Chapter 38 Problem 35 †

Given

Solution

Find the number of neutrons released in the neutron-induced fission of ^{235}U.

The nuclear reaction of this process is as follows:

$$n^0 +^{235} U \rightarrow^{139} I +^{95} Y + bn^0$$

where b is the number of neutrons released in the process. This reaction needs to be neutron-induced because the half-life for ^{235}U is $7.04 \times 10^8\ yrs$. However, if a neutron is absorbed it makes the nucleus unstable and it breaks into two nuclei, ^{139}I and ^{95}Y.
Since Uranium has 92 protons, the number of neutrons in ^{235}U is

$$n_U = 235 - 92 = 143$$

Iodine has 53 protons. Therefore, the number of neutrons in ^{139}I is

$$n_I = 139 - 53 = 86$$

Yttrium has 39 and, therefore, ^{95}Y has

$$n_Y = 95 - 39 = 56$$

Therefore, the number of neutrons unaccounted for in the fission process is

$$n_{n^0} + n_U - n_I - n_Y = 1 + 143 - 86 - 56 = 2$$

The neutron-induced fission of ^{235}U releases 2 neutron. If one out of the two neutrons is used to initiate another reaction, the nuclear reaction will be self-sustaining. The mass that achieves this threshold is called the critical mass.

† Problem from Essential University Physics, Wolfson