UNIT 6

NUCLEAR PHYSICS

Important Points

- This phenomenon of spontaneous emission of radiation from certain elements on its own is called 'natural radioactivity'.
- Curie is defined as the quantity of a radioactive substance, which undergoes $3.7 \times 10_{10}$ disintegrations in one second. This is actually close to the activity of 1 g of radium–226.
- Rutherford (Rd) is defined as the quantity of a radioactive substance which produces 10^6 disintegrations in one second.
  1 Rd = 10^6 disintegrations per second.
- The SI unit of radioactivity is becquerel. It is defined as the quantity of one disintegration per second.
- Helium nucleus ($_2He^4$) consisting of two protons and two neutrons is known as alpha particle.
- Beta particles are electrons ($_{-1}e^0$), which are the basic elementary particles present in all atoms.
- Gamma rays are electromagnetic waves consisting of photons.
- A nuclear reaction in which an unstable parent nucleus emits an alpha particle and forms a stable daughter nucleus is called as 'alpha decay'.
- A nuclear reaction in which an unstable parent nucleus emits a beta particle and forms a stable daughter nucleus is called as 'beta decay'.
- The process of breaking (splitting) up of a heavier nucleus into two smaller nuclei with the release of a large amount of energy is called 'nuclear fission'.
- The energy released in a nuclear fission process is about 200 MeV.
- There are some radioactive elements which can be converted into a fissionable material. They are called as 'fertile materials'. e.g. Uranium–238, Thorium–232, Plutonium–240
- Controlled chain reaction is used in a nuclear reactor to produce energy in a sustained and controlled manner.
- The process in which two lighter nuclei combine to form a heavier nucleus is termed as 'nuclear fusion'
- Nuclear fusion or thermonuclear reaction is the source of light and heat energy in the Sun and other stars.
- The safe limit of receiving the radiation is about 100 mR per week.

TEXT BOOK EVALUATION

I. Book Exercise – Choose the best answer

1. Man-made radioactivity is also known as _____.

a. Induced radioactivity
b. Spontaneous radioactivity
c. Artificial radioactivity
d. a & c

Ans : (d) a & c

2. Unit of radioactivity is _____.

a. roentgen
b. curie
c. becquerel
d. all the above

Ans : (d) all the above

3. Artificial radioactivity was discovered by _____.

a. Bequerel b. Irene Curie c. Roentgen d. Neils Bohr

Ans : (b) Irene Curie

4. In which of the following, no change in mass number of the daughter nuclei takes place

i) α decay ii) β decay iii) γ decay iv) neutron decay

a. (i) is correct b. (ii) and (iii) are correct

c. (i) & (iv) are correct d. (ii) & (iv) are correct

Ans : (c) (i) & (iv) are correct

5. _____ isotope is used for the treatment of cancer.

a. Radio Iodine b. Radio Cobalt c. Radio Carbon d. Radio Nickel

Ans : (b) Radio Cobalt

6. Gamma radiations are dangerous because

a. it affects eyes & bones b. it affects tissues

c. it produces genetic disorder d. it produces enormous amount of heat

Ans : (c) it produces genetic disorder

7. _____ aprons are used to protect us from gamma radiations

a. Lead oxide b. Iron c. Lead d. Aluminium

Ans : (c) Lead

8. Which of the following statements is/are correct?

i) α particles are photons ii) Penetrating power of γ radiation is very low

iii) Ionization power is maximum for α rays iv) Penetrating power of γ radiation is very high

a. (i) & (ii) are correct b. (ii) & (iii) are correct c. (iv) only correct d. (iii) & (iv) are correct

Ans : (d) (iii) & (iv) are correct

9. Proton - Proton chain reaction is an example of _____.

a. Nuclear fission b. α - decay c. Nuclear fusion d. β - decay

Ans : (c) Nuclear fusion

10. In the nuclear reaction $_6X^{12} \xrightarrow{\alpha \text{ decay}} {}_ZY^A$, the value of A & Z.

a. 8, 6 b. 8, 4

c. 4, 8 d. cannot be determined with the given data

Ans : (c) 4, 8

11. Kamini reactor is located at _____.

a. Kalpakkam b. Koodankulam c. Mumbai d. Rajasthan

Ans : (a) Kalpakkam

12. Which of the following is/are correct?

i) Chain reaction takes place in a nuclear reactor and an atomic bomb.

ii) The chain reaction in a nuclear reactor is controlled

iii) The chain reaction in a nuclear reactor is not controlled

iv) No chain reaction takes place in an atom bomb

a. (i) only correct b. (i) & (ii) are correct c. (iv) only correct d. (iii) & (iv) are correct

Ans : (b) (i) & (ii) are correct

II. Book Exercise – Fill in the blanks

1. One roentgen is equal to _____ disintegrations per second. **Ans :** 2.58×10^{-4}
2. Positron is an _____. **Ans :** Elementary particle
3. Anemia can be cured by _____ isotope. **Ans :** Fe^{59}
4. Abbreviation of ICRP _____. **Ans :** International Commission on Radiological Protection

5. _____ is used to measure exposure rate of radiation in humans. **Ans :** Roentegen
6. _____ has the greatest penetration power. **Ans :** γ–rays
7. ${}_{Z}Y^{A} \rightarrow {}_{Z+1}Y^{A} + X$; Then, X is _____. **Ans :** beta
8. ${}_{Z}X^{A} \rightarrow {}_{Z}Y^{A}$ This reaction is possible in _____ decay. **Ans :** γ
9. The average energy released in each fusion reaction is about _____ J. **Ans :** 3.84×10^{-12}
10. Nuclear fusion is possible only at an extremely high temperature of the order of _____ K.
Ans : 10^{7} to 10^{9}
11. The radio isotope of _____ helps to increase the productivity of crops. **Ans :** Phosphorus 32
12. If the radiation exposure is 100 R, it may cause _____. **Ans :** fatal diseases like leukemia

III. Book Exercise – True or False (If false correct it)

1. **Plutonium -239 is a fissionable material.**
Ans : True.
2. **Elements having atomic number greater than 83 can undergo nuclear fusion.**
Ans : False. Elements having atomic number lesser than 83can undergo nuclear fusion.
3. **Nuclear fusion is more dangerous than nuclear fission.**
Ans : False. Nuclear fission is more dangerous than Nuclear fusion.
4. **Natural uranium U-238 is the core fuel used in a nuclear reactor.**
Ans : False. Natural plutonium is the core fuel used in a nuclear reactor.
5. **If a moderator is not present, then a nuclear reactor will behave as an atom bomb.**
Ans : True.
6. **During one nuclear fission on an average, 2 to 3 neutrons are produced.**
Ans : True.
7. **Einstein's theory of mass energy equivalence is used in nuclear fission and fusion.**
Ans : True.

IV. Book Exercise – Match the following

1.

1.	**BARC**	**(a)**	**Kalpakkam**
2.	**India's first atomic power station**	**(b)**	**Apsara**
3.	**IGCAR**	**(c)**	**Mumbai**
4.	**First nuclear reactor in India**	**(d)**	**Tarapur**

Ans :

1	BARC	c	Mumbai
2	India's first atomic power station	d	Tarapur
3	IGCAR	a	Kalpakkam
4	First nuclear reactor in India	b	Apsara

2.

1.	**Fuel**	**(a)**	**Lead**
2.	**Moderator**	**(b)**	**Heavy water**
3.	**Coolant**	**(c)**	**Cadmium rods**
4.	**Shield**	**(d)**	**Uranium**

Ans :

1	Fuel	d	Uranium
2	Modertaor	b	Heavy water
3	Coolant	c	Cadmium rods
4	Shielf	a	Lead

3.

