≈ Atomic Physics ≈

26. Radioactivity

Content

26.1 Detection of radioactivity

26.2 Characteristics of the three types of emission

26.3 Nuclear reactions

26.4 Half-life

26.5 Uses of radioactive isotopes including safety precautions

Learning outcomes

Candidates should be able to:

(a) describe the detection of alpha-particles, beta-particles and gamma rays by appropriate methods.

(b) state and explain the random emission of radioactivity in direction and time.

(c) state, for radioactive emissions, their nature, relative ionising effects and relative penetrating powers.

(d) describe the deflection of radioactive emissions in electric fields and magnetic fields.

(e) explain what is meant by *radioactive decay*.

(f) explain the processes of fusion and fission.

(g) describe, with the aid of a block diagram, one type of fission reactor for use in a power station.

(h) discuss theories of star formation and their energy production by fusion.

(i) explain what is meant by the term *half-life*.

(j) make calculations based on half-life which might involve information in tables or shown by decay curves.

(k) describe how radioactive materials are moved, used and stored in a safe way.

(l) discuss the way in which the type of radiation emitted and the half-life determine the use for the material.

(m) discuss the origins and effect of background radiation.

(n) discuss the dating of objects by the use of ^{14}C.

27. The Nuclear Atom

Content

27.1 Atomic model ✓

27.2 Nucleus ✓

Learning outcomes

Candidates should be able to:

(a) describe the structure of the atom in terms of nucleus and electrons.

(b) describe how the Geiger-Marsden alpha-particle scattering experiment provides evidence for the nuclear atom.

(c) describe the composition of the nucleus in terms of protons and neutrons.

(d) define the terms *proton number* (atomic number), Z and *nucleon number* (mass number), A.

(e) explain the term *nuclide* and use the nuclide notation $^{A}_{Z}X$ to construct equations where radioactive decay leads to changes in the composition of the nucleus.

(f) define the term *isotope*.

(g) explain, using nuclide notation, how one element may have a number of isotopes.

How to do Radioactivity in 3-Days!

Day 1 :- Basics & Start of Radioactivity

- o) Understand structure of an atom
- o) Go through chronological explanation of the Atom
- o) Learn the Observations & Deductions of the Geiger-Marsden
- o) Understand the behavior of Alpha Particles!
- o) Learn the basics about Isotopes

TAKE A BREAK

- o) Basics of Radioactivity

→ Learn Alpha-Beta-Gamma Properties

Day 2:- Half Life & End of Radioactivity

- Understand Calculations of Half life
- Learn the working of Geiger Muller Tube!
- View the patterns of Radioactive emissions
- Learn how to store Radioactive substance

★ Most Importantly Learn the USEs!

- Hazards of Radioactivity & Background Radiations!

Day 3:- Nuclear Reactions & Star Formation

- Fission Reactions & Nuclear Equations
- Understand working of Nuclear Fission reacto
- Fusion reactions

TAKE A BREAK

→ Learn Theories of Star Formation

PP's :- Unit 25 & 26 Pg 374!]- P1

P2 → Unit 26 & 27 → Pg 582

≈ The Atomic Model ≈

The Atom :-

'Atomos' → Greek

o) Atom is composed of subatomic Particles :-

→ Electrons → Protons → Nuetrons

Electrons ↓ orbit around the shell

Protons & Nuetrons → exist in the nucleus of atom

Q) describe the structure and composition of C^{14}_{6}

C^{14}_{6} → Carbon !

Composition :-

Proton = 6

Nuetron = 14 - 6 = 8

Electron = 6

Structure :-

o) Proton & Nuetron are in the nucleus of an atom

o) Electrons exist around the nucleus in shells.

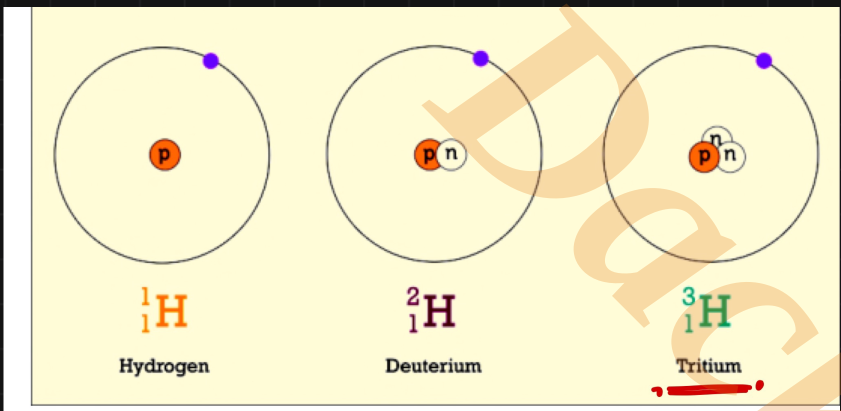
Nuetral atom → Same no of e^- & protons !

≈ Isotopes ≈

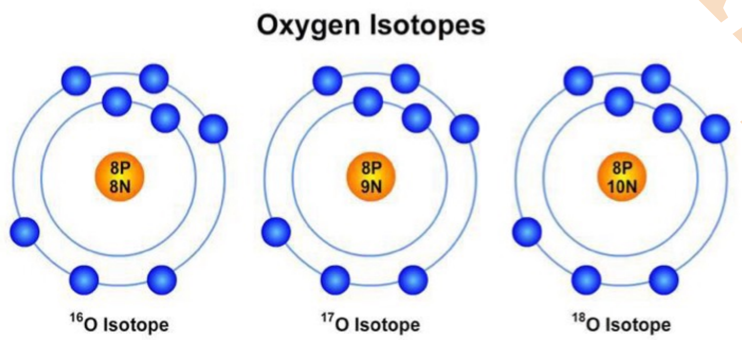
Atoms of the same element with same → no of protons, but dif no of nuetrons

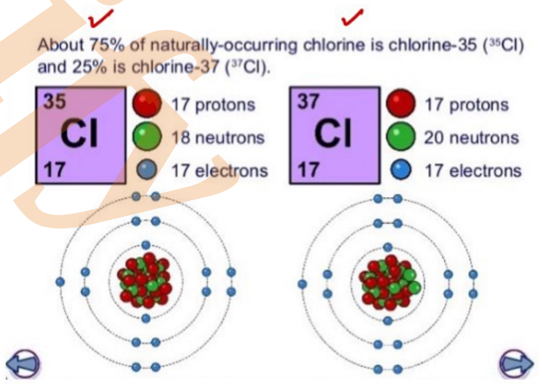
Hence, they have different mass numbers

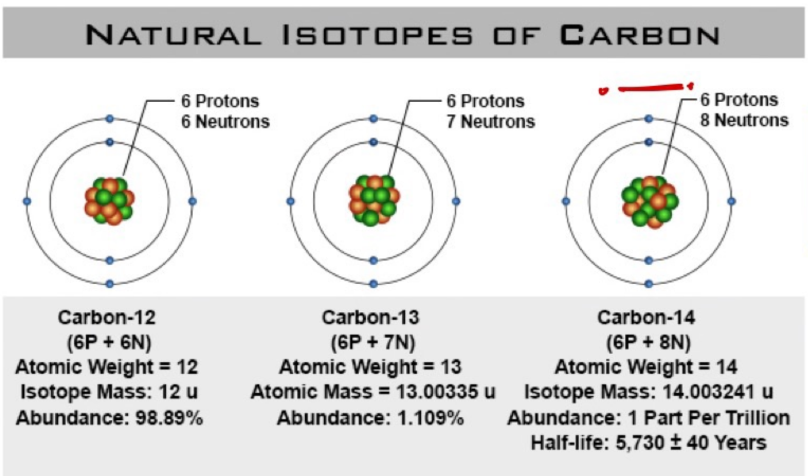
Some Isotopes are Radioactive in nature, Hence, they are called Radioactive Isotopes e.g:- C^{14}_{6}

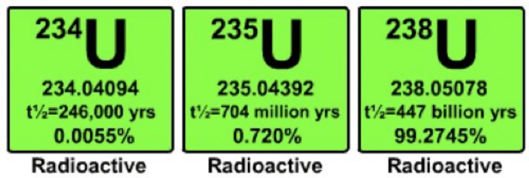


plants.

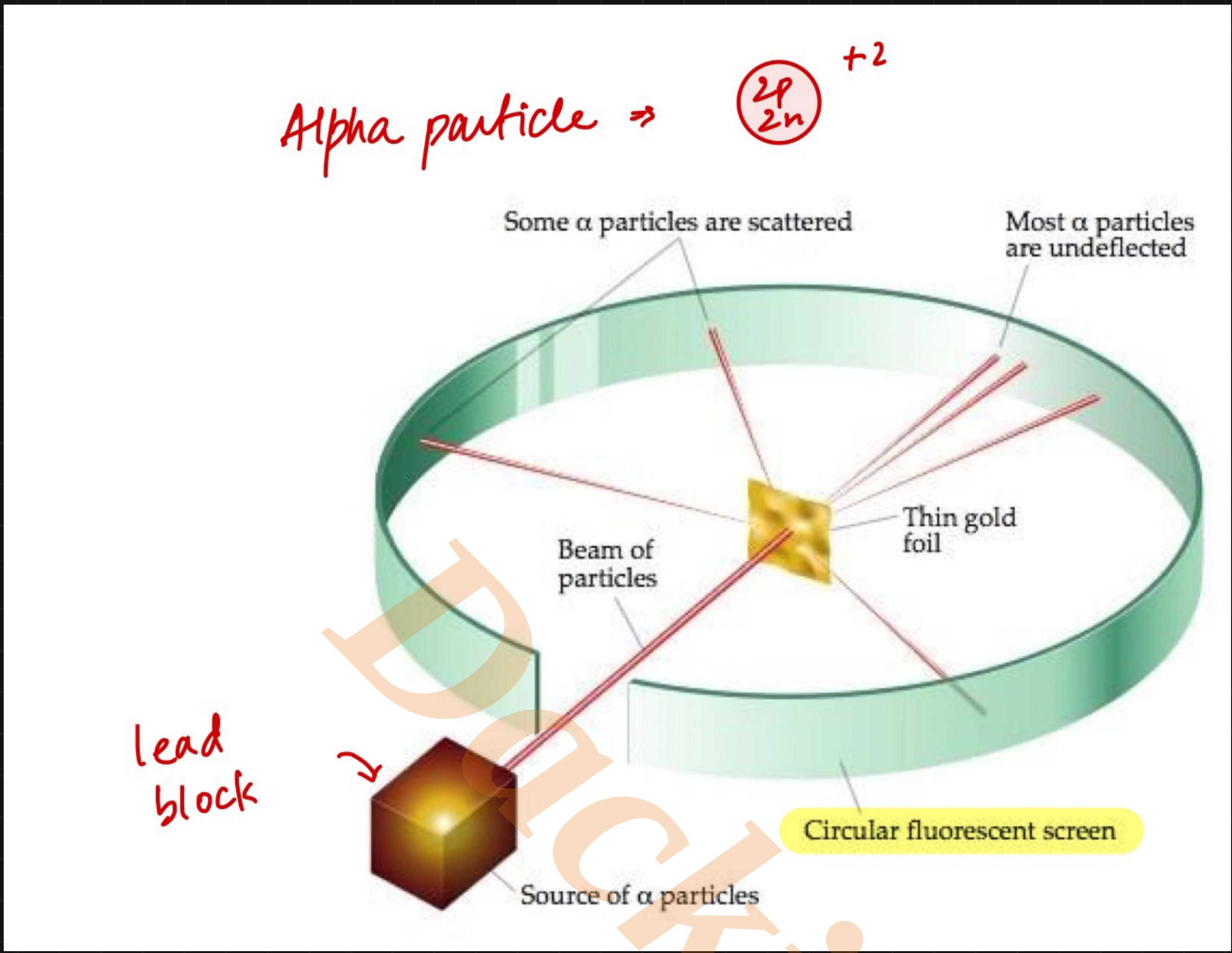


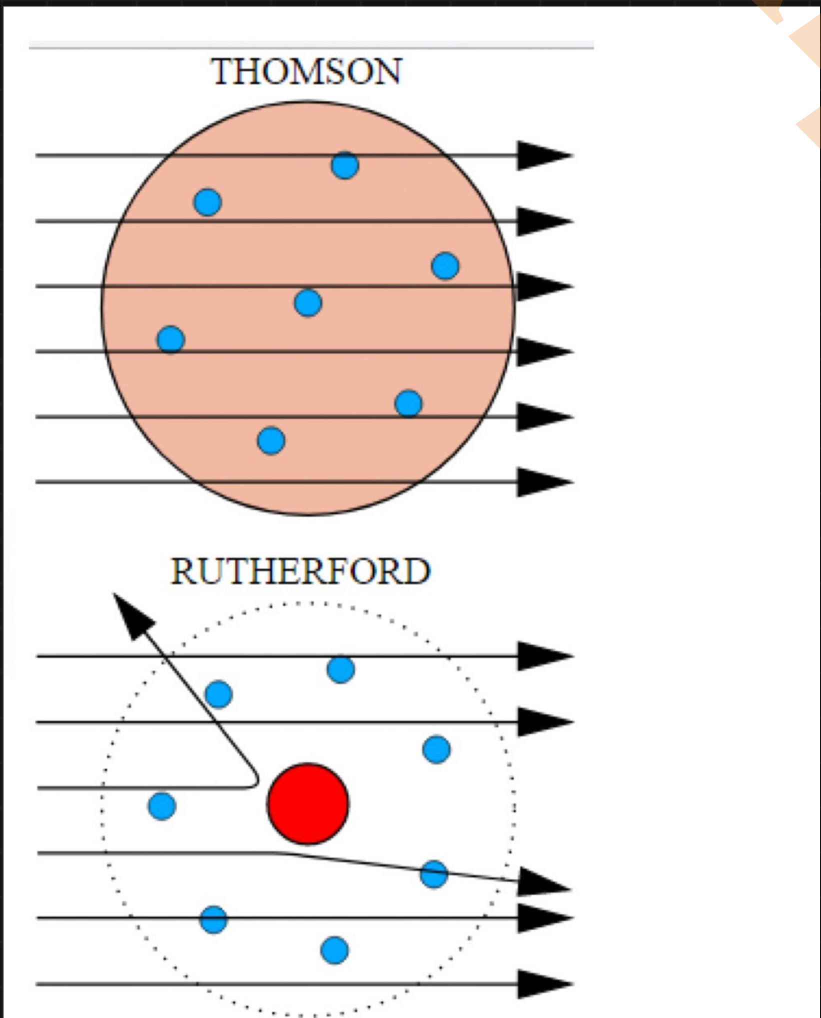






Geiger-Marsden Experiment





Expectation ☹

Reality ☺

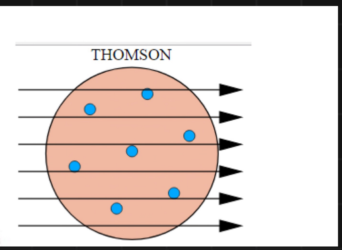
Plum Puddings

! IMPRACTICAL YET BELIEVABLE !

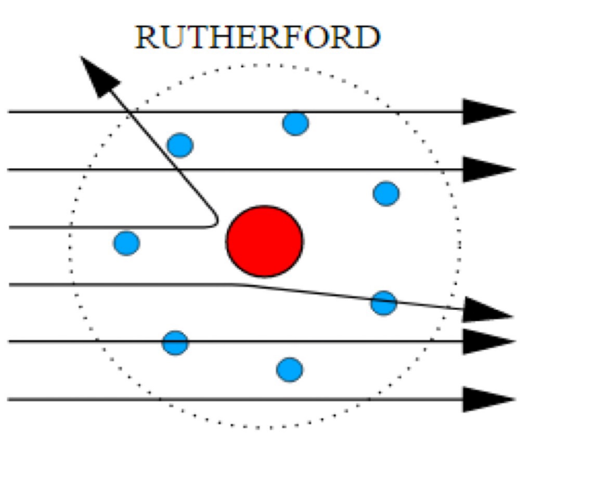
JJ Thompson → Discoverer of Electron in 1896!

Discovery was well Flawed ... So on came Rutherford

The Geiger-Mardsen experiment was done ...!



These were the expected results. Alpha particles passing through undisturbed! hehehe!



These were the observed results and boy were they surprising to say the least!

Observations & More → Next page

Swipe

≈ Observations and Deduction ≈

① Most Alpha particles Passed away

② Few deflected at large angles!

③ Few Bounced back! 😯

① Atom is mostly empty

② Atom has a dense but small positively charged nucleus

③ Electrons exist around the nucleus

Q) Why did Alpha particles behave like this

→ They were passing straight through the empty space b/w atoms

→ The Alpha particles which approach close to the Nucleus deflect due to repulsion

→ Nucleus is rigid, so the alpha particle which approached it head on, Bounced back!

Unit 26: The Nuclear Atom

26.1 Atomic model

1. O/N 16/P11/Q40

Which number is always equal to the proton number of a neutral atom of a radioactive isotope?

A the number of electrons in the atom
B the number of neutrons in the atom
C the number of nucleons in the atom
D the number of particles in the atom

2. O/N 15/P12/Q40

In the Geiger-Marsden experiment, a beam of alpha-particles is fired at a very thin sheet of gold foil, in a vacuum.
What is deduced from this experiment?

A Alpha-particles are repelled by electrons.
B Atoms contain air.
C Electrons are found in atomic nuclei.
D Nuclei are much smaller than atoms.

3. O/N 14/P11/Q40

How many nucleons are in one neutral atom of the krypton isotope $^{84}_{36}Kr$?

A 36 B 48 C 84 D 120

4. O/N 13/P11/Q40

The compositions of four nuclei are shown in the table.

nucleus	number of protons	number of neutrons	number of nucleons
P	88	141	229
Q	88	136	224
R	89	139	228
S	92	136	228

Which two nuclei are isotopes of the same element?

A P and Q B P and S C Q and S D R and S

5. M/J 13/P12/Q40

In the Geiger-Marsden experiment, a beam of alpha-particles is fired at a thin sheet of gold in a vacuum. The majority of the alpha-particles pass straight through the sheet without being deflected.
What does this show?

A The alpha-particle is uncharged.
B The alpha-particle is very large.
C The nucleus is positively charged.
D The nucleus is very small.

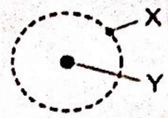
6. M/J 12/P12/Q38

The nucleus of a helium atom is represented as $^{4}_{2}He$.

What does a neutral atom of helium contain?

	electrons	protons	neutrons
A	2	2	2
B	2	4	2
C	4	2	2
D	4	4	2

7. **O/N 12/P11/Q38**
In the simple model of an atom, X orbits around Y.



What are X and Y?

