RADIOACTIVITY:

SAFETY ASPECTS

By
Mrs. REKHA GUPTA
GOVT. V.Y.T.PG.AUTO.
COLLEGE, DURG

What is Radiation Safety

Radiation safety is a term applied to concepts ,requirements, technologies and operations related to protection of people against harmful effect of ionizing radiations.

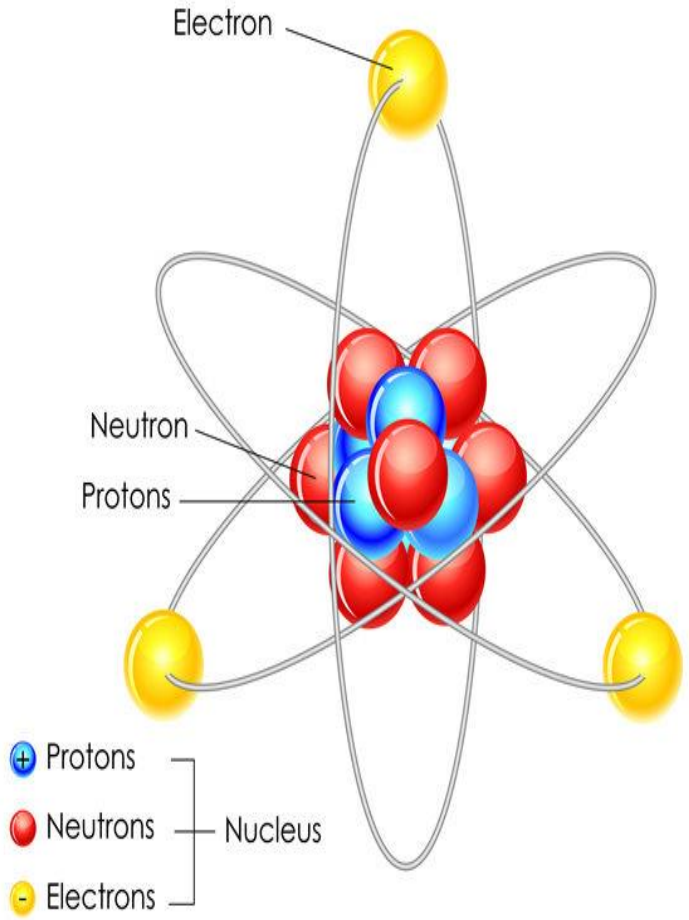
Introduction

- Radioactive isotopes occur naturally or can be generated artificially.
- They emit ionising radiation in the form of electromagnetic waves or energetic particles.
- Exposure to ionising radiation above permissible limits can result in serious biological damage.