1.	**Soddy Fajan**	**(a)**	**Natural radioactivity**
2.	**Irene Curie**	**(b)**	**Displacement law**
3.	**Henry Bequerel**	**(c)**	**Mass energy equivalence**
4.	**Albert Einstein**	**(d)**	**Artificial Radioactivity**

Ans :

1	Soddy Fajan	b	Displacement law
2	Irene Curie	d	Artificial Radioactivity
3	Henry Bequerel	a	Natural radioactivity
4	Albert Einstein	c	Mass energy equivalence

4.

1.	**Uncontrolled fission reaction**	**(a)**	**Hydrogen bomb**
2.	**Fertile material**	**(b)**	**Nuclear reactor**
3.	**Controlled fission reaction**	**(c)**	**Breeder reactor**
4.	**Fusion reaction**	**(d)**	**Atom bomb**

Ans :

1	Uncontrolled fission reaction	d	Atom bomb
2	Fertile material	c	Breeder reactor
3	Controlled fission reaction	b	Nuclear reactor
4	Fusion reaction	a	Hydrogen bomb

5.

1.	**Co – 60**	**(a)**	**Age of fossil**
2.	**I – 131**	**(b)**	**Function of heart**
3.	**Na – 11**	**(c)**	**Leukemia**
4.	**C – 14**	**(d)**	**Thyroid disease**

Ans :

1	Co – 60	c	Leukemia
2	I – 131	d	Thyroid disease
3	Na – 11	b	Function of heart
4	C – 14	a	Age of fossil

V. Book Exercise – Answer the following in correct sequence

1. Arrange in descending order, on the basis of their penetration power

Alpha rays, beta rays, gamma rays, cosmic rays

Gamma rays, Beta rays, Alpha rays, Cosmic rays.

2. Arrange the following in the chronological order of discovery

Nuclear reactor, radioactivity, artificial radioactivity, discovery of radium.

radioactivity, Discovery of radium, artificial radioactivity, Nuclear reactor.

VI. Book Exercise – Use the analogy to fill in the blank

1. Spontaneous process : Natural Radioactivity, Induced process : _____. **Ans :** Artificial Radioactivity
2. Nuclear Fusion : Extreme temperature, Nuclear Fission : _____. **Ans :** Low Temperature
3. Increasing crops : Radio phosphorous, Effective functioning of heart : _____. **Ans :** Radio sodium
4. Deflected by electric field : α ray, Null Deflection : _____. **Ans :** γ rays

VII. Book Exercise – Numerical problems

1. **$_{88}Ra^{226}$ experiences three α - decay. Find the number of neutrons in the daughter element.**
   132 Neutrons.

1. **A cobalt specimen emits induced radiation of 75.6 millicurie per second. Convert this disintegration in to becquerel (one curie = 3.7×10^{10} Bq)**
   2797200000 becquerel = 75.6 millicurie.

VIII. Book Exercise – Assertion and reason type questions

Mark the correct choice as

- **i) If Both the assertion and the reason are true and the reason is the correct explanation of assertion.**
- **ii) Both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.**
- **iii) Assertion is true, but the reason is false.**
- **iv) Assertion is false, but the reason is true.**

1. **Assertion:** A neutron impinging on U^{235}, splits it to produce Barium and Krypton.
   Reason: U - 235 is a fissile material.
   Ans : (i) Both the assertion and the reason are true and the reason is the correct explanation of the assertion

2. **Assertion:** In a β - decay, the neutron number decreases by one.
   Reason: In β - decay atomic number increases by one.
   (i) If Both the assertion and the reason are true and the reason is the correct explanation of assertion

3. **Assertion:** Extreme temperature is necessary to execute nuclear fusion.
   Reason: In a nuclear fusion, the nuclei of the reactants combine releasing high energy.
   Ans : (i) Both the assertion and the reason are true and the reason is the correct explanation of the assertion

4. **Assertion:** Control rods are known as 'neutron seeking rods'.
   Reason: Control rods are used to perform sustained nuclear fission reaction.
   Ans : (i) Both the assertion and the reason are true and the reason is the correct explanation of the assertion

IX. Book Exercise – Answer in one or two word (VSA)

1. **Who discovered natural radioactivity?**
   Henri Becquerel.
2. **Which radioactive material is present in the ore of pitchblende?**
   Uranium.
3. **Write any two elements which are used for inducing radioactivity?**
   Boron, Aluminium.
4. **Write the name of the electromagnetic radiation which is emitted during a natural radioactivity.**
   α – rays.
5. **If A is a radioactive element which emits an α - particle and produces $_{104}Rf^{259}$. Write the atomic number and mass number of the element A.**
   $_{106}Sg^{263}$ Atomic number of A = 106, Mass number of A = 263.
6. **What is the average energy released from a single fission process?**
   3.2×10^{-11}J.
7. **Which hazardous radiation is the cause for the genetic disease?**
   γ – rays.

8. What is the amount of radiation that may cause death of a person when exposed to it?

Acute radiation Syndrome is a collection of health effects that are present within 24 hrs of exposure to ionizing radiation. It is also called radiation poisoning, radiation sickness and radiation toxicity.

9. When and where was the first nuclear reactor built?

Chicago, USA 1942.

10. Give the SI unit of radioactivity.

Becquerel.

10. Which material protects us from radiation?

Lead.

X. Book Exercise – Answer the following in few sentences

1. Write any three features of natural and artificial radioactivity.

S.No.	Natural radioactivity	Artificial radioactivity
1	Emission of radiation due to self–disintegration of a nucleus.	Emission of radiation due to disintegration of anucleus through induced process
2	Alpha, beta and gamma radiations are emitted.	Mostly elementary particles such as neutron, positron, etc., are emitted.
3	it is a spontaneous process.	It is an induced process.
4	Exhibited by elements with atomic number more than 83.	Exhibited by elements with atomic number less than 83.
5	This cannot be controlled.	This can be controlled.

2. Define critical mass.

The minimum mass of a fissile material necessary to sustain the chain reaction is called 'critical mass (mc)'. It depends on the nature, density and the size of the fissile material.

3. Define one roentgen.

Roentgen (R): It is The radiation exposure of y and x-rays is measured by another unit called roentgen. One roentgen is defined as the quantity of radioactive substance which produces a charge of 2.58×10^{-4} coulomb in 1 kg of air under standard conditions of pressure, temperature and Humidity.

4. State Soddy and Fajan's displacement law.

i) When a radioactive element emits an alpha particle, a daughter nucleus is formed whose mass number is less by 4 units and the atomic number is less by 2 units, than the mass number and atomic number of the parent nucleus.

ii) When a radioactive element emits a beta particle, a daughter nucleus is formed whose mass number is the same and the atomic number is more by 1 unit, than the atomic number of the parent nucleus.

5. Give the function of control rods in a nuclear reactor.

Control rod : Control rods are used to control the number of neutrons in order to have sustained chain reaction. Mostly boron or cadmium rods are used as control rods. They absorb the neutrons.

6. In Japan, some of the new born children are having congenital diseases. Why?

The nuclear bomb that was dropped in Hiroshima during World War II was called as 'Little boy'. It was a gun-type bomb which used a uranium core. The bomb, which was subsequently dropped over Nagasaki was called as 'Fat man'. It was an explosion type bomb, which used a plutonium core. Due to this some of the new born children are having congenital diseases.

7. Mr. Ramu is working as an X - ray technician in a hospital. But, he does not wear the lead aprons. What suggestion will you give to Mr. Ramu?

Lead aprons are the most effective personal radiation protection means and should be worn by everyone in a fluoroscopy room (except the patient).Lead aprons may reduce the dose received by over 90% depending on the energy of the X- rays and the lead equivalent thickness of the apron.

8. What is stellar energy?

Fusion reaction that takes place in the cores of the Sun and other stars results in an enormous amount of energy, which is called as 'stellar energy'. Thus, nuclear fusion or thermonuclear reaction is the source of light and heat energy in the Sun and other stars.

