NEET REVISION SERIES

NUCLEAR PHYSICS

Revise Most Important Questions to Crack NEET 2020

Q-1 - 11970593

If the nuclear radius of $.^{27}A1$ is 3.6 Fermi, the approximate nuclear radius of $64Cu$ in Fermi is :

(A) 3.6

(B) 2.4

(C) 1.2

(D) 4.8

CORRECT ANSWER: D

SOLUTION:

(d) Nuclear radius $r \propto A^{1/3}$, where A is mass number

$$r = r_0(27)^{1/3} = 3r_0$$

$$\Rightarrow r_0 = \frac{3.6}{3} = 1.2fm$$

For

$$.^{64}Cu, r = r_0 A^{1/3}$$

$$= 1.2fm(64)^{1/3}$$

$$= 4.8fm$$

.

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Q-2 - 17960310

The nuclear radius of Pb^{208} is is 8.874 fm. What will be the nuclear radius of Ca^{44} ?

CORRECT ANSWER: 5.286 FM

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Q-3 - 11970569

M_p denotes the mass of a proton and M_n that of a neutron. A given nucleus, of binding energy B, contains Z protons and N neutrons. The mass $M(N, Z)$ of the nucleus is given by.

(A)
$M(N, Z) = NM_n$
$+ ZM_p - Bc^2$

(B)
$M(N, Z) = NM_n$
$+ ZM_p + Bc^2$

(C)
$M(N, Z) = NM_n$
$+ ZM_p - B/c^2$

(D)
$M(N, Z) = NM,,$
$+ ZM_p + B/c^2$

CORRECT ANSWER: C

SOLUTION:

(c) Binding energy of a nucleus containing N neutrons

and Z protons is

$$B = [NM_n + ZM_p - M(N, Z)]c^2$$

$$\Rightarrow \frac{B}{c^2} = NM_n + ZM_p - M(N, Z)$$

$$\Rightarrow M(N, Z) = NM_n + ZM_p - B/c^2$$

.

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Q-4 - 9729583

Calculate the minimum energy needed to separate a neutron form a nucleus with Z protons and N neutrons in terms of the masses

$M_{Z,N}$, $M_{Z,N-1}$ and the mass of the neutron.

CORRECT ANSWER: A::B::C

SOLUTION:

$E_z, N = E_{z,N-1} +_0^1 n$

Energy released = (Initial Mass of nucleus

- Final mass of nucleus)c^2

$= (m_{z,N-1} + m_n$

$- M_{z,N})c^2$

.

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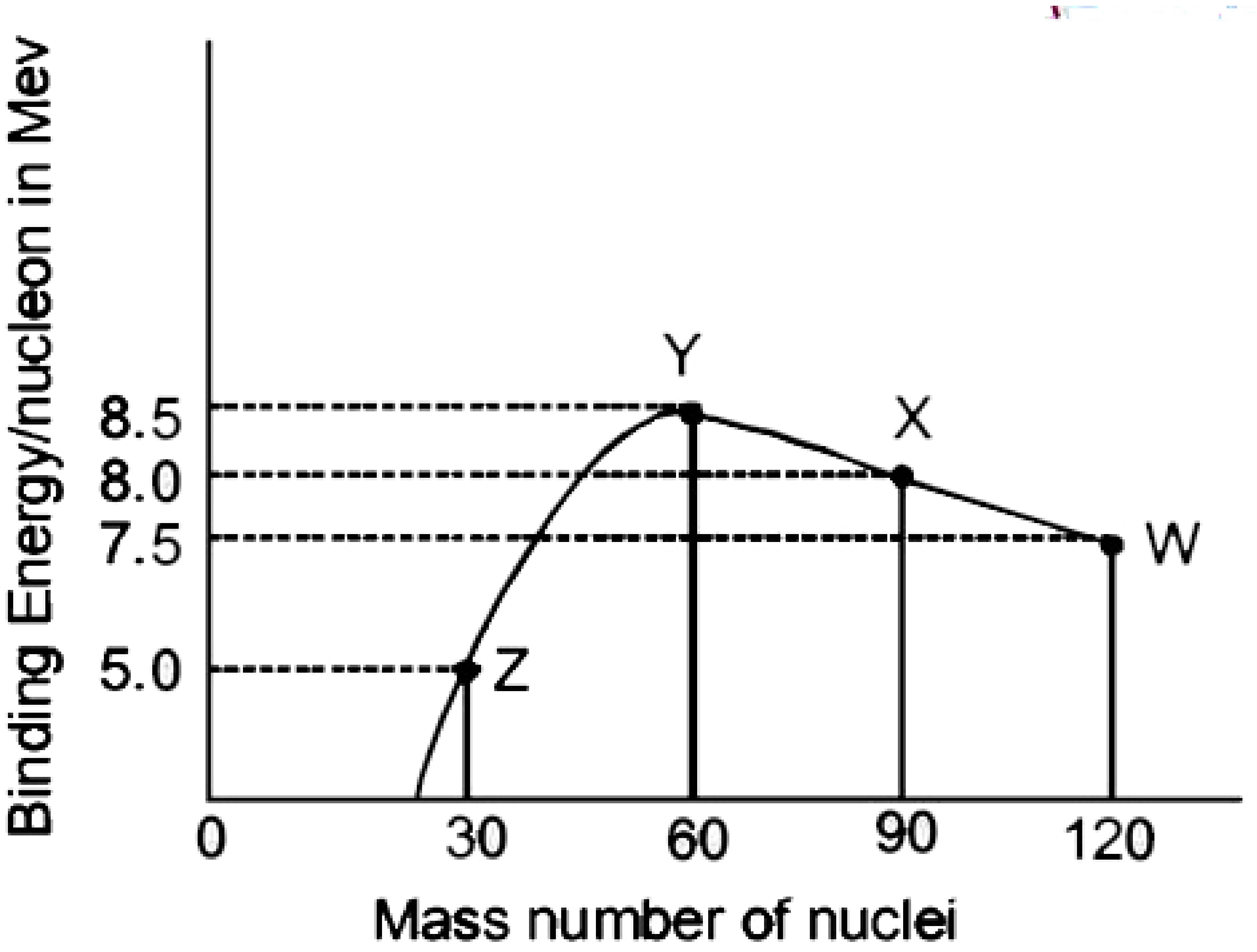
Q-5 - 10060379

Binding energy per vs mass curve for nucleus is shown in the figure

$W, X, Y$and Z are four nuclei indicated on the curve . The process that would rease energy is



(A) $Y \rightarrow 2Z$

(B) $W \rightarrow X + Z$

(C) $W \rightarrow 2Y$

(D) $X \rightarrow Y + Z$

CORRECT ANSWER: C

SOLUTION:

KEY CONCEPT: Energy is released when stability increases . This will happen when binding energy per

nucleon increases

Reactant

Reaction(a)

$$60 \times 8.5 MeV \\ = 510 MeV$$

Reaction(b) $120 \times 7.5 = 900 MeV$ MeV$Reaction(c)$

120 xx 7.5 = 900 MeVMeV

Reaction(d) $90 \times 8 = 720$

Product

$$2 \times 30 \times 5 = 300 MeV \\ (90) \times 8 + 30 \times 5) \\ = 870 MeV$$

$$2 \times 60 \times 8.5 \\ = 1020 MeV$$

$$(60 \times 85 + 30 \times 5) \\ = 600 MeV$$

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Q-6 - 12016272

A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is split into two fragments Y and Z of mass numbers 110 and 130. The binding energy of nucleons in Y and Z is 8.5MeV per nucleon. Calculate the energy Q released per fission in MeV.

SOLUTION:

The nuclear reaction is

$$X^{240} \rightarrow Y^{110} + Z^{130} + Q$$

As per the given data,

$$Q = 110 \times 8.5 + 130 \times 8.5 - 240 \times 7.6$$

$$= 240(0.9) MeV$$

$$= 216 MeV$$

Energy released /fission $= 216 MeV$

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Q-7 - 11971084

The number of beta particles emitter by radioactive sustance is twice the number of alpha particles emitter by it. The resulting daughter is an

(A) Isobar of parent

(B) isomer of parent

(C) isoton of parent

(D) isotope of parent

CORRECT ANSWER: D

SOLUTION:

Let the radioactive substance be $._{Z}^{A}X$

Radioactive transition is given by

$._{Z}^{A}X \xrightarrow{-\alpha}$._(Z-2)^(A-4)X overset(-2beta)to._(Z)^(A-4)X
$Thea \to msofe$
$\leq menthav$
$\in gthesamea$
$\to micvmbersbutd$
$\Leftrightarrow erentmassvmbersarecal$
$\leq diso \top es. So,$
._(Z)^(A)X and ._(Z)^(Z-4)X` are isotopes.

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Q-8 - 9729526

Suppose, the daughter nucleus in a nuclear decay is itself radioactive. Let λ_p and λ_d be the decay constants of the parent and the daughter nuclei. Also, let N_p and N_d be the number of parent and daughter nuclei at time t. Find the condition for which the number of daughter nuclei becomes constant.

SOLUTION:

The number of parent nuclei decaying in ashort time interval t to $t + dt$ is $\lambda_p N_p dt$. This is also the number of daughter nuclei produced in this interval. The number of daughter nuclei decaying during the same time interval is $\lambda_d N_d dt$. The number of the daughter nuclei will be constant if

$$\lambda_p N_p dt = \lambda_d N_d dt.$$

or, $\lambda_p N_p = \lambda_d N_d$.

