Seat No. : _____

N12-120

November-2014

M.Sc., Physics Sem.-III

PHY-501 : Nuclear Physics-I, Advance Quantum Mechanics-I and Instrumentation

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) Attempt **all** questions
(2) Symbols used have their usual meanings

1. (a) Derive an expression for the magnetic dipole moment μ_z of the nucleus. Prove that magnetic dipole moment μ_z of a nucleus in a definite parity is non-zero. **7**

OR

Derive an expression for the electric quadrupole moment of a nucleus. Show that the nucleus can have non-zero electric quadrupole moment only if its spin $I \geq 1$.

(b) Discuss : Molecular excitations of I from molecular band spectra. **7**

OR

Describe the molecular beam resonance method for determine the magnetic moment of nuclei and also discuss the experiment of H_2.

2. (a) Discuss meson theory of nuclear force. **7**

OR

State assumptions of the ground state of deuteron and derive an expression $V_0 r_0^2 = \frac{\pi^2 \hbar^2}{4M}$

(b) In case of effective range theory in n-p scattering, derive an expression for the differential scattering cross-section $\sigma = \frac{3\pi}{k^2 + [\frac{1}{a_t} - \frac{k^2 r_t}{2}]^2} + \frac{\pi}{k^2 + [\frac{1}{a_s} - \frac{k^2 r_s}{2}]^2}$

OR

Why *p-p* scattering has higher accuracy than *n-p* scattering ? Discuss *p-p* scattering at low energy in detail. **7**

3. (a) Discuss how phase shift can be related to potential. Solving radial schrodinger equation for free particle and particle moving under the influence of $V(r) = -\frac{Ze^2}{r}$. Obtain following relation

$Sin\delta_l = -k\int_0^\infty U(r).r^2\,[j_l(kr)]^2 dr$ and also calculate scattering amplitude. **7**

OR

Discuss Eikonal approximation to calculate scattering amplitude. Derive an expression for scattering amplitude. What is the difference between Eikonal and Born approximation.

(b) Starting with scattering amplitude in terms of phase shift, derive an expression for total scattering cross-section σ(Optical Theorem) $\sigma = \frac{4\pi}{k} I_m f(0)$. **7**

OR

Discuss in detailed, how green function method can be used to find scattering amplitude. Derive $f(\theta,\phi) = -\frac{m}{2\pi\hbar^2}\int e^{-i\vec{k}.\vec{r}}\, V(\vec{r})U(\vec{r})d\tau$

4. (a) What is transducer ? Give the concept of different temperature transducers. Explain resistance temperature detector transducer. **7**

OR

Enlist desired characteristics of transducer. Explain (1) Magnetic search coil and (2) Optical transducer.

(b) Define noise power for an equipment. Prove that in a multistage amplifier, efforts should be made to minimize the noise power of the 1st stage amplifier. **7**

OR

Explain the terms : (1) Signal conditioning (2) Phase sensitive detection.

5. Answer the following in brief : **14**

(1) What is the value of nuclear density of nucleus ?

(a) 10^{17} gm/m^3 (b) 10^{17} kg/cm^3

(c) 10^{17} kg/m^3 (d) 10^{17} kg/m^2

(2) Magnetic dipole moment gives _____.

(a) Angular momentum (b) Electric dipole moment

(c) