# PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

# Particle physics - CSIR NET Physics PYQs

Nuclear and Particle Physics . All PYQs (2015-2025) with answer key

**19 questions . Answer key included**

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**Q1. [Dec 2015] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2015 Dec | 5 M |
|---|---|---|

Consider the following processes involving free particles

(i) $\bar{n} \rightarrow \bar{p} + e^{+} + \bar{\nu}_e$

(ii) $\bar{p} + n \rightarrow \pi^{-}$

(iii) $p + n \rightarrow \pi^{+} + \pi^{0} + \pi^{0}$

(iv) $p + \bar{\nu}_e \rightarrow n + e^{+}$

Which of the following statements is true?

1. Process (i) obeys all conservation laws
2. Process (ii) conserves baryon number, but violates energy-momentum conservation
3. process (iii) is not allowed by strong interaction but is allowed by weak interactions
4. Process (iv) conserves baryon number, but violates lepton number conservation

**Q2. [June 2015] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2015 June | 5 M |
|---|---|---|

The charm quark is assigned a charm quantum number $C = 1$. How should the Gellmann-Nishijima formula for electric charge be modified for four flavours of quarks?

1. $I_3 + \frac{1}{2}(B - S - C)$
2. $I_3 + \frac{1}{2}(B - S + C)$
3. $I_3 + \frac{1}{2}(B + S - C)$
4. $I_3 + \frac{1}{2}(B + S + C)$

**Q3. [June 2015] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2015 June | 5 M |
|---|---|---|

The reaction ${}^{2}_{1}\mathrm{D} + {}^{2}_{1}\mathrm{D} \rightarrow {}^{4}_{2}\mathrm{He} + \pi^0$ cannot proceed via strong interactions because it violates the conservation of

1. angular momentum
2. electric charge
3. baryon number
4. isospin

**Q4. [Dec 2016] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2016 Dec | 5M |
|---|---|---|

Which of the following reaction(s) is/are allowed by the conservation laws?

(i) $\pi^+ + n \rightarrow \Lambda^0 + K^+$

(ii) $\pi^- + p \rightarrow \Lambda^0 + K^0$

1. both (i) and (ii)
2. only (i)
3. only (ii)
4. neither (i) nor (ii)

**Q5. [Dec 2016] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2016 Dec | 5M |
|---|---|---|

A particle, which is a composite state of three quarks $u, d$ and $s$, has electric charge, spin and strangeness respectively, equal to

1. $1, \frac{1}{2}, -1$
2. $0, 0, -1$
3. $0, \frac{1}{2}, -1$
4. $-1, -\frac{1}{2}, +1$

**Q6. [Dec 2017] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2017 Dec | 5M |
|---|---|---|

Which of the following process is not allowed by the strong interaction but is allowed by the weak interaction?

1. $K^0 + \pi^0 \rightarrow \bar{K}^0 + \pi^+ + \pi^-$
2. $p + n \rightarrow d + p + \bar{p}$
3. $\Delta^+ + K^0 \rightarrow p + n$
4. $p + \Delta^+ \rightarrow \bar{n} + \Delta^{++}$

**Q7. [June 2017] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2017 June | 5M |
|---|---|---|

A baryon $X$ decays by strong interaction as $X \rightarrow \Sigma^{+} + \pi^{-} + \pi^{0}$, where $\Sigma^{+}$ is a member of the isotriplet $(\Sigma^{+}, \Sigma^{0}, \Sigma^{-})$. The third component $I_3$ of the isospin of $X$ is

1. 0
2. ½
3. 1
4. $^{3}/_{2}$

**Q8. [June 2018] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2018 June | 5M |
|---|---|---|

Which of the following elementary particle processes does not conserve strangeness?

1. $\pi^{0} + p \rightarrow k^{+} + \Lambda^{0}$
2. $\pi^{-} + p \rightarrow k^{0} + \Lambda^{0}$
3. $\Delta^{0} \rightarrow \pi^{0} + n$
4. $\mathrm{K}^{0} \rightarrow \pi^{+} + \pi^{-}$

**Q9. [June 2018] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2018 June | 5M |
|---|---|---|

A deuteron $d$ captures a charged pion $\pi^-$ in the $l = 1$ state, and subsequently decays into a pair of neutrons ( $n$ ) via strong interaction. Given that the intrinsic parities of $\pi^-, d$ and $n$ are $-1, +1$ and +1 respectively, the spin wavefunction of the final state neutrons is.

1. linear combination of a singlet and a triplet
2. Singlet
3. Triplet
4. doublet

**Q10. [Dec 2019] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2019 Dec | 5M |
|---|---|---|

Which of the following decay processes is allowed?

1. $\mathrm{K}^0 \rightarrow \mu^+ + \mu^-$
2. $\mu^- \rightarrow e^- + \gamma$
3. $n \rightarrow p + \pi^-$
4. $n \rightarrow \pi^+ + \pi^-$

**Q11. [June 2019] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2019 June | 5M |
|---|---|---|

The mean life-time of the following decays: $\rho_0 \to \pi^+ + \pi^-, \pi^0 \to \gamma + \gamma, \mu^- \to e^- + \bar{\nu}_e + \nu_\mu$, are $\tau_\rho, \tau_\pi$ and $\tau_\mu$ respectively.

