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Radiopharmaceutical

Radiopharmaceutical

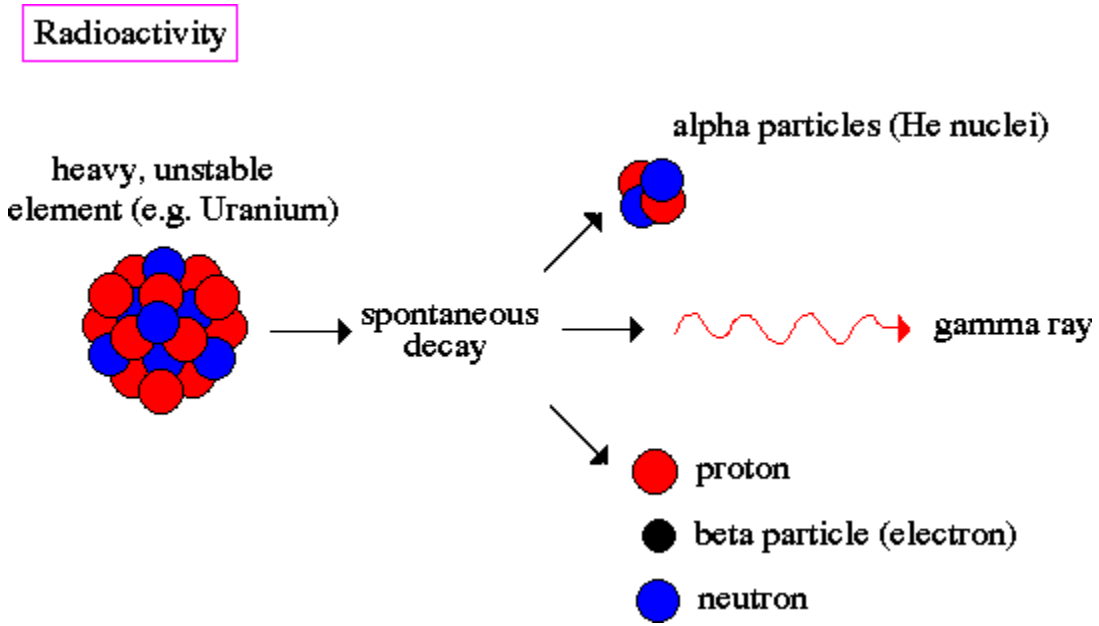
- Radioactive substances-They are unstable and undergo spontaneous decomopsition by emission of radiation
- Isotopes-Nuclides having same number of protons but different numbers of neutrons are termed as isotopes.
- When radioisotopes undergo disintegration or radioactive decay,they produce alpha,beta,gamma radiation
- Types of Radioactive nuclide
- 1.natural radionuclide 2.Artificial radionuclide.
- E.g uranium 238,radium 226 undergo disintigration to produce alpha,beta,gamma radical
- Unit of radioactivity-Curie(c)

Radiopharmaceuticals

- Curie-It may defined as the quantity of any radioactive substances undergoes same number of disintegration in unite time as 1gm of radium is equal to 3.7×10^{10} disintegration per second
- Half life-Time reqiured to Disintegration of active compounds at half concentration is known as half life

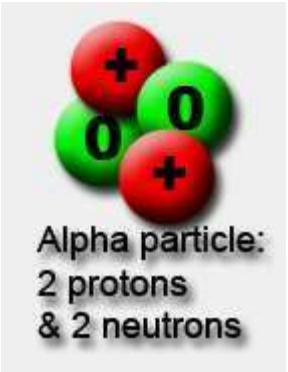
  $t_{1/2}$=0.693/lambda

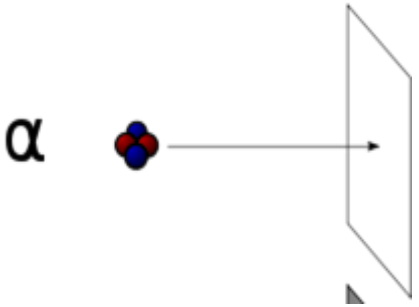
Radioactivity



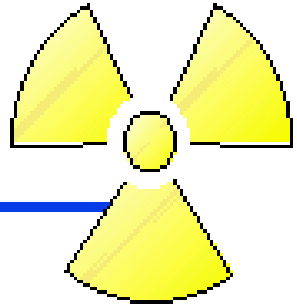
1- Alpha particle decay:

