Gamma Radiation

Calculate the wavelength of a gamma radiation photon of energy 2.0 MeV.

$$E = hf \qquad c = \lambda f$$

$$f = \frac{c}{\lambda}$$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E}$$

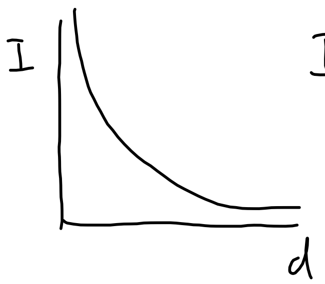
Planck's constant

$$\lambda = \frac{(6.63\times10^{-34}\,J\,s)(3.00\times10^{8}\,m\,s^{-1})}{(2.0\times10^{6}\,eV)\left(\frac{1.6\times10^{-19}\,J}{1\,eV}\right)}$$

$$\lambda = 6.2\times10^{-13}\,m$$

Properties of Gamma Radiation

- emitted with discrete energies due to difference in energy levels in the nucleus.
- zero rest mass
- travels at the speed of light.
- very penetrating. (absorbed by thick lead or concrete)
- intensity of source obeys inverse square law



$$I \propto \frac{1}{d^2}$$

Ionizing Radiation

- alpha & beta particles } all ionizing radiation.
- gamma rays

- energy required to remove an electron from an atom is a few eV.

- so when ionizing radiation of energy of a few MeV passes through a substance, collisions occur with the atoms and can easily cause electrons to be removed. (forming ions)

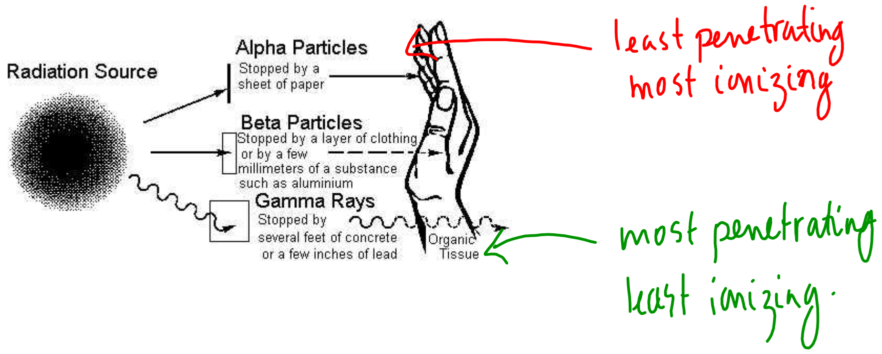
Penetration of ionizing radiation through matter

As radiation passes through a substance it ionizes atoms and therefore loses energy

As a result:

→ particles that are highly ionizing are not very penetrating.

→ particles that do not readily ionize matter are more penetrating.



Penetrating ability of α, β, γ radiation

- refer to notes

Radiation Damage to Living Tissue

- radiation which ionizes → α, β, neutrons, protons, X rays, γ rays, high freq UV.

→ damage begins when an electron is removed from atom in a molecule that makes up living tissue.

Direct Effect – cell may be killed or not able to reproduce.

Indirect Effect – radiation triggers the formation of toxic substances that may destroy or damage the cell.

Short term + long term effect

Acute (short term) – high dose over a short time; if the radiation was intense enough → immediate death

Chronic (long term) – low dose over long periods; may not be an immediate problem; effects may not be noticed for several years (usually in the form of cancer)

When ionization occurs within a cell any of the following can occur:

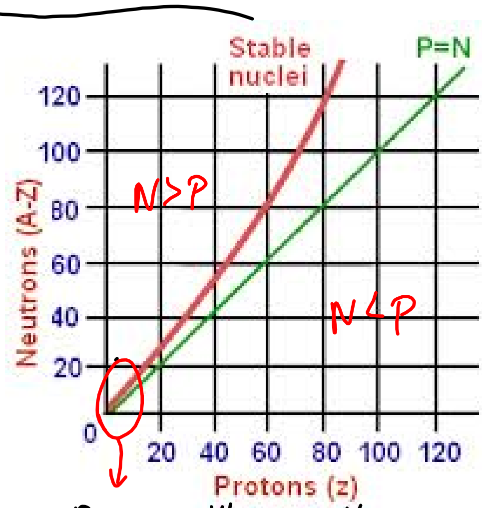
- cell might repair itself + return to normal.
- cell may die.
- cell may lose ability to divide.
- cell division might go out of control ⇒ cancerous tumour.

Protection to exposure from radiation (see sheet)

- Distance
- Time.
- Shielding
- Containment

The neutron-proton ratio curve of stable nuclei.

Two observations:



(1) Stable nuclei of low mass have approximately an equal number of neutrons and protons

He^{4}_{2} Li^{7}_{3} Be^{9}_{4} B^{10}_{5} C^{12}_{6} N^{14}_{7} O^{16}_{8}

2p	3p	4p	5p	6p	7p	8p
2n	4n	5n	5n	6n	7n	8n

(2) Stable nuclei of larger mass have more neutrons than protons

Fe^{56}_{26} Ra^{226}_{88} U^{238}_{92}

26p	88p	92p
30n	138n	146n

This is due to the forces between the nucleons in the nucleus.

You <u>MUST</u> know why → see sheet.