Radioactivity – 2022 November IGCSE 0625

1. Nov/2022/Paper_11/No.37

The nuclide notation for the isotope lithium-7 is $^{7}_{3}Li$.

How many neutrons are there in an atom of lithium-7?

A 3 **B** 4 **C** 7 **D** 10

2. Nov/2022/Paper_11/No.38

A radioactive material is emitting α-particles. The radioactive material is used in a demonstration in a school laboratory experiment.

Which safety precaution must be taken by the person carrying out the experiment?

A Handle the source with tongs.

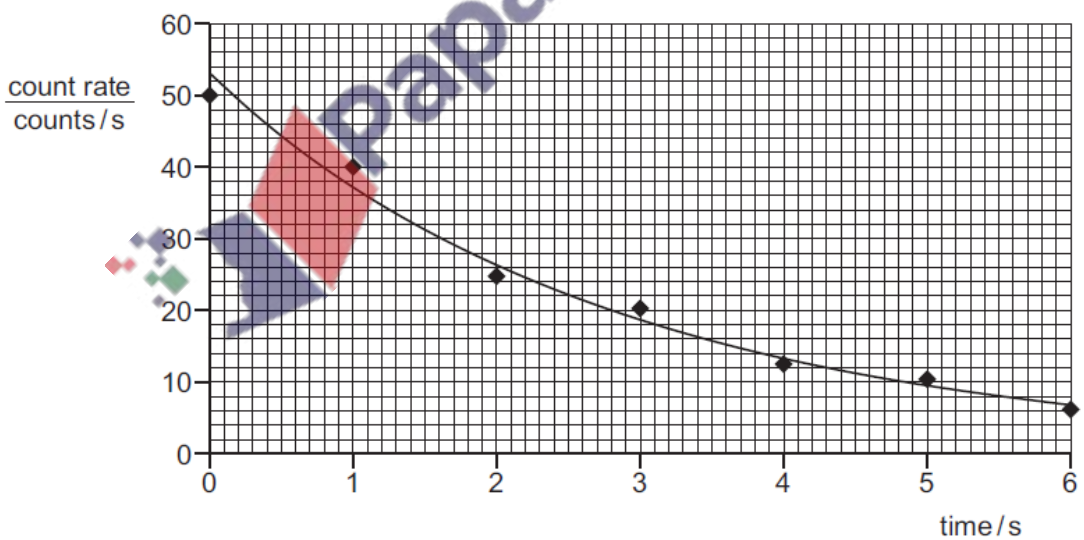
B Place the source on a heat-proof mat.

C Surround the experiment with a lead screen.

D Wear goggles.

3. Nov/2022/Paper_11/No.39

The graph shows how the count rate from a radioactive isotope changes with time.

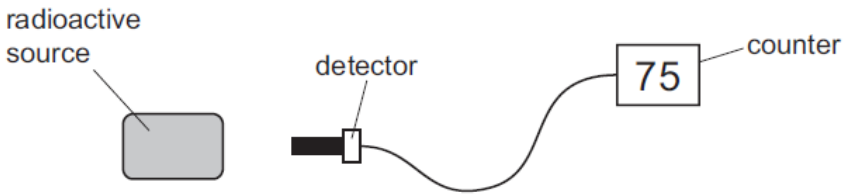


What is the half-life of this isotope?

A 2.0 s **B** 6.0 s **C** 12 s **D** 53 s

4. Nov/2022/Paper_11/No.40

A student measures the count rate near a radioactive source using a detector of ionising radiation. The diagram shows the arrangement.



The counter reads 75 counts per minute.

When the source is taken away, the reading on the counter decreases to 5 counts per minute.

What was the rate of emission from the radioactive source when the counter reading is corrected for background radiation?

A 5 counts per minute

B 15 counts per minute

C 70 counts per minute

D 80 counts per minute

5. Nov/2022/Paper_12,13/No.37

A nuclide of cobalt contains 27 protons and 32 neutrons.

Which symbol represents this nuclide?

A $^{27}_{59}Co$ **B** $^{32}_{27}Co$ **C** $^{32}_{59}Co$ **D** $^{59}_{27}Co$

6. Nov/2022/Paper_12/No.38

Everyone is exposed to background radiation.