9. Give any two uses of radio isotopes in the field of agriculture?

Phosphorus- 32 and Nitrogen-15.

10. What is stellar energy?

Fusion reaction that takes place in the cores of the Sun and other stars results in an enormous amount of energy, which is called as 'stellar energy'. Thus, nuclear fusion or thermonuclear reaction is the source of light and heat energy in the Sun and other stars.

XI. Book Exercise – Answer the following questions in detail

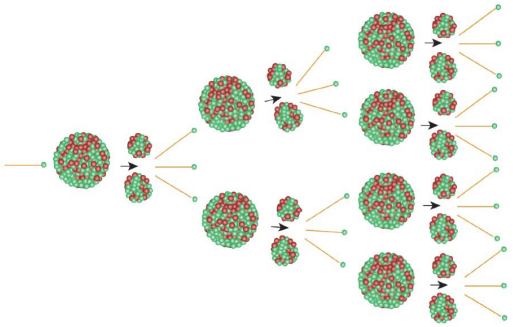
1. Explain the process of controlled and uncontrolled chain reactions.

Two kinds of chain reactions are possible. They are;

(i) controlled chain reaction and (ii) uncontrolled chain reaction.

i) Controlled chain reaction In the controlled chain reaction the number of neutrons released is maintained to be one. This is achieved by absorbing the extra neutrons with a neutron absorber leaving only one neutron to produce further fission. Thus, the reaction is sustained in a controlled manner. The energy released due to a controlled chain reaction can be utilized for constructive purposes. Controlled chain reaction is used in a nuclear reactor to produce energy in a sustained and controlled manner.

ii) Uncontrolled chain reaction In the uncontrolled chain reaction the number of neutrons multiplies indefinitely and causes fi ssion in a large amount of the fissile material. Th is results in the release of a huge amount of energy within a fraction of a second. Th is kind of chain reaction is used in the atom bomb to produce an explosion. Figure 6.3 represents an uncontrolled chain reaction.



2. Compare the properties of alpha, beta and gamma radiations.

Properties	**α rays**	**β rays**	**γ rays**
What are they? (Nature)	Helium nucleus ($_2He^4$) consisting of two protons and two neutrons.	They are electrons ($_{-1}e^0$), basic elementary particle in all atoms.	They are electromagnetic waves consisting of photons.
Charge	Positively charged particles. Charge of each alpha particle = +2e	Negatively charged particles. Charge of each beta particle = –e	Neutral particles. Charge of each gamma particle = zero
Ionising power	100 time greater than β rays and 10,000 times greater than γ rays	Comparatively low	Very less ionization power

Properties	α rays	β rays	γ rays
Penetrating power	Low penetrating power (even stopped by a thick paper)	Penetrating power is greater than that of α rays. They can penetrate through a thin metal foil.	They have a very high penetrating power greater than that of β rays. They can penetrate through thick metal blocks.
Effect of electric and magnetic field	Deflected by both the fields. (in accordance with Fleming's left hand rule)	Deflected by both the fields; but the direction of deflection is opposite to that for alpha rays. (in accordance with Fleming's left hand rule)	They are not deflected by both the fields.
Speed	Their speed ranges from 1/10 to 1/20 times the speed of light.	Their speed can go up to 9/10 times the speed of light.	They travel with the speed of light.

3. What is a nuclear reactor? Explain its essential parts with their functions.

A Nuclear reactor is a device in which the nuclear fission reaction takes place in a self-sustained and controlled manner to produce electricity. The first nuclear reactor was built in 1942 at Chicago, USA.

Components of a nuclear reactors : The essential components of a nuclear reactor are (i) fuel, (ii) moderator, (iii) control rod, (iv) coolant and (v) protection wall.

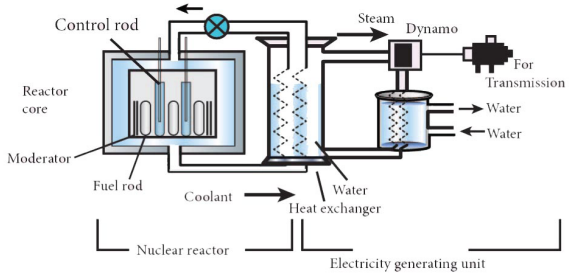
i) **Fuel :** A fissile material is used as the fuel. The commonly used fuel material is uranium.

ii) **Moderator :** A moderator is used to slow down the high energy neutrons to provide slow neutrons. Graphite and heavy water are the commonly used moderators.

iii) **Control rod :** Control rods are used to control the number of neutrons in order to have sustained chain reaction. Mostly boron or cadmium rods are used as control rods. They absorb the neutrons.

iv) **Coolant :** A coolant is used to remove the heat produced in the reactor core, to produce steam. This steam is used to run a turbine in order to produce electricity. Water, air and helium are some of the coolants.

v) **Protection wall :** A thick concrete lead wall is built around the nuclear reactor in order to prevent the harmful radiations from escaping into the environment.



XII. Book Exercise – HOT questions

1. Mass number of a radioactive element is 232 and its atomic number is 90. When this element undergoes certain nuclear reactions, it transforms into an isotope of lead with a mass number 208 and an atomic number 82. Determine the number of alpha and beta decay that can occur.?

Determine the number of alpha decay:

$208 = 232 - 4X$

Solve for X

$232 - 4X - 232 = 208 - 232$ (substract 232 from both sides)

$-4X = -24$

$-X = -6$

$X = 6.$

This means that this progress undergoes 6 α-decays, which means 6 nuclei of He have been emitted. Determine the number of Beta decay is four.

2. 'X – rays should not be taken often'. Give the reason.

X- rays and gamma rays can cause a number of other problems besides cancer. Lower doses of radiation, such as from imaging tests are not known to cause short – term health problems.

3. Cell phone towers should be placed far away from the residential area – why?

Cell towers produce non ionizing radiation with a wavelength longer than that of visible light. If cell towers residing in our area, then turnoff all lights, because short wavelength,like X-rays and Gamma rays are dangerous, ionizing radiation. Long wave ultra violet light, with a wave length shorter than visible light, causes sunburn. Shorter still is short UV light, that with continued exposure can cause melanoma (wear sunscreen).

Additional – Choose the best answer

1. Matter is made up of tiny indestructible units called _____.

a) Atoms b) molecules c) element d) compound

Ans : (a) Atoms

2. _____ discovered cathode rays known as electrons.

a) Democritus b) JJ Thomson c. Goldstein d) milikan

Ans : (b) JJ Thomson

3. _____ discovered positive rays which were named as protons.

a) Democritus b) JJ Thomson c. Goldstein d) milikan

Ans : (c) Goldstein

4. _____ discovered charge less particles called Neutrons.

a) JJ Thomson b) Democritus c) Goldstein d) milikan

Ans : (c) Goldstein

5. _____ explained that the mass of an atom is concentrated in its central part called nucleus.

a) JJ Thomson b) Democritus c) Rutherford d) milikan

Ans : (c) Rutherford

6. _____ discovered that he could reproduce the effect whenever he placed uranium near a photographic film.

a) JJ Thomson b) Democritus c) Henri Becquerel d) Marie curie

Ans : (c) Henri Becquerel

7. _____ was identified to be a radioactive element.

a) Thorium b) Uranium c) Polonium d) radium

Ans : (b) Uranium

8. Henri Becqurrel is a _____ physicist.

a) French b) English c) Italian d) german

Ans : (a) French

9. The elements whose atomic number is more than _____ undergo spontaneous radioactivity.

a) 85 b) 83 c) 89 d) 90

Ans : (b) 83

10. Techneciumwith atomic number _____.

a) 40 b) 43 c) 67 d) 50

Ans : (b) 43

11. Promethium with atomic number _____.

a) 40 b) 67 c) 34 d) 61

Ans : (d) 61

12. There have been _____ radioactive substances discovered so far. Most of them are rare earth metals and transition metals.

