UBC Physics 102

Lecture 3

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Outline

Nuclear reactions [Text: Sect. 43-1,3,4]

- **Definition:** *nuclear reaction*
  - When a nucleus interacts with a particle or another nucleus.
  - (Nuclear reactions often produce unstable isotopes.)
- **Discussion: Energy minimization**
  - Reactions occur spontaneously if they reduce the system's potential energy.
- **Discussion: Conservation**
  - Remember: mass and charge must be conserved in reaction.
- **Interactive Quiz: PRS 03a**

Nuclear reactions, contd

- **Definition:** *nuclear fission*
  - The splitting of a nucleus into two or more smaller nuclei.
- **Definition:** *nuclear fusion*
  - The joining of several nuclei into a single, larger nucleus.

Radiation damage [Text: Sect. 43-5]

- **Discussion: Radiation damage**
  - Radiation often causes ionization of particles it encounters.
  - Ions in cells interfere with normal cell processes.
  - Cell may cease to function or perform harmful function (eg. unregulated reproduction).

Dosimetry [Text: Sect. 43-6]

- **Definition:** *Curie,* Ci
  - Unit of activity.

$$1\ \mathrm{Ci} = 3.70{\times}10^{10}\ \mathrm{decays/s}.$$

- **Definition:** *Absorbed dose*
  - Radiation energy deposited, E, per unit mass of absorbing material, m.

$$\mathrm{dose_{abs}} = \frac{E}{m}.$$

Dosimetry, contd

- **Discussion: Quality Factor, QF**
  - Different types of radiation have more or less effect on biological tissue.
  - Absorbed dose does not take type of radiation into account.
  - Quality Factor, QF (no units), gives scale of effectiveness for radiation type.
  - (Quality factor (QF) will be provided on tests if needed.)

Dosimetry, contd

- **Definition:** *Effective dose*
  - Absorbed dose rescaled by QF to reflect biological damage.

$$\mathrm{dose_{eff}} = \mathrm{dose_{abs}} \times \mathrm{QF}.$$

- **Definition:** rem *and Sievert,* Sv
  - Units of effective dose.

$$\begin{aligned} 1\ \mathrm{rem} &= 1\ \mathrm{rad} \times 1\ \mathrm{QF} \\ 1\ \mathrm{Sv} &= 100\ \mathrm{rem}. \end{aligned}$$

Dosimetry, contd

- **Example: Ch. 43 Pr. 42**
  - Fifty rads of α-particle radiation is equivalent to how many rads of X-rays in terms of biological damage?
  - $\mathrm{QF}(\alpha) = 20,\ \mathrm{QF}(\text{X-rays}) = 1$.
- **Solution:**
  - First let's calculate the effective dose of the alpha radiation, $\mathrm{dose}_{\mathrm{eff}}$,

$$\mathrm{dose}_{\mathrm{eff}} = 50\ \mathrm{rad} \times 20\ \mathrm{QF} = 1000\ \mathrm{rem}.$$

  - Now we want to find x, the absorbed (real) dose of X-rays that produces the same effective dosage,

$$x = \frac{\mathrm{dose}_{\mathrm{eff}}}{\mathrm{QF(X\text{-}rays)}} = \frac{1000\ \mathrm{rem}}{1\ \mathrm{QF}} = 1000\ \mathrm{rad}. \quad \square$$

End

- **Interactive Quiz: PRS 03b**
- **Practice Problems:**
  - Ch. 43: Q. 9, 19, 21 27
  - Ch. 43: Pr. 49, 51, 59, 61, 71
- **Midterm Test: #1**
  - First 60 min. test at start of class on Mon (July 7).
  - Will cover all material in Lectures 1–3.
  - Recommend you study by doing practice problems.
  - No notes allowed. Formula sheet will be attached to test.
- **Interactive Quiz: Feedback**