	X	Y
A	electron	nucleus
B	neutron	electron
C	nucleus	proton
D	proton	neutron

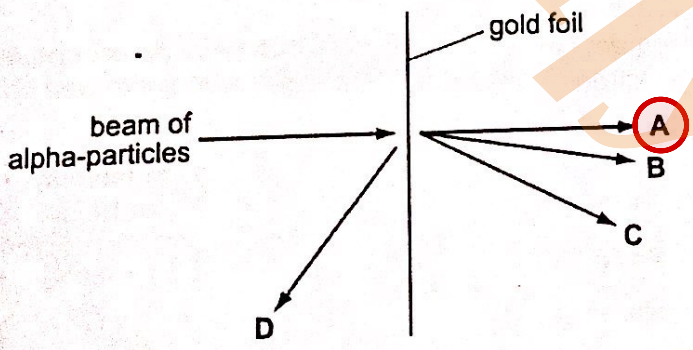
8. **M/J 12/P11/Q38**
The radioactive isotope radium-226 may be shown as $^{226}_{88}Ra$.
How many protons does an atom of radium contain?

A 44 B 88 C 138 D 226

9. **M/J 09/P1/Q40**
What are the numbers of neutrons, protons and electrons in a neutral atom of $^{235}_{92}U$?

	number of neutrons	number of protons	number of electrons
A	92	143	143
B	92	235	235
C	143	92	92
D	235	92	92

10. **O/N 08/P1/Q40, M/J 04/P1/Q39**
A narrow beam of alpha-particles is fired at a thin piece of gold foil.
Which is the final direction of the largest number of alpha-particles?



11. **M/J 03/P1/Q40**
The results of the Geiger-Marsden scattering experiment provided evidence for the presence of the nucleus within an atom.
What were scattered in this experiment?

A alpha-particles B beta-particles C gamma rays D gold nuclei

12. M/J 06/P1/Q40, M/J 02/P1/Q38
Which conclusion can be drawn from the Geiger-Marsden alpha-particle scattering experiment?
A A positive charge is spread throughout the atom.
B Electrons are arranged in orbits.
C Electrons are negatively charged.
D There is a dense nucleus in the atom.

13. O/N 05/P1/Q40
Which statement defines isotopes?
A two (or more) nuclides which have the same number of protons but different numbers of electrons
B two (or more) nuclides which have the same number of neutrons but different numbers of electrons
C two (or more) nuclides which have the same number of neutrons but different numbers of protons
D two (or more) nuclides which have the same number of protons but different numbers of neutrons

14. M/J 05/P1/Q40
Between 1909 and 1911, Geiger and Marsden carried out experiments in which alpha particles were fired at metal foil. Most of the alpha particles passed through the foil with small deflections, but some were deflected through a large angle.
These results suggest that
A atoms contain clouds of electrons through which some alpha particles cannot pass.
B atoms contain neutrons that alpha particles bounce off.
C atoms have positive and negative charges spread throughout their volume.
D atoms have positive charges concentrated in a small volume.

15. O/N 03/P1/Q40
Three nuclei P, Q and R have proton numbers (atomic numbers) and nucleon numbers (mass numbers) as shown.

	proton number	nucleon number
P	43	93
Q	43	94
R	44	94

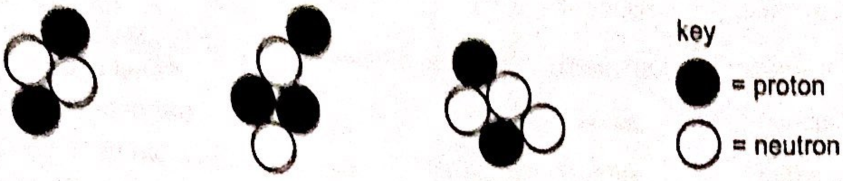
Which nuclei are isotopes of the same element?
A P and Q only B P and R only C Q and R only D P, Q and R

16. O/N 02/P1/Q40
Atoms P and Q are isotopes.
How does the composition of neutral atom P compare with neutral atom Q?

	number of protons	number of neutrons	number of electrons
A	different	different	different
B	different	same	same
C	same	different	same
D	same	same	different

26.2 Nucleus

17. M/J 16/P12/Q40
The diagrams represent the nuclei of three atoms.



Which are isotopes of the same element?

A P and Q only **(B)** P and R only C Q and R only D P, Q and R

18. M/J 16/P11/Q40
Which statement about a nucleus of $^{15}_{7}N$ is correct?

A The nucleus contains 7 neutrons and 8 protons.
B The nucleus contains 7 neutrons and 15 protons.
(C) The nucleus contains 7 protons and 8 neutrons.
D The nucleus contains 7 protons and 15 neutrons.

19. M/J 15/P12/Q38

A nucleus of $^{215}_{84}Po$ decays by emitting an alpha-particle and the resulting nucleus then decays by emitting a beta-particle.
What is the nucleon number and proton number of the final nucleus?

	nucleon number	proton number
A	211	81
B	211	83
C	212	81
D	212	83

20. M/J 15/P11/Q40
A nucleus contains 94 protons and 240 nucleons. It emits an alpha-particle.
How many protons and how many neutrons are in the nucleus produced?

	number of protons	number of neutrons
A	90	144
B	90	236
C	92	144
D	92	236

21. **O/N 14/P12/Q40**
A neutral atom of chlorine-37 is compared with a neutral atom of argon-37.
How do the number of electrons and the number of neutrons in each of the atoms compare?

	number of electrons	number of neutrons
A	different	different
B	different	same
C	same	same
D	same	different

22. **M/J 14/P11/Q40**
$^{14}_{6}C$ represents a nuclide of the element carbon and $^{14}_{7}N$ a nuclide of nitrogen.
How does a neutral atom of $^{14}_{7}N$ differ from a neutral atom of $^{14}_{6}C$?

A The nitrogen atom has one electron less than the carbon atom.
B The nitrogen atom has one neutron more than the carbon atom.
C The nitrogen atom has one proton less than the carbon atom.
D The nitrogen atom has one proton more than the carbon atom.

23. **O/N 13/P12/Q39**
For which purpose is the radioactive isotope carbon-14 used?

A dating of ancient bones
B fuel for a nuclear power station
C killing cancerous cells
D operating mobile telephones

24. **O/N 13/P12/Q40**
A nucleus of phosphorus $^{32}_{15}P$ emits a beta-particle to form a new nucleus.
What is the nucleon number and what is the proton number of the new nucleus?

	nucleon number (mass number)	proton number (atomic number)
A	28	13
B	31	14
C	31	15
D	32	16

25. **M/J 13/P11/Q40**
Which nuclides have the same number of neutrons in a nucleus?

A $^{12}_{5}B$ and $^{12}_{6}C$ B $^{1}_{1}H$ and $^{2}_{1}H$ C $^{12}_{6}C$ and $^{13}_{7}N$ D $^{14}_{6}C$ and $^{14}_{7}N$

26. **O/N 12/P12/Q38**
How many protons are in the nucleus of an atom of radium, $^{226}_{88}Ra$?

A 88 B 138 C 226 D 314

27. O/N 12/P11/Q40

40 Which nucleus is produced when thorium ($^{223}_{90}Th$) emits an alpha-particle?

A $^{219}_{88}RA$ **B** $^{219}_{92}Ra$ **C** $^{227}_{88}U$ **D** $^{227}_{92}U$

28. O/N 11/P12/Q38, O/N 11/P11/Q39

The isotope barium-140 has a half-life of 13 days. A sample of this isotope is kept for 13 days.
Which quantity halves during this time?

A the number of atoms of barium-140 in the sample
B the number of electrons in an atom of barium-140
C the number of nucleons in an atom of barium-140
D the number of protons in a nucleus of barium-140

29. O/N 11/P12/Q40, O/N 11/P11/Q38

One isotope of carbon is $^{14}_{6}C$.
How many neutrons and protons does each atom of this isotope contain?

	number of neutrons	number of protons
A	6	6
B	6	8
C	8	6
D	14	6

30. M/J 11/P12/Q39, M/J 11/P11/Q40

Chlorine exists as two isotopes. One has a nucleon number (mass number) of 35 and the other has a nucleon number (mass number) of 37.
Which table shows the correct numbers of protons and neutrons in the isotopes?

A

	number of protons	number of neutrons
isotope 1	17	18
isotope 2	17	20

B

	number of protons	number of neutrons
isotope 1	18	17
isotope 2	20	17

C

	number of protons	number of neutrons
isotope 1	35	17
isotope 2	37	17

D

	number of protons	number of neutrons
isotope 1	17	35
isotope 2	17	37

31. O/N 10/P12/Q40, O/N 10/P11/Q39

$^{15}_{7}N$ is a nuclide of nitrogen.

How many electrons are there in a neutral atom of $^{15}_{7}N$?

A 7 **B** 8 **C** 15 **D** 22

32. **M/J 10/P12/Q39, M/J 10/P11/Q40**
Proton number is another name for atomic number. Nucleon number is another name for mass number.
What are isotopes?
A nuclei with different proton numbers and different nucleon numbers
B nuclei with different proton numbers and the same nucleon number
C nuclei with the same proton number and different nucleon numbers
D nuclei with the same proton number and the same nucleon number

33. **O/N 09/P1/Q40**
A nuclide of strontium is represented by the symbol $^{88}_{38}Sr$. What does the nucleus contain?
A 38 electrons and 50 neutrons
B 38 neutrons and 38 protons
C 38 neutrons and 50 protons
D 38 protons and 50 neutrons

34. **O/N 08/P1/Q39**
The radioactive nucleus $^{87}_{37}Rb$ decays with the emission of a beta-particle.
How many protons and neutrons are left in the nucleus?

	protons	neutrons
A	37	49
B	37	50
C	38	49
D	38	87

35. **M/J 08/P1/Q40**
A nucleus of the element cobalt may be represented by the symbol $^{59}_{27}Co$.
What is the structure of this nucleus?

	number of protons	number of neutrons
A	27	32
B	27	59
C	59	27
D	59	32

36. **O/N 07/P1/Q40**
The neutral atoms of all isotopes of the same element contain the same number of
A electrons and protons.
B electrons and neutrons.
C neutrons only.
D neutrons and protons.

37. M/J 07/P1/Q40

A nuclide has the notation $^{48}_{23}X$

Which line in the table describes a different isotope of this nuclide?

	proton number (atomic number)	nucleon number (mass number)
A	23	50
B	24	48
C	48	24
D	50	23

38. O/N 06/P1/Q37

A nucleus of sodium, Na, has 11 protons and 12 neutrons.
Which symbol represents this nucleus?

A $^{11}_{12}Na$ B $^{12}_{11}Na$ C $^{23}_{11}Na$ D $^{23}_{12}Na$

39. O/N 05/P1/Q39

A nuclide of the element plutonium is $^{242}_{94}Pu$.

What is the number of neutrons in its nucleus?

A 94 B 148 C 242 D 336

40. O/N 04/P1/Q39

A nucleus consists of 90 protons and 144 neutrons.
After emitting two beta-particles followed by an alpha-particle, this nucleus has

A 86 protons and 140 neutrons.
B 86 protons and 142 neutrons.
C 90 protons and 140 neutrons.
D 90 protons and 142 neutrons.

41. O/N 03/P1/Q39

The nucleus of a nitrogen atom can be represented as $^{14}_{7}N$. The nucleus of this atom consists of

A 7 protons and 7 electrons.
B 7 protons and 7 neutrons.
C 14 protons and 7 electrons.
D 14 protons and 7 neutrons.

42. M/J 02/P1/Q39

There is a dense nucleus in the atom.

	the Sun	*nuclear power stations*
A	fission	fission
B	fission	fusion
C	fusion	fission
D	fusion	fusion

Unit 27: The Nuclear Atom

Section A

1. M/J 15/P22/Q8

Two isotopes of hydrogen are written as ^1_1H and ^2_1H.

(a) Complete Fig. 8.1 to show the number of protons and neutrons in one nucleus of each of these isotopes of hydrogen.

	number of protons	number of neutrons
^1_1H	1	0
^2_1H	1	1

Fig. 8.1

[2]

(b) Explain, using ideas about electrons, neutrons and protons, why atoms of ^1_1H and ^2_1H are uncharged.

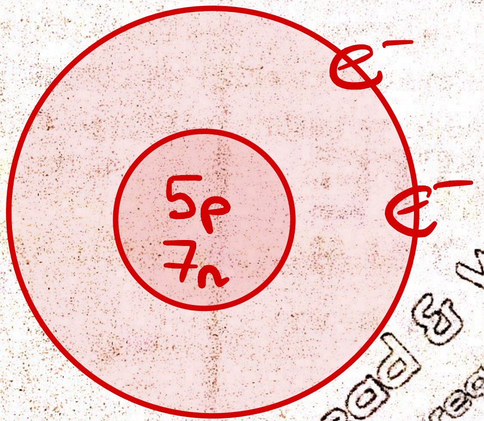
As these atoms contain same no of electrons and protons, hence they are uncharged The positive charge on proton and -ve charge on electron cancel out.

[3]

2. O/N 14/P21/Q8

The nuclide notation for the radioactive isotope boron-12 is $^{12}_5B$.

(a) In the space below, draw a labelled diagram to illustrate the structure of a neutral atom of this isotope. Show all the particles in the atom.



As boron-12 decays, it emits a beta-particle. A new atom is produced.
Determine

(i) the proton number (atomic number) of the new atom,

proton number = ...[1]

(ii) the nucleon number (mass number) of the new atom.

nucleon number = ...[1]

...J 14/P22/Q8

(a) An atom consists of electrons surrounding a nucleus made up of protons and neutrons.
State which of these particles

(i) have an equal and opposite charge,

e⁻ & protons
.... [1]

(ii) have almost equal mass.

protons and nuetrons
.... [1]

(b) The nuclide notation for carbon-14 is $^{14}_{6}C$. Carbon-14 decays by beta emission to a stable isotope of nitrogen (N).

(i) Write numbers in the empty boxes below to show the nuclide notation for this isotope of nitrogen.

$$^{14}_{6}C \rightarrow ^{\square}_{\square}N + \beta$$

[2]

(ii) The half-li...

4. O/N 12/P22/Q8

The nuclei of four neutral atoms are represented using nuclide notation as:

$^{12}_{6}C$ $^{14}_{6}C$ $^{14}_{7}N$ $^{15}_{8}O$

(a) Neutral atoms also contain electrons. State which of the four nuclei is surrounded by the greatest number of electrons.

Oxygen → O^{15}_{8} .... [1]

(b) From these four nuclei, state the two nuclei that have the same number of

(i) protons,

Carbon → C^{12}_{6} & C^{14}_{6} .... [1]

(ii) nucleons,

Carbon & Nitrogen → C^{14}_{6} & N^{14}_{7} .... [1]

(iii) neutrons.

Nitrogen & Oxygen → N^{14}_{7} & O^{15}_{8} .... [1]

Section B

1. M/J 15/P21/Q11

(a) A student makes a model of an atom. The model contains 24 electrons, 25 protons and 26 neutrons. Some of these particles are inside a nucleus at the centre of the model.

26
+25
51

(i) Determine the nucleon number (mass number) of the atom.

51 ....[1]

(ii) Explain why the model represents a charged atom.

As there are more no of protons than electrons
So, Protons are in excess making atom +vely charged! ....[2]

(iii) The student makes a new model of a different isotope of the same element. Describe the nucleus of this new model.

It will have 25 protons but different
number of nuetrons! ....[2]

(b) Americium-241 is radioactive. Its nuclide notation is $^{241}_{94}Am$.

(i) Determine the number of neutrons in a nucleus of americium-241.

241
− 94
147

number = 147 ....[1]

(ii) A nucleus of americium-241 emits an α-particle and decays to uranium-237. Complete the nuclear equation for the decay of americium-241.

$$^{241}_{94}Am \rightarrow \;^{\cdots}_{\cdots}\alpha + \;^{237}_{\cdots}U$$

[3]

(c) Geiger and Marsden studied the structure of gold atoms. Fig. 11.1 shows a version of their apparatus. Alpha-particles strike a thin gold foil.

2. O/N 14/P22/Q11

Strontium-90 ($^{90}_{38}Sr$) is a radioactive isotope. A nucleus of strontium-90 decays by the emission of a beta-particle (β).

(a) Define the term *isotope*.

It is the same element with same number of protons but different number of neutrons ....[2]

(b) For a neutral atom of strontium-90, state

(i) the number of electrons,

number of electrons = 38 ....[1]

(ii) the number of neutrons.

90 − 38 = 52

number of neutrons = 52 ....[1]

(c) When a nucleus of strontium-90 decays, it becomes a nucleus of yttrium (symbol Y). Complete the equation for this decay.

$$^{90}_{38}Sr \rightarrow \ ^{\cdots}_{\cdots}Y + \ ^{\cdots}_{\cdots}\beta$$ [2]

(d) A sample initially contains 6.0×10^8 atoms of strontium-90.

(i) The half-life of strontium-90 is 29 years.

Calculate the number of strontium-90 atoms that remain in the sample after 87 years.

number of atoms = ... [

THE ANATOMY OF

RADIOACTIVITY

By Ahmed Afzal

WHAT IS
RADIOACTIVITY

The phenomenom of the emission of radio active radiations (α, β, γ) from nucleus of an atom!

◦) Any radioactive nucleus can produce emission at any time!

