## EXERCISE 12(A) PAGE NO: 297

**Question: 1**

**Name the three constituents of an atom and state mass and charge of each. How are they distributed in an atom?**

**Solution:**

The three constituents of an atom are electrons, protons and neutrons. The mass of electrons is $9.1 \times 10^{-31}$ kg and charge is $-1.6 \times 10^{-19}$ C. The mass of protons is $1.6726 \times 10^{-27}$ kg and charge is $+ 1.6 \times 10^{-19}$ C and the mass of neutrons is $1.6749 \times 10^{-27}$ kg and charge is zero.

**Question: 2**

**Define the following terms:**

**(a)Atomic number and (b) mass number.**

**Solution:**

(a) The atomic number of an atom is equal to the number of protons in its nucleus.
(b) The mass number of an atom is equal to the total number of nucleons in its nucleus.

**Question: 3**

**What is nucleus of an atom? Compare its size with that of the atom. Name its constitutents. How is the number of these constituents determined by the atomic number and mass number of an atom?**

**Solution:**

The centre of an atom whose size is of the order of $10^{-15}$ m to $10^{-14}$ m is known as the nucleus of an atom. The size of the nucleus is $10^{-5}$ to $10^{-4}$ times the size of the atom. Nucleus consists of protons and neutrons. If Z is the atomic number and A is the mass number of an atom, then the atom contains

Number of electrons = Z
Number of protons = Z
Number of neutrons = A – Z

The atom is specified by the symbol $^{A}_{Z}X$ where X is the chemical symbol for the element.

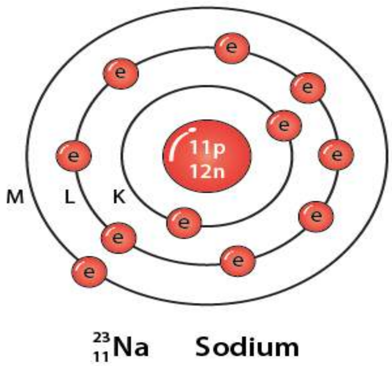
**Question: 4**

**State the atomic number and mass number $^{23}_{11}Na$ of and draw its atomic model.**

**Solution:**

The atomic number Z = 11
The mass number A = 23

Number of neutrons A – Z = 12
Its atomic model is




**Question: 5**
**What are isotopes? Give one example.**
**Solution:**
The atoms of the same element, having same atomic number Z, but different mass number A, are called isotopes.

Examples: Hydrogen has three isotopes namely protium $^{1}_{1}H$ deuterium $^{2}_{1}H$ and tritium $^{3}_{1}H$

**Question: 6**
**What are isobars? Give one example.**
**Solution:**
Isobars are the atoms of different elements which have the same mass number A, but different atomic number Z
Example: $^{23}_{11}Na$ and $^{23}_{12}Mg$ are isobars.

**Question: 7**
**Name the atoms of a substance having same atomic number, but different mass numbers. Give one example of such a substance. How do the structures of such atoms differ?**
**Solution:**
The atoms of a substance having same atomic number, but different mass number are known as isotopes.
Example: Hydrogen has three isotopes namely protium, deuterium and tritium. Each

isotope structure differs by the number of neutrons in its nuclei.

**Question: 8**

**What is meant by radioactivity? Name two radioactive substances.**

**Solution:**

Radioactivity is a nuclear phenomenon. It is the process of spontaneous emission of α or β and γ radiations from the nucleus of atoms during their decay. Uranium and radium are the two radioactive substances.

**Question: 9**

**A radioactive substance is oxidized. What changes would you expect to take place in the nature of radioactivity? Explain your answer.**

**Solution:**

As radioactivity is a nuclear phenomenon. Hence there will be no change in the nature of radioactivity.

**Question: 10**

**A radioactive source emits three types of radiations.**

**(a) Name the three radiations.**

**(b) Name the radiations which are deflected by the electric field.**

**(c) Name the radiation which is most penetrating.**

**(d) Name the radiation which travels with the speed of light.**

**(e) Name the radiation which has the highest ionizing power.**

**(f) Name the radiation consisting of the same kind of particles as the cathode rays.**

**Solution:**

(a) Alpha, beta and gamma are the three types of radiations

(b) The radiations which are deflected by the electric field are alpha and beta radiations.