a) 30 b) 29 c) 28 d) 31

Ans : (b) 29

13. During such a disintegration, the nucleus which undergoes disintegration is called _____.
a) parent nucleus b) daughter nucleus c) either a or b d) none
Ans : (a) parent nucleus

14. _____ is a induced process.
a) Natural radioactivity b) Artificial radioactivity c) either a or b d) none
Ans : (b) Artificial radioactivity

15. _____ rays electromagnetic waves consisting of photons.
a) α rays b) γ rays c) cosmic rays d) β rays
Ans : (b) γ rays

16. Decay of Uranium to thorium with the emission of an _____ particles.
a) α b) γ c) cosmic d) β
Ans : (a) α

17. Fissile Materials are _____ and _____.
a) Uranium-235 and Plutonium 239, 241 b) Thorium 232, Uranium 238
c) aluminium - 27 thorium232 d) non
Ans : (a) Uranium-235 and plutonium 239, 241

18. Fertile materials are _____.
a) Uranium–238 b) Thorium–232 c) Plutonium–240 d) all the above
Ans : (d) All the above

19. The energy released in a nuclear fission process is about _____ MeV.
a) 200 b) 300 c) 250 d) 350
Ans : (a) 200

20. _____ is based on the principle of nuclear fusion.
a) Hydrogen Bomb b) Atom bomb c) nuclear reactor d) none
Ans : (a) Hydrogen Bomb

21. _____ is used to diagnose anemia and also to provide treatment for the same.
a) Radio–Iodine b) Radio–iron c) Radio–sodium d) all the above
Ans : (b) Radio-Iron

22. _____ is a device used to detect the levels of exposure to an ionizing radiation.
a) Dosimeter b) pocket dosimeter c) either a or b d) none
Ans : (a) Dosimeter

Additional – Fill in the blanks

1. A Greek philosopher _____ in 400 BC believed that matter is made up of tiny indestructible units called atoms.
Ans : Democritus
2. In 1803, _____ considered that elements consist of atoms, which are identical in nature.
Ans : John Dalton
3. _____ and her husband _____ detected radioactivity in Pitchblende.
Ans : Marie curie, Pierre curie
4. _____ is a tiny black ore substance.
Ans : Pitchblende
5. _____ is known as an ore of Uranium.
Ans : Pitchblende
6. _____ and _____ are radioactive elements.
Ans : Uranium, radium
7. The natural radioactive elements emit harmful radioactive radiations like _____,_____ and _____.
Ans : alpha, beta and gamma rays
8. The phenomenon of nuclear decay of certain elements with the emission of radiations like alpha, beta and gamma rays is called _____.
Ans : natural radioactivity

9. The elements, which undergo this phenomenon are called _____. **Ans :** radioactive elements
10. The phenomenon of spontaneous emission of radiation from certain elements on their own is called _____. **Ans :** Natural radioactivity
11. The elements whose atomic number is more than 83 undergo _____. **Ans :** spontaneous radioactivity
12. _____ and _____ there are only two elements which have been identified as radioactive substances with atomic number less than 83. **Ans :** Uranium and radium
13. The phenomenon by which even light elements are made radioactive, by artificial or induced methods, is called _____ or _____. **Ans :** Artificial radioactivity or man made radioactivity
14. Artificial radioactivity was discovered by _____ and _____ in 1934. **Ans :** Irene curie , F. Joliot
15. _____ particles emitted during the natural radioactivity of Uranium. **Ans :** Alpha
16. During such a disintegration, the nucleus which undergoes disintegration is called _____ **Ans :** parent nucleus.
17. Radiations produced after the disintegration is called a _____. **Ans :** Daughter nucleus
18. The particle is used to induce the artificial disintegration is termed as _____. **Ans :** Projectile
19. The particle which is produced after the disintegration is termed as _____ particle. **Ans :** Ejected particle
20. _____ is unstable and is radioactive. **Ans :** $_6C^{12}$
21. _____ radioactivity cannot be controlled. **Ans :** Natural
22. _____ radioactivity can be controlled. **Ans :** Artificial
23. _____ is the traditional unit of radioactivity. **Ans :** Curie
24. Curie is defined as the quantity of a radioactive substance which undergoes _____ disintegrations in one second. **Ans :** 3.7×10^{10}
25. Cuire is actually close to the activity of 1g of _____. **Ans :** radium 226
26. 1 curie = _____ disintegrations per second. **Ans :** 3.7×10^{10}
27. _____ is another unit of radioactivity. **Ans :** Rutherford
28. Rutherford is defined as the quantity of a radioactive substance, which produces _____ disintegrations per second. **Ans :** 10^6
29. 1Rd = _____ disintegrations per second. **Ans :** 10^6
30. _____ SI unit of radioactivity. **Ans :** Becqurel
31. Becqurel is defined as the quantity of _____ disintegration per Second. **Ans :** one
32. _____ is the radiation exposure of ɣ and x–rays is measured by another unit. **Ans :** Roentgen
33. One roentgen is defined as the quantity of radioactive substance which produces a charge of _____ coulomb in 1kg of air. **Ans :** 2.58×10^{-4}
34. Uranium, named after the planet _____. **Ans :** Uranus
35. Pitchblende mineral was discovered by _____. **Ans :** Martin Klaproth
36. In1913, _____ and _____ framed the displacement law. **Ans :** Soddy and Fajan.
37. When a radio active element emits an _____ particle, a daughter nucleus is formed whose mass number is less by 4 units. **Ans :** Alpha
38. The atomic number is less by 2 units, than the mass number and atomic number of the _____. **Ans :** Parent nucleus
39. When a radioactive element emits a _____ particle, a daughter nucleus is formed. **Ans :** Beta or alfa
40. _____ nucleus consisting of two protons and two neutrons. **Ans :** Helium
41. _____ rays are electrons basic elementary particle in all atoms. **Ans :** Beta

42. _____ positively charged particles. **Ans :** Alpha rays
43. _____rays are Negatively charged particles. **Ans :** Beta
44. _____ neutral particles. **Ans :** Gamma
45. Charge of each gamma ray is _____. **Ans :** Zero
46. _____ rays are comparatively low. **Ans :** Beta
47. _____ rays are very less ionization power. **Ans :** gamma
48. _____ rays have low penetrating power. **Ans :** Alpha
49. _____ rays are penetrate through a thin metal foil. **Ans :** beta
50. _____ rays are penetrate through thick metal blocks. **Ans :** Gamma
51. Alpha rays their speed ranges from _____ times the speed of light. **Ans :** 1/10 to 1/20
52. Beta rays speed can go up to _____ times the speed of light. **Ans :** 9/10
53. _____ rays travel with the speed of light. **Ans :** Gamma
54. A nuclear reaction in which an unstable parent nucleus emits an alpha particle and forms a stable daughter nucleus is called _____ decay. **Ans :** Alpha
55. Decay of Uranium to thorium with the emission of an _____ particle. **Ans :** Alpha
56. A nuclear reaction, in which an _____ parent nucleus emits a beta particle and forms a stable daughter nucleus is called beta decay. **Ans :** Unstable
57. In Gamma decay, only the energy level of the _____ changes. **Ans :** nucleus
58. In 1939, german scientist _____ and _____ discovered nuclear fission reaction. **Ans :** Otta Hahn and F.Strassman
59. When a Uranium nucleus is bombarded with a neutron, it breaks up into smaller nuclei of comparable mass along with the emission of few neutrons and _____. **Ans :** energy
60. The process of breaking up of a heavier nucleus into two smaller _____ with the release of _____ amount of energy and a few neutrons is called Nuclear fission. **Ans :** nuclei, large
61. A fissionable material is a radioactive element, which undergoes fission in a sustained manner when it absorbs a neutron. It is also termed as _____ material. **Ans :** fissile
62. All isotopes of _____ do not undergo nuclear fission when they absorb a neutron. **Ans :** uranium
63. Uranium 235 is a ---------- material and Uranium 238 is a _____. **Ans :** Fissionable , Non fissionable
64. A Uranium nucleus when bombarded with a neutron undergoes fission producing _____ neutrons. **Ans :** three
65. _____ chain reaction is used in a nuclear reactor to produce energy in a sustained and controlled manner. **Ans :** Controlled
66. In _____ reaction a huge amount of energy within a fraction of second. **Ans :** Umcontrolled chain
67. The minimum mass of a fissile material necessary to sustain the chain reaction is called _____. **Ans :** critical mass
68. ---------- depends on the nature, density and the size of the fissile material. **Ans :** Critical mass
69. If the mass of the fissile material is _____ than the critical mass it is termed as _____. **Ans :** Subcritical
70. If the mass of the fissile material is more than the critical mass it is termed as _____. **Ans :** Supercritical
71. The _____ is based on the principle of uncontrolled reaction. **Ans :** Atom bomb
72. In an _____ chain reaction , the number of neutrons and the number of fission reactions multiply almost in a geometrical progression. **Ans :** Uncontrolled