What are sources of background radiation?

A food and drink only

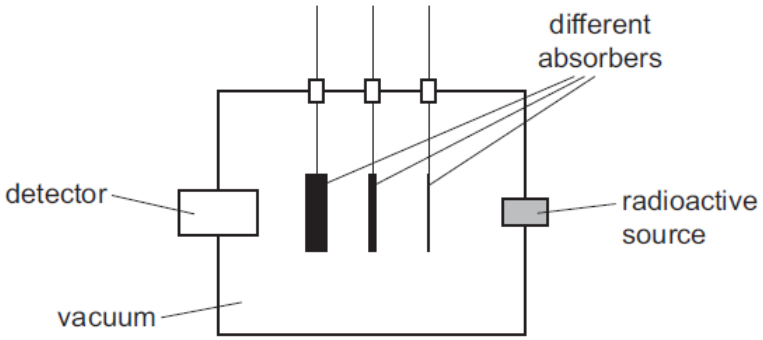
B rocks only

C cosmic rays only

D food and drink, rocks and cosmic rays

7. Nov/2022/Paper_12/No.39

The diagram shows a piece of apparatus used to determine the nature of the emissions from a radioactive source. The absorbers can be raised out of or lowered into the path of the radiation from the source to the detector. The apparatus is evacuated.



The table gives a set of results for a particular radioactive source.

absorber in use	count rate on detector (counts per second)
none	350
thin paper	350
1.0 mm aluminium	180
1.0 cm lead	23

Which types of radiation are being emitted by the radioactive source?

A α-particles and β-particles

B α-particles only

C β-particles and γ-rays

D β-particles only

8. Nov/2022/Paper_12/No.40

The half-life of a sample of radioactive material is 400 years.

How long will it take until only $\frac{1}{4}$ of this sample remains undecayed?

A 100 years

B 400 years

C 800 years

D 1600 years

9. Nov/2022/Paper_13/No.38

In the processes shown, X and Y are elements.

Which process describes α-decay?

A Atoms of X collide with atoms of Y.

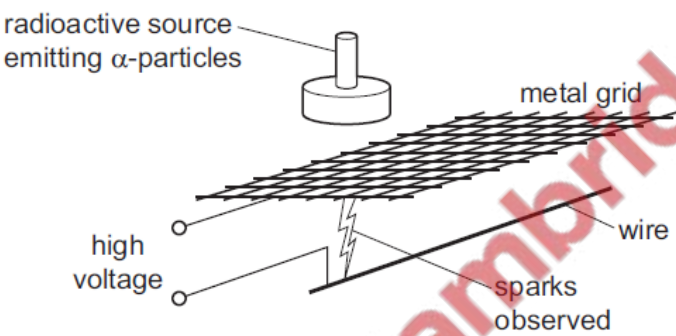
B Atoms of X emit atoms of Y.

C Atoms of X change into ions of Y.

D Atoms of X absorb α-particles.

10. Nov/2022/Paper_13/No.39

A high-voltage power supply is connected to a metal grid and a wire, as shown.



When the radioactive source is placed close to the grid, sparks are observed in the position indicated.

Which statement explains why the sparks are formed?

A α-particles have a long range.

B α-particles have no charge.

C α-particles have no mass.

D α-particles are strongly ionising.

11. Nov/2022/Paper_13/No.40

A radioactive substance has a half-life of 6 hours.

It has an initial rate of emission of 120 counts per second.

How long will it take for this rate of emission to fall to 30 counts per second?

A 1.5 hours **B** 12 hours **C** 30 hours **D** 240 hours

12. Nov/2022/Paper_21/No.37

A very important experiment increased scientists' understanding of the structure of matter.

In the experiment, particles scattered as they passed through a thin metal foil.

Which particles were used, and to which conclusion did the experiment lead?

	particles	conclusion
A	alpha-particles	matter is made up of atoms
B	alpha-particles	atoms have a very small nucleus
C	beta-particles	matter is made up of atoms
D	beta-particles	atoms have a very small nucleus

13. Nov/2022/Paper_21/No.38

Polonium, Po, has a proton number equal to 84 and a nucleon number equal to 218.