Q-9 - 13165231

The half-life of a radioactive sample is T. If the activities of the sample at time t_1 and t_2 $(t_1 < t_2)$ and R_1 and R_2 respectively, then the number of atoms disintergrated in time $t_2 - t_1$ is proportional to

(A) $(R_1 - R_2)T$

(B) $(R_1 + R_2)T$

(C) $\frac{R_1 R_2}{R_1 + R_2}T$

(D) $\frac{R_1 R_2}{T}$

CORRECT ANSWER: A

SOLUTION:

Activity $R = \lambda N$ so that

$R_1 = \lambda N_1$ and $R_2 = \lambda N_2$

$$R_1 - R_2 = \lambda(N_1 - N_2) = \frac{0.6931}{T}(N_1 - N_2)$$

$$N_1 - N_2 = \frac{(R_1 - R_2)T}{0.6931}$$

$N_1 - N_2$
$\propto (R_1 - R_2)T, \ \therefore t_2$
$- t_1 \alpha (R_1 - R_2)T$

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Q-10 - 11970592

Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time $t = 0$, number of P species are $4N_0$ and that of Q are N_0. Half-life of P (for conversation to R) is $1mm$ whereas that of Q is $2 \min$. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be :

(A) $3N_0$

(B) $\dfrac{9N_0}{2}$

(C) $\dfrac{5N_0}{2}$

(D) $2N_0$

CORRECT ANSWER: B

SOLUTION:

(b) Initially $p \rightarrow 4N_0$

$Q \rightarrow N_0$

Half-life $T_p \rightarrow 1 \text{ min}$

$T_Q \rightarrow 2 \text{ min}$

Let after time t number of nuclei of P and Q are equal,

i.e., $\frac{4N_0}{2^{t/1}} = \frac{N_0}{2^{t/2}}$

$4 = 2^{t/2}$

$2^2 = 2^{t/2} \Rightarrow \frac{t}{2} = 2$

$t = 4 \text{ min}$

Deactivate nucleus or nuclei of R

=

$$\left(4N_0 - \frac{4N_0}{2^4}\right)$$

$$+ \left(N_0 - \frac{N_0}{2^2}\right)$$

=

$$4N_0 \frac{N_0}{4} + N_0 - \frac{N_0}{4}$$

$$= 5N_0 - \frac{N_0}{2} = \frac{9}{2}N_0$$

.

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Q-11 - 11313238

Nuclei of a radioactive element X are being produced at a constant rate K and this element decays to a stable nucleus Y with a decay constant λ and half-life $T_{1/3}$. At the time $t = 0$, there are N_0nuclei of the element X.

The number N_Y of nuclei of Y at $t = T_{1/2}$ is.

(A)

$$K\frac{\ln 2}{\lambda}$$
$$+\frac{3}{2}\left(\frac{K-\lambda N_0}{\lambda}\right)$$

(B)

$$K\frac{\ln 2}{\lambda}$$
$$+\frac{1}{2}\left(\frac{K-\lambda N_0}{\lambda}\right)$$

(D)

$$K\frac{\ln 2}{\lambda}$$
$$-2\left(\frac{K-\lambda N_0}{\lambda}\right)$$

CORRECT ANSWER: C

SOLUTION:

$$\frac{dN_X}{dt}=K-\lambda N_X$$

N_(X)=(1)/(lambda)[K-K-lambda N_(0))e^(-lambda t)] (dN_(Y))/(dt)=lambdaN_(X)N_(Y)=Kt+(K-lambda N_0/lambda)e^(-lambda t) -(K-lambda N_(0))/(lambda)`.

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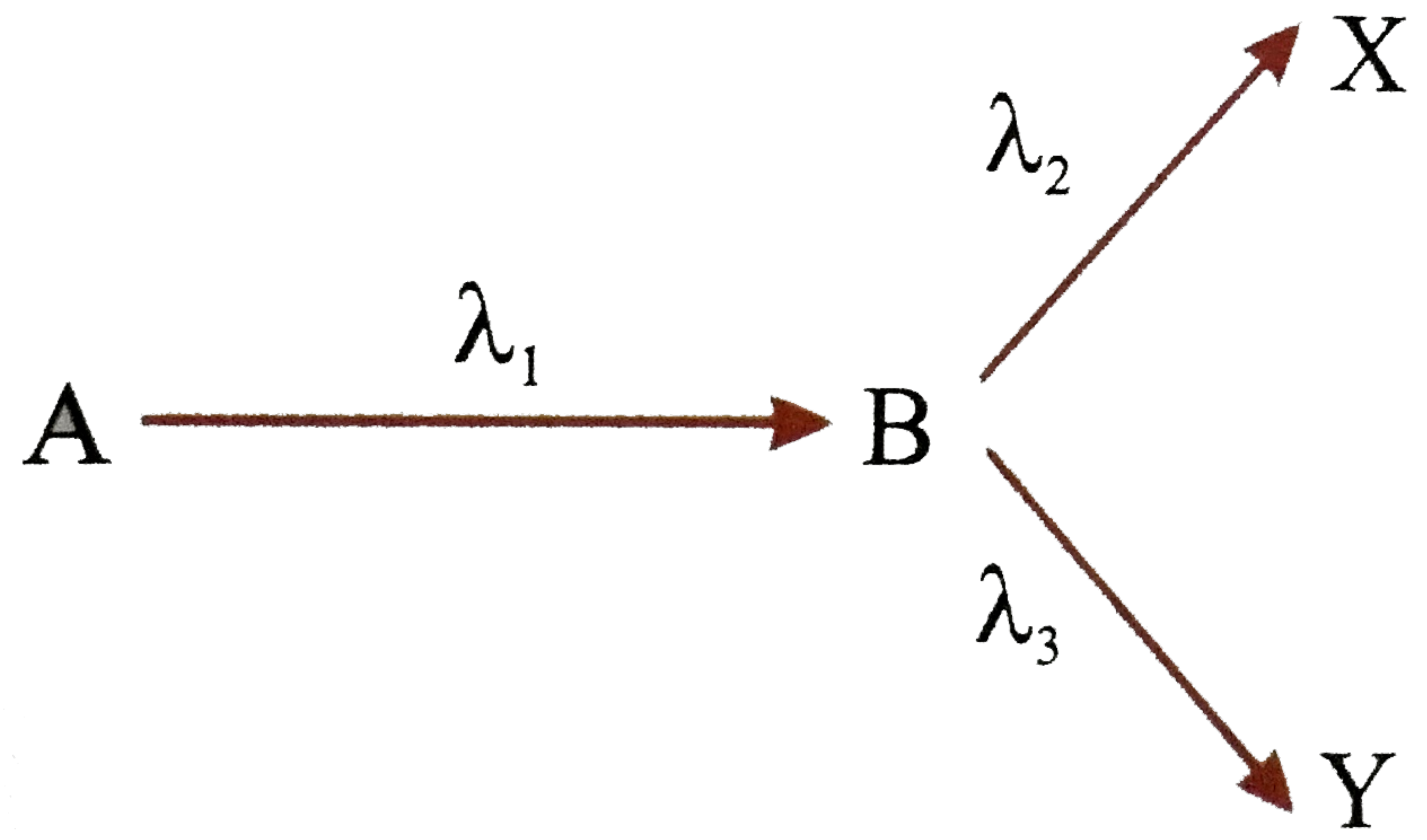
Q-12 - 13165304

Consider radioactive decay of A to B with which further decays either to X or Y, λ_1, λ_2 and λ_3 are decay constant for A to B decay, B to X decay and Bto Y decay respectively. At $t=0$, the number of nuclei of A, B, X and Y are N_0, N_0 zero and zero respectively.

N_1, N_2, N_3 and N_4 are the number of nuclei of A, B, X and Y at any instant t.



The number of nuclei of B will first increase and then after a maximum value, it decreases for

(A) $\lambda_1 > \lambda_2 + \lambda_3$

(B) $\lambda_1 = \lambda_2 = \lambda_3$

(C) $\lambda_1 = \lambda_2 + \lambda_3$

(D) For any values of λ_1, λ_2 and λ_3

CORRECT ANSWER: A

SOLUTION:

The initial rate of formation and disintergration of B are respectively $N_0\lambda_1$ and $N_0(\lambda_2 + \lambda_3)$.

B will be first increase if

$N_0\lambda_1 > N_0(\lambda_2 + \lambda_3)$ or $\lambda_1 > \lambda_2 + \lambda_3$

Q-13 - 19037366

Calculate the energy of the reaction ,

$Li^7 + p \to 2_2 He^4$

If the binding energy per nucleon in Li^7 and He^4 nuclei are 5.60 MeV and 7.06 MeV , respectively .

(A) 19.6 MeV

(B) 2.4 MeV

(C) 8.4 MeV

(D) 17.28 MeV

CORRECT ANSWER: D

SOLUTION:

Binding energy of Li = 39.20 MeV

Binding energy of He^4 = 28.24 MeV

Binding energy of = 56.48 MeV

$\therefore$ Energy = 56.48 - 39.20 = 17.28 MeV

Q-14 - 11313123

In a sample of a radioactive substance, what fraction of the initial nuceli will remain undecayed after a time $t = T/2$, where T=half -life of radioactive substance?

(A) $\frac{1}{\sqrt{2}}$

(B) $\frac{1}{2\sqrt{2}}$

(C) $\frac{1}{4}$

(D) $\frac{1}{\sqrt{2}-1}$

CORRECT ANSWER: A

SOLUTION:

Fraction of nuclei which reamin undecayed is

$$f=\frac{N}{N_0}=\frac{N_0 e^{-\lambda t}}{N_0}$$

$=e^{-\lambda t}$

$=e^{\left(-1\frac{n}{T}\right)\left(\frac{T}{2}\right)}$

$$=\frac{1}{e^{1n\left(\sqrt{2}\right)}=\frac{1}{\sqrt{2}}}$$

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Q-15 - 10969007

Half-life of a radioactive substance is T. At time t_1 activity of a radioactive substance is R_1 and at time t_2 it is R_2. Find the number of nuclei decayed in this interval of time.

CORRECT ANSWER: A::B

SOLUTION:

Half-life is given by

$$t_{1/2} = \frac{1n2}{\lambda}$$

$$:. \lambda = \frac{1n2}{t_{1/2}} = 1n\frac{2}{T}$$

Activity $R = \lambda N$

$$:. N = \frac{R}{\lambda} = \frac{RT}{1n2}$$

When activity is R_1, numbers of nuclei are

$$N_1 = \frac{R_1 T}{1n2}$$

Similarly, $N_2 = \dfrac{R_2 T}{1n2}$

:. Numbers decayed

$$= N_1 - N_2$$

$$= \frac{(R_1 - R_2)T}{1n2}$$

Q-16 - 10969048

A radioactive substance has a half-life of 64.8 h. A sample containing this isotope has an initial activity $(t = 0)$ of $40 \mu Ci$. Calculate the number of nuclei that decay in the time interval between $t_1 = 10.0h$ and $t_2 = 12.0h$.