(c) Gamma radiations are the most penetrating radiations

(d) Gamma radiations travels with the speed of light

(e) Alpha radiations has the highest ionizing power

(f) The radiations consisting of the same kind of particles as the cathode rays are beta radiations

**Question: 11**

**A radioactive source emits three type of radiations.**

**(a) Name the radiation of zero mass.**

**(b) Name the radiation which has the lowest ionising power.**

**(c) Name the radiation which has the lowest penetrating power.**

**(d) Give the charge and mass of particles composing the radiation in part (c).**

**(e) When the particle referred to in part (c) becomes neutral, it is found to be the**

**atom of model of its neutral atom.**

**(f) From which part of the atom do these radiations come?**

**Solution:**

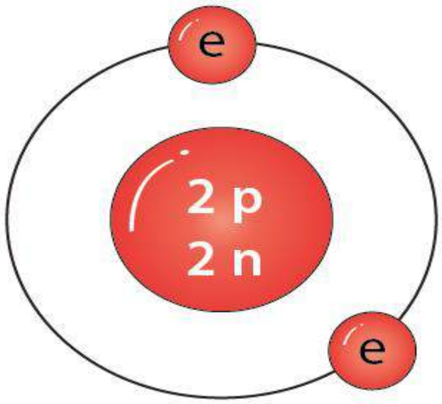
(a) The radiation which has zero mass are gamma radiations

(b) Gamma radiations has the lowest ionizing power

(c) Alpha radiation has the lowest penetrating power

(d) Alpha particles has positive charge = $3.2 \times 10^{-19}$ C and rest mass = 4 times the mass of proton i.e., $6.68 \times 10^{-27}$ kg

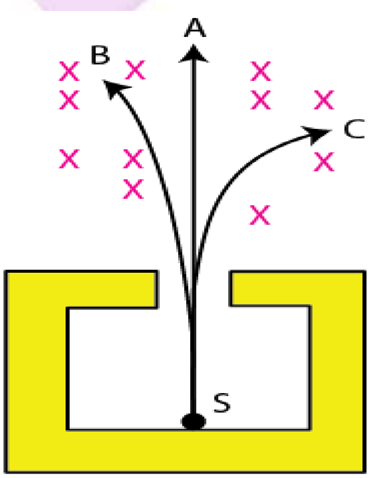
(e) The name of the gas is helium




(f) These radiations come from the nucleus of an atom

**Question: 12**

**The diagram in figure shows a radioactive source S placed in a thick lead walled container. The radiations given out are allowed to pass through a magnetic field. The magnetic field (shown as x) acts perpendicular to the plane of paper inwards. Arrows shows the paths of the radiation A, B and C.**




**(a)Name the radiations labelled A, B and C.**

**(b)Explain clearly how you used the diagram to arrive at the answer in part (a).**

**Solution:**

(a) The radiations labelled as A, B and C are γ, α and β respectively

(b) The radiation labelled as A is gamma radiation as they have no charge and thus under the action of magnetic field they go undeflected

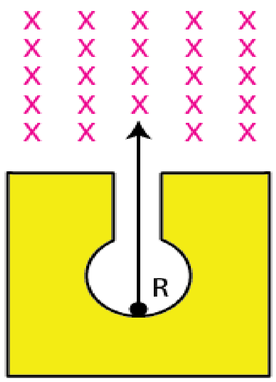
The radiation labelled as B is alpha radiation since its mass is large and it would be deflected less in comparison to beta radiation. Fleming's left hand rule determines the direction of deflection. As the alpha and beta have opposite charges, hence the direction of deflection of alpha and beta radiations are also opposite

**Question: 13**

**Fig. shows a mixed source R of alpha and beta particles in a thick lead walled container. The particles pass through a magnetic field in a direction perpendicular to the plane of paper inwards as shown by x.**

