Chapter: 18

Atomic and Nuclear Physics

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Objective

1. The number of Neutrons in Tritium ${}_{1}^{3}H$ is:

Ⓐ 4 Ⓑ 3 **Ⓒ 2** Ⓓ 1

2. One of the Isotopes of uranium ${}_{92}^{238}U$. Find the number of Neutrons in this isotope is:

Ⓐ 146 Ⓑ 238 Ⓒ 330 Ⓓ 92

3. Particles in the nucleus of an atom are:

Ⓐ Protons and Neutrons Ⓑ Protons
Ⓒ Electrons and neutrons Ⓓ Protons and electrons

4. Isotopes of hydrogen are:

Ⓐ 5 Ⓑ 4 **Ⓒ 3** Ⓓ 2

5. Atomic number is denoted by a symbol:

Ⓐ ${}_{Z}^{B}X$ Ⓑ ${}_{Z}^{A}X$ Ⓒ A **Ⓓ Z**

6. Isotopes are atoms of same elements whose ..... is different.

Ⓐ Atomic mass Ⓑ No. of protons Ⓒ No. of Atoms Ⓓ Atomic number

7. The proton is heavier than an Electron:

Ⓐ 1800 times Ⓑ 1870 times **Ⓒ 1836 times** Ⓓ 1863 times

8. Generally an atom is represented by the symbol:

Ⓐ X^{A} Ⓑ X Ⓒ ${}_{Z}^{A}X$ **Ⓓ ${}_{Z}^{A}X$**

9. In ${}_{92}^{238}U$,92 is the number of:

Ⓐ N + e Ⓑ P + N **Ⓒ Protons** Ⓓ Neutrons

10. During natural radioactivity how many types of radiations are emitted?

Ⓐ 4 Ⓑ 2 **Ⓒ 3** Ⓓ 1

11. Which among the following Radiations has more penetrating power?

Ⓐ Gamma particle Ⓑ Alpha particle Ⓒ All of these Ⓓ Beta particle

12. Atomic mass number can be found by relation:

Ⓐ Z + N Ⓑ Z − A Ⓒ A + N Ⓓ Z + A

13. The half-life of Hydrogen is:

Ⓐ 2.85 years **Ⓑ 12.3 years** Ⓒ 30 years Ⓓ 5730 years

14. Safe limit of radiation exposure in one year is:

Ⓐ 5 rem Ⓑ 3 rem Ⓒ 4 rem Ⓓ 6 rem

15. The half-life of lead is:

Ⓐ 10.4 hours **Ⓑ 10.6 hours** Ⓒ 10.0 hours Ⓓ 10.2 hours

16. The Half-life of plutonium in years is:

Ⓐ 1.85 Ⓑ 3.85 Ⓒ 0.85 **Ⓓ 2.85**

17. The half-life of a certain isotope is 1 day. What is the quantity of the isotopes?

(A) One quarter (B) One eight (C) One half (D) None of these

18. The half-life of radium-226 is:

(A) 2800 years (B) 5730 years (C) 4000 years (D) 1620 years

19. For the diagnosis of brain tumor is used:

(A) Iodine-131 (B) Phosphorus-32 (C) Cobalt-60 (D) Carbon-14

20. The half-life of Carbon-14 is:

(A) 3750 years (B) 5730 years (C) 5370 years (D) 7530 years

21. In $^{235}_{92}U$, 92 is the number of:

(A) Number of protons (B) Protons and Neutrons
(C) Neutrons and Electron (D) Number of neutrons

22. When uranium (92 protons) ejects a beta particle, how many protons are left in the remaining nucleus:

(A) 90 (B) 91 (C) 92 (D) 93

23. Release of Energy by the Sun due to:

(A) By Nuclear Fusion (B) By chemical reaction
(C) By Nuclear Fission (D) By burning of gases

24. The nuclear fission observed by:

(A) Stress Amin (B) Newton (C) Eon stein (D) Snell

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Subjective

Q1: ***What is neutron number?***

Ans: ***Neutron number:***

Number of Neutrons in nucleus is called neutron number. It is denoted by letter N.

Q2: ***Define Atom and write its basic particles.***

Ans: ***Atom:***

Atom is an indivisible particle of matter.

Basic Particle:

An atom consists of nucleus contains proton and neutron, while electrons revolve in nearly circular orbits about the positively charged nucleus.

