

Radioactivity 2

1.

Atoms contain protons, neutrons and electrons.

State which of these three

- (a) has a negative charge,[1]
- (b) is uncharged,[1]
- (c) has a much smaller mass than the others,[1]
- (d) is outside the nucleus,[1]
- (e) are nucleons,[2]
- (f) are lost from the nucleus during α -particle emission.[2]

2.

- (a) The decay of a nucleus of radium ${}^{226}_{88}\text{Ra}$ leads to the emission of an α -particle and leaves behind a nucleus of radon (Rn).
In the space below, write an equation to show this decay. [2]

- (b) In an experiment to find the range of α -particles in air, the apparatus in Fig. 11.1 was used.

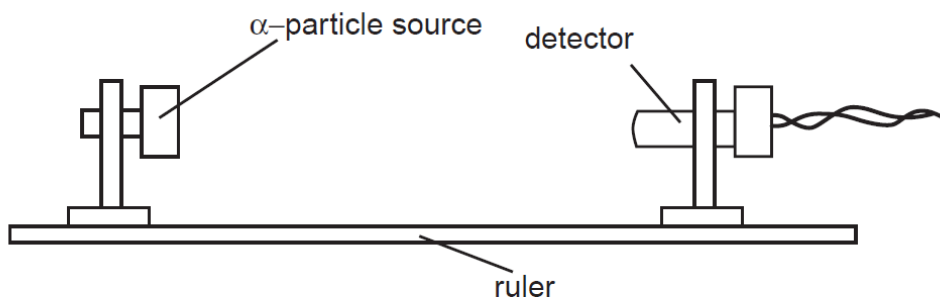


Fig. 11.1

The results of this experiment are shown below.

count rate / (counts/minute)	681	562	441	382	317	20	19	21	19
distance from source to detector/cm	1	2	3	4	5	6	7	8	9

(i) State what causes the count rate 9 cm from the source.

.....

(ii) Estimate the count rate that is due to the source at a distance of 2 cm.

.....

(iii) Suggest a value for the maximum distance that α -particles can travel from the source.

.....

(iv) Justify your answer to (iii).

.....

.....

[4]

3.

Which type of radiation has the greatest ionising effect?

- A α -particles
- B β -particles
- C γ -rays
- D all have the same ionising effect

[1]

4.

A powder contains 400 mg of a radioactive material that emits α -particles.

The half-life of the material is 5 days.

What mass of that material remains after 10 days?

- A 0 mg
- B 40 mg
- C 100 mg
- D 200 mg

[1]

5.

In the symbol below, A is the nucleon number and Z is the proton number.



What is represented by the symbol?

- A an electron
- B a neutron
- C a nuclide
- D an X-ray

[1]

6.

- (a) Complete the following table about the particles in an atom. The first row has been filled in as an example.

particle	mass	charge	location
proton	1 unit	+1 unit	in the nucleus
neutron			
electron			

[6]

- (b) (i) Which of the particles in the table make up an α -particle?

.....

- (ii) On the same scale as indicated by the table, state

1. the mass of an α -particle,
2. the charge of an α -particle.

[3]

7.

Fig. 10.1 is the decay curve for a radioactive isotope that emits only β -particles.

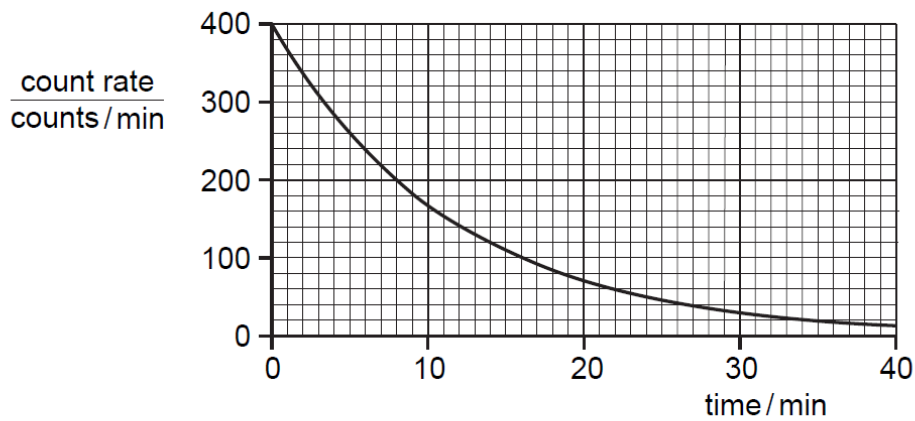


Fig. 10.1

Use the graph to find the value of the half-life of the isotope.

Indicate, on the graph, how you arrived at your value.

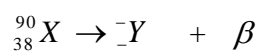
half-life [2]

8. When a nucleus of ${}_{38}^{90}\text{X}$ decays by beta radiation, it changes into a nucleus of an isotope of a different element Y.