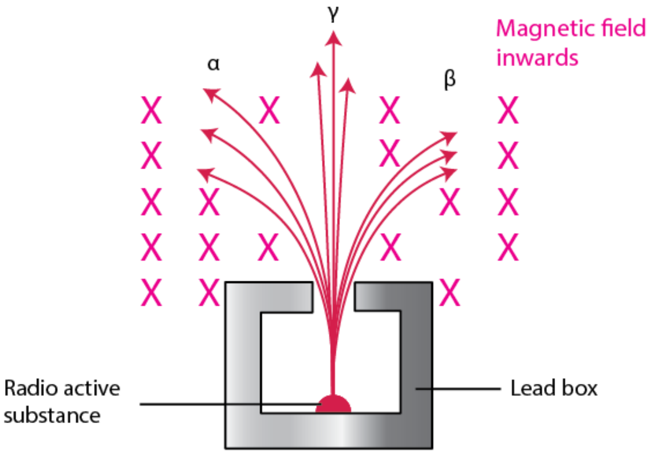
**(a) Show in the diagram how the particles get affected.**

**(b) Name the law used in part (a)**




**Solution:**

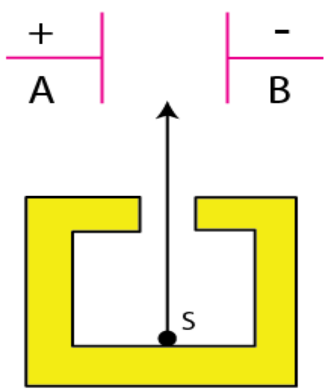
**(a)**




(b) The name of the law is Fleming's left hand rule

**Question: 14**

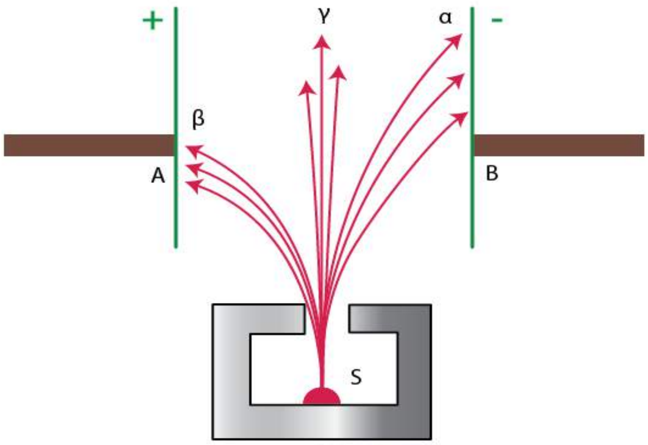
**Fig. shows a radioactive source S in a thick lead walled container having a narrow opening. The radiations pass through an electric field between the plates A and B.**




**(a)Complete the diagram to show the paths of α, β and γ radiations.**
**(b)Why is the source S kept in a thick lead walled container with a narrow opening?**
**(c) Name the radiation which is unaffected by the electrostatic field.**
**(d) Which radiation is deflected the most. Give reason.**
**(e) Which among the three radiations causes the least biological damage?**

**Solution:**

(a)




(b) The radiation coming out from other directions may cause biological damage. Hence to stop these radiations the radioactive substances are kept in thick lead containers with a very narrow opening.
(c) The radiation unaffected by the electrostatic field is gamma radiations
(d) The radiation which deflect the most is beta radiations. This is because the deflection of a beta particle is in a direction opposite to that of an alpha particle since the charge on beta particle is negative, while the charge on alpha particle is positive. Hence beta particle is much lighter than an alpha particle
(e) Alpha radiations causes the least biological damage

**Question: 15**

**Explain why alpha and beta particles are deflected in an electric or a magnetic field, but gamma rays are not deflected in such a field.**

**Solution:**

Alpha and beta radiations are charged particles. Alpha is positively charged and beta is negatively charged. Hence these are deflected in an electric or magnetic field whereas gamma radiations uncharged particles or neutral and therefore cannot deflect in an electric or magnetic field.

**Question: 16**

**Is it possible to deflect γ radiations in a way similar to α and β particles, using the electric or magnetic field? Give reasons.**

**Solution:**

No, gamma radiations cannot deflect in a way similar to alpha and beta particles using electric or magnetic field because they are uncharged or neutral. Thus they do not deflect under the action of electric or magnetic field.

