Decay Kinetics - Variation of Decay Rate with Time

The number of alpha, beta or gamma rays emitted per unit time is called the decay rate or radioactivity. Its variation with time is called decay kinetics.

- **Radioactivity Units, Decay Constants and Half Lives** Decay rate is number of decays per unit time. One decay per second (dps) is a becquerel (Bq).

  Another widely used unit is curie (Ci), which is 3.700e10 Bq.

  The decay rate of a radioactive nuclide is independent of its physical and chemical state, but proportional to the number of nuclei present. The proportional constant \( l \) is called the decay constant.

**Summary of Decay Kinetics**

- \( N_0 \) is number of nuclei at \( t = 0 \).
- \( N \) is the number of nuclei at \( t \).
- \( A \) is the Radioactivity.

\[
A = - \frac{dN}{dt} = lN
\]

Integrating gives

\[
N = N_0 \exp(-lt)
\]

\[
\ln N = \ln N_0 - lt
\]

Because of decay, the number of nuclei decrease exponentially. The period of time required for half of the nuclei to decay is called half-life, \( t_{1/2} \). The half-life multiplied by the decay constant is a constant.

\[
t_{1/2}l = 0.693
\]

The life time \( t \) or average life time of all nuclei is

\[
t = \frac{1}{l} = 1.44 t_{1/2}
\]

- **Mixtures of Radioactive Nuclides**

  Behavior of various mixtures of radioactive nuclides will be described using diagrams during the lecture.

- **Consecutive Decay and Growth**

  When the daughter nuclide is also radioactive, the apparent radioactivity of the parent and daughter show certain patterns. The apparent radioactivity may give some insight of the half-lives of the consecutive decay.

- **Applications of Decay Kinetics**

  One important application of nuclear technology is the dating of old, but once living things. If radioactive carbon, \(^{14}\text{C}\), is used, the process is called carbon-14 dating.

  However, one need to understand how \(^{14}\text{C}\) is produced, and the transformation of carbon in biosphere in order to
comprehend the process.

Carbon-14 dating is an application of decay kinetics. How accurate is C-14 dating gives an excellent discussion.

Carbon-14 Data is a good source of information regarding carbon.

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