(a) Explain the changes taking place in the nucleus when a beta particle is emitted.

(3 marks)

(b) Complete the nuclear equation given below for the beta decay of ${}_{38}^{90}\text{X}$.



(2 marks)

9.

- (a) There are many isotopes of the element molybdenum (Mo).

What do the nuclei of different molybdenum isotopes have in common?

[1 mark]

.....

- (b) The isotope molybdenum-99 is produced inside some nuclear power stations from the nuclear fission of uranium-235.

- (b) (i) What happens during the process of nuclear fission?

[1 mark]

.....

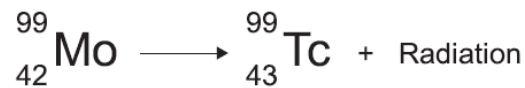
.....

- (b) (ii) Inside which part of a nuclear power station would molybdenum be produced?

[1 mark]

.....

- (c) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.



What type of radiation is emitted by molybdenum-99?

[2 marks]

.....

Give a reason for your answer.

.....

.....

- (d) Technetium-99 has a short half-life and emits gamma radiation.

What is meant by the term 'half-life'?

[1 mark]

.....

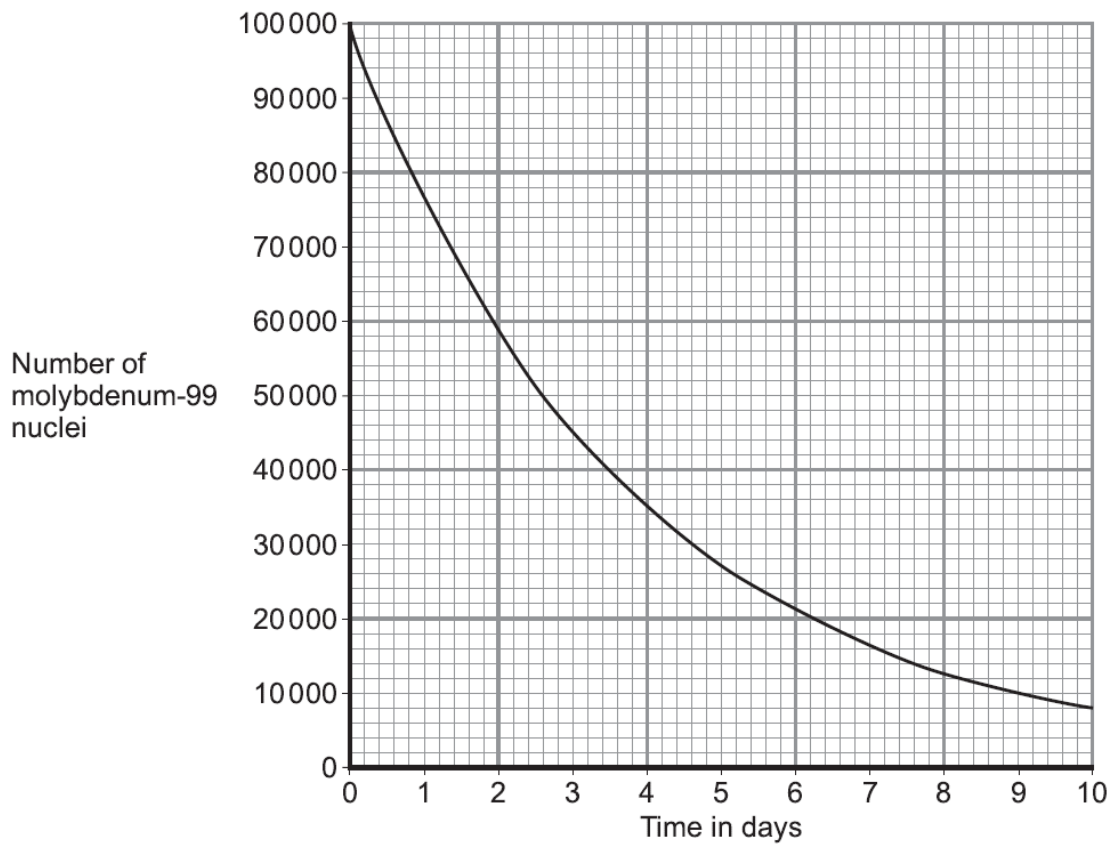
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- (e) Technetium-99 is used by doctors as a medical tracer. In hospitals it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.

- (e) (i) **Figure 7** shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.

Figure 7



A technetium generator will continue to produce sufficient technetium-99 until 80% of the original molybdenum nuclei have decayed.

After how many days will a source of molybdenum-99 inside a technetium-99 generator need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

[2 marks]

.....
.....
.....

