Exercise :⇒ O-2

① · Reaction

$$4 \times {}^{4}_{2}He \longrightarrow {}^{16}_{8}O$$

mass $\quad 4.0021\ amu \quad 15.834\ amu$

∴ mass defect = $\Delta m = (4 \times 4.0026 - 15.834)\ amu$

Energy released = $\Delta m \times 931.5$ MeV

$= 0.1764 \times 931.5 = 164.3166$

$$\left[\frac{BE}{nucleon}\right]_{O\ atom} = \frac{\text{Energy Released}}{\text{total nucleons}} = \frac{164.3166}{16} = 10.27\ \text{MeV}$$

Ans A

② Let permissible value $= N_t$

∴ initial amount $= 10 \times N_t = N_0$

$t_{1/2} = 30$ days

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

$$\frac{\ln 2}{30} = \frac{1}{t} \ln \frac{10 N_t}{N_t}$$

$t = 3.33 \times 30$ Ans D

$t = 100$ Days

Q3)

$$\overset{N_0}{A} \xrightarrow{t_{1/2} = t\ hr} \frac{N_0}{2} \quad (t \Rightarrow)$$

$$\overset{N_0}{B} \xrightarrow{t_{1/2} = 2t\ hr}$$

[at the end of t hr, no of atoms of B]

$$N_t = N_0 e^{-\lambda t}$$

$$= N_0 \times e^{-\frac{\ln 2}{2t} \times t}$$

$$= N_0 \times e^{-\ln \sqrt{2}}$$

$$N_t = \frac{N_0}{\sqrt{2}}$$

Ans C

$$\frac{[Rate]_A}{[Rate]_B} = \frac{(N\lambda)_A}{(N\lambda)_B} = \frac{\left(\frac{N_0}{2} \times \frac{\ln 2}{t}\right)_A}{\left(\frac{N_0}{\sqrt{2}} \times \frac{\ln 2}{2t}\right)_B} = \frac{2\sqrt{2}}{2} = \frac{\sqrt{2}}{1}$$

Q4)

$$A \xrightarrow{\lambda_1} B \qquad A \xrightarrow{\lambda_2} C$$

$\lambda_1 = 1.8 \times 10^{-2}$ or $18 \times 10^{-3}\ sec^{-1}$

$\lambda_2 = 2 \times 10^{-3}\ sec^{-1}$

$$\lambda_{net} = \lambda_1 + \lambda_2$$

$$= 20 \times 10^{-3} = 2 \times 10^{-2}\ sec^{-1}$$

$$\text{Average life} = \frac{1}{\lambda_{net}} = \frac{1}{2 \times 10^{-2}} = 50\ sec$$

Ans C

(5)

A_1 :- Activity of initial Sample.

$^{14}CO_2$ + CO_2 $\longrightarrow$ only 10 ml Sample is taken.

$A_2 = 10^4$ dpm.

60 L

Since $A = N\lambda$

$\boxed{A \propto N}$.

and no of radio active particles are evenly distributed in given volume. therefore

$N \propto V \propto A$

$$\frac{A_1}{V_1} = \frac{A_2}{V_2}$$

$$\frac{A_1}{60 \times 1000\,ml} = \frac{10^4\ dpm}{10\ ml}$$

$$A_1 = 6 \times 10^7\ dpm = 10^6\ dps$$

$$(\ 1\ Ci = 3.7 \times 10^{10}\ dps$$

$$1\ \mu Ci = 3.7 \times 10^4\ dps\ )$$

$$A_1 = \frac{10^6}{3.7 \times 10^4} = 27\ \mu Ci$$

Ans B

(6) (A) Correct reason of emission of gamma radiation.

(B) $^{3}_{1}H \longrightarrow ^{3}_{2}He + ^{0}_{-}\beta$

(C) $^{1}_{+}p \longrightarrow ^{1}_{0}n + ^{0}_{+}\beta$, due to increase in no of neutron and decrease in no of proton, ratio increases. (n/p).

(D) Rate of decay is independent of all physical and chemical conditions.

(Ans) A, C, D.

(7) (A) $^{A}_{Z}X \xrightarrow{\alpha} {}^{A-4}_{Z-2}Y \xrightarrow{-\beta} {}^{A-4}_{Z-1}Z \xrightarrow{-\beta} {}^{A-4}_{Z}W$

X & W are isotopes

(B) mass no of Y is less than X by 4 unit

(C) $^{29}_{13}Al \rightarrow {}^{27}_{13}Al$ stable, so for decreasing n/p ratio, $^{29}_{13}Al$ disintegrated by β-emission

(D) emission of β particle, n/p ratio decreases

(Ans) A, B, C, D

(8) (A) End product is last product i.e no further decay. So decay constant will be zero here.

(B) positron and electron, have same mass.

(D) SI unit of activity is becquerel.

Ans A, B

(9) (A) λ does not depend upon any external condition.

(C) It is applicable on large no of particles. At $t_{1/2}$ half of the nuclio will be decayed. but which half it can not be said perfectly.

Ans B, D

(10) Binding energy per nucleon does not increases continuously with mass number.

Ans A, B, C

(11) Statement-I is wrong, since molar mass of both the species are different, therefore their masses will be different. and specific activity is defined as the activity per unit mass.

Statement-II is correct

Ans D

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Q.N (12) Theoritical concept (Ans A)

Q.N (13) nuclear reaction:

$${}^{10}_{4}Be \longrightarrow {}^{10}_{5}B + e^-$$

Since only nuclear Rxn is given, therefore only nucleons should be counted

$$\Delta m = (4p+6n) - (5p+5n) - e^-$$

But in options atomic masses are given, we should add and ~~subtract~~ 5e⁻.

$$\Delta m = (4p + 6n + 4e) - (5p + 5n + 5e) + e^- - e^-$$

$$= \text{Atomic mass of } {}^{10}_{4}Be - \text{Atomic mass of } {}^{10}_{5}B$$

Q.N (14) Nuclear Reaction

$${}^{8}_{5}B \longrightarrow {}^{8}_{4}Be + e^+$$

mass defect

$$\Delta m = (5p+3n) - (4p+4n) - e^+$$

Since options are given in terms of Atomic masses and in the calculation of atomic mass, mass of e should also be considered, therefore add 5e and subtract 5e.

$\Delta m = (5p + 3n + 5\bar{e}) - (4p + 4n + 4\bar{e}) - e^+ - \bar{e}$

$\Rightarrow$ At mass of ${}^{8}_{5}B$ – At mass of ${}^{8}_{4}Be$ – mass of two electrons

Q.15

(A) $n \longrightarrow \overset{+}{p} + \bar{e}$ (beta) (q)

(B) $p \longrightarrow n + \overset{+}{\beta}$ (positron) (P)

(C) K-electron capture → X ray emitted (R)

(D) $4[{}^{1}_{1}H] \longrightarrow {}^{4}_{2}He + 2\beta^+ + \text{Energy}$ (S)