Size of atom and its constituents.

Q3: ***Define Atomic Number and Mass Number.***

Ans: ***Atomic number:***

The number of protons presented inside a nucleus is called the charge number or the atomic number and it is denoted by the letter Z.

Atomic Mass Number:

The sum of neutrons and protons presented in a nucleus is called its atomic mass number. It is denoted by the letter A.

Q4: ***Define atomic number. Write its symbol.***

Ans: ***Atomic Number:***

The number of protons presented inside a nucleus is called the charge number or the atomic number.

Symbol:

Atomic number is denoted by the letter Z.

Q5: ***Define atomic mass number. Write its symbol.***

Ans: ***Atomic Mass Number:***

The sum of neutrons and protons presented in a nucleus is called its atomic mass number.

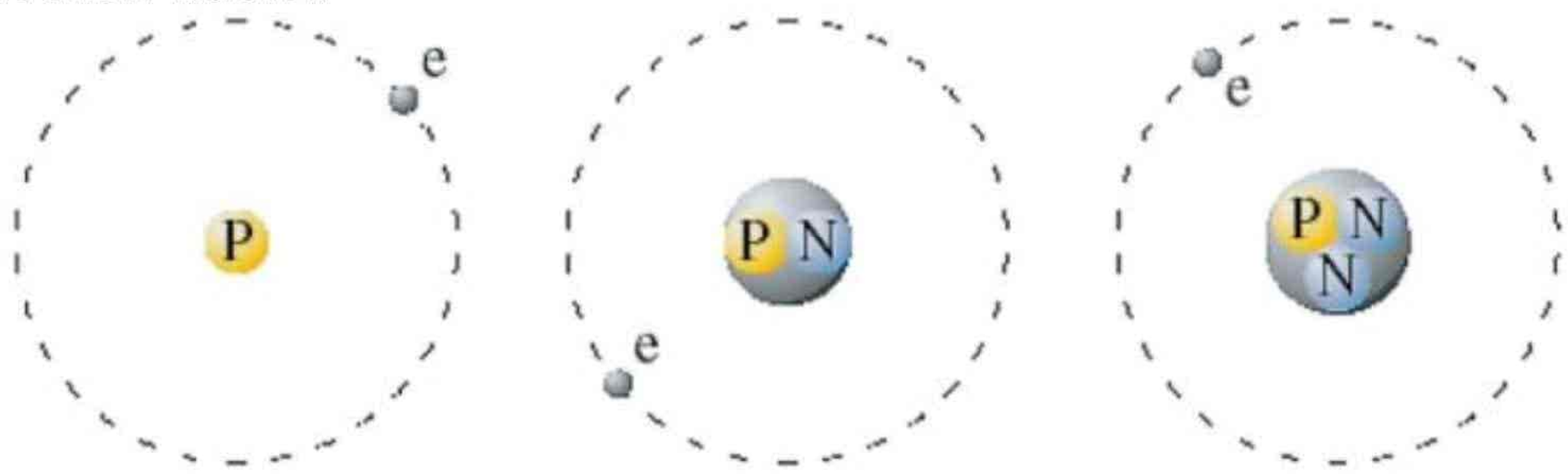
Symbol:

Atomic mass number denoted by the letter A.

Q6: ***What is meant by Isotope? Write the names of Hydrogen's Isotopes.***

Ans: ***Isotopes:***

Isotopes are atoms of an element which have same number of protons but different number of neutrons in their nuclei.



Example:-

The Isotopes of Hydrogen are:

- *Protein* $^{1}_{1}\mathrm{H}$
- *Deuterium* $^{2}_{1}\mathrm{H}$
- *Tritium* $^{3}_{1}\mathrm{H}$

Q7: ***Is it possible for an element to have different types of atoms? Explain.***

Ans: ***Yes,*** *it is possible for an element to have different types of atoms called isotopes. "Isotopes are atoms of an element which have same number of protons but different number of neutrons in their nuclei".*

Example:

- *Hydrogen has three isotopes. Protium* ($^{1}_{1}\mathrm{H}$) *contains on propons in the nucleus and one electron that revolves around of nucleus.*
- *Deuterium* ($^{2}_{1}\mathrm{H}$) *contains one proton, one neutron and one electron.*
- *Terminiyam* ($^{3}_{1}\mathrm{H}$) *contain one proton, two neutron and one electron.*

Q8: ***Define Natural Radio Activity.***

Ans: ***Natural Radio Activity:***

The spontaneous emission of radiation by unstable nuclei is called natural radioactivity. The elements which emit such radiations are called radioactive element.