**Question: 17**

**State following four properties each of α, β and γ radiations: (a) nature, (b) charge,**

**(c) mass, and (d) effect of electric field.**
**Solution:**

| Property | α - particle | β - particle | γ - particle |
|---|---|---|---|
| Nature | Stream of positively charged particles i.e., helium nucleus. | Stream of negatively charged particles, i.e., energetic electrons | Highly energetic electromagnetic radiation. |
| Charge | Positive charge (two times that of a proton) = $+3.2 \times 10^{-19}$ C (or +2e) | Negative charge = $-1.6 \times 10^{-19}$ C (or –e) | No charge |
| Mass | Four times the mass of proton i.e., $6.68 \times 10^{-27}$ kg | Equal to the mass of electron i.e., $9.1 \times 10^{-31}$ kg | No mass (rest mass is zero) |
| Effect of electric field | Less deflected | More deflected than alpha particles, but in a direction opposite to those of α-particles | Unaffected |

**Question: 18**
**Arrange the α, β and γ radiations in ascending order of their (i) ionizing power, and (ii) penetrating power.**
**Solution:**
(i) Gamma radiation have least ionizing power, beta radiations have lesser ionizing power i.e., 100 times of gamma radiation and alpha radiations have maximum ionizing power i.e., 1000 times of gamma radiation.
Thus the ascending order of their ionizing power is

$\gamma < \beta < \alpha$

(ii) Penetrating power is least for alpha particle, large for beta particles and very large for gamma particles.
Hence, the ascending order of penetrating power is

$\alpha < \beta < \gamma$

**Question: 19**
**State the speed of each of** α, β and **γ radiations.**
**Solution:**
The speed of α radiations is of the order of $10^7$ m s$^{-1}$, speed of β radiations is of the order of $10^8$ m s$^{-1}$ and the speed of **γ** radiations is same as the speed of light i.e., $3 \times 10^8$ m s$^{-1}$ in

vacuum or air.

**Question: 20**
**(a) What is the composition of α, β and γ radiations?**
**(b) Which one α, β and γ radiation has the least penetrating power?**
**Solution:**
**(a)** Alpha radiations are composed of two protons and two neutrons, α radiation carries a double positive charge. Beta radiations are composed of fast moving electrons and are negatively charged. Gamma radiations are composed of photons or electromagnetic waves like X rays.
(b) Radiations which have the least penetrating power are alpha radiations.

**Question: 21**
**How are γ radiations produced? Mention two common properties of the gamma radiations and visible light.**
**Solution:**
When a nucleus is in a state of excitation i.e., when it has an excess of energy then the gamma radiations are produced. Hence, this extra energy is released in the form of gamma radiation.
Like X-rays and light, gamma radiations are not deflected by the electric and magnetic fields since they are uncharged particles. The speed of gamma radiations is same as the speed of light.

**Question: 22**
**An α particle captures (i) one electron, (ii) two electrons. In each case, what does it change to?**
**Solution:**
When an α particle captures one electron it becomes a singly ionized helium $He^+$ and when it captures two electrons it changes to neutral helium atom.

**Question: 23**
**‘Radioactivity is a nuclear phenomenon’. Comment on this statement.**
**Solution:**
Any physical change (such as change in pressure and temperature) or chemical change (such as excessive heating, freezing, action of strong electric and magnetic fields, chemical treatment, oxidation etc.) does not change the rate of decay and the nature of radiation emitted by the substance. This shows clearly that the phenomenon of radioactivity cannot be due to the orbital electrons which could easily be affected by such changes. Therefore the radioactivity should be the property of the nucleus. Thus the

radioactivity is a nuclear phenomenon.

**Question: 24**
**What kind of change takes place in a nucleus when a β particle is emitted? Express it by an equation. State whether (a) atomic number, and (b) mass number are conserved in a radioactive β-decay?**
**Solution:**
Due to the emission of β particle, the number of nucleons in the nucleus remains same, but the number of neutrons is decreased by one and the number of protons is increased by one.
If a radioactive nucleus P with mass number A and atomic number Z emits a beta-particle to form a daughter nucleus Q with mass number A and atomic number Z + 1, the change can be represented as follows:

$$\underset{\text{Parent nucleus}}{{}^{A}_{Z}P} \longrightarrow \underset{\text{Daughter nucleus}}{{}^{A}_{Z+1}Q} + \underset{\text{Beta-particle}}{{}^{0}_{-1}e}$$

