NUCLEAR AND PARTICLE PHYSICS

GATE-2010

Q1. The basic process underlying the neutron β-decay is

(a) $d \to u + e^- + \bar{\nu}_e$ (b) $d \to u + e^-$

(c) $s \to u + e^- + \bar{\nu}_e$ (d) $u \to d + e^- + \bar{\nu}_e$

Ans: (a)

Q2. In the nuclear shell model the spin parity of ${}^{15}_{7}N$ is given by

(a) $\frac{1^-}{2}$ (b) $\frac{1^+}{2}$ (c) $\frac{3^-}{2}$ (d) $\frac{3^+}{2}$

Ans: (a)

Solution: $Z = 7$; $(s_{1/2})^2\ (p_{3/2})^4\ (p_{1/2})^1$ and $N = 8$

$$l = 1,\ J = \frac{1}{2} \Rightarrow \text{parity} = (-1)^1 = -1, \quad \text{spin - parity} = \left(\frac{1}{2}\right)^-$$

Q3. Match the reactions on the left with the associated interactions on the right.

(1) $\pi^+ \to \mu^+ + \nu_\mu$ (i) Strong

(2) $\pi^0 \to \gamma + \gamma$ (ii) Electromagnetic

(3) $\pi^0 + n \to \pi^- + p$ (iii) Weak

(a) (1, iii), (2, ii), (3, i) (b) (1, i), (2, ii), (3, iii)

(c) (1, ii), (2, i), (3, iii) (d) (1, iii), (2, i), (3, ii)

Ans: (a)

Q4. The ground state wavefunction of deuteron is in a superposition of s and d states. Which of the following is NOT true as a consequence?

(a) It has a non-zero quadruple moment

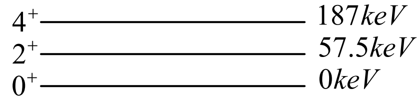
(b) The neutron-proton potential is non-central

(c) The orbital wavefunction is not spherically symmetric

(d) The Hamiltonian does not conserve the total angular momentum

Ans: (d)

Q5. The first three energy levels of $^{228}Th_{90}$ are shown below



The expected spin-parity and energy of the next level are given by

(a) (6^+; 400 keV) (b) (6^+; 300 keV) (c) (2^+; 400 keV) (d) (4^+; 300 keV)

Ans: (a)

Solution: $\frac{E_2}{E_1} = \frac{J_2(J_2+1)}{J_1(J_1+1)} \Rightarrow \frac{E_6}{E_4} = \frac{6(6+1)}{4(4+1)} \Rightarrow E_6 = 393keV$

GATE-2011

Q6. The semi-empirical mass formula for the binding energy of nucleus contains a surface correction term. This term depends on the mass number A of the nucleus as

(a) $A^{-1/3}$ (b) $A^{1/3}$ (c) $A^{2/3}$ (d) A

Ans: (c)

Q7. According to the single particles nuclear shell model, the spin-parity of the ground state of $^{17}_{8}O$ is

(a) $\frac{1}{2}^-$ (b) $\frac{3}{2}^-$ (c) $\frac{3}{2}^+$ (d) $\frac{5}{2}^+$

Ans: (d)

Solution: $Z = 8$ and $N = 9$; $(s_{1/2})^2\ (p_{3/2})^4\ (p_{1/2})^2\ (d_{5/2})^1$

$l = 2,\ J = \frac{5}{2} \Rightarrow \text{parity} = (-1)^2 = +1, \quad \text{spin - parity} = \left(\frac{5}{2}\right)^+$

Q8. In the β-decay of neutron $n \rightarrow p + e^- + \bar{\nu}_e$, the anti-neutrino $\bar{\nu}_e$, escapes detection. Its existence is inferred from the measurement of

(a) energy distribution of electrons (b) angular distribution of electrons

(c) helicity distribution of electrons (d) forward-backward asymmetry of electrons

Ans: (a)

Q9. The isospin and the strangeness of Ω^- baryon are

(a) 1, -3 (b) 0, -3 (c) 1, 3 (d) 0, 3

Ans: (b)

GATE-2012

Q10. Deuteron has only one bound state with spin parity 1^+, isospin 0 and electric quadrupole moment 0.286 efm^2. These data suggest that the nuclear forces are having

(a) only spin and isospin dependence

(b) no spin dependence and no tensor components

(c) spin dependence but no tensor components

(d) spin dependence along with tensor components

Ans: (d)

Q11. The quark content of Σ^+, K^-, π^- *and* p is indicated:

$$\left|\Sigma^+\right\rangle = |uus\rangle; \left|K^-\right\rangle = |s\bar{u}\rangle; \left|\pi^-\right\rangle = |\bar{u}d\rangle; |p\rangle = |uud\rangle.$$

In the process, $\pi^- + p \to K^- + \Sigma^+$, considering strong interactions only, which of the following statements is true?