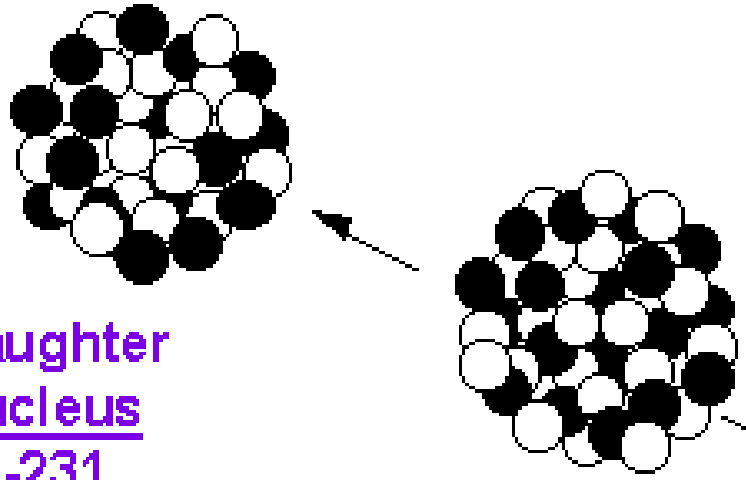
- Alpha particles are made of **2 protons and 2 neutrons.**
- We can write them as $^{4}_{2}\alpha$, or $^{4}_{2}He$, because they're the same as a helium nucleus.
- This means that when a nucleus emits an alpha particle, its atomic number decreases by 2 and its **atomic mass decreases by 4.**
- Alpha particles are relatively **slow** and **heavy.**
- They have a **low penetrating power** - you can stop them with just a sheet of **paper**.
- Because they have a large charge, alpha particles ionise other atoms strongly.
- Alpha-decay occurs in very heavy elements, for example, Uranium and Radium.