Q9: ***What is meant by Artificial Radio Activity?***

Ans: ***Artificial Radio Activity:***

Nuclei which are not radioactivity naturally, the scientist make them radioactive in lab by bombardment electrons on them and they exit radiation. It is called artificial radio activity.

Q10: ***What is meant by background radiation?***

Ans: ***Background radiation:***

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

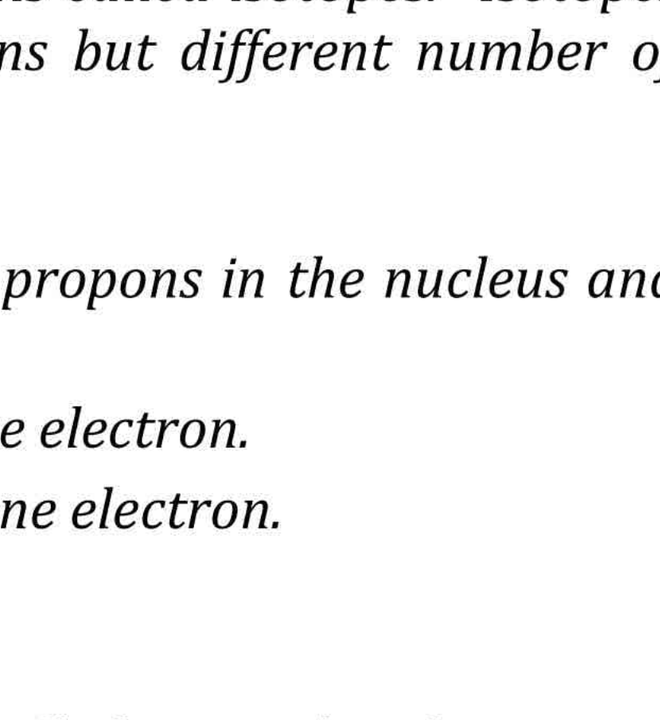


Fig. The sources of background radiation from the environment

Q11: ***Write a note on Cosmic Radiation.***

Ans: ***Cosmic Radiation.***

The cosmic radiation interacts with atoms in the atmosphere to create a shower of secondary radiation, including x-rays, mounts, protons, alpha particles, electrons, and neutrons.

Q12: ***Define Nuclear Transmutation?***

Ans: ***Nuclear Transmutation:***

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

Example:

$$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He + Energy$$

Q13: ***Define lionization.***

Ans: ***lionization:***

The phenomenon by which radiation split matter into positive and negative ions is called ionization. Alpha particles have the greatest power of ionization as compared to beta particles and gamma rays.

Q14: ***What is meant by penetrating power?***

Ans: ***Penetrating power:***

The strength of radiation to penetrating a certain material is called penetrating power.

Explanation:

The alpha particle has the shortest range because of its strong entreating or ionizing power. The gamma rays can penetrate a considerable thickness of concrete. The beta radiations have range greater than alpha particles.