◦) No change in the rate of emissions of radio-active radiations by changing external parameters →

e.g:- Temperature, pressure, etc

→ So we can deduce that radioactive emissions :

◦) Random & ◦) Spontaneous

☆ There are three types of Radioactive radiations :-

1. Alpha particles (rays)
2. Beta particles (rays)
3. Gamma Rays

Radioactive decay :-

Emission of radioactive radiation, from Nucleus for the Stability of Nucleus

ALPHA PARTICLES

Symbol → α o) Nuclear symbol → $^4_2\alpha$

o) Charge → $+2$

---

o) Least penetration power, stopped by a piece of paper!

o) Lowest range → 4 or 5cm

o) Lowest speed → $10^6\ ms^{-1}$

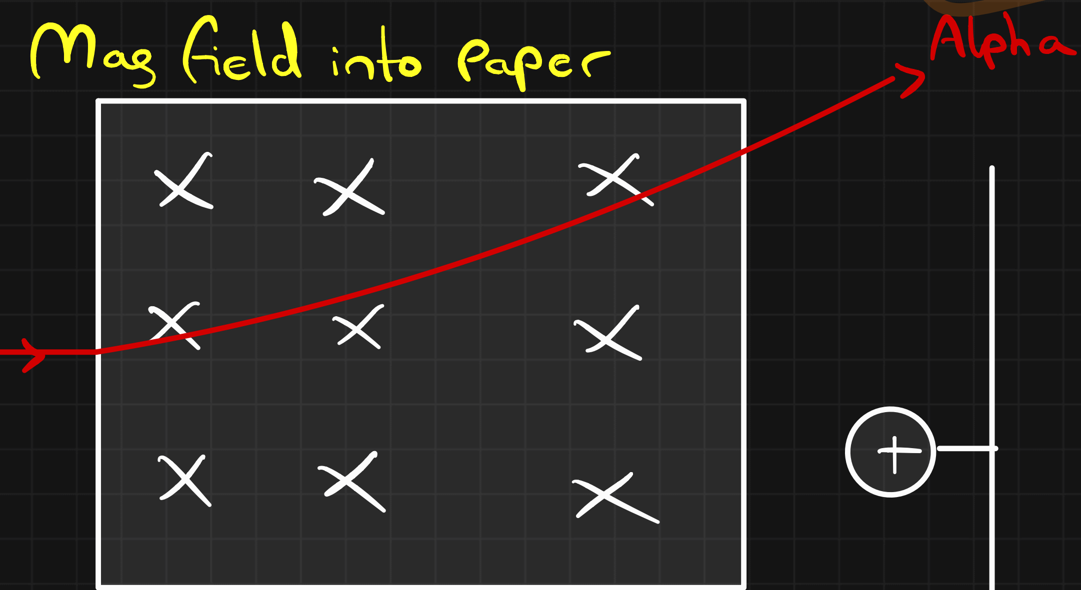
---

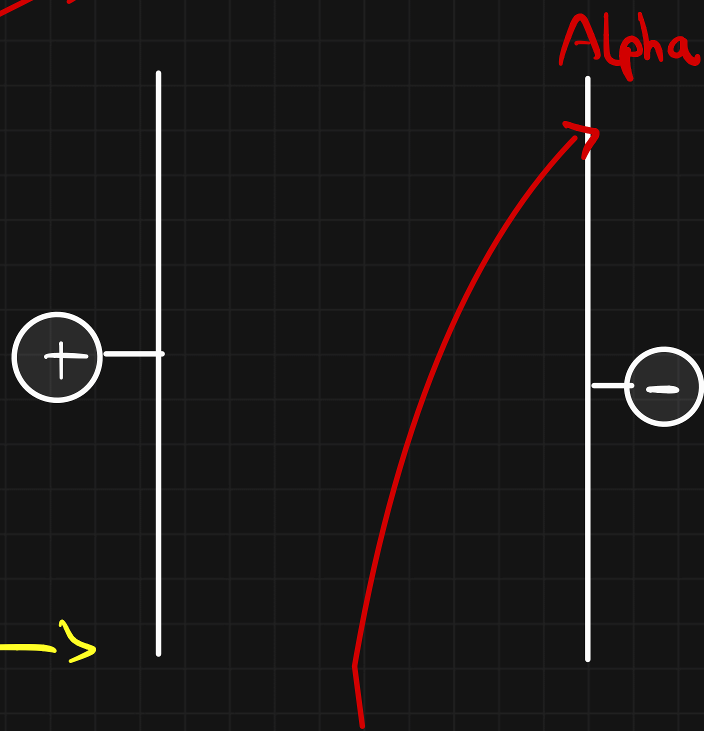
o) It has the greatest ionization power due to +2 charge

→ removes electron from atoms and absorbs them

$$^{235}_{92}U \longrightarrow {}^{4}_{2}\alpha + X^{231}_{90}$$

Mag field into paper





Deflection in electric field →

BETA PARTICLES

Symbol → β

- Nuclear symbol → $^{0}_{-1}\beta$
- Charge → -1

Fast moving electron!

- More penetrating than α, but less than γ

→ Stopped by 1cm–2cm thick Aluminium block

- Range = 15cm ~ 20cm
- Speed = Less than close to $3.0 \times 10^{8}\ ms^{-1}$

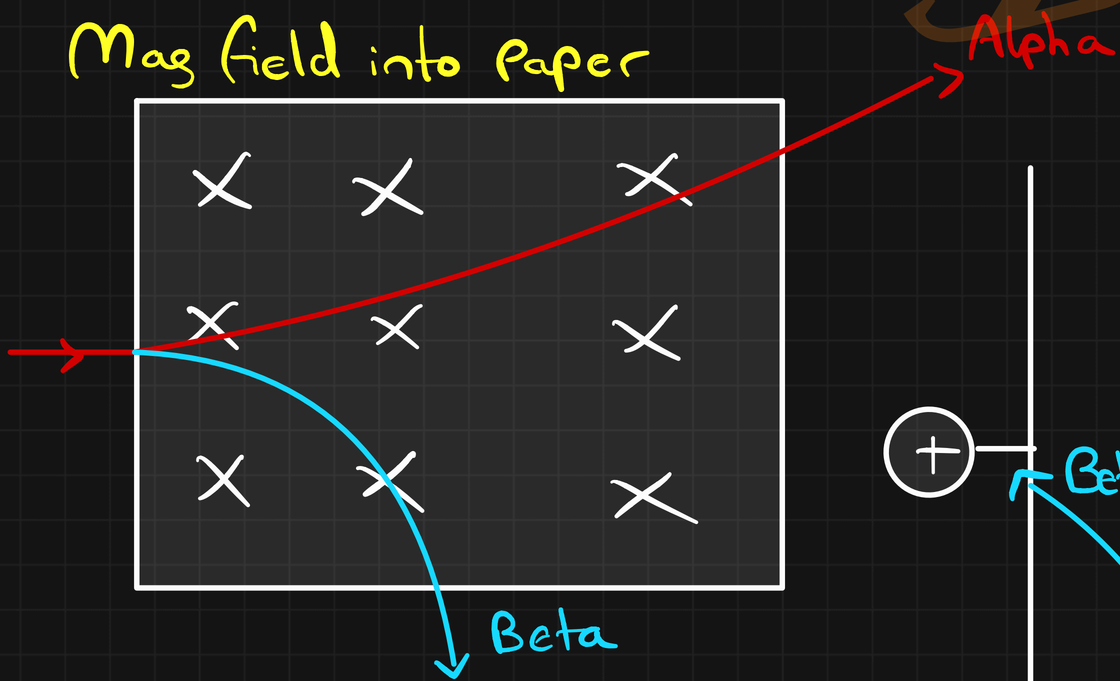
→ Less ionization power as −1 charge

→ either removes electron via collision or gets absorbed!

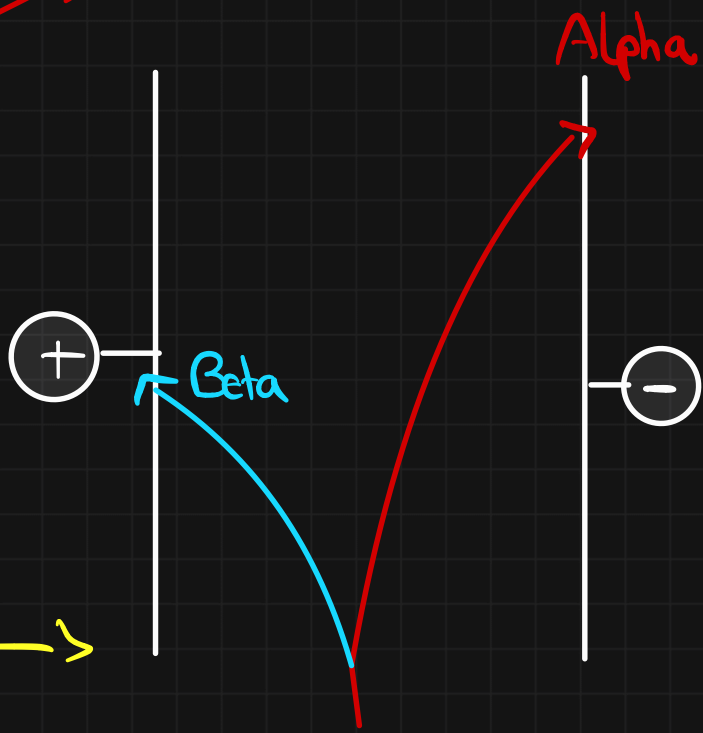
$$^{235}_{92}U \longrightarrow {}^{0}_{-1}\beta + {}^{235}_{93}Y$$

92 − (−1) → 93

Mag field into paper



Deflection in electric field →



GAMMA RAYS

Symbol → γ

- Nuclear symbol → γ
- Charge → 0

high frequency electro magnetic Radiation!

→ Greatest Penetration power

- Stopped by 4cm thick lead block or Thick concrete walls

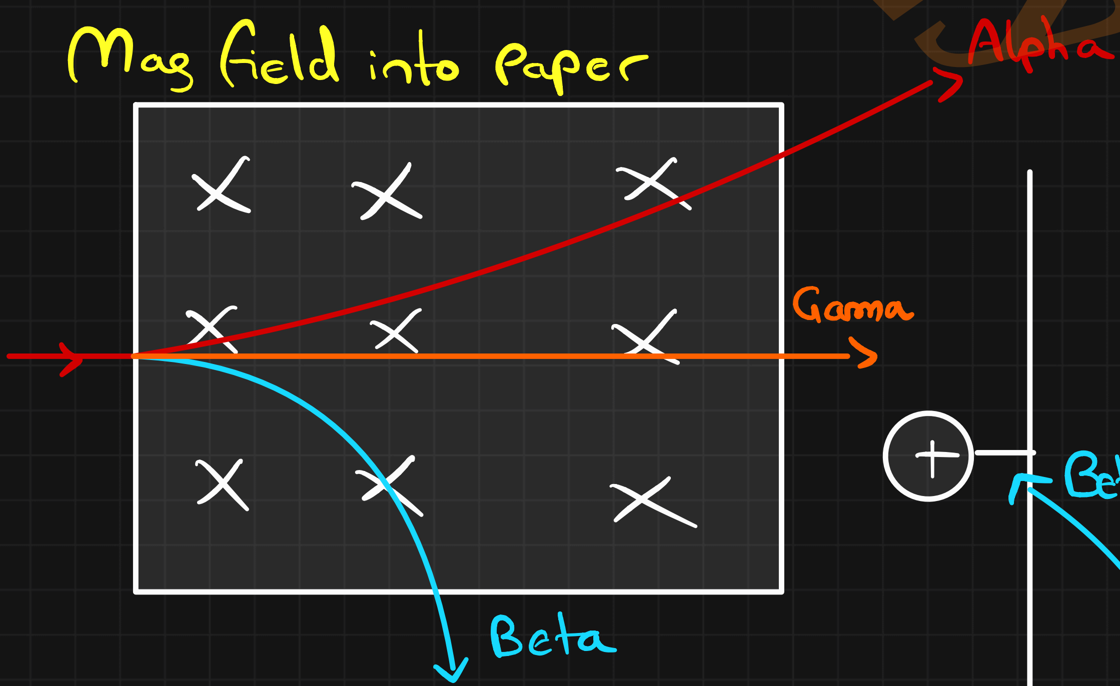
→ Greatest range → 10m

→ Speed of Light → $3.0 \times 10^8\ ms^{-1}$

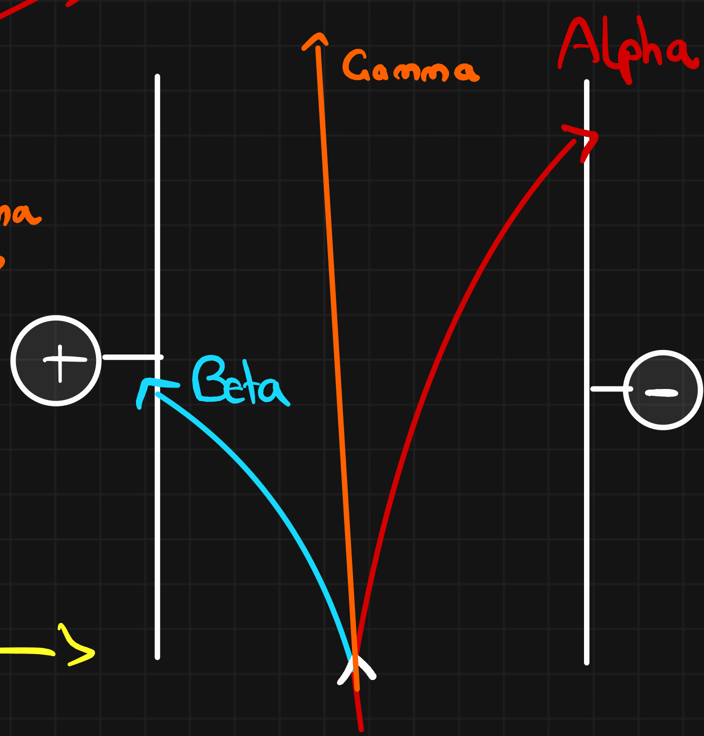
- Least ionization power as no charge
- remove electrons, if electrons absorb them! (Leaving the shell)

$$^{235}_{92}U^* \longrightarrow \gamma + ^{235}_{92}U$$

Mag field into paper



Deflection in electric field →



Unit 25: Radioactivity

25.1 Detection of radioactivity

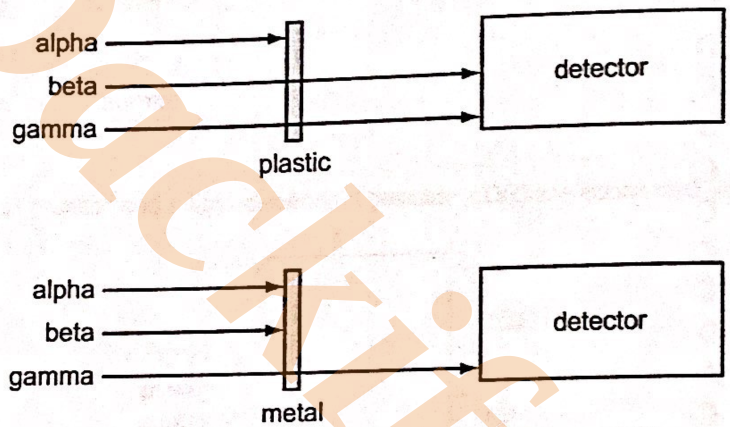
1. O/N 14/P11/Q37

Three types of radiation emitted by unstable nuclei are electrons, helium nuclei and electromagnetic radiation.
What are these types of radiation?

	electrons	helium nuclei	electromagnetic radiation
A	alpha	beta	gamma
B	alpha	gamma	beta
C	beta	alpha	gamma
D	beta	gamma	alpha

2. O/N 12/P12/Q39

The diagram shows the radioactive emissions that pass through a piece of plastic and a piece of metal of the same thickness.

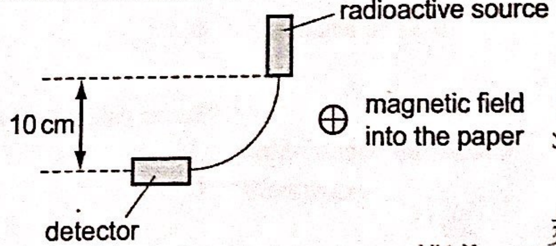


Which types of radioactive emission can distinguish between the plastic and the metal?

A alpha, beta and gamma
B alpha only
C beta only
D gamma only

3. O/N 11/P12/Q39, O/N 11/P11/Q40

In a laboratory experiment, particles from a radioactive source are deviated by a magnetic field and reach a detector.

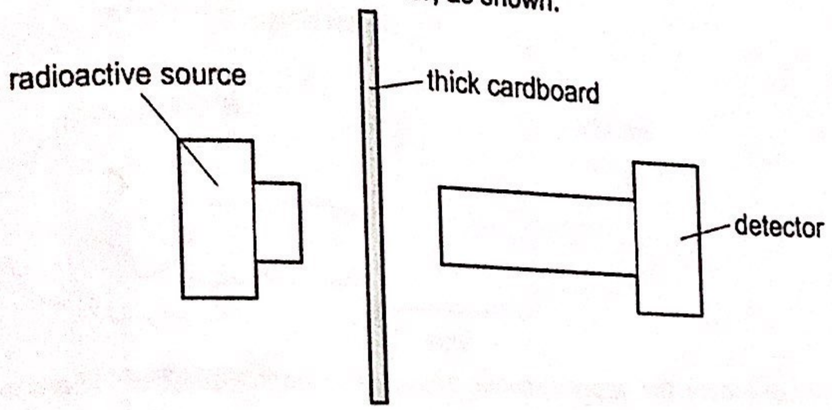


Which particles are deviated and reach the detector?

A alpha-particles and gamma-rays
B alpha-particles only
C beta-particles and gamma-rays
D beta-particles only

4. **O/N 10/P12/Q39, O/N 10/P11/Q38**

A student investigates a radioactive source that emits only alpha-particles. Without any source nearby, the detector shows a low reading.
The source and thick cardboard are placed near the detector, as shown.

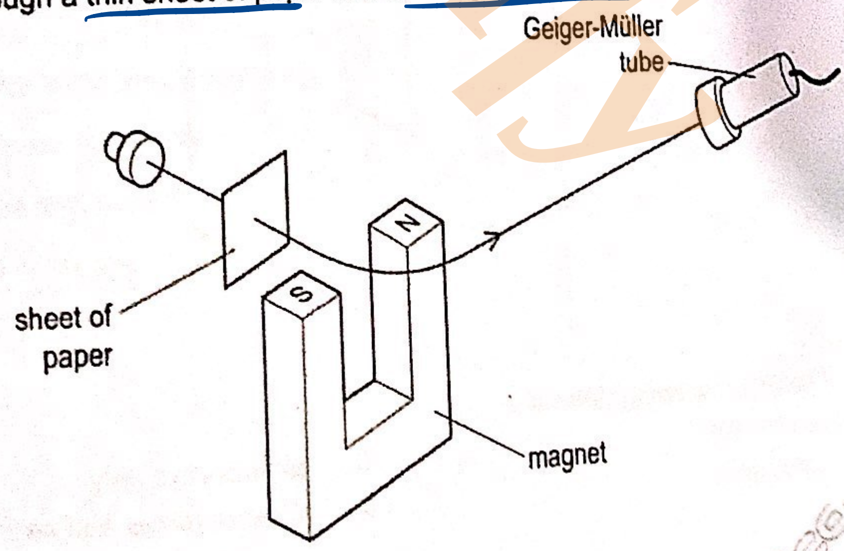


What is the reading on the detector now, and why?

	detector reading	reason
A	low	background radiation is detected
B	low	some alpha-particles pass through cardboard
C	zero	alpha-particles are all absorbed by the cardboard
D	zero	background radiation is all absorbed by the cardboard

5. **MJ 09/P1/Q38**

A radioactive source emits alpha-particles, beta-particles and gamma-rays. A Geiger-Muller tube and counter detect the emissions, which pass through a thin sheet of paper and a strong magnetic field.



What is detected by the Geiger-Muller tube?

