BINDING ENERGY

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Mass defect

Binding energy holds nucleons together within the nucleus.

The mass of nucleus is smaller than the sum of the masses of its constituents.The difference is called mass defect.

$$\text{Mass defect} = Zm_p + Nm_n - m$$

Z =No.of protons,m_p=mass of proton

N=No.of neutrons,m_n=mass of neutron and m is the mass of nucleus

Binding energy

The energy corresponds to the missing mass is called binding energy

Binding energy=(Mass defect)c^2 in Joules

Or

Binding energy=(Mass defect)931.49 in MeV

In equation form $B.E=(Zm_p+Nm_n-m)931.49$

Binding energy is the energy released when a nucleus is formed from its components

Or

It is the energy required to split a nucleus into its components

Problem1

Find the Binding energy of $_{10}Ne^{20}$.

Mass of proton=1.007276u, mass of neutron=1.008665u and mass of neon=19.9924u

B.E=(Zm_p+Nm_n-m)931.49 MeV

= (10 x 1.007276 + 10 x 1.008665 - 19.9924)931.49

=155.56 MeV

Problem 2

Helium nucleus has a mass of 4.00151 u.Mass of proton is 1.00727u and that of neutron is 1.00865u.Find the Binding energy per nucleon.

B.E $=(Zm_p+Nm_n-m)931.49$ MeV

$=(2 \times 1.00727+2 \times 1.00865-4.00151)931.49$

$=.03029 \times 931.49=28.2148$MeV

B.E/nucleon=28.2148/4=7.0537MeV

Binding energy/Nucleon

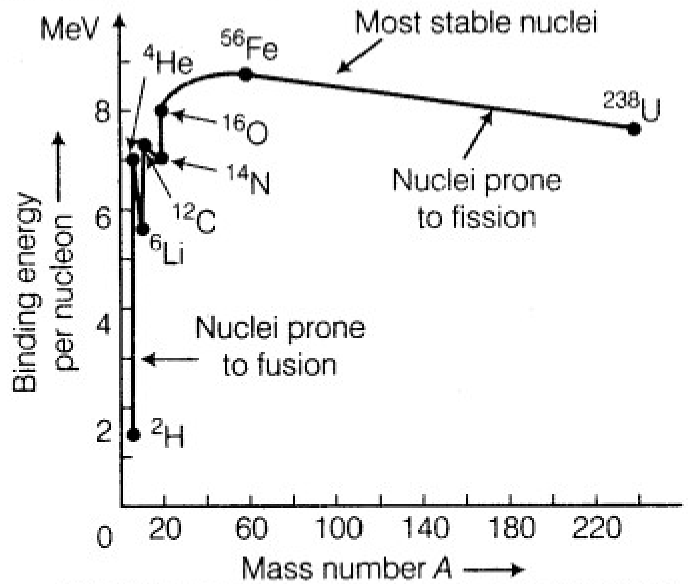
Binding energy per nucleon is the energy required to release a single nucleon from a nucleus.

B.E/nucleon=Binding Energy/No.of nucleons in the nucleus OR B.E/A where A is the mass number.

More the value of B.E/A means the nucleus is more stable.

Graph: B.E/A Vs A

The binding energy per nucleon curve is shown as below:



Binding energy per nucleon as a function of mass number A **(1)**

The graph has its maximum of 8.8MeV/nucleon where the mass no.is 56.($_{26}Fe^{56}$-an isotope of iron).This is therefore the most stable nucleus.

The peak at A=4 corresponds to exceptionally stable $_{2}He^{4}$ nucleus,)alpha particle)

The B.E/nucleon is practically constant for nuclei of mass number between 30 and 170.

For nuclei with A>170,the B.E/A is very low,due to which the heavy unstable nucleus split into two or more lighter nuclei of greater Binding energy per nucleon.This process is called **Nuclear fission**.Energy is released in this process.

Eg:If $_{92}U^{238}$ is broken into two smaller nuclei,188 MeV energy is released.

For lighter nuclei A<10the B.E/A is small ,hence two or more nuclei fuse to form a heavy nucleus.This process is called **Nuclear fusion**.Energy is released during the process.

Eg:If two $_{1}H^{2}$ nuclei combine to form a $_{2}He^{4}$ nucleus ,23 MeV energy is released.

THANK YOU….