

RADIO - ACTIVITY

(S-I)

① $^{114}_{49}\text{In}$, elements having odd no of neutrons and protons are likely to be radioactive.

② $^{49}_{20}\text{Ca} \rightarrow ^{40}_{20}\text{Ca}$ is stable, therefore to decrease $\frac{n}{p}$ ratio, β should be emitted.

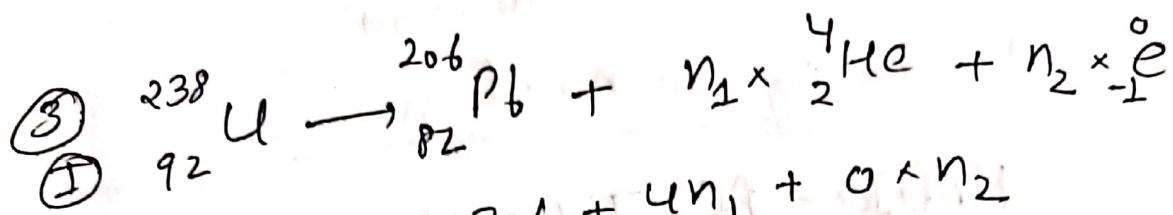
$^{195}_{80}\text{Hg} \rightarrow ^{204}_{80}\text{Hg}$ is stable, therefore to increase $\frac{n}{p}$ ratio, positron emitted.

~~$^{8}_{5}\text{B}$~~ $^{8}_{5}\text{B} \rightarrow ^{10}_{5}\text{B}$ is stable, therefore to increase $\frac{n}{p}$ ratio, positron emitted.

$^{150}_{67}\text{Ho} \rightarrow ^{165}_{67}\text{Ho}$ is stable, therefore to increase $\frac{n}{p}$ ratio, positron emitted.

$^{30}_{13}\text{Al} \rightarrow ^{27}_{13}\text{Al}$ is stable, therefore to decrease $\frac{n}{p}$ ratio, β emitted.

$^{94}_{36}\text{Kr} \rightarrow ^{84}_{36}\text{Kr}$, therefore to decrease n/p ratio,
 β emitted.

