1. June/2021/Paper_11,12,13,21,22&23/No.37,38

The charge on a proton is *e*.

What is the charge on an electron and what is the charge on a neutron?

	electron	neutron
A	*e*	*e*
B	*e*	0
C	$-e$	$-e$
D	$-e$	0

2. June/2021/Paper_11/No.38

The nuclide notation of the isotope strontium-90 is $^{90}_{38}\mathrm{Sr}$.

Which statement is correct?

A A nucleus of strontium-90 has 38 neutrons.

B A nucleus of strontium-90 has 52 neutrons.

C A nucleus of strontium-90 has 90 electrons.

D A nucleus of strontium-90 has 90 neutrons.

3. June/2021/Paper_11/No.39

Which statement about α-particles and γ-rays is correct?

A α-particles are a form of electromagnetic radiation.

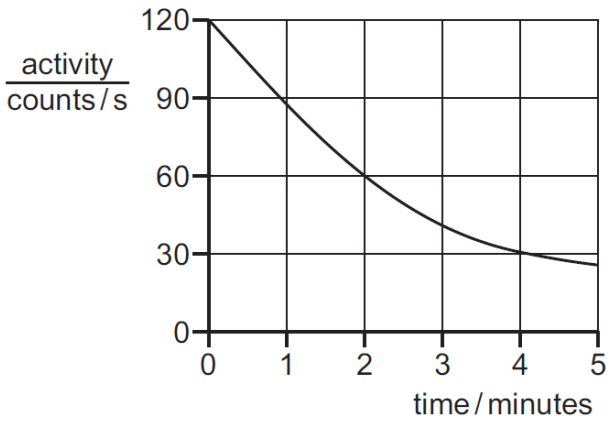
B α-particles penetrate materials more easily than γ-rays.

C The emission of an α-particle produces a nucleus of a different element.

D γ-rays are more ionising than α-particles.

4. June/2021/Paper_11,12,13.21,22&23/No.40

The graph shows the activity of a radioactive source over a period of time.



What is the half-life of the source?

A 1.0 minute **B** 2.0 minutes **C** 2.5 minutes **D** 4.0 minutes

5. June/2021/Paper_12/No.38

The proton numbers and nucleon numbers of four nuclides are shown.

$^{231}_{88}Ra$ $^{232}_{90}Th$ $^{238}_{92}U$ $^{239}_{94}Pu$

Which statement is correct?

A Plutonium (Pu) contains one more proton then uranium (U).

B Thorium (Th) contains one more neutron than radium (Ra).

C Thorium (Th) contains one more proton than radium (Ra).

D Uranium (U) contains one more neutron than plutonium (Pu).

6. June/2021/Paper_12/No.39

A radioactive atom decays by emission of a β-particle.

Which row is correct?

	what decays	what happens to the atom
A	the nucleus of the atom	it becomes a different element
B	the nucleus of the atom	it becomes a lighter version of the same element
C	the outer layers of the atom	it becomes a different element
D	the outer layers of the atom	it becomes a lighter version of the same element

7. June/2021/Paper_13/No.38

The nuclide notation for sodium-23 is $^{23}_{11}Na$.

How many protons are in a nucleus of sodium-23?

A 11 **B** 12 **C** 23 **D** 34

8. June/2021/Paper_13/No.39

A student is investigating the count rate of a radioactive substance.

How must he adjust his reading for the background count?

A Add the background count to his reading.

B Ignore the background count as it will not affect his reading.

C Subtract the background count from his reading.

D Take repeat readings to eliminate the background count.

9. June/2021/Paper_21/No.38

Four students are asked to comment on the processes of nuclear fission and nuclear fusion.

Their comments are recorded in the table.

Which row is correct?

	fission	fusion
A	energy is absorbed	a large unstable nucleus splits
B	a large unstable nucleus splits	energy is absorbed
C	two light nuclei join	energy is absorbed
D	energy is released	two light nuclei join

10. June/2021/Paper_21/No.39

Radon $^{219}_{86}Rn$ decays by emitting an α-particle.

Which nuclide is formed in this decay?