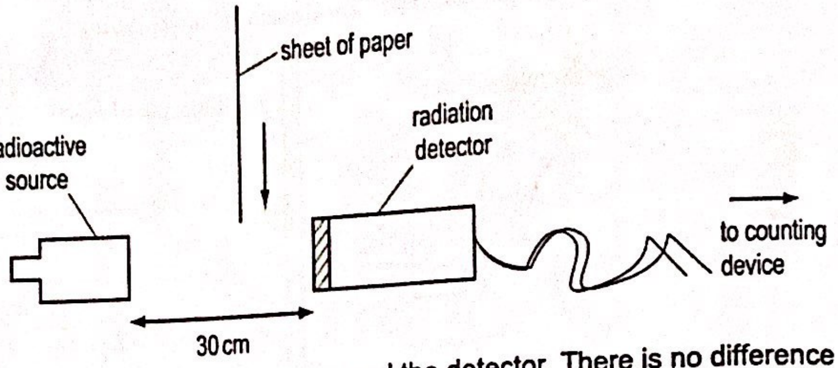
A alpha-particles and beta-particles

B alpha-particles only

C beta-particles and gamma-rays

D beta-particles only

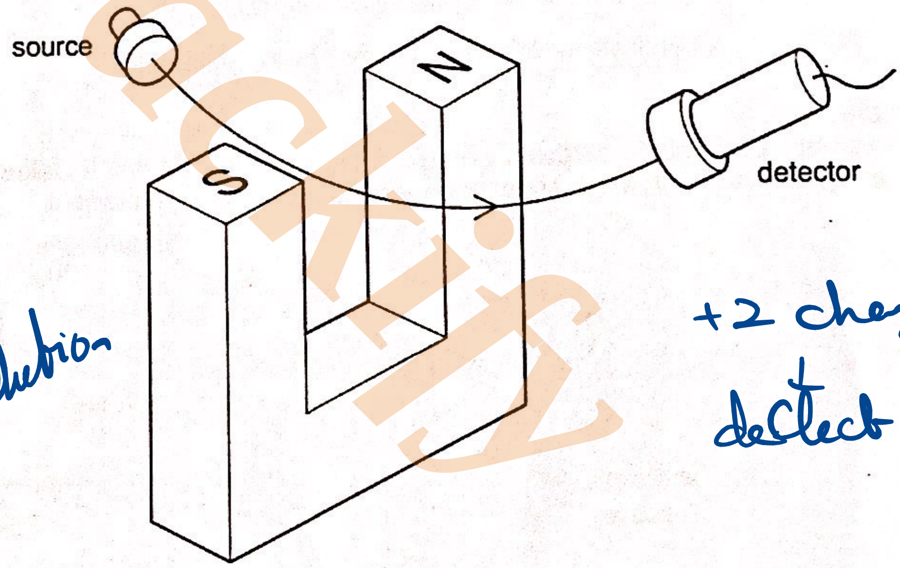
6. **O/N 07/P1/Q38**
An experimenter sets up the following apparatus, in air, to discover whether a radioactive source is emitting alpha-particles.



The experimenter moves the paper between the source and the detector. There is no difference in the count-rate. Why is the?

- **A** Paper does not absorb alpha-particles.
- **B** The count-rate due to the background radiation is too high.
- **C** The radioactive source is too far from the detector.
- **D** The source emits beta-particles and alpha-particles.

7. **M/J 07/P1/Q39**
The diagram shows one type of radiation passing between the poles of a strong magnet and being detected.



Which type of radiation is being detected?

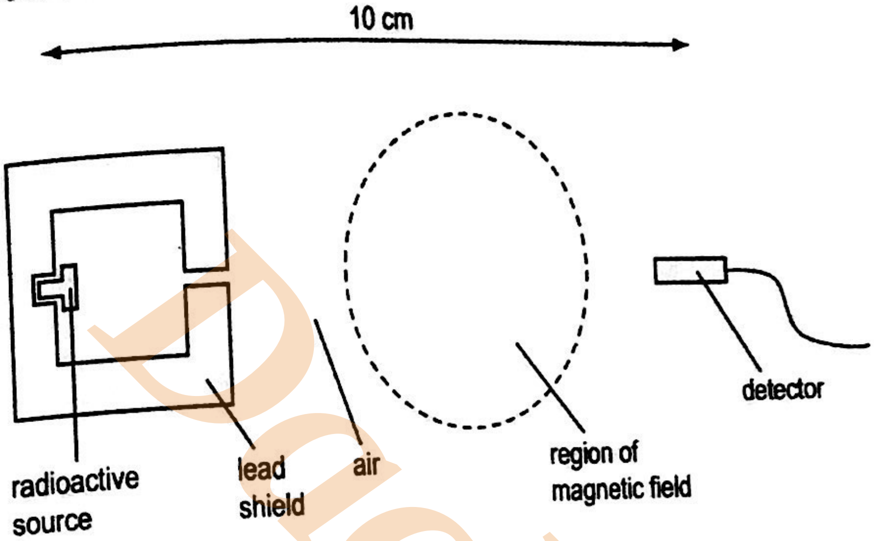
- **A** alpha-particles only
- **B** beta-particles only
- **C** gamma-rays only
- **D** alpha-particles and beta-particles

8. **O/N 02/P1/Q36**
Which of the following occurs in the decay of a radioactive nucleus?

- **A** The nucleus absorbs another nucleus.
- **B** The nucleus absorbs at least one form of radiation.
- **C** The nucleus always splits into two equal fragments.
- **D** The nucleus emits at least one form of radiation.

MJ 06/P1/Q38

A student investigates the emission from an unknown radioactive source. The source is 10 cm in front of a detector. A strong magnetic field between the source and the detector is then switched on.



The results are shown.

	average count per minute
without magnetic field	4500
with magnetic field	2000
background radiation	50

Which radioactive source produced these results?

source	emissions from source
A	alpha-particles and gamma-rays only
B	beta-particles only
C	beta-particles and gamma-rays only
D	gamma-rays only

25.2 Characteristics of the three types of emission

10. O/N 16/P11/Q38

Which types of radiation may be emitted by radioactive nuclei?

A beta and gamma
B microwaves and infra-red
C radio waves and microwaves
D ultra-violet and X-rays

11. M/J 16/P12/Q38

Which states the three types of radiation emitted by radioactive isotopes in order of their ionizing effect from highest to lowest?

A alpha-particles, beta-particles, gamma-rays
B alpha-particles, gamma-rays, beta-particles
C beta-particles, gamma-rays, alpha-particles
D gamma-rays, beta-particles, alpha-particles

12. M/J 16/P11/Q38

Which type of radiation consists of electrons?

A alpha-particles B beta-particles C gamma-rays D X-rays

13. O/N 15/P11/Q39

Which type of electromagnetic radiation is produced during radioactive decay?

A alpha-particles B beta-particles C gamma-rays D X-rays

14. M/J 14/P12/Q39

Which row states the nature and range of beta-particles in air?

	nature	range in air
A	electromagnetic radiation	1-10 cm
B	electromagnetic radiation	10-100 cm
C	electron	1-10 cm
D	electron	10-100 cm

15. M/J 14/P11/Q39

Which row gives the range and electrical charge of an alpha-particle?

	range in air	electrical charge
A	a few centimetres	negative
B	a few centimetres	positive
C	a few metres	negative
D	a few metres	positive

16. O/N 13/P11/Q37

What are the characteristics of an alpha-particle?

	charge	ionising effect
A	negative	strong
B	negative	weak
C	positive	strong
D	positive	weak

O/N 13/P12/Q36

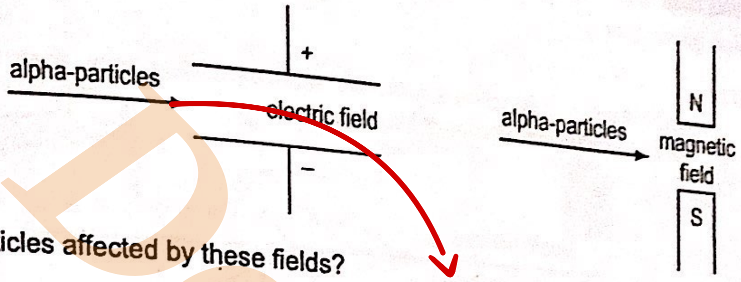
Three types of radiation emitted by unstable nuclei are helium nuclei, short wavelength electromagnetic waves and electrons.

What are these three types of radiation?

	helium nuclei	electromagnetic waves	electrons
A	alpha	gamma	beta
B	beta	gamma	alpha
C	gamma	alpha	beta
D	gamma	beta	alpha

O/N 13/P11/Q38

Alpha-particles pass through an electric field or a magnetic field.



How is the path of the particles affected by these fields?

	electric field	magnetic field
A	deflected	deflected
B	deflected	undeflected
C	undeflected	deflected
D	undeflected	undeflected

M/J 08/P1/Q38

Which travels in a straight line across a magnetic field?

A alpha-particle B electron C gamma-ray D proton

M/J 07/P1/Q38

Which statement is true for all three types of radioactive emission (alpha-particles, beta-particles and gamma-rays)?

A They are completely absorbed by a thin aluminum sheet.

B They are deflected by electric fields.

C They emit light.

D They ionise gases.

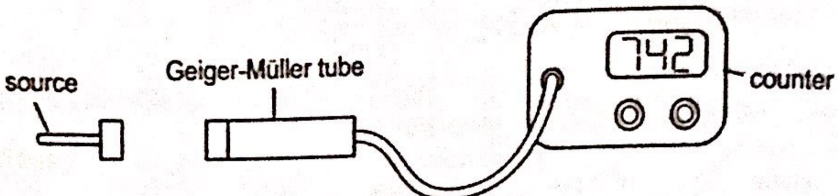
O/N 06/P1/Q39

Which is the correct comparison of the penetrating power and ionising power of alpha-particles and gamma radiation?

	greater penetrating power	greater ionising power
A	alpha	alpha
B	alpha	gamma
C	gamma	alpha
D	gamma	gamma

22. M/J 05/P1/Q38

A radioactive source is placed 3 cm from a Geiger-Müller tube in air. The average count rate is 742 counts / minute.



Then, in three experiments, measurements are taken with sheets of different materials placed between the source and the tube. The results are recorded in the table.

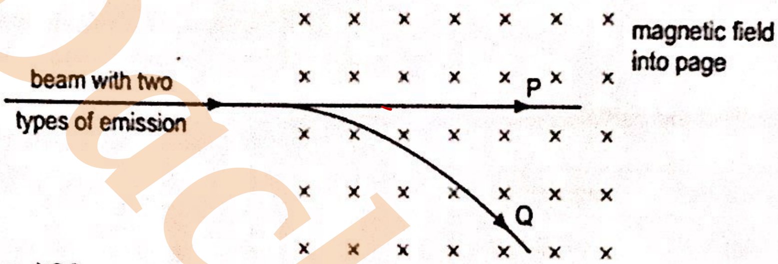
material of sheet between source and tube	thin card	aluminium foil	thick lead
average count rate / counts per minute	273	275	68

Which types of radiation does the source emit?

A alpha and beta only
B alpha and gamma only
C beta and gamma only
D alpha, beta and gamma

23. M/J 04/P1/Q38

Two types of emission from a radioactive source are separated by passing them through a magnetic field. The deflections are shown in the diagram.



What are the emissions P and Q?

	emission P	emission Q
A	alpha-particles	gamma-rays
B	beta-particles	gamma-rays
C	gamma-rays	alpha-particles
D	gamma-rays	beta-particles

24. O/N 03/P1/Q38

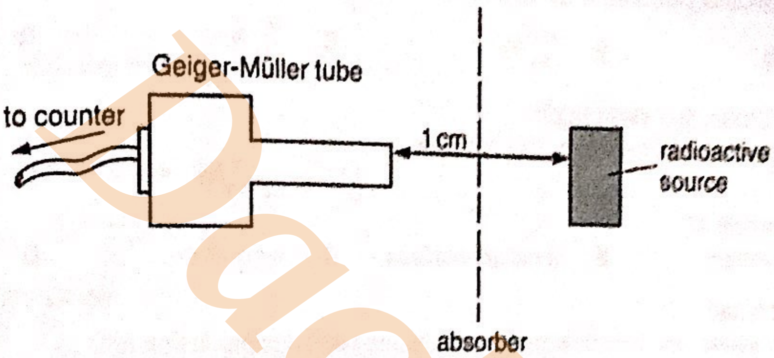
X, Y and Z are three types of radiation.
X is almost completely absorbed by 5 cm lead but not by 5 mm aluminium.
Y is almost completely absorbed by 5 mm aluminium but not by thin card.
Z is absorbed by thin card.
What are X, Y and Z?

	X	Y	Z
A	alpha	beta	gamma
B	beta	alpha	gamma
C	gamma	alpha	beta
D	gamma	beta	alpha

O/N 02/P1/Q37
The table shows the possible properties of radioactive emissions.
Which emission could be a beta-particle?

emission	charged	deflected in a magnetic field	level of ionisation
A	no	yes	none
B	yes	yes	none
C	yes	yes	weak
D	yes	no	weak

16. **O/N 02/P1/Q38**
A pupil investigates the penetrating power of radiation from a radioactive source.



The table shows her results.

background count	25 counts per minute
count with source only	630 counts per minute
count with source and paper absorber	630 counts per minute
count with source and aluminium absorber 3 mm thick	180 counts per minute

The source emits
- A alpha and beta-particles.
- B beta-particles and gamma-rays.
- C beta-particles only.
- D gamma-rays only.

17. **O/N 02/P1/Q39**
Which particle is positively charged?
- A alpha-particle
- B beta-particle
- C electron
- D neutron

M/J 02/P1/Q36
How do the ionising abilities of beta particles and gamma rays compare with the ionising ability of alpha particles?

	beta particles	*gamma rays*
A	less	less
B	less	more
C	more	less
D	more	more

HALF LIFE 🤍

The time taken for the radioactive sample to reduce its activity to half of its initial value

Activity is the number of radioactive radiations emitted per unit time e.g:- 1000 emissions per second!

$$t_{1/2} = t/n \longrightarrow n = t/t_{1/2}$$

$t_{1/2} \longrightarrow$ time for half life

$t \rightarrow$ total time elapsed

$n \longrightarrow$ no. of half lifes

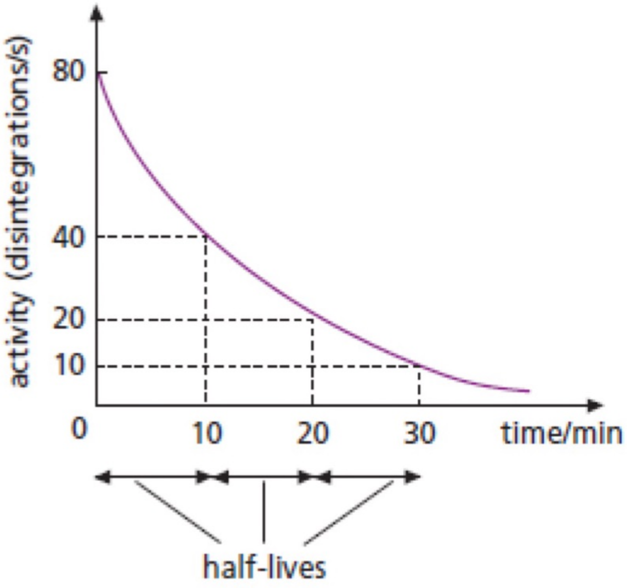
initial — $t_1 = 0$

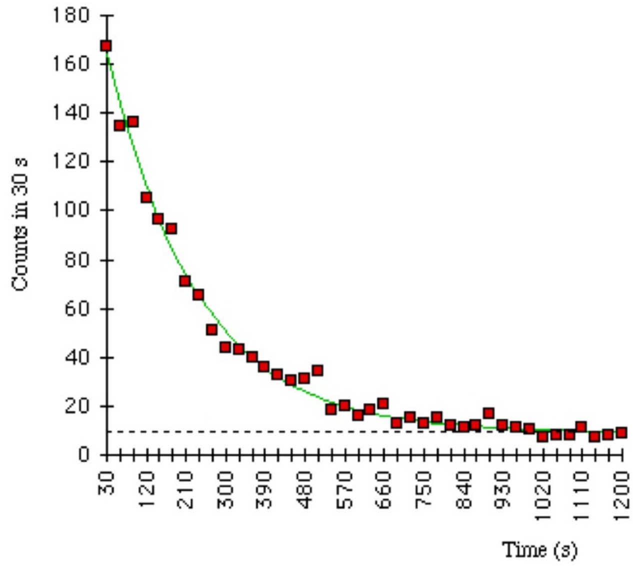
current — $t_2 = t$

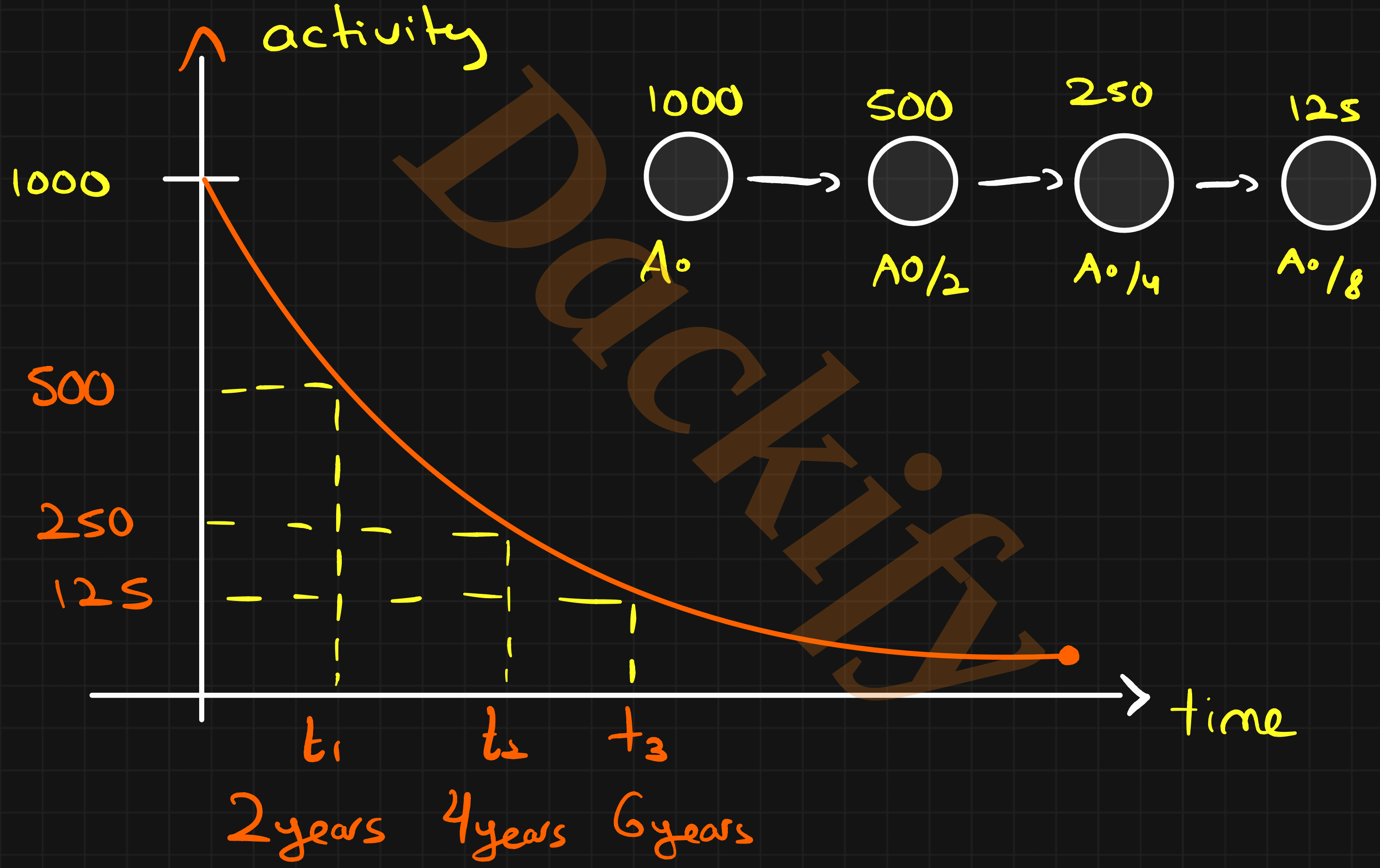
$t = 2$ years $\quad t_{1/2} = 6$ months

$$n = t/t_{1/2} = \frac{24}{6} = 4 \text{ half lives}$$

$$1000 \xrightarrow{t/t_{1/2}} 500 \xrightarrow{t/t_{1/2}} 250 \xrightarrow{t/t_{1/2}} 125$$







☆ do not touch the x-axis

Question Type 1

A radioactive isotope has a half-life of 6000 years.