CORRECT ANSWER: A::C::D

SOLUTION:

$$R_0 = \lambda N_0 \Rightarrow N_0 = \frac{R_0}{\lambda}$$

where, $\lambda = \dfrac{In2}{t_{1/2}}$

$$N = N_{0^{e-\lambda t}}$$

Find $N_1 = N_{0e^{-\lambda t1}}$

and $N_2 = N_{0e^{-\lambda t2}}$

$\therefore$ Number of nuclei decayed in given

time $= N_1 - N_2$

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Q-17 - 12307699

The binding energy of the electron in the ground state of He atom is equal to $E_0 = 24.6eV$. Find the energy required to remove both the electrons from the atom.

SOLUTION:

To remove one elctron requires $24.6eV$

The ion that is left is He^+ which in its ground stat has a

binding energy of $4E_H = 4?R$.

The complete binding energy of both electrons is then

$E = E_0 + 4?R$

Substitution gives $E = 79.1 eV$

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Q-18 - 15160309

The Uranium -238 decay series (also known as 4n+2 series. Can you tell why?) ends at a stable isotope $.^{82} Pb^{206}$. Lead -206 is found in a certain Uranium ore due to dissintegration of Uranium.

(a) How many alpha and beta particles are emitted in the series decay of one $._{92} U^{238}$ nucleus into $._{82} Pb^{206}$?

(b) what is the age of uranium ore if it now contains 8g of Pb^{206} for every 10g of U^{238}? Hlaf life of U^{238} is 4.5 bilion year.

[Take

$\ln 2 = 0.6930, \ln(1.9243)$
$= 0.6546$
]

CORRECT ANSWER: (A) $8 ALPHA$ AND 6BETA(B)

4.25XX10^(9)YR

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Q-19 - 17960344

The half - life of $._{92}U^{238}$ against $\alpha - decay$ is 4.5×10^{9} years. How many disintegrations per second occur in 1 g of $._{92}U^{238}$?

CORRECT ANSWER: $1.23XX10^{4}DISS^{-1}$

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Q-20 - 13165244

A sample of uranium is a mixture of three isotopes $._{92}U^{234}$, $._{92}U^{235}$ and $._{92}U^{238}$ present in the ratio $0.006\ \%$, $0.71\ \%$ and $99.284\ \%$ respectively. The half lives of then isotopes are 2.5×10^{5} years, 7.1×10^{8} years and 4.5×10^{9} years respectively. The contribution to activity (in $\%$) of each isotope in the sample respectively

(A)
$51.41\,\%$, $2.13\,\%$,
$46.46\,\%$

(B)
$51.41\,\%$, $46.46\,\%$,
$2.13\,\%$

(C)
$2.13\,\%$, $51.41\,\%$,
$46.46\,\%$

(D)
$46.46\,\%$, $2.13\,\%$,
$51.41\,\%$

CORRECT ANSWER: A

SOLUTION:

Let m is the total mass of the uranium mixture. The masses of the isotopes $._{92}U^{234}$, $._{92}U^{235}$ and $._{92}U^{238}$

in the mixture are $m_1 = \frac{0.006}{100} m$,

$m_2 = \frac{0.71}{100} m$, and $m_3 = \frac{99.284}{100} m$.

If N_A is the Avogadro number, then number of atoms of

threeisotopes are, $N_1 = \frac{m_1 N_A}{M_1}$

$N_2 = \frac{m_2 N_A}{M_2}$, and $N_3 = \frac{m_3 N_A}{M_3}$

Activity of radioactive sample $A = \lambda N$

As

$$\lambda = \frac{0.693}{t_{1/2}}, \ \therefore A$$

$$= \frac{0.693}{t_{1/2}} N$$

If $t_{1}, _{t_2}$ and t_3 be the half-lives, then

$$A_1 : A_2 : A_3 = \frac{N_1}{t_1} : \frac{N_2}{t_2}$$

$$: \frac{N_3}{t_3}$$

or

$$A_1 : A_2 : A_3 = \frac{m_1}{M_1 t_1} : \frac{m_2}{M_2 t_2}, \frac{m_3}{M_3 t_3}$$

$$= \frac{0.006}{234(2.5 \times 10^5)} : \frac{0.71}{235(7.5 \times 10^8)} : \frac{99.284}{238(4.5 \times 10^9)}$$

$$51.41\% : 2.13\% : 46.46\%$$

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Q-21 - 19037392

Analysis of potassium and argon atoms in a moon rock sample by a mass spectrometer shows that the ratio of the number of stable Ar^{40} atoms present to the number of radioactive K^{40} atoms is 7 : 1 .

Assume that all the argon were produced by the decay of potassium atoms, with a half-life of 1.25×10^9 year. How old is the rock?

(A) $1.25 \times 10^9 yr$

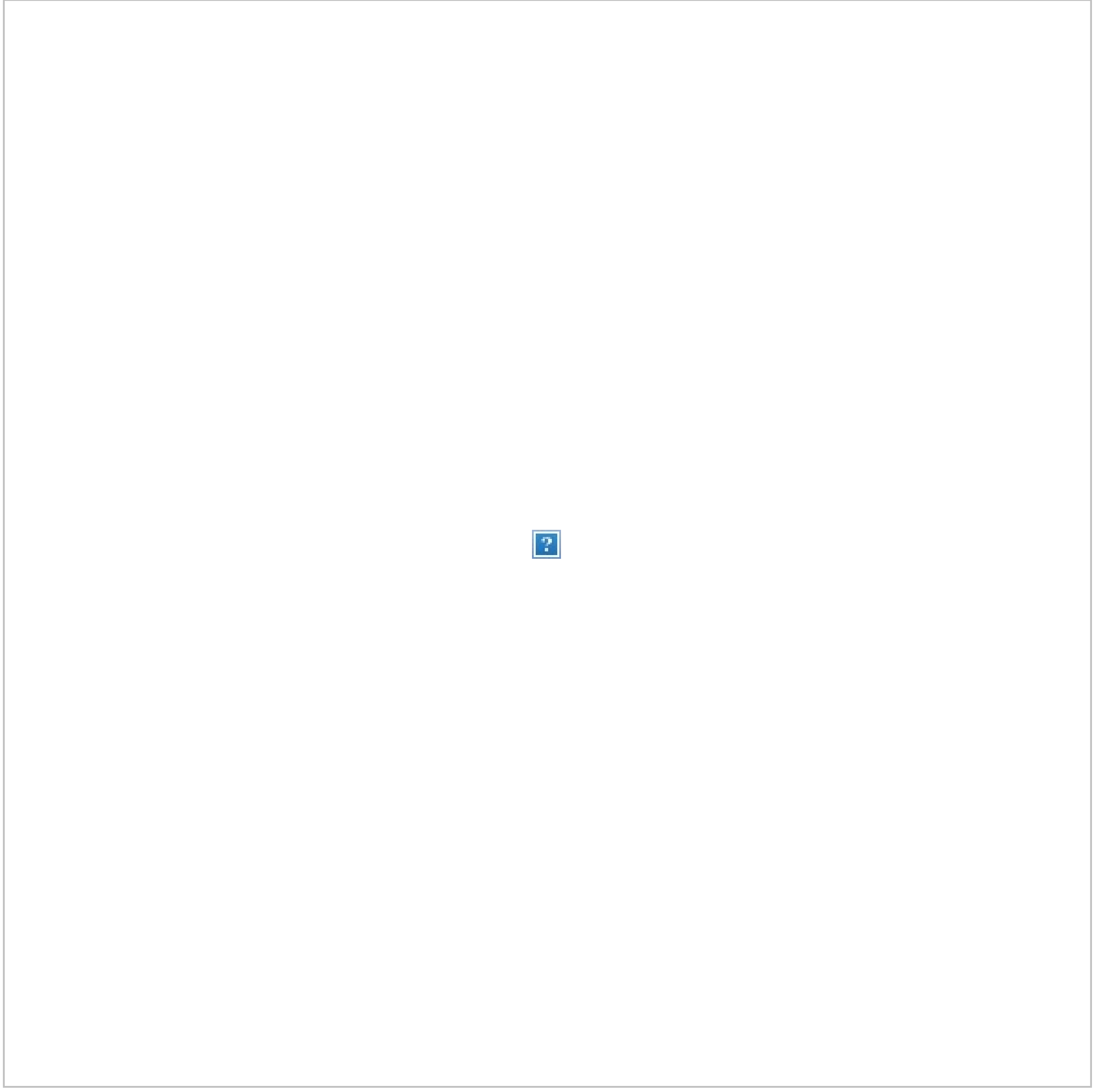
(B) 3.75×10^9yr

(C) 8.75×10^9 yr

(D) 1.00×10^{10} yr

CORRECT ANSWER: B

SOLUTION:



Numberof atoms after time t $N_0 - x$ x

But from question, $\dfrac{N_0 - x}{x} = \dfrac{1}{7}$

$$x = \frac{7}{8} N_0$$

$$\therefore (N_0 - x) = \frac{N_0}{8}$$

$$N_0 \rightarrow \frac{N_0}{2} \rightarrow \frac{N_0}{4}$$

$$\left. \rightarrow \frac{N_0}{8} \right)$$

So, time = $3 \times T_{1/2} = 3.75 \times 10^{9}$ year

Q-22 - 17960352

A slow neutron strikes a nucleus of $._{92}U^{235}$ splitting it into lighter nuclei of barium and krypton and releasing three neutrons. Write the corresponding nuclear reaction. Also calculate the energy released on this reaction

Given

$m\left(._{92}U^{235}\right)$

$= 235.043933 \text{amu} m\left(._{0}n^{1}\right)$

$= 1.008665$

amu

$m\left(._{56}Ba^{141}\right)$

$= 140.917700 \text{amu} m\Big($

$._{36}Kr^{92}\Big) = 91.895400$

amu

CORRECT ANSWER: 198.77 MEV

Q-23 - 10969137

A stable nuclei C is formed from two radioactive nuclei A and B with decay constant of λ_1 and λ_2 respectively. Initially, the number of nuclei of A is N_0 and that of B is zero. Nuclei B are produced at a constant rate of P. Find the number of the nuclei of C after time t.

