Points to Remember

Radioactivity	Nuclear decay of certain elements with the emission of radiations like alpha, beta, and gamma rays is called radioactivity. ***i) Natural radioactivity :*** Spontaneous emission of radiation from certain elements on their own. ***Ex :*** Uranium, Radium ***ii) Artificial (or) Man-made radioactivity :*** Light elements are made radioactive, by artificial or induced methods. ***Ex :*** Beryllium, Boron

Units of Radioactivity

Curie	Quantity of a radioactive substance, which undergoes 3.7×10^{10} disintegrations in one second.
Rutherford (Rd)	The quantity of a radioactive substance, which produces 10^6 disintegrations in one second.
Becquerel (Bq)	***SI unit*** of Radioactivity. The quantity of one disintegration per second.
Roentgen (R)	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.

Alpha, Beta and Gamma rays

Alpha rays (α)	Helium nucleus ($_2He^4$) consisting of two protons and two neutrons.
Beta rays (β)	They are electrons ($_{-1}e^0$), basic elementary particle in all atoms.
Gamma rays (γ)	Electromagnetic waves consisting of photons.
Radioactive displacement law (or) Soddy and Fajan's 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.

$_{92}U^{235}$ — Mass Number (A); Atomic Number (Z)

Mass number = No. of protons + No. of neutrons
Atomic number = No. of protons

Alpha decay : $_ZY^A \rightarrow {}_{Z-2}Y^{A-4} + {}_2He^4$

Beta decay : $_ZY^A \rightarrow {}_{Z+1}Y^A + {}_{-1}e^0$

Nuclear fission

Nuclear fission reaction	It is the process of breaking (splitting) up of a heavier nucleus into two smaller nuclei with the release of a large amount of energy and a few neutrons. ***Ex:*** $_{92}U^{235} + {}_0n^1 \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\ {}_0n^1 + Q$ (energy)
Fissionable material	It is a radioactive element which undergoes fission in a sustained manner when it absorbs a neutron. ***Ex :*** Uranium-235, Plutonium-239, Plutonium-241.
Fertile material	It is a radioactive element, which can be converted into fissionable material. ***Ex :***Uranium-238, Thorium-232, Plutonium-240.
Chain reaction	A self- propagating process in which the number of neutrons goes on multiplying rapidly almost in a geometrical progression. ***Types :*** ***(i) controlled chain reaction :*** The number of released neutron is maintained to be one to sustain the chain reaction in a controlled manner. ***(ii)uncontrolled chain reaction :***The number of neutrons multiply indefinitely causing more fusion to occur and releases huge energy.
Critical mass (m_c)	It is the minimum mass of a fissile material necessary to sustain the chain reaction. ❋ ***Sub critical :*** If the mass of the fissile material is less than the critical mass. ❋ ***Super critical :*** If the mass of the fissile material is more than the critical mass.
Atom bomb (fission bomb)	***Principle :*** Nuclear fission. It is based on uncontrolled chain reaction which releases a huge amount of energy in a very small time interval leading to explosion.

Nuclear fusion

Nuclear fusion reaction	It is the process in which two lighter nuclei combine to form a heavier nucleus. ***Ex :*** $_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Q$ (energy) It is possible only at extremely high temperature(10^7 *to* 10^9 K) and pressure.
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.
Hydrogen bomb (fusion bomb)	***Principle :*** Nuclear fusion. It have an inbuilt atom bomb to create high temperature and pressure. When it explodes, fusion occurs and releases very large amount of energy in an uncontrolled manner.

Symbols

- Electron - $\mathbf{e^-}$
- Proton - $\mathbf{p^+}$
- Neutron - $\mathbf{{}_0n^1}$
- Positron - $\mathbf{{}_{+1}e^0}$
- Deuterium - $\mathbf{{}_1H^2}$
- α particle - $\mathbf{{}_2He^4}$
- β particle - $\mathbf{{}_{-1}e^0}$

Permitted range of radiation

100 mR per week (or)
20 milli Sievert per year } Safe limit
100 R
→leukemia (or) cancer
600 R → death

Nuclear reactor

A device in which nuclear fission reaction takes place in a self-sustained and controlled manner to produce electricity. ***Types :*** *Breeder, fast breeder, pressurized water, pressurized heavy water, boiling water, water-cooled, gas-cooled, fusion, thermal reactor.*

Fuel	A fissile material is used as the fuel. ***Ex :*** Uranium
Moderator	It slows down high energy neutrons to slow neutrons.***Ex :*** graphite & heavy water.
Control rod	It controls number of neutrons to maintain sustained chain reaction. ***Ex :***Boron, Cadmium
Coolant	It removes heat produced in reactor core, to produce steam. ***Ex :*** Water, Air, Helium
Protection wall	Thick concrete lead wall to prevent harmful radiations from escaping into environment.

❋ **Uses :** *Power generation, Produce radio isotopes, convert non fissionable material to fissionable material, research in nuclear physics.*