How much time passes before the rate of emission from a sample of this isotope falls to $\frac{1}{16}$ of its original value?

A 6000 years

B 18 000 years

C 24 000 years

D 96 000 years

$1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8 - 1/16$

1 2 3 4

4 half lives →

$6000 \times 4 = 24000$

Question Type 2

When a sample of a radioactive nuclide decays, the count rate falls from 1200 to 150 in three minutes.

What is the half-life of the radioactive nuclide?

A 0.75 minutes

B 1.0 minutes

C 3.0 minutes

D 9.0 minutes

$\frac{1200}{2} \rightarrow \frac{600}{2} \rightarrow \frac{300}{2} \rightarrow 150$

3 half lives → 3 minutes

1 half live → 1 minute

Question Type 3

The background count rate in a laboratory is 10 counts / min.

The measured count rate from a radioactive source is 410 counts / min, which includes the background.

The half-life of the source is 5 days.

What is the measured count rate after 15 days?

A 10 counts / min

B 50 counts / min

C 60 counts / min

D 110 counts / min

$\frac{400}{2} = \frac{200}{2} \rightarrow \frac{100}{2} \rightarrow 50$

1 2 3

Question type 4

A sample of wood contains 9.0×10^{16} nuclei of carbon-14. The nuclei undergo radioactive decay with a half-life of 5600 years.

How many carbon-14 nuclei remain in this sample after 16 800 years?

A 1.1×10^{2} **B** 1.1×10^{16} **C** 3.0×10^{16} **D** 4.5×10^{16}

$\frac{9.0 \times 10^{16}}{2} \rightarrow \frac{4.5 \times 10^{16}}{2} \rightarrow \frac{2.25 \times 10^{16}}{2} = 1.125 \times 10^{16}$

16800 / 5600 → 3 half lives

25.4 Half-life

51. O/N 16/P12/Q39, O/N 16/P11/Q39
A freshly made sample of radioactive material gives a count rate of 8000 counts per minute. After 20 days, it gives a count rate of 500 counts per minute.
What is the half-life of the material?

A 4.0 days B 5.0 days C 20 days D 80 days

52. M/J 16/P12/Q39
Which statement about the half-life of a radioactive isotope is correct?

A Half-life changes as the isotope decays.
B Half-life is the time it takes for the nucleon number of the isotope to halve.
C Half-life is half the time it takes for the number of nuclei of the isotope to decrease to zero.
D Half-life is the time it takes for the number of nuclei of the isotope to decrease by half.

53. M/J 16/P11/Q39
A sample of a radioactive isotope produces a count rate of 10 000 counts per minute. The half-life of the isotope is one day.
What was the count rate of the sample two days ago?

A 2500 counts per minute
B 5000 counts per minute
C 20 000 counts per minute
D 40 000 counts per minute

54. O/N 15/P12/Q39
A radioactive isotope ^{14}C emits beta-particles.
A sample of this isotope is left for a period of time that is equal to its half-life.
Which two quantities decrease to **half** of their initial value during this time?

A the decay rate and the number of protons
B the mass of the sample and the number of ^{14}C nuclei
C the number of ^{14}C nuclei and the decay rate
D the number of protons and the mass of the sample

55. M/J 15/P12/Q40
The half-life of a radioactive isotope is 24 hours. A sample of this isotope produces an initial count rate of 720 counts per second.
How long does it take for the count rate to fall to 90 counts per second?

A 3 hours B 72 hours C 96 hours D 192 hours

56. M/J 15/P11/Q39
A source contains a radioactive material.
Without the radioactive source present, a detector records a background count rate of 20 counts per minute.
This source is placed in a fixed position near the detector. Initially a count rate of 520 per minute is recorded.
What count rate is recorded after a time of two half-lifes of the radioactive source?

A 125 counts per minute
B 130 counts per minute
C 135 counts per minute
D 145 counts per minute

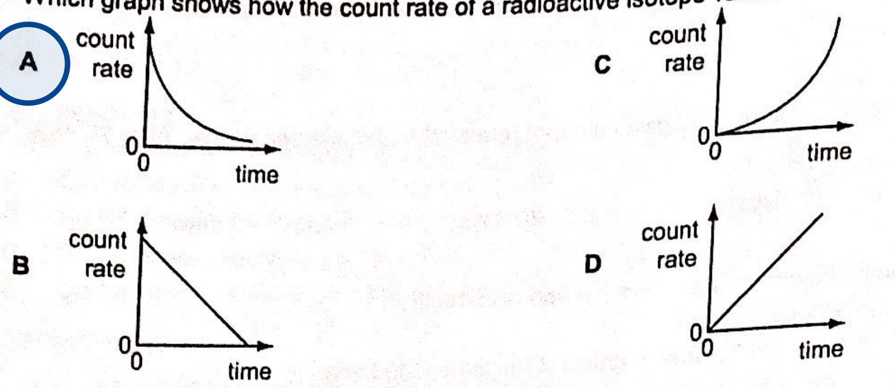
57. O/N 14/P11/Q39
A sample of wood contains 9.0×10^{16} nuclei of carbon-14. The nuclei undergo radioactive decay with a half-life of 5600 years. How many carbon-14 nuclei remain in this sample after 16 800 years?

A 1.1×10^{2} B 1.1×10^{16} C 3.0×10^{16} D 4.5×10^{16}

58. M/J 13/P12/Q39
The count rate from a radioactive source falls from 4000 counts per minute to 500 counts per minute in 72 minutes. What is the half-life of the source?

A 8 minutes B 9 minutes C 18 minutes D 24 minutes

59. O/N 13/P12/Q38
Which graph shows how the count rate of a radioactive isotope varies with time?



60. O/N 12/P12/Q40
The background count rate in a laboratory is 10 counts / min. The measured count rate from a radioactive source is 410 counts / min, which includes the background.
The half-life of the source is 5 days.
What is the measured count rate after 15 days?

A 10 counts / min **B** 50 counts / min **C** 60 counts / min **D** 110 counts / min

61. M/J 12/P12/Q40
The count rate from a radioactive material falls from 400 counts per second to 50 counts per second in 12 minutes.
What is its half-life?

A 8 minutes **B** 6 minutes **C** 4 minutes **D** 3 minutes

62. M/J 12/P11/Q40
An isotope X is radioactive and has a half-life of 4 years. A sample initially contains 8000 atoms of X.
After how many years will the sample contain 1000 atoms of X?

A 4 **B** 8 **C** 12 **D** 16

63. M/J 11/P12/Q40, M/J 11/P11/Q38
Tritium is a radioactive isotope of hydrogen with a half-life of 12 years.
If a sample starts with 40 million atoms of tritium, how many atoms of tritium will be left after 12 years?

A 40 million **B** 20 million **C** 10 million **D** 5 million

64. O/N 10/P12/Q38, O/N 10/P11/Q40
The table shows details of two samples of radioactive nuclides X and Y.

nuclide	number of radioactive atoms at time = 0	half-life
X	16 000	1 day
Y	2 000	2 days

After how many days will the number of atoms of nuclide X be equal to the number of atoms of nuclide Y?

A 2 days **B** 4days **C** 6days **D** 8days

65. M/J 10/P12/Q40, M/J 10/P11/Q39
When a sample of a radioactive nuclide decays, the count rate falls from 1200 to 150 in three minutes.
What is the half-life of the radioactive nuclide?

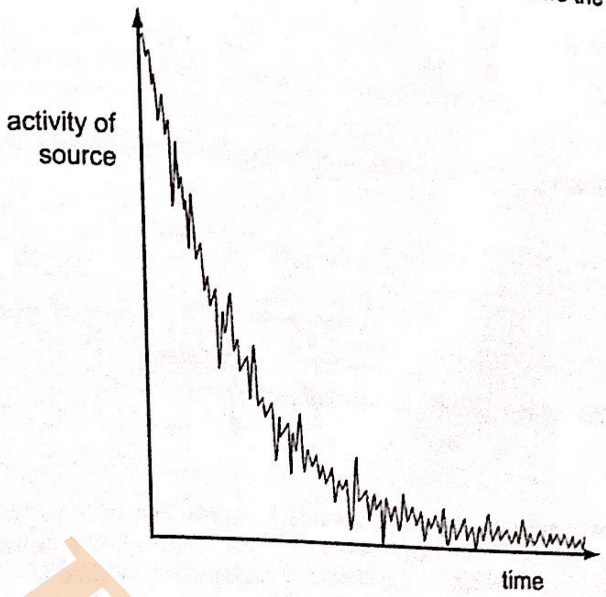
A 0.75 minutes **B** 1.0 minutes **C** 3.0 minutes **D** 9.0 minutes

66. O/N 09/P1/Q39
A radioactive isotope has a half-life of 6000 years.

How much time passes before the rate of emission from a sample of this isotope falls to $\frac{1}{16}$ of its original value?

A 6000 years **B** 18 000 years **C** 24 000 years **D** 96 000 years

O/N 09/P1/Q38
The activity of a radioactive source is measured over a period of time. The graph shows the decay curve.



Why is the curve not smooth?

A Background radiation has not been subtracted.
B Radioactive decay is a random process.
C The half-life is not constant.
D The temperature is changing.

8. M/J 09/P1/Q39
The count-rate from a radioactive source falls from 400 to 50 in 3.0 minutes.
What is the half-life?

A 0.75 minutes B 1.0 minutes C 2.7 minutes D 8.0 minutes

9. O/N 08/P1/Q38
What occurs in the decay of a radioactive nucleus?

A The nucleus absorbs another nucleus.
B The nucleus absorbs at least one form of radiation.
C The nucleus always splits into two equal fragments.
D The nucleus emits at least one form of radiation.

10. M/J 08/P1/Q39
In the treatment of brain cancer, a patient's head is enclosed in a helmet containing a number of radioactive sources. The radiation from each source is directed towards the cancer.
Which nuclide is the most suitable for these sources?

	nuclide	radiation	half-life
A	caesium-137	gamma	30 years
B	sodium-24	beta	15 hours
C	strontium-90	beta	29 years
D	californium-246	alpha	36 hours

11. O/N 07/P1/Q39
The half-life of a radioisotope is 2400 years. The activity of a sample is 720 counts / s.
How long will it take for the activity to fall to 90 counts/s?

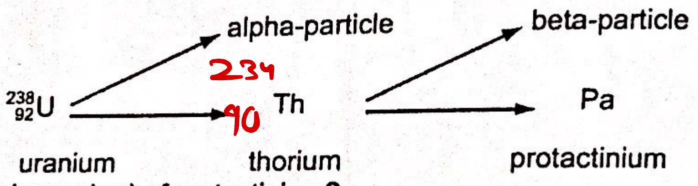
A 300 years B 2400 years C 7200 years D 19 200 years

72. O/N 06/P1/Q38
The half-life of a radioactive material is 24 years. The activity of a sample falls to a fraction of its initial value after 72 years.
What is the fraction?

A 1/3 B 1/4 C 1/6 D 1/8

73. O/N 06/P1/Q40

The uranium nucleus $^{238}_{92}U$ emits an alpha-particle to become thorium, which then emits a beta-particle to become protactinium.



What is the proton number (atomic number) of protactinium?

A 95 B 91 C 90 D 89

74. M/J 06/P1/Q39
A detector is used to measure the count-rate near a radioactive source. The reading is 4000 counts per minute. After 30 minutes the count-rate has fallen to 500 counts per minute.What is the half-life of the radioactive source? You may ignore the effects of background radiation.

A 3 minutes B 5 minutes C 6 minutes D 10 minutes

75. M/J 03/P1/Q38
A radioactive isotope has a half-life of 2 minutes.
What can be deduced from this statement?

A After $\frac{1}{2}$ minute, $\frac{1}{4}$ of the isotope remains.

B After 1 minute, $\frac{1}{4}$ of the isotope remains.

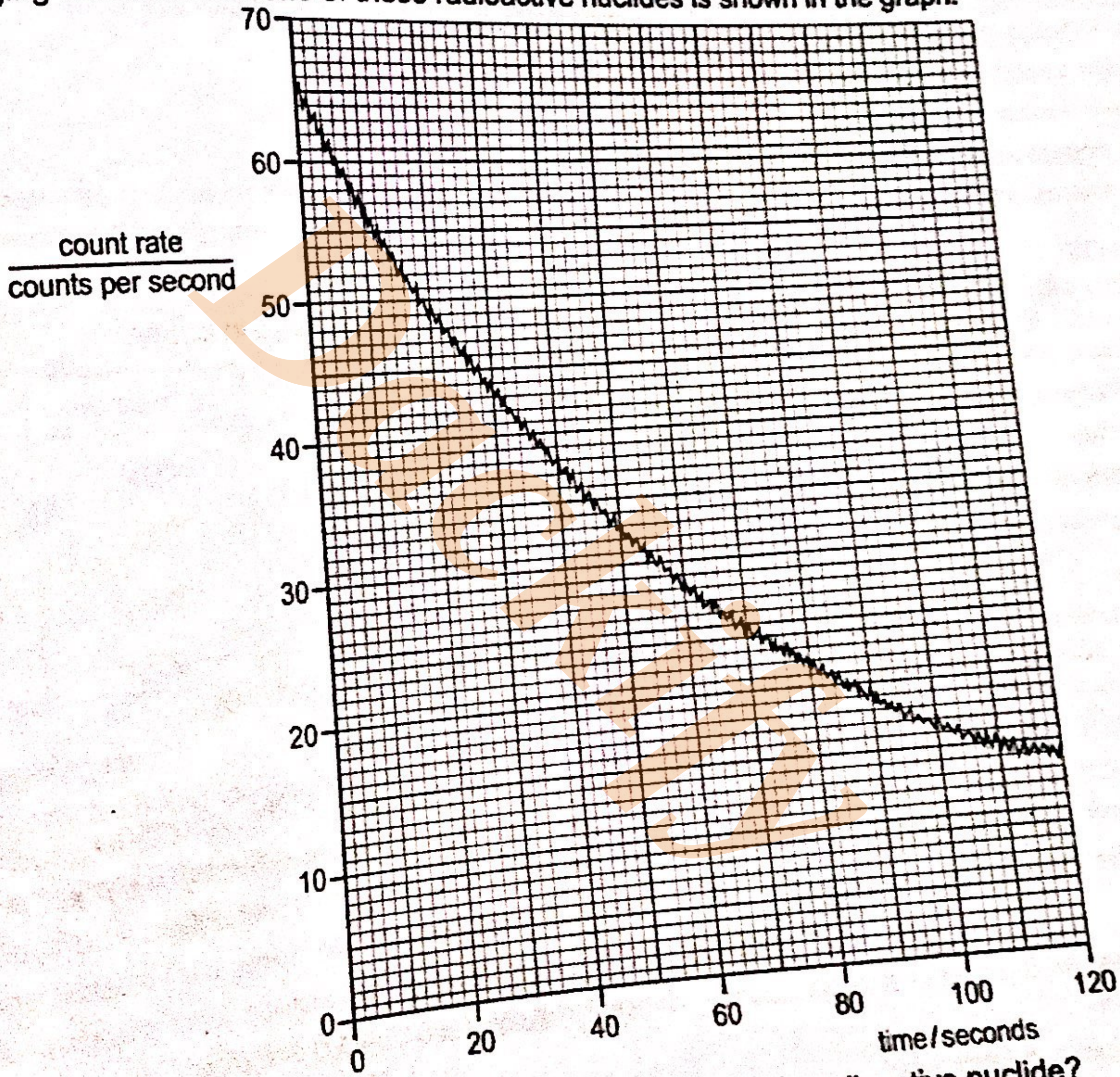
C After 4 minutes, $\frac{1}{4}$ of the isotope remains.

D After 4 minutes, none of the isotope remains.

76. M/J 02/P1/Q40
Which variation would produce a graph of the shape shown?

A count rate against time for radioactive decay
B current against potential difference for a metal obeying Ohm's law
C pressure against volume for a gas at constant temperature
D speed against time for a car moving at constant speed

77. **M/J 04/P1/Q40**
Ra decays with a half-life of 1600 s.
Rn decays with a half-life of 52 s.
Po decays with a half-life of 9.1 s.
Pb decays with a half-life of 10.6 h.
The changing count rate for one of these radioactive nuclides is shown in the graph.

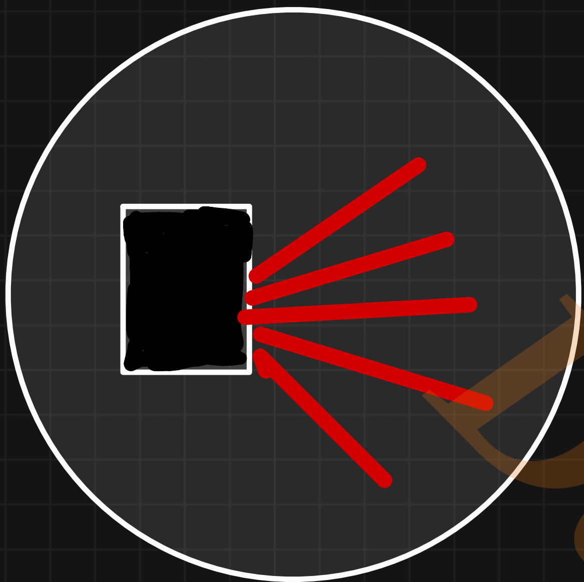


From the half-life shown by the graph, which was the decaying radioactive nuclide?

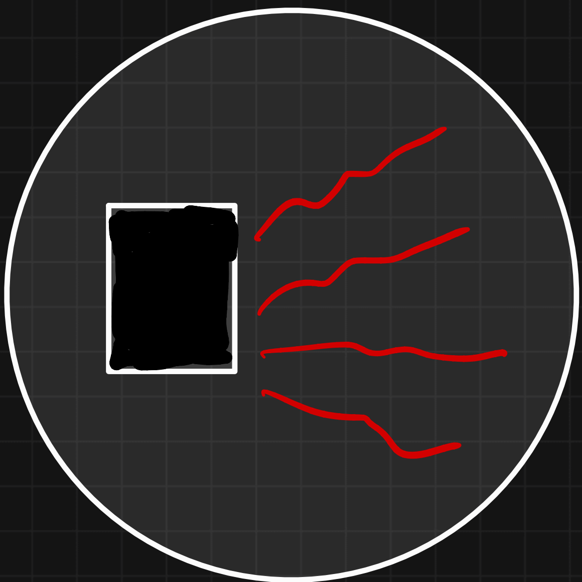
A Ra **B** Rn **C** Po **D** Pb

Patterns of Radioactive emissions in a diffusion cloud chamber

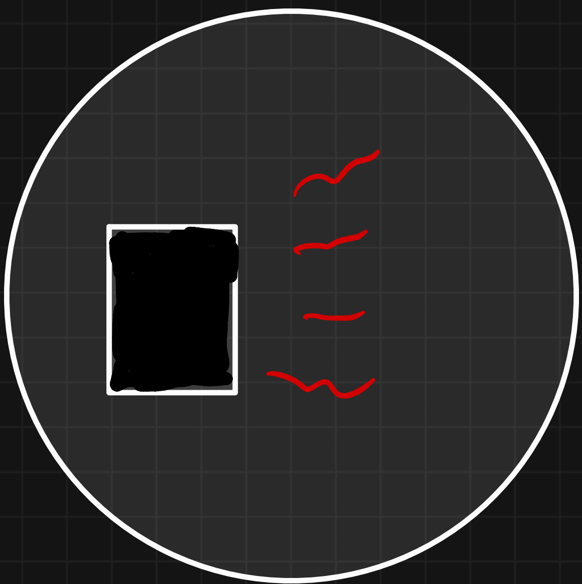
- Used to detect the types of emission recieved!
- Vapours condense on the ions and hence, resulting white lines of liquid drops formed



ALPHA PARTICLES



BETA PARTICLES



GAMMA RAYS

≈ How to Store Radioactive sources ≈

o) Stored in Lead chambers ? (why)
→ As Gamma radiations which are most penetrating can't go through Lead !

o) How should we carry radioactive substances?

