CH # 19 NUCLEAR PHYSICS

NUCLEAR PHYSICS:

"The branch of physics that deals with the study of nucleus of an atom is called nuclear physics."

PARTICLES OF NUCLEUS:

Nucleus is the central part of atom. It consists of proton and neutrons.

NUCLEONS:

"Nucleus consists of proton and neutrons these protons and neutrons are called nucleons."

ATOMIC NUMBER:

"Number of proton in nucleus of an atom is called atomic number."

MASS NUMBER:

"Sum of proton and neutron in nucleus of an atom is called mass number."

RADIOACTIVITY:

"The process in which emission of fundamental particles in the form of radiation takes place is called radioactivity."

Experiment:

Rutherford used a simple method for the detection and separation of these radiations. He placed a piece of radioactive substance in a pot lead. These were allowed to pass through a magnetic or electric field.

Observation:

In the presence of strong magnetic field, three distinct lines will be found on photographic plate.

PROPERTIES OF ALPHA, BETA AND GAMMA RAYS

ALPHA RAYS	BETA RAYS	GAMMA RAYS
• They are emitting with a velocity ranging 1.47 x 10^7 m/s.	• They possess the velocity ranging from 9 x 10^7 m/s to 27 x 10^7 m/s.	• They possess the same velocity as that of the light 3 x 10^8m/s.
• They are strong ionizing agents. They are 100 times better ionizing agent than beta particles and 10,000better then gamma rays.	• They are week ionizing agent. They are 100 times less ionizing agent then alpha particles.	• They are also week ionizing agent. They are 1000 times less ionizing agent then alpha particles.
• They produce fluorescence in solution like zinc supplied.	• They produce fluorescence in barium platino-cynide.	• They produce fluorescence in barium platino cyanides.
• Alpha particles can move 2.7cm to 8.2 cm through air at atmospheric pressure.	• They are more penetrating than alpha particles and can easily pass through 3 cm of iron.	• They are more penetrating then beta particles and can easily pass through 30 cm of iron.

• They are scattered by gold foil.	• They are also scattered.	• They are also scattered.
• They produce heating effect.	• They produce heating effect.	• They produce heating effect.

HALF LIFE OF AN ELEMENT:

"The time during which the half of the parent element decays into daughter element is called half-life of an element."

RADIO-ISOTOPES:

"Those species of an element have same atomic number and different mass number and are radio-active in nature are called radio isotopes."

Example:

Sodium = 24 Sulphure 35 Cobalt = 60 Iodine = 31 Carbon = 14 Gold 198.

ISOTOPES:

"Isotopes are atomic species of the same elements which have the same atomic number (Z) but different mass numbers (A). They have the identical chemical properties."

Example:

ISOTOPES OF HYDROGEN	ISOTOPES OF URANIUM	ISOTOPES OF OXYGEN
• Protium ($_1H^1$)	• Uranium ($_{92}U^{234}$)	• Oxygen ($_8O^{16}$)
• Deuterium ($_1H^2$)	• Uranium ($_{92}U^{235}$)	• Oxygen ($_8O^{17}$)
• Tritium ($_1H^3$)	• Uranium ($_{92}U^{238}$)	• Oxygen ($_8O^{18}$)

EINSTEIN MASS-ENERGY RELATION:

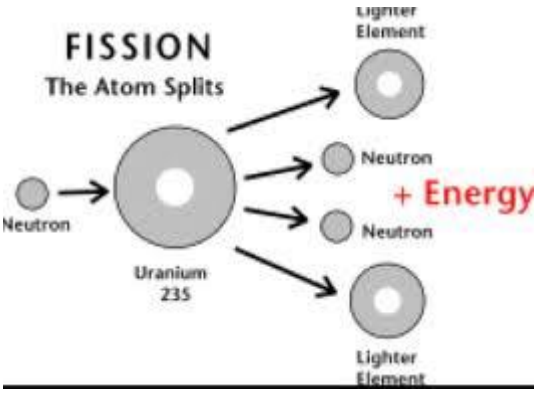
"Einstein proposed a theory of interconvertibility of matter and energy according to the following equation."

$$E = mC^2$$

Where 'E' is the energy produced as a result of conversion of mass into energy and 'C' is the speed of light.

NUCLEAR FISSION:

"The process in which heavy nucleus is broken into two or more fragments with release of energy are called fission."



PROCESS:

Hahn and Steersman found that when an element of uranium ($_{92}U^{235}$) is bombarded with slow moving neutrons, fission takes place spontaneously with the release of energy.

EQUATION:

$$_{92}U^{235} + {}_0n^1 \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_0n^1 + Q$$

Where 'Q' is the amount of energy released in this process.

CHAIN REACTION:

"During fission of one uranium atom three neutrons are released which produced fission in next three uranium atoms and then the fission takes place in ever negative increasing manner. This process is known as chain reaction."

CRITICAL MASS:

"The mass of uranium for producing smooth chain reaction is called critical mass."

Use:

The energy produced during chain reaction can be used for two purposes.