Number of days =

(e) (ii) Medical tracers are injected into a patient's body; this involves some risk to the patient's health.

Explain the risk to the patient of using a radioactive substance as a medical tracer.

[2 marks]

.....
.....
.....
.....

(e) (iii) Even though there may be a risk, doctors frequently use radioactive substances for medical diagnosis and treatments.

Suggest why.

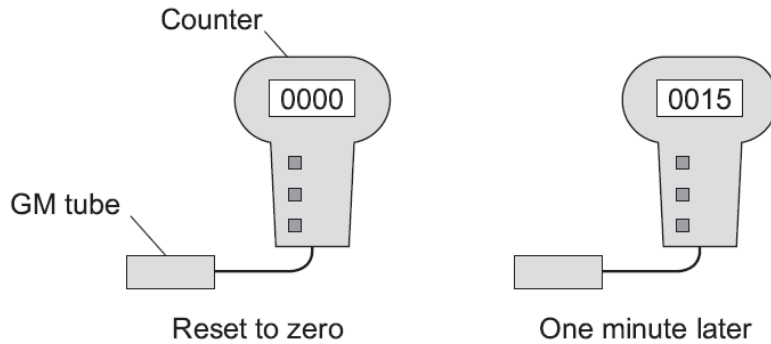
[1 mark]

.....
.....

10.

- (a) A teacher used a Geiger-Müller (GM) tube and counter to measure the *background radiation* in her laboratory.

The teacher reset the counter to zero, waited one minute and then took the count reading. The teacher repeated the procedure two more times.



- (a) (i) Background radiation can be either from natural sources or from man-made sources.

Name **one man-made** source of background radiation.

.....
(1 mark)

- (a) (ii) The three readings taken by the teacher are given in the table.

Count after one minute
15
24
18

The readings given in the table are correct.

Why are the readings different?

.....
.....
(1 mark)

- (b) Some scientists say they have found evidence to show that people living in areas of high natural background radiation are less likely to develop cancer than people living in similar areas with lower background radiation.

The evidence these scientists found does not definitely mean that the level of background radiation determines whether a person will develop cancer.

Suggest a reason why.

.....
.....
(1 mark)

- (c) An atom of the isotope radon-222 emits an alpha particle and decays into an atom of polonium.

An alpha particle is the same as a helium nucleus. The symbol below represents an alpha particle.



- (c) (i) How many protons and how many neutrons are there in an alpha particle?

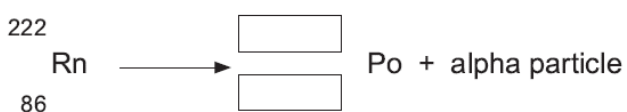
Number of protons =

Number of neutrons =

(2 marks)

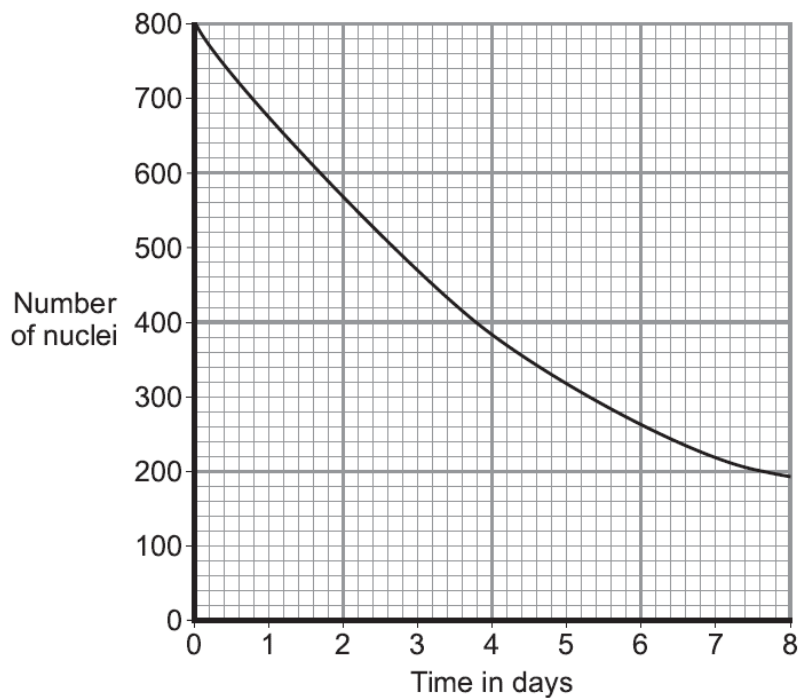
- (c) (ii) The decay of radon-222 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.



(2 marks)

- (d) The graph shows how, in a sample of air, the number of radon-222 nuclei changes with time.



Use the graph to find the half-life of radon-222.

Show clearly on the graph how you obtain your answer.

Half-life = days
(2 marks)