(a) Atomic number Z is increased by 1
(b) Mass number remains unchanged

**Question: 25**
**A certain radioactive nucleus emits a particle that leaves its mass number unchanged, but increases its atomic number by one. Identify the particle and write its symbol.**
**Solution:**
A particle that leaves its mass number unchanged, but increases its atomic number by one is beta particle. The symbol of β particle is given by

$${}^{0}_{-1}e \text{ or } {}^{0}_{-1}\beta$$

**Question: 26**
**What happens to the (i) atomic number, (ii) mass number of the nucleus of an element when (a) an α particle, (b) a β particle, and (c) γ radiation, is emitted?**
**Solution:**
(a) When an α particle is emitted atomic number decreases by 2 and mass number decreases by 4
(b) When a β particle is emitted atomic number increases by 1 and mass number remains unchanged
(c) When γ radiation is emitted there is no change in atomic number and mass number

**Question: 27**

**What happens to the position of an element in the periodic table when its nucleus emits (a) an α particle, (b) a β particle and (c) γ radiation? Give reason for your answer.**

**Solution:**

When an α particle is emitted, the daughter element occupies two places to the left of the parent element in the periodic table

Reason: If a parent nucleus X becomes a new daughter nucleus Y as a result of α decay, then the change can be expressed in the form of reaction as follows:

$$\underset{\text{Parent nucleus}}{{}^{A}_{Z}X} \longrightarrow \underset{\text{Daughter nucleus}}{{}^{A-4}_{Z-2}Y} + \underset{\alpha\ \text{particle}}{{}^{4}_{2}He}$$

Thus due to emission of an alpha particle, atomic number Z decreases by 2 units and therefore it shifts two places to the left of the parent element in the periodic table

(b) When β particle is emitted, the daughter element occupies one place to the right of the parent element in the periodic table.

Reason: As a result of β decay, if a parent nucleus X becomes a new daughter nucleus Y then the β decay can be represented as follows:

$$\underset{\text{Parent nucleus}}{{}^{A}_{Z}P} \longrightarrow \underset{\text{Daughter nucleus}}{{}^{A}_{Z+1}Q} + \underset{\text{(Beta particle)}}{{}^{0}_{-1}e}$$

Thus it shifts one place to the right of the parent element in the periodic table as the resulting nucleus has an atomic number equal to (Z+1).

(c) By the emission of γ radiation, the element occupies the same position in the periodic table

Reason: As a result of γ decay, if a parent nucleus X becomes a new daughter nucleus Y then the γ decay can be represented as follows:

$$\underset{\text{Parent nucleus}}{{}^{A}_{Z}X} \longrightarrow \underset{\text{Daughter nucleus}}{{}^{A}_{Z}Y} + \underset{\text{(gamma particle)}}{\gamma}$$

Therefore since the resulting nucleus has atomic number equal to Z so, it occupies the same position as the parent element in the periodic table

**Question: 28**

**What changes occur in a nucleus of a radioactive element when it emits (a) an alpha particle, (b) a beta particle, (c) gamma radiation? Give one example, in each case (a) and (b) in support of your answer.**

**Solution:**

The following are the changes which occur when an atom emits

(a) When alpha particle emits, the atomic number decreases by 2 units and mass number decreases by 4 units

Example:

$$^{238}_{92}U \longrightarrow ^{234}_{90}Th + ^{4}_{2}He$$

(b) When beta particle emits, the atomic number increases by 1 and the mass number remains unchanged

Example:

$$^{1}_{0}n \longrightarrow ^{1}_{1}P + ^{0}_{-1}e$$

(c) When gamma particle emits, the atomic number and mass number does not change. Hence, the energy of the nucleus decreases

Example:

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

**Question: 29**

**(a) An atomic nucleus A is composed of 84 protons and 128 neutrons. The nucleus A emits an α particle and is transformed into a nucleus B. What is the composition of B?**

**(b) The nucleus B emits a β particle and is transformed into a nucleus C. What is the composition of C?**

**(c) What is the mass number of the nucleus A?**

**(d) Does the composition of nucleus C change if it emits the γ radiation?**

**Solution:**

(a) The composition of B becomes 82 protons and 126 neutrons

(b) The composition of C becomes 83 protons and 125 neutrons

(c) The mass number of nucleus A = number of protons + number of neutrons

84 + 128 = 212

Thus the mass number of nucleus A = 212

(d) The composition of nucleus C does not change if it emits the γ radiation

**Question: 30**

**A certain nucleus A (mass number 238 and atomic number 92) is radioactive and becomes a nucleus B (mass number 234 and atomic number 90) by the emission of a particle.**

**(a) Name the particle emitted.**

**(b) Explain how you arrived at your answer.**

**(c) State the change in the form of a reaction.**

**Solution:**

(a) The particle emitted is alpha particle

(b) The atomic number is decreased by 2 and mass number is decreased by 4. This happens when alpha particle is emitted.

