SHORT QUESTIONS

18.1 Atom and Atomic Nucleus
18.2 Natural Radioactivity

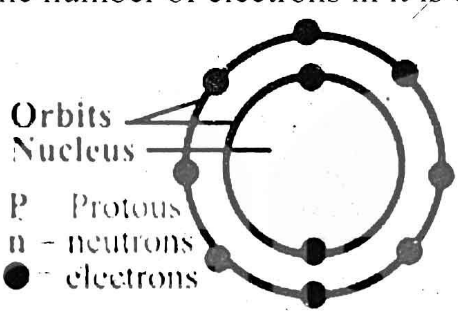
Q.1. Define atom and write down its parts.

Ans: The smallest part of an element is called an atom.

Parts of atom

(i) Atom consists of two parts and its central part is called nucleus. The nucleus consists of protons and neutrons. The proton is a positively charged particle and neutron has no charge so the nucleus carries a positive charge.

(ii) The electrons revolve around the nucleus in nearly circular orbits. Since an atom is a neutral particle, so the number of electrons in it is equal to the number of protons.



Q.2. What are Nucleons?

Ans: The mass of the proton & neutron is nearly the same i.e. 1.67×10^{27} kg. Since the protons and neutrons exist inside the nucleus so these are called nucleons.

Q.3. What is Atomic Mass Number?

Ans: A nucleon is nearly 1836 times heavier than an electron. So the mass of an atom is nearly equal to the total sum of the masses of all the protons and neutrons present in the nucleus of that atom.

"The total number of protons and neutrons in the nucleus is called the Atomic Mass Number and is denoted by the letter A".

Q.4. What is Atomic Number?

Ans: Since the number of protons in an atom of different elements is different so the number of protons in the nucleus indicates the charge on that nucleus.

"The number of protons in a nucleus is called the charge number or Atomic number and is denoted by the letter Z".

The number of neutrons in the nucleus is denoted by the letter N.

Q.5. What do you know about Nuclide?

Ans: If atomic number of an atom is Z and its Atomic Mass Number is A then this atom is represented by the symbol which is called a nuclide $\left(^{A}_{Z}X\right)$. For example there is only one proton in the nucleus of hydrogen atom so its atomic number is 1 and its atomic mass number is also 1. Hence it is denoted by $^{1}_{1}H$.

Q.6. What is the difference between Atomic number and Atomic Mass number?

Ans:

Atomic number	Atomic Mass number
• The total number of protons and neutrons in the nucleus is called the Atomic Mass Number. • It is denoted by the letter A.	• The number of protons in a nucleus is called the charge number or Atomic number. • It is denoted by the letter Z.

Q.7. What are radioactive isotopes?

Ans: The atoms of the same radioactive element whose atomic numbers are the same but have different atomic mass numbers are called Radioactive Isotopes.

Q.8. What are isotopes? What do they have in common and what are there differences.

Ans: Atoms of the same element having same atomic number but different mass number, are called isotope. They have same chemical properties but different physical properties. For example, Hydrogen has three isotopes

Protium	Z = 1	A=1	N=A- Z = 0
Deutrium	Z = 1	A=2	N=A-Z = 1
Tritium	Z = 1	A=3	N=A- Z = 2

Hence, from above relations we conclude that the number of protons are same and number of neutrons are different in the isotopes of hydrogen.

Fig.18.2: Three Isotopes of hydrogen
Protium (^1_1H), Deutrium (^2_1H) and Tritium (^1_1H).

Q.9. Why Marie Curie and Pierre are famous?

The most significant investigations of the process of radioactivity were done by Marie Curie and the husband Pierre.

They discovered two new elements which emitted radiations. These were named **polonium** and **radium**. This process of emission of radiations by some elements was called natural radioactivity by Marie Curie.

Q.10. Why are heavy nuclei unstable?

Ans: Heavy nuclei are unstable due to large number of protons. The strong nuclear force cannot balance the repulsive Coulomb force which comes into play due to increase in size.

Q.11. Find the number of neutrons and protons in $^{238}_{92}U$

Ans: In $^{238}_{92}U$

A = 238 and Z = 92

N = ? No of protons = ?

or $\boxed{N = 146}$ Ans

and No. of protons = Z = 92

or $\boxed{Z = 92}$

18.3 Background Radiations
18.4 Nuclear Transmutations
18.5 Half-life and its Measurement

Q.12. What is meant by Background Radiations ?

Background Radiations

"Radiations present in atmosphere due to different radioactive substances are called background radiations".