A $^{215}_{84}Po$ **B** $^{223}_{88}Ra$ **C** $^{219}_{87}Fr$ **D** $^{219}_{85}At$

11. June/2021/Paper_22/No.37

Which row correctly states how nuclei behave during nuclear fission and during nuclear fusion?

	fission	fusion
A	nuclei join together	nuclei join together
B	nuclei join together	nuclei split apart
C	nuclei split apart	nuclei join together
D	nuclei split apart	nuclei split apart

12. June/2021/Paper_22/No.39

Some radioactive nuclei decay to give new nuclei which are also radioactive. Part of a series of decays is shown.

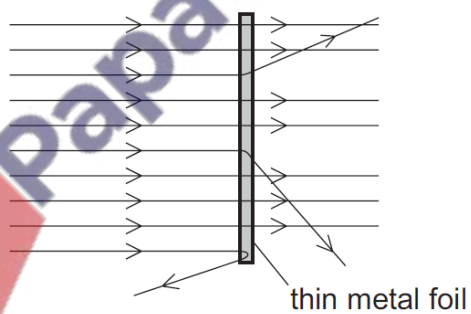
$$^{238}_{92}U \rightarrow {}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa \rightarrow {}^{234}_{92}U \rightarrow {}^{230}_{90}Th \rightarrow {}^{226}_{88}Ra$$

How many decays involve the emission of a β-particle?

A 1 **B** 2 **C** 3 **D** 5

13. June/2021/Paper_23/No.38

The diagram shows α-particles incident on a thin metal foil.



How does the motion of these particles give evidence for the nuclear atom?

A Most particles passing through with minimal deflection shows that the atom is mostly empty space.

B Most particles passing through with minimal deflection shows that the mass of the atom is uniformly distributed.

C Large deflections of some particles shows that the atom is mostly empty space.

D Large deflections of some particles shows that the charge in the atom is uniformly distributed.

14. June/2021/Paper_23/No.39

Radium-226, $^{226}_{88}Ra$, is an α-emitter.

It is implanted inside cancerous tumours.

It is safe to use as it kills the cancerous cells, but not the healthy ones surrounding the tumour.

Which properties of α-particles, compared to other emissions, enable this use of radium-226?

	ionising effect of α-particles	penetration of α-particles
A	high	high
B	high	low
C	low	high
D	low	low

15. March/2021/Paper_12&22/No.37,38

Three students are describing the structure of an atom.

student 1 All the positively charged particles are in the nucleus.

student 2 Positive electrons are in the nucleus.

student 3 Negative electrons orbit around the nucleus.

Which students are making a correct statement?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

16. March/2021/Paper_12/No.38

The symbol below describes a nuclide.

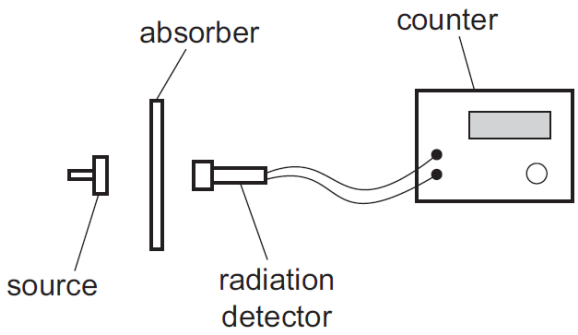
$^{9}_{4}Be$

Which row is correct?

	proton number (Z)	nucleon number (A)
A	4	5
B	4	9
C	9	4
D	9	5

17. March/2021/Paper_12/No.39

The diagram shows a radioactivity experiment.



When a piece of paper is used as the absorber, the count rate drops to the background count rate.

Which radiation is the source emitting?