(c) $^{238}_{92}P \longrightarrow ^{234}_{90}Q + ^{4}_{2}\alpha$

**MULTIPLE CHOICE TYPE**

**Question: 1**

**A radioactive substance emits radiations:**

**(a) α, β and γ simultaneously**

**(b) in the order α, β and γ one by one**

**(c) X-rays and γ-rays**

**(d) α or β.**

**Solution:**

A radioactive substance emits radiations α or β.

**Question: 2**

**In β-emission from a radioactive substance, an electron is ejected. This electron comes from:**

**(a) the outermost orbit of atom**

**(b) the inner orbits of atom**

**(c) the surface of substance**

**(d) the nucleus of atom**

**Solution:**

The electron comes from the nucleus of an atom

**Question: 3**

**The least penetrating radiation is:**

**(a) α-particles**

**(b) β-particles**

**(c) X-rays**

**(d) γ-radiations**

**Solution:**

The least penetrating radiation is α-particles

**Question: 4**

**The radiation suffering the maximum deflection in a magnetic field is:**

**(a) α-particles**
**(b) β-particles**
**(c) X-rays**
**(d) γ-radiations**
**Solution:**
The radiation suffering the maximum deflection in a magnetic field is β-particles.

## EXERCISE 12(B) PAGE NO: 306

**Question: 1**
**What do you mean by nuclear energy? What is responsible for its release?**
**Solution:**
The energy released by the nucleus of an atom during nuclear reaction i.e., during fission or fusion is called as nuclear energy. Nuclear fission and nuclear fusion are responsible for the release of nuclear energy.

**Question: 2**
**Write down the Einstein's mass-energy equivalence relation, explaining the meaning of each symbol used in it.**
**Solution:**
Einstein's mass-energy equivalence relation is $E = (\Delta m)\ c^2$
Here Δm is the loss in mass in kg, c is the speed of light (= $3 \times 10^8$ m $s^{-1}$) and E is the energy in joule (J).

**Question: 3**
**(a) What is a.m.u? Express 1 a.m.u. in MeV.**
**(b) Write the approximate mass of a proton, neutron and electron in a.m.u.**
**Solution:**
The mass of atomic particles expressed in atomic mass unit (a.m.u) where 1 a.m.u. = 931

MeV.
The mass of a proton = 1.00727 a.m.u.
The mass neutron = 1.00865 a.m.u.
The mass of electron = 0.00055 a.m.u.

**Question: 4**
**What is nuclear fission? Name the particle used for it. Write one fission reaction.**
**Solution:**
Nuclear fission is the process in which a heavy nucleus splits into two lighter nuclei of nearly the same size, when bombarded with slow neutrons.

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow (^{236}_{92}U) \longrightarrow ^{144}_{56}Ba + ^{89}_{36}Kr + 3\ ^{1}_{0}n + \text{energy}$$

**Question: 5**
**(a) Name two isotopes of uranium which are fissionable.**
**(b) Which of the isotope mentioned in part (a) above is easily fissionable? Give reason.**
**(c) State whether the neutron needed for fission reaction of the isotope mentioned in part (b) above, is slow or fast?**
**Solution:**
(a) $^{238}_{92}U$ and $^{235}_{92}U$ are the isotopes which are fissionable
(b) $^{235}_{92}U$ is more easily fissionable than the isotope $^{238}_{92}U$. This is because the fission of $^{238}_{92}U$ nucleus is possible only by the fast neutrons, while the fission of $^{235}_{92}U$ nucleus can be even by the slow neutrons.
(c) Both slow and fast

**Question: 6**
**Write the approximate value of the energy released in the fission of one nucleus of $^{235}_{92}U$. What is the reason for it?**
**Solution:**
In the fission of one $^{235}_{92}U$ nucleus, nearly 190 MeV energy is released. The loss in mass is the main cause of emission of this energy i.e., the sum of masses of product nuclei is less than the sum of mass of the parent nucleus and the mass of neutron.

