

Binding Energy and Mass defect

Data:

Particle	Relative Charge	Electric Charge (C)	Relative Mass (u)	Mass (kg)
Electron	-1	-1.60×10^{-19}	5.485779×10^{-4}	9.109390×10^{-31}
Proton	+1	$+1.60 \times 10^{-19}$	1.007276	1.672623×10^{-27}
Neutron	0	0	1.008665	1.674929×10^{-27}
$1u = 1.6605 \times 10^{-27} \text{ kg}$				
$1eV = 1.60 \times 10^{-19} \text{ Joules}$				
<i>The 'cheating' equivalence shortcut</i> $1u = 931.5 \text{ MeV}$				

Problem

${}^4_2\text{He}$ is the most abundant isotope of helium. Its mass is $6.6447 \times 10^{-27} \text{ kg}$. What is

- a) The mass defect?
- b) The binding energy of the nucleus in joules?
- c) The binding energy of the nucleus in electron volts?

Questions:

1) ${}^{238}_{92}\text{U}$ decays into ${}^{234}_{90}\text{Th}$ and an alpha particle

- a) Write down the full decay equation
- b) How much energy is released.

Mass of ${}^{238}_{92}\text{U}$ = 238.0508u

Mass of ${}^{234}_{90}\text{Th}$ = 234.0426u

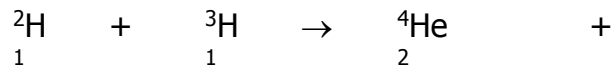
Mass of ${}^4_2\alpha$ = 4.0026u

2) Calculate the mass defect and binding energy the nuclide ${}^{10}_5\text{B}$ where the mass of ${}^{10}_5\text{B}$ atom = 10.0129 u

3) Oxygen has an unstable isotope O-17 that has a mass of 17.00454. If the mass of a neutron is 1.00898 u and the mass of a proton is 1.00814 u, calculate the binding energy of the oxygen nucleus in MeV.

4) A thorium atom of mass 232.038 u decays by the emission of an alpha particle to a radium atom of mass 228.031 u. If the alpha particle has a mass of 4.003 u, how much energy in J is released in the process ?

5) The fusion reaction below is one of the final stages in the fusion process that occurs in the Sun.



- (a) Complete the reaction identifying the missing particle.
- (b) Calculate the energy released in the fusion reaction using the following information (you will also need the mass of the other particle).

$${}^2_1\text{H} = 3.345 \times 10^{-27} \text{ Kg}$$

$${}^3_1\text{H} \rightarrow 5.008 \times 10^{-27} \text{ Kg}$$

$${}^4_2\text{He} = 6.647 \times 10^{-27} \text{ Kg}$$