Sources of background radiations

The back ground radiation present in the atmosphere is due to the following two possible causes.

(i) The presence of radioactive material under the earth

(ii) The cosmic rays entering the earth from the upper atmosphere along with the sun light

Q.13. What are cosmic radiation?

The earth and all living things on it also receive radiation from outer space. This radiation is called cosmic radiation which primarily consists of positively charged ions from protons to iron and large nuclei. The cosmic radiation interacts with atom in the atmosphere to create a shower of secondary radiation, including x-rays, muons, protons, alpha particles, electrons and neutrons.

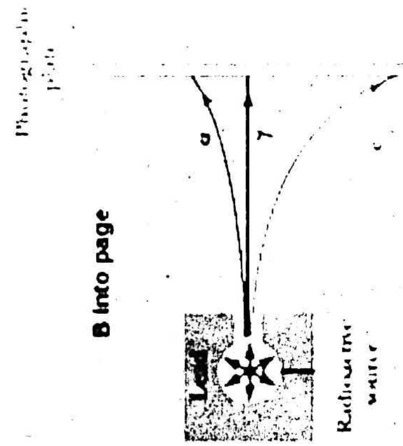
Q.14. Describe a brief account of Interaction of various types of radiations with matter.

Ans: α-radiation: It is a helium nuclei. When an alpha particle passes through a gas it interact with the atom of the gas and ionizes them. As its mass is comparatively more than β *and* γ so it has less penetrating power. Each ionization by an α-particle produces an ion pair and an average of about 3.5 electron volt energy is used to produce one ion pair. The range of α particle is around 7 cm and it can be stopped by a thick paper. α particle are capable of producing fluorescence in zinc sulphide or barium platinocyanide.

β-Radiations: These are negative charge particles they can penetrate 100 times more than α particles. The β-particle looses most its energy in a single collision. β Particle can also produce fluorescence in some materials like barium platinocyanide.

γ-Radiations: γ – rays have no charge that is why the cause very little ionization. The γ – ray photon can be absorbed by an atom and a photo electron can be ejected

(Photoelectric effect). When fast moving γ – ray photon is stopped it disintegrates into an electron positron pair (pair production). Material having large no of electron in a unit volume absorbs more γ – radiations. They have high penetration power than α & β particles and their intensity decreases exponentially with increase in depth of penetration into the material.



Q.15. Explain how α and β-particles may ionize an atom without directly hitting the electrons? What is the difference in the action of the two particles for producing ionization?

Ans: Since α and β-particles are electrically charged they can cause ionization without hitting an atom either by attracting or repelling the electrons of the target atom. α particle produces ionization by exerting electrostatic force of attraction while β-particles produce ionization by exerting electrostatic force of repulsion. α-particles cause ionization by attracting the electron while β-particles cause ionization by repelling the electron.

Q.16. A particle which produces more ionization is less penetrating why?

Ans: A particle which produces more ionization interacts strongly with the matter and loses its energy in a short distance and hence comes to rest soon, that's why it is less penetrating

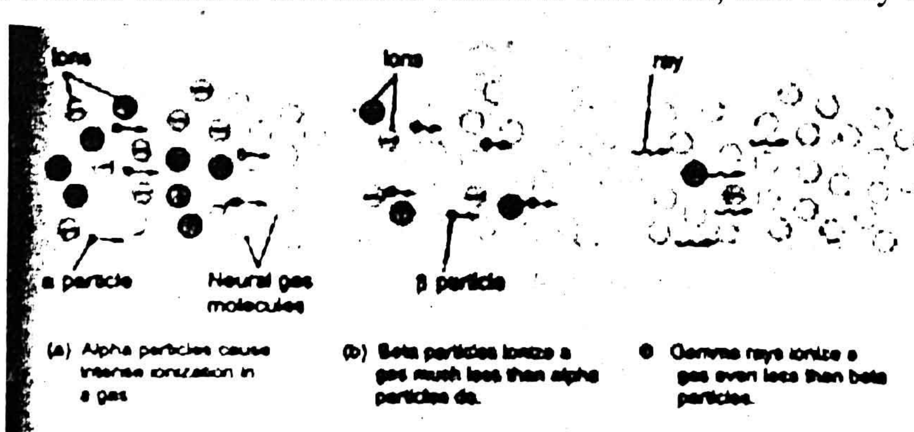


Fig. 18.5: Ionization effect of radiations in gas.

Q.17. If someone accidentally swallows an α-source and a β-source which would be the more dangerous to him? Explain why?

