B.Sc Part II Physics (Hons)

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Q What is nuclear Fission. How has it been explained and utilised.?

Ans

Nuclear Fission:-

The process in which a heavy nucleus splits up into two nuclei of nearly comparable masses is called nuclear fission.

It is also found that in this process a large amount is released. This energy is produced due to its original mass of the nucleus is greater than the sum of masses of the product after fission and this excess mass appears as energy $E = mc^2$. Bohr and wheeler appears that slow nutrons are responsible for the fission of Uranium ($_{92}U^{235}$) whereas practically no fission was observed with $_{92}U^{238}$. Neutrons with energy greater than 0.7 MeV are necessary for the fission of U^{238}. Consider the fission of U^{235} by thermal neutrons. The reaction can be given as

$$_{92}U^{235} + {}_0n^1 \longrightarrow U^{236} \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_0n^1 + \text{Energy}$$

unstable

Mass of $_{92}U^{235}$	= 235.04573 a.m.u
Mass of $_0n^1$	= 1.008665 a.m.u
Total initial mass	= 236.054398 a.m.u
Mass of barium	= 140.9177
Mass of krypton	= 91.8854 a.m.u
Mass of 3 neuton	= 3×1.008665 = 3.025995 a.m.u
Total final mass	= 235.829095
Difference	= 0.2153 am.u
1 am.u	= 931 MeV

Energy released $= .2153 \times 931$ MeV

$= 200.4443$ MeV

Thus in this process of one nucleus of uranium released energy of about 200 MeV

Energy released by 1 gram of uranium :-

No of atoms in 1 gram atom of uranium $= 6.023 \times 10^{23}$

$\therefore$ No of atom in 1 gram of uranium $= \frac{6.023 \times 10^{23}}{235}$

Energy produced by 1 gram of uranium during fission

$$= \frac{6.023 \times 10^{23}}{235} \times 200 \text{ MeV}$$

$\therefore E = 5.125 \times 10^{23}$ MeV

But $1 \text{ MeV} = 1.6 \times 10^{-13}$ joule

$\therefore E = 5.125 \times 10^{23} \times 1.6 \times 10^{-13}$ J

$\because$ 1 Kwh $= 3600 \times 10^3$ Joule

$$\therefore E = \frac{5.125 \times 10^{23} \times 1.6 \times 10^{-13}}{36 \times 10^5}$$

$= 2.26 \times 10^4$ Kwh

Thus the disintegration of 1 gram of Uranium produces energy $= 2.26 \times 10^4$ Kwh