CORRECT ANSWER: A::B::C::D

SOLUTION:

We have for B $\dfrac{dN_B}{dt} = P - \lambda_2 N_B$

$$\Rightarrow \int_0^{N_B} \frac{dN_B}{P - \lambda_2 N_B}$$

$$= \int_0^t dt$$

$$\Rightarrow 1n\left(\frac{P-\lambda_2 N_B}{P}\right)$$
$$= -\lambda_2 t$$

$$\Rightarrow N_B = P\frac{1-e^{-\lambda_2 t}}{\lambda_2}$$

The number of nuclei of A after time t is

$$N_A = N_0 e^{-\lambda_1 t}$$

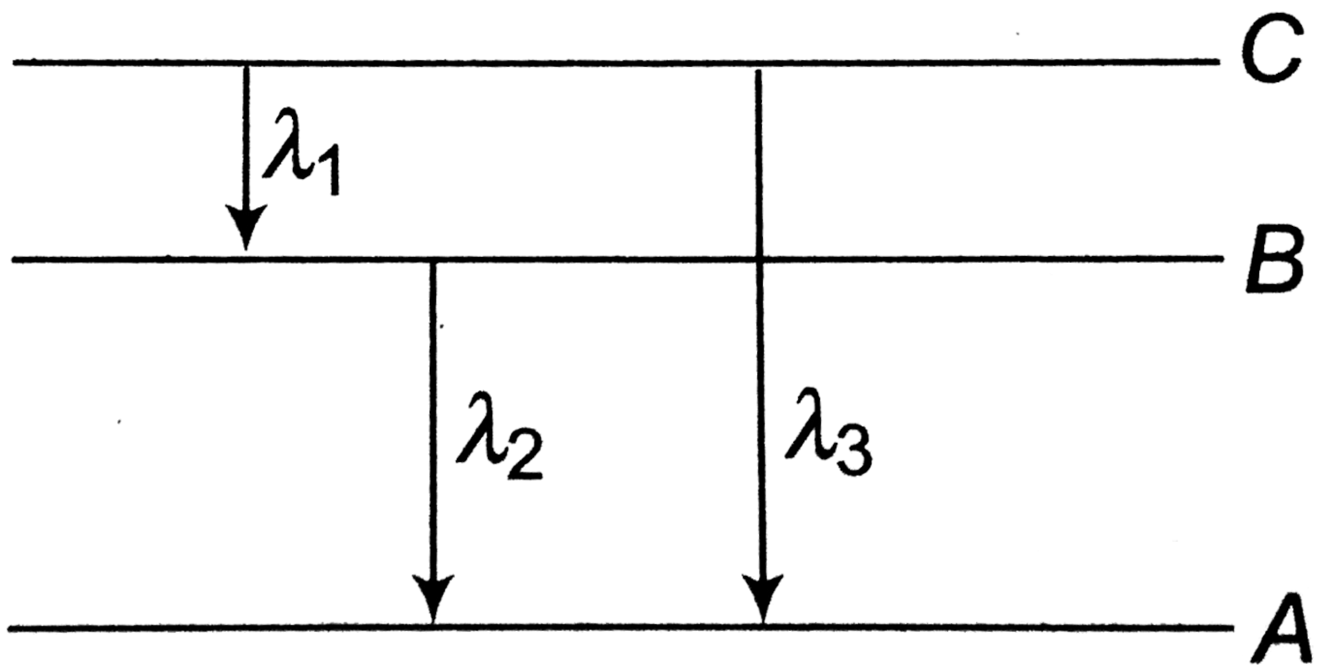
Thus, $\frac{dN_c}{dt} = \lambda_1 N_A + \lambda_2 N_B$

$$\frac{dN_c}{dt} = \lambda_1 N_0 e^{-\lambda_1 t}$$
$$+ P\left(1-e^{-\lambda_2 t}\right)$$

$$\Rightarrow N_c$$
$$= N_0\left(1-e^{-\lambda_1 t}\right)$$
$$+ P\Bigg(t$$
$$+ \frac{\left(e^{-\lambda_2 t}\right)-1}{\lambda_2}\Bigg)$$

Q-24 - 11970034

Energy levels A, B, C of a certain atom corresponding to increasing values of energy i.e., $E_A < E_B < E_C$. If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiations correspnding to the transitions C to B, B to A and C to A respectively, which o fthe following statements is correct?



(A) $\lambda_3 = \lambda_1 + \lambda_2$

(B) $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

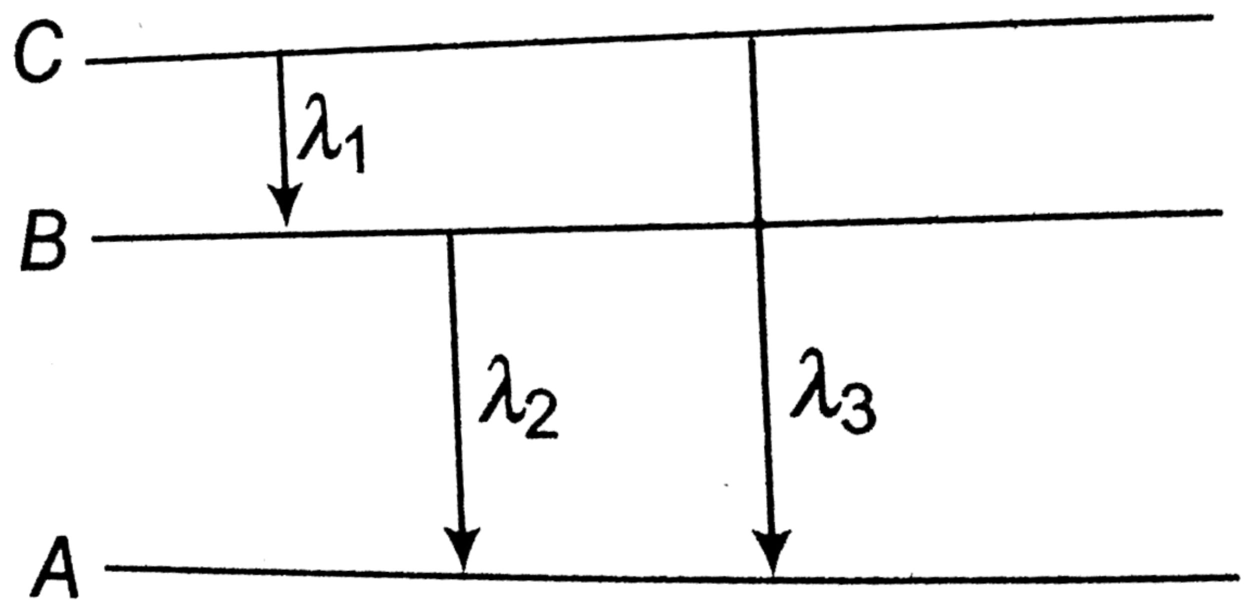
(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

(D) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

CORRECT ANSWER: B

SOLUTION:

Let the energy in A, B and C state be E_A. E_B and E_C then from the figure



$$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$$

or $\dfrac{hc}{\lambda_1} + \dfrac{hc}{\lambda_2} = \dfrac{hc}{\lambda_3}$

$$\Rightarrow \lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

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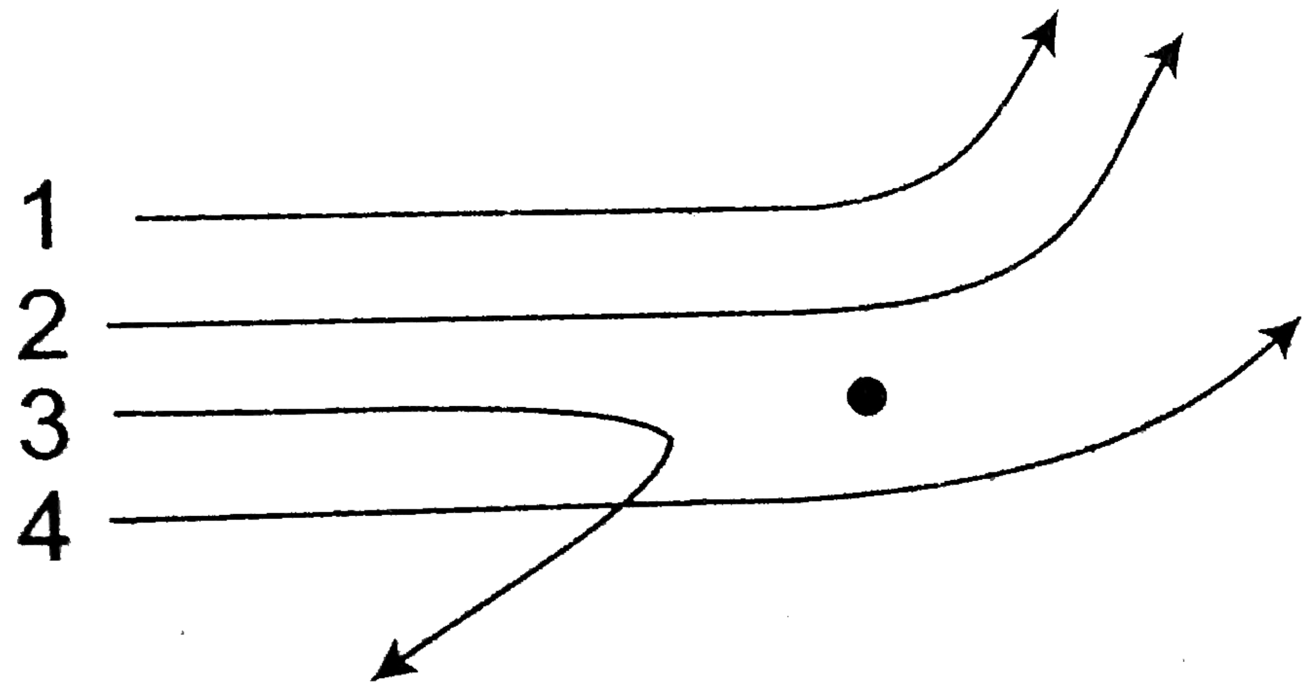
Q-25 - 11969916

The diagram shown the path of four α-particles of the same energy being scattered by the nucleus of an atom simutaneously. Which of these are/is not physically possible ?



