NEET

PHYSICS MODEL QUESTIONS

NUCLEI

1. The density of a nucleus of mass number A is proportional to

a) A^3 b) $A^{1/3}$ c) A d) A°

Sol: Density of nucleus is independent of mass no. ***Ans: d***

2. The B.E. per nucleon of $_3Li^7$ and $_2He^4$ nuclei are 5.60 meV and 7.06 meV. In the nuclear reaction $_3Li^7 + {}_1H^1 \longrightarrow {}_2He^4 + {}_2He^4 + Q$. The value of energy released 'Q' is.

a) 19.6 meV b) −2.4 meV c) 8.4 meV d) 17.3 meV

Sol: $\frac{BE}{A} = \frac{BE}{7} = 5.60 \Rightarrow BE = 5.60 \times 7$ mev

$\frac{BE}{4} = 7.06 \Rightarrow BE = 7.06 \times 4$ mev

$\frac{BE}{A}$ for $_1H^1$ is not given, ignore it.

$(5.60)7 \longrightarrow 2\,(4 \times 7.06) + Q$

$\Rightarrow$ Q = 17.3 meV.

3. A Uranium nucleus $_{92}U^{238}$ α particle β particle in succession. The atomic number and mass number of final nucleus will be

a) 90, 233 b) 90, 238 c) 91, 234 d) 93, 238

Sol: $_{92}U^{238} \xrightarrow{\alpha} {}_{90}X^{234} \xrightarrow{\beta} {}_{91}Y^{234}$

α − particle emits Z decreases by two mass number decreases by four

β − particle emits Z increase by one mass number remains same. ***Ans: c***

4. An α − particle of mass 'm' suffers dimensional elastic collision with a nucleus of unknown mass. After collision α − particle is scattered directly backwards losing 75% of its KE. Then mass of nucleus is

a) m b) 2 m c) 3 m d) $\frac{3}{2}$ m

Sol: $\frac{1}{2} m_1 u_1^2$ = Initial KE of α − particle

$\frac{1}{2} m_1 v_1^2$ = Final KE of α − particle.

loss of KE = Initial KE − Final KE

$\frac{75}{100}\frac{1}{2} m_1 u_1^2 = \frac{1}{2} m_1 u_1^2 - \frac{1}{2} m_1 v_1^2$

$\frac{3}{4} u_1^2 = u_1^2 - v_1^2 \Rightarrow v_1 = \frac{1}{2} u_1$

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$v_1 = \left[\frac{m_1 - m_2}{m_1 + m_2}\right] u_1$

$\frac{1}{2} u_1 = \frac{m_1 - m_2}{m_1 + m_2} u_1 \Rightarrow m_2 = 3m$

5. Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be

a) 1 : 3 b) $3^{1/3}$: 1 c) 3 : 1 d) 1 : 1

Sol: Nuclear density is independent on mass number. *Ans: d*

6. Atomic mass of $_6C^{13}$ is 13.00335 amu, and mass number is 13. If 1 amu = 931 meV. BE of neutrons present in the nucleus is

a) 0.24 meV b) 1.44 meV c) 1.68 meV d) 3.12 meV

Sol: BE $= \Delta m \times 931$ meV

$= (13.00335 - 13) \times 931$

$= 3.12$ meV

7. The radius of germanium (Ge) nuclei is measured to be twice the radius of $_4Be^9$. The number of nucleons in Ge are

a) 73 b) 74 c) 75 d) 72

Sol: $R = R_0 A^{1/3}$

$\frac{R_1}{R_2} = \left[\frac{A_1}{A_2}\right]^{1/3} \Rightarrow \left[\frac{r}{2r}\right] = \left[\frac{9}{A_2}\right]^{1/3}$

$\Rightarrow A_2 = 9 \times 23$

$= 72$

8. A radio isotope X with a half life 1.4×10^9 yr decays of Y which is stable. A sample of rock from a cave was found to contain X and Y in the ratio 1 : 7, the age of rock is

a) 1.96×10^9 yr b) 3.92×10^9 yr c) 4.20×10^9 yr d) 8.40×10^9 yr

Sol: $\frac{X}{Y} = \frac{1}{7} \Rightarrow m_x + m_y = m$

$\Rightarrow \frac{m_y}{7} + m_y = m$

$\Rightarrow \frac{8m_y}{7} = m \Rightarrow m_y = \frac{7}{8} m$

$1 - \frac{7}{8} = \frac{1}{8}$ is left as undisintegrated

$\frac{N}{N_0} = \frac{1}{8} = \frac{1}{2^n} \Rightarrow n = 3$

Time taken to become $\frac{1}{8}$ unstable part is

$n = \frac{T}{T_{1/2}} \Rightarrow T = nT_{1/2}$

$= 3 \times 1.4 \times 10^9$

$= 4.20 \times 10^9$ yrs

9. Two radio active substances A and B have decay constants 5λ and λ respectively. At t = 0 they have same number of nuclei. The ratio of number of nuclei of A to that of B will be (Ye^2) after a time interval of ....