Alpha Particle Radiation





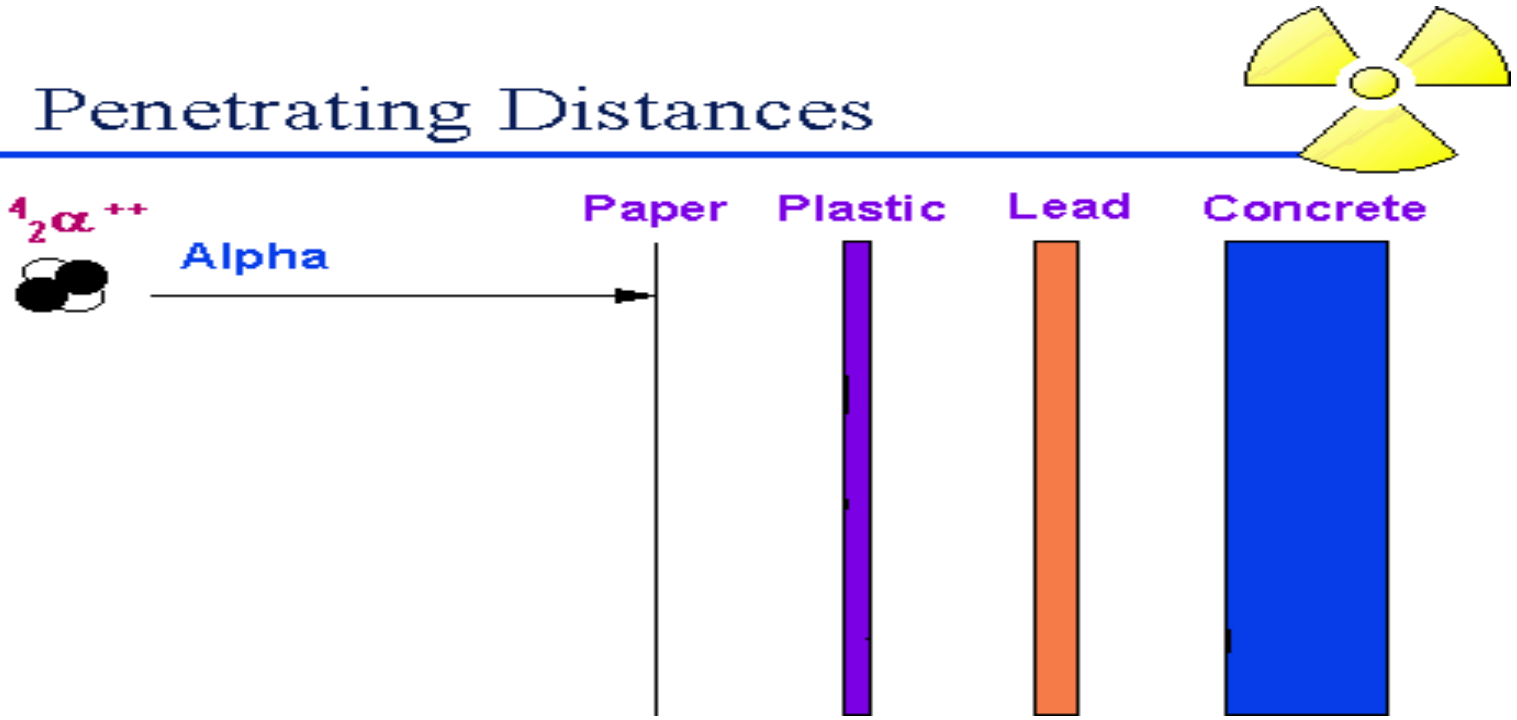
Daughter Nucleus
Th-231

Parent Nucleus
U-235

$^{4}_{2}\alpha^{++}$

Alpha Particle
(Helium Nucleus)

Penetrating Distances

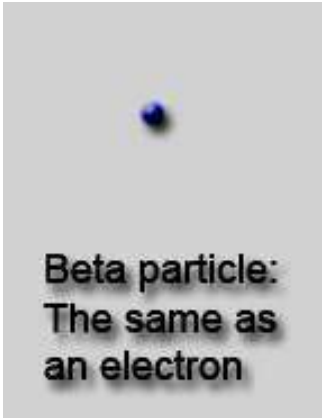


Since alpha particles cannot penetrate the dead layer of the skin, they do not present a hazard from exposure external to the body.

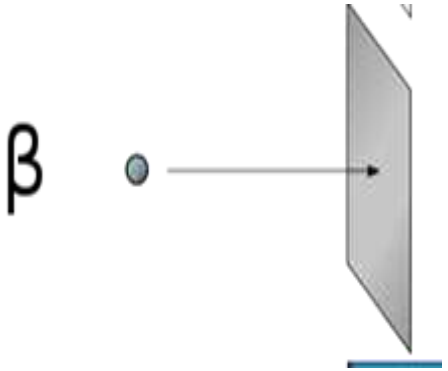
However, due to the ***very large number of ionizations*** they produce in a very short distance, alpha emitters can present a serious hazard when they are in close proximity to cells and tissues such as the lung. Special precautions are taken to ensure that ***alpha emitters are not inhaled, ingested or injected.***

2- Beta particle decay:

- Beta particles have a charge of **minus 1.** This means that beta particles are **the same as an electron**.
  We can write then β^- or e^-, because they're the same as an electron.

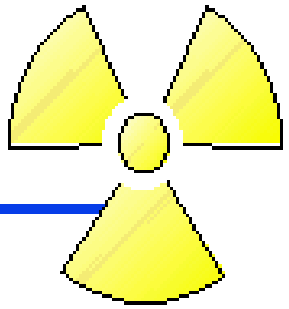


- This means that when a nucleus emits a β^- particle: the **atomic mass is unchanged**
  the **atomic number increases or decreases by 1**.
- They are **fast**, and **light**.
- Beta particles have a **medium penetrating power** - they are stopped by a sheet of **aluminium**.



- Example of radiopharmaceutical emits β^-, phosphorus-32
- Beta particles ionise atoms that they pass, but not as strongly as alpha particles do.