Ans: α-particles have greater ionizing power as compare to β-particles. So, they can cause more damage to tissues, if swallowed.

Q.18. Rn^{222} decays to a new element 'y' by two alpha and two β-emissions. What you can say about new element?

Ans: $_{86}Rn^{222} \longrightarrow {}_{82}Y^{214} + 2\,{}_2He^4$ (α -particles)

After two β-emissions

$_{82}Y^{214} \longrightarrow {}_{84}Y^{214} + 2\,{}_{-1}e^0$ (β-particle)

Hence, new element will be $_{84}Y^{214}$.

Q.19. Do α,β and γ radiations emit from the same element ? Why they are found in many radioactive elements?

Ans: α,β and γ rays emit from the same element . But, an element can not emit α and β rays simultaneously.

When a radioactive element emit α or β rays, it decays into new element and so on. Hence, we find all the three radiations in many radioactive element.

Q.20. Define nuclear transmutation?

"The spontaneous process in which a parent unstable nuclide changes into a more stable daughter nuclide with the emission of radiations is called nuclear transmutation".

Examples of radioactive decay

There are three processes given as

(i) Alpha (α) decay

$$^{A}_{Z}X \rightarrow {}^{A-4}Y + {}^{4}_{2}H_e + \text{Energy}$$

$$^{226}_{85}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}H_e + \text{Energy};$$

(ii) Beta (β) decay

General Equation

$$^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \text{Energy}$$

Parent nuclide — daughter nuclide — beta (β) -particle

Example

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \text{Energy}$$

carbon — nitrogen — beta (β) – particle

In (β) - decay, the parent nuclide has its proton number Z increased by 1 but is mass number or nucleon number a remains unchanged.

(iii) Gamma (γ) – decay

General Equation

$${}^{A}_{Z}X \rightarrow {}^{A}_{Z}X + (\gamma)$$

parent nuclide — daughter nuclide — gamma rays

Example:

$${}^{60}_{27}C_o \rightarrow {}^{60}_{27}C_o + {}^{0}_{0}\gamma + \text{Energy}$$

γ – rays are usually emitted at the same moment as either an alpha or a beta particle.

Q.21. What is the use of α,β and γ-radiation?

Ans: α-particles

They are used to treat skin cancer because their penetrating power is small.

β-particles

They are used to treat the tumors under the skin due to their large penetration power

γ-particles

They are used to treat the infection in interior parts of the body clue to their longest penetration power.

Q.22. What is the difference between an electron and β-particles?

Ans: β-particle is negatively charged particle emitted from the nucleus of radioactive element. An electron is negatively charge particle which revolves around the nucleus.

Q.23. What do you know about half life?

Ans: "The half life of an element is that time during which the numbers of atoms of that element are reduced to one half".

Example

If the half life time of a radioactive element is T, then at the end of this time the number of atoms in this element remain one half, after a time 2T, the number of atoms remain 25% and after time 3T, the number of atoms are reduced to 12.5% of the initial number.

Q.24. What is meant by Penetrating ability?

Penetrating ability

"The strength of radiations to penetrate a certain material is called penetrating power".

All kind of radiations penetrate but penetrating range is different for each.

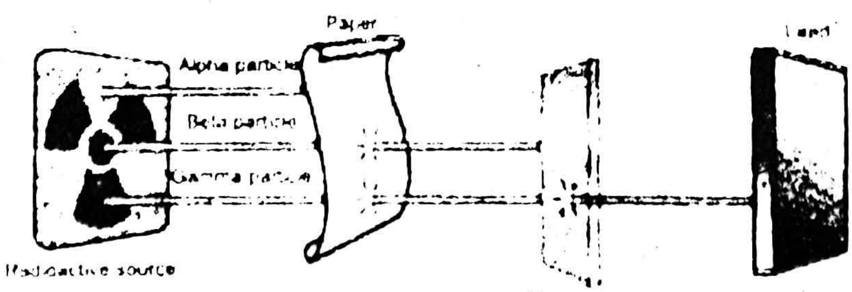


Fig 18 6 Penetrating power of radiations in different materials

18.6 Radioisotopes and their uses

Q.25. What are radioactive isotopes?

Ans: The atoms of the same radioactive element whose atomic numbers are the same but have different atomic mass numbers are called Radioactive Isotopes.

Q.26. What are stable nuclides?

Ans: Nuclei which do not emit radiations naturally are called stable nuclei. Most of the nuclei whose atomic number is from 1 to 82 are stable nuclei. They do not change from one type of element to another. The stable elements can also be changed into unstable form by bombarding them with neutrons. Such elements are called radio isotopes.