Atoms

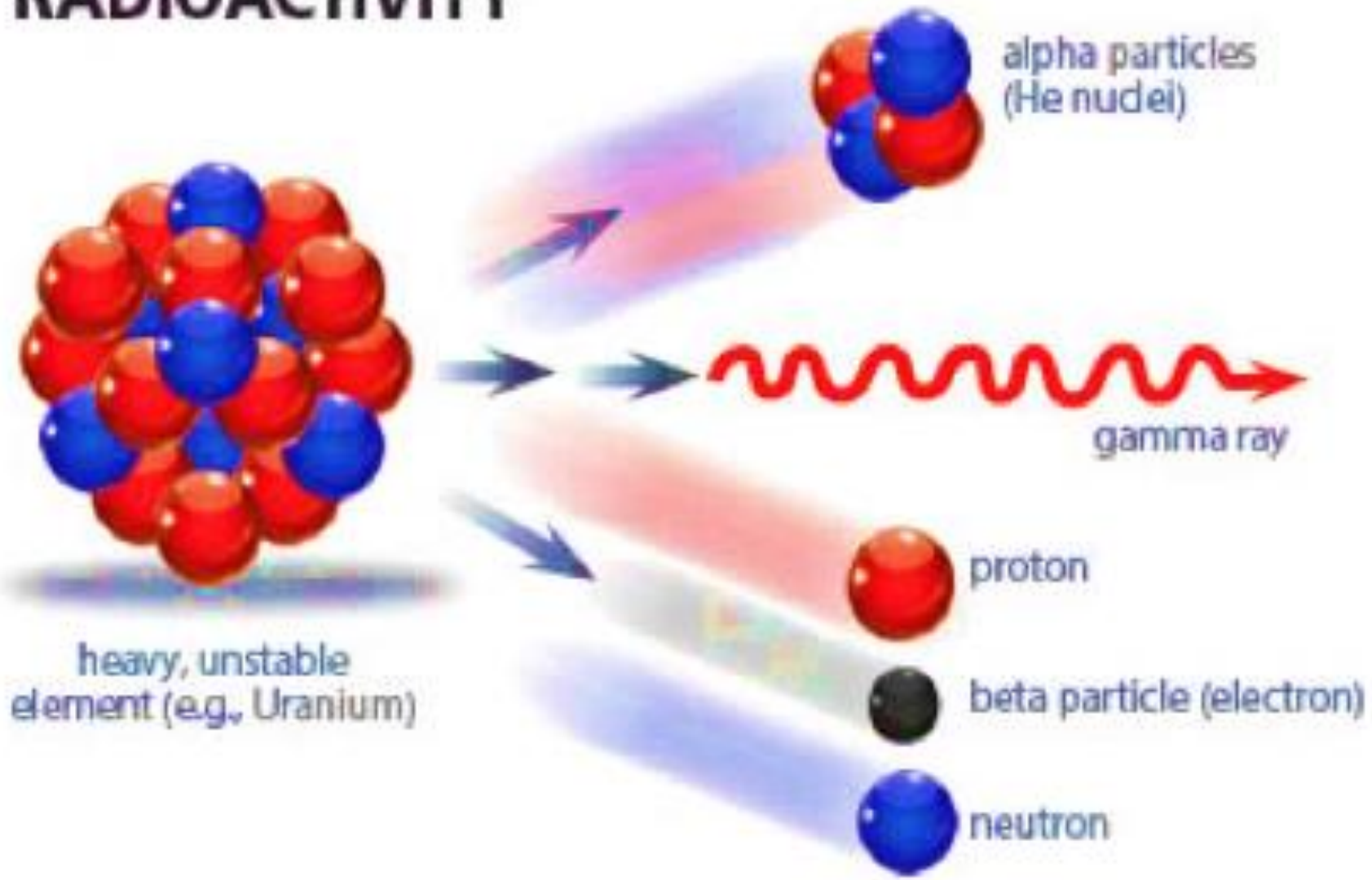
- All matter is made up of atoms.
- An atom consists of a nucleus in the center and electrons orbiting around it in defined shells.
- The nucleus of an atom consists of positively charged protons and neutral particles called neutrons.

Structure of Atom’s Nucleus



- A radioactive nucleus is unstable it can become stable by ejecting particles and electromagnetic waves.
- If an atom loses an orbiting electron it becomes a positive ion as it will have more positive charges than negative charges.
- The electron that was removed becomes a negative ion.

RADIOACTIVITY



Types of emissions

The electromagnetic wave/particles emitted by the radioactive isotopes are-

- Alpha
- Beta
- Gamma

Properties of α, β and γ rays

The three types of radiation

Use this table to find information about and to compare α, β and γ radiation

	Alpha (α)	Beta (β)	Gamma (γ)
Nature	It's a nucleus of helium ^4_2He. Two protons and two neutrons	It's an electron e^-	It's an electromagnetic wave
Charge	+2	-1	0
Mass	Relatively large	Very small	No mass
Speed	Slow	Fast	Speed of light
Ionizing effect	Strong	Weak	Very weak
Most dangerous	When source is inside the body	When source is outside the body	When source is outside the body

Alpha radiation

- Alpha particle consist of two protons and two neutrons.
- Their range in air is about 10 cm.
- They will not penetrate through the dead layers of the skin.
- They can be stopped completely by a piece of paper or by clothing worn
- Alpha source is not an external hazard to the body. But they are an internal hazard if it get inside the body through ingestion or via a wound, etc. Once inside the body they disintegrate, causing serious damage to the surrounding tissue within few microns depth.

