1. $T_\alpha = \frac{A-4}{A}Q$ $\therefore$ T_α = 4.78 MeV

A = 226

$4.78 \times 10^6 = \frac{226-4}{226} \times Q \Rightarrow Q = 4.86$ MeV

2. Intial Activity $R_1 = \lambda N_1$

Activity after time t $R_2 = \lambda N_2$

Now, $N_2 = N_1 e^{-\lambda t}$

Because only one α-particle out of 4000 induces a reaction we can find the number of radon atoms introduced into the source.

$$N' = nN_1 = \frac{nN_2}{e^{-\lambda t}} = nN_2 e^{\lambda t}$$

$\therefore$ mass of radon m

$$= \frac{AN'}{N_A} = \frac{A}{N_A} nN_2 e^{\lambda t} = \frac{Ane^{\lambda t}.R_2}{N_A \lambda}$$

Given that A = 222, n = 4000, T = 3.8 days

t = 7.6 days

$e^{\lambda t} = e^{\frac{0.693}{3.8} \times 5} = 2.49$, $R_2 = 1.2 \times 10^6$ sec

m = 3.3 μg

3. $\Delta m = (10.01167 + 1.00894 - m_{Li} - 4.00386)$

Q = 1.83 MeV

or Q = $\Delta m \times 931$ MeV

$\therefore$ $\Delta m = 0.001965$

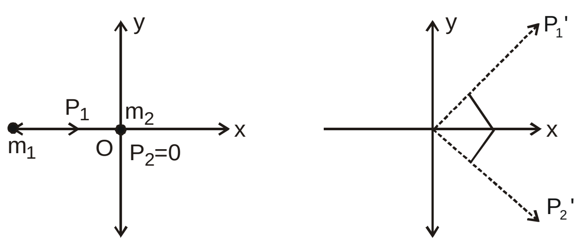
$m_{Li} = 7.01675 - 0.001965$

$m_{Li} = 7.01478$ a.m.u

4. Intially m_1 has a monmentum P_1 & m_2 is at rest ($P_2 = 0$) in the lab frame. The masses of the particular after collision are m_p & m_o.

The conservation of momentum given

$P_1' + P_2' = P_1$ or $P_2' = P_1 - P_1'$ ...(1)



After collision

Squaring above equation

$P_2'^2 = (P_1 - P_1')^2 = P_1^2 + P_1'^2 - 2P_1.P_1' = P_1^2 + P_1'^2$

$\{\because P_1.P_1' = 0\}$

$$\therefore Q = \frac{P_1'^2}{2m_p} + \frac{P_2'^2}{2m_0} - \frac{P_1^2}{2m_1}$$

$$\Rightarrow Q = \frac{1}{2}\left(\frac{1}{m_p} + \frac{1}{m_0}\right)P_1'^2 + \frac{1}{2}\left(\frac{1}{m_0} - \frac{1}{m_1}\right)P_1^2$$

$\therefore$ $E_k = \frac{P^2}{2m}$ Now

$$Q = K_p\left(1 + \frac{m_p}{m_0}\right) - K_1\left(1 + \frac{m_1}{m_0}\right)$$

5. $T_{1/2} = \frac{1}{\lambda}$

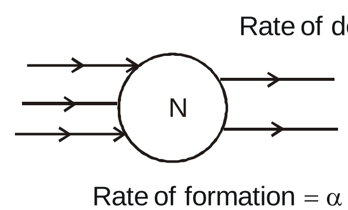
$\therefore$ $\frac{dN}{N}$ = fraction of body disintegrate in time dt

$\therefore$ $\frac{dN}{N} = \lambda dt$

or $\frac{dm}{m} = \lambda dt$ or $\frac{dv}{v} = \lambda dt$ $\Rightarrow \int_0^v dv = \int_0^t u\lambda dt$

$\Rightarrow$ v = $u\lambda$ t

6.



