

Homework 5

Nuclear Engineering 162

Due 3 March 2008

V.1 Turner 9.3 (Page 235)

- (a) Estimate the average energy that a 2-MeV neutron transfers to a deuteron in a single collision.
- (b) What is the maximum possible energy transfer?

V.2 Turner 9.8 (Page 236)

- (a) Estimate the average recoil energy of a carbon nucleus scattered elastically by 1-MeV neutrons.
- (b) What is the average recoil energy of a hydrogen nucleus?
- (c) Discuss the relative importance of these two reactions as a basis for producing biological effects in soft tissue exposed to 1-MeV neutrons.

V.3 Turner 9.20 (Page 237)

The thermal-neutron reaction $^{15}\text{B}(n, \alpha)^3\text{Li}$ leaves the ^3Li nucleus in the ground state 7% of the time. Otherwise, the reaction leaves the ^3Li nucleus in an excited state, from which it decays to the ground state by emission of a 0.48-MeV gamma ray.

- (a) Calculate the Q value of the reaction in both cases.
- (b) Calculate the alpha-particle energy in both cases.

V.4 Turner 9.27 (Page 237)

A sample containing 127 g of ^{23}Na (100% abundant) is exposed to a beam of thermal neutrons at a constant fluence rate of $(1.19 \cdot 10^4 \text{cm}^{-2}\text{s}^{-1})$. The thermal-neutron capture cross section for the reaction $^{23}\text{Na}(n, \gamma)^{24}\text{Na}$ is 0.53 barn.

- (a) Calculate the saturation activity.
- (b) Calculate the ^{24}Na activity in the sample 24 h after it is placed in the beam.
- (c) How many ^{23}Na atoms are consumed in the first 24 h?

V.5 Turner 9.30 (Page 238)

To make a ^{60}Co source, a 50-g sample of cobalt metal (^{59}Co , 100% abundant) is exposed to thermal neutrons at a constant fluence rate of $(10^9 \text{cm}^{-2}\text{s}^{-1})$. The thermal-neutron capture cross section is 37 barns.

- (a) How much exposure time is required to make a 1-mCi source of ^{60}Co ?
- (b) Estimate the number of ^{59}Co atoms consumed in 1 week.