A α-radiation only

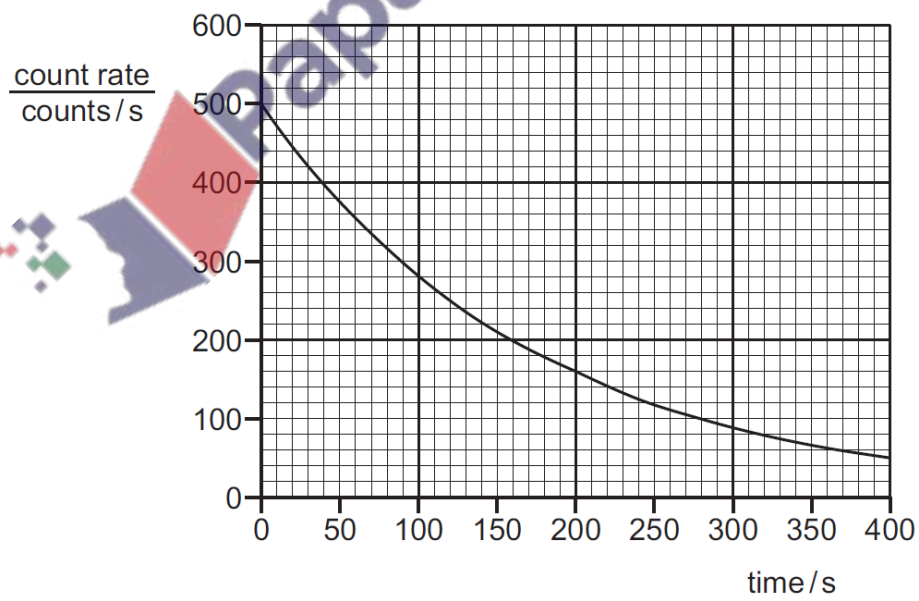
B β-radiation only

C γ-radiation only

D α-radiation, β-radiation and γ-radiation

18. March/2021/Paper_12/No.40

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



What is the half-life for this sample?

A 90 s **B** 120 s **C** 200 s **D** 400 s

19. March/2021/Paper_22/No.39

When alpha particles are incident on a thin metal foil, most of them pass through undeviated.

What does this observation reveal about the nature of the atom?

A The atom has a dense nucleus.

B The atom is mostly empty space.

C The atom is very small.

D The nucleus of the atom is positively charged.

20. March/2021/Paper_22/No.40

A laboratory worker measures the count rate from a radioactive source. He records his results in a table.

time / minutes	count rate / counts / s
0	100
1.0	73
2.0	54
3.0	41
4.0	31

The average background radiation in the laboratory is 8 counts per second.

What is the half-life of the source?

A 1.5 minutes

B 2.0 minutes

C 3.0 minutes

D 4.0 minutes

21. June/2021/Paper_31/No.12

(a) Table 12.1 describes four nuclides.

Table 12.1

name of nuclide	plutonium-238	thorium-234	uranium-235	uranium-238
nuclide notation	$^{238}_{94}Pu$	$^{234}_{90}Th$	$^{235}_{92}U$	$^{238}_{92}U$

(i) State which **two** nuclides have the same number of protons.

..... [1]

(ii) State which **two** nuclides have the same number of nucleons.

..... [1]

(iii) State which **one** of the four nuclides has the most electrons orbiting when it is in a neutral atom.

..... [1]

(b) Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

mass of thorium-234 remaining = ... mg [3]

[Total: 6]

22. June/2021/Paper_32/No.11

(a) The nuclide notation ${}^{A}_{Z}X$ describes the nucleus of an atom.

Draw a line from each symbol to the correct description of the symbol.

symbol	description
	half-life value
A	neutron number
	nucleon number
Z	type of radiation
	proton number

[2]

(b) The activity of a sample of a radioactive nuclide is measured in June of each year.
In June 2004 the activity was 80 000 counts / s.
In June 2014 the activity was 20 000 counts / s.

(i) Show that the half-life of the nuclide is 5 years.

[3]

(ii) Determine the year when the activity of the sample was 10 000 counts / s.

year = ... [2]

[Total: 7]

23. June/2021/Paper_33/No.11

(a) A nucleus of nitrogen-13 has the nuclide notation: $^{13}_{7}N$.

Determine:

(i) the number of protons in one nucleus of nitrogen-13 ..... [1]

(ii) the number of neutrons in one nucleus of nitrogen-13 ..... [1]

(iii) the number of electrons in one neutral atom of nitrogen-13. ..... [1]

(b) Fig. 11.1 shows a counter measuring the radioactivity of a sample of nitrogen-13.