Polonium changes into astatine, At, by emitting a β-particle.

Which equation represents this decay?

A $^{84}_{218}\text{Po} \rightarrow {}^{85}_{218}\text{At} + {}^{-1}_{0}\beta$

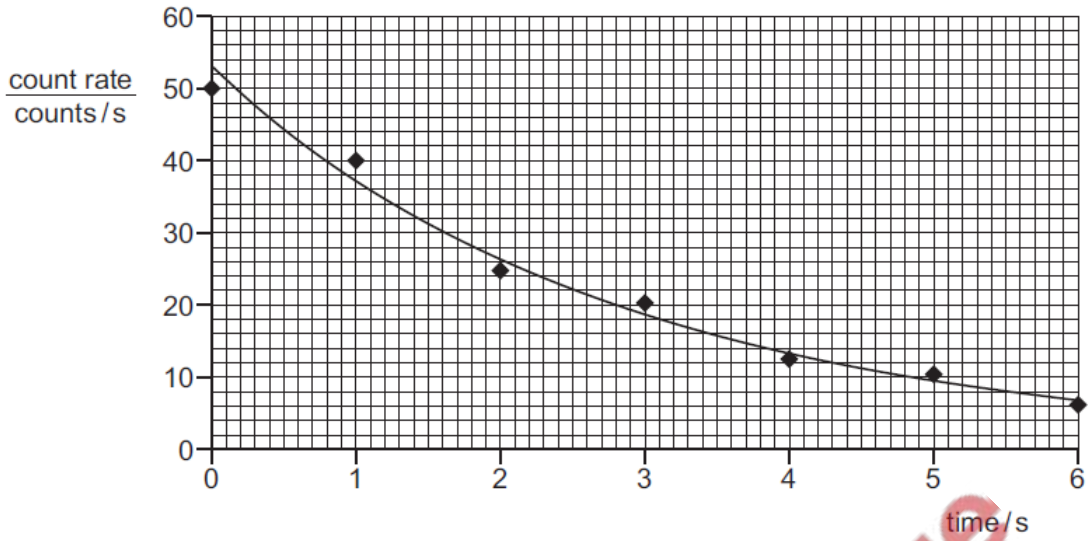
B $^{84}_{218}\text{Po} + {}^{-1}_{0}\beta \rightarrow {}^{85}_{218}\text{At}$

C $^{218}_{84}\text{Po} \rightarrow {}^{218}_{85}\text{At} + {}^{0}_{-1}\beta$

D $^{218}_{84}\text{Po} + {}^{0}_{-1}\beta \rightarrow {}^{218}_{85}\text{At}$

14. Nov/2022/Paper_21/No.39

The graph shows how the count rate from a radioactive isotope changes with time.



What is the half-life of this isotope?

A 2.0 s **B** 6.0 s **C** 12 s **D** 53 s

15. Nov/2022/Paper_21/No.40

What is the nature of α-emission?

A electromagnetic waves

B negatively charged particles

C positively charged particles

D uncharged particles

16. Nov/2022/Paper_22/No.37

A thin metal foil is placed in a vacuum. α-particles are fired at the foil and most go straight through. A very small proportion of the α-particles are deflected through large angles.

What does this provide evidence for?

A α-particles are very small.

B There are negative electrons in each atom.

C There is a tiny nucleus in each atom.

D There are neutrons in each atom.

17. Nov/2022/Paper_22/No.38

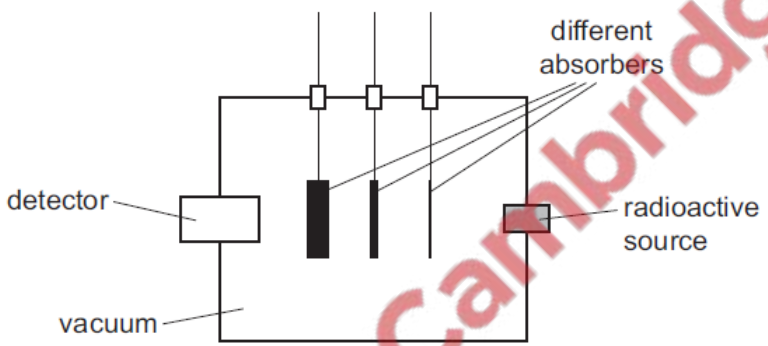
Thorium-230 is represented by the symbol $^{230}_{90}Th$. This isotope is radioactive and decays to radium by emitting α-particles.