**Question: 7**
**Complete the following nuclear fission reactions:**

**(a)** $^{235}_{92}U + ^{1}_{0}n \longrightarrow {}_{56}Ba + ^{92}Kr + 3\ ^{1}_{0}n + .......$

**(b)** $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{148}La + ^{85}_{35}Br + ......\ ^{1}_{0}n$ **+ energy**

**Solution:**

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

(b) $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{148}_{57}La + ^{85}_{35}Br + 3\ ^{1}_{0}n$ + energy

**Question: 8**

**What do you mean by the chain reaction in nuclear fission? How is it controlled?**

**Solution:**

A process in which a neutrons released in fission produces an additional fission in at least one further nucleus releasing enormous amount of energy is known as a chain reaction. The chain reaction is controlled by absorbing some of the neutrons emitted in the fission process by means of the cadmium rods and then making them slow by the moderators such as graphite, heavy water, etc, the energy obtained in fission can be utilized for the constructive purposes.

**Question: 9**

**State two uses of nuclear fission?**

**Solution:**

Nuclear fission can be used in two ways

(i) It is used in a nuclear bomb where the energy released is fast and uncontrolled

(ii) It is used in a nuclear reactor where the rate of release of energy is slow and controlled. This energy is used to generate the electric power.

**Question: 10**

**Give two differences between the radioactive decay and nuclear fission.**

**Solution:**

| Radioactive decay | Nuclear fission |
|---|---|
| It is a spontaneous process | It does not occur by itself. It is initiated when, neutrons are bombarded on a heavy nucleus |
| The rate of radioactive decay cannot be controlled | The rate of nuclear fission can be controlled |

**Question: 11**

**(a) What is nuclear fusion? Give one example and write its nuclear reaction.**

**(b) What other name is given to nuclear fusion? Give reason.**
**Solution:**
A nuclear fusion is the process in which two light nuclei combine to form a heavy nucleus releasing huge amount of energy.
Example: Hydrogen and hydrogen can fuse to form helium

$${}_1^2H + {}_1^3H \longrightarrow {}_2^4He + {}_0^1n + 17.6\ MeV$$

(b) Nuclear fusion is also called as thermo-nuclear reaction because nuclear fusion takes place at very high temperature

**Question: 12**
**Why is a very high temperature required for the process of nuclear fusion? State the approximate temperature required.**
**Solution:**
When two nuclei approach each other, due to their positive charge, the electrostatic force of repulsion becomes too strong between them that they donot fuse. Hence, at ordinary temperature and pressure nuclear fusion is not possible.
To make the fusion possible, a high temperature of approximately $10^7$ K and high pressure is required. Due to thermal agitations both nuclei acquire sufficient kinetic energy at such a high temperature so as to overcome the force of repulsion between them when they approach each other and so they get fused.

**Question: 13**
**(a) Write one nuclear fusion reaction.**
**(b) State the approximate value of energy released in the reaction mentioned in part (a).**
**(c) Give reason for the release of energy stated in part (b).**
**Solution:**
(a)

$$\underset{\text{(deuterium)}}{{}_1^2H} + \underset{\text{(deuterium)}}{{}_1^2H} \longrightarrow \underset{\text{(helium isotope)}}{{}_2^3He} + \underset{\text{(neutron)}}{{}_0^1n} + 3.3\ MeV$$

(b)

$$\underset{\text{(helium isotope)}}{{}_2^3He} + \underset{\text{(deuterium)}}{{}_1^2H} \longrightarrow \underset{\text{(helium)}}{{}_2^4He} + \underset{\text{(proton)}}{{}_1^1H} + 18.3\ MeV$$

Thus in all three deuterium nuclei fuse to form a helium nucleus with a release of 21.6 MeV.

When two deuterium nuclei $({}_1^2H)$ fuse, 3.3 MeV energy is released and the nucleus of helium isotope $({}^{3}_{2}He)$ is formed. In this process again this helium isotope gets fused with one deuterium nucleus to form a helium nucleus $({}^{4}_{2}He)$ and 18.3 MeV is released.

