

## PYQ Solution [IIT-JAM]

### (Chapter 3 Radioactivity)

Ans. 1: 87.5

Solution:  $N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}} = N_0 \left(\frac{1}{2}\right)^{15/5} = \frac{N_0}{8}$

In 15 days the probability of decay =  $\frac{N_0 - N}{N_0} \times 100 = \frac{7}{8} \times 100 = 87.5\%$

Ans. 2: (d)

Solution:  $R = \lambda N$ , where  $N = \frac{10}{60} \times (6 \times 10^{23}) = 10^{23}$

$$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{2 \ln 2 \times 10^8} = \frac{0.693}{2 \times 2.303 \times 0.3010 \times 10^8} = \frac{0.693}{1.386 \times 10^8} = \frac{0.693}{1.386 \times 10^8} = 5 \times 10^{-9} \text{ s}^{-1} \text{ Thus,}$$

$$R = 5 \times 10^{-9} \times \frac{10}{60} \times (6 \times 10^{23}) = 5 \times 10^{14}.$$

Ans. 3: (d)

Solution:  $\lambda = \frac{1}{t} \ln\left(\frac{R_0}{R}\right) = \frac{1}{30} \ln\left(\frac{R_0}{3/4 R_0}\right) = \frac{1}{30} \ln\left(\frac{4}{3}\right) = \frac{1}{30} (1.4 - 1.1) = \frac{1}{100}$

$$T_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{1/100} = 69.3 \text{ day.}$$

Ans. 4: 6.0

Solution:  $\left|\frac{dN}{dt}\right| = \lambda N = \frac{0.693}{3.942 \times 10^6 (s)} \times \frac{(70 \times 10^3)}{40} \times \frac{3.24 \times 10^{-5}}{100} \times 6.022 \times 10^{23}$

$$= 6.0 \times 10^{13} \text{ Disintegrations/s} = 6.0 \times 10^{13} \text{ Bq} = 6.0 \times 10^{10} \text{ kBq}$$

Ans. 5: (d)

Ans. 6: (b) and (c)

Solution: From given statement only (b) and (c) are correct.

Ans. 7: 3.57

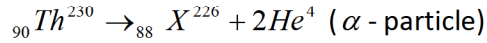
Solution:  $\frac{K^{40}}{A^{40}} = \frac{N_0 e^{-\lambda t}}{N_0 - N_0 e^{-\lambda t}} = 50 \Rightarrow e^{\lambda t} = \frac{51}{50} = 1.02 \Rightarrow \lambda t = \ln(1.02)$

$$\Rightarrow t = \frac{1.25 \times 10^9}{0.693} \ln(1.02) \Rightarrow t = 3.57 \times 10^7 \text{ years.}$$

## PYQ Solution [GATE]

Ans. 1: 25.995

Solution: The height of coulomb barrier for  $\alpha$  particle from



$$V_C = \frac{1}{4\pi\epsilon_0} \left( \frac{2ze^2}{R} \right)$$

Here,  $R_0 = 1.3 \text{ fm}$ ,  $\frac{e^2}{4\pi\epsilon_0} = 1.44 \text{ MeV fm}$

And  $R = R_0 A^{1/3}$

Here, we consider pure Columbic interaction

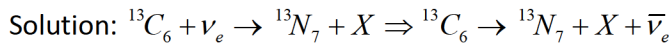
$$A_{Th}^{1/3} = A_X^{1/3} + A_\alpha^{1/3} = (226)^{1/3} + (4)^{1/3} = (6.09 + 1.58) = 7.67, \quad R = R_0 A_{Th}^{1/3} = 1.3(7.67)$$

Hence,  $V_C = \left( \frac{e^2}{4\pi\epsilon_0} \right) \frac{2 \times 90}{1.3(7.67)} = \frac{180 \times 1.44 \text{ MeV}}{1.3 \times 7.67 \text{ fm}}$

$$V_C = 25.995 \text{ MeV}$$

Ans. 2: (b)

Ans. 3: (a)



$$L_e = 0 \quad 0 \quad +1 \quad -1$$

To conserve the Lepton number  $L_e$ ,  $X$  should be  $e^-$

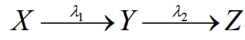
Ans. 4: 40

Solution: Branching ratio is the fraction of particles (here  $\beta$ ) which decays by an individual decay mode with respect to the total number of particles which decays

$$BR = \frac{\left( \frac{dN}{dt} \right)_x}{\left( \frac{dN}{dt} \right)_\beta} = \frac{(T_{1/2})_x}{(T_{1/2})_\beta} \Rightarrow (T_{1/2})_\beta = \frac{(T_{1/2})_x}{BR} = \frac{30}{0.75} = 40 \text{ hours}$$

## PYQ Solution [NET-JRF]

Ans. 1: (a)



Solution:  $t = 0$      $N_0$     0    0

$t$      $N_1$      $N_2$      $N_3$

Rate equations  $N_1 = N_0 e^{-\lambda_1 t}$ ,  $\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2$ ,  $\frac{dN_3}{dt} = \lambda_2 N_2$

$$\begin{aligned} N_3 &= N_0 \left[ 1 + \frac{\lambda_1 e^{-\lambda_2 t}}{(\lambda_2 - \lambda_1)} - \frac{\lambda_2 e^{-\lambda_1 t}}{(\lambda_2 - \lambda_1)} \right] \\ &= N_0 \left[ 1 + \frac{\lambda_1}{(\lambda_2 - \lambda_1)} \left( 1 - \lambda_2 t + \frac{\lambda_2^2 t^2}{2} \right) - \frac{\lambda_2}{(\lambda_2 - \lambda_1)} \left( 1 - \lambda_1 t + \frac{\lambda_1^2 t^2}{2} \right) \right] \\ &= N_0 \left[ 1 + \frac{\lambda_1}{(\lambda_2 - \lambda_1)} - \frac{\lambda_1 \lambda_2 t}{(\lambda_2 - \lambda_1)} + \frac{\lambda_1 \lambda_2^2 t^2}{(\lambda_2 - \lambda_1) 2} - \frac{\lambda_2}{(\lambda_2 - \lambda_1)} + \frac{\lambda_2 \lambda_1 t}{(\lambda_2 - \lambda_1)} - \frac{\lambda_2 \lambda_1^2 t^2}{(\lambda_2 - \lambda_1) 2} \right] \\ &= N_0 \left[ \frac{\lambda_1}{(\lambda_2 - \lambda_1)} \times \frac{\lambda_2^2 t^2}{2} - \frac{\lambda_2}{(\lambda_2 - \lambda_1)} \times \frac{\lambda_1^2 t^2}{2} \right] = \frac{\lambda_1 \lambda_2 t^2}{2} N_0 \left[ \frac{\lambda_2}{\lambda_2 - \lambda_1} - \frac{\lambda_1}{\lambda_2 - \lambda_1} \right] = \frac{1}{2} \lambda_1 \lambda_2 N_0 t^2 \end{aligned}$$