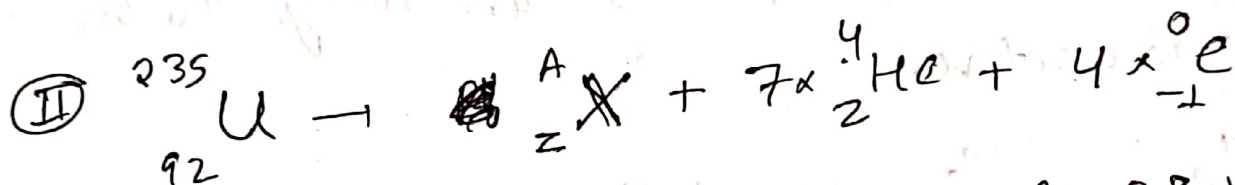


$$238 = 206 + 4n_1 + 0 \times n_2$$

$$n_1 = 32/4 = 8$$

$$92 = 82 + 2n_1 + (-1) \times n_2$$

$$92 = 82 + 16 + (-n_2) \quad | \quad n_2 = 6$$



$$92 = Z + 14 + (-4)$$

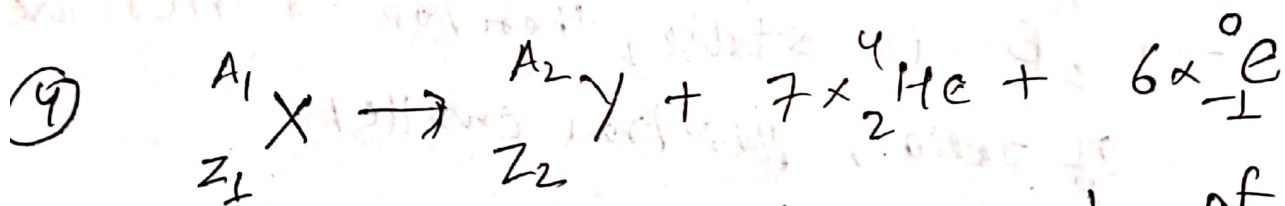
$$Z = 82$$

$$235 = A + 28 + 4 \times 0$$

$$A = 235 - 28$$

$$A = 207$$

Ans = $^{207}_{82}\text{Pb}$



difference between atomic number of
 parent and stable product = $Z_1 - Z_2$

$$Z_1 = Z_2 + 7 \times 2 + 6 \times (-1)$$

$$Z_1 - Z_2 = 14 - 6 = 8$$

⑤

$$\text{Activity} = A = N\lambda$$

$N \rightarrow$ no of radioactive atoms.

$$\lambda = \frac{1}{200}$$

$$N = \frac{1}{200} \times N_A$$

$$A = \frac{1}{200} \times 6 \times 10^{23} \times 4.8 \times 10^{-7} \text{ dpm}$$

$$= 1.44 \times 10^{15} \text{ dpm.}$$

⑥

$$A = N\lambda$$

$$1 \text{ mCi} = \frac{W}{220} \times N_A \times \frac{\ln 2}{t_{1/2}}$$

$$3.7 \times 10^7 \text{ dps} = \frac{W}{220} \times 6 \times 10^{23} \times \frac{0.693}{54.3}$$

$$W = 1.06 \times 10^{-15} \text{ kg.}$$

⑦

$$A = N\lambda$$

$$A = \frac{10^{12} \times \ln 2}{30 \times 24 \times 60 \times 60 \text{ sec}}$$

$$A = 2.67 \times 10^5 \text{ dps}$$

⑧

$$t = 2 \text{ hr}$$

let initial activity = A_0

$$\text{Activity after 2 hours} = A_t = \frac{A_0}{64}$$

from I order Kinetics :-

$$\lambda = \frac{1}{t} \ln \frac{A_0}{A_t}$$

$$\lambda = \frac{1}{2} \ln \frac{A_0}{A_0/64}$$

$$\lambda = \frac{1}{2} \ln 64$$

$$\lambda = 2.079 \text{ hr}^{-1}$$

$$(9) \quad \lambda = \frac{1}{10} \times \ln \frac{100}{20}$$

(Since substance decays 20% in 10 min)

$$N_0 = 5 \times 10^{20} \text{ atoms}, \quad N_t = 10^{18}, \quad t = ?$$

$$\lambda = \frac{1}{t} \ln \frac{N_0}{N_t}$$

$$\frac{1}{10} \ln \frac{100}{20} = \frac{1}{t} \times \ln \frac{5 \times 10^{20}}{10^{18}}$$

take
 $\ln 2 = 0.3$

$$t = 270 \text{ min}$$

$$t = \frac{270}{60} = 4.5 \text{ hr}$$

$$(10) \quad t_{1/2} = 60 \text{ days}, \quad \lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{60}$$

$$\text{no of half life} = \frac{240}{60} = 4 = n$$

After four half lives, remaining nuclei will be,

$$N_t = \frac{N_0}{(2)^n} = \frac{N_0}{2^4} = \frac{N_0}{16}$$

$$\% \text{ of Radioactivity present} = \frac{N_t}{N_0} \times 100$$

$$= \frac{N_0}{16 \times N_0} \times 100 = 6.25\%$$

(11) Decay constant will remain same after 9 and 18 year.