Q.27. What are unstable nuclides?

Ans: Nuclei which do not emit radiations naturally are called stable nuclei. Some elements, whose atomic number is greater than 82, are naturally unstable. These elements depending upon their characteristics, emit, all the time, different types of radiations and they continously change from one type of element to another.

Q.28. Differentiate between stable and unstable nuclides?

Ans:

Stable eleme[nts]	Unstable elements
• Nuclei which do not emit radiations naturally are called stable nuclei.	• Nuclei which emit radiations naturally are called unstable nuclei.
• Most of the nuclei whose atomic number is from 1 to 82 are stable nuclei.	• The elements, whose atomic number is greater than 82, are naturally unstable.
• They do not change from one type of element to another.	• They continuously change from one type of element to another.

Q.29. What is a radioactive tracer? Describe one application each in medicine, agriculture and industry.

Ans: A definite quantity of radio isotope introduced into a mechanical or biological system to enable its route through the system.

(i) Tracers are widely used in medicine to detect malignant tumors, blockage in the blood vessels, e.g brain and thyroid tumors are detected using I-131. Radio sodium has been largely used in medical research to study the action of various medicines

(ii) Tracers are also used in agriculture to study the uptake of a fertilizer by a plant, e.g P^{32} is incorporated in fertilizer and added to the soil.

(iii) Tracer technique is also very useful in industry in detecting the cracks and leakage in the pipes and welding joints e.g Iridium 192- is used to test the welds.

Q.30. How can radioactivity help in the treatment of cancer?

Ans: Medical applications of radio isotopes can be divided into two parts (i) diagnostic and (ii) therapy. Radiotherapy with γ – rays from cobalt-60 is often used in the treatment of cancer. The γ – rays are carefully focused on to the malignant tissue.

Radioactive Iodine-131 is used to fight with cancer of the thyroid gland.

Skin Cancers: for skin cancers, phosphorus-32 or strontium-90 may be used. They produce β radiation.

Q.31. How can radioactivity help in the treatment of Cancer?

Ans: **Radioactivity & Treatment of Cancer:** Cancerous cells are always weak as compared to the normal cells, and hence are destroyed by firing β-radiation or γ-radiation from radioactive source. Some times encapsulated "seeds" made from radioactive source are implanted in the malignant tissues for local and short ranged treatment.

For example:

- γ-rays from Co-60 in general
- Iodine–131 for treatment of cancer of thyroid gland.
- Phosphorus–32 or strontium–90 may be used for skin-cancers.

Q.32. How a radioisotope be used to determine the effectiveness of fertilizer?

Ans: Radioactive phosphorus or nitrogen used as a tracer in agriculture, provide information about the best fertilizer to supply to a particular crop and soil. Due to their use, varieties of crops such as rice, wheat and cotton have improved. Moreover, plants have shown more resistance to disease and give better yield and grain quality.

18.7 Fission Reaction
18.8 Nuclear Fusion
18.9 Hazards of Radiations and Safety Measures

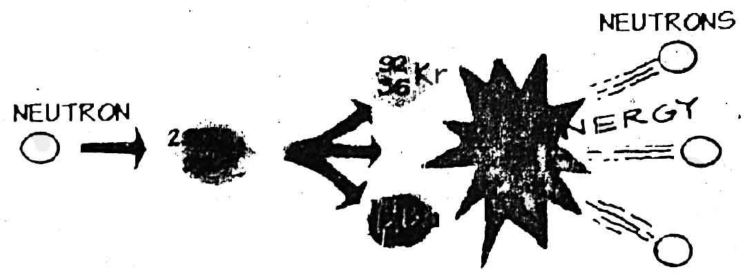
Q.33. What is positron?

Ans: Positron is a particle with mass equal to the mass of an electron having opposite and equal charge.

Q.34. What is by Nuclear fission

Nuclear fission

Nuclear fission takes place when a heavy nucleus, such as U-235, splits or fissions, into two smaller nuclear by bombarding a slow moving (low- energy) neutron represent in equation.



$${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{236}_{92}U \rightarrow X + Y + \text{neutron} + \text{energy}$$

U-236 in an intermediate state that lasts only for few seconds before splitting into nuclei X and Y, called fission fragments.

Q.35. Briefly explain how heat is produced in a nuclear reactor?

Ans: The fission of U-235 may be represent as:

$${}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_{0}n^{1} + Q$$

Where Q is the amount of energy released and it is nearly equal to 200 Mev. This energy is appeared in the form of heat.

