

Problem 1. 2-1

What target isotope must be used for forming the compound nucleus ${}^{24}_{11}\text{Na}$ 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: ${}^{23}_{10}\text{Ne}$

Part (b)

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

Part (c)

Capturing an α particle increases the mass number by four and the element number by two: ${}^{20}_8\text{O}$

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