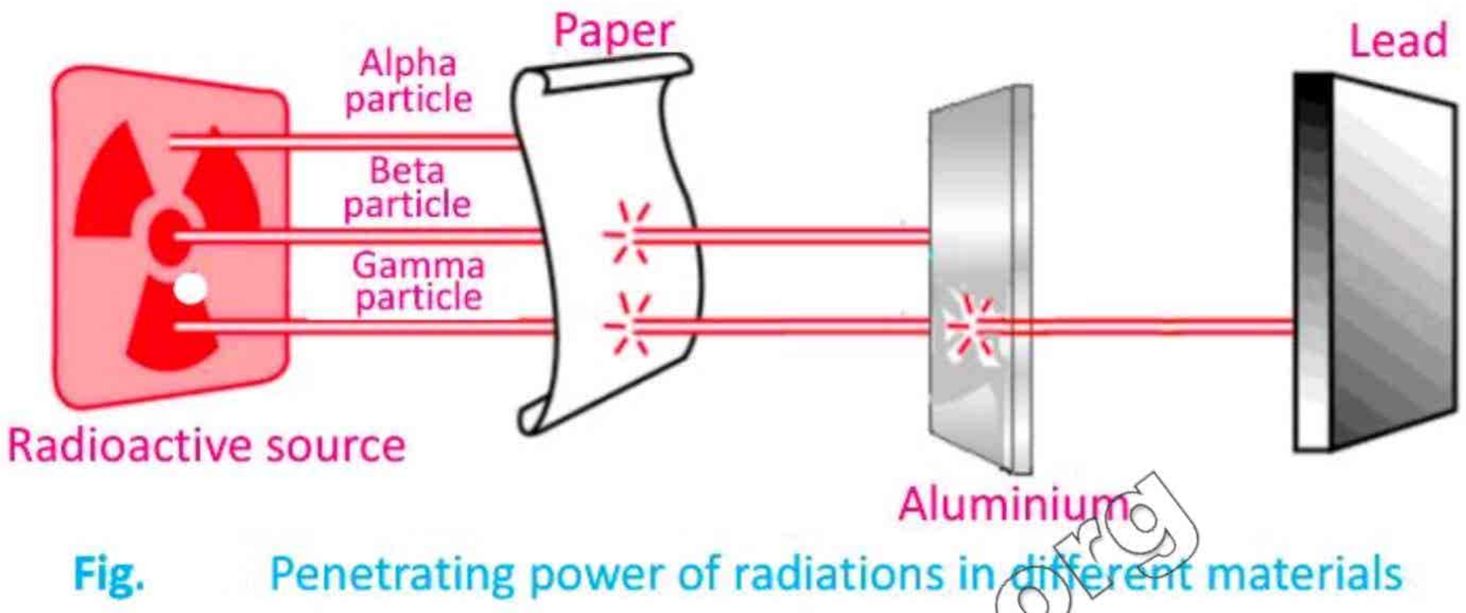


Fig. Penetrating power of radiations in different materials

Q15: ***What is meant by ionization and penetrating power?***

Ans: ***Penetrating power:***

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

Ionizing:

The phenomenon by which radiations split matter into positive and negative ions is called ionization.

Q16: ***What is difference between stable and unstable elements?***

Ans: Difference between stable and unstable elements is:

Stable Elements	***Unstable Elements***
❖ *Those nucleuses which can't emit radiations naturally are called stable elements.* ❖ *It atomic mass is between 1 and 82.*	❖ *Those elements which emit radiations naturally are called unstable elements.* ❖ *All elements whose atomic mass is more than 82 are naturally unstable and converted into other elements.*

Q17: ***Define Fission Reaction. OR Write equation of Nuclear Fission Reaction.***

Ans: ***Fission Reaction:***

Nuclear fission takes place when a heavy nucleus, such as U-235*, splits, or fissions, into two smaller nuclei by absorbing a slow moving (low-energy) neutron.*