1. *For the benefit of mankind.*
2. *Destructive process(Mechanism of atomic bomb)*

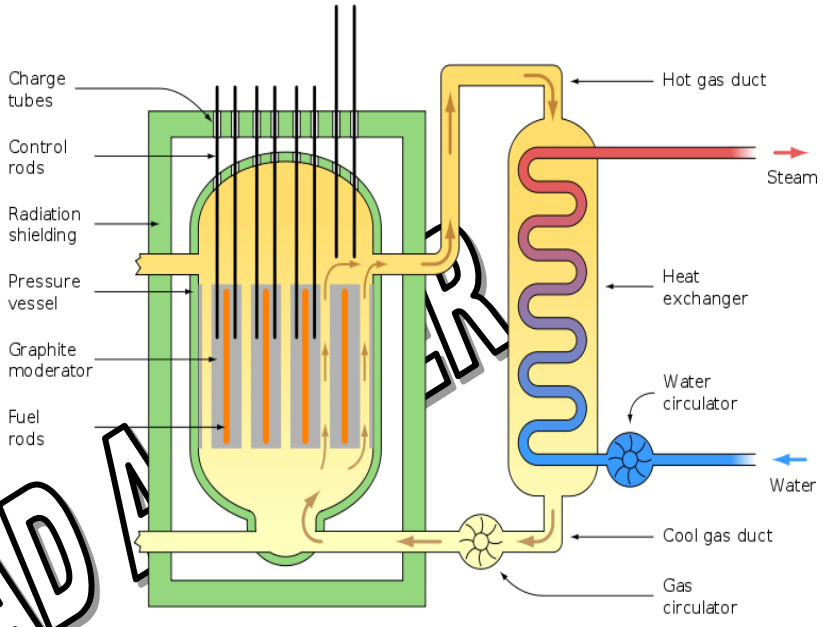
NUCLEAR REACTOR:

"It is a system in which fission takes place in a controlled and self sustaining manners."

PARTS OF REACTOR:

1. Nuclear Fuel:

It is usually $_{92}U^{235}$ moderator. It is usually made up of calcium and used to speed up or slow down the reaction.



2. Coolant:

It extracts heat form core and produces steam which runs turbines of power generator.

3. Control Material:

It controls nuclear chain reaction.

4. Shielding:

It is used to protect the workers.

5. Moderator

Heavy water is used as a moderator to slow down the speed of fast moving neutrons.

IMPORTANCE OF BORON ROD OR CONTROL RODS:

Boron rods or control rods are used as a control material which controlled the amount of energy by controlling the nuclear fission chain reaction.

NUCLEAR FUSION:

"When two lighter stable nuclei combine to form a large unstable nucleus the process is called fusion."

PROCESS:

When two atoms of heavy hydrogen fused together to form helium atom, tremendous amount of energy is released.

EQUATION:

$$_1H^2 + {}_1H^2 \longrightarrow {}_2He^3 + {}_0n^1 + Q$$

Where 'Q' is the amount of energy released in this process.

AMOUNT OF ENERGY:
One kilogram of deuterium when converted into helium, the energy released is six times greater than the energy produce by fission of one kilogram of uranium.

MODERATOR
"Moderator is a part of nuclear used to slow down the speed of fast moving neutrons."

MODERATION:
"The process of slow down the speed of fast moving neutrons in nuclear reactor is called moderation."

ATOMIC BOMB:
It is a war weapon. It is assembled on the principle that if a chain reaction is uncontrolled then the energy released will be enormous. Sub-critical mass of uranium is placed at the two corners of a tube. Atom bomb produces explosion and shock waves, which cause destruction.

HYDROGEN BOMB:
It is a war weapon. It is assembled on the principle of fusion. Hydrogen bomb produces an enormous amount of energy causes destruction.

GENERATION OF ELECTRICITY BY NUCLEAR FISSION:
The heat energy released in a nuclear reactor is used for generating electricity. The het energy produced in a nuclear reactor is carried away by circulating carbon dioxide gas or pressurized water around the reactor core. This hot fluid boils water. The steam produce by billing water is used to drive the turbine of the electric generator for producing electricity. In this way nuclear fission energy is transformed into electrical energy.

USES OF RADIO ISOTOPES
USES OF RADIO ISOTOPES IN INDUSTRY:
- Radioisotopes are used to determine strength of tools of machines.
- Radioisotopes are used to determine the life of tools of machines.
- They are used to remove the faults of machine.

USES OF RADIO ISOTOPES IN AGRICULTURE:
- They are used to increase the resistant power of crops against disease.
- They are used to improve the quality of crops.
- They are also used to preserve the foods.

USES OF RADIO ISOTOPES IN MEDICINE:
- It help in understanding the basic work of many internal organs and vital metabolic process.
- They are use in diagnosis and cure of many complicated diseases.
- It can play a vital role in determining the effectively and absorption of medicine.
- Iodine-131 is used for study of thyroid glands.
- Phosphorous-32 is used to locate brain tumor.
- Radio strontium has been found effective in the treatment of internal hemorrhages and wounds.
- Radio strontium is used in tracing the blood circulation.
- Cobalt-60 is used for the treatment of tumor.

- Radio phosphorous is used in the treatment of leukemia and cancer.
- Surgical accessories are sterilized by radio-active isotopes.

HARMFUL EFFECT OF RADIOACTIVITY/ RADIATION HAZARDS:

- Radioactivity can cause bone-marrow cancer.
- Radioactive rays by ionization damaged the living tissues.
- Radiations falling on the nerves causing paralysis.

Some other diseases are:

- Anemia (A decrease in red blood cell).
- Leukemia (An increase in white blood cells).
- Malignant tumor.
- Cataracts (Opacities of the lens of the eye).

PRECAUTION TO MINIMIZE RADIATION HAZARDS:

- One should keep safe distance away from the radiation emitting sources.
- Patients getting treatment from radiation must be exposed from a minimum possible time.
- Radiations from reactor must be shielded by thick concrete wall.
- Radio-active element must be handled carefully.