(a) The process, is allowed because $\Delta S = 0$

(b) The process is allowed because $\Delta I_3 = 0$

(c) The process is not allowed because $\Delta S \neq 0$ and $\Delta I_3 \neq 0$

(d) The process is not allowed because the baryon number is violated

Ans: (c)

Solution: $\pi^- + p \to k^- + \sum^+$

$S: \quad 0 \quad 0 \quad -1 \quad -1$ (not conserved)

$I_3: \quad -1 \quad +\frac{1}{2} \quad -\frac{1}{2} \quad +1$ (not conserved)

For strong interaction S and I_3 must conserve. Therefore this process is not allowed under strong interaction

Q12. Which one of the following sets corresponds to fundamental particles?

(a) proton, electron and neutron

(b) proton, electron and photon

(c) electron, photon and neutrino

(d) quark, electron and meson

Ans: (a)

Q13. In case of a Geiger-Muller (GM) counter, which one of the following statement is CORRECT?

(a) Multiplication factor of the detector is of the order of 10^{10}

(b) Type of the particles detected can be identified

(c) Energy of the particles detected can be distinguished

(d) Operating voltage of the detector is few tens of Volts

Ans: (c)

Q14. Choose the CORRECT statement from the following

(a) Neutron interacts through electromagnetic interaction

(b) Electron does not interact through weak interaction

(c) Neutrino interacts through weak and electromagnetic interaction

(d) Quark interacts through strong interaction but not through weak interaction

Ans: (d)

GATE-2013

Q15. The decay process $n \rightarrow p^{+} + e^{-} + \bar{v}_e$ violates

(a) Baryon number (b) lepton number (c) isospin (d) strangeness

Ans: (c)

Q16. The isospin (I) and baryon number (B) of the up quark is

(a) $I = 1, B = 1$ (b) $I = 1, B = 1/3$

(c) $I = 1/2, B = 1$ (d) $I = 1/2, B = 1/3$

Ans: (d)

Q17. In the β decay process, the transition $2^{+} \rightarrow 3^{+}$, is

(a) allowed both by Fermi and Gamow-Teller selection rule

(b) allowed by Fermi and but not by Gamow-Teller selection rule

(c) not allowed by Fermi but allowed by Gamow-Teller selection rule

(d) not allowed both by Fermi and Gamow-Teller selection rule

Ans: (c)

Solution: According to Fermi Selection Rule:

$\Delta I = 0, \quad Parity = No\ Change$

According to Gammow-Teller Selection Rule:

$\Delta I = 0, \pm 1, \quad Parity = No\ Change$

In the β decay process, the transition $2^+ \to 3^+$,

$\Delta I = \pm 1, \quad Parity = No\ Change$.

GATE-2014

Q18. Which one of the following is a fermions'?

(a) α -particle (b) ${}_4Be^7$ nucleus

(c) Hydrogen atom (d) deuteron

Ans: (b)

Solution: If a nucleus contains odd number of nucleons, it is fermions. If a nucleus contains even number of nucleons, it is a boson.

Q19. Which one of the following three-quark states (qqq) denoted by X CANNOT be a possible baryon? The corresponding electric charge is indicated in the superscript.

(a) X^{++} (b) X^{+} (c) X^{-} (d) X^{--}

Ans: (d)

Solution: $X = qqq$

$X^{++}(uuu)\frac{2}{3}+\frac{2}{3}+\frac{2}{3}=\frac{6}{3}=2$ (two unit positive charge)

$X^{+}(uud)\frac{2}{3}+\frac{2}{3}-\frac{1}{3}=\frac{4}{3}-\frac{1}{3}=1$ (single unit positive charge)

$X^{-}(ddd)=-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}=-1$ (single unit negative charge)

X^{--} [Not possible with qqq]. So the correct option is (d)

Q20. Consider the process $\mu^+ + \mu \to \pi^+ + \pi^-$. The minimum kinetic energy of the muons (μ) in the centre of mass frame required to produce the pion (π) pairs at rest is ______ MeV.