$$\lambda_1 = \lambda_2$$

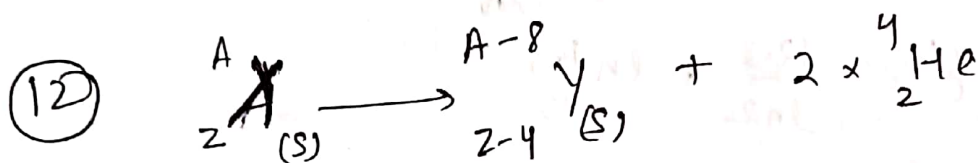
$$\frac{1}{t_1} \ln \frac{A_1}{A_2} = \frac{1}{t_2} \ln \frac{A_3}{A_4}$$

$$\frac{1}{9} \ln \frac{A_0}{A_0/3} = \frac{1}{18} \ln \frac{A_0}{A_0/x}$$

$$\frac{1}{9} \ln 3 = \frac{1}{18} \ln x$$

$$2 \ln 3 = \ln x$$

$$\boxed{x = 9}$$



$t=0$, 5 mol

$t=16 \text{ hr}$, 5-a

a

2a mol

Pressure is due to α particle.

$$pV = nRT,$$

$$15 \times 24.6 = n_a \times 0.082 \times 600$$

$$15 \times 24.6 = 2a \times 0.082 \times 600$$

$$a = 3.75 \text{ mol}$$

After 16 hours ; 1.25 mol of ${}^A_Z X$ will be left.
 \therefore % of ${}^A_Z X$ decomposed = $\frac{3.75}{5} \times 100$
 $= 75\%$

$$t_{75\%} = 2 \times t_{50\%}$$

$$t_{50\%} = \frac{16}{2} = \underline{\underline{8 \text{ hr}}}$$

(13) Let Initial tritium Content = N_0

After t time, remaining tritium

$$\text{Content} = N_t = N_0 \times \frac{15}{100}$$

from first order kinetics,

$$\lambda = \frac{1}{t} \times \ln \frac{N_0}{N_t} \quad \Bigg| \quad \lambda = \frac{\ln 2}{12.3}$$

$$t = \frac{1}{\lambda} \times \ln \frac{N_0}{N_0 \times 15/100}$$

$$t = \frac{12.3}{\ln 2} \times \ln \frac{100}{15}$$

$$t = 33.62 \text{ years}$$

(14) $N_0 = 2 \times 10^3 \text{ Bq}$ or $2 \times 10^3 \times 60 \text{ dpm}$.

$$t_{1/2} = 15 \text{ hrs.}$$

Let V is the volume of blood in ml.
therefore activity will be —

$$N_t = 8 \times V \text{ dpm}$$

from first order kinetics,

$$\lambda = \frac{1}{t} \ln \frac{N_0}{N_t}$$

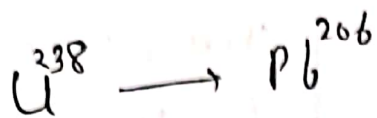
$$\frac{\ln 2}{15_3} = \frac{1}{25_5} \ln \frac{2 \times 10^3 \times 60}{8 \times V}$$

$$\ln(32)^{1/3} = \ln \frac{15 \times 10^3}{\sqrt{V}}$$

$$\ln 3 = \ln \frac{15 \times 10^3}{\sqrt{V}}$$

$$V = 5000 \text{ ml or } 5 \text{ L.}$$

15) initially only U^{238} was present in the ore.



1 mol of U^{238} forms 1 mol of Pb^{206} .
and in final mixture 0.1 mol of U^{238} and
0.1 mol of Pb^{206} are present. So
initial mole of U^{238} will be 0.2.



$t=0$, 0.2 mol

$t=t$, 0.1 mol : 0.1 mol

$$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{1}{t} \ln \frac{N_0}{N_t}$$

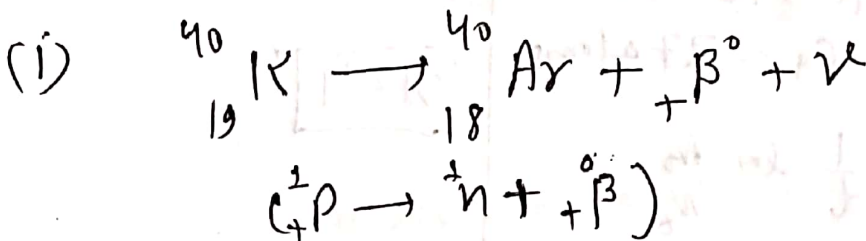
$$\frac{\ln 2}{4.5 \times 10^9} = \frac{1}{t} \ln \frac{0.2}{0.1}$$