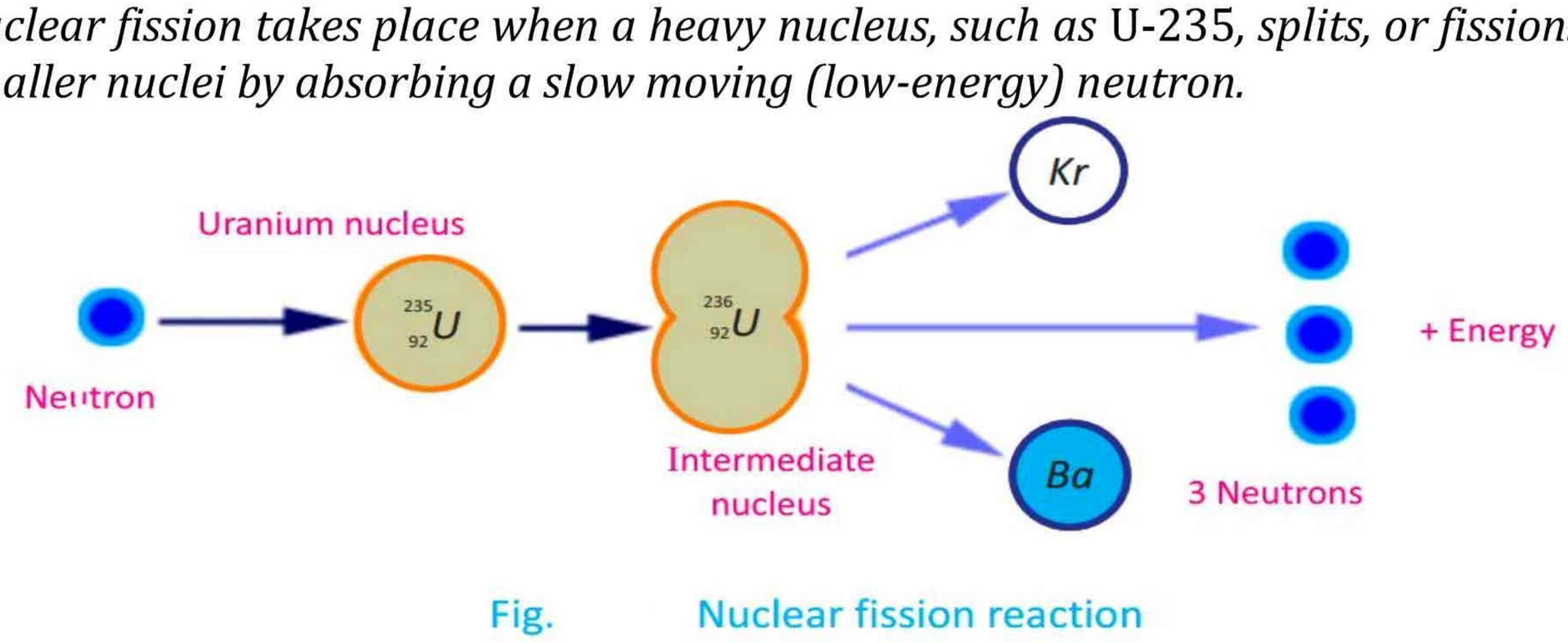


Fig. Nuclear fission reaction

Equation:

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

Q18: ***What is meant by unstable nuclei? Explain.***

Ans: ***Unstable nuclei:***

Those elements which emit radiations naturally are called unstable elements.
All elements whose atomic mass is more than 82 are naturally unstable and converted into other elements.

Q19: ***Write half-life of Hydrogen, Lead, Uranium and carbon.***

Ans: ***Hydrogen:***

The half-life hydrogen isotope $^{3}_{1}\mathrm{H}$ *is* 12.3 *year.*

Lead:

The half-life of lead isotope $^{212}_{82}\mathrm{P}$ *is* 10.6 *hours.*

Uranium:

The half-life of uranium isotope $^{235}_{92}\mathrm{U}$ *is* 7.1×10^{8} *years and half-life of uranium isotope* $^{238}_{92}\mathrm{U}$ is 4.51×10^{9} *years.*

Carbon:

The half-life of carbon isotope $^{14}_{6}\mathrm{C}$ *is* 5730 *years.*

Q20: ***Describe the safety measures to avoid the hazards of radiations.***

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

- *Frequent visits to the radiation sensitive areas should be avoided.*
- *The user should only rubber gloves and hands should be washed carefully after the experiment.*
- *All radioactive sources should be stored in thick lead containers.*
- *All radioactive sources should be stored in thick lead containers.*
- *The sources should only be handled with tongs and forceps.*

Q21: ***Differentiate between nuclear fission and nuclear fusion reactions.***

Ans: Difference between nuclear fission and nuclear fusion reactions:

Fission Reaction	***Fusion Reaction***
❖ *Nuclear fission takes place when a heavy nucleus, such as U-235, splits or fissions into two smaller nuclei by absorbing a slow moving (low energy) neutron.* ❖ $^{0}_{1}\mathrm{n} + {}^{235}_{92}\mathrm{U} \longrightarrow \mathrm{X} + \mathrm{Y} + \mathrm{energy}$	❖ *When two light nucleuses continue to from a heavier nucleus the process is called nuclear fusion.* ❖ $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \longrightarrow {}^{4}_{2}\mathrm{He} + {}^{0}_{1}\mathrm{n} + \mathrm{energy}$

Q22: ***What is fission chain reaction?***

Ans: ***Fission chain reaction:***

We have seen that neutrons are emitted when U-235 *undergoes fission. These neutrons can in turn trigger other nuclei to undergo fission with the possibility of a chain reaction. Calculation show that if the chain reaction is not controlled, it will proceed too rapidly and possibly result in the sudden release of an enormous amount of energy (an explosion).*

