BINDING ENERGY PER NUCLEON (BEN):

It is the average energy required to remove a nucleon out from its nucleus.

It is also called average binding energy or specific binding energy.

It is given by the total binding energy divided by the mass number of the nucleus.

i.e. $BEN = \frac{B.E}{A}$

Significance of binding energy per nucleon (BEN):

Binding energy per nucleon explains the stability of nucleus, greater the value of binding energy per nucleon, the more stable is the nucleus and vice versa.

Packing fraction:

$$Packing\ fraction,\ f = \frac{isotopic\ mass - mass\ number}{mass\ number}$$

$$or \qquad f = \frac{M-A}{A}$$

It is the measure of comparative stability of an atom.

If $PF > 0$ then the nucleus is less stable.

If $PF < 0$ then nucleus is more stable.

Example:

1. *For $_2He^4$: isotopic mass, $M = 4.00377\ amu$ and mass number, $A = 4$*
   $\therefore packing\ fraction > 0$, which indicates $2He^4$ is relatively less stable.
2. *For $_{26}Fe^{56}$: isotopic mass, $M = 55.9349\ amu$ and mass number, $A = 56$*
   $\therefore packing\ fraction < 0$, which indicates $_{26}Fe^{56}$ is relatively more stable.

Numerical:

Mass defect Δm:

$$\Delta m = (Zm_p + Nm_n) - M$$

Z = atomic number

m_p = mass of proton

m_n = mass of neutron

M = rest mass of nucleus

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$$BEN = \frac{B.E}{A}$$

Unit of BEN: $J/nucleon$ **OR** $MeV/nucleon$

Binding energy BE:

$BE = \Delta m\, c^2$ if Δm is in Kg.

→ Unit of BE is Joule (J).

OR

$BE = \Delta m \times 931\ MeV$ if Δm is in amu.

→ Unit of BE is MeV.

1. The Mass of $_{17}Cl^{35}$ is 34.9800amu. Calculate its binding energy and binding energy per nucleon. Mass of proton ($_1H^1$) is 1.007825amu and mass of neutron ($_0n^1$) = 1.008665amu.

   8.219 MeV/ nucleon

2. Calculate the binding energy per nucleon of $_{26}Fe^{56}$. {Atomic mass of $_{26}Fe^{56}$ is 55.9349 u and that of $_1H^1$ is 1.00783 u and mass of $_0n^1$= 1.00867 u and 1u=931MeV}.

   8.791 MeV/ nucleon

3. Calculate the binding energy per nucleon of calcium nucleus ($_{20}Ca^{40}$). {mass of $_{20}Ca^{40}$ is 39.962589u and that of proton($_1H^1$) is 1.007825u and mass of neutron ($_0n^1$) = 1.008665u and 1u=931MeV.}

   8.54 MeV/nucleon