Which nuclide is produced by this decay?

A $^{226}_{88}Ra$ **B** $^{230}_{89}Ra$ **C** $^{230}_{91}Ra$ **D** $^{234}_{92}Ra$

18. Nov/2022/Paper_22/No.39

The diagram shows a piece of apparatus used to determine the nature of the emissions from a radioactive source. The absorbers can be raised out of or lowered into the path of the radiation from the source to the detector. The apparatus is evacuated.



The table gives a set of results for a particular radioactive source.

absorber in use	count rate on detector (counts per second)
none	350
thin paper	350
1.0 mm aluminium	180
1.0 cm lead	23

Which types of radiation are being emitted by the radioactive source?

A α-particles and β-particles

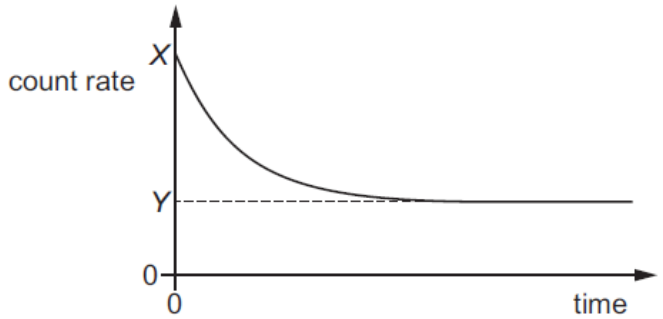
B α-particles only

C β-particles and γ-rays

D β-particles only

19. Nov/2022/Paper_22/No.40

The graph shows the measured count rate of radiation from a source containing a radioactive isotope. The detector is in a laboratory, with no shielding from background radiation.



What is the measured count rate after a time of one half-life?

A $\frac{X}{2}$ **B** $\frac{Y}{2}$ **C** $\frac{(X-Y)}{2}$ **D** $\frac{(X+Y)}{2}$

20. Nov/2022/Paper_23/No.37

A thin metal foil is placed in a vacuum. α-particles are fired at the foil and most go straight through. A very small proportion of the α-particles are deflected through large angles.

What does this provide evidence for?

A α-particles are very small.

B There are negative electrons in each atom.

C There is a tiny nucleus in each atom.

D There are neutrons in each atom.

21. Nov/2022/Paper_23/No.38

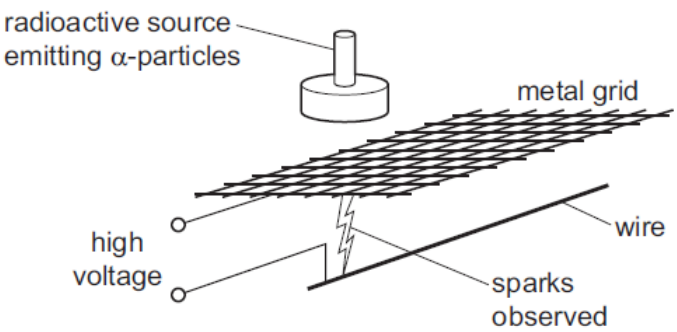
The table compares α-radiation, β-radiation and γ-radiation.

Which row is correct?

	α-radiation	β-radiation	γ-radiation
A	more ionising than β or γ	a proton	electromagnetic radiation
B	less ionising than β or γ	an electron	two protons and two neutrons
C	more ionising than β or γ	an electron	electromagnetic radiation
D	less ionising than β or γ	electromagnetic radiation	a proton

22. Nov/2022/Paper_23/No.39

A high-voltage power supply is connected to a metal grid and a wire, as shown.



When the radioactive source is placed close to the grid, sparks are observed in the position indicated.

