Radiation protection -practical
Lec.3. Half Life Determination

Asst.Lec.Dumoaa Haider Shakir

1.1 The objectives of this experiment

1. To study radioactive decay
2. To learn the concept of nuclear activity
3. To learn the concept for radioactive half-life and how to measure it, and to measure the radioactive half-life of an isotope of barium

1.2 Apparatus

a) Geiger- Mueller: tube holder and source.

b) Timer

c) Barium-137m is source.



1.3 Theory

- One of the characteristics often used to describe radioisotopes is half-life.
- Half-life is the time required for half of a radioisotope to disintegrate. This value is a constant and is not affected by changes such as temperature or pressure.
- Half-lives of radioisotopes can vary from fractions of a second to millions of years.
- In order to determine the half-life of a sample, the actual number of radioactive atoms need not be known.
- The activity of a sample measured by a G-M tube and scalar is proportional to the number of radioactive atoms in that sample. When the measured activity of a sample reaches a value equal to one half the original activity, half of that sample has undergone radioactive decay. The period of time required for this process is the half-life of the sample.

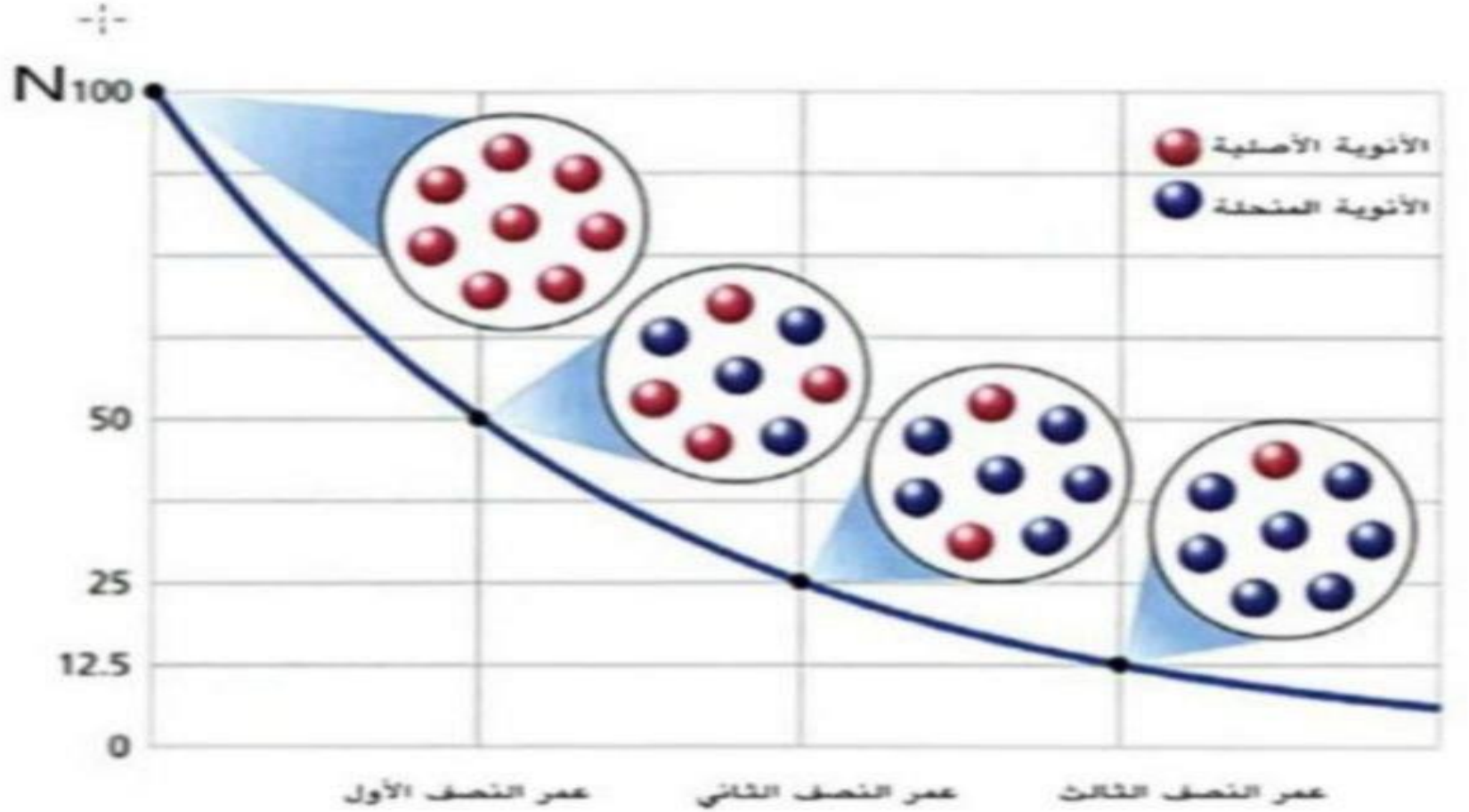
- **Radioactivity decay** is the spontaneous disintegration of unstable atomic nuclei with accompanying emission of radiation.
- **Half-life** is the time it takes for half of the unstable nuclei in a sample to decay or for the activity of the sample to halve or for the count rate to halve.

