

### Structure and Properties of the Nucleus

Proton mass:

Neutron mass:

Atomic Mass

Strong Nuclear Force



where X is the chemical symbol, A is the atomic mass (number of protons + neutrons), Z is the atomic number (number of protons)

### Isotopes

#### EX: Carbon



Atomic mass values in periodic charts include % abundance of all isotopes... they represent an average mass by abundance

### The Unified Atomic Mass Unit

$$1 \text{ u} = 1.6605 \times 10^{-27} \text{ kg}$$

$$1 \text{ u} = 931.5 \text{ MeV}/c^2$$

OR we say the energy is 931.5 MeV/u

**Binding Energy and Nuclear Forces**

Refer to Appendix B pg A-12

${}^4_2\text{He}$  mass compared to its constituents.

$$m_n \ 2 \times 1.008665 \ \text{u} = 2.017330 \ \text{u}$$

$$m_p \ 2 \times 1.007276 \ \text{u} = 2.014552 \ \text{u}$$

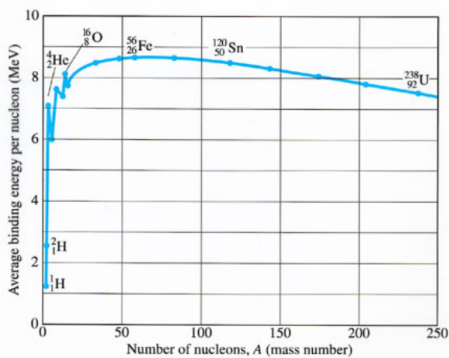
$$m_e \ 2 \times 0.000549 \ \text{u} = \underline{0.001098 \ \text{u}}$$

$$4.032980 \ \text{u}$$

${}^4_2\text{He}$  is measured to be 4.002603 u or 0.030377 u less than the individual masses.

**Calculating the Binding Energy**

$$(0.030378 \ \text{u})(931.5 \ \text{MeV/u}) =$$



**Example 30-4, pg 840**

Calculate the total binding energy and the average binding energy per nucleon for  ${}^{56}_{26}\text{Fe}$ , the most common stable isotope of iron.



## Alpha Decay

## Beta Decay

### Example 30-8, pg 845

How much energy is released when  ${}^{14}_6\text{C}$  decays to  ${}^{14}_7\text{N}$  by beta emission?

## Gamma Decay

### Various Decay Particles

$\alpha$  particle  ${}^4_2\text{He}^{++}$

$\beta$  particle  ${}^0_{-1}\text{e}^-$

$\gamma$  high energy radiation

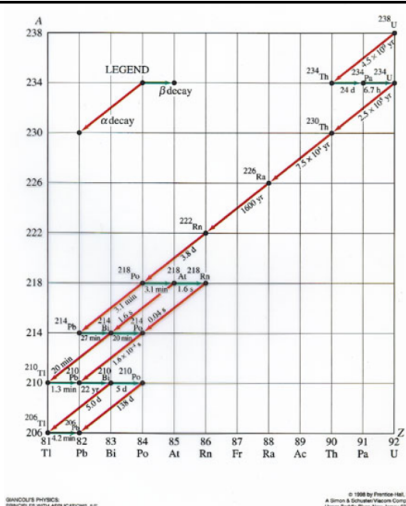
positron  ${}^0_{+1}\text{e}^+$

proton  ${}^1_1\text{p}^+$

neutron  ${}^1_0\text{n}$

### Nuclear Decay

- Complete this radioactive-decay formula:  ${}^{12}_5\text{B} \rightarrow ? + {}^0_{-1}\text{e} + \bar{\nu}$   
(Refer to Appendix G for this problem and the following problems.)
- Complete this radioactive-decay formula:  ${}^{212}_{83}\text{Bi} \rightarrow ? + {}^4_2\text{He}$
- Complete this radioactive-decay formula:  $? \rightarrow {}^4_7\text{N} + {}^0_{-1}\text{e} + \bar{\nu}$
- Complete this radioactive-decay formula:  ${}^{225}_{89}\text{Ac} \rightarrow {}^{221}_{87}\text{Fr} + ?$
- Nickel-63 decays by  $\beta^-$  emission to copper-63. Write the complete decay formula for this process.
- The isotope  ${}^{56}_{26}\text{Fe}$  decays into the isotope  ${}^{56}_{27}\text{Co}$ .
  - By what process will this decay occur?
  - Write the decay formula for this process.



T-272 (a)

FIG. 30-4 Radioactive particles

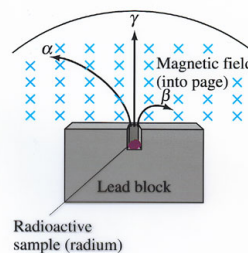


FIGURE 30-3  
PROCESSES WITH APPLICATIONS, 4E

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