B. Sc. (H) paper IV Group :- C
& B. Sc (Sub/Gen) paper II :-
group :- B.

"Nuclear Fission"

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It was discovered in 1938 that a nucleus of $^{235}_{92}U$ undergoes fission when bombarded by a neutron. The uranium nucleus absorbs the neutron and becomes $^{236}_{92}U$ which is very unstable and explodes into two fragments. The fission fragments are unequal in size. Since the heavy nuclei have large N/Z ratio, the fragments contain an excess of neutrons. This excess is reduced by emission of neutrons by the fragments as soon as they are produced. These are called prompt neutrons. The fragments reach stability by subsequent beta decay

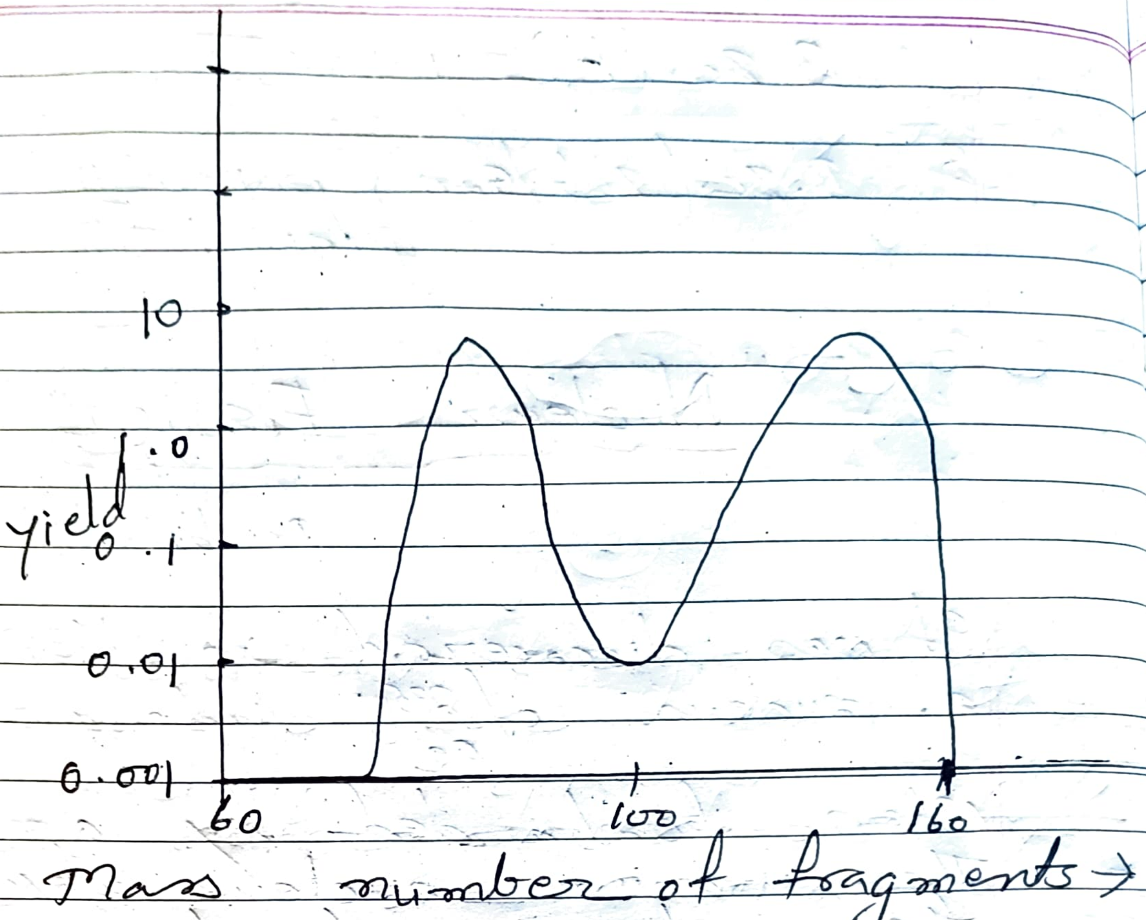

fig 1.

The fission reaction is

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{236}_{92}U \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + ^{1}_{0}n + ^{1}_{0}n$$

The distribution of energy released is as follows:

(i) 170 MeV as Kinetic energy of fission fragments
(ii) 5 MeV as combined kinetic energy of fission neutrons.

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(iii) 15 MeV as β- and γ-ray energy.

(iv) 10 MeV as neutrino energy.

The amount of energy that has to be spent to make the fission possible is called the nuclear fission activation energy. In the liquid drop model, just as a liquid drop is stable in the spherical shape because of minimum surface energy, the nucleus has the greatest stability if the sum of the surface energy and the electrostatic energy of repulsion of the protons is smallest. When a neutron is captured by nucleus, it is deformed into an ellipsoid. The surface area increases and therefore the surface energy of the nucleus increases. The electrostatic energy diminishes because of the increase in the mean distance between protons. The condition for stability is no longer

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there and the nucleus starts oscillating by stretching out and contracting

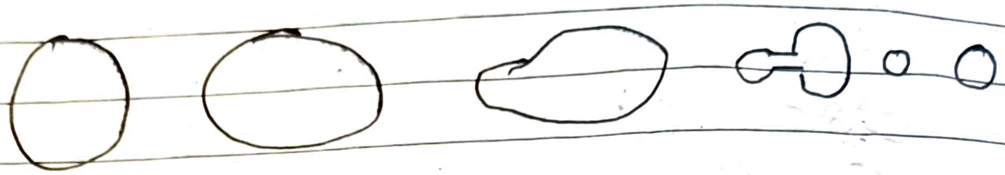

fig (2)

At excitation energies of the nucleus less than the fission activation energy the deformation does not reach the critical value. The nucleus returns to its basic energy state after emitting a gamma photon.

The quantity Z^2/A is called fission parameter. For fission to take place $Z^2/A > 17$ only for heavy nuclei. the fission activation energy makes fission possible under the action of neutrons. At the critical value of fission parameter of $Z^2/A = 49$ spontaneous fission of the nucleus occurs.

—x— The end.