→ wearing proper protective clothing which include

o) Long gloves, closed shoes , Full length lab coats !

Hazards of Radioactivity

1. Cancer
2. Tumor
3. DNA mutation
4. Leukemia
5. Blin

Uses of Radioactive Substances

1. **Medical Treatment :-**
   Gamma rays of Cobalt Isotope for Cancer treatment

2. **Crack detector :-** Space analysis for cracks, voids, etc
   value of count rate monitored

3. **Carbon dating :-** Use of C^{14} isotope
   Age of fossils estimated

4. **Sterilization :-** Cleaning of medical instruments using γ

5. **Tracers :-** Used in these circumstances :-
   1. determine flow of material
   2. Inserted in blood for vascular operation
   3. In Gas lines to detect any leaks!

Background Radiation

→ Radioactive radiations present in the atmosphere!

◦) Very less in quantity, so no effect

→ If GM tube is present where there is no radioactive substance, The ratemeter will still show some count rate which is because of Background Radiations

Q) What are the possible sources?

◦) Rocks

◦) Cosmic radiation

◦) Nuclear waste dumpsites

◦) Underground Nuclear reserves!

25.5 Uses of radioactive isotopes including safety precautions

78. M/J 15/P11/Q38

A factory continuously produces plastic sheets. A radioactive isotope and a detector are used to check the thickness of the sheets. What is the most suitable source to use?

A an alpha source with a half-life of a few minutes
B an alpha source with a half-life of several years
C a beta source with a half-life of a few minutes
D a beta source with a half-life of several years

79. O/N 14/P12/Q38

People working with radioactive materials use a photographic film badge covered in paper.
The badge is used to monitor the level of their exposure to radiation.
Which radiation is detected?

A alpha-particles only
B beta-particles only
C gamma-rays and beta-particles
D gamma-rays only

80. M/J 13/P11/Q39

A school keeps radioactive sources for use in radioactivity experiments in a laboratory.
The background radiation is measured at the start of an experiment.
Which statement is correct?

A The background radiation is caused by the school?'s radioactive sources in the laboratory.
B The background radiation is present when there are no radioactive sources in the laboratory.
C The background radiation is radiation that is not detected in radioactivity experiments.
D The background radiation is the same in laboratories in different countries.

81. M/J 12/P12/Q39

What is the safest way to dispose of a large quantity of highly radioactive waste?

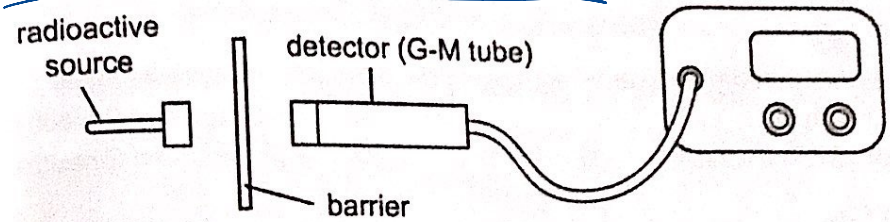
A burning it on a fire
B burying it in dry rock underground
C pouring it down the drain
D pumping it into a river

82. M/J 12/P11/Q39, O/N 04/P1/Q38

When dealing with radioactive materials there are possible dangers.
Which statement is correct?

A Beta-particles can pass through skin and damage body cells.
B Materials that emit only alpha-particles must be kept in thick lead containers.
C Radioactive materials are safe to handle after two half-lives.
D Sources of gamma radiation are dangerous because they have long half-lives.

O/N 05/P1/Q37
The diagram shows the apparatus used in an experiment in which barriers of various materials are placed in turn between different radioactive sources and a detector.



The table shows the count rates recorded by the detector for four sources.
Which source emits alpha-particles only?

source	count rate / counts per minute			
	no barrier	paper	thin aluminium	thick lead
A	200	200	200	30
B	200	30	30	30
C	1200	600	200	30
D	1200	1200	30	30

M/J 02/P1/Q37
A company built five identical houses in different parts of the same country. When a radioactivity count was carried out ir each house, one of them had a much higher reading than the others.
What is most likely to cause this higher reading?

A the Sun's radioactivity
B the time of year when the reading was taken
C a nuclear power station ten miles away from the house
D background radiation from rocks under the house

Nuclear Reactions

Fission Reaction

A nuclear reaction in which a large unstable nucleus breaks down into smaller and more stable nuclei

- This releases energy
- A neutron is needed to initiate Fission reaction

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{140}_{56}Ba + ^{93}_{36}Kr + 3\,^{1}_{0}n$$

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{144}_{54}Xe + ^{90}_{38}Sr + \alpha\,^{1}_{0}n$$

α ↓ ?

$$235+1 = 144+90+\alpha(1)$$

$$236 = 234+\alpha(1)$$

$$\alpha = 2$$

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{y}_{55}Ba + ^{90}_{x}Rb + 2\,^{1}_{0}n$$

(y → ?, x → ?)

$$235+1 = y+90+2$$

$$236 = 92+y \qquad y = 144$$

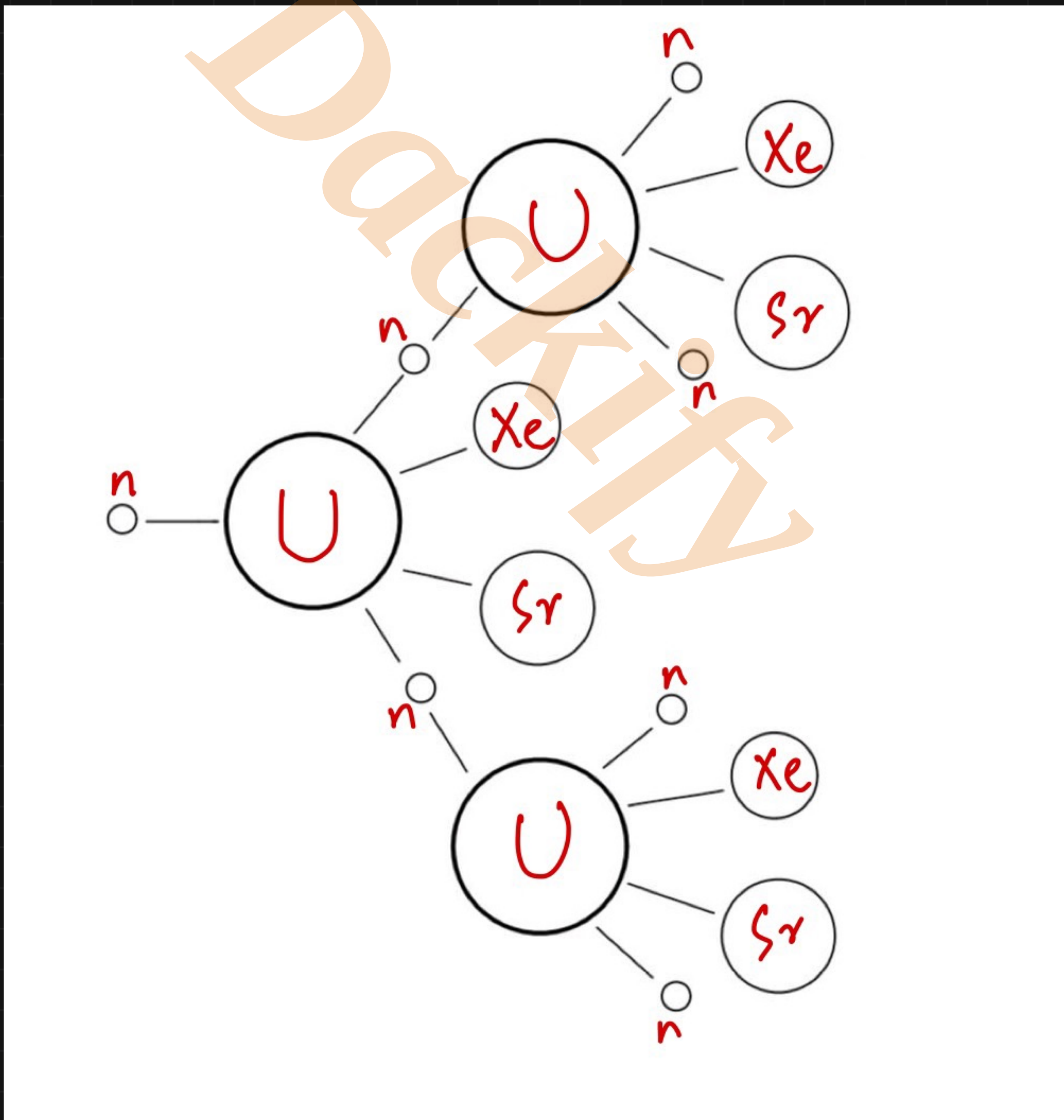
$$92+0 = 55+x+0$$

$$x = 37$$

2 Fission Reaction 2

Q) Why is insertion of nuetron prefered?

- Nuetron is nuetral, hence no repulsion force
- Nuetron is several times heavier as its a large particle → Greater instability

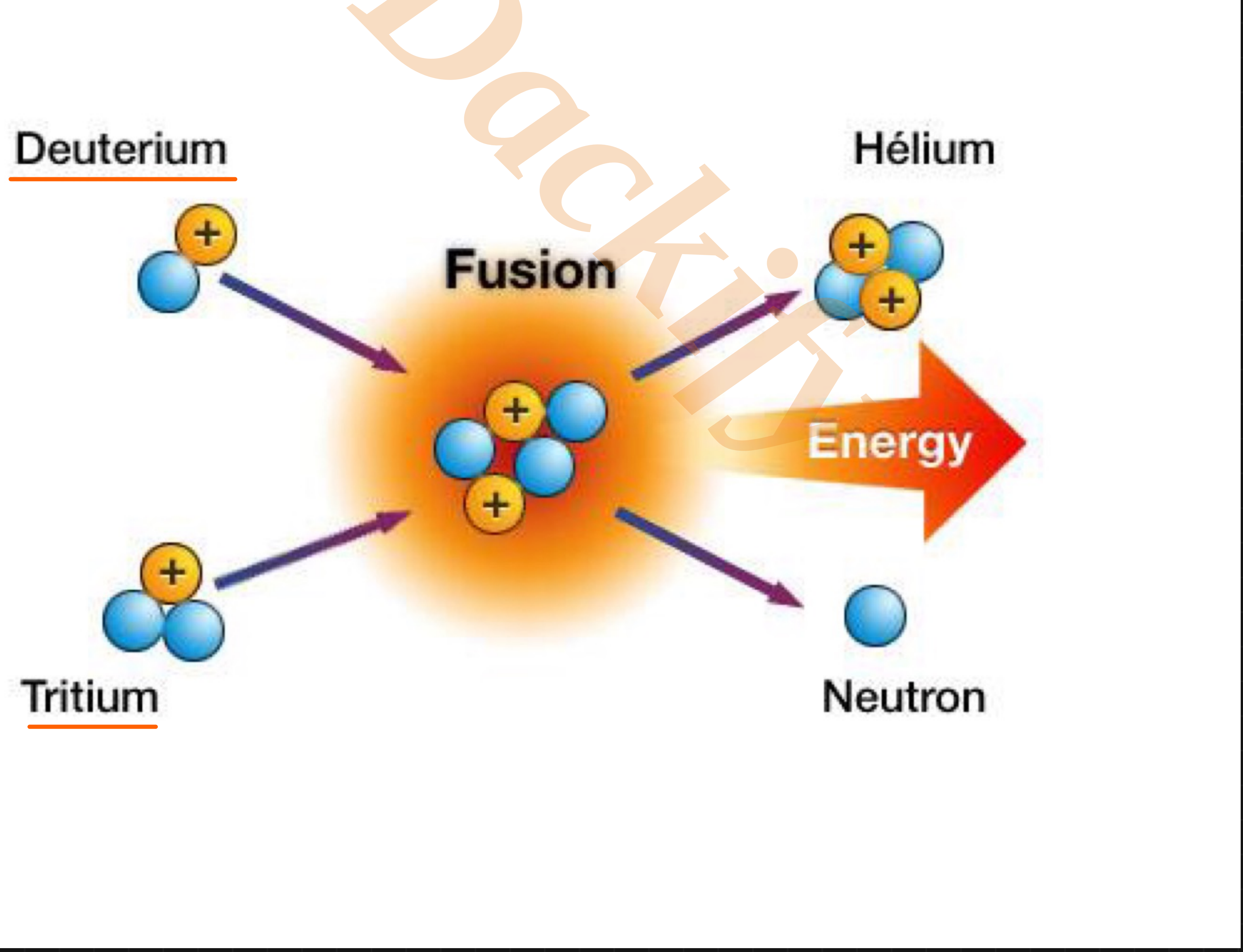


Nuclear Reactions

Fusion Reactions

A nuclear reaction in which two smaller nuclei combine to form :-

- A larger and much more stable nucleus
- This releases a large amount of energy



STAR FORMATION

space is Known as the region of no gravity of a planet or a star, hydrogen particles form small clouds with dust particles in space to such dusters attract each other to form a bigger hydrogen / dust cloud. The size gradually increases until it converts into a huge ball.

The particles in the ball of gas remain in the state of collisions, their kinetic energy gradually converts into heat, the temperature exceede the minimum energy required for Fusion!

The critical temperature, The rate of energy released increases significantly.

With the start of fusion and the ball of gas converts into a Star!

So, what is its man Source of energy?

The Nuclear fusion, The star has an estimated age, in that time it continues to release energy

---

Large Cloud of Gas → collapses

Temp inc, The Cloud of Gas triesto expand

Gravitational force > repulsive force, so

Collapsing continues until Critical Temperature

i.e:- Initiating Fusion reaction

A Star is Born!

25.3 Nuclear reactions

29. O/N 16/P12/Q40

A nucleus of uranium $^{238}_{92}U$ decays to thorium by emitting an alpha-particle.

What is the resulting thorium nucleus?

A $^{234}_{90}Th$ **B** $^{236}_{90}Th$ **C** $^{238}_{90}Th$ **D** $^{239}_{90}Th$

30. M/J 16/P12/Q8, M/J 16/P11/Q13, M/J 09/P1/Q12

Which process in the Sun produces energy?

A burning **B** nuclear fission **C** nuclear fusion **D** radiation

31. M/J 16/P12/Q37

Which nucleus is produced when americium-241 ($^{241}_{95}Am$) emits an alpha-particle?

A $^{237}_{93}Np$ **B** $^{237}_{97}Bk$ **C** $^{245}_{93}Np$ **D** $^{245}_{97}Bk$

32. M/J 15/P12/Q39, M/J 15/P11/Q37

A radioactive material decays by this process:

$$^{Y}_{Z}L \rightarrow {}^{Y}_{Z+1}M + x$$

What is particle x?

A an electron **B** a helium nucleus **C** a neutron **D** a proton

33. O/N 15/P11/Q40

Which row states where nuclear fusion occurs and what nuclear fusion is?

	nuclear fusion occurs in	nuclear fusion is
A	a power station	the joining of small nuclei
B	a power station	the splitting of large nuclei
C	a star	the joining of small nuclei
D	a star	the splitting of large nuclei

34. O/N 14/P11/Q38

The energy emitted by the Sun is released when the nuclei of an element fuse together.
Which nuclei, when fusing together, release most of the energy in the Sun?

A carbon **B** helium **C** hydrogen **D** uranium

35. O/N 13/P12/Q37, O/N 13/P11/Q39

Which row is correct for nuclear fission and for nuclear fusion?

	fission	fusion
A	produces larger nuclei	is the energy source of a star
B	produces larger nuclei	releases energy in a power station
C	produces smaller nuclei	is the energy source of a star
D	produces smaller nuclei	releases energy in a power station

36. M/J 11/P12/Q11, M/J 11/P11/Q13

The centre of the Sun produces large amounts of energy. What is the source of this energy?

A chemical reaction **B** nuclear fission **C** nuclear fusion **D** radioactive decay

37. **M/J 13/P11/Q10**
Energy is released in some power stations and in the Sun by either nuclear fission or nuclear fusion.
Which type of nuclear reaction applies in each case?

	power station	Sun
A	fission	fission
B	fission	fusion
C	fusion	fission
D	fusion	fusion

38. **O/N 12/P11/Q39**
In nuclear ...... 1 ......, hydrogen nuclei ...... 2 ...... to form helium nuclei, releasing energy.
Which words correctly complete gaps 1 and 2?

	1	2
A	fission	join together
B	fission	split apart
C	fusion	join together
D	fusion	split apart

39. **M/J 11/P12/Q38, M/J 11/P11/Q39**
A radioactive nuclide $^{238}_{92}U$ decays into thorium by emitting an alpha-particle.
The thorium then decays into protactinium by emitting a beta-particle.
What is the symbol for protactinium?

A $^{230}_{90}Pa$ **B** $^{234}_{89}Pa$ **C** $^{234}_{90}Pa$ **D** $^{234}_{91}Pa$

40. **M/J 10/P12/Q37, M/J 10/P11/Q38**
Which row is correct for fission and for fusion?

	fission of a nucleus	fusion
A	produces larger nuclei	is the energy source of a star
B	produces larger nuclei	is used to release energy in a power station
C	produces smaller nuclei	is the energy source of a star
D	produces smaller nuclei	is used to release energy in a power station

41. **M/J 10/P12/Q38, M/J 10/P11/Q37**
In one radioactive decay, radium (Ra) gives rise to radon (Rn) as shown.

$$^{226}_{88}Ra \rightarrow \, ^{222}_{86}Rn$$

What particle is also produced?

A an alpha-particle
B a beta-particle
C both an alpha-particle and a beta-particle
D no particle but only gamma-rays

42. **O/N 08/P1/Q11**
Where is energy released by the fusion of hydrogen atoms to form helium?

