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

$$A = Z + N$$

$${}^{A}_{Z}X$$

Strong Nuclear Force and Stability of Nucleus

- Strong nuclear force holds nucleons together
- As nucleii 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 _ 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

$$A = Z + N$$

$${}^{A}_{Z}X$$

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

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

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