**Question: 14**
**Complete the following fusion reactions:**

**(a)** $^{3}_{2}He + {}^{2}_{1}H \longrightarrow {}_{2}He + {}_{1}H$ **+ energy**

**(b)** $^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}_{2}He + {}^{1}n$ **+ energy**

**Solution:**
Following are the complete fusion reactions

(a) $^{3}_{2}He + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{1}H$ + energy

(b) $^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}^{3}_{2}He + {}^{1}_{0}n$ + energy

**Question: 15**
**(a) Name the process, nuclear fission or nuclear fusion, in which the energy released per unit mass is more?**
**(b) Name the process, fission or fusion which is possible at ordinary temperature.**
**Solution:**
(a) The process in which the energy released per unit mass is more is nuclear fusion
(b) The process which is possible at ordinary temperature is nuclear fission

**Question: 16**
**(a) State one similiarity in the process of nuclear fission and fusion.**
**(b) State two differences between the process of nuclear fission and fusion.**
**Solution:**
(a) Similiarity: Both nuclear fission and fusion release large amounts of energy
(b) (i) In nuclear fission when neutrons are bombarded on a heavy nucleus, it splits in two nearly equal light fragments whereas in nuclear fusion, at a very high temperature and high pressure two light nuclei combine to form a heavy nucleus
(ii) Nuclear fission is possible at ordinary temperature and ordinary pressure whereas nuclear fusion is possible only at a very high temperature and a very pressure.

**Question: 17**
**Give two examples of nuclear fusion.**
**Solution:**
(i)

$$\underset{\text{(proton)}}{{}^{1}_{1}H} + \underset{\text{(proton)}}{{}^{1}_{1}H} \longrightarrow \underset{\text{(deuterium)}}{{}^{2}_{1}H} + 0.42\text{ MeV}$$

(ii)

$$\underset{\text{(deuterium)}}{{}^{2}_{1}H} + \underset{\text{(deuterium)}}{{}^{2}_{1}H} \longrightarrow \underset{\text{(tritium)}}{{}^{3}_{1}H} + \underset{\text{(proton)}}{{}^{1}_{1}H} + 4.0\text{ MeV}$$

**Question: 18**
**What is the source of energy of sun or stars?**
**Solution:**
The source of energy of the sun or stars is the nuclear fusion of light nuclei such as hydrogen present in their inner part at a very high temperature and a high pressure. This results the formation of helium nucleus with a release of tremendous amount of energy.

**Question: 19**
**Name the following nuclear reactions:**
**(a)**

$${}^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{90}_{38}Sr + {}^{143}_{54}Xe + 3\,{}^{1}_{0}n + \gamma$$

**(b)**

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

**Solution:**
(a) The name of the reaction is nuclear fission
(b) The name of the reaction is nuclear fusion

**MULTIPLE CHOICE TYPE**
**Question: 1**
**The particle used in nuclear fission for bombardment is:**
**(a) alpha particle**
**(b) proton**
**(c) beta particle**
**(d) neutron.**
**Solution:**
The particle used in nuclear fission for bombardment is neutron

**Question: 2**
**The temperature required for the process of nuclear fusion is nearly:**
**(a) 1000 K**

**(b) $10^4$ K**
**(c) $10^5$ K**
**(d) $10^7$ K**
**Solution:**
The temperature required for the process of nuclear fusion is nearly $10^7$ K

**NUMERICALS**
**Question: 1**
**In fission of one uranium-235 nucleus, the loss in mass is 0.2 a.m.u. Calculate the energy released.**
**Solution:**
We know that,
1 a.m.u = 931 MeV
During nuclear fission the reaction mass defect is converted into energy release = 0.2 a.m.u
Hence, E = 0.2 × 931
E = 186.2 MeV
**Question: 2**
**When four hydrogen nuclei combine to form a helium nucleus in the interior of sun, the loss in mass is 0.0265 a.m.u. How much energy is released?**
**Solution:**
Given
$\Delta m$ = 0.0265 a.m.u.
1 a.m.u = 931.5 MeV of energy
Therefore energy liberated equivalent to 0.0265 a.m.u. is
= 0.0265 a.m.u. × 931.5 MeV
= 24.7 MeV