Which statement explains why the sparks are formed?

A α-particles have a long range.

B α-particles have no charge.

C α-particles have no mass.

D α-particles are strongly ionising.

23. Nov/2022/Paper_23/No.40

A student investigates four different radioactive isotopes. The student places a detector near each radioactive material.

The background count rate is 36 counts per minute throughout the investigation.

The table shows the detector readings at the start and after 8 hours.

Which isotope has a half-life of 4 hours?

	count rate at the start counts per minute	count rate after 8 hours counts per minute
A	150	36
B	212	53
C	260	92
D	356	80

24. Nov/2022/Paper_31/No.10

(a) α (alpha)-particles, β (beta)-particles and γ (gamma)-rays have different characteristics.

Complete Table 10.1 by indicating with a tick (✓) the correct type of radiation for each characteristic. The first row is done for you.

Table 10.1

characteristic	type of radiation		
	α (alpha)-particles	β (beta)-particles	γ (gamma)-rays
electromagnetic wave			✓
least ionising			
least penetrating			
a helium nucleus			
negatively charged			

[3]

(b) The nucleus of an isotope of plutonium has 94 protons and 147 neutrons. The chemical symbol for plutonium is Pu.

Write the nuclide notation that describes this nucleus.

[2]

(c) A sample contains 8.0×10^{12} atoms of a radioactive isotope of plutonium.
The half-life of this isotope of plutonium is 14 years.

Calculate the number of atoms of this isotope of plutonium remaining in the sample after 28 years.

number of atoms of plutonium remaining = ... [3]

[Total: 8]

25. Nov/2022/Paper_32/No.11

Fig. 11.1 represents an atom of carbon-14.

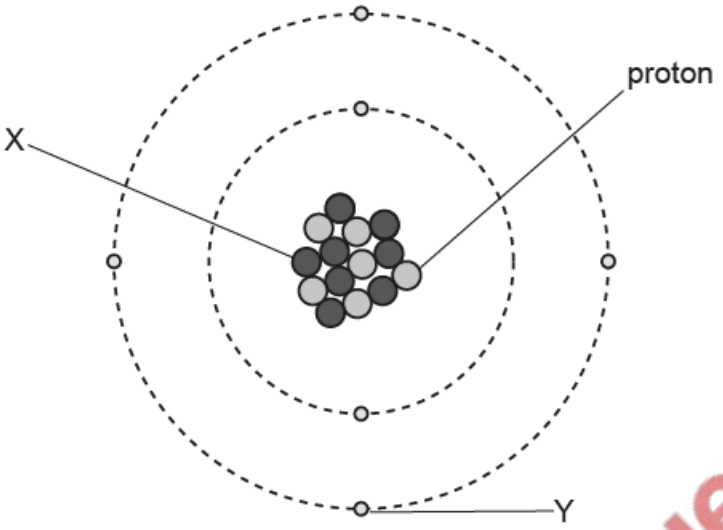


Fig. 11.1

(a) (i) State the name of the particle labelled X.

..... [1]

(ii) State the name of the particle labelled Y.

..... [1]

(iii) State the nucleon number of carbon-14.

..... [1]

(b) Carbon-14 decays by emitting a β (beta)-particle.

State the nature of a β (beta)-particle.

..... [1]

(c) Scientists find an ancient wooden spoon. They find that the spoon contains 2000 atoms of carbon-14.

When the spoon was made, it contained 16 000 atoms of carbon-14.

The half-life of carbon-14 is 5800 years.

Calculate the age of the ancient spoon.

age of spoon = ... years [2]

[Total: 6]

26. Nov/2022/Paper_33/No.10

(a) State which radioactive emission:

(i) is the most penetrating ..... [1]

(ii) is the most ionising ..... [1]

(iii) has a positive charge. ..... [1]

(b) Iodine-131 is a radioactive isotope that is commonly used in medicine.

The nuclide notation for a nucleus of iodine-131 is:

$$^{131}_{53}\mathrm{I}$$

(i) Determine the number of protons in one nucleus of iodine-131. ..... [1]

(ii) Determine the number of neutrons in one nucleus of iodine-131. ..... [1]

(c) Radioactive iodine-131 has a half-life of 8 days.

