

Problem Sheet 4

3C24

February 23, 2001

1. i)

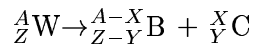
$$\begin{aligned} E_{nucleus} &= Zm_p + Nm_n - B_{volume} - B_{surface} - B_{Coulomb} - B_{Symmetry} - B_{Pairing} \\ &= Zm_p + Nm_n - u_v A + u_c Z^2 A^{-\frac{1}{3}} + u_s A^{\frac{2}{3}} + u_a T^2 A^{-1} \pm \frac{\delta}{2A} \end{aligned}$$

Explain in detail each of the terms in this expression.[11]

- ii) Obtain an expression for Z as a function of A for the stable isobars[8] (Stable : $\frac{\partial U}{\partial Z} = 0$)
- iii) Obtain an expression for the difference in energy of the parent nuclei and the decay products in alpha decay.[2]
- iv) Show it can be written in the form: (You need to differentiate U wrt A)[8]

$$\frac{Z}{A^{\frac{1}{3}}} \left[\chi_1 - \chi_2 \frac{Z}{A} \right] + \frac{\chi_3}{A^{\frac{1}{3}}} - \chi_4 \left[1 - \frac{2Z}{A} \right]^2 - 28.1 MeV$$

2. i) Write down a general expression for the energy released in a nuclear decay



in terms of parameters of the SEMF. [2]

- ii) Which parameter does not appear in the expression and why? [2]
- iii) Show that if the two decay fragments are of equal size, (i.e. $X=A/2, Y=Z/2$) that [4]

$$\frac{Z^2}{A} > \frac{u_s(2 - 2^{2/3})}{u_c(2^{2/3} - 1)} \quad (1)$$

$$> 18 \quad (2)$$

- iv) Use this expression to estimate the energy given out in fission of ${}^{235}\text{U}$ to two equal sized fragments. [2]

- 3. i) Explain how the strong and electromagnetic forces are involved in the existence of stable nuclei.[5]
- ii) Describe the three radioactive processes and explain the differences between them.[6]
- iii) Explain why there are very few odd-odd even nuclei which are beta stable[4]
- iv) Explain the requirements for X and Y isobars differing by one unit in Z being stable against beta decay and explain why this is a rare occurrence. [4]