sketch a line to show how the count rate changes over the 24 hours.

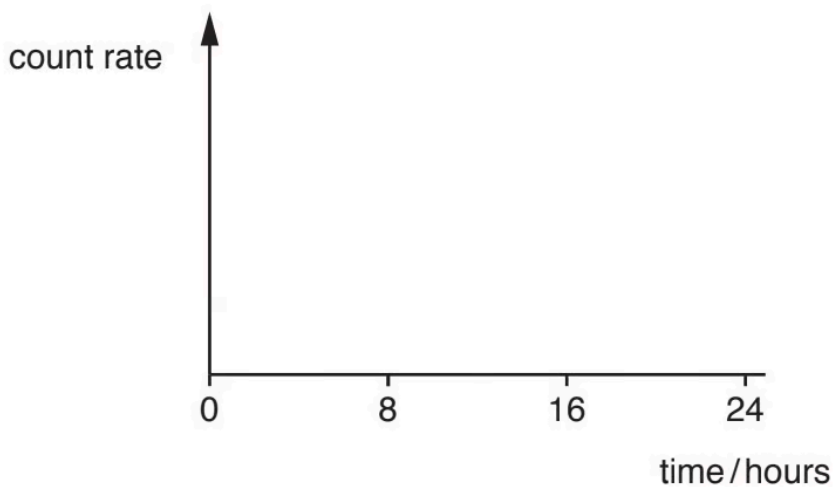


Fig. 12.1

- (ii) The mass of a sample of astatine-210 is 0.500 kg.

Calculate how long it takes for 0.375 kg of the sample to decay.

decay time = hours [3]
[5 marks]

Question 6a

State the type of radioactive emission that causes

- (i) the proton number of a nuclide to increase by 1,
- (ii) the nucleon number of a nuclide to decrease by 4,
- (iii) no change in the proton number and no change in the nucleon number of a nuclide.

[1]

[1]

[1]

[3 marks]

Question 6b

Extended tier only

The isotope radon-220 is radioactive and it decays by α -particle emission.

- (i) Fig. 11.1 shows a beam of α -particles entering the electric field between two charged plates.

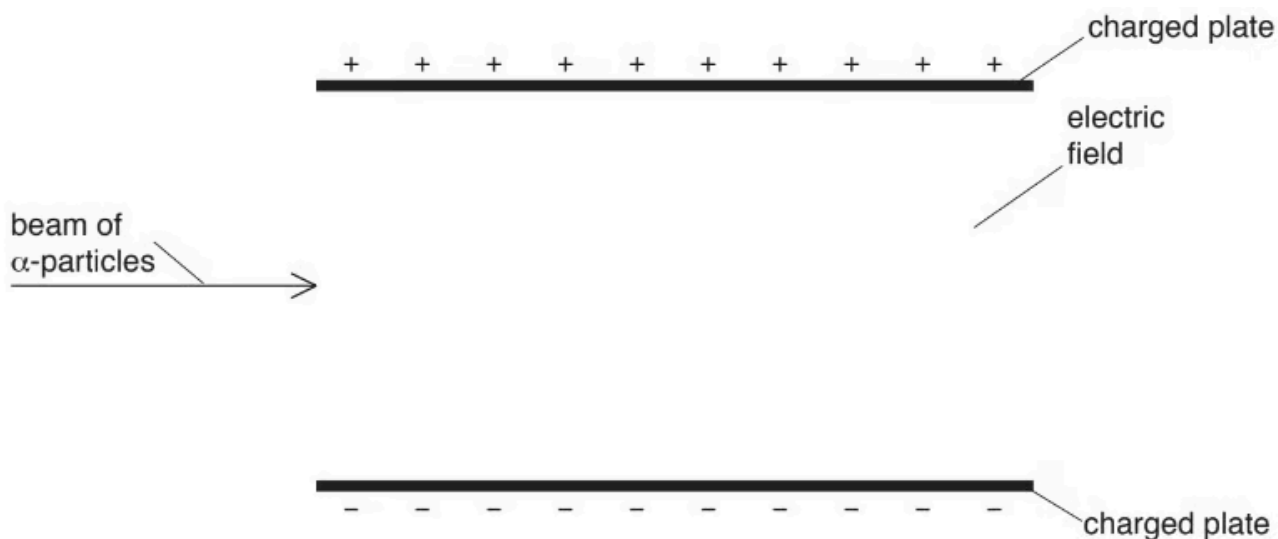


Fig. 11.1

On Fig. 11.1, sketch the path that the beam of α -particles follows in the electric field.

[1]

- (ii) The half-life of radon-220 is 56 s.

A sample of this isotope contains 7.2×10^6 atoms.

Predict the number of α -particles that the radon-220 in the sample emits in the next 168 s.

number of α -particles emitted =[3]



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[4 marks]