Q- Kr-85 is a radioactive isotope that is used in measuring paper thickness. It decays by emission with a half-life of 10.8 years

(a) Write down the decay equation showing the daughter isotope and decay products of this process.

(b) A Kr-85 source had activity 30 mCi when new. Estimate its activity after 5 years' use.

(c) What is the activity of a 30 mCi source in becquerels?

(d) What is the mass of Kr-85 in the source when new?

(a) We can write the formula for the beta decay of Krypton-85 as:

$$^{85}Kr \rightarrow \ ^{85}Rb + \beta^- + \gamma$$

The Krypton-85 nucleus turns into a nucleus of the element Rubidium which still has a sum of 85 protons and neutrons, and a beta particle (electron) flies out with (687 keV) energy. In this case, a *gamma ray* photon has energy 513,990 electron volts (514 keV)

(b) Activity $dN/dt = 30$ m Ci $= 30 \times (3.7 \times 10^7$ disintegrations/sec$) = 1.11 \times 10^9$ dis/s

Decay constant $\lambda = 0.693/T = 0.693/10.8 = 0.0642$ year^{-1}

The activity varies with time as

$$A = A_0 e^{-\lambda t}$$

gives activity after five years

$A = (1.11 \times 10^9$ dis/s$) e^{-(0.0642 \text{ per year})*(5 \text{ year})} = 1.11 \times 10^9 \times 0.7254$

$= 8.0522 \times 10^8$ dis/s $= 21.76$ mCi.

(c) 1 becquerel = 1 Bq = 1 decay per second

30mCi $= 1.11 \times 10^9$ dis/s $= 1.11 \times 10^9$ Bq.

(d) $DN/dt = - N_o \lambda$ gives numerically (-ve because N is decreasing)

$N_0 = (dN/dt)/\lambda = (1.11 \times 10^9$ dis/s$)/0.0642$ year^{-1}

$= 1.11 \times 10^9 \times 365 \times 24 \times 3600 = 3.50 \times 10^{16}$

$= 3.50 \times 10^{16}/6.023 \times 10^{23}$.mol $= 5.81 \times 10^{-8}$ mol.

Therefore, mass of sample $= 5.81 \times 10^{-8} \times 85 = 4.94 \times 10^{-6}$ gm.