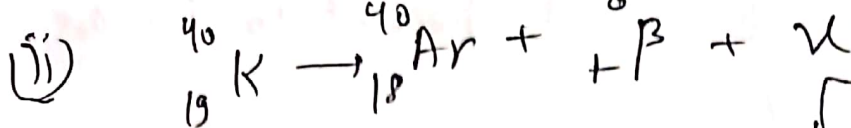
$$t = \frac{\ln 2 \times 4.5 \times 10^9}{\ln 2}$$

$$t = 4.5 \times 10^9 \text{ year}$$

short cut \rightarrow since
half amount of
 U^{238} converted into
 Pb^{206} . so time
required will be
one half life time.

16) $t_{1/2} = 1.4 \times 10^9 \text{ years}$





$t=0$ ~~$t=0$~~ 49
 $t=t'$ a 39

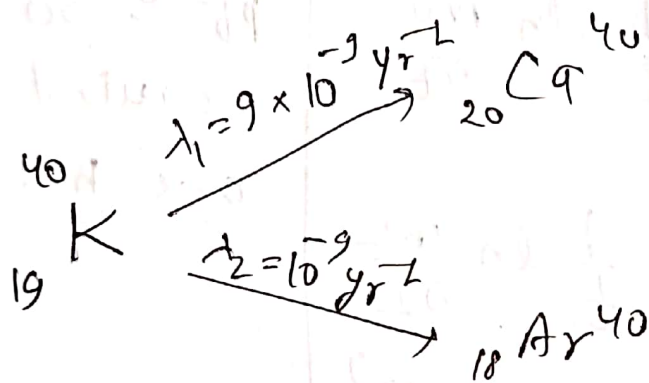
given: after time
 t , $\frac{K}{Ar} = \frac{1}{3}$

$$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{1}{t} \ln \frac{N_0}{N_t}$$

$$\frac{\ln 2}{1.4 \times 10^9} = \frac{1}{t} \times \ln \frac{49}{9}$$

$$t = 2 \times 1.4 \times 10^9 = 2.8 \times 10^9 \text{ year}$$

Q (17)



$$\lambda_{\text{net}} = \lambda_1 + \lambda_2 = 9 \times 10^{-9} + 10^{-9} = 10^{-8} \text{ year}^{-1}$$

$$\frac{Ar}{K} = \frac{3}{10}, \quad \frac{Ca}{Ar} = \frac{\lambda_1}{\lambda_2} = \frac{9}{1}$$

