Chemistry H

Exercise 21.1a(H)

Mass Defect and Nuclear Binding Energy

Name: _____

Date: _____ Per: _____

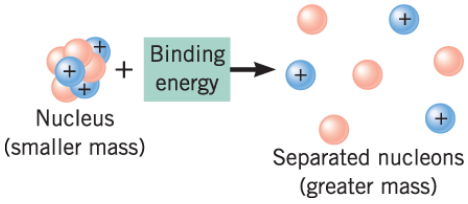
Nuclei are made up of protons and neutrons, but the mass of a nucleus is always less than the sum of the individual masses of the protons and neutrons which constitute it. The difference (mass defect) is a measure of the nuclear binding energy which holds the nucleus together. Nuclear binding energy is the energy required to disassemble a nucleus into free unbound neutrons and protons. Nuclear binding energy derives from the strong (nuclear) force and can be calculated from the mass-energy equivalence formula derived by Einstein:

$$\text{Nuclear binding energy(E)} = \text{mass defect}(\Delta m) \bullet \text{speed of light}(c)^2 \rightarrow E = mc^2$$

$$\text{mass defect}(\Delta m) = (\sum \text{masses of individual } p^+ \text{ \& } n^o) - (\text{mass of the nucleus})$$

E = binding energy in joules, m = mass defect in kilograms, c = 3.00 x10^8 m/s

Particle	Relative Mass (*u*)	Conversion Factors
Electron	5.485779 x 10^{-4}	**1*u* = 1.6605 x 10^{-27} kg** **1eV = 1.60 x 10^{-19} joules**
Proton	1.007276	
Neutron	1.008665	



DIRECTIONS: Using the values above, answer the following in the space provided:

1. The mass of a neon–20 atom is 19.99244 *u*. Calculate its mass defect.

2. The mass of a lithium–7 atom is 7.01600 *u*. Calculate it mass defect.

3. Calculate the nuclear binding energy of one lithium–6 atom. The actual atomic mass of lithium–6 is 6.015 *u*.

4. Calculate the binding energy of one potassium–35 atom. The actual atomic mass of potassium–35 is 34.988011 *u*.

5. Calculate the mass defect and binding energy for the nuclide $^{10}_{5}B$ where the mass of $^{10}_{5}B$ atom = 10.0129 *u*.

6. Because binding energy is calculated using only one variable (*m*) and one constant (*c*), it is possible to calculate the binding energy for specific mass changes. Calculate the binding energy associated with a mass defect of 1.000*u* in both joules and MeV(megaelectronvolts).

Answers: 1) 0.17246 u 2) 0.04213 u 3) 5.1 x 10^{-12} J 4) 4.47 x 10^{-11} J 5) 1.04 x 10^{-11} J 6) 1.49 x 10^{-10} J, 934 MeV