(A) 3 and 4

(B) 2 and 3

(C) 1 and 4

(D) 4 only

CORRECT ANSWER: D

SOLUTION:

αparticles cannot be attracted by the nuclues. As A' is transmitted beam appoximate undeviated hence particles should be maximum in this case B' is reflected beam as most of the α particles and get transmitted hence α particles should be minimum in this case.

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Q-26 - 11970503

The radioactivity of a given sample of whisky due to tritium (half life 12.3 years) was found to be only 3% of that measured in a recently purchased bottle marked $''7$ years old". The sample must have been prepared about.

(A) 220 years back

(B) 300 years back

(C) 400 years back

(D) 70 years back

CORRECT ANSWER: D

SOLUTION:

(d) After one half life period, the activity of Tritium

becomes 50%

After 2 half life period 25%

After 3 half period 12.5%

After 4 half life period 6.25%

After 5 half life period $3.12\% \approx 3\%$

It is

$5 \times 12.5 years$

$+ 7 years$

i.e., approximately 70 years only.

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Q-27 - 14939574

A nucleus at rest undergoes a decay emitting an α -particle of de-broglie wavelength $\lambda = 5.76 \times 10^{-15} m$. The mass of daughter nucleus is 223.40 amu and that of α-particle is 4.002 amu - The linear momentum of α -particle and that of daughter nucleous is -

(A)
$1.15 \times 10^{-19} N \times s \;\; \& \;\; 2.25 \times 10^{-19} N \times s$

(B)
$2.25 \times 10^{-19} N \times s \;\; \& \;\; 1.15 \times 10^{-19} N \times s$

(C) both $1.15 \times 10^{-19} N \times s$

(D) both $2.25 \times 10^{-19} N \times s$

CORRECT ANSWER: C

Q-28 - 10060542

which a U^{238} nucleus original at rest , decay by emitting an alpha particle having a speed u , the recoil speed of the residual nucleus is

(A) $\frac{4u}{238}$

(B) $-\frac{4u}{234}$

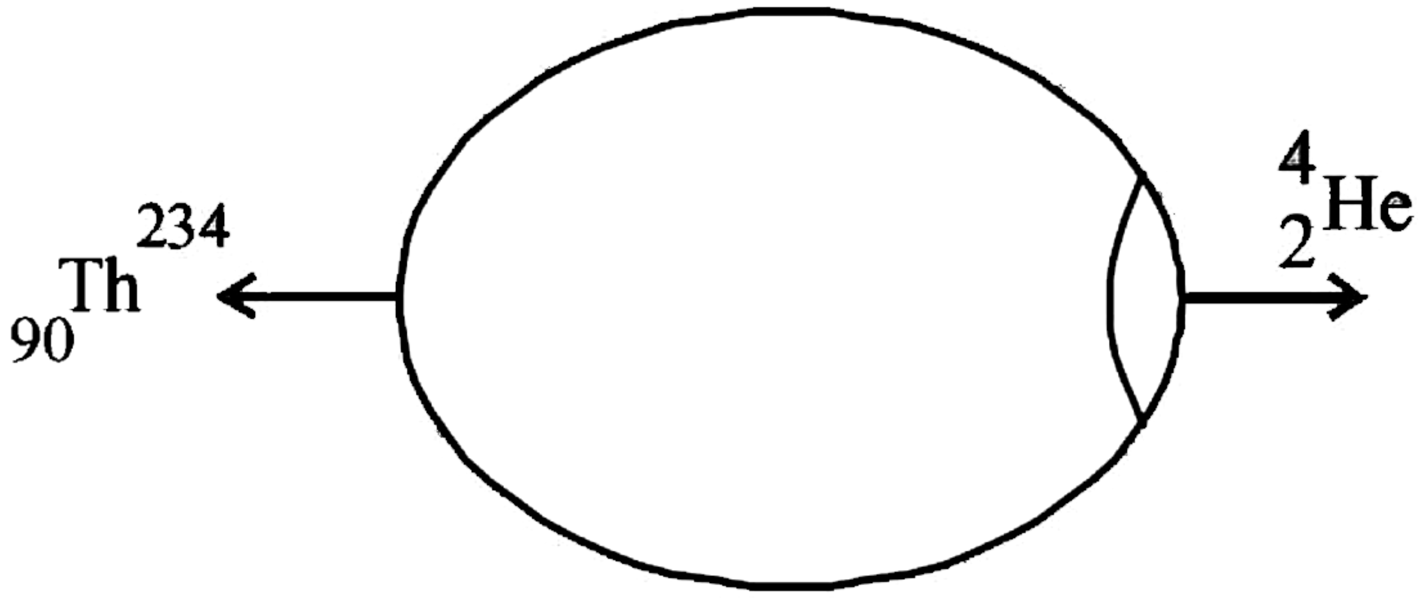
(C) $\frac{4u}{234}$

(D) $-\frac{4u}{238}$

CORRECT ANSWER: C

SOLUTION:

Here , conservation of linear momentum can be applied



$$238 \times 04u + 234V \Rightarrow$$

$$\therefore V = \frac{4}{234}u$$

$$\therefore Speed = |\overline{V}|$$

$$= \frac{4}{234}u$$

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Q-29 - 14530177

Two isotopes P and Q atomic weight 10 and 20, respectively are mixed in equal amount by weight. After 20 days their weight ratio is found to be $1:4$. Isotope P has a half-life of 10 days. The half-life of isotope Q is

(A) zero

(B) 5 days

(C) 20 days

(D) infinite

CORRECT ANSWER: D

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Q-30 - 11312964

Suppose 3.0×10^{7} radon atoms are trapped in a basement at a given time. The basement is sealed against further enetry of the gas. The half - life of radon is 3.83 days. How many radon atoms remain after31 days?

SOLUTION:

During each half-life, the number of radon atoms is reduced by a factor of two. Thus , we determine the number of half-lives in a period of $31J$ days and reduced the number of radon atoms by a factor of two for each one. In a period of $31 days$, there are $31 days / 3.83$ days $= 8.1$ half-lives. In 8 half -lives, the number of radon atoms is reduced by a factor of $.2^8 = 256$, Ignoring the difference between 8 and 8.1 half- lives, we find that the number of atoms ramaining is

$$3.0 \times 10^7 / 256 = 1.2 \times 10^5$$

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Q-31 - 19037398

Calculate the total energy released during a fission reaction .

The resulting fission fragements are unstable hence, decay into stable and products and by sucessive emission of β-particles . Take mass of neutron = 1.0087 amu , mass of =236.0526 amu, mass of

=97.9054 amu and mass of =135.9170 amu.

(A) 198 MeV

(B) 220 MeV

(C) 185 MeV

(D) 230 MeV

CORRECT ANSWER: A

SOLUTION:

$$-(0)^{1} n +^{235}_{92} U$$
$$\rightarrow^{98}_{42} Mo +^{136}_{54} Xe + 2^{1}_{0}n$$

$$(1.0087 + 235.0439)$$
$$= (97.9054 + 135.917$$
$$+ 2.0174)$$

$\Delta m = 0.2128$

$\therefore$ Total energy released during a fission reaction

$= 0.2128 \times 931$ MeV = 198 MeV

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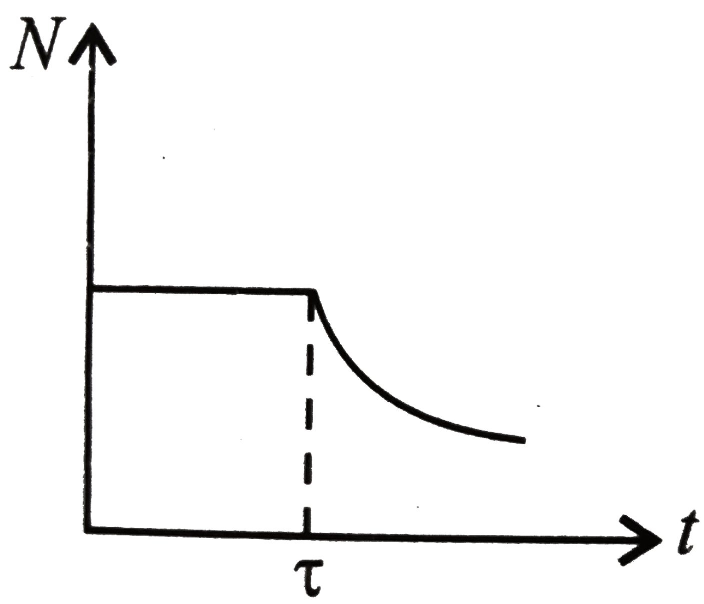
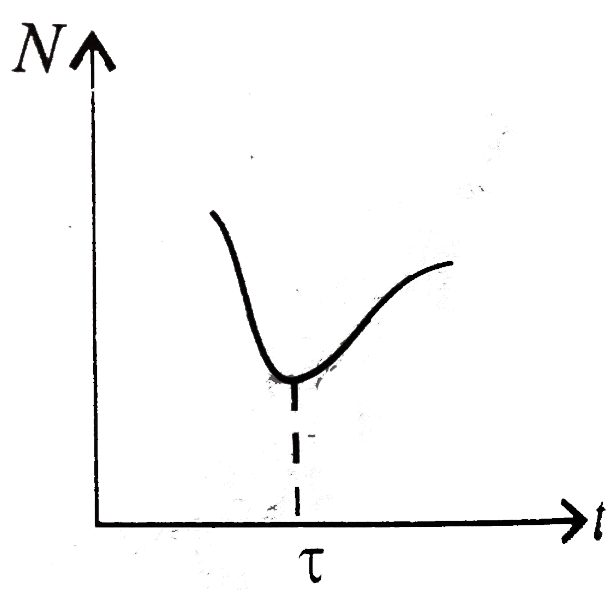
Q-32 - 11045855