a) $\frac{1}{\lambda}$ b) $\frac{1}{2\lambda}$ c) $\frac{1}{3\lambda}$ d) $\frac{1}{5\lambda}$

Sol: $N = N_0 e^{-\lambda t}$

$N_A = N_0 e^{-5\lambda t} \Rightarrow \frac{N_A}{N_B} = \frac{1}{e^2} = \frac{e^{-5\lambda t}}{e^{-\lambda t}}$

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

$e^{-2} = e^{-4\lambda t} \Rightarrow 2 = 4\lambda t \Rightarrow t = \frac{1}{2\lambda}$

10. A Radio active nucleus of mass M emits a photon of frequency γ and nucleus recoils. The recoil energy will be

a) $\frac{h^2\gamma^2}{2Mc^2}$ b) Zero c) $h\gamma$ d) $Mc^2 - h\gamma$

Sol: Momentum of photon $P = \frac{h\gamma}{c}$

recoil energy $E = \frac{P^2}{2M} = \frac{(h\gamma)^2}{2Mc^2} = \frac{h^2\gamma^2}{2Mc^2}$

11. A radio active element forms its own isotope after 3-consecutive disintigrations. The particles emitted are

a) 3β – particles

b) 2β – particles and $1 - \alpha$ particle

c) 2β – particles, $1 - \gamma$ particle

d) 2α – particles, $1 - \beta$ particle ***Ans: b***

Sol: To form its own isotope atomic number remains same. So, emission of one α – particle and $2 - \beta$ particles maintain same Z.

$$X^A \xrightarrow{\alpha} y^{A-4} \xrightarrow{\beta} y^{A-4} \xrightarrow{\beta} y^{1\,A-Z}$$

Z   Z – 2   [Z – 2 + 1]   Z

12. A radio active nucleus (initial mass number A and atomic number Z) emits 3α – particles and 2 – positrons. The ratio of number of neutrons to that of protons in the final nucleus will be

a) $\frac{A-Z-8}{Z-4}$ b) $\frac{A-Z-4}{Z-8}$ c) $\frac{A-Z-12}{Z-4}$ d) $\frac{A-Z-4}{Z-2}$

Sol: ${}_ZX^A \xrightarrow{3\alpha} {}_{Z-6}Y^{A-12} \xrightarrow{2 + {}_1e^0} {}_{Z-8}Y'^{A-12}$

No. of protons = Z – 8

No. of neutrons = [A – 12] – [Z – 8]

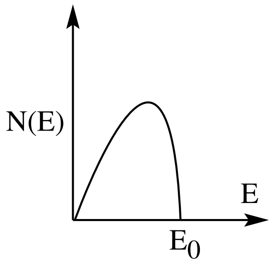
= [A – Z – 12 + 8]

= [A – Z – 4]

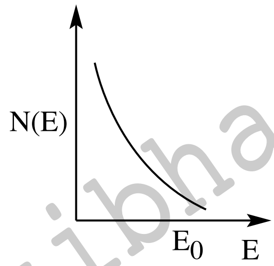
Ratio of $\frac{N_n}{N_p} = \frac{[A - Z - 4]}{[Z - 8]}$

13. The energy spectrum of β – particles [N(E) as a function of β – energy E] emitted from a radio active source is

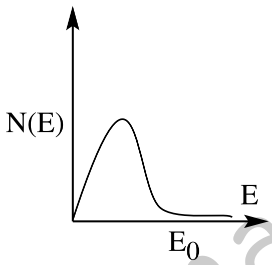
a)



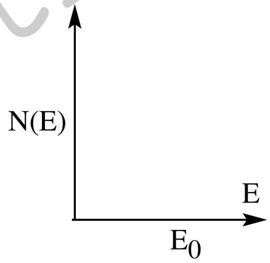
b)



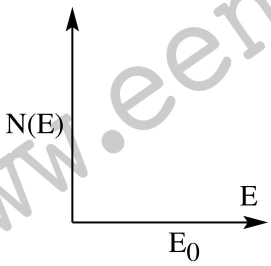
c)



d)



Sol: ***Ans: c***



Range of β – particle is from Zero to maximum value.