Ans: 81.7

Solution: Use conservation of energy and momentum in relativistic form.

$$m_\mu = 105\ MeV/c^2 \quad and \quad m_\pi = 140\ MeV/c^2$$

$$E_\mu = \frac{\left(m_{\pi^+} + m_{\pi^-}\right)^2 c^2 - \left(m_{\mu^+} + m_\mu\right)^2 c^2}{2m_\mu} \Rightarrow E_\mu = \frac{(280)^2\ MeV - (210)^2\ MeV}{2\times 105} = 163.3\ MeV$$

For pair it will be $\frac{163.3}{2}\ MeV = 81.7\ MeV$

Q21. A nucleus X undergoes a first forbidden β-decay to nucleus Y. If the angular momentum (I) and parity (P), denoted by I^P as $\frac{7^-}{2}$ for X, which of the following is a possible I^P value for Y?

(a) $\frac{1^+}{2}$ (b) $\frac{1^-}{2}$ (c) $\frac{3^+}{2}$ (d) $\frac{3^-}{2}$

Ans: (c)

Solution: For first forbidden β-decay; $\Delta I = 0, 1$ or 2 and Parity does change.

GATE-2015

Q22. The decay $\mu^+ \to e^+ + \gamma$ is forbidden, because it violates

(a) momentum and lepton number conservations

(b) baryon and lepton number conservations

(c) angular momentum conservation

(d) lepton number conservation

Ans.: (d)

Solution: $\mu^+ \to e^+ + \gamma$. In this decay lepton number is not conserved.

Q23. A beam of X - ray of intensity I_0 is incident normally on a metal sheet of thickness $2\ mm$. The intensity of the transmitted beam is $0.025\ I_0$. The linear absorption coefficient of the metal sheet $\left(in\ m^{-1}\right)$ is _______________ (upto one decimal place)

Ans.: 1844.4

Solution: $I = I_0 e^{-\mu x} \Rightarrow \mu = \frac{1}{x}\ln\left(\frac{I_0}{I}\right) = \frac{1}{2\times 10^{-3}}\ln\left(\frac{I_0}{0.025 I_0}\right) = \frac{1}{2\times 10^{-3}}\ln(40)$

$$\Rightarrow \mu = \frac{2.303}{2\times 10^{-3}}\left[\log_{10} 40\right] = 1.151\times 10^3\left[2\times 0.3010 + 1\right] = 1844.4\ m^{-1}$$

Q24. The mean kinetic energy of a nucleon in a nucleus of atomic weight A varies as A^n, where n is____________(upto two decimal places)

Ans.: -0.67

Solution: $$\langle T\rangle = \frac{\int_0^R -\frac{\hbar^2}{2m}\left(\frac{d^2}{dr^2}+\frac{1}{r}\frac{d}{dr}\right)4\pi r^2 dr}{\int_0^R 4\pi r^2 dr} = \frac{-\frac{\hbar^2}{2m}4\pi\int_0^R (2+2)\,dr}{\int_0^R 4\pi r^2 dr} = \frac{-\frac{\hbar^2}{2m}4\pi\times 4R}{4\pi R^3/3}$$

$$\Rightarrow \langle T\rangle \propto \frac{1}{R^2} = \frac{1}{\left(R_0 A^{\frac{1}{3}}\right)^2} = \frac{1}{A^{\frac{2}{3}}} = A^{-\frac{2}{3}} \Rightarrow n = -\frac{2}{3} = -0.667 = -0.67$$

Q25. The atomic masses of ${}^{152}_{63}Eu$, ${}^{152}_{62}Sm$, ${}^{1}_{1}H$ and neutron are 151.921749, 151.919756, 1.007825 and 1.008665 in atomic mass units (amu), respectively. Using the above information, the Q- value of the reaction ${}^{152}_{63}Eu + n \rightarrow {}^{152}_{62}Sm + p$ is ____________ $\times 10^{-3}$ amu (upto three decimal places)

