Unit of mass: In nuclear physics since we deal with the particles of very very small mass like proton neutron, electron etc hence we define a smaller unit of mass known as unified atomic mass constant 1 u.

1 u of mass is defined as the 1/12 th of the mass of 12_{C6} carbon atom.

1 u = 1.66065 x 10^{-27} Kg

M_p= mass of proton =1.007276 u =1.6726 x 10^{-27} Kg

M_n= mass of neutron =1.008665 u = 1.6749 x 10^{-27} Kg

Mass energy equivalence: According to Einstein mass can be converted into energy by the expression $E = mc^2$

m = mass annihilated

c = velocity of electromagnetic wave

E = energy obtained

1 u of mass is equivalent to E = 1.66 x 10^{-27} Kg x (3 x 10^8 m/sec $)^2$

= 1.66 x 9 x 10^{-11} Joules

Electron volt is a smaller unit of energy and is defined as the work done to take one electron through one volt potential difference.

W = Q X V

1eV = 1.6 x 10^{-19} Coulomb x 1 volt = 1.6 x 10^{-19} Joules

1 Joule = 1/(1.6 x 10^{-19}) eV

To find energy equivalent of 1 amu :

E = 1.66 x 9 x 10^{-11} x 1/(1.6 x 10^{-19}) eV = 9.33.75 x 10^6 eV

E = 934 MeV

1 u of mass = 934 MeV

Mass defect: Since the nucleus consists of proton and neutrons the mass of nucleus should be sum total of mass of all the protons and neutrons in the nucleus. But it is found that the mass of the nucleus is less than the theoretical mass. The difference between the theoretical mass and actual given mass of the nucleus is known as Mass defect.

$$\text{Let } M_P = \text{mass of each proton}$$
$$M_n = \text{mass of each neutron}$$
$${}_Z X_M^A = \text{the given mass of nucleus } M(ZA)$$
$$\text{Theoritical mass} = \left[ZM_P + (A - Z)M_n\right] > M(ZA)$$
$$\text{Mass defect} = \Delta m = \left[ZM_P + (A - Z)M_n - M(ZA)\right]$$
$$\text{Packing fraction : f : The mass defect per nucleus is known as packing fraction}$$
$$f = \frac{\Delta m}{A}$$

Binding Energy : A nucleus is a conglomerate of protons and neutrons since protons are all positively charged particles they should suffer electrostatics repulsion between them and should get scattered due to that repulsive force but actually the reverse is found to be true i.e. In spite of the repulsive force they remain adhered together. This will be possible only if some external energy holds them together. This external energy is known as binding energy.

The binding energy is obtained from the mass defect of the nucleus. The missing mass of the nucleus (i.e. Mass defect) is converted into energy according to Einstein's mass energy equivalence and this supplies the binding energy required to keep all the positively charged particle together.

Binding Energy = ΔmC^2

Example: The mass of Helium nucleus is 4.0078 u, Calculate the binding energy of Helium nucleus.

$${}_2He^4$$
$$\text{Given } M_P = 1.007672\ u$$
$$M_n = 1.008225\ u$$
$$\Delta m = 2 \times 1.007672 + 2 \times 1.008225 - 4.0028 = 0.02994\ u = 0.03\ u$$
$$\text{Binding Energy} = \Delta mC^2 = 0.03 \times 934\ \text{MeV} = 28.02\ \text{MeV}$$