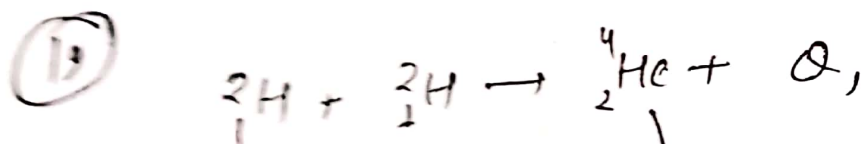
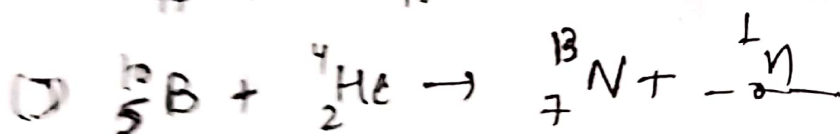
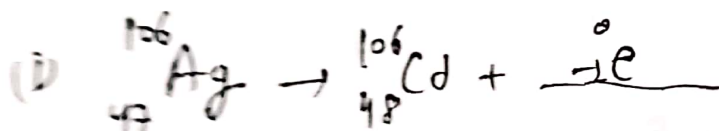
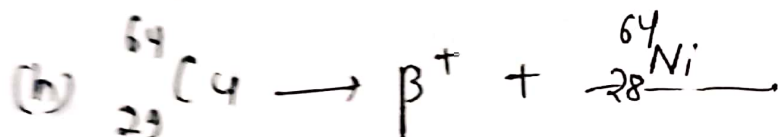
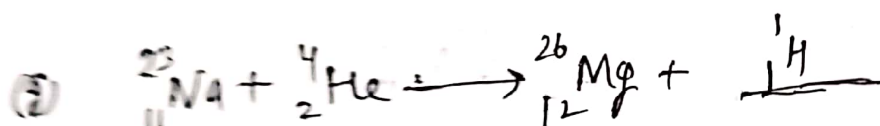
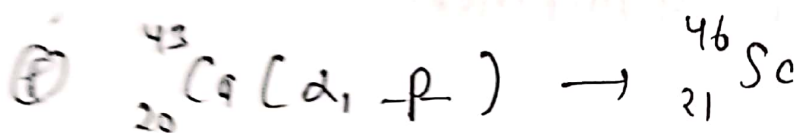
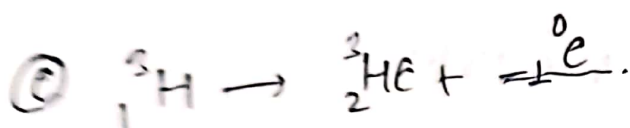
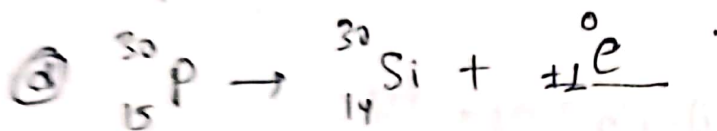
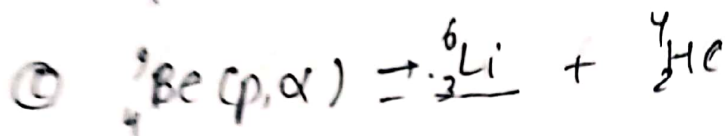
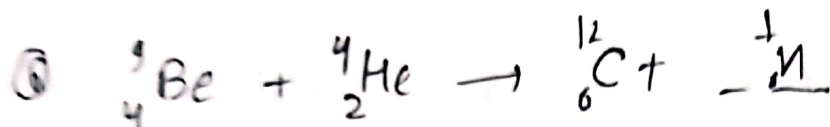
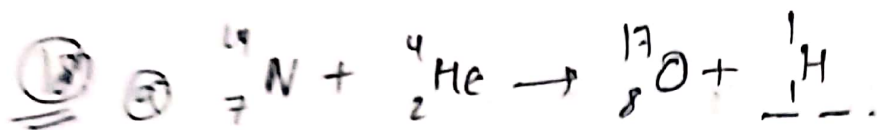
Let: $Ar = 3$ atoms,
 then $K = 10$ atoms
 and $Ca = 27$ atoms

$$\lambda_{\text{net}} = \frac{1}{t} \ln \frac{N_0}{N_t}$$

$$10^{-8} = \frac{1}{t} \ln \frac{40}{10}$$

$$t = \ln 4 \times 10^8 \text{ year}$$

$$\boxed{\lambda = 4}$$



$$\begin{array}{ccc} 2.01412 & 2.01412 & 4.00242 \\ \text{mamu} & & \end{array}$$

$$\Delta m = [(2 \times 2.0141) - 4.0024]$$

$$\Delta m = 0.0258$$

$$\begin{aligned} \text{Energy released} &= \Delta m \text{ in amu} \times 931.5 \text{ MeV} \\ &= 0.0258 \times 931.5 = 24.0327 \text{ MeV} \end{aligned}$$

$$\therefore \text{value of } Q = 24.$$

Q(20)



mass 2.020 2.020 3.016 1.008

$$\Delta m = (2.020 + 2.020) - (3.016 + 1.008)$$

$$\Delta m = 0.016$$

$$\text{Energy Released} = \Delta m \times 931.5 \text{ MeV}$$

$$= 0.016 \times 931.5$$

$$= 14.904 \text{ MeV}$$