Ans.: 2.833

Solution: $Q = 152.930414 - (152.927581) = 2.833\times 10^{-3}\,a.m.u.$

Q26. In the nuclear shell model, the potential is modeled as $V(r) = \frac{1}{2}m\omega^2 r^2 - \lambda\vec{L}\cdot\vec{S},\ \lambda > 0$. The correct spin-parity and isospin assignments for the ground state of ${}^{13}_{6}C$ is

(a) $\frac{1^-}{2};\ \frac{-1}{2}$ (b) $\frac{1^+}{2};\ \frac{-1}{2}$ (c) $\frac{3^+}{2};\ \frac{1}{2}$ (d) $\frac{3^-}{2};\ \frac{-1}{2}$

Ans.: (a)

Solution: ${}^{13}C_6$, $N = 7, Z = 6$, for $N = 7$; $\left(1S_{\frac{1}{2}}\right)^2\left(1P_{\frac{3}{2}}\right)^4\left(P_{\frac{1}{2}}\right)^1 \Rightarrow j = \frac{1}{2}$ and $l = 1$

Thus spin- parity is $\left(\frac{1}{2}\right)^-$.

GATE-2016

Q27. In the $SU(3)$ quark model, the triplet of mesons (π^+, π^0, π^-) has

(a) Isospin $= 0$, Strangeness $= 0$ (b) Isospin $= 1$, Strangeness $= 0$

(c) Isospin $= \frac{1}{2}$, Strangeness $= +1$ (d) Isospin $= \frac{1}{2}$, Strangeness $= -1$

Ans.: (b)

Solution: π^+, π^0, π^- are not strange particle thus strangness $= 0$

Since meson group contain 3 particles, thus $I = 1$

Q28. Consider the reaction ${}^{54}_{25}Mn + e^- \rightarrow {}^{54}_{24}Cr + X$. The particle X is

(a) γ (b) ν_e (c) n (d) π^0

Ans.: (b)

Q29. Which of the following statements is NOT correct?

(a) A deuteron can be disintegrated by irradiating it with gamma rays of energy $4\ MeV$.

(b) A deuteron has no excited states.

(c) A deuteron has no electric quadrupole moment.

(d) The ${}^1S_0$ state of deuteron cannot be formed.

Ans.: (c)

Q30. According to the nuclear shell model, the respective ground state spin-parity values of ${}^{15}_{8}O$ and ${}^{17}_{8}O$ nuclei are

(a) $\frac{1}{2}^+, \frac{1}{2}^-$ (b) $\frac{1}{2}^-, \frac{5}{2}^+$ (c) $\frac{3}{2}^-, \frac{5}{2}^+$ (d) $\frac{3}{2}^-, \frac{1}{2}^-$

Ans.: (b)

Solution: ${}^{15}_{8}O$; $Z = 8$ and $N = 7$; $N = 7 : (s_{1/2})^2 (p_{3/2})^4 (p_{1/2})^1$

$\Rightarrow j = \frac{1}{2}$ and $l = 1$. Thus spin and parity $= \left(\frac{1}{2}\right)^-$

${}^{17}_{8}O$; $Z = 8$ and $N = 9$; $N = 9 : (s_{1/2})^2 (p_{3/2})^4 (p_{1/2})^2 (d_{5/2})^1$

$\Rightarrow j = \frac{5}{2}$ and $l = 2$. Thus spin and parity $= \left(\frac{5}{2}\right)^+$

GATE-2017

Q31. Which one of the following conservation laws is violated in the decay $\tau^+ \to \mu^+ \mu^+ \mu^-$

(a) Angular momentum (b) Total Lepton number

(c) Electric charge (d) Tau number

Ans. : (d)

Solution: $\tau^+ \to \mu^+ + \mu^+ + \mu^-$

$q = +1$ $\quad +1 \quad +1 \quad -1$ conserved

$L = +1$ $\quad +1 \quad +1 \quad -1$ conserved

$L_\tau = +1$ $\quad 0 \quad 0 \quad 0$ Not conserved

spin $= 1/2$ $\quad \frac{1}{2} \quad \frac{1}{2} \quad \frac{1}{2}$ conserved

Tau number is not conserved

Q32. Electromagnetic interactions are:

(a) C conserving

(b) C non-conserving but CP conserving

(c) CP non-conserving but CPT conserving

(d) CPT non-conserving

Ans. : (a)