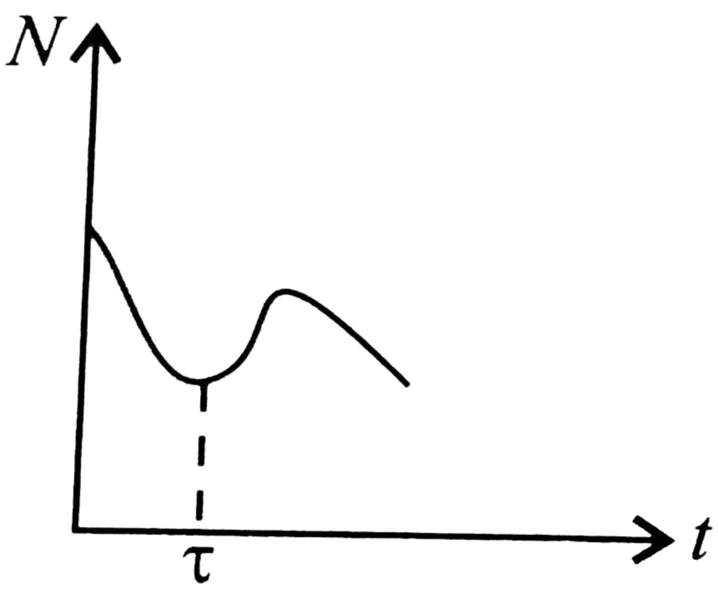
A radioactive substance consists of two distinct having equal number of atoms initially. The mean products in both cases are stable. A plot is made of total number of radioactive nuclei as a function of time. Which of the following figures best represents the form of this plot?

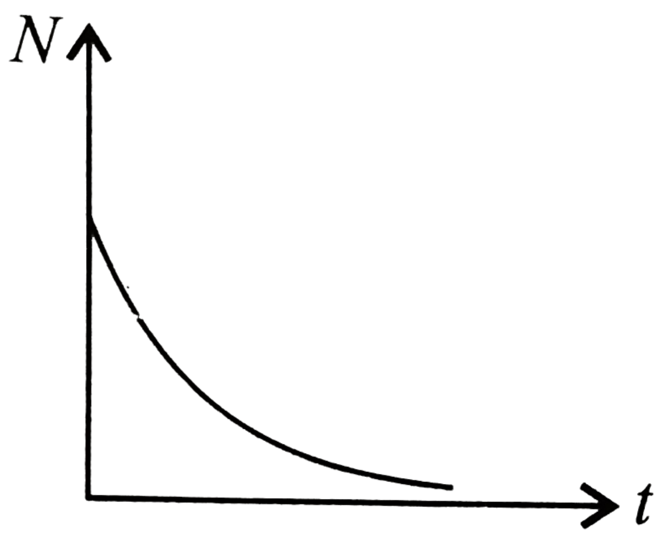
a.



b.



c. 

d. 

SOLUTION:

The decrease of radioactive element (parent element) follows the exponential functions.

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Q-33 - 12016225

The half life of a radioactive element A is same as mean life time of another radioactive element B.Initially, both have same number of atoms. B decays faster than A . Why?

SOLUTION:

$$T_A = \tau_B = 1.44 T_B$$
$$\therefore T_A > T_B$$

$\lambda_A < \lambda_B$. Therefore, B decays faster than A.

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Q-34 - 10969009

The half-life period of a radioactive element x is same as the mean life time of another radioactive element y. Initially, both of them have the same number of atoms. Then,

(a) x and y have the same decay rate initially

(b) x and y decay at the same rate always

(c) y will decay at a faster rate than x

(d) x will decay at a faster rate than y

CORRECT ANSWER: C

SOLUTION:

$(t_{1/2})_x = (t_{mean})_y$

or $\frac{0.693}{\lambda_x} = \frac{1}{\lambda_y}$

:. $\lambda_x = 0.693\lambda_y$

$\lambda_x < \lambda_y$

or Rate of decay $= \lambda N$

Initially, number of atoms(N) of both are equal but since

$\lambda_y > \lambda_x$, therefore, y will decay at a faster rate than x .

:. The correct option is (c) .

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Q-35 - 11970493

U^{238} decays into Th^{234} by the emission of an a-particle. There follows a chain of further radioactive decays, either by α-decay or by $\beta -$ decay. Eventually a stable nuclide is reached and after that, no further radioactive decay is possible. which of the following stable nuclides is the end product of the U^{238} radioactive decay chain ?

(A) Pb^{206}

(B) Pb^{207}

(C) Pb^{208}

(D) Pb^{209}

CORRECT ANSWER: A

SOLUTION:

(a) $(4n+2)$ series starts from U^{238} and its stable end product if Pb^{206}.

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Q-36 - 15160308

Two isotopes of radioactive Radon gas $-R_n^{222}$ and R_n^{220} are mixed in atomic ratio 1000:1 and kept in a $831 cm^3$ container at $10^5 N/m^2$ pressure and $27C$ temperature the two isotopes have half life of 4 days and 1 minute respectively. Calculate the activity of Radon gas sample in unit of curie.

CORRECT ANSWER: $7.3XX10^6 CI$

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Q-37 - 11970436

The half-life of radon is 3.8 days. Three forth of a radon sample decay in.

(A) 5.02 days

(B) 15.2 days

(C) 7.6 days

(D) 11.4 days

CORRECT ANSWER: C

SOLUTION:

(c) Decayed fraction $= \frac{3}{4}$, so undecayed fraction

$$= \frac{1}{4}$$

Now

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{4}$$

$$= \left(\frac{1}{2}\right)^n \Rightarrow n = 2$$

$$\Rightarrow t = n \times T_{1/2} = 2$$

$$\times 3.8 = 7.6 days$$

.

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Q-38 - 9729617

A radioactive isotope is being produced at a constant rate

$dN/dt = R$ in an experiment. The isotope has a half-life $t_{1/2}$ .Show that after a time $t >\ > t_{1/2}$,the number of active nuclei will become constant. Find the value of this constant.

CORRECT ANSWER: A::B::C

SOLUTION:

Given Half life period =$t_{\frac{1}{2}}$

Rate of Radio active decay

$$= \frac{dN}{dt} = R$$
$$\Rightarrow R = \frac{dN}{dt}$$

After time$t >\ > t_{\frac{1}{2}}$ the number of active nuclei will became constant

$$i.e. \left(\frac{dN}{dt}\right)_{present} = R$$
$$= \left(\frac{DN}{Dt}\right)_{decay}$$

$$\therefore R = \left(\frac{DN}{Dt}\right)_{decay}$$

rArr $R = \lambda N$

(Where$\lambda =$ Radioactive decay constant ,

$N =$ constant number]

$$\Rightarrow R' = \frac{0.693}{t_{\frac{1}{2}}}(N)$$

$$\Rightarrow Rt_{\frac{1}{2}} = 0.693N$$

$$\Rightarrow N = \frac{Rt_{\frac{1}{2}}}{0.693}.$$

Q-39 - 11406012

1xxint log34dx

Q-40 - 11970488

A radioactive nucleus is being produced at a constant rate α per second. Its decay constant is λ. If N_0 are the number of nuclei at time $t = 0$, then maximum number of nuclei possible are.

(A) $\frac{\alpha}{\lambda}$

(B) $N_0 + \frac{\alpha}{\lambda}$

(C) N_0

(D) $\frac{\lambda}{\alpha} + N_0$

CORRECT ANSWER: A

SOLUTION:

(a) Maximum number of nuclei will be present when rate of decay = rate of formation

$$\Rightarrow \lambda N = \alpha \Rightarrow N = \frac{\alpha}{\lambda}$$

.

Q-41 - 11313112

A radioactive substance is being consumed at a constant of $1s^{-1}$. After what time will the number of radioactive nuclei becoem 100. Initially, there were 200 nuceli present.

(A) $1s$

(B) $\frac{1}{1n(2)}s$

(C) $\ln(2)s$

(D) $2s$

CORRECT ANSWER: C

SOLUTION:

Let N be the number of nuclei at any time t. Then,

$$\frac{dN}{dt} = 200 - \lambda N$$

$$\therefore \int_0^N \frac{dN}{(200 - \lambda N)}$$

$$= \int_0^t dt$$

or N=(200)/(lambda) (1-e^(-lambda t))$Given:$ N =100

and lambda =1 s^(-1):. 100=200 (1-e^(-t)) or e^(-t)=

((1)/(2)) :. t=ln(2) s`.

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Q-42 - 9525890

Two radioactive materials have decay constant $5\lambda \& \lambda$. If initially they have same no. of nuclei. Find time when ratio of nuclei become $\left(\frac{1}{e}\right)^2$:

(A) $\frac{1}{2\lambda}$

(B) $\dfrac{1}{\lambda}$

(C) $\dfrac{2}{\lambda}$

(D) $\dfrac{1}{4\lambda}$

CORRECT ANSWER: A

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Q-43 - 11313237

Nuclei of a radioactive element X are being produced at a constant rate K and this element decays to a stable nucleus Y with a decay constant λ and half-life $T_{1/3}$. At the time $t=0$, there are N_0nuclei of the element X.

The number N_Y of nuclei of Y at time t is .

(A)

$$Kt - \frac{K - \lambda N_0}{\lambda} e^{-\lambda t}$$
$$+ K - \lambda \frac{N_0}{\lambda}$$

(B)

$$Kt - \frac{K - \lambda N_0}{\lambda} e^{-\lambda t}$$
$$+ K - \lambda \frac{N_0}{\lambda}$$

(C) $Kt + \dfrac{K - \lambda N_0}{\lambda} e^{-\lambda t}$

(D) $Kt + \dfrac{K - \lambda N_0}{\lambda} e^{-\lambda t}$

CORRECT ANSWER: B

SOLUTION:

$$\frac{dN_X}{dt} = K - \lambda N_X$$

N_(X)=(1)/(lambda)[K-K-lambda N_(0))e^(-lambda t)]

(dN_(Y))/(dt)=lambdaN_(X)N_(Y)=Kt+(K-lambda

N_0/lambda)e^(-lambda t) -(K-lambda N_(0))/(lambda)`.