Common Radioactive Isotopes

Isotope	*Half-Life*	*Radiation Emitted*
Technetium-99	6 hours	γ
Radon-222	3.8 days	α
Carbon-14	5,730 years	β, γ
Uranium-235	7.0×10^8 years	α, γ
Uranium-238	4.46×10^9 years	α

- The decay rate is proportional to the number of original (un decayed) nuclei (N) in a substance. The number of nuclei lost to decay, dN in time interval dt , is written

- $\frac{dN}{dt} \propto \mathbf{N}$
- $\frac{dN}{dt} = -\lambda \mathbf{N}$



- After some basic Algebra, we got:

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

- where

N= number of radioactive nuclei present at time (t)

N_0= number of radioactive nuclei present at time zero ($t0$)

λ = decay constant

When the count - rate with time the equation become:

$$R = R_0 e^{-\lambda t}$$

R= count - rate present at time (t)

R_0= count - rate present at time zero ($t0$)

Then, The Half-Life is

$$T_{1/2} = \frac{Ln2}{\lambda} = \frac{0.693}{\lambda} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

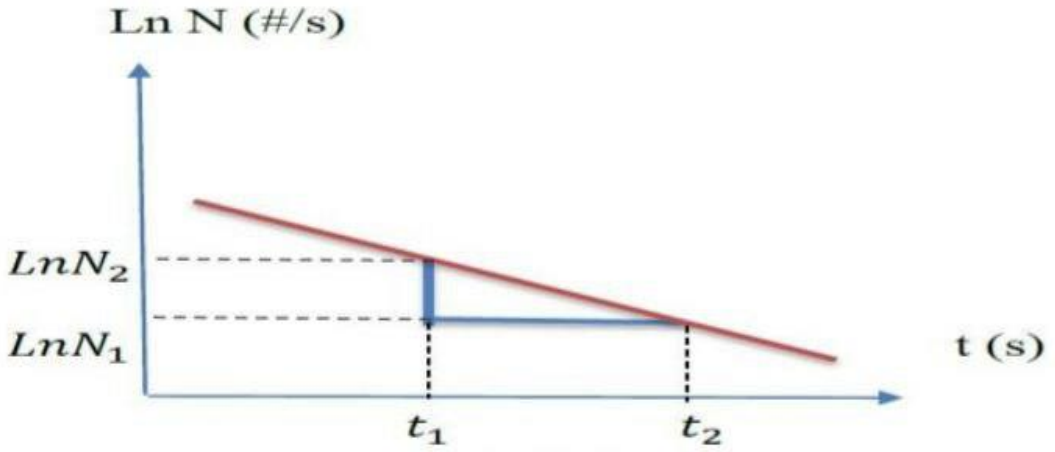
1.4 Reading

- $N_0 = 1$ For air (count/sec)

t(s)	N (count/sec)	N/N_0	$Ln\ N$
25	63.08		
50	58.16		
75	55.04		
100	48.28		
125	43.20		

Calculations:

1. Draw between (Ln N) and (t), as the following:



Find slope from: $Slope = \frac{\Delta Ln\ N}{\Delta t} = \frac{LnN_2 - LnN_1}{t_2 - t_1}$ in unit (sec^{-1})

Slope = $-\lambda$

1.5 Procedure

- 1. Make sure the high voltage on the scaler/timer unit for Geiger Mueller tube is set to OPTIMUM OPERTATING VOLTAGE.
- 2. Connect the Geiger tube to the counter and turn on the counter.
- 3. Measure the background activity (or in our case, the count rate) for 30 second two times and find the average.
- 4. Immediately start counting (start the counter, then start your timer as you freeze the screen for your first reading) and record the count every 30 seconds until 10 minutes have passed, using the screen freezing feature in the device (if it is available).
- 5. Examine the points on the graph to see if they lie along a straight line.
- 6. This graph should look something the one in Figure 1. The slope of the trendline for the second portion of the graph is negative and is equal to -λ, the decay constant.
- 7. Using (equ. 1), calculate the half-life for Ba-137m and record