Beta radiation

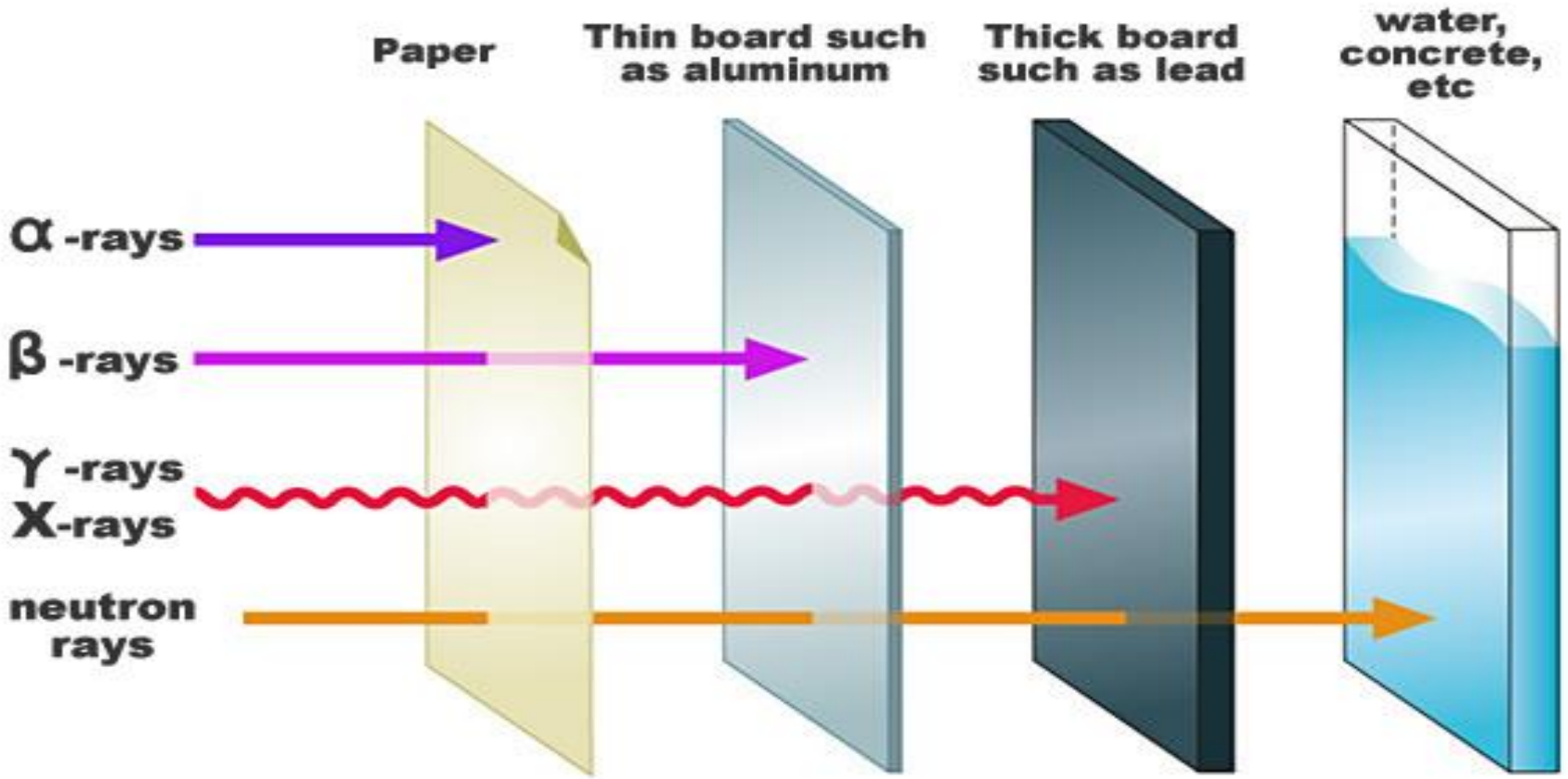
- Beta particles are electrons which are ejected from the nuclei of radioactive atoms by disintegration.
- They can penetrate into the human body from 0.2 to 1.3 cm and can travel few meters through air.
- If they are deposited on the skin for long periods of time they could cause severe burns.