14. The half life of thorium X is 3.64 days. After how many days will 0.1 of mass of a sample of the substance remain undecayed?

a) 12.1 days b) 24 days c) 60 days d) 4 days

Sol: $\lambda = \frac{0.693}{T} = \frac{0.693}{3.64} = 0.1904$ per day

$N = N_0 e^{-\lambda t} \Rightarrow \frac{N}{N_0} = 0.1 = e^{-\lambda t}$

$ln(10^{-1}) = -\lambda t \, ln(e)$

$ln(10) = \lambda t \Rightarrow t = \frac{10 \times 2.303}{0.1904} = 12.1$ days

15. Energy released by fission of one uranium atom is 200 meV. The number of fission per Second required to produce 3.2 W of power is... (1eV = 1.6×10^{-19}c)

a) 10^7 b) 10^{10} c) 10^{15} d) 10^{11}

Sol: $P = \frac{nE}{t} \Rightarrow 3.2 = \frac{n}{t}(200) \Rightarrow \frac{n}{t}$

$= \frac{3.2}{200 \times 1.6 \times 10^{-19} \times 10^6}$

$(1meV = 1 \times 10^6 \times 1.6 \times 10^{-19} J) = 10^{11}$

16. If speed of light was $\frac{2}{3}$ of its present value, then the energy released in the atomic explosion would.....

a) decreases by a factor $\frac{2}{3}$

b) decreases by a factor $\frac{4}{9}$

c) decreases by a factor $\frac{5}{9}$

d) decreases by a factor $\frac{\sqrt{5}}{9}$

Sol: $\Delta E = mc^2 - mc^2\left(\frac{2}{3}\right)^2 = \frac{5}{9}\ mc^2$

$\therefore$ Energy decreases by a factor of $\frac{5}{9}$

17. In Beta minus decay a neutron transforms with the nucleus according to

a) $P \longrightarrow n + e^+ + \upsilon$

b) $n \longrightarrow P + e^+ + \bar{\upsilon}$

c) $n \longrightarrow P + e^+ + \bar{\upsilon}$

d) $n \longrightarrow P + e^- + \bar{\upsilon}$

Sol: β^- is like an electron. Emission of β^- involves transformation of a neutron into proton, an electron and anti neutrino.

$n \longrightarrow P + e^- + \bar{\upsilon}$

18. Following process is known as

$e^+ + e^- \longrightarrow 2\,h\upsilon$

a) Pair production

b) Compton effect

c) Pair anihilation

d) Zeeman effect

Ans: c

19. **Assertion (A):** Nuclear forces arise from strong interactions between protons and neutrons.

Reason (R): Nuclear forces are independent of charge of nucleon.

a) Both A & B are correct R is correct explanation of A

b) Both A & B are correct but R is not correct explanation of A

c) A is correct R is incorrect

d) Both A and R are incorrect.

Ans: a

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20. An electron and photon possess the same de-broglie wave length. If E_e and E_p are the energies of electron and photon respenctively. V and C are their respective velocities then $\frac{E_e}{E_p}$ is equal to

a) $\frac{V}{C}$

b) $\frac{V}{2c}$

c) $\frac{V}{3c}$

d) $\frac{V}{4c}$

Sol: $\lambda_e = \lambda_p$

$$\frac{h}{\sqrt{2mEe}} = \frac{h_c}{E_p} \Rightarrow 2mEe = \left[\frac{E_p}{c}\right]^2 \text{ ..... (1)}$$

$$E_e = \frac{1}{2}\,mv^2 \Rightarrow m = \frac{2E_e}{v^2} \text{ .... (2)}$$

Substistute (2) in (1)

$$2\left[\frac{2E_e}{V^2}\right]E_e = \frac{(Ep)^2}{c^2} \Rightarrow \frac{Ee^2}{Ep^2} = \frac{V^2}{4c^2} \Rightarrow \frac{V}{2c}$$

21. The material particle with a rest mass m_0 is moving with speed of light C. The de-Broglie wavelength associated is given by....

a) $\frac{h}{m_0c}$ b) $\frac{m_0c}{h}$ c) Zero d) Infinite

Sol: $\lambda = \frac{h}{mv}$, $m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$

given V = C $\Rightarrow$ m = ∞

$\lambda = \frac{h}{mv} = \frac{h}{\infty} = 0$

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