Solution: In electromagnetic interaction C is conserved

CPT: Conserved in all interaction

CP: Conserved in EM and Strong interactions

$$E_n = \frac{-13.6}{n^2}(eV)$$

For $n = 1$, $E_1 = -13.6\ eV$ Ground state

For $n = \infty$, $E_\infty = 0$ Highest state

Thus, correct option is (a)

Q33. In the nuclear reaction ${}^{13}C_6 + \nu_e \to {}^{13}N_7 + X$, the particle X is

(a) an electron (b) an anti-electron

(c) a muon (d) a pion

Ans. : (a)

Solution: ${}^{13}C_6 + \nu_e \to {}^{13}N_7 + X \Rightarrow {}^{13}C_6 \to {}^{13}N_7 + X + \bar{\nu}_e$

$L_e = 0 \qquad 0 \;\; +1 \;\; -1$

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

Q34. J^P for the ground state of the ${}^{13}C_6$ nucleus is

(a) 1^+ (b) $\frac{3^-}{2}$ (c) $\frac{3^+}{2}$ (d) $\frac{1^-}{2}$

Ans. : (d)

Solution: ${}^{13}C_6$: $Z = 6,\ N = 7,\ N = 7:\ (s_{1/2})^2 (p_{3/2})^4 (p_{1/2})^1$

$\Rightarrow j = \frac{1}{2}$ and $l = 1$. Thus spin and parity $= \left(\frac{1}{2}\right)^-$

Q35. The π^+ decays at rest to μ^+ and ν_μ. Assuming the neutrino to be massless, the momentum of the neutrino is…………….. MeV/c. (up to two decimal places)

$(m_\pi = 139\, MeV/c^2, m_\mu = 105\, MeV/c^2)$

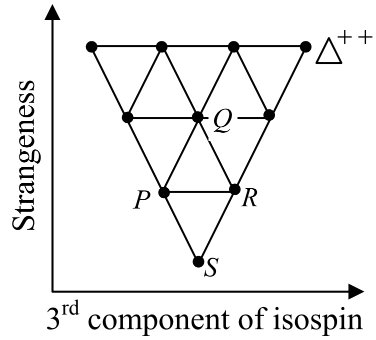
Ans. : 29.84

Solution: $E_\nu = \frac{\left(m_\pi^2 - m_\mu^2\right)c^2}{2m_\pi} = p \times c$

So $p = \frac{\left(m_\pi^2 - m_\mu^2\right)c}{2m_\pi} = \frac{19321 - 11025}{2 \times 139\, c} = \frac{29.84}{c}(MeV)$

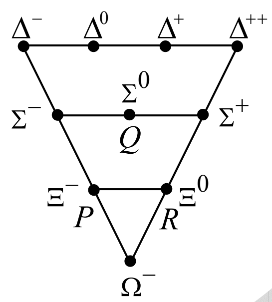
GATE-2018

Q36. The elementary particle Ξ^0 is placed in the baryon decuplet, shown below, at



(a) P (b) Q (c) R (d) S

Ans. : (c)



Q37. In the decay, $\mu^+ \to e^+ + \nu_e + X$, what is X?

(a) γ (b) $\bar{\nu}_e$ (c) ν_μ (d) $\bar{\nu}_\mu$

Ans. : (d)

Solution:- $u^+ \to e^+ + \nu_e + \bar{\nu}_u$

$L_u: \ -1 \quad 0 \quad 0 \quad -1$

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

Q38. For nucleus ^{164}Er, a $J^\pi = 2^+$ state is at 90 keV. Assuming ^{164}Er to be a rigid rotor, the energy of its 4^+ state is __________ keV (up to one decimal place)

Ans. : 300

Solution: $E_J = hcBJ(J+1)$ ________ 4^+

$E_{2^+} = hc\ B\ 2(2+1)$ and $E_{4^+} = hc\ B\ 4(4+1)$ ________ 2^+

Then, $\frac{E_{4^+}}{E_{2^+}} = \frac{20}{6} \Rightarrow E_{4^+} = \frac{20}{6} \times 90\ keV = 300\ keV$

Q39. Inside a large nucleus, a nucleon with mass $939\,MeVc^{-2}$ has Fermi momentum 1.40 fm^{-1} at absolute zero temperature. Its velocity is Xc, where the value of X is__________ (up to two decimal places).