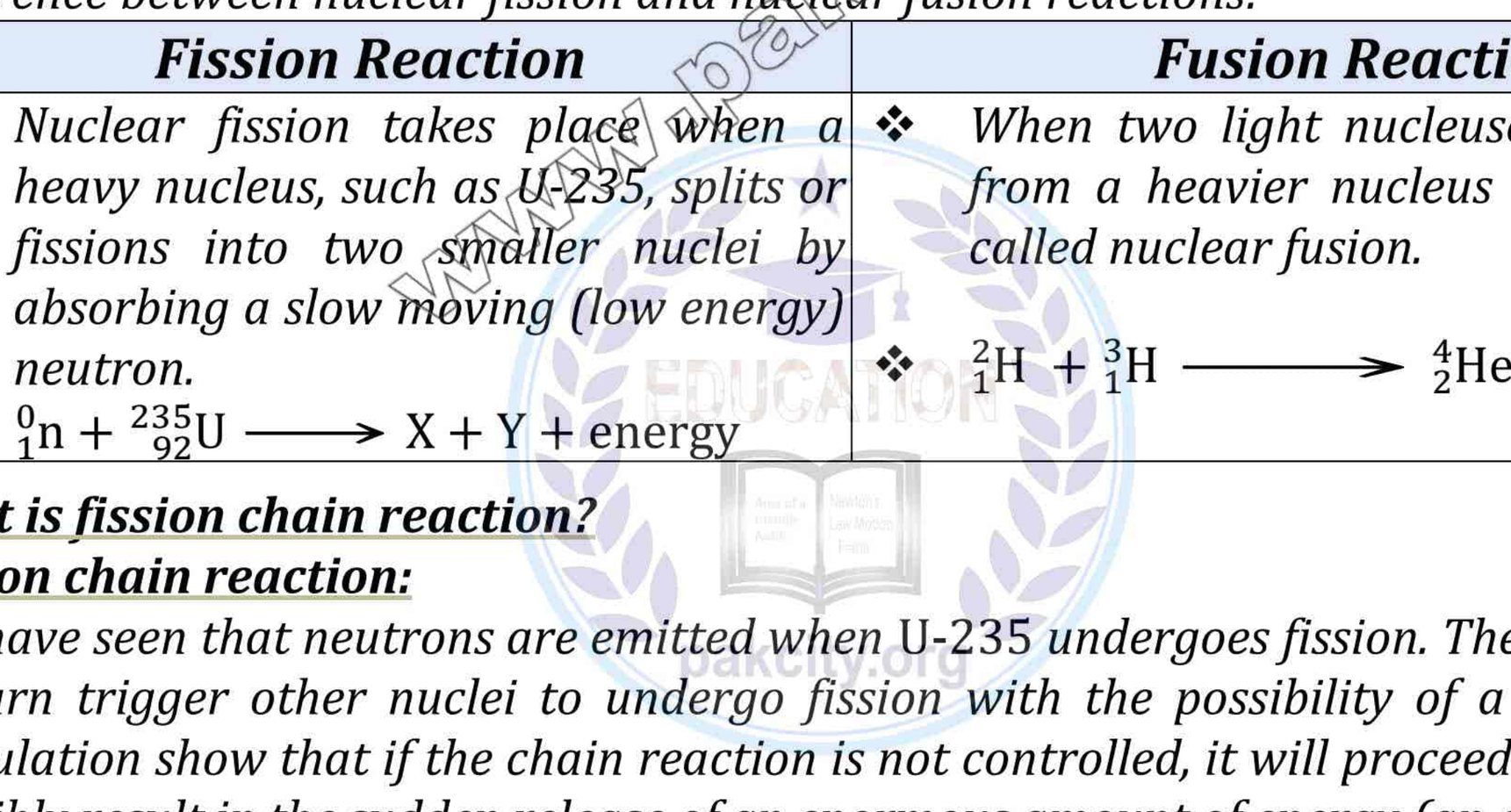
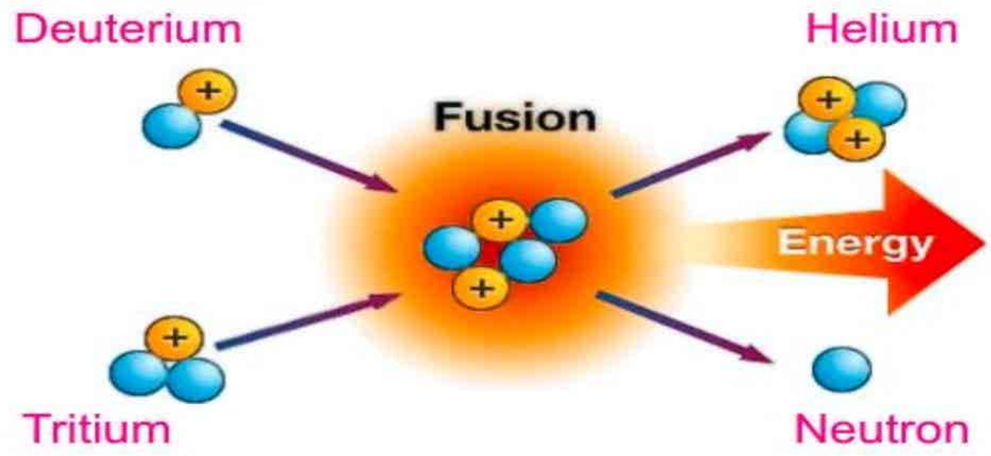