Let N be the no of radionucler any time t. Then net rate of form of nuclei at time t is

$\frac{dN}{dt} = \alpha - \lambda N$ or $\int_0^N \frac{dN}{\alpha - \lambda N} = \int_0^t dt$

$N = \frac{\alpha}{\lambda}(1 - e^{-\lambda t})$

Number of nuclei formed in time t = α t

& Number of nuclei left after time

t = $\frac{\alpha}{A}(1 - e^{-\lambda t})$

$\therefore$ energy released till time

t = $E_0[\alpha t - \frac{\alpha}{\lambda}(1 - e^{-\lambda t})]$

But only 20% of it is used in rasing the tamprature of water

So $0.2E_0[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})] = Q$

where Q = ms $\Delta\theta$

$\therefore$ $\Delta\theta$ = increase in temprature of water = $\frac{Q}{ms}$

$$\Rightarrow \Delta\theta = \frac{0.2E_0[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})]}{ms}$$

7. At the time of observation t = t

$\frac{m_1}{m_2} = \frac{140}{1}$ $\therefore$ $\frac{A_1}{A_2} = \frac{238}{235} = 1.01$

Number of atoms N = $\frac{m}{A}$

$\therefore \frac{N_1}{N_A} = \frac{m_1}{m_2} \times \frac{A_2}{A_1} = \frac{140}{1.01}$ ...(i)

Let N_0 be the no. of atoms of both isotopes at the time of formation the

$\frac{N_1}{N_2} = \frac{N_0 e^{-\lambda_1 t}}{N_0 e^{-\lambda_2 t}} = e^{(\lambda_2 - \lambda_1)t}$ ...(ii)

Equation (i) & (ii) we have

$$e^{(\lambda_2-\lambda_1)t} = \frac{140}{1.01}$$

$(\lambda_2 - \lambda_1)t = \ell n\ (140) - \ell n\ (1.01)$

$$t = \frac{4.9305}{\frac{0.693}{10^8}\left[\frac{45-7.13}{45\times 7.13}\right]} = 6.04 \times 10^9 \text{ yrs}$$

8. Given that Activity = 8.4 sec^{-1}

According to Avagadro hypothesis the no. of atoms in 2.5 mg.

$$N = \frac{6.02\times 10^{23}}{230} \times 2.5 \times 10^{-3}$$

$\Rightarrow$ N = 6.54 × 10^{18}

Now λN = 8.4 sec^{-1}

$\therefore \lambda = \frac{8.4}{N} = \frac{8.4}{6.54\times 10^{18}}$

λ = 1.28 × 10^{-18} sec^{-1}

$\therefore T = \frac{0.6931}{\lambda} = 1.7 \times 10^{10}$ year

9. From $t_{1/2} = \frac{0.693}{\lambda}$ $\Rightarrow \lambda = \frac{0.693}{5730}$

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

A_0 = 50 × 12 = 600

A = 320

From above data t = 5196 years

10. Energy from one α deacy

$${}^{248}_{96}cm \longrightarrow {}^{244}_{94}Pu + {}^{4}_{2}He$$

Δm = 248. 072220 – 244.064100 – 4.002603

= 0.005 517

E = Δmx931

= 5. 136327 Mev.

Total energy

$$= \left(\frac{8}{100}\times 200 + \frac{92}{100}\times 5.1366327\right)10^{20}$$

= (20. 725421) Mev. × 10^{20}

Average cufe – 10^{13} sec.

Power output

$$= \frac{20.725421\times 10^{20}\times 1.6\times 10^{-19}\times 10^{6}}{10^{13}}$$

= 33.16 μW

11. $\lambda = \frac{len2}{15\times 3600}$

Activity of ^{24}Na after 5 hours

$\Rightarrow$ A = 1 × 10^{-6} × 3.7×10^{10}

1 cm^3 $\longrightarrow$ 296

x cm^3 $\longrightarrow$ 296 x

And 296 x = 3.7 × 10^4 × $e^{-ln2/3}$

x = 6 liters

12. = $\frac{25}{100}$ x $e^{-\lambda 10}$

$e^{-\lambda 10} = \frac{1}{2}$

$\lambda = \frac{ln\ 2}{10}$

$\frac{t_1}{2}$ = 10 sec.

tan g = $\frac{10}{ln\ 2}$

t = 40 sec.