The activity of a sample of iodine-131 is 1600 counts/s.

Calculate the activity of this sample after 24 days.

activity = ... counts/s [2]

[Total: 7]

27. Nov/2022/Paper_41/No.9

Only one isotope of gold occurs naturally on Earth.

(a) State what this indicates about the nuclear structure of all the naturally occurring atoms of gold on Earth.

.....

..... [1]

(b) There are several artificially produced isotopes of gold.

Gold-198 ($^{198}_{79}Au$) is an artificial isotope which is used in medicine and in scientific research.

Gold-198 decays by β (beta)-emission to a stable isotope of mercury.

(i) Determine the number of protons and the number of neutrons in a nucleus of this isotope of mercury.

number of protons = ...

number of neutrons = ...

[2]

(ii) A sample of gold-198 is placed near to a radiation detector in a research laboratory. The count rate is recorded at the same time every day for 32 days.

The results are used to plot the graph shown in Fig. 9.1.

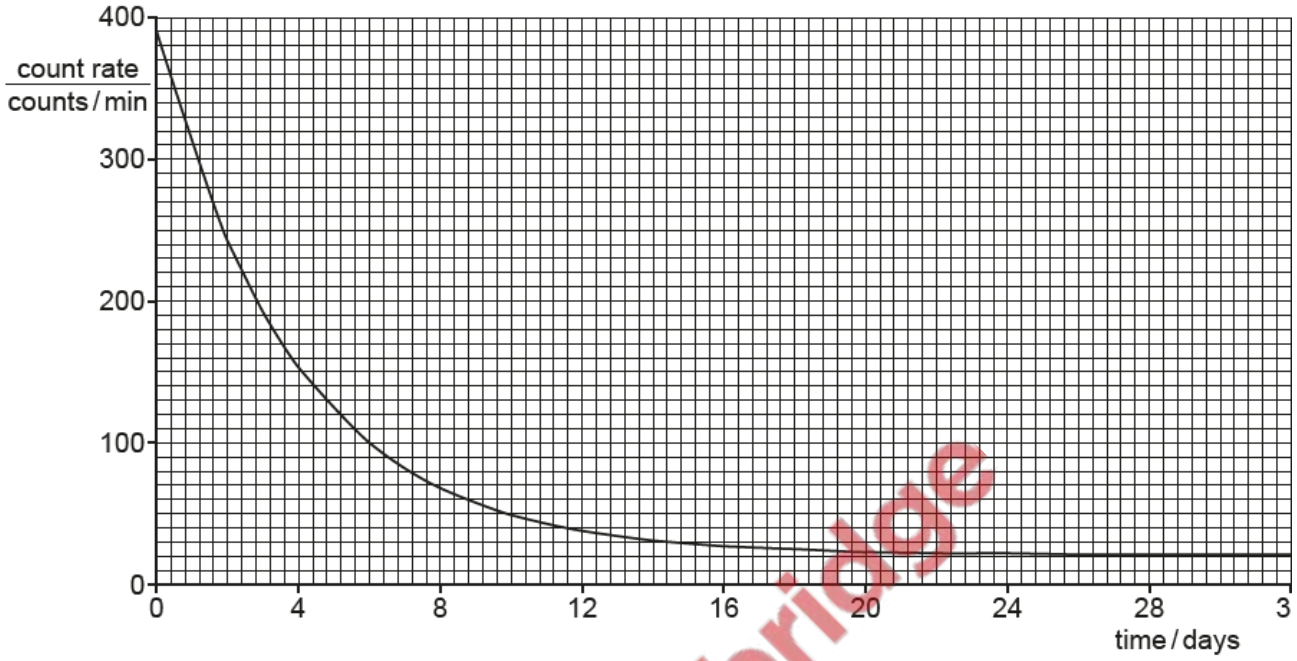


Fig. 9.1

Using Fig. 9.1, determine the background count rate in the research laboratory.

count rate = ... [1]

(iii) Using Fig. 9.1, determine the half-life of gold-198.

half-life = ... [4]

[Total: 8]

28. Nov/2022/Paper_42/No.10

(a) The magnitude of the charge on a β (beta)-particle is 1.6×10^{-19} C.