Q.36. Why does water is used to slow down the neutrons rather than lead?

Ans: When neutrons collide with lead nuclei, they are bounced back. While lead atoms remain at rest due to their greater mass. But, in case of water, collision b/w neutrons and hydrogen nuclei, present in water is perfectly elastic. In this collision, neutrons are slowed down, while proton starts moving.

Hence, water may be used efficiently to slow down the neutrons rather than lead.

Q.37. Write a note on Einstein's mass energy equation.

Ans: In classical physics, the various forms of energy were related under the law of conservation of energy but no relationship was established between the energy and mass. In 1905, when Einstein gave his theory of relativity, it also contained the idea that the energy and matter are interchangeable. For this change an equation was also given which is known as Einstein's mass-energy equation. It is

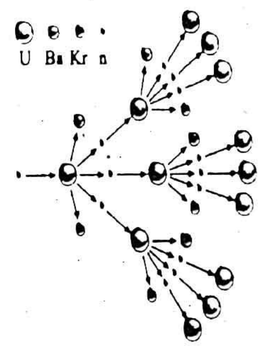
$$E=mc^2$$

Which means that if mass m of matter is converted into energy, then this will be equal to E, where in this mass-energy equation c is the speed of light that is 3×10^8 ms^{-1}.

Q.38. What is do you know about Fission chain reaction

Fission chain reaction

When a neutron reacts with a uranium nucleus, two or three neutrons are released. Every one of these reacts with next nuclei producing two or three more neutrons and hence, the number of available neutrons and the fission goes on increasing. Such a reaction is called the chain reaction.



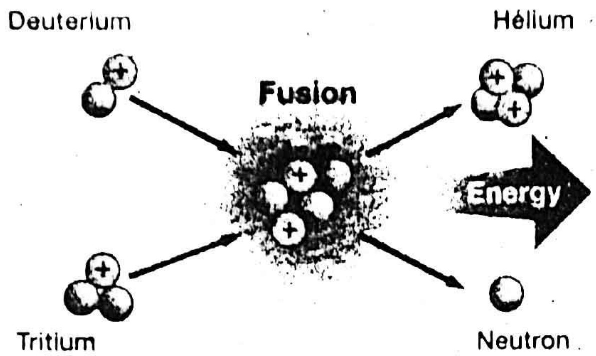
Q.39. Define Fusion Reaction.

Ans: "When two light nuclei combine to form a heavier nucleus, the process is called nuclear fusion".

Equation:

If an atom of Deuterium is fused with an atom of Tritium, the a Helium nucleus or alpha particle is formed as given by

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$$



Pictorially fusion reaction is shown in the following figure.

Q.40. Why it is more difficult to start a fusion reaction rather than fission reaction?

Ans: because, in bringing two nuclei closer to each other, great work has to be done against repulsive forces of nuclei. Hence, more energy is needed. On the other hand fission may be proceeded with slow neutrons.

Q.41. Differences between nuclear fission and nuclear fusion.

Nuclear Fission	Nuclear Fusion
1. A bigger heavier nucleus splits into smaller (lighter) nuclei.	1. Lighter nuclei fuse together to form the heavier nucleus.
2. It does not require temperature.	2. Extremely high temperature is require for fusion to take place.
3. A chain reaction sets in.	3. It is not a chain reaction.
4. It can be controlled and energy released can be used for peaceful purpose.	4. It cannot be controlled and energy released cannot be used properly.
5. The products of the reaction are radioactive in nature.	5. The products of a fusion reaction are non-radioactive in nature.
6. At the end of the reaction nuclear waste is left behind.	No nuclear waste is left at the end of fusions reaction.

Q.42. Discuss uses and the hazards of radiations

Some of harmful effects on human beings due to large doses or prolonged small doses of radiations.

1. Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.
2. Sterility (i.e. inability to produce children).
3. Genetic mutations in both human and plants. Some children are born with serious deformities.
4. Leukernia (Cancer of the blood cells)
5. Blindness or formation of cataract in the eye.

Q.43. Describe the precaution to minimize radiations dangers (safety measures)

Precautions to minimize radiation dangers

Because we cannot detect radiations directly, we should strictly follow safety precautions, even when the radioactive sources are very weak.

1. Sources should not be handled with tongs and forceps.
2. The user should use rubber gloves and hand should be washed carefully after the experiment.
3. All radioactive sources should be stored in thick lead containers.
4. Never point radioactive source towards a person.
5. Frequent visits to the radiation sensitive areas should be avoided.