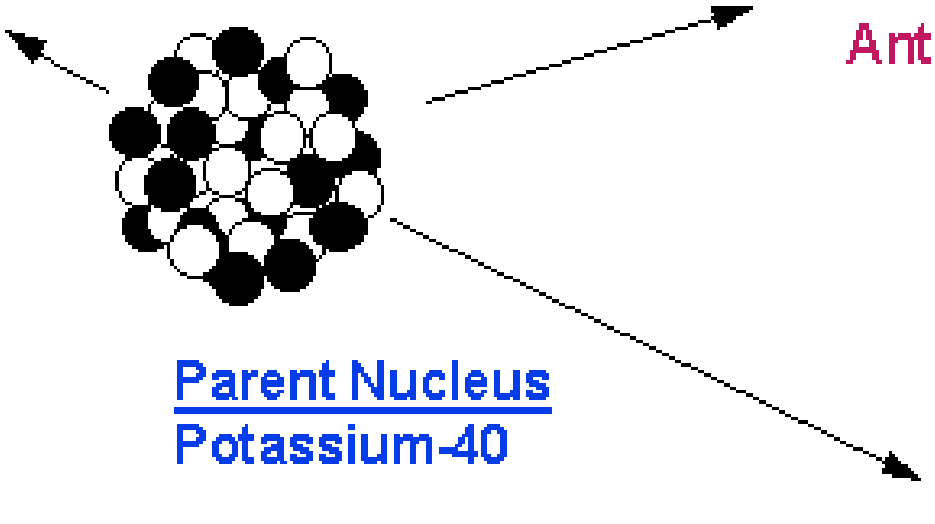
Beta Particle Radiation



Daughter Nucleus
Calcium-40

$^{0}_{0}\nu$

Antineutrino

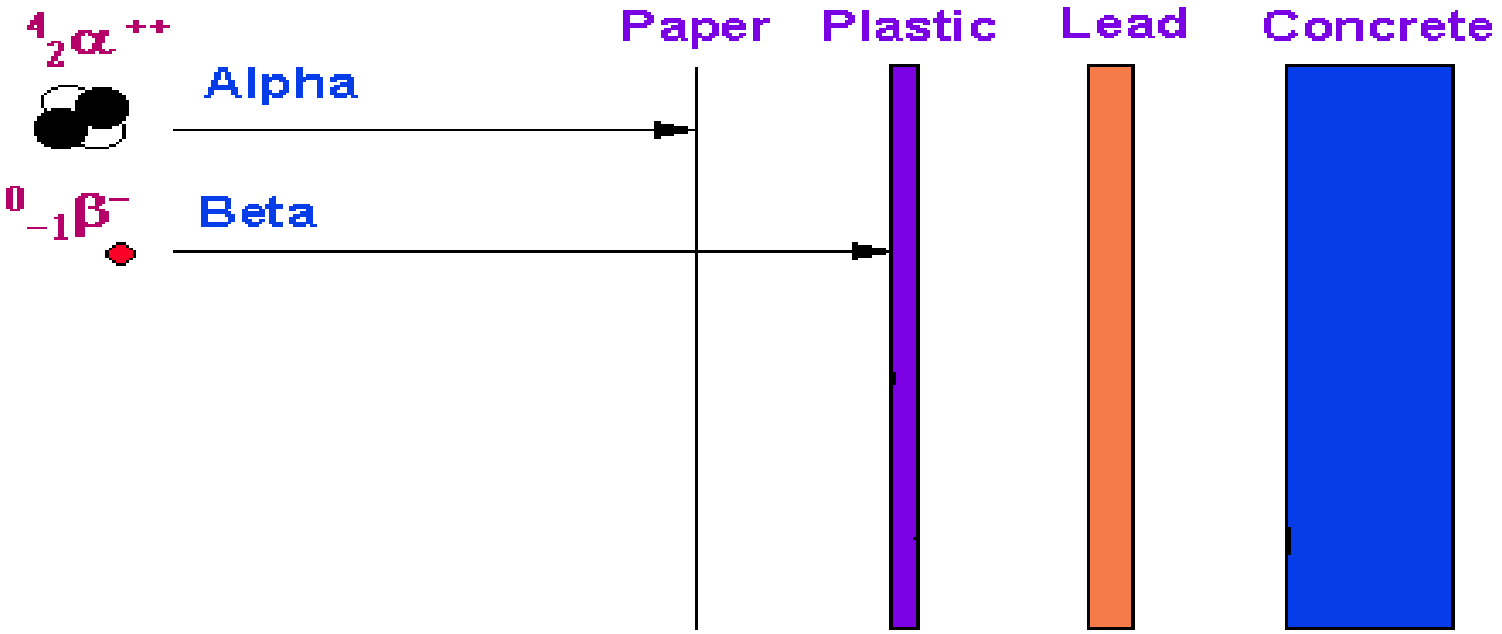


Parent Nucleus
Potassium-40

$^{0}_{-1}\beta^{-}$

Beta Particle

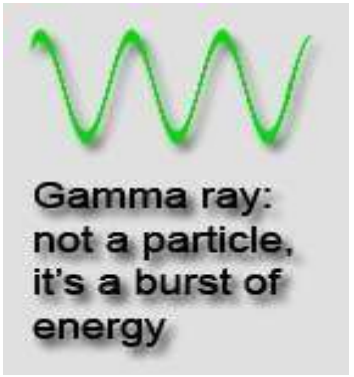
Penetrating Distances

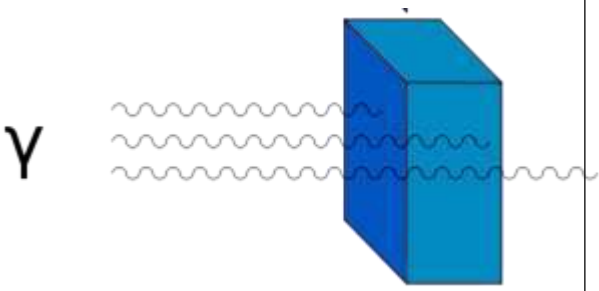


Beta particles are *much less massive and less charged* than alpha particles and *interact less intensely* with atoms in the materials they pass through, which gives them a longer range than alpha particles.

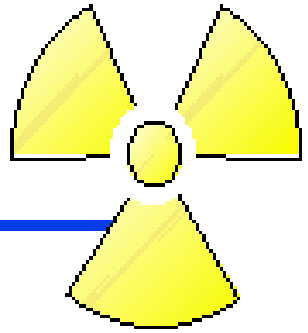