- Beta emitters are internal radiation hazards when taken inside the body.
- When the beta particle is slowed down or stopped, secondary X radiation known as bremsstrahlung may be produced.
- Beta particles can be stopped by the walls of a room or by a sheet of plastic about 1.3 cm thick.

Gamma radiation

- Gamma rays are electromagnetic radiation of short wavelength that are deep penetrating.
- Due to the deep penetration, they present an external exposure hazard.
- They can travel many meters in air.

Radiation types and the degree of penetration



Type of Exposure to ionizing radiation

Radiation exposure may be internal or external, and can be acquired through various exposure pathways.

- **Internal exposure** to ionizing radiation occurs when a radionuclide is inhaled, ingested or otherwise enters into the bloodstream (for example, by injection or through wounds).
- Internal exposure stops when the radionuclide is eliminated from the body, either spontaneously (such as through excreta) or as a result of a treatment.
- **External exposure** may occur when airborne radioactive material (such as dust, liquid, or aerosols) is deposited on skin or clothes.
- This type of radioactive material can often be removed from the body by simply washing.

Radiation Dose

The magnitude of radiation exposures is specified in terms of the radiation dose. There are two important categories of dose:

1. **The *Absorbed dose***, sometimes also known as the *physical dose*, defined by the amount of energy deposited in a unit mass in human tissue or other media.

- The original unit is the *rad* it is now being widely replaced by the SI unit, the gray (Gy) [1 J/kg], where 1 gray = 100 rad.

2. **The *Biological* dose**, sometimes also known as the *dose equivalent*, expressed in units of rem or, in the SI system, *sievert* (Sv).

- This dose reflects the fact that the biological damage caused by a particle depends not only on the total energy deposited but also on the rate of energy loss per unit distance travelled by the particle.

Biological effects of radiation

- As radioactive photons/particles pass through living cells, they cause rupture of bonds in the molecules resulting in molecular changes that injure the affected cells.
- This destroys the capacity of reproduction in some cells or causes mutation, in which the cells resulting from division are different from parent cell.
- A very weak exposure over several years, can be as potentially injurious as a large single exposure.

- An important characteristic of injuries arising from penetrating radiation is the latent period that intervenes between the exposure and the visible signs of its effects.
- The time between the exposure and the first signs of radiation damage is called the “latent period”. The larger the dose, the shorter the latent period.

Basic safety factors

- For external radiation exposure hazards, the basic protection measures are associated with
- Time
- Distance
- Shielding

Time

- The simplest method for protection from ionizing radiation is to spend as little time as possible in the vicinity of radiation source.
- This is applicable even when other protection methods are adopted.

Distance

- Doubling the distance between the person and the source helps to reduce the exposure to a quarter of its original value.
- Maintaining a safe distance is important when working near inadequately shielded sources of radiation.