73. Atom bomb releases a _____ amount of energy in a very small time interval and leads to an explosion. **Ans :** Huge
74. During atombomb explosion tremendous amount of energy in the form of _____, _____ and _____ is released. **Ans :** heat, light and radiation
75. Atom bombs were exploded in 1945 at _____ and _____ in japan during the world war II. **Ans :** Hiroshima and Nagasaki
76. _____ is the unit used in nuclear physics to measure the energy of small particles. **Ans :** Electron Volt
77. Electron volt is nothing but the energy of one electron when it is accelerated using an electric potential of _____. **Ans :** One volt
78. 1 electron volt = _____. **Ans :** 1.602×10^{-19} Joule
79. I million electron volt = _____. **Ans :** 1 MeV = 10^6 electron volt
80. The energy released in a nuclear fission process is about _____. **Ans :** 200Mev
81. A heavy nucleus is split up into smaller nuclei. Energy can be produced when two lighter nuclei combine to form a heavier nucleus. This phenomenon known as _____. **Ans :** Nuclear fusion
82. The process in which two lighter nuclei combine to form a heavier nucleus is termed as _____. **Ans :** nuclear fusion
83. $_1H^2$ represents an isotope of hydrogen known as _____. **Ans :** Deuterium
84. The average energy released in each fusion reaction is about _____. **Ans :** 3.84×10^{-12}J
85. The concept of mass- energy equivalence was proposed by _____ in 1905. **Ans :** Einstein
86. The velocity of light in vaccum and is equal to _____. **Ans :** 3×10^8 m/s
87. The nuclear bomb that was dropped in Hiroshima during World War II called as _____. **Ans :** Little Boy
88. The little boy was a _____ type bomb which used a uranium Core. **Ans :** GUN
89. The bomb , which was subsequently dropped over _____ Was called as _____. **Ans :** Nagasaki, Fatman
90. _____ was an explosion type bomb, which used in plutonium core. **Ans :** Fatman
91. Earth's atmosphere contains a small trace of _____. **Ans :** hydrogen
92. _____ is a Spontaneous process at normal temperature and pressure. **Ans :** Nuclear fusion
93. Nuclear fusion is possible only at an extremely high temperature of the order of 10^7 to 10^9 K. This is called as _____ reaction. **Ans :** Thermonuclear
94. _____ is the combination of two lighter nuclei. **Ans :** Nuclear Fusion
95. The charge of nuclei is _____. **Ans :** Positive
96. According to electrostatic theory , when they come closer they tend to _____ each other. **Ans :** repel
97. _____ force will be overcome by the kinetic energy of the nuclei at higher temperature of the order of _____. **Ans :** ans: Repulsive, 10^7 to 10^9 K
98. The stars like our sun emit a large amount of energy in the form of _____ and _____. **Ans :** Light and heat
99. All stars contain a large amount of _____. **Ans :** Hydrogen
100. The surface temperature of the stars is very _____ which is sufficient to induce fusion of the hydrogen nuclei. **Ans :** high
101. _____ reaction that takes place in the cores of the sun and other stars results in an enormous amount of energy, which is called as stellar energy. **Ans :** Fusion
102. Nuclear fusion or _____ is the source of light and heat energy in the sun and other stars. **Ans :** thermonuclear reaction
103. _____ is based on the principle of nuclear fusion. **Ans :** Hydrogen bomb

104. A _____ bomb is always designed to have an inbuilt atom bomb which creates the high temperature and pressure required for fusion when it explodes. **Ans :** Hydrogen

105. The energy released in a _____ is much higher than that released in an atom bomb. **Ans :** Hydrogen

106. Sun fuses about _____ million metric tons of hydrogen each second and radiates about _____ J of energy per second. **Ans :** 620, 3.8×10^{26}

107. Radio isotope of Phosphorous (P^{32}) Helps to increase the _____. **Ans :** productivity of crops

108. Radio Sodium (Na^{24}) is used for the effective _____. **Ans :** Functioning of the heart

109. Radio Iodine (I^{131}) is used to cure _____. **Ans :** Goiter

110. Radio-Iron is (Fe^{59}) is used to diagnose _____ and also to provide treatment for the same. **Ans :** Anaemia

111. Radio-phosphorus (P^{32}) is used in the treatment of _____ diseases. **Ans :** Skin

112. Radio cobalt (Co^{60}) and Radio gold (Au^{198}) are used in the treatment of _____ cancer. **Ans :** Skin

113. Radiations are used to sterilize the surgical devices as they can kill the _____ and _____. **Ans :** germs and microbes

114. In industries, radioactive isotopes are used as tracers to detect any manufacturing defects such as _____ and _____. **Ans :** Cracks and leaks

115. An isotope of _____ is used in the airlines to detect the explosives in the luggage. **Ans :** Californium–252

116. An isotope of Americium (Am-241) is used in many industries as a _____. **Ans :** Smoke detector

117. _____ research used to identify the radio carbon dating the age of earth , fossils , old paintings and Monuments. **Ans :** Archeological

118. The second source of radiation exposure is _____. **Ans :** Man made

119. Safe limit of overall exposure is given as _____ milli Sievert per year. **Ans :** 20

120. In terms of Roentgen, the safe limit of receiving the radiation is about _____ mR per week. **Ans :** 100

121. Leukemia is a death of _____ in the blood. **Ans :** red blood corpuscle

122. _____ is a device used to detect the levels of exposure to an ionizing radiation. **Ans :** Dosimeter

123. _____ is used to provide the wearer with an immediate reading of exposure to X–rays and Y–rays. **Ans :** Pocket dosimeter

124. Radioactive materials should be kept in a thick walled _____ container. **Ans :** Lead

125. _____ and _____ should be used while working with hazardous radioactive materials. **Ans :** Lead coated aprons and Lead gloves

126. A _____ is a device in which the nuclear fission reaction takes place in a self- sustained and controlled manner to produce electricity. **Ans :** Nuclear reactor

127. The first nuclear reactor was built in 1942 at _____, USA. **Ans :** Chicago

128. _____ and _____ are the commonly used moderators. **Ans :** Graphite and Heavy water

129. Mostly _____ or _____ rods are used as control rods. **Ans :** boron , cadmium

130. Water, air and _____ are some of the coolants. **Ans :** Helium

131. _____ are widely used in power generation. **Ans :** Nuclear reactors

132. _____ are used to convert non-fissionable materials into fissionable materials. **Ans :** breeder reactors

133. _____ was the first chairman of Indian Atomic energy commission. **Ans :** Homi Jahangir bhaba

134. BARC _____. **Ans :** Baba Atomic Research centre

135. Nuclear power is the _____ largest source of power in India. **Ans :** Fifth

136. Total number of power stations in India is _____. **Ans :** 7

137. _____ was the first nuclear reactor built in India and Asia. **Ans :** Apsara

138. There are _____ nuclear reactors which are opening in India. **Ans :** 22

Additional – True or false (correct the statement if it is false)

1. Pitchblende had less concentration of Uranium.
Ans : True.

2. Gamma rays are not defelected by both the fields
Ans : False.Alpha rays deflected by both the fields.

3. A chain reaction is self propagating process in which the number of neutrons goes on multiplying rapidly almost in a geometrical progression.
Ans : True

4. The energy released due to a controlled chain reaction can be not utilized for constructive purposes.
Ans : False. The energy released due to a controlled chain reaction can be utilized for constructive purposes.

