Problem 1. 2-1

What target isotope must be used for forming the compound nucleus $^{24}_{11}$Na when the incident projectile is:

(a) a neutron

(b) a proton

(c) an alpha particle?

Solution

Part (a)

A neutron will increase the mass number, A, by one, but leave the element number, Z, unchanged. Therefore, the answer is a lighter isotope of Neon: $^{23}_{11}$Na

Part (b)

Capturing a proton increases both the mass number and element number by one: $^{23}_{10}$Ne

Part (c)

Capturing an α particle increases the mass number by four and the element number by two: $^{20}_{8}$O

Problem 2. 2-4

A fission product of very considerable importance in thermal reactor operation is ^{135}Xe, which has an enormous thermal absorption cross section of $2 * 10^6 b$. This nuclide can be produced either directly as a fission product or by beta decay of ^{135}I, as indicated by the radioactive chains below: Write the rate equations describing the concentration of ^{135}I and ^{135}Xe in a nuclear reactor. Then assuming a constant production rate of these isotopes from fission and transmutation rate by neutron capture, determine the steady-state or saturated concentration of ^{135}Xe.

Solution

Holy hell that was really hard! Like, just typing it!

Problem 3. 2-6

Boron is a common material used to shield against thermal neutrons. Estimate the thickness of boron required to attenuate an incident thermal neutron beam to 0.1% of its intensity. (Use the thermal cross section data in Appendix A.)

Solution

This one was quite a bit easier.

Problem 4. 2-8

A free neutron is unstable against beta decay with a half-life of 11.7m. Determine the relative probability that a neutron will undergo beta-decay before being absorbed in an infinite medium. Estimate this probability for a thermal neutron in H_2O.

Solution

Not too bad. Did have to break out the
ce, though

Problem 5. 2-10

How many mean free paths thick must a shield be designed in order to attenuate an incident neutron beam by a factor of 1000?

Solution

From *2-27*