Fig. Fission Chain reaction in *U*-235

Q23: ***Write equation for nuclear fusion. OR Define nuclear fusion.***

Ans: ***Nuclear fusion:***



When two light nucleuses continue to from a heavier nucleus the process is called nuclear fusion.

Equation:

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

Q24: ***Explain four hazards of radiations.***

Ans: ***Hazards of radiations:***

- *Genetic mutations in both human and plants. Some children are born with serious deformities.*
- *Leukemia (cancer of blood cells).*
- *Blindness of formation of cataract in the eye.*
- *Sterility. (I. e inability to produce children)*
- *Radiation burns, mainly due to data and gamma radiations, which may cause redness and stores on the skin.*

Additional Question

Q1: ***Find the number of protons and neutrons in nuclide defined by*** $^{13}_{6}\mathbf{X}$**.**

Ans: From the symbol, we have:

Atomic number = number of protons = $z = 6$

Atomic mass = $A = 13$

Atomic mass = Number of protons + number of neutrons

$$A = Z + N$$
$$N = A - Z$$
$$N = 13 - 6$$
$$N = 7$$

But number of protons are 6, so number of neutrons will be 7.

So the element is an isotope of carbon−12, and is written as $^{13}_{6}\mathbf{C}$**.**

Q2: ***What are difference between daughter and parents elements?***

Ans: Difference between daughter and parents elements are:

Daughter	***Parents***
❖ *The elements obtained by parent's elements are called daughter elements.*	❖ *The elements from which radiations are emits are called parents elements.*

Q3: ***Explain gamma rays with the help of examples.***

Ans: ***General equation:***

$$^{A}_{Z}X \longrightarrow ^{A}_{Z}X + \gamma + \text{Energy}$$

Example:

$$^{60}_{27}CO^{*} \longrightarrow ^{60}_{27}Co + ^{0}_{0}\gamma + \text{Energy}$$

Parent daughter radiation

Normally gamma rays reduce radiation with Alfa or beta particles.

Q4: ***Write two characteristics of alpha particles.***

Ans: Alpha particle is helium nucleus comprising of two protons and two neutrons and two protons.

- *The alpha particle has strong ionizing power.*
- *Alpha particle has a range of only a few centimeters in air.*
- *May decay by emitting alpha radiations.*
- *An unstable nucleus with large protons and neutrons.*
- *The charge on that particle is* 2e.

Q5: ***Write two characteristics of Beta rays.***

Ans: Beta rays have following characteristics:

- *The speed of Beta particle is nearly equal to speed of light. Beta particles have range of several meters in air.*
- *Beta radiation is a stream of high-energy electrons. Unstable nuclei with excess of neutrons may eject beta radiations.*
- *The beta radiations strongly interact with matter due its charge and have a short-range as compared to gamma radiations.*

Q6: ***What is photon?***

Ans: *An energy packet whose energy is always quantized is called photon.*

Q7: ***Write two properties of Gamma rays?***

Ans: *Properties of Gamma rays:*

- *Gamma rays can penetrate at least 30 cm of lead or 2 kilometer of air.*
- *These are electromagnetic radiation of very short wavelength.*

Q8: ***Explain alpha decay with example.***

Ans: ***General equation:***

$$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He + Energy$$

Parent nuclide daughter nuclide alpha particle.