A in a nuclear power station
B in a radioactive isotope
C in the core of the Earth
D in the core of the Sun

Nuclear Fusion

Unit 26: Radioactivity

Section A

1. **O/N 17/P21/Q8**
A sample of the radioactive isotope radon-222 decays by the emission of alpha-particles.
(a) As alpha-particles travel through air, the air is ionised.
(i) Describe the composition of an alpha-particle.

It is 2 protons and 2 nuetrons joined toghether

[1]

(ii) Explain how an alpha-particle ionises air.

As it is positively charged, it remove electron from its shell and absorbs it

[2]

(iii) State how the relative ionising effect of alpha-particles compares with that of
1. beta-particles,

Stronger

2. gamma rays.

Stronger

[1]

(b) The half-life of radon-222 is 3.3×10^5 s.
The number of radon-222 atoms in the sample is 4.8×10^4.
(i) Determine the time that it takes for the number of radon-222 atoms in this sample to decrease to 1.5×10^3.

$\frac{4.8 \times 10^4}{2} \rightarrow \frac{2.4 \times 10^4}{2} \rightarrow 1.5 \times 10^3$

time = ... [3]

(ii) Suggest one reason why, in practice, the time for the number of radon-222 atoms to decrease to 1.5×10^3 may differ slightly from the value obtained in **(b)(i)**.

[1]

M/J 17/P21/Q8

A doctor has the choice of two isotopes, $^{131}_{53}I$ and $^{125}_{53}I$, to inject into a patient.

These isotopes emit radiation from deep inside the body. The radiation is detected outside the body and provides information to help the doctor find out what is wrong with the patient.

The isotope $^{131}_{53}I$ decays into a stable isotope of xenon by emitting a beta-particle (β) and a gamma ray (γ).

(a) State what is meant by a *gamma ray*.

It is a high frequency electromagnetive ray ....[1]

(b) Complete the equation to show the radioactive decay of $^{131}_{53}I$.

$$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}\beta + \gamma$$ [2]

(c) When a nucleus of $^{125}_{53}I$ decays, only a gamma ray is emitted.

Suggest why it is better for the doctor to inject the isotope $^{125}_{53}I$ into the patient.

As Gamma rays cannot be stopped by the body, hence there is less chance of cell damage and other harms! ....[2]

M/J 16/P22/Q7

An uncharged piece of metal P rests on an insulator. A positively charged rod is placed close to P, as shown in Fig. 7.1.

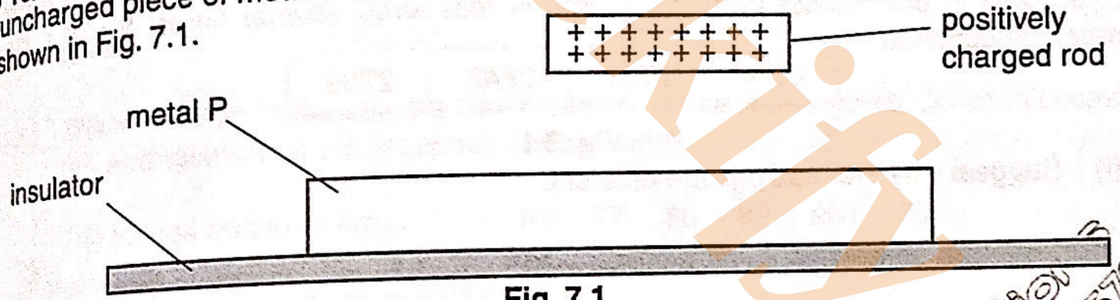


Fig. 7.1

(a) State a material that is an electrical insulator.

Perspex ....[1]

(b) On Fig. 7.1, draw the distribution of charges on P. [2]

(c) P is then connected to earth by a wire, as shown in Fig. 7.2.

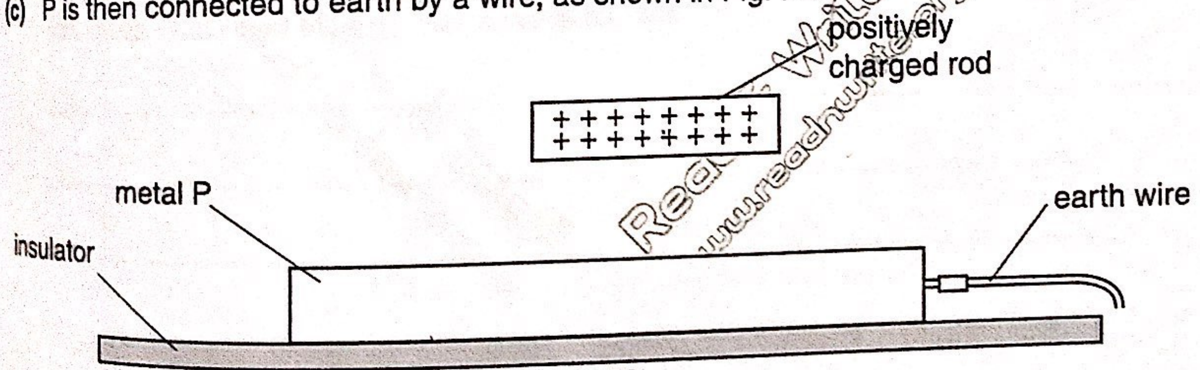


Fig. 7.2

(i) On Fig. 7.2, show the distribution of charges on P with the earth wire connected. [1]

(ii) State what happens to the charges on P if the positively charged rod is removed

1. with the earth wire still connected to P,

Electricity!

....[1]

2. after the earth wire is disconnected from P.

....

....[1]

4. **M/J 14/P21/Q8**

A hospital laboratory uses a small sample of a radioactive isotope of iodine, $^{131}_{53}I$.

(a) (i) Describe the structure of the nucleus of an atom of this isotope.

It has 53 protons and 78 nuetrons

....[2]

(ii) The sample is radioactive. Describe what happens in radioactive decay.

Emission of radioactive radiation, from Nucleus for the Stability of Nucleus

....[2]

(b) The count in one minute from the source is measured several times. Fig. 8.1 shows the readings obtained.

2686	2759	2847	2799

Fig. 8.1

(i) Suggest why the readings are different.

Random emmission!

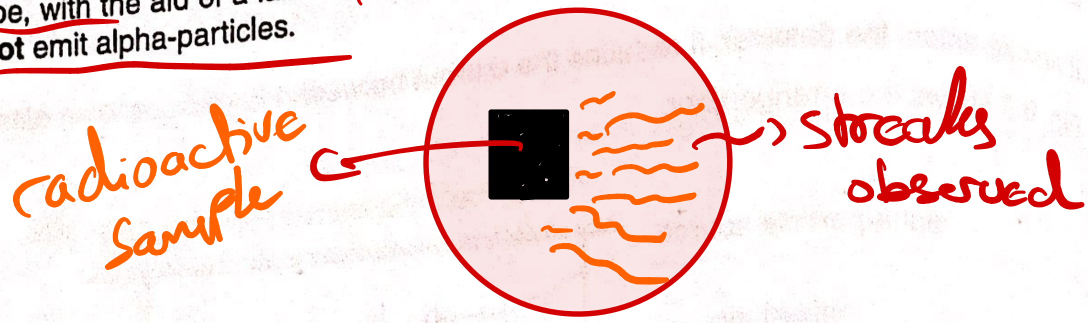
....[1]

(ii) The half-life of $^{131}_{53}I$ is 8.0 days. Estimate the count in one minute obtained from the sample after 24 days.

6. **O/N 13/P21/Q8**

A radioactive sample emits only beta-particles and gamma-rays.

(a) Describe, with the aid of a labelled diagram, an experiment that shows that the sample does **not** emit alpha-particles.



Here is a Cloud chamber, we put a radioactive sample in it, As it shows no straight tracks, we can say it does not emit Alpha particle
[3]

(b) State two safety precautions that must be taken when working with the radioactive sample.

1. Wear lead clothing

2. wear film badge [2]

7. **O/N 12/P22/Q7**

A small piece of metal taken from a nuclear reactor is radioactive.

(a) Describe a method to determine whether the piece of metal emits gamma-rays.

Cloud chamber → track, not straight
[3]

(b) State two safety precautions that must be taken when handling the piece of metal.

1. reduced time

2. wear film badge [2]

O/N 11/P21/Q8

(a) One radioactive isotope of iodine is $^{131}_{53}I$. As a nucleus of this isotope decays, it emits a beta-particle (symbol: β) and it becomes a nucleus of an isotope of xenon (symbol: Xe).

Complete the equation in nuclide form, for this decay.

$$^{131}_{53}I \rightarrow ^{131}_{54}Xe + ^{0}_{-1}\beta$$

[2]

(b) A sample of a radioactive isotope emits both beta-particles and gamma-rays.

Fig. 8.1 shows these two types of radiation entering a magnetic field.

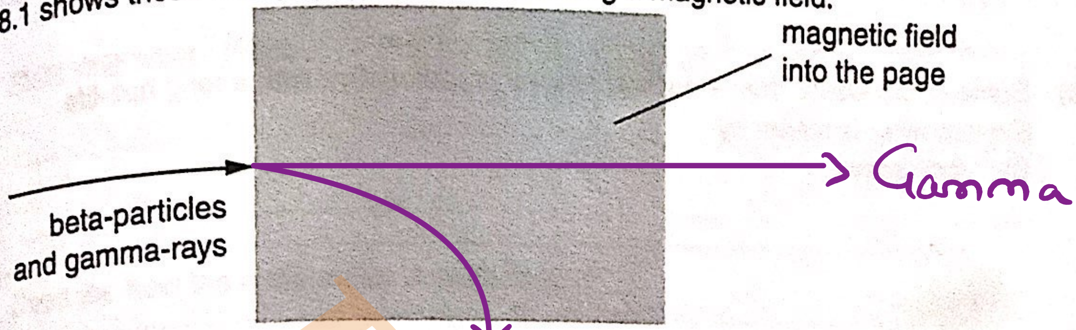


Fig. 8.1

The direction of the magnetic field is into the page.

On Fig. 8.1, mark **and** label the path taken by

(i) the beta-particles, [1]

(ii) the gamma-rays. [1]

(c) Emission from a radioactive source is a random process.

State two ways in which the process is random.

1. The period b/w emissions is unpredictable

2. .... [2]

M/J 11/P22/Q8

Fig. 8.1 illustrates the process that occurs in the core of a nuclear reactor.

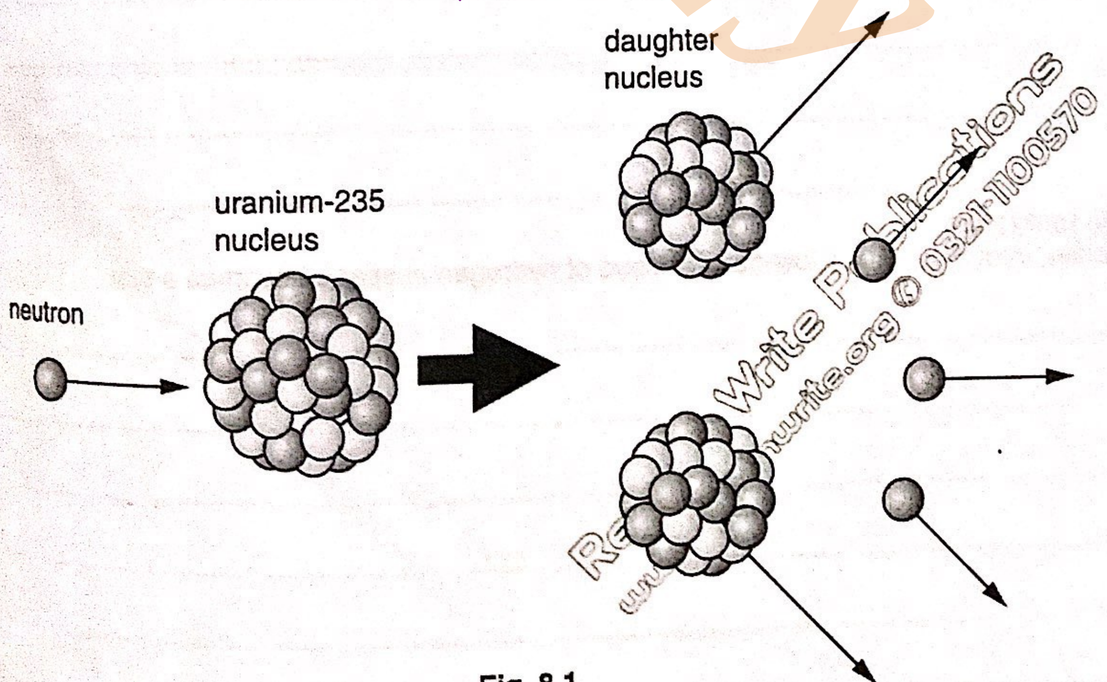


Fig. 8.1

(a) State the name of the process illustrated in Fig. 8.1.

Fission .... [1]

(b) Describe what happens during this process.

The large unstable Uranium nucleus breaks into smaller stable daughter nucleus and also emits energy .... [2]

(c) Some of the waste from a nuclear reactor is radioactive with a long half-life.
Explain what is meant by

(i) *radioactive*,

Radioactive is something which emits particles in a random & spontaneous way .... [1]

(ii) a *long half-life*.

It takes a long time to decay and half its countrate, etc. .... [2]

10. O/N 10/P22/Q7

(a) Explain what is meant by *background radiation*.

It's a negligible amount of radiation always present in the atmosphere. It can be in the form of Cosmic radiations or Rocks! .... [2]

(b) Describe how one human activity has led to an increase in background radiation.

Nuclear power leads to disposal of Nuclear waste .... [2]

11. O/N 10/P22/Q8

Explain, in outline, how a low-density cloud of hydrogen in space becomes a star.

....

....

....

....

....

....

...J 10/P22/Q8

...adioactive rock emits gamma-rays. A teacher plans an experiment to show a class that ...emission of gamma-rays from the rock is random in time.

...) (i) State the apparatus that the teacher needs to detect the gamma-rays.

Geiger Muller tube

[1]

(ii) State one safety precaution that the teacher must take.

Wear a lead suit

[1]

(iii) Describe how the experiment is performed.

[2]

...) Describe what is meant by a *gamma-ray*.

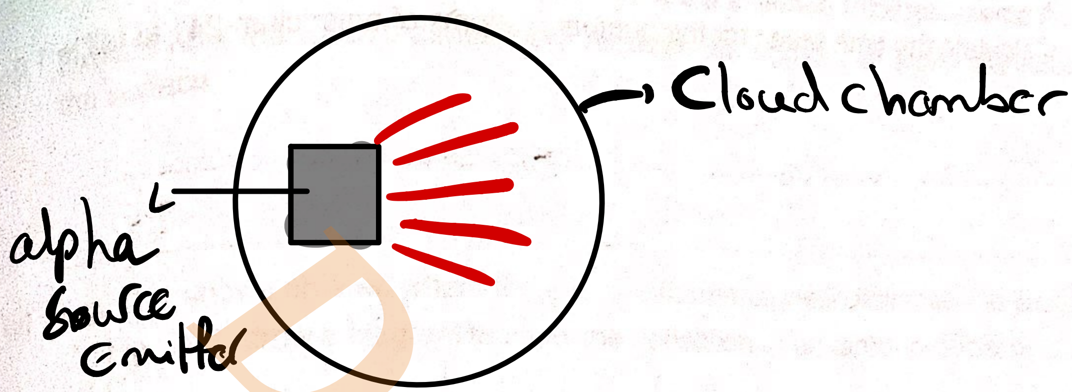
Gamma ray is a high frequency electromagnetic radiation

[2]

Section B

1. M/J 18/P22/Q11
A smoke detector contains a small radioactive source of americium-241. The source emits alpha-particles.

(a) (i) In the space below, draw a diagram of an apparatus that can be used to show that the source emits alpha-particles.



[2]

(ii) Describe how this apparatus is used.

....

....

....

.... [2]

(iii) Explain how the results of the test show that the source emits alpha-particles.

....

....

....

.... [2]

(b) The smoke detector works because alpha-particles from the source ionise the air.

Compare the relative ionising effects and penetrating powers of alpha-particles, beta-particles and gamma rays.

ionising effects ....

....

penetration effects ....

.... [2]

(c) Americium-241 has a half-life of 430 years.
Radium-224 is another element that emits alpha-particles. It has a half-life of 3.6 days.

(i) Explain why americium-241 is more suitable as the radioactive source in a smoke detector than radium-224.

As the detector will work for longer and not need replacing

....[1]

(ii) A smoke detector contains 8.0×10^{11} atoms of americium-241.
Calculate the time taken for the number of atoms of americium-241 to fall to 1.0×10^{11}

$$\frac{8.0\times10^{11}}{2} = \frac{4\times10^{11}}{2} = \frac{2\times10^{11}}{2} = 1.0\times10^{11}$$

1 2 3

430 × 3 = 1290

time = 1290 years [3]

(d) When used correctly, the radioactive source in the smoke detector is less harmful than background radiation.

(i) State one harmful effect of background radiation.

It can cause Cancer [1]

(ii) A radioactive source is picked up using a long-handled tool. Explain why this is safer than using a short-handled tool.

As the source will be more distant from the body, and as the particles emitting will be stopped in the air

....[2]

M/J 17/P22/Q11

One source of background radiation is cosmic rays.

The cosmic rays that enter the Earth's atmosphere are known ... Most of

(i) Describe how a nucleus of carbon ...

....

....

....[2]

(ii) Describe one similarity in the structure of the nuclei of these isotopes.

....

....

....[1]

3. M/J 16/P22/Q11

Fig. 11.1 represents a nuclear fusion reaction.

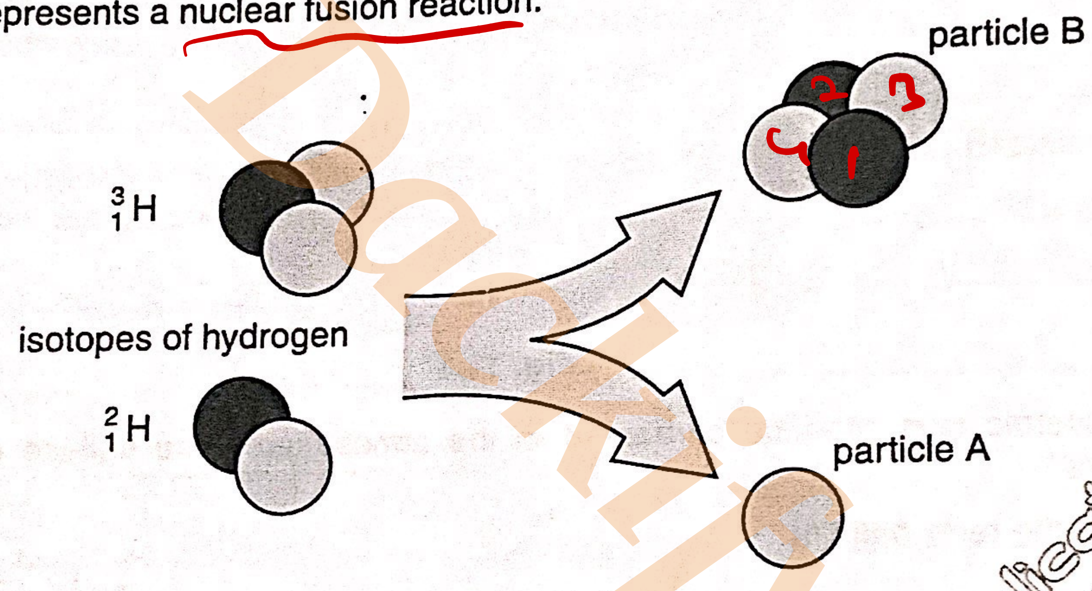


Fig. 11.1

At very high temperatures, nuclei of the two isotopes ^2_1H and ^3_1H fuse together. Energy is produced and two new particles are formed, particle A and particle B.