5. Tarapur Atomic power station is India's first nuclear power Station.
Ans : True.

Additional – Assertion and reason

1. Assertion: Alpha, Beta and Gamma radiations are emitted.
Reason: It says about Natural radioactivity.

a. A is right R is wrong
b. R explains A
c. R is right A is wrong
d. R does not explain A

Ans : (c) R is right A is wrong

2. Assertion: Gamma rays have a very high penetrating power greater than that of Beta rays.
Reason: They can penetrate through thick metal blocks.

a. A is right R is wrong
b. R is right A is wrong
c. A and R are right
d. A and R are wrong

Ans : (c) A and R are right

3. Assertion: The minimum mass of a fissile material necessary to sustain the chain reaction is called Critical Mass.
Reason: It does not depends on the nature ,density and the size of the fissile material.

a. A is right R is wrong
b. R is right A is wrong
c. A and R are right
d. A and R are wrong

Ans : (a) A is right R is wrong

4. Assertion: Alpha, beta and gamma radiations are emitted in Nuclear fission.
Reason: Alpha rays , positrons and neutrinos are emitted in Nuclear fusion.

a. A is right R is wrong
b. R is right A is wrong
c. A and R are right
d. A and R are wrong

Ans : (c) A and R are right

5. Assertion: A coolant is used to remove the heat produced in the reactor core, to produce steam.
Reason: This steam is used to run a turbine in order to produce electricity.

a. A is right R is wrong
b. R is right A is wrong
c. R explains A
d. R does not explain A

Ans : (c) R explains A

Additional – Short answer questions

1. Define radioactivity.

Ans : The nucleus of some elements is unstable. Such nuclei undergo nuclear decay and get converted into more stable nuclei. During this nuclear reaction, these nuclei emit certain harmful radiations and elementary particles. The phenomenon of nuclear decay of certain elementwith the emission of radiations like alpha, beta, and gamma rays is called 'radioactivity.

2. What are called radio active elements?

The nucleus of some elements is unstable. Such nuclei undergo nuclear decay and get converted into more stable nuclei. During this nuclear reaction, these nuclei emit certain harmful radiations and elementary particles. The phenomenon of nuclear decay of certain elementwith the emission of radiations like alpha, beta, and gamma rays is called 'radioactivity.and the elements, which undergo this phenomenon are called radio active elements.

3. What is called Natural Radio activity?

The elements such as uranium and radium undergo radioactivity and emit the radiations on their own without any human intervention. This phenomenon of spontaneous emission of radiation from certain elements on their own is called 'natural radioactivity'.

4. What is called Artificial Radio activity?

The phenomenon by which even light elements are made radioactive, by artificial or induced methods, is called 'artificial radioactivity' or 'man-made radioactivity'.

5. Compare between Natural and Artificial Radioactivity.

S.No.	Natural radioactivity	Artificial radioactivity
1	Emission of radiation due to self–disintegration of a nucleus.	Emission of radiation due to disintegration of anucleus through induced process
2	Alpha, beta and gamma radiations are emitted.	Mostly elementary particles such as neutron, positron, etc., are emitted.
3	it is a spontaneous process.	It is an induced process.
4	Exhibited by elements with atomic number more than 83.	Exhibited by elements with atomic number less than 83.
5	This cannot be controlled.	This can be controlled.

6. Define the term Curie.

Ans :

Curie: It is the traditional unit of radioactivity. It is defined as the quantity of a radioactive substance which undergoes 3.7×10^{10} disintegrations in one second. This is actually close to the activity of 1 g of radium 226. 1 curie = 3.7×10^{10} disintegrations per second.

7. Define the unit Ruther ford.

Ans : It is another unit of radioactivity. It is defined as the quantity of a radioactive substance, which produces 10^6 disintegrations in one second. 1 Rd = 10^6 disintegrations per second.

8. Define the unit Becquerel.

Ans : It is The SI unit of radioactivity is becquerel. It is defined as the quantity of one disintegration per second.

9. Define the unit Roentgen.

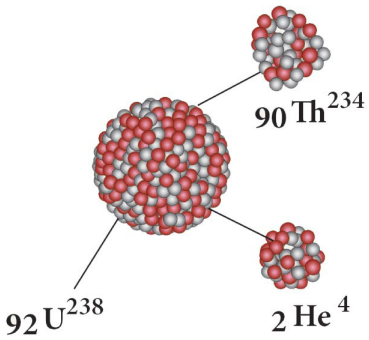
Ans : It is The radiation exposure of γ and x-rays is measured by another unit called roentgen. One roentgen is defined as the quantity of radioactive substance which produces a charge of 2.58×10^{-4} coulomb in 1 kg of air under standard conditions of pressure, temperature and Humidity.

10. Write the types of Rays.

Ans : When a radioactive nucleus undergoes radioactivity, it emits harmful radiations. These radiations are usually comprised of any of the three types of particles. They are alpha (α), beta (β) and gamma (γ) rays.

11. Write a short note on Alpha Decay.

Ans : A nuclear reaction in which an unstable parent nucleus emits an alpha particle and forms a stable daughter nucleus, is called 'alpha decay'. E.g.: Decay of uranium (U^{238}) to thorium (Th^{234}) with the emission of an alpha particle. ${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_{2}He^{4}$ (α - decay) In α - decay, the parent nucleus emits an α particle and so it is clear that for the daughter nucleus, the mass number decreases by four and the atomic number decreases by two.



12. Write a short note on Beta Decay.

Ans : A nuclear reaction, in which an unstable parent nucleus emits a beta particle and forms a stable daughter nucleus, is called 'beta decay'. E.g.: Beta decay of phosphorous. ${}_{15}P^{32}$ ${}_{16}S^{32} + {}_{-1}e^{0}$ (β - decay) In β - decay there is no change in the mass number of the daughter nucleus but the atomic number increases by one.

13. Write a short note on Gamma Decay

Ans : In a γ - decay, only the energy level of the nucleus changes. The atomic number and mass number of the radioactive nucleus remain the same.

14. Differentiate between fissile material and fertile material.

Ans :

Fissile Material :

A fissionable material is a radioactive element, which undergoes fission in a sustained manner when it absorbs a neutron. It is also termed as 'fissile material'. E.g.: U^{235}, plutonium (Pu^{239} and Pu^{241}).

Fertile material :

There are some radioactive elements, which can be converted into fissionable material. They are called as fertile materials. E.g.: Uranium–238, Thorium–232, Plutonium–240.

15. What is called subcritical and supercritical?

Ans : If the mass of the fissile material is less than the critical mass, it is termed as 'subcritical'. If the mass of the fissile material is more than the critical mass, it is termed as 'supercritical'.