3- Gamma ray:

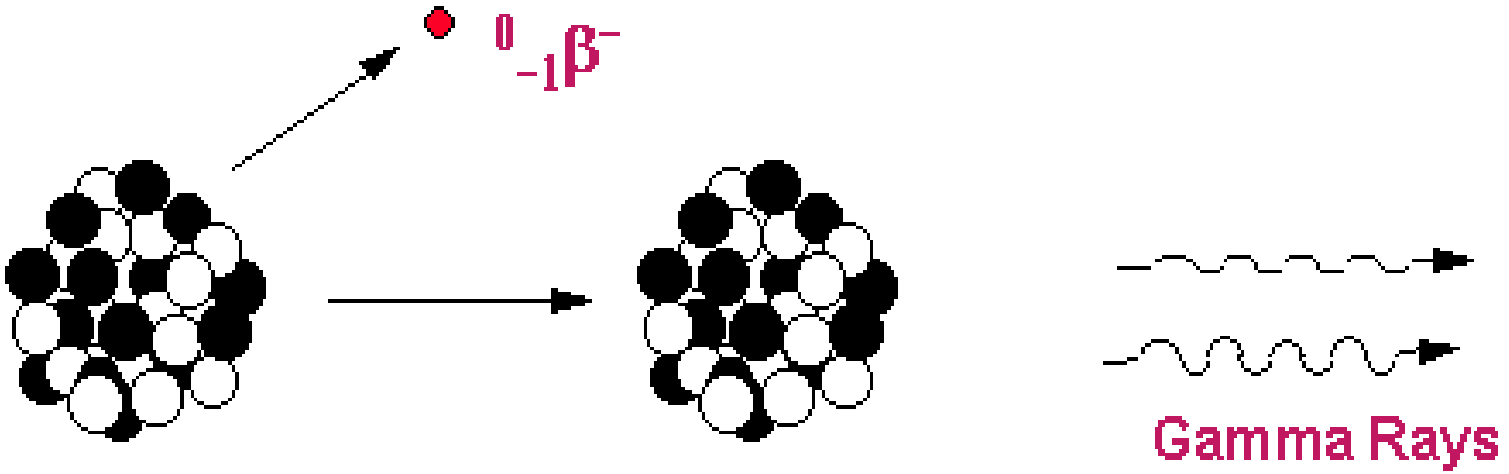
- Gamma rays are **waves, not particles**. This means that they have **no mass** and **no charge**.
- **in Gamma decay:**
  - **atomic number unchanged**
  - **atomic mass unchanged.**
- Gamma rays have a **high penetrating power** - it takes a thick sheet of metal such as **lead** to reduce them.
- Gamma rays do not directly ionise other atoms, although they may cause atoms to emit other particles which will then cause ionisation.
- We don't find pure gamma sources - gamma rays are emitted along side alpha or beta particles.





