Q-Value of a nuclear reaction:

Q- value of a nuclear reaction is defined as the amount of energy released or absorbed in the nuclear reaction.

✓ Q-value is the energy equivalent of mass difference observed in the nuclear reaction.

i.e., $Q - value = \Delta m \times c^2$

; $\Delta m =$ *mass difference*

[$\Delta m = mas\ of\ reactants - mass\ of\ products$]

The energy change occurring in a nuclear reaction is termed as Q- value of the nuclear reaction.

- If $Q - value > 0$ then energy is released & reaction is called Exothermic or Exoergic reaction. (*In this case, mass is converted into energy.*)
- If $Q - value < 0$ then energy is absorbed & reaction is called Endothermic or Endoergic reaction. (*In this case, energy is converted into mass.*)

NUMERICAL:

Steps for finding Q-value of a nuclear reaction:

Step 1: Find the mass difference of the nuclear reaction:

$mass\ difference, \quad \Delta m = total\ mass\ of\ reactants - total\ mass\ of\ products$

Step 2: Find the Q-value:

$Q - value = \Delta m \times c^2$	$Q - value = \Delta m \times 931\ MeV$
If Δm is in Kg	If Δm is in amu

1. What will be the amount of energy released in the fusion of three alpha particles into a C^{12} nucleus if the mass of He^4 and C^{12} nuclei are respectively 4.00263amu and 12 amu. [$7.37\ MeV$]

2. Calculate the Q-value of the reaction $_7N^{14} + {}_2He^4 \rightarrow {}_8O^{16} + {}_1H^1 +$ Q and mention the type of reaction (endothermic or exothermic). Mass of proton ($_1H^1$) is 1.00814 u and mass of Helium ($_2He^4$) = 4.00377 u, Mass of Nitrogen ($_7N^{14}$) is 14.00783 u and mass of Oxygen ($_8O^{16}$) = 17.00450 u. [$-0.96824\ MeV$]

NUCLEAR FISSION:

The phenomenon in which a heavy nucleus splits up into two (or more) relatively lighter nuclei of nearly comparable masses with the release of large amount of energy is called Nuclear Fission.

When a Uranium nucleus $_{92}U^{235}$ is bombarded by slow neutron $_0n^1$ then it splits into $_{56}Ba^{141}$ & $_{36}Kr^{92}$ along with three neutrons & huge amount of energy is released.

$$_0n^1 + {}_{92}U^{235} \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\ {}_0n^1 + Q$$

Where, Q is energy released in the process is about 200MeV.

Here, the total initial mass of reactants ($_{92}U^{235}$ & $_0n^1$) is greater than the total final mass of products ($_{56}Ba^{141}$, $_{36}Kr^{92}$ & 3 $_0n^1$).

The decrease in mass is converted into energy 'Q' according to mass- energy relation ($E=mc^2$).

ENERGY RELEASED IN FISSION:

Mass of neutron, $_0n^1$ =1.008665 u

Mass of Uranium, $_{92}U^{235}$ = 235.045733 u

Mass of Barium, $_{56}Ba^{141}$ = 140.917704 u

Mass of krypton, $_{36}Kr^{92}$ = 91.8854 u

Mass of reactant = 1.008665 +235.045733 = 236.054398 u

Mass of product = 140.917704 + 91.8854 + 3x 1.008665 = 235.829095u