



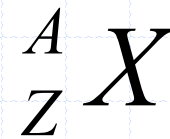
# Chapter 31: Nuclear Physics and Radioactivity

## Essential Concepts and Summary

# Nuclear Structure

- ◆ Nucleus consists of neutrons and protons, called **nucleons**.
- ◆ Atomic number =  $Z$  = number of protons in atom.
- ◆ Atomic mass number =  $A$  = protons + neutrons
- ◆ Isotopes: atoms with same number of protons, different number of neutrons

$$A = Z + N$$



# Strong Nuclear Force and Stability of Nucleus

- ◆ Strong nuclear force holds nucleons together
- ◆ As nuclei increase in size, they become less stable
- ◆ Spontaneous disintegration or rearrangement of internal structure is called **radioactivity**

# Mass Defect and Nuclear Binding Energy

- ◆ **Binding energy:** Energy required to break apart nucleus
- ◆ Sum of individual masses of nucleons is greater than sum of single nucleus. Difference in mass is known as **mass defect**

$$E = (\Delta m)c^2$$

# Radioactivity

- ◆ Three kinds of rays are produced naturally: alpha, beta, and gamma
- ◆ Alpha rays are helium nuclei
- ◆ Beta rays are electron streams
- ◆ Gamma rays are electromagnetic waves
- ◆ **Transmutation:** process by which parent nuclei changes into different daughter nuclei via radioactive decay

# Radioactive Decay and Activity

- ◆ **Half life:** Time in which  $\frac{1}{2}$  of radioactive nuclei disintegrate
- ◆ **Activity:** number of disintegrations per second
- ◆ Lambda is proportionality constant known as **decay constant**
- ◆ Amount left after time  $t$  related to initial amount and an exponential in  $t$

$$\frac{\Delta N}{\Delta t} = -\lambda N$$

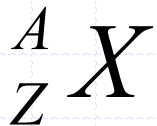
$$N = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

$$A = A_0 e^{-\lambda t}$$

# Equation Summary

$$A = Z + N$$



$$E = (\Delta m)c^2$$

$$\frac{\Delta N}{\Delta t} = -\lambda N$$

$$N = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

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