Q-44 - 10060339

The binding energy per nucleon number for deuteron $\left(\_(1)H^{2}\right)$ and belium $\left(\_(2)Hx^{4}\right)$ are $1.1MeV$ and $7.0MeV$ respectively . The energy released when two deuterons fase to form a belium nucleus $\left(\_(2)He^{4}\right)$ is ..

CORRECT ANSWER: B::C

SOLUTION:

$\_(1)^{2}H +_{2}^{4} He$

Binding energy of two deuterons

$= 2[1.1 \times 2]$
$= 4.4MeV$

Binding of the belium nucleue $= 4 \times 7.0 = 28MeV$

The energy released

$= 28 - 4.4$
$= 23.6MeV$

Q-45 - 10969121

A radioactive material of half-life T was kept in a nuclear reactor at two different instants. The quantity kept second time was twice of the kept first time. If now their present activities are A_1 and A_2 respectively, then their age difference equals

(A) (a) $\frac{T}{1n2}1n\frac{2A_1}{A_2}$

(B) (b) $T1n\frac{A_1}{A_2}$

(C) (c) $\frac{T}{1n2}1n\frac{A_2}{2A_1}$

(D) (d) $T1n\frac{A_2}{2A_1}$

CORRECT ANSWER: C

SOLUTION:

Activity $A \propto$ Number of atomsA_1=A_0e^(-lambdat_1)

:.t_1=1/lambda1n((A_0)/(A_1))=(T)/(1n2)1n(A_0)/(A_1)

A_2=2A_0e^(-lambda_(t_2))t_2=

(T)/(1n2)1n((2A_0)/(A_2))t_1-t_2=(T)/(1n2)

(A_0/A_1xx(A_2)/(2A_0))=(T)/(1n2)1n((A_2)/(2A_1))`

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Q-46 - 11313126

The ratio of molecular mass of two radioactive substances is $3/2$ and the ratio of their decay cosntatnt is $4/3$. Then. The ratio of their initial activity per mole will be

(A) 2

(B) $\frac{8}{9}$

(C) $\frac{4}{3}$

(D) $\frac{9}{8}$

CORRECT ANSWER: C

SOLUTION:

Activity, $R = \lambda N$. Number of nuclei N per mole are equal for both the substance.

$\therefore R \propto \lambda$

or $\frac{R_1}{R_2} = \frac{\lambda_1}{\lambda_2} = \frac{4}{3}$.

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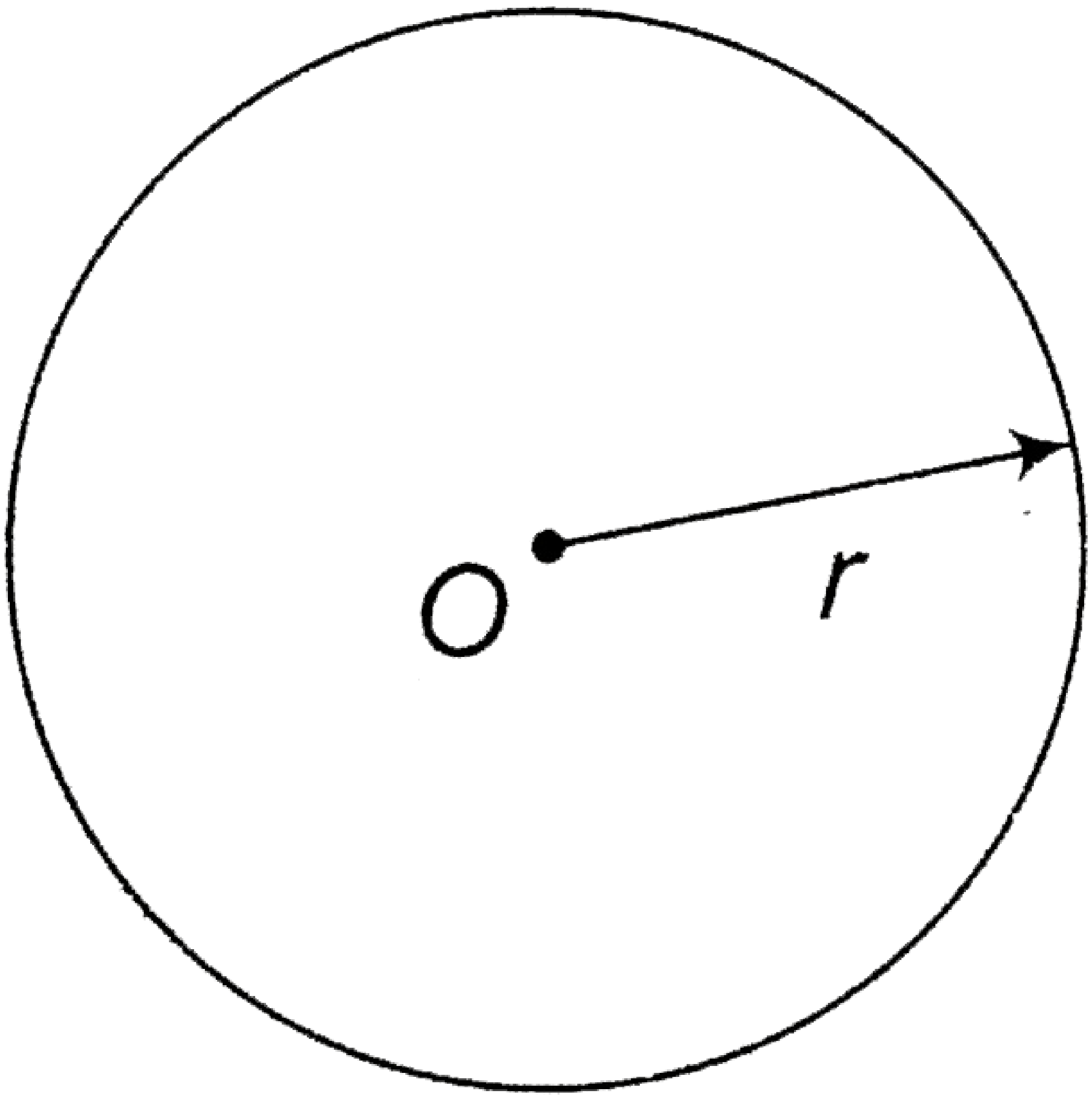
Q-47 - 13397132

A radioactive source, in the form of a metallic sphere of radius $10^{-2} m$ emits $\beta -$ particles at the rate of 5×10^{10} particles per second. The source is electrically insulated. How long will it take for its potential to be raised by $2V$, assuming that 40% of the emitted $\beta -$ particles escape the source.

SOLUTION:



β-particles i.e. electron

$$V = \frac{1}{4\pi \in_0} \cdot \frac{q}{r}$$

$$= \frac{9 \times 10^9}{10^{-2}} q = 9 \times 10^{11} q$$

$$2 = 9 \times 10^{11} q$$

$$q = \frac{2}{9} \times 10^{-11} C$$

where q: charge acquired by sphere.

Number of β-particles emitted by source

$$= 5 \times 10^{10} / \sec$$

$40\ \%$ of this

$$= 0.4 \times 5 \times 10^{10}$$
$$/ \sec = 2 \times 10^{10} / \sec$$

$$q = \text{net}$$
$$\frac{2}{9} \times 10^{-11} = 2 \times 10^{10}$$
$$\times 1.6 \times 10^{-19} t$$

$$t = \frac{10^{-2}}{9 \times 1.6}$$

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Q-48 - 17937362

Consider a nuclear reaction :

$$A \xrightarrow{\lambda_1} B + C$$

and $B \xrightarrow{\lambda_2} C$

A converts into B and to C with decay with decay constant λ_1 B is alos stable nucleus which futher decays into stable nucleus C with decay constant λ_2. Mark the correct statement(s)