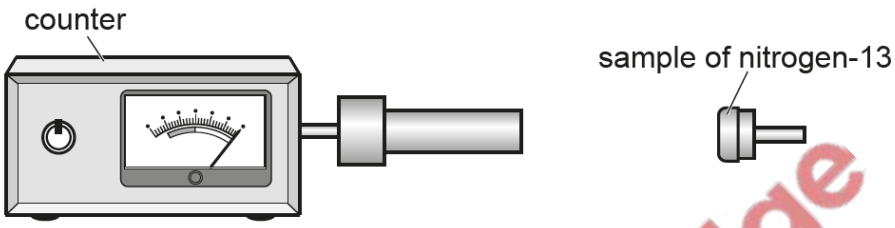


Fig. 11.1

The counter shows the count rate in counts per minute.

Table 11.1 shows the count rate every 5 minutes.

Table 11.1

time / min	count rate due to nitrogen-13 / counts / min
0	300
5	212
10	150
15	106
20	75
25	53

Calculate the half-life of nitrogen-13 using information from Table 11.1.

half-life of nitrogen-13 = ... min [2]

[Total: 5]

24. June/2021/Paper_41/No.9

There are three naturally occurring isotopes of hydrogen: hydrogen-1, hydrogen-2 and hydrogen-3.
The nuclide notation for hydrogen-1 is ${}^{1}_{1}\mathrm{H}$.

(a) Write down the symbol, using nuclide notation, for:

hydrogen-2 .....

hydrogen-3. .....

[1]

(b) In a fusion reactor, a nucleus of hydrogen-2 and a nucleus of hydrogen-3 undergo fusion.

(i) State what is meant by *nuclear fusion*.

.....

.....

..... [2]

(ii) The fusion reaction produces a free neutron and **one** other particle.

Write down, using nuclide notation, the equation that represents this reaction.

[3]

(c) Nuclear fusion in the Sun is the source of most but not all of the resources that are used to generate electrical energy on Earth.

State **two** resources for which nuclear fusion in the Sun is **not** the source.

1. .....

2. .....

[2]

[Total: 8]

25. June/2021/Paper_42/No.8

(a) Two identical radioactive sources emit α-particles and γ-rays into two vacuum tubes.

(i) Fig. 8.1 shows two electrically charged plates on either side of one of the vacuum tubes.

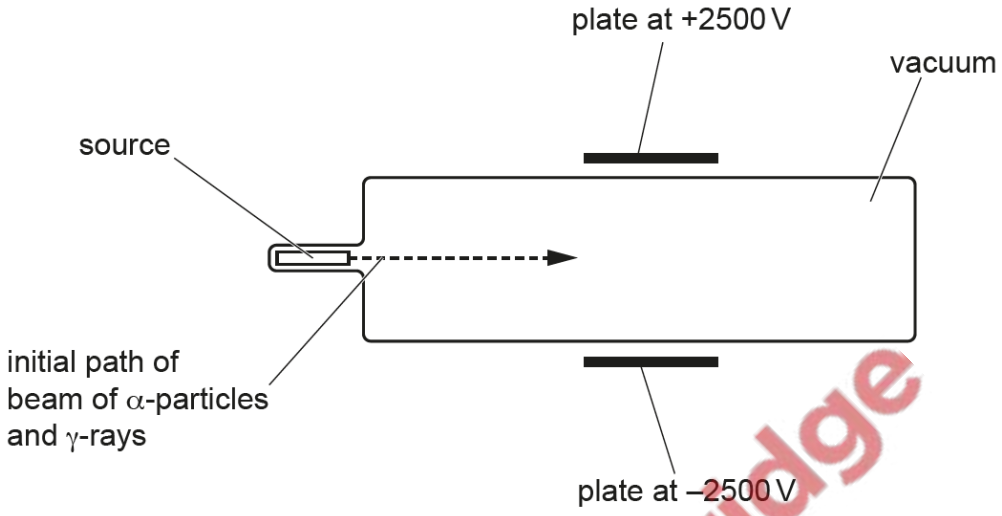


Fig. 8.1

Write the symbol α **once** in Table 8.1 to indicate any deflection of the α-particles.

Write the symbol γ **once** in Table 8.1 to indicate any deflection of the γ-rays.