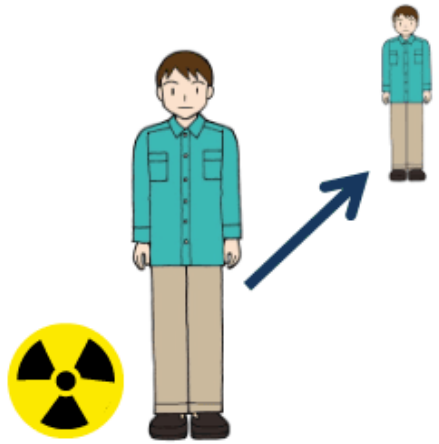
Shielding

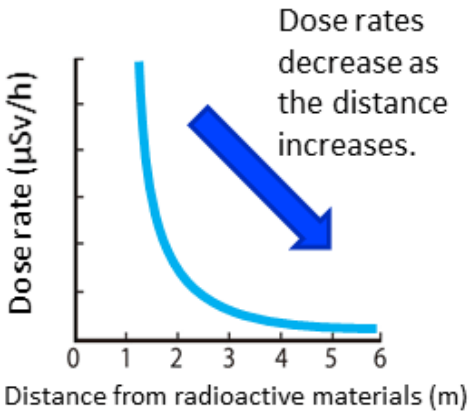
- The more mass that is placed between a source and a person, the less radiation the person will receive.
- Transparent plates of thick plastic or aluminium is used for shielding beta particles.
- Gamma rays can be attenuated by using lead shields or concrete.

Dose Reduction

Three Principles of Reduction of External Exposure

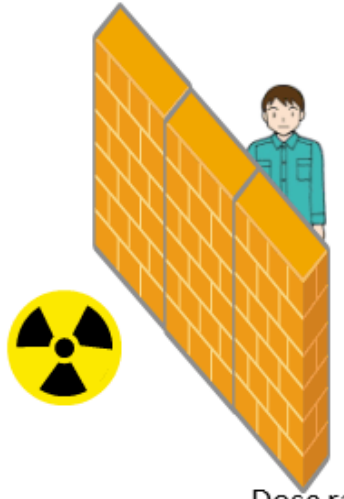
(i) Keep away (distance)

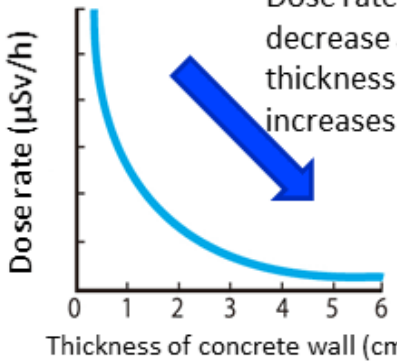




Dose rates decrease as the distance increases.

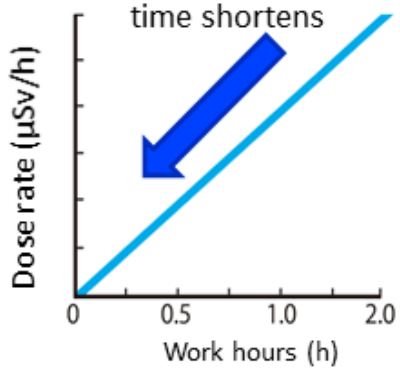
(ii) Place something heavy in between (shielding)





Dose rates decrease as the thickness increases.

(iii) Shorten time while being close to radioactive materials (time)



Exposure doses decrease as the time shortens

Safety Precautions

- Lab coats, shoes and safety glasses must be worn in the laboratory.
- Materials/equipment which are not required must not be brought into the laboratory or stored inside.
- An inventory of radioactive sources used in the laboratory must be maintained and updated.
- Food items must not be stored or consumed inside the laboratory.
- Radiation symbols must be displayed wherever active sources are being manipulated or stored.
- Gloves, clothing, apparatus and benches must be monitored after work with radioactive materials.

Precaution measure:

Safety Precautions

- Always use appropriate shielding when working with radioactive materials.
- Use remote handling devices such as forceps, tongs wherever possible.
- Never pipette solutions by mouth.
- Work surface must be covered with smooth, non absorbent materials.

References

- http://www.iitb.ac.in/safety/sites/default/files/Radiation%20Safety_0_0.pdf
- greenfacts.org/en/chernobyl/toolboxes/radioactivity-dose-units.htm

THANK U