(A) $\frac{dN_C}{dt} = -(\lambda_1 N_A + \lambda_2 N_B)$

(B) $\frac{dN_A}{dt} = -\lambda_1 N_A$

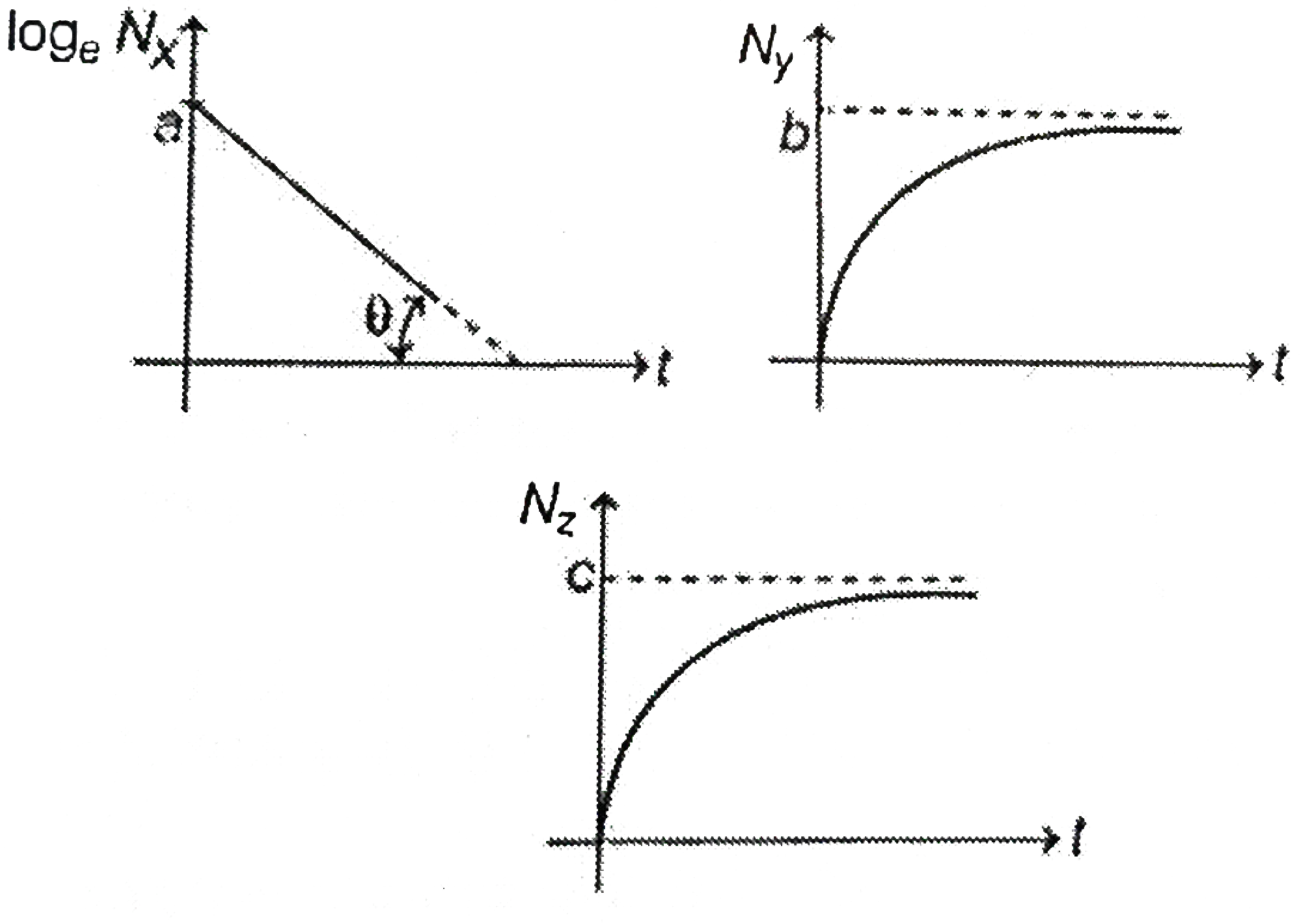
(C) $\frac{dN_A}{dt} = (\lambda_1 N_A + \lambda_2 N_B)$

(D) $\frac{dN_B}{dt} = \lambda_1 N_A + \lambda_2 N_B$

CORRECT ANSWER: B

Q-49 - 17937393

An unstable nucleus X can decay into two stable nuclie Y and Z A sample containing only X is taken at t=0 Three graphs $\log_e(N_x$ vs t, $N_x,$ vs t and N_z vs t are drawn as shown below Here N_x, N_y and N_z represent number of nuclei of X,Y and Z repectively at any instant. t



Choose the correct choice (s) from the following :

(A) Decay constant for decay of X into Y is $\dfrac{b\tan\theta}{e^a}$

(B) ecay constant for decay of X into Z is $\frac{c \tan \theta}{e^a}$

(C) Number of nuclei of X at t=0-is e^a

(D) Half-life of nuclei X is $\frac{1}{\tan \theta}$

CORRECT ANSWER: A::B::C

Q-50 - 11970541

Radioactivity of 108 undecayed radioactive nuclei of half life of 50 days is equal to that of 1.2×108 number of undecayed nuclei of some material with half life of 60 days

Radioactivity is proportional to half-life.

(A) If both assertion and reason are true and reason is the correct explanation of assertion.

(B) If both assertion and reason are true but reason is not the correct explanation of assertion.

(C) If assertion is true but reason is false

(D) If assertion is false but reason is true.

CORRECT ANSWER: C

SOLUTION:

(c) Radioactivity

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

$$= \frac{0.693N}{T}$$

=

$$\frac{0.693 \times 10^8}{50}$$

$$= \frac{0.693 \times 1.2 \times 10^8}{60}$$

$$= 0.693 \times 2 \times 10^6$$

Radioactivity is proportional to $1/T_{1/2}$ and not to $T_{1/2}$.

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Q-51 - 19037365

The binding energy expressed in MeV is given for the following

nulcear reactions

$_(2)He^3 +_0 n^1 \rightarrow_2 He^4$
$+ 20MeV$

$_(2)He^4 +_0 n^1 \rightarrow_2 He^5$
$+ 0.9meV$

Which of the following conclusion is correct ?

(A) $_(2)He^4$is less stable than both $_(2)He^3$ and $_(2)He^5$

(B) $_(2)He^4$ is less stable than $_(2)He^3$ but more stable than $_(2)He^5$.

(C) $_(2)He^{4}$ is less stable than $_(2)He^{3}$

(D) $_(2)He^{4}$ is more stable than both $_(2)He^{4}$ and $_(2)He^{5}$

CORRECT ANSWER: A

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Q-52 - 16757254

In neutron-induced fission of $._{92}^{235}U$ (235.044amu) two stable end products usually formed are $._{42}^{98}Mo$ (97.905amu) and $._{54}^{136}Xe$ usually formed (135.917 amu. Assuming that these isotopes have come from the original fisiion process, find (i) what elementary particles are released (ii) mass defect of the reaction (iii) the equivalent energy released.

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Q-53 - 17960320

The atomic mass of $._8 O^{16}$ is 16.000000 amu. Calculate the binding energy of $._8 O^{16}$ in MeV per nucleon.

CORRECT ANSWER: 7.68 MEV

Q-54 - 19037409

Consider two nuclei of the same radioactive nucclide . One of the nuclei was created in a supernova explsion 5 billions year ago . The probability of decay during the next time is

(A) different for each nuclei

(B) nuclei created in explosion decays first

(C) nuclei created in the reactor decays first

(D) Independent of the time of creation

CORRECT ANSWER: D

SOLUTION:

Radioactivity decay does not depend upon the time of creation.

Q-55 - 11970592

Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time $t = 0$, number of P species are $4N_0$ and that of Q are N_0. Half-life of P (for conversation to R) is $1mm$ whereas that of Q is $2 \min$. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be :

(A) $3N_0$

(B) $\frac{9N_0}{2}$

(C) $\frac{5N_0}{2}$

(D) $2N_0$

CORRECT ANSWER: B

SOLUTION:

(b) Initially $p \rightarrow 4N_0$

$Q \rightarrow N_0$

Half-life $T_p \rightarrow 1 \text{ min}$

$T_Q \rightarrow 2 \text{ min}$

Let after time t number of nuclei of P and Q are equal,

i.e., $\frac{4N_0}{2^{t/1}} = \frac{N_0}{2^{t/2}}$

$4 = 2^{t/2}$

$2^2 = 2^{t/2} \Rightarrow \frac{t}{2} = 2$

$t = 4 \text{ min}$

Deactivate nucleus or nuclei of R

=

$$\left(4N_0 - \frac{4N_0}{2^4}\right) + \left(N_0 - \frac{N_0}{2^2}\right)$$

=

$$4N_0 \frac{N_0}{4} + N_0 - \frac{N_0}{4} = 5N_0 - \frac{N_0}{2} = \frac{9}{2}N_0$$

.

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Q-56 - 15160304

A nucleus at rest decays by emitting at α particle. The de-Broglie wavelenght of emitted α particle is $\lambda = -5.76$ femtometer. Mass of the daughter nucleus and α particle is 223.610u and 4.002u. Find the mass of the parent nucleus.

CORRECT ANSWER: 227.62U

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Q-57 - 11970464

A nucleus of mass 218 amu in Free State decays to emit an α-particle. Kinetic energy of the $\beta-$ particle emitted is $6.7 MeV$. The recoil energy (in MeV) of the daughter nucleus is

(A) 1.0

(B) 0.5

(C) 0.25

(D) 0.125

CORRECT ANSWER: D

SOLUTION:

(d) Using conservertion of momentum

$$P_{\text{daughter}} = P_{\alpha}$$
$$\Rightarrow \frac{E_d}{E_{\alpha}} = \frac{m_{\alpha}}{m_d} \Rightarrow E_d$$
$$= \frac{E_{\alpha} \times m_{\alpha}}{m_d}$$
$$= \frac{6.7 \times 4}{214}$$

$$= 0.125 MeV.$$

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Q-58 - 15160288

Nuclei of $.^{64} Cu$ can decay be electron capture (probability 61%) or by β^{+} decay (39%). Half life of $.^{64} Cu$ is 12.7 hour. Find the partial half life for electron capture decay oricess,

CORRECT ANSWER: 20.8HR.

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Q-59 - 13397258

A radioactive nuclide can decay simultaneously by two different processes which have decay constant λ_1 and λ_2. The effective decay constant of the nucleide is λ

(A) $\lambda = \lambda_1 + \lambda_2$

(B) $\lambda = (\lambda_1 + \lambda_2)/2$

(C) $\frac{1}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

(D) $\lambda = \sqrt{\lambda_1 \lambda_2}$

CORRECT ANSWER: A

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Q-60 - 11313209

Gold $._{79}^{198}Au$ undergoes β^- decay to an excited state of $._{80}^{198}Hg$. If the excited state decays by emission of a γ-photon with energy $0.412MeV$, the maximum kinetic energy of the electron emitted in the decay is (This maximum occurs when the antineutrino has negligble energy. The recoil enregy of the $._{80}^{198}Hg$ nucleus can be ignored. The masses of the neutral atoms in their ground states are $197.968255u$ for $._{79}^{198}Hg$).

(A) $0.412MeV$

(B) $1.371MeV$

(C) $0.959MeV$

(D) $1.473MeV$

CORRECT ANSWER: C

SOLUTION:

$m\left(._{}^{198} Au_{79}\right)$
$= 197.968225u$

$m\left(._{80}^{198} Hg\right)$
$= 197.966752u$

Mass defect,

$\Delta m = 1.473 \times 10^{-3} u$
$= 1.371 MeV$

Energy of γ-photon $= 0.412 MeV$

Maximum kinetic energy of the electron emitted in the decay is

$E_e = 1.371 MeV$
$- 0.412 MeV$
$= 0.959 MeV$

.

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