Table 8.1

into page	out of page	no deflection	towards bottom of page	towards top of page

[2]

(ii) Fig. 8.2 shows the poles of a very strong magnet on either side of the other vacuum tube.

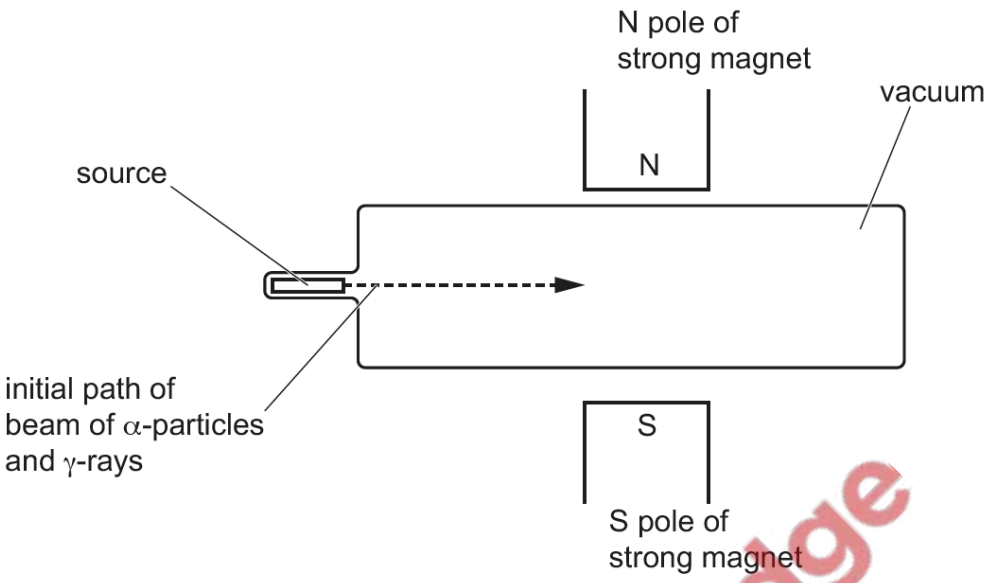


Fig. 8.2

Write the symbol α **once** in Table 8.2 to indicate any deflection of the α-particles.

Write the symbol γ **once** in Table 8.2 to indicate any deflection of the γ-rays.

Table 8.2

into page	out of page	no deflection	towards bottom of page	towards top of page

[2]

26. June/2021/Paper_42/No.11

(a) A student investigates a radioactive substance in a laboratory.

Fig. 11.1 is a graph showing the count rate detected as the substance decays for 7.5 minutes.

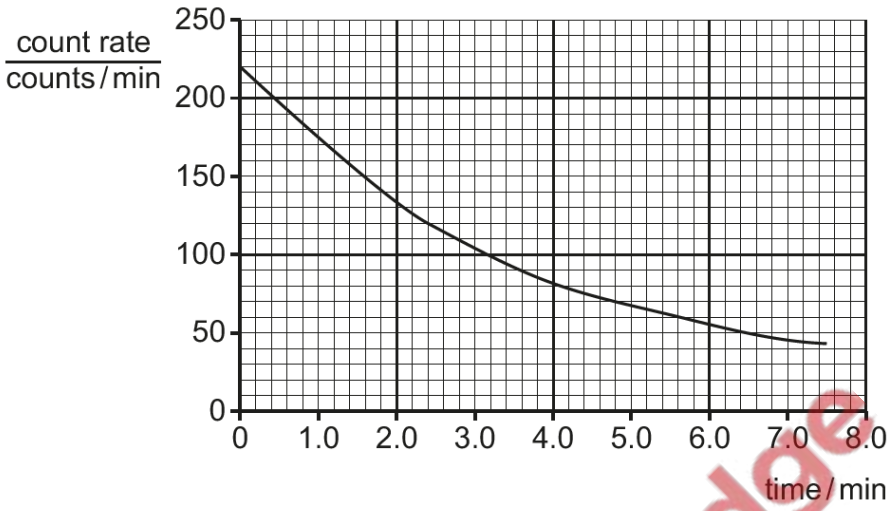


Fig. 11.1

The background radiation is 20 counts / min.