16. Explain Electron Volt

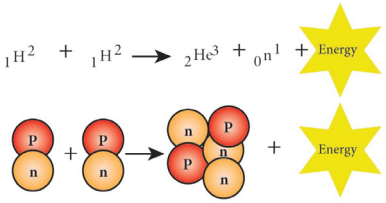
Ans : Electron Volt (eV) is the unit used in nuclear physics to measure the energy of small particles. It is nothing but the energy of one electron when it is accelerated using an electric potential of one volt. 1eV = 1.602×10^{-19} joule. 1 million electron volt = 1 MeV = 10^{6} eV (mega electron volt) The energy released in a nuclear fission process is about 200 MeV.

17. What is called nuclear fusion?

Ans : When a heavy nucleus is split up into two smaller nuclei. Similarly, energy can be produced when two lighter nuclei combine to form a heavier nucleus. This phenomenon is known as Nuclear Fusion.

18. Define Nuclear Fusion

Ans : The process in which two lighter nuclei combine to form a heavier nucleus is termed as 'nuclear fusion'. E.g.: $_1H2 + _1H2 \rightarrow _2He^4 + Q$ (Energy) Here, $_1H^2$ represents an isotope of hydrogen known as 'deuterium'. The average energy released in each fusion reaction is about 3.84×10^{-12} J.



19. Tabulate the features of Nuclear fission and Nuclear Fusion

Ans :

S.No.	Nuclear Fission	Nuclear Fusion
1	The process of breaking up (splitting) of a heavy nucleus into two smaller nuclei is called 'nuclear fission'.	Nuclear fusion is the combination of two lighter nuclei to form a heavier nucleus.
2	Can be performed at room temperature.	Extremely high temperature and pressure is needed.
3	Alpha, beta and gamma radiations are emitted.	Alpha rays, positrons, and neutrinos are emitted.
4	Fission leads to emission of gamma radiation. This triggers the mutation in the human gene and causes genetic transform diseases.	Only light and heat energy is emitted.

20. How old is our mother Earth? Any guess??

Ans : It is nearly 4.54×10^9 years (around 45 Crore 40 lakh years).

21. Write the types of Nuclear reactors.

Ans : Breeder reactor, fast breeder reactor, pressurized water reactor, pressurized heavy water reactor, boiling water reactor, watercooled reactor, gas-cooled reactor, fusion reactor and thermal reactor are some types of nuclear reactors, which are used in different places world wide.

22. Write the uses of a Nuclear reactor.

Ans :

- ✦ Nuclear reactors are widely used in power generation.
- ✦ They are also used to produce radio isotopes, which are used in a variety of applications.
- ✦ Some reactors help us to do research in the field of nuclear physics.
- ✦ Breeder reactors are used to convert nonfissionable materials into fissionable materials.

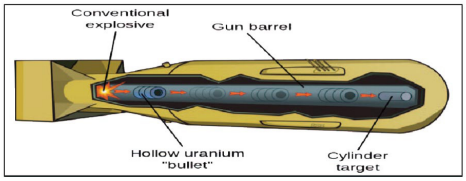
Additional – Long answer questions

1. Explain the structure and working principle of Atom Bomb.

Ans :

- ❖ The atom bomb is based on the principle of uncontrolled chain reaction.
- ❖ In an uncontrolled chain reaction, the number of neutrons and the number of fission reactions multiply almost in a geometrical progression.
- ❖ This releases a huge amount of energy in a very small time interval and leads to an explosion.
- ❖ Structure : An atom bomb consists of a piece of fissile material whose mass is subcritical.
- ❖ This piece has a cylindrical void. It has a cylindrical fissile material which can fit into this void and its mass is also subcritical.
- ❖ When the bomb has to be exploded, this cylinder is injected into the void using a conventional explosive.

- ❖ Now, the two pieces of fissile material join to form the supercritical mass, which leads to an explosionDuring this explosion tremendous amount of energy in the form of heat, light and radiation is released.
- ❖ A region of very high temperature and pressure is formed in a fraction of a second along with the emission of hazardous radiation like γ rays, which adversely affect the living creatures.



2. Explain the principle of Hydrogen Bomb.

Ans : Hydrogen bomb is based on the principle of nuclear fusion. A hydrogen bomb is always designed to have an inbuilt atom bomb which creates the high temperature and pressure required for fusion when it explodes. Then, fusion takes place in the hydrogen core and leads to the release of a very large amount of energy in an uncontrolled manner. The energy released in a hydrogen bomb (or fusion bomb) is much higher than that released in an atom bomb (or fission bomb).

3. Write the Uses of Radio acticity.

Ans : Many radio isotopes can be obtained from radioactivity. These radio isotopes have found wide variety of applications in the fields of medicine, agriculture, industry and archeological research.

Agriculture :

The radio isotope of phosphorous (P–32) helps to increase the productivity of crops. The radiations from the radio isotopes can be used to kill the insects and parasites and prevent the wastage of agricultural products. Certain perishable cereals exposed to radiations remain fresh beyond their normal life, enhancing the storage time. Very small doses of radiation prevent sprouting and spoilage of onions, potatoes and gram.

Medicine Medical applications of radio isotopes can be divided into two parts:

- ❖ Diagnosis.
- ❖ Therapy Radio isotopes are used as tracers to diagnose the nature of circulatory disorders of blood, defects of bone metabolism, to locate tumors, etc.
- ❖ Some of the radio isotopes which are used as tracers are: hydrogen, carbon, nitrogen, sulphur, etc.
- ❖ Radio sodium (Na^{24}) is used for the effective functioning of heart.
- ❖ Radio – Iodine (I^{131}) is used to cure goiter.
- ❖ Radio-iron is (Fe^{59}) is used to diagnose anaemia and also to provide treatment for the same.
- ❖ Radio phosphorous (P^{32}) is used in the treatment of skin diseases.
- ❖ Radio cobalt (Co^{60}) and radio-gold (Au^{198}) are used in the treatment of skin cancer.
- ❖ Radiations are used to sterilize the surgical devices as they can kill the germs and microbes.
- ❖ Industries.
- ❖ In industries, radioactive isotopes are used as tracers to detect any manufacturing defects such as cracks and leaks. Packaging faults can also be identified through radio activity. Gauges, which have radioactive sources are used in many industries to check the level of gases, liquids and solids.
- ❖ An isotope of californium (Cf ^{252}) is used in the airlines to detect the explosives in the luggage.
- ❖ An isotope of Americium (Am^{241}) is used in many industries as a smoke detector.

Archeological research :

Using the technique of radio carbon dating, the age of the Earth, fossils, old paintings and monuments can be determined. In radio carbon dating, the existing amount of radio carbon is determined and this gives an estimate about the age of these things.

4. Explain the safety measures , permitted range and preventive measures of Radioactivity.

Safty measures :

In day to day life, you do receive some natural radiation from the Sun. The radioactive elements present in the soil and rocks, the house hold appliances like television, microwave ovens, cell phones and the X-rays used in hospitals.

- These radiations do not produce any severe effects as they are very low in intensity.The second source of radiation exposure is man-made.
- These are due to nuclear reactors and during the testing of the nuclear devices in the atmosphere or in the ground.
- Improper and careless handling of radioactive materials release harmful radiations in our environment.
- These radiations are very harmful to the human body. A person who is exposed to radiations very closely or for a longer duration, is at a greater health risk and can be affected genetically.

Permitted range :

- The International Commission on Radiological Protection (ICRP) has recommended certain maximum permissible exposure limits to radiation that is believed to be safe without producing any appreciable injury to a person.
- Safe limit of overall exposure to radiation is given as 20 millisievert per year. In terms of roentgen, the safe limit of receiving the radiation is about 100 mR per week.
- If the exposure is 100 R, it may cause fatal diseases like leukemia (death of red blood corpuscle in the blood) or cancer.
- When the body is exposed to about 600 R, it leads to death.