They satisfy

1. $\tau_\pi < \tau_\rho < \tau_\mu$
2. $\tau_\mu < \tau_\rho < \tau_\pi$
3. $\tau_\rho < \tau_\pi < \tau_\mu$
4. $\tau_\rho < \tau_\mu < \tau_\pi$

**Q12. [June 2020] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2020 June | 5M |
|---|---|---|

Charged pions $\pi^-$ decay to muons $\mu^-$ and anti-muon neutrinos $\vec{\nu}_\mu$; $\pi^- \to \mu^- + \vec{\nu}_\mu$. Take the rest masses of a muon and a pion to be 105 MeV and 140 MeV, respectively. The probability that the measurement of the muon spin along the direction of its momentum is positive, is closest to

1. 0.5
2. 0.75
3. 1
4. 0

**Q13. [June 2021] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2021 June | 5M |
|---|---|---|

In the reaction $p + n \rightarrow p + K^{+} + X$ mediated by strong interaction, the baryon number $B$, strangeness $S$ and the third component of isospin $I_3$ of the particle $X$ are, respectively

1. $-1, -1$ and $-1$
2. $+1, -1$ and $-1$
3. $+1, -2$ and $-\frac{1}{2}$
4. $-1, -1$ and $0$

**Q14. [Dec 2023] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2023 Dec | 5 M |
|---|---|---|

Atmospheric neutrinos are produced from the cascading decays of cosmic pions ( $\pi^{\pm}$) to stable particles. Ignoring all other neutrino sources, the ratio of muon neutrino $(\nu_\mu + \bar{\nu}_\mu)$ flux to electron neutrino $(\nu_e + \bar{\nu}_e)$ flux in atmosphere is expected to be closest to

1. 2:3
2. 1:1
3. 1:2
4. 2:1

**Q15. [Dec 2024] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2024 Dec | 5M |
|---|---|---|

For the decay of the Δ-baryons, the ratio of the decay rates $\frac{\Gamma(\Delta^- \to n\pi^-)}{\Gamma(\Delta^0 \to p\pi^-)}$ is best approximated by

1. $\frac{3}{2}$
2. 3
3. 1
4. $\frac{2}{3}$

**Q16. [June 2024] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2024 June | 5M |
|---|---|---|

The $\Delta^{++}$can be produced by colliding a pion beam onto a $H_2$ target, in a reaction $\pi^+ + p \rightarrow \Delta^{++} \rightarrow \pi^+ + p$. In the rest frame of $\Delta^{++}$, the energy and momentum of the pion in the final state (in MeV) are closest to (assume $c = 1$, and $m_\pi \approx 140\text{MeV}, m_p \approx 1\text{GeV}, m_{\Delta^{++}} \approx 1.2\text{GeV}$)

1. 210,156
2. 230,182
3. 175,105
4. 190, 130

**Q17. [Dec 2025] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2025 Dec | 5M | NPP |
|---|---|---|---|

Consider the cross-sections

$$\sigma_1 = \sigma(p + n \to \Delta^+ + n) \text{ and } \sigma_2 = \sigma\left(p + n \to \Delta^0 + p\right)$$

where the ( $\Delta^+, \Delta^0$ ) are part of the baryon decuplet. Then

1. one of the $\sigma_{1,2}$ vanishes identically.
2. $\sigma_1 \gg \sigma_2$, with both being non-zero.
3. $\sigma_1 \ll \sigma_2$, with both being non-zero.
4. $\sigma_1 \approx \sigma_2$.

**Q18. [June 2025] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2025 June | 5M | NPP |
|---|---|---|---|

When a neutron of 1 keV kinetic energy impinges on a $^{12}C$ target, the total scattering cross section is 1000 barns. The approximate value of the phase shift $\delta_0$ is

1. $18^\circ$
2. $108^\circ$
3. $90^\circ$
4. $36^\circ$

**Q19. [June 2025] . 5.0 marks**

Nuclear and Particle Physics > Particle physics

| CSIR NET | 2025 June | 5M | NPP |
|---|---|---|---|

The $\rho$-mesons are $J^P = 1^-$ particles that decay strongly into pions. The ratio of the particle decay widths $\frac{\Gamma(\rho^0 \to \pi^0 \pi^0)}{\Gamma(\rho^+ \to \pi^+ \pi^0)}$ is closest to

1. 1
2. $\frac{1}{2}$
3. 0
4. 2

# Answer Key

19 questions . Subject and topic for quick revision

| Q. No | Subject | Topic | Answer |
|---|---|---|---|
| Q1 | Nuclear and Particle Physics | Particle physics | **2** |
| Q2 | Nuclear and Particle Physics | Particle physics | **4** |
| Q3 | Nuclear and Particle Physics | Particle physics | **4** |
| Q4 | Nuclear and Particle Physics | Particle physics | **1** |
| Q5 | Nuclear and Particle Physics | Particle physics | **3** |
| Q6 | Nuclear and Particle Physics | Particle physics | **1** |
| Q7 | Nuclear and Particle Physics | Particle physics | **1** |
| Q8 | Nuclear and Particle Physics | Particle physics | **4** |
| Q9 | Nuclear and Particle Physics | Particle physics | **2** |
| Q10 | Nuclear and Particle Physics | Particle physics | **1** |
| Q11 | Nuclear and Particle Physics | Particle physics | **3** |
| Q12 | Nuclear and Particle Physics | Particle physics | **3** |
| Q13 | Nuclear and Particle Physics | Particle physics | **2** |
| Q14 | Nuclear and Particle Physics | Particle physics | **4** |
| Q15 | Nuclear and Particle Physics | Particle physics | **2** |
| Q16 | Nuclear and Particle Physics | Particle physics | **4** |
| Q17 | Nuclear and Particle Physics | Particle physics | **4** |
| Q18 | Nuclear and Particle Physics | Particle physics | **4** |
| Q19 | Nuclear and Particle Physics | Particle physics | **3** |

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