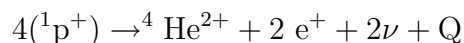


Chemistry 485

Spring, 2010  
Distributed: Wed., 7 Apr. 2010  
(10 points)

Problem Set #8  
Due: Mon., 12 Apr. 2010

1. Boron is used in nuclear reactor control rods and also in neutron detectors because  $^{10}\text{B}$  has an extremely large cross section for the  $(n,\alpha)$  reaction and does not make radioactive products. For example, the control “rods” are often plates of the ceramic  $\text{B}_4\text{C}$  with a density of  $2.5 \text{ g/cm}^3$ .
  - (a) Write a balanced nuclear reaction for this reaction.
  - (b) What is the fraction of  $^{10}\text{B}$  is converted to product in a 5.0 mm thick control rod that is exposed to a reactor flux of  $2 \times 10^{12}$  neutrons/ $\text{cm}^2/\text{s}$  for 1.00 hour, if the total cross section for this reaction is 5580 b?
2.  $^{32}\text{P}$  is a beta-minus emitting nuclide that is used extensively in biological and biochemical studies. This nuclide is made in nuclear reactors by the  $(n,\alpha)$  reaction with a cross section of 80 mb (on the appropriate target nucleus). The target material for the production is usually ammonium chloride ( $\text{NH}_4\text{Cl}$ ) because it is a simple ionic solid. Calculate the activity of a 5.00 g sample of natural  $\text{NH}_4\text{Cl}$  that is uniformly irradiated for 30 minutes in a high-flux reactor with a flux of  $1 \times 10^{14}$  neutrons/ $\text{cm}^2/\text{s}$ .
3. Calculate the Q-value for the net solar burning reaction (show your work):



4. Calculate the Q-value for the net helium burning reaction (show your work):