(a) Explain what is meant by *isotopes* of hydrogen.

Nucleus of Hydrogen with same no of protons, different no of neutrons.

....[2]

(b) Using Fig. 11.1, state

(i) the number of neutrons in a nucleus of the isotope ^3_1H, ...2....

(ii) the name of particle A, ...nuetron....

(iii) the proton number of particle B, ...2....

(iv) the nucleon number (mass number) of particle B. ....4....

[4]

(c) A very high temperature is needed to force nuclei together.
Explain why.

As like charges repel, we need large amount of kinetic energy to overcome repulsion
.....[2]

(d) A star forms from a large cloud of gas and dust in space.
Describe what happens as the star forms.

....

....

....

....

..........[3]

(e) The isotope of hydrogen ^3_1H has a half-life of 12 years.

(i) State what is meant by *half-life*.

Half life is the time for the radioactive emissions to half!
.....[2]

(ii) A sample contains 16 000 atoms of ^3_1H.

Calculate the number of atoms of ^3_1H present in the sample after 48 years.

$\frac{48}{12} = 4$

$\frac{16000}{2} = \frac{8000}{2} = \frac{4000}{2} = \frac{2000}{2} = 1000$

4. O/N 16/P21/Q8

Sodium-24 and sodium-23 are two of the isotopes of sodium. Sodium-24 is a radioactive isotope that emits beta-particles and gamma-rays as it decays.

(a) The nuclide notation for the isotope sodium-24 is $^{24}_{11}$Na.

(i) Describe the composition and structure of a neutral atom of sodium-24.

A sodium atom consist of 11 electrons 11 protons and 13 nuetrons! The electrons orbit in the shells, while the protons and nuetrons make the nucleus ....[3]

(ii) State how the composition of a nucleus of sodium-24 differs from the composition of a nucleus of sodium-23.

The only difference is in the number of nuetrons. Sodium-24 has one more nuetron ....[1]

(b) A nucleus of sodium-24 decays. It emits a beta-particle and produces a nucleus of an isotope of magnesium (Mg).

(i) State the name of the particle that is identical to a beta-particle.

Electron ....[1]

(ii) Complete the nuclide equation for the emission of a beta-particle (β) by sodium-24.

$$^{24}_{11}\text{Na} \rightarrow {}^{0}_{-1}\beta + {}^{24}_{12}\text{Mg}$$

[3]

(c) When it decays, sodium-24 also emits gamma-rays.
State what gamma-rays are.

Gamma rays are high frequency electro-magnetic radiations ....[2]

(d) Fig. 8.1 shows a beam of beta-particles and a beam of gamma-rays entering the electric field between two oppositely charged plates.

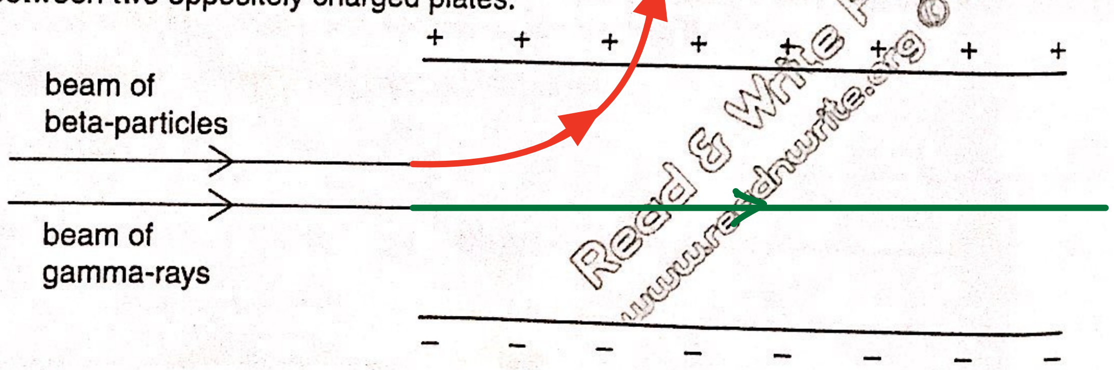


Fig. 8.1 (not to scale)

O/N 15/P21/Q11

11 Fig. 11.1 shows the proton number and the nucleon number of the nuclei of five neutral atoms.

	neutral atom 1	neutral atom 2	neutral atom 3	neutral atom 4	neutral atom 5
proton number	16	17	18	18	19
nucleon number	35	35	38	40	39
	21	18	20	22	20

Fig. 11.1

(a) State the two atoms in Fig. 11.1 that

(i) are different isotopes of the same element,

3, 4 .... [1]

(ii) contain the same number of neutrons,

3, 5 .... [1]

(iii) contain the same number of electrons.

3, 4 .... [1]

(b) The nucleus of atom 1 is radioactive and when it decays, it emits a beta-particle.

State, for the nucleus produced by this decay

(i) the proton number,

$^{35}_{16}X$

proton number = ...17...... [1]

(ii) the nucleon number.

nucleon number = ...35...... [1]

(c) A sample contains a large number of radioactive nuclei that emit beta-particles. The sample is placed near to a radiation detector in a laboratory and the count rate is recorded over a long period of time.

Fig. 11.2 shows the count rate recorded by the detector during this period.

1. M/J 13/P21/Q11

(a) The nucleus of an atom of carbon-14 is represented as $^{14}_{6}C$.

(i) Describe the structure of an atom of carbon-14.

It consists of six electrons, six protons, & eight nuetrons. The six electrons orbit in shells outside nucleus and the protons & nuetrons are inside Nucleus

[3]

(ii) Carbon has several isotopes.
Describe, in terms of the particles within the nucleus, how isotopes are

1. different from one another,

They have different nuetron number [1]

2. the same as one another.

Same number of protons [1]

(b) Carbon-14 decays by beta emission to a stable isotope of nitrogen.
Carbon-14 has a half-life of 5700 years and is used to find the age of objects by carbon dating.

(i) A pure sample of carbon-14 initially contains 8.0×10^{20} atoms.
Calculate the number of atoms of carbon and of nitrogen present in the sample after 11 400 years.

$\frac{11400}{5700} = 2$

$\frac{8.0\times10^{20}}{2} = \frac{4\times10^{20}}{2} = \frac{2.0\times10^{20}}{2}$

number of atoms of carbon = 2×10^{20}

number of atoms of nitrogen = 6×10^{20} [3]

(ii) Explain why carbon-14 is not used to find the age of a piece of coal that has been in the ground for millions of years.

many half lives have taken place

.... [1]

(c) A teacher sets up the apparatus shown in Fig. 11.1.

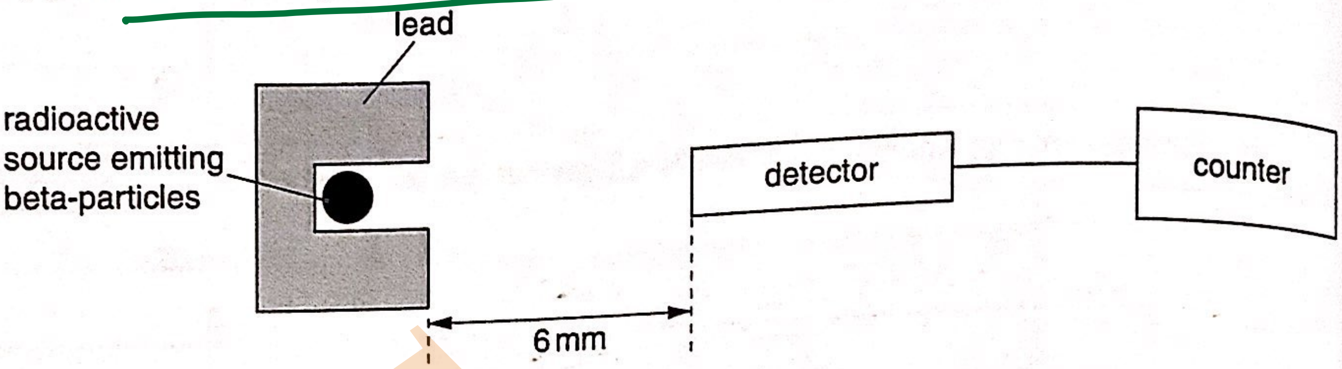


Fig. 11.1

The teacher also has available a number of sheets of aluminium, each of which is 1 mm thick.

(i) Describe how the apparatus and the sheets are used to demonstrate that beta-particles are stopped by 5 mm of aluminium.

In your account, make clear how the background count is measured and used.

....

....

....

....

....

.... [4]

(ii) Suggest why the lead in Fig. 11.1 is placed around the radioactive source during the demonstration.

....

.... [1]

(iii) The radioactive source in Fig. 11.1 is changed for one that emits gamma-rays.

Describe why the apparatus cannot be used to find the thickness of aluminium needed to stop gamma-rays.

....

.... [1]

M/J 12/P22/Q10

To find out whether a radioactive source emits alpha-particles, beta-particles or gamma-rays, the source is placed in front of a radiation detector, as shown in Fig. 10.1.

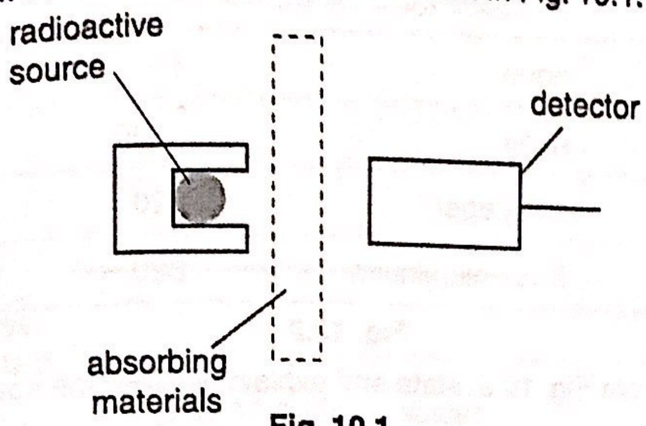


Fig. 10.1

Different absorbing materials are placed between the source and the detector. The detector measures the number of counts per minute.

(a) State what is meant by

(i) an alpha-particle,

An Alpha particle is like a helium nucleus it consists of 2 nuetrons & 2 protons ....[2]

(ii) a gamma-ray.

It is a high frequency electromagnetic radiation! ....[2]

(b) (i) Suggest why, in this experiment,

1. the distance between the source and the detector is only a few centimetres,

As alpha particle can be stopped by penetrating only a few cm in the air ....[2]

2. the half-life of the radioactive source is longer than a few minutes.

....

..........[1]

(ii) State one precaution taken when using a radioactive source.

....

Wear a film badge and ....[1]

KEEP DISTANCE!

(c) Fig. 10.2 shows the results obtained.

source present	material between source and detector	counts per minute
no	none	10
yes	none	1200
yes	thin paper	820
yes	5 mm aluminium	820

Fig. 10.2

Using information from Fig. 10.2, state and explain whether the source emits

(i) alpha-particles,

Yes as the count decreases after it passes through thin paper [1]

(ii) beta-particles,

No as the count should have decreased as Beta particles cannot penetrate 5mm Aluminium [2]

(iii) gamma-rays.

Yes, as the count rate is same even after passing 5mm aluminium. [1]

(d) There is a count recorded even when no source is present. This is caused by background radiation.

State two sources of background radiation.

1. Cosmic radiation

2. Rocks

[2]

(e) Describe one effect on the human body of a very high level of radiation.

It can cause gene mutation [1]

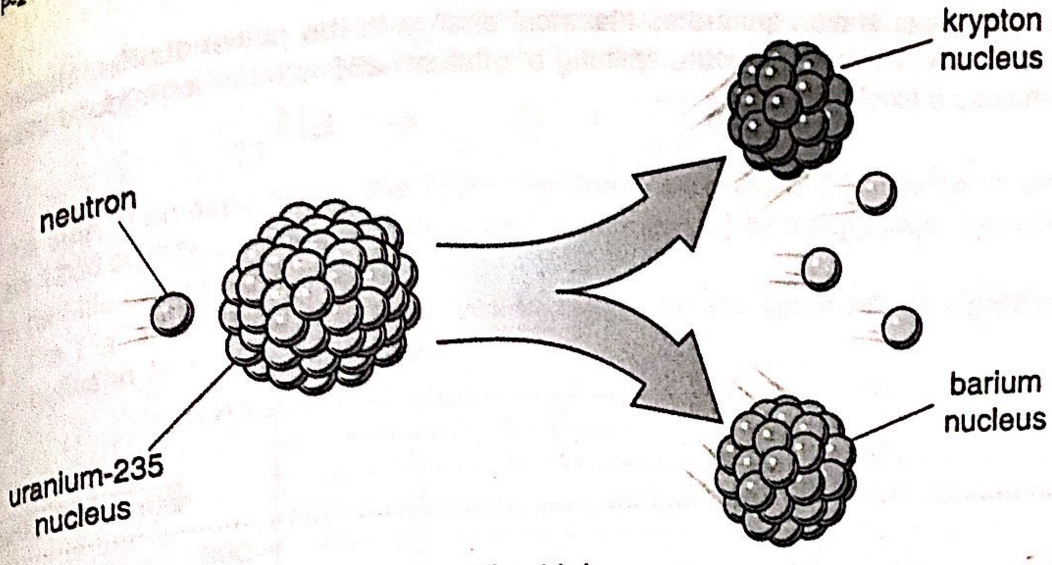


Fig. 11.1

The uranium-235 nucleus splits into a nucleus of barium (Ba) and a nucleus of krypton (Kr) and three neutrons are released.

(a) State the name of this process.

Fission ....[1]

(b) This process may be represented by a nuclear equation. An incomplete version of this equation is shown below.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow {}_{56}Ba + {}^{92}Kr + 3\,^{1}_{0}n$$

92 − 56 = 36   235 − 92 = 143

(i) Calculate

1. the number of neutrons in a nucleus of uranium-235,

number of neutrons = 143 ....[1]

2. the proton number (atomic number) of krypton,

proton number = 36 ....[1]

3. the nucleon number (mass number) of the barium nucleus.

nucleon number = 141 ....[1]

(ii) During this process, there is a decrease in mass. Energy is released. The decrease in mass is 3.1×10^{-28} kg and the speed of light is 3.0×10^{8} m/s.

Calculate the energy released in this process.

energy = ...[3]

(d) Some of the waste products from a nuclear power station are radioactive and have very long half-lives.

(i) State the meaning of *half-life*.

It is the time for the radioactive emmissions to halve!

.....[2]

(ii) Describe one safety precaution that is taken when radioactive waste products are handled.

Wear protective cloathing:- Lead suits, Film badge!

.....[1]

12. O/N 10/P21/Q10

An atom of phosphorus (chemical symbol P) is composed of 15 electrons, 17 neutrons and 15 protons.

(a) For this atom, state

(i) the proton number (atomic number), 15 [1]

(ii) the nucleon number (mass number). 32 [1]

(b) This phosphorus atom is radioactive. As it decays to an atom of sulfur (chemical symbol S), it emits a beta-particle (symbol β).

(i) Write a nuclear equation for this decay.

$$^{32}_{15}P + ^{0}_{-1}\beta \longrightarrow ^{32}_{16}S$$

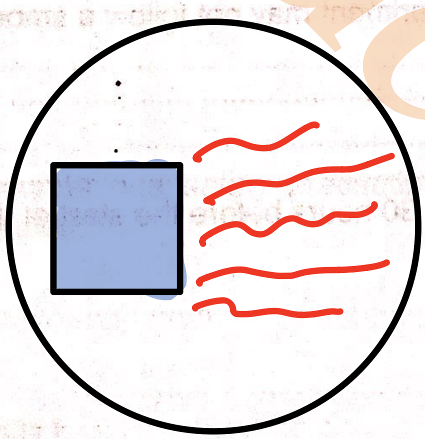
[3]

(ii) Explain what is meant by a *beta-particle*.

It is a fast moving electron !

[2]

(iii) A sample of radioactive material contains many of these phosphorus atoms. Describe an experiment to investigate whether the sample emits only beta-particles. A diagram may be included.



Diffusion Cloud Chamber

[4]

43. O/N 06/P1/Q9

How much energy would be released if 1×10^{-20} kg of matter was entirely converted to energy? (The speed of light is 3×10^{8} m/s.)

A 3×10^{-12} J B 9×10^{-7} J C 4.5×10^{-4} J D 9×10^{-4} J

44. M/J 06/P1/Q12

Which statement about fission or fusion is correct?

A During fission, hydrogen converts into helium and releases energy.

B During fission, uranium converts into daughter products and releases energy.

C During fusion, helium converts into hydrogen and releases energy.

D During fusion, uranium converts into daughter products and releases energy.

45. O/N 05/P1/Q38

A nucleus is represented by $^{230}_{91}Z$. It emits one alpha-particle and then one beta-particle.

What is the resulting nucleus X?

A $^{226}_{88}X$ B $^{226}_{89}X$ C $^{226}_{90}X$ D $^{230}_{89}X$

46. M/J 05/P1/Q11

The speed of light is 3×10^{8} m/s.

What is the energy equivalent of 2 kg of matter?

A $2 \times 3 \times 10^{8}$ J

B $2000 \times 3 \times 10^{8}$ J

C $\frac{1}{2} \times 2 \times 3 \times (10^{8})^{2}$ J

D $(2 \times 3 \times 10^{8})^{2}$ J

47. M/J 05/P1/Q39

Which equation shows a nuclear fission reaction?

A $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He$

B $^{14}_{7}N$ + neutron $\rightarrow ^{15}_{7}N$

C $^{46}_{21}Sc \rightarrow ^{46}_{21}Sc$ + gamma ray

D $^{239}_{92}U \rightarrow ^{95}_{38}Sr + ^{141}_{54}Xe$ + 3 neutrons

48. O/N 04/P1/Q40

Deuterium $^{2}_{1}H$ and tritium $^{3}_{1}H$ are two isotopes of hydrogen.

Compared to a deuterium atom, how many protons and neutrons does a tritium atom have?

	protons	neutrons
A	more	more
B	more	same
C	same	more
D	same	same

49. M/J 04/P1/Q11

When a nucleus of Uranium-235 absorbs a neutron, nuclear fission occurs. In a typical reaction the total mass decreases by 3×10^{-28} kg.

Given that the speed of light c is 3×10^{8} m/s, approximately how much energy is released?

A 9×10^{-20} J B 2×10^{-13} J C 3×10^{-11} J D 3×10^{-5} J

50. M/J 03/P1/Q37

In a fission reactor, which particle causes a Uranium-235 nucleus to split?

A alpha-particle B gamma ray C neutron D proton