Gamma-Ray Radiation

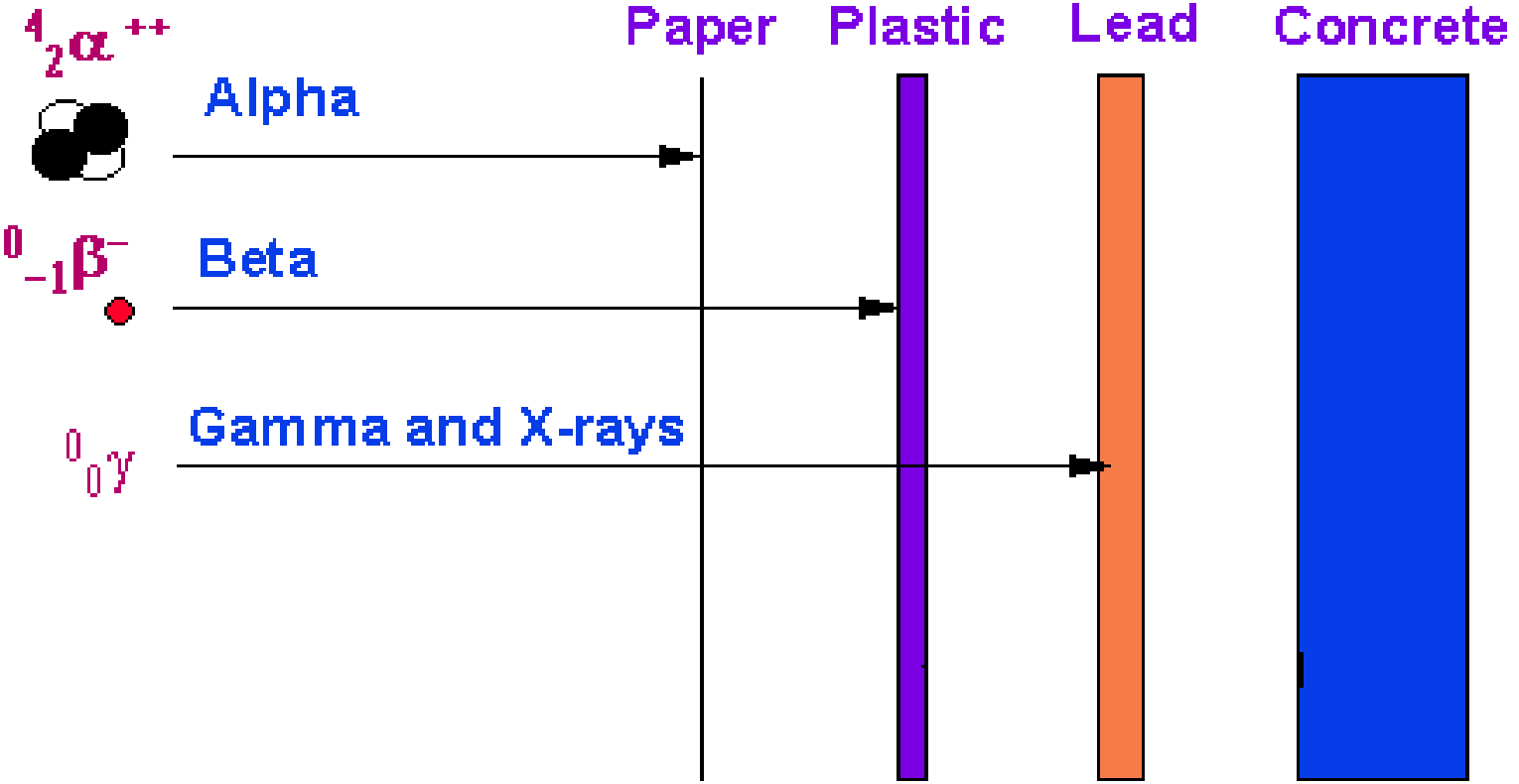




Parent Nucleus
Cobalt-60

Daughter Nucleus
Ni-60

Penetrating Distances

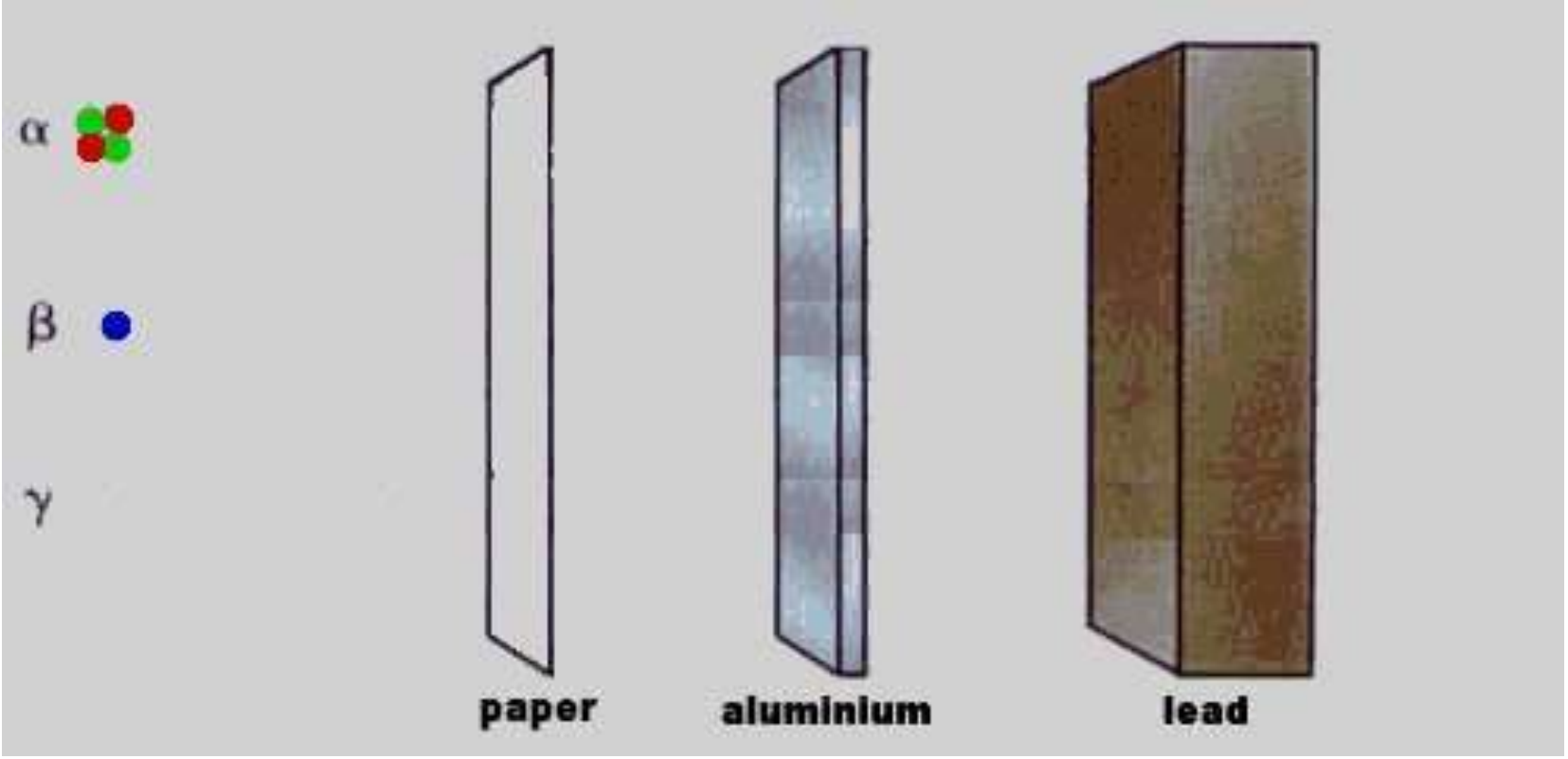


3- Gamma ray:

- Useful gamma sources inculde Technetium-99m, which is used as a "tracer" in medicine.

- This is a combined beta and gamma source, and is chosen because betas are less harmful to the patient than alphas (less ionisation) and because Technetium has a short half-life (just over 6 hours), so it decays away quickly and reduces the dose to the patient.

Alpha particles are easy to stop, gamma rays are hard to stop.



Mode of radioactive decay:

Type of Radiation	Alpha particle	Beta particle	Gamma ray
Symbol	$^{4}_{2}\alpha$ or $^{4}_{2}He$	β^{-}	γ
Charge	+2	-1	0
Speed	slow	fast	Very fast
Ionising ability	high	medium	0
Penetrating power	low	medium	high
Stopped by:	paper	aluminium	lead

Production of radionisotopes

- Reactor irradiation-fissionable material(uranium) taken In moderator and neutron fluxing on uranium forms isotopes.