Example:

$$^{226}_{88}Ra \longrightarrow {}^{222}_{86}Rn + {}^{4}_{2}He + Energy$$

Radium Radon alpha particle

It means in alpha decay, the proton number or atomic number (z) of the parent nuclide reduces by 2 and its mass number or nucleon number (A) decreases by 4.

Q9: ***Write general equation and an example of beta-decay.***

Ans: ***General equation:***

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

Parent nuclide daughter nuclide beta particle.

Example:

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

Carbon Nitrogen beta particle

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

Q10: ***What is meant by Half-life of a Radioactive Element?***

Define half-life and write half-life of $^{14}_{6}C$.

Ans: ***Half-life:***

The time during which half of the unstable radioactive nuclei disintegrate is called the half-life of the sample of radioactive element.

Example:

Different elements has different half-life $^{14}_{6}C$ *has* 5730 *years half-life and radium* -226 *has* 1620 *year half-life.*

Q11: ***How long would it take for complete decay of a pure radioactive atom?***

Ans: *Infinite time required for complete decay of a pure radioactive atom, because after every half-life the remaining number of atom half and so on.*

Q12: ***What are Tracers?***

Ans: ***Tracers:***

Radioactive tracers are chemical compounds containing some quantity of radioisotope.

Example:

Radio iodine-131 *readily accumulates in the thyroid gland and can be used for monitoring of thyroid gland. For the diagnosis of brain tumor phosphorous* -32 *is used.*

Q13: ***Define radioactive elements.***

Ans: ***Radioactive elements:***

The elements which emit radiations naturally are called radioactive elements. The atomic number of radioactive elements is greater than 82.

Q14: ***Write two uses of Radio Isotopes.***

Ans: *These are following uses of Radio Isotopes:*

- *These are used as tracers in medical, industry and agriculture.*
- *Radioisotopes are used in nuclear medicines for curing various diseases.*

For example:

Radioactivecobalt-60 is used for curing cancerous tumors and cells.

Q15: ***What is meant by Carbon Dating?***

Ans: *When a tree dies, the radio Carbon-14 present inside the plant starts decaying. Since the half-life of Carbon14 is 5730 years, the age of a dead tree can be calculated by comparing the activity of carbon-14 in the live and dead tree. This process is called Carbon dating.*

Q16: ***Define radioactive isotopes.***

Ans: ***Radioactive isotopes:***

Artificially produced radioactive elements are called radioactive isotopes or radioisotopes.

Example:

$$^{0}_{1}n + {}^{23}_{11}N \longrightarrow {}^{14}_{7}N + \text{Gamma } (\gamma) \text{ rays}$$

Neutron stable sodium Sodium radioisotopes

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Imp.Long Questions

Q.1: ***What is meant by background radiations? Describe briefly.***

Q.2: ***Define Nuclear Transmutation Also describe Alpha and beta decay.***

Q.3: ***Write a note on alpha (α) decay general equation, and give example also.***

Q.4: ***The activity of a sample of a radioactive bismuth decreases to one-eight of its original activity in 15 days. Calculate the half-life of sample.***

Q.5: ***What is meant by radio isotopes? Describe their uses in medicine industry or research.***

Q.6: ***How radioisotopes are used as tracers and in medical treatment?***

Q.7: ***What is meant by radio isotopes? Describe uses of radio isotopes as medical treatment and carbon dating.***

Q.8: ***What are two common-radiation hazards? Briefly describe the precautions that are taken against them.***

Q.9: ***The half-life of $^{14}_{7}N$ is 7.3s. A sample of this nuclide of nitrogen is observed for 29.2 s. Calculate the fraction of the original radioactive isotope remaining after this time.***

Q.10: ***Ashes from a campfire deep in a cave show carbon-14 activity of only one-eighth the activity of fresh wood. How long ago was that campfire made?***

Q.11: ***Carbon-14 has a half-life of 5730 years. How long will it take for the quantity of carbon-14 in a sample to drop to one-eighth of the initial quantity?***