(i) State the proton number and nucleon number of an α (alpha)-particle.

proton number .....

nucleon number .....

[2]

(ii) Determine the magnitude of the charge of an α (alpha)-particle.

charge .....

[1]

(b) A nucleus of radium-230 consists of 88 protons and 142 neutrons. Radium-230 is radioactive and decays by β (beta)-emission to an isotope of actinium. The symbol for radium is Ra and the symbol for actinium is Ac.

Write down the nuclide equation for this decay.

[3]

(c) The half-life of radium-230 is 93 min. A sample contains 9.6×10^{-12} g of radium-230.

Calculate the mass of radium in the sample after 279 min.

mass = ... [2]

[Total: 8]

29. Nov/2022/Paper_43/No.10

(a) A cloud chamber can be used to detect α (alpha)-particles and β (beta)-particles. Alcohol in the cloud chamber exists as a vapour and condenses on ions produced in the air. This forms visible tracks.

Fig. 10.1 shows the tracks when a source of α-particles and β-particles is present in the cloud chamber.

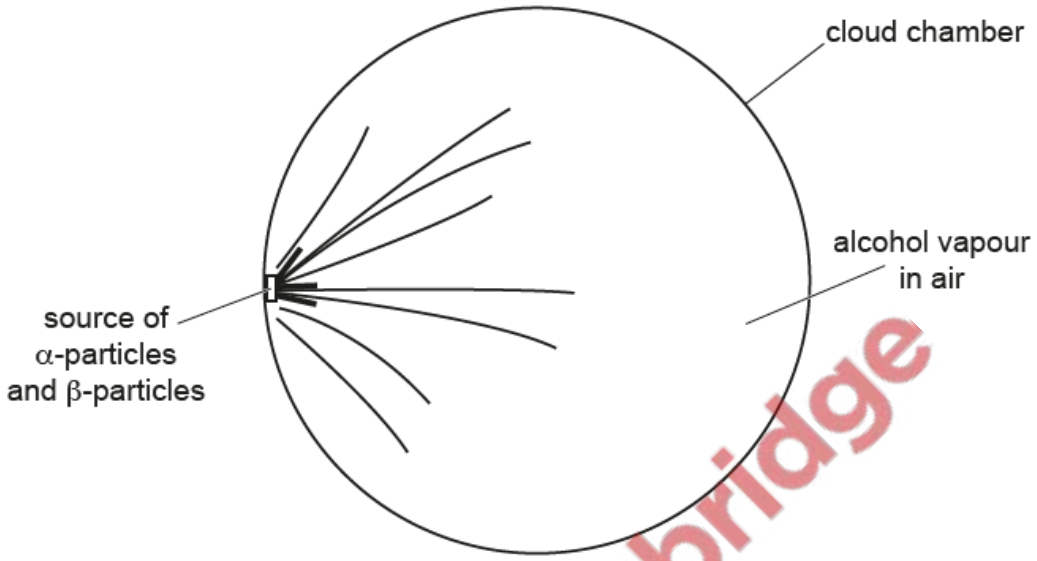


Fig. 10.1

Some of the tracks are short and thick. Other tracks are longer and thinner.

State and explain which tracks are produced by α-particles and which tracks are produced by β-particles.

α-particles .....

.....

β-particles .....

..... [3]

(b) A radioactive isotope of sodium (Na) is used to detect leaks from water pipes. A nucleus of this isotope of sodium contains 11 protons and 13 neutrons. This nucleus decays by emitting a β-particle to form a nucleus of magnesium (Mg).

(i) Describe what is meant by an isotope.

.....

.....

..... [2]

(ii) Write down the nuclide equation for the decay of this isotope of sodium to magnesium.

[3]

(iii) This isotope of sodium has a half-life of 15 hours. The isotope of magnesium is stable and does not undergo radioactive decay.

Suggest why these properties of the isotope of sodium and the isotope of magnesium make this isotope of sodium suitable to detect leaks from water pipes.

.....

.....

..... [2]

[Total: 10]