- Cyclon Irradiation-Bambarding of atoms causes generation of radioactive isotopes.

Measurement of radioactivity

- 1.Ionization of Chamber-Ionization chamber filled with gases and fitted with two electrodes.When radiation passes over it,causes ionization of gas molecules and forms ions.that ions moves to cathode and anode and produce electricity.According electricity ampilcity determines radioactivity
- 2.Proportional counters-in this application of potential electones causes bursting of gases and forms more electron.This electron moves to anode.Generates electric current.Showes radioactivity in terms of curie.
- 3.Geiger-Muller counter-These are most popular Radiation detectors.They can detect alpha,beta,gamma radiation.Geiger Muller contains chamber filled with gas under low atmospheric pressure.Ionization of gas molecule by radiation forms electric current.electric current showes activity in terms of curie

Handelling and storage of Radioactive isotopes

- **Precaution during handling and storage of radioactive substances**

1. One should not touch radioactive emitter with hand but it should be handeled by means of foreceps
2. Smoking,eating and drinking activity should not be done in laboratory where the radioactive materials handeled
3. Sufficient protective clothing have to be used while handling the materials
4. Radiactive materials have to be stored in suitable labelled containers,shielded by lead bricks
5. Area where radioactive materials have to been stored or used should be monitored.
6. Disposal of radioactive materials should be carried out with great care

Application of Isotopes

1. Radiation source in therapy-it produces destructive role because radiation has ability to cause radiation.they destruct cancerous cell by ionization.e.g Sodium phosphate is(^{32}p) used in therapy of blood cancer
2. Diagnostic purposes-Labeled cyanocobalamine finds use for measuring glomerular filteration rate and sodium rose bengal used in liver function test
3. Research-In research isotopes are used as tracers
4. Sterilization-Radiation are use in sterilization of instrument in hospital and final packed container.Radiation cause ionization of bacteria,viruses,fungi,pathogenic bacteria.Hence it is used in sterilization.e.g Cesium used for sterlization of surgical instrument.
5. Determination of hypothyroidism and hyperthyroidism

Radio-Opaque contrast media

- **Defination** -are the substances having property of casting shadow on x-ray films. These substances are having ability to stops X-ray and hence appear opaque on x-ray examination.such preparation is known as x-ray contrast media.
- X-ray passes through high atomic number.The bone is very harder hence by passing x-ray gives x-ray film image.hence it is used for diagnosis
- But soft tissue having less atomic number can able to pass x-ray hence we cant take x-ray of soft tissue.hence for imaging or casting the x-ray of soft tissue the radio-opaque contrast media are used
- These compounds administered by systemic i.e orally and intravenously
- These compounds have been successfully for examination of gastrointestinal tract,kidney,liver,gall bladder,blood vessels of heart
- E.g Barium Sulphate

➢ **Classification of Radio-opaque contrast media**

1. Water soluble contrast media
2. Water insoluble contrast media

Ideal requirement of radio-opaque contrast media

1. It should have high solubility
2. It should have high stability
3. It should not have any pharmacological effects
4. It should excrete rapidly with no toxic effects
5. It should stay in the body for sufficient x-ray visualisation
6. It should concentrate in selectively in the concerned organs
7. It should have adequate radio-opacity

Preparation of radio-opaque contrast media

Barium sulphate(barium meal,shadow meal

- Molecular formula-$BaSO_4$
- Molecular wt-233.4
- Preparation-barium sulphate is prepared by treating barium chloride with sulphuric acid.
- $BaCl_2+H_2SO_4 \longrightarrow BaSO_4+_2HCl$
- $Ba(OH)_2+H_2SO_4 \longrightarrow BaSO_4+2H_2O$
- Properties-Fine,odourless,tasteless,odourless,free from grittiness.It is iinsoluble in water
- Test for identity-sample is treated with sodium carbonate and potasium carbonate in crucible and then treated with HCl give characterstics of sulphates.
- Test for purity-It has to tested for Limit test for arsenic,sulphate,iron,heavy metal,choride,LOD
- Storage-It should be stored in a well closed container
- Use-Barium sulphate is a diagnostic drug which is used medicinally in x-ray examination.It is administered by enema before x-ray examination in the form of barium meal to make intestine opaque to x-ray examination.