($\hbar c = 197\,MeV$-fm)

Ans. : 0.29

Solution: Here, fermi – momentum or fermi radius, $k_F = 1.40\,fm^{-1}$ and $\hbar c = 197$ Mev – fm

Now, Fermi velocity –

$$V_F = \frac{P}{m} = \frac{\hbar k_F}{m} = \frac{(\hbar c)k_F \cdot c}{mc_2} = \frac{(197)\times 1\cdot 40\times c}{939} = \frac{275\cdot 8c}{939} = 0.29c$$

Q40. An α particle is emitted by a $^{230}_{90}Th$ nucleus. Assuming the potential to be purely Coulombic beyond the point of separation, the height of the Coulomb barrier is________ MeV (up to two decimal places).

($\frac{e^2}{4\pi \in_0} = 1.44\,MeV$-fm, $r_0 = 1.30$ fm)

Ans. : 25.995

Solution: The height of coulomb barrier for α particle from

$${}_{90}Th^{230} \rightarrow {}_{88}X^{226} + 2He^4 \quad (\alpha\text{ - particle})$$

$$V_C = \frac{1}{4\pi \in_0}\left(\frac{2ze^2}{R}\right)$$

Here, $R_0 = 1.3\ fm,\ \frac{e^2}{4\pi \in_0} = 1.44\ MeV\ fm$

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

Here, we consider pure Coulombic interection

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

$$R = R_0 A_{Th}^{1/3} = 1.3(7.67)$$

Hence, $V_C = \left(\frac{e^2}{4\pi \in_0}\right)\frac{2\times 90}{1.3(7.67)} = \frac{180\times 1.44}{1.3\times 7.67}\frac{MeV}{fm}$

$$V_C = 25.995\ MeV$$

GATE-2019

Q41. Considering baryon number and lepton number conservation laws, which of the following process is/are allowed?

(i) $p \to \pi^0 + e^+ + \nu_e$

(ii) $e^+ + \nu_e \to \mu^+ + \nu_\mu$

(a) both (i) and (ii) (b) only (i) (c) only (ii) (d) neither (i) nor (ii)

Ans. : (c)

Solution: (i) $P \to \pi^0 + e^+ + \nu_e$

$B: +1 \quad 0 \quad 0 \quad 0$: Not conserved

Therefore, this is not an allowed process

(ii) $e^+ \quad +\nu_e \quad \to \quad \mu^+ \; + \; \nu_\mu$

$q:$ +1 0 +1 0 : conserved

$spin:$ 1/2 1/2 1/2 1/2: conserved

$L_e:$ −1 +1 0 0: conserved

$L_\mu:$ 0 0 −1 +1: conserved

Since neutrino is involve, therefore parity is violated. This is allowed through weak interaction

Q42. A massive particle X in free space decays spontaneously into two photons. Which of the following statements is true for X?

(a) X is charged

(b) Spin of X must be greater than or equal to 2

(c) X is a boson

(d) X must be a baryon

Ans. : (c)

Solution: $X \to r + r$

$q:$ 0 0 0

$spin:$ 0,1,2 1 1

Thus spin of X can be either 0,1 or 2. (integer)

Therefore, option (b) is wrong while option (c) is correct.

Q43. The nuclear spin and parity of ${}^{40}_{20}Ca$ in its ground state is

(a) 0^+ (b) 0^- (c) 1^+ (d) 1^-

Ans.: (a)

Solution: ${}^{40}_{20}Ca$ is an even-even nuclei, therefore $I = 0, P = +ve$

$\therefore$ Spin-parity $= 0^+$

Q44. Low energy collision (s - wave scattering) of pion (π^+) with deuteron (d) results in the production of two proton ($\pi^+ + d \to p + p$). The relative orbital angular momentum (in units of $\hbar$) of the resulting two-proton system for this reaction is

(a) 0 (b) 1 (c) 2 (d) 3

Ans.: (b)

Solution: $\pi^+ + d \quad \to \quad p + p$

Parity: $(-1)\times(+1) \qquad (-1)^l \ \pi_p \pi_p$

$\therefore \ (-1)^l \pi_p \pi_p = -1$

Since $\pi_p = +1 \qquad \therefore \ (-1)^l = -1$

Thus, $l = 1$.

Q45. A radioactive element X has a half-life of 30 hours. It decays via alpha, beta and gamma emissions with the branching ratio for beta decay being 0.75. The partial half-life for beta decay in unit of hours is ____________

Ans.: 40

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

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