LESSON 1

- **NUCLEAR PHYSICS**

1.0 STRUCTURE OF THE NUCLEUS

PROPERTIES OF THE PROTON AND THE NEUTRON

DEFINITIONS

NUCLEONS, NUCLIDE

ATOMIC NUMBER, MASS NUMBER

NEUTRON NUMBER, ISOTOPES

RADIO- ISOTOPES, ISOBARS, ISOTONES

ISOTOPES OF HYDROGEN (H – 1, 2, 3)

HYDROGEN – 1 (PROTON ATOM)

Representation is $\mathbf{{}_{1}^{1}H}$ or $\mathbf{{}_{1}^{1}p}$

HYDROGEN – 2 (DEUTERIUM ATOM)

Representation is ${}_{1}^{2}\mathrm{H}$ or ${}_{1}^{2}\mathrm{D}$

HYDROGEN – 3 (TRITIUM ATOM)

Representation is ${}_{1}^{3}\mathrm{H}$

1.5 EINSTEIN'S MASS – ENERGY EQUATION (EINSTEIN'S THEORY OF RELATIVITY)

$$E = \Delta m\, c^2$$

Where E = Energy in Joule

Δm = change in mass in kilogram

c = speed of light, 3×10^8 ms^{-1}

Example

In a certain nuclear reaction, the change in mass was 1.02×10^{-29} kg.
Calculate the energy released
[speed of light c = 3×10^{8} ms^{-1}]

$\Delta m = 1.02 \times 10^{-29}$ kg

$c = 3 \times 10^{8}$ ms^{-1}

From Einstein's mass – energy equation

$E = \Delta m\, c^2$

$= 1.02 \times 10^{-29} (3 \times 10^{8})^2$

$= 9.18 \times 10^{-13}$ J

ELECTRON – VOLT (eV)

$$1\ eV = 1e \times 1V$$

$$= 1.6 \times 10^{-19}\ \mathbf{C} \times 1J/C$$

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

ATOMIC MASS UNIT (amu. Mu. U)

One atomic mass unit is defined as one twelfth of the mass of one atom of carbon – 12.

$$\mathbf{1\ a.m.u\ = 1.661 \times 10^{-27}\ kg}$$

A change in mass of **1 a.m.u** at the speed of light will produce energy E given by

$$E = \Delta m\, c^2$$

$$= 1.661 \times 10^{-27}(3 \times 10^{8})^2$$

$$= 14.95 \times 10^{-11}\ J$$

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

This implies that $E = \left(\frac{14.95 \times 10^{-11}}{1.6 \times 10^{-19}}\right) 1eV$

$= 9.33 \times 10^{8}$ eV

= 933 M eV

Hence change in 1 a.m.u = 933 MeV

End of lesson