(i) Determine the half-life of the substance.

half-life = ... [3]

(ii) Calculate the count rate detected at time = 9.6 minutes.

count rate = ...counts / min [2]

(b) The substance emits α-particles and γ-rays. The student suggests that it is safe to store the substance in a plastic container of thickness 2 mm.

State and explain whether the student's suggestion is correct.

statement .....

explanation .....

..... [3]

[Total: 8]

27. June/2021/Paper_43/No.10

(a) Fig. 10.1 shows a beam of radiation in a vacuum. The beam contains α-particles, β-particles and γ-rays.

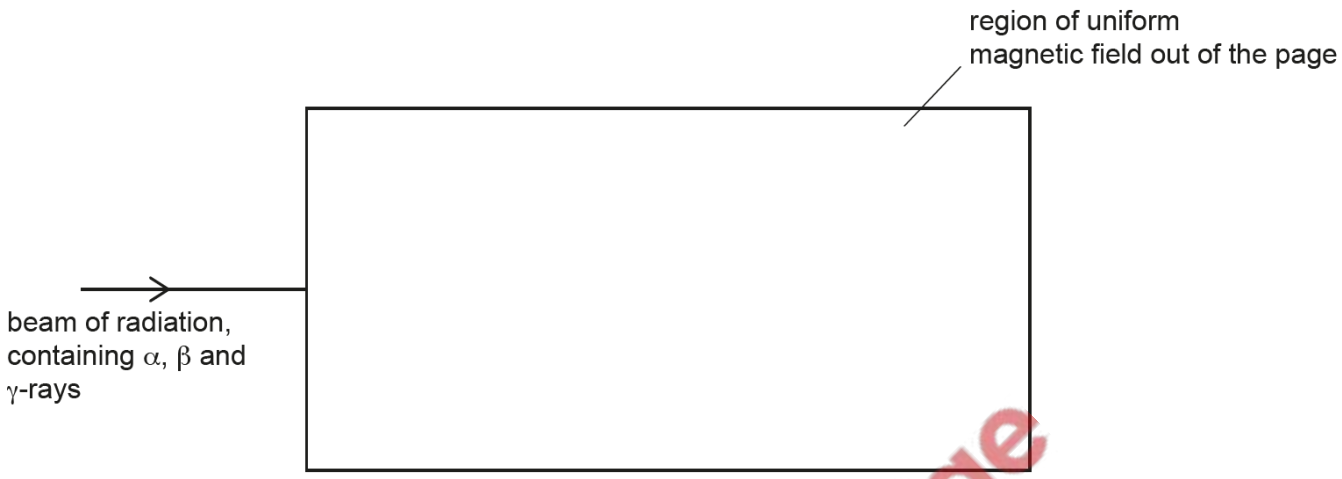


Fig. 10.1

The beam enters a region where there is a strong, uniform magnetic field. The direction of the magnetic field is out of the page.

On Fig. 10.1, mark and label the paths through the magnetic field of:

(i) α-particles (label this path α) [1]

(ii) β-particles (label this path β) [2]

(iii) γ-rays (label this path γ). [1]

(b) Radioactive sources have many uses in medicine.

State **two** safety precautions which hospital staff take when working with γ-ray sources.

1. .....

2. ..... [2]

(c) The radioactive isotope iodine-131 is used as a tracer in medical diagnosis. A nucleus of iodine-131 contains 53 protons and 78 neutrons. The symbol for iodine is I.

(i) Use nuclide notation to show this isotope of iodine.

[1]

(ii) Iodine-131 emits γ-radiation. It has a half-life of 8 hours.

Explain why this emission and this half-life make iodine-131 a suitable material for a tracer in medical diagnosis.

.....

.....

.....

..... [2]

[Total: 9]

28. March/2021/Paper_32/No.11

Carbon-12 is a stable isotope of carbon. Its nuclide notation is shown in Fig. 11.1.

Carbon-14 is an unstable isotope of carbon. Its nuclide notation is shown in Fig. 11.2.

$^{12}_{6}C$

Fig. 11.1

$^{14}_{6}C$

Fig. 11.2

(a) Determine the numbers of electrons, protons and neutrons in an atom of carbon-12 and the numbers of electrons, protons and neutrons in an atom of carbon-14.

