PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Nuclear forces and Scattering - CSIR NET Physics PYQs

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

8 questions . Answer key included

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Q1. [June 2017] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2017 June	5M

The range of the nuclear force between two nucleons due to the exchange of pions is 1.40 fm . If the mass of pion is $140\mathrm{MeV}/c^2$ and the mass of the rho-meson is $770\mathrm{MeV}/c^2$, then the range of the force due to exchange of rho-mesons is

1. 1.40 fm
2. 7.70 fm
3. 0.25 fm
4. 0.18 fm

Q2. [Dec 2018] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2018 Dec	5M

Assume that pion-nucleon scattering at low energies, in which isospin is conserved is described by the effective interaction potential $V_{\text{eff}} = F(r)\vec{I}_\pi.\vec{I}_N$, where $F(r)$ is a function of the radial separation r and $\vec{I}_\pi$ and $\vec{I}_N$ denote, respectively, the isospin vectors of a pion and the nucleon. The ratio $\frac{\sigma_{I=3/2}}{\sigma_{I=1/2}}$ of the scattering cross-sections corresponding to total isospins $I = \frac{3}{2}$ and $\frac{1}{2}$ is

1. $\frac{3}{2}$
2. $\frac{1}{4}$
3. $\frac{5}{4}$
4. $\frac{1}{2}$

Q3. [Dec 2019] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2019 Dec	5M

The strong nuclear force between a neutron and a proton in a zero orbital angular momentum state is denoted by $F_{np}(r)$, where r is the separation between them. Similarly, $F_{nn}(r)$ and $F_{pp}(r)$ denote the forces between a pair of neutrons and protons, respectively, in zero orbital momentum state. Which of the following is true on average if the inter-nucleon distance is $0.2fm < r < 2fm$?

1. F_{np} is attractive for triplet spin state, and F_{nn}, F_{pp} are always repulsive
2. F_{nn} and F_{np} are always attractive and F_{pp} is repulsive in the triplet spin state
3. F_{pp} and F_{np} are always attractive and F_{nn} is always repulsive
4. All three forces are always attractive

Q4. [June 2019] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2019 June	5M

The elastic scattering of a neutrino v_e by an electron e^-, i.e. the reaction $v_e + e^- \rightarrow v_e + e^-$ can be described by the interaction Hamiltonian

$$H_{\text{int}} = \frac{1}{\sqrt{2}} G_F \int d^3x (\bar{\psi}_e(x)\gamma^\mu \psi_{ve}(x))(\bar{\psi}_{ve}(x)\gamma_\mu \psi_e(x))$$

The cross-section of the above process depends on the centre of mass energy E, as

1. $\frac{1}{E^2}$
2. E^2
3. E
4. $\sqrt{E}$

Q5. [June 2022] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2022 June	5M

The tensor component of the nuclear force may be inferred from the fact that deuteron nucleus ${}^2_1H$

1. has only one bound state with total spin $S = 1$
2. has a non-zero electric quadrupole moment in its ground state
3. is stable while triton ${}^3_1\text{H}$ is unstable
4. is the only two nucleon bound state

Q6. [June 2022] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2022 June	5M

The elastic scattering process $\pi^- p \rightarrow \pi^- p$ may be treated as a hard-sphere scattering. The mass of π^-, $m_\pi \cong \frac{1}{6} m_p$, where $m_p \cong 938\mathrm{MeV}/c^2$ is the mass of the proton. The total scattering cross-section is closet to

1. 0.01 milli-barn
2. 1 milli-barn
3. 0.1 barn
4. 10 barn

Q7. [June 2023] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2023 June	5M

A neutral particle X^0 is produced in $\pi^- + \mathrm{p} \rightarrow \mathrm{X}^0 + \mathrm{n}$ by s-wave scattering. The branching ratios of the decay of X^0 to $2\gamma, 3\pi$ and 2π are 0.38,0.30 and less than 10^{-3}, respectively. The quantum numbers J^{CP} of X^0 are

1. 0^{-+}
2. 0^{+-}
3. 1^{-+}
4. 1^{+-}

Q8. [June 2024] . 5.0 marks

Nuclear and Particle Physics > Nuclear forces and Scattering

CSIR NET	2024 June	5M

In a scattering experiment, a beam of e^- with an energy of 420 MeV scatters off an atomic nucleus. If this first minimum of the differential cross section is observed at a scattering angle of $45°$, the radius of the nucleus (in fermi) is closest to

1. 0.4
2. 8.0
3. 2.5
4. 0.8

Answer Key

8 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Nuclear and Particle Physics	Nuclear forces and Scattering	**3**
Q2	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q3	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q4	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q5	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q6	Nuclear and Particle Physics	Nuclear forces and Scattering	**3**
Q7	Nuclear and Particle Physics	Nuclear forces and Scattering	**2**
Q8	Nuclear and Particle Physics	Nuclear forces and Scattering	**3**

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