# Physics with Synno – Matter – Lesson 5

## *M.5 Radiation*

**Video:** Radioactive Isotopes
Alpha, beta, and gamma radiation demonstrated
Radiation Explained Alpha Beta Gamma 1960s Mr Wizard

There are three types of radiation Alpha (α), Beta (β) and Gamma (γ).

## *M.5.1 Properties of Radiation*

### *M.5.1.1 Alpha (α) Particle*

α-particles have the following properties:
They are a Helium nucleus ${}_{2}^{4}He^{2+}$
The charge is two elementary charges, positive.
The mass is four atomic mass units, i.e. 4 times the mass of a proton.
The penetration is a few cm in air and absorbed by paper.
Easily able to ionize atoms.
Relatively slow speeds ≈10% of the speed of light.
Very small deflection due to electric and magnetic fields.

### *M.5.1.2 Beta (β) Particle*

β-particles have the following properties:
They are an electron or positron moving quickly from the nucleus.
$\beta^-$ (electron) formed when a Neutron decays
$\beta^+$ (positron) formed when a Proton decays
The charge is that of an electron.
It has the mass of an electron, $\frac{1}{7000}^{th}$ of an α-particle.
Penetration of a few metres in air, ~ 3.5 cm in lead.
Weak ionization ability.
Fast speeds ≈90% of the speed of light.
Large deflection in electric and magnetic fields

### *M.5.1.3 Gamma (γ) Ray*

γ-rays have the following properties:
They are high frequency (short wavelength) electromagnetic radiation.
They have no charge.
They have no mass.
Penetration of ~ 30 cm in steel, no maximum in air, never really completely absorbed.
Very weak ionization ability.
No deflection in electric or magnetic fields.
Travel at the speed of light.
Lethal effect on living tissues (used in medicine for cancer treatment).
Originating from the nucleus of the atom.

### *M.5.1.4* *Energy of $\alpha$, $\beta$ and $\gamma$ Radiation*

The energy of moving objects is usually measured in Joule (J). However for small objects the unit is too large. The energy of radioactive emissions is usually measured in electron-volts (eV).

$$1\ eV = 1.6\ \times 10^{-19}\ J$$

Example

Uranium-238 emits alpha particles with a maximum energy of 4.2 MeV. (M ≡ mega = $10^6$)

a) Explain why a sample of this radioisotope encased in plastic is quite safe to handle yet, if inhaled as dust, would be considered very dangerous.

Plastic would stop the alpha particles. Dust in the lungs, the lung tissue would absorb the alpha particles.

b) Calculate the energy of an alpha particle in joules.

$$4.2\ \times 10^{6}\ \times\ 1.6\ \times 10^{-19}\ = 6.72\ \times 10^{-13}\ J$$

**Problem Set # 5:** Text Page 217 All Questions