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Measurement of the half-life of thorium emanation

Lecture 2

By

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The aim of this experiment:

to calculate of the half-life of thorium emanation.

The device used in this experiment:

1-GM counter

2-radioactive isotope (thorium)

Theory:

Th-^{232} :natural isotope, the percentage of founding it in natural environment is 99.98%. The half-life of it equal to14 billion years, which makes it the longest-lived isotope, when Th-^{232} decay its emitting alpha then convert to radium^{-228} isotopes , and the decay series end with stable lead^{-208}.

The radioactivity: the time rate of unstable nuclear decay and it Proportional with Number of nucleus (N) as following formula:

$$A = -\frac{dN}{dt} = \lambda N \text{..........}(1)$$

The negative sign in equation (1) represent the decrease in number of (N)due to the decay, and the proportionality constant is called the decay constant (λ). By Solving equation (1) will get the law of radioactive decay in terms of the number of nuclei:

$$N = N_O \exp(-\lambda t) \text{.........}(2)$$

$$A = A_O \exp(-\lambda t) \text{..........}(3)$$

Whereas:

N: represents the total number of particles.

N_o: the original number of nuclei.

A: The activity of the source at the present time.

$A_{o:}$ The activity of the radioactive source (original activity).

The unit of radioactivity is **(Becquerel),** which is equivalent to one decay per

Second (the old units are the curie, which is equivalent to ($\mathbf{3.7 \times 10^{10}}$)decay

Per Second), While the units of the decay constant are the reciprocal the time (1/sec).

The half-life ($t_{1/2}$): is defined as the period of time that required to get half original number of nuclei (N_O) (original activity A_O) .The relationship with a decay constant can be derivative using one of the equations (3 and 2):

$$t_{1/2} = \frac{0.693}{\lambda} \ldots\ldots\ldots\ldots\ldots (4)$$

working method:

1. A radioactive source is placed in front of the window of the G-M counter at a constant distance as shown in Figure (1).
2. The rate counter is measured for one minute.
3. Point (2) is must repeated every time, it must increase time minute by minute then calculate the counting rate, until it reaches 10 minutes.

Calculation:

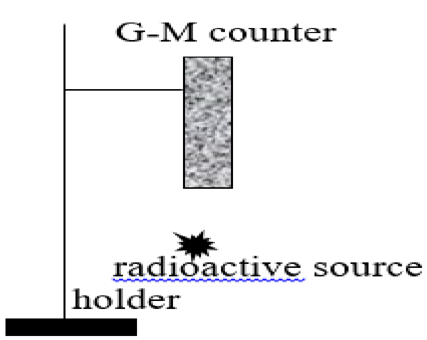
1. The results are arranged as in the following table:

Time (Sec)	Average Count (N)	Ln(N_{Ave})
0	1000	
10	938.806	
20	881.358	
30	827.425	
40	776.792	
50	729.25	
60	684.632	
70	642.738	
80	603.407	
90	566.482	
100	531.879	
110	499.274	
120	468.722	

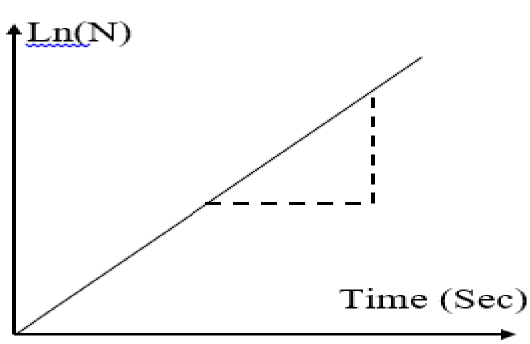
2. Draw a graphic relationship between (Ln N) on the (Y) axis and (Time) on the (X) axis and as in Figure (2) and its slope represents (the decay constant λ).

3. The value of ($t_{1/2}$) is calculated from the relationship (4).

4. The real value of the element is extracted from nuclear physics books, the extracted value is practically compared and compared with the real value, the error percentage is extracted and the result is discussed.



(1) Fig



(2) Fig