Complete Table 11.1.

Table 11.1

	carbon-12	carbon-14
number of electrons		
number of protons		
number of neutrons		

[3]

(b) Fig. 11.3 shows the decay curve for a sample of carbon-14.

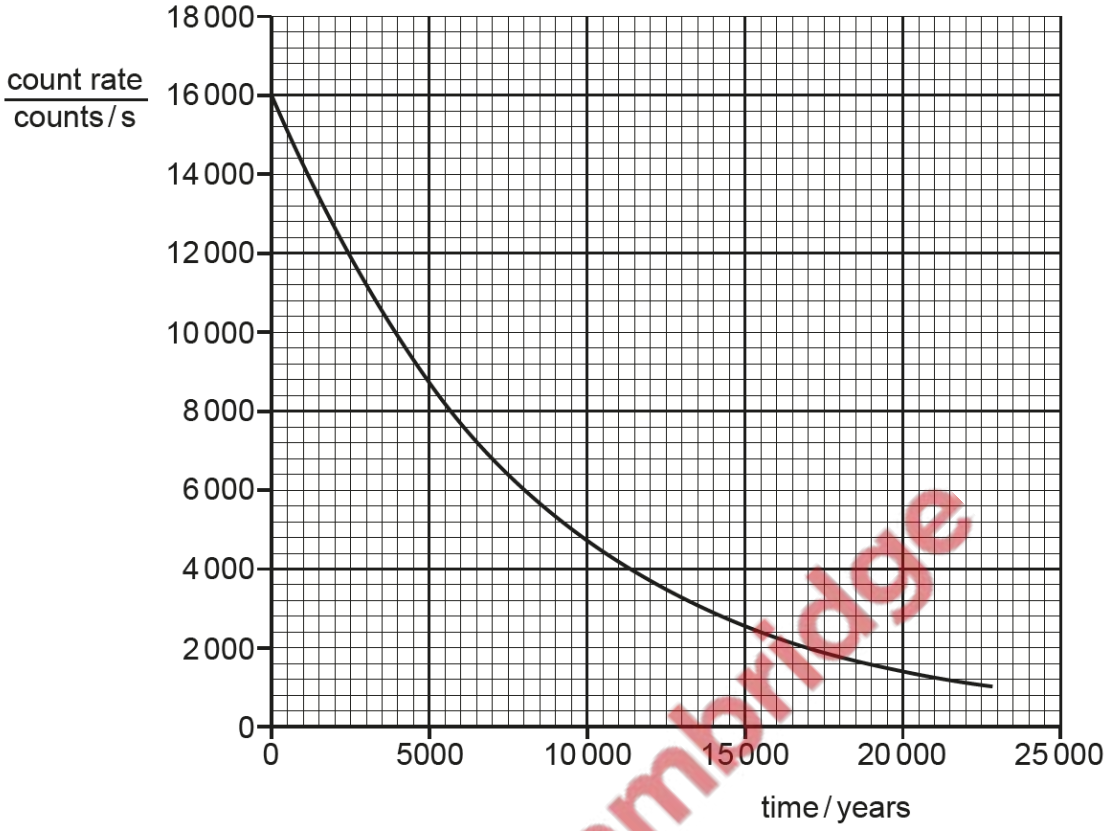


Fig. 11.3

Use the graph to determine the half-life of carbon-14.

half-life = ... years [2]

[Total: 5]

29. March/2021/Paper_42/No.10

(a) State the proton number, nucleon number and the value of the charge on an α-particle.

proton number .....

nucleon number .....

charge .....

[3]

(b) A nucleus of strontium-90 consists of 38 protons and 52 neutrons. Strontium-90 is radioactive and decays by β-emission to an isotope of yttrium. The symbol for strontium is Sr and the symbol for yttrium is Y. Write down the nuclide equation of this decay.

[3]

(c) The half-life of radon-220 is 56 s. A sample of radon-220 is in a container. After 112 s the mass of radon-220 is 9.2 mg.

Calculate the mass of the original sample.

mass = ... [2]

[Total: 8]