Hello students I am Manjita Porob, working as Assistant Professor in the department of Chemistry, Parvatibai Chowgule college Margao. Today I will be teaching you module number 12 under the unit of Nuclear Chemistry and the title of the module is average life of radioactive nuclei and numericals. The outline for today's module is , we will be studying about average life of radioactive nuclei , solve some problems and I have listed references. You can go through the learning outcomes of this module stated in this presentation.

Now to start with, the average life period of radioactive nuclei. It is denoted as tau (τ) or some textbooks even denote it as phi (φ). It is the statistical average of the life span of all the atoms present in the radioactive substance. For eg, to find the average marks of a class, the marks of all the students are added and divided by the total number of students, likewise here the life periods of all the nuclei are added and divided by the total number of nuclei. Alternatively it can also be found from the decay constant or the half life period by the formulae,

$\tau = 1/\lambda$ or $\tau = 1.44 \times t_{1/2}$

The unit for average life is the same as that of time and will take the same unit of time like minutes, hours etc.

Before I proceed with the numericals, we shall quickly revise the 4 formulae learnt by us.

$$\lambda = \frac{2.303}{t} \log N0/Nt$$

Where the initial number of nuclei are substituted as N0, λ is the decay constant and t is the time. Nt is the number of nuclei left unreacted after time t.

$$t_{1/2} = \frac{0.693}{\lambda}$$

$\tau = 1/\lambda$

$\tau = 1.44 \times t_{1/2}$

We shall see some numericals of different types,

1) **Half life period of a radioactive element is 10 years. Calculate its disintegration constant & average life?**

While solving any problem, you should always read the problem and write the correct data before proceeding with the solution.

Solution

Data given

$t_{1/2}$ *=10 years*

λ = ?

τ = ?

Now you have to use appropriate formula , substitute the data and solve using a scientific calculator.

$\lambda = 0.693 / t_{1/2}$

$=0.693 / 10$

$\lambda = 0.0693 \text{ years}^{-1}$

$\tau = 1.44 \times t_{1/2}$

$=1.44 \times 10$

$\tau = 14.4 \text{ years}$

2) Half life of $_{83} I^{125}$ is 60 days. How much of its radioactivity remains after 180 days ?

Solution

Data given

$t_{1/2} = 60$ days ,

$t = 180$ days

$No = 1$ g

$Nt = ?$

When No value has not been given then you can either take as one or 100 %

$$\lambda = \frac{0.693}{t_{1/2}}$$

$= 0.693/60$

$\lambda = 0.01155 \text{ days}^{-1}$

$$\lambda = \frac{2.303}{t} \log \frac{No}{Nt}$$

$$0.01155 = \frac{2.303}{180} \log \frac{1}{Nt}$$

$\log \frac{1}{Nt} = 0.9027$

$\frac{1}{Nt} = 7.993$

$Nt = 0.125g$

3) Half life period of a radioactive element is 35 Hours. Calculate its disintegration constant & the time required to reduce by 63% of its initial activity?

Solution

Data given

$t_{1/2}$ =35 Hours

N_0 = 100 %

Nt = 100 – 63 = 37 %

λ = ?

t = ?

Since the concentration has been reduced by 63%, it indicates that 63% has been converted to products and hence 37% would remain unreacted, hence the value of No is 37%. If the problem read that the concentration has been reduced to 63% then it would indicate that 63% has been unreacted and hence No should be 63%.

$\lambda = 0.693 / t_{1/2}$

$= 0.693 / 35$

$\lambda = 0.0198\ Hours^{-1}$

$\lambda = \frac{2.303}{t} \log \frac{No}{Nt}$

$0.0198 = \frac{2.303}{t} \log \frac{100}{37}$

$t = \frac{2.303}{0.0198} \log 2.703$

$t = 116.31 \times 0.4318$

$t = 50.22\ Hours$