Preventive measures :

- Radioactive materials should be kept in a thick walled lead container.
- Lead coated aprons and lead gloves should be used while working with hazardous radioactive materials.
- You should avoid eating while handling radioactive materials.
- The radioactive materials should be handled only by tongs or by a remote control device.
- Dosimeters should be worn by the users to check the level of radiation.

5. Explain the nuclear power plants in India.

Ans :

- Indian Atomic Energy Commission (AEC) was established in August 1948 by theDepartment of Indian Scientific Research committee at Bombay (now Mumbai) in Maharashtra.
- It is the nodal agency for all the research done in the field of atomic energy.
- Dr. Homi Jahangir Bhaba was the first chairman of Indian Atomic Energy Commission.
- Now, it is known as Bhaba Atomic Research Centre (BARC). Nuclear power is the fifth largest source of power in India.
- Tarapur Atomic Power Station is India's first nuclear power station.
- Now, there are a total of seven power stations, one each inMaharashtra, Rajasthan, Gujarat, Uttar Pradesh and two in Tamilnadu. In Tamilnadu, we have nuclear power stations in Kalpakkam and Kudankulam.
- Apsara was the first nuclear reactor built in India and Asia. Now, there are 22 nuclear reactors which are operating in India.
- Some other operating reactors are;
- Cirus.
- Dhuruva.
- Purnima.

Additional – Solved problems

1. Identify A, B, C, and D from the following nuclear reactions.

i) $_{13}Al^{27} + A \longrightarrow {}_{15}P^{30} + B$

ii) $_{12}Mg^{24} + B \longrightarrow {}_{11}Na^{24} + C$

iii) $_{92}U^{238} + B \longrightarrow {}_{93}Np^{239} + D$

Ans :

i) $_{13}Al^{27} + {}_{2}He^{4} \longrightarrow {}_{15}P^{30} + {}_{0}n^{1}$

ii) $_{12}Mg^{24} + {}_{0}n^{1} \longrightarrow {}_{11}Na^{24} + {}_{1}H^{1}$

iii) $_{92}U^{238} + {}_{0}n^{1} \longrightarrow {}_{93}Np^{239} + {}_{-1}e^{0}$

A is alpha particle, B is neutron, C is proton, and D is electron.

2. A radon specimen emits radiation of 3.7×10^3 GBq per second. Convert this disintegration in terms of curie. (one curie = 3.7×10^{10} disintegration per second)

Ans :

$$1 \text{ Bq} = \text{one disintegration per second}$$

$$\text{one curie} = 3.7 \times 10^{10} \text{ Bq}$$

$$1 \text{ Bq} = \frac{1}{3.7 \times 10^{10}} \text{ curie}$$

$$\therefore 3.7 \times 10^3 \text{ G Bq} = 3.7 \times 10^3 \times 10^9 \times \frac{1}{3.7 \times 10^{10}}$$

$$= 100 \text{ curie.}$$

3. $_{92}U^{235}$ experiences one α - decay and one β - decay. Find number of neutrons in the final daughter nucleus that is formed.

Ans : Let X and Y be the resulting nucleus after the emission of the alpha and beta particles respectively.

$$_{92}U^{235} \xrightarrow{\alpha \text{ decay}} {}_{90}X^{231} + {}_{2}He^{4}$$

$$_{90}X^{231} \xrightarrow{\beta \text{ decay}} {}_{91}Y^{231} + {}_{-1}e^{0}$$

Number of neutrons = Mass number – Atomic number

= 231 – 91

= 140.

4. Calculate the amount of energy released when a radioactive substance undergoes fusion and results in a mass defect of 2 kg.

Ans :

Mass defect in the reaction (m) = 2 kg

Velocity of light (c) = 3×10^8 m s^{-1}

By Einstein's equation,

Energy released E = mc^2

So E = $2 \times (3 \times 10^8)^2$

= 1.8×10^{17} J.

UNIT TEST-6

Time : 1.15 Hrs. Marks : 50

I. Choose the best answer

(5 × 1 = 5)

1. Unit of Radioactivity is _____.

a) Roentgen b) Curie c) Bequrrel d) All the above

2. Artificial radioactivity was discovered by _____.

a) Bequrrel b) Irene curie c) Roentgen d) Neilsbohr

3. _____ aprons are used to protect us from gamma radiations

a) Lead oxide b) lead c) Aluminium d) none

4. Proton-Proton chain reaction is an example of _____.

a) Nuclear fusion b) Nuclear fission c) Alpha decay d) beta decay

5. Kamini reactor is located at _____.

a) Kalpakkam b) Koodankulam c) Mumbai d) Rajasthan

II. Fill in the blanks

(5 × 1 = 5)

6. _____ is the traditional unit of radioactivity.
7. 1 curie = _____ disintegrations per second.
8. _____ SI unit of radioactivity.
9. A Uranium nucleus when bombarded with a neutron undergoes fission producing _____ neutrons.
10. The little boy was a _____ type bomb which used a uranium Core.

III. State whether the statements are true or false. Correct the false statement

(4 × 1 = 4)

11. Pitchblende had less concentration of Uranium.
12. Gamma rays defelected by both the fields.
13. Tarapur Atomic power station is India's first nuclear power Station.
14. Plutonium –239 is a fissionable material.

IV. Match the following

(4 × 1 = 4)

15.	BARC	(a)	Displacement law
16.	IGCAR	(b)	Leukemia
17.	Soddy Fajan	(c)	Mumbai
18.	Co – 60	(d)	Kalpakkam

V. Assertion and Reasoning

(3 × 1 = 3)

Direction: In each of the following questions, a statement of Assertion is given and a corresponding statement of Reason is given just below it. Of the statements given below, mark the correct answer as

a. If both A and R are true and R is the correct explanation of A.
b. If both A and R are true but R is not the correct explanation of A.
c. If A is true but R is false.
d. If both A and R are false.

19. **Assertion :** Alpha, Beta and Gamma radiations are emitted.
Reason : It says about Natural radioactivity.

20. **Assertion :** Gamma rays have a very high penetrating power greater than that of Beta rays.
Reason : They can penetrate through thick metal blocks.

21. **Assertion :** The minimum mass of a fissile material necessary to sustain the chain reaction is called Critical Mass.
Reason : It does not depends on the nature ,density and the size of the fissile material.

VI. Write the answer for the following questions in word or sentence

(3 × 1 = 3)

22. Who discovered natural radioactivity?
23. Which radioactive material is present in the ore of pitchblende?
24. Which material protects us from radiation?

VII. Arrange the following in the correct sequence

(3 × 1 = 3)

25. Arrange in descending order, on the basis of their penetration power.
    Alpha rays, beta rays, gamma rays, cosmic rays
26. Arrange the following in the chronological order of discovery:
    Nuclear reactor, radioactivity, artificial radioactivity, discovery of radium

VIII. Use the analogy to fill in the blank

(3 × 1 = 3)

27. Spontaneous process : Natural Radioactivity, Induced process : _____.
28. Nuclear Fusion : Extreme temperature, Nuclear Fission : _____.
29. Increasing crops : Radio phosphorous, Effective functioning of heart : _____.
30. Deflected by electric field: αray :Null deflection _____.

IX. Write the short answer for ANY 5 of the following questions.

(5 × 2 = 10)

31. Write any three features of natural and artificial radioactivity.
32. Define critical mass.
33. Define one roentgen.
34. State Soddy and Fajan's displacement law.
35. Give the function of control rods in a nuclear reactor.
36. What is stellar energy.
37. Differentiate the Nuclear fusion and Nuclear fission.

X. Write long answer for the following questions

(2 × 5 = 10)

38. Explain the process of controlled and uncontrolled chain reaction.

    [OR]

39. Explain the structure and working principle of Atom Bomb.
40. Explain the principle of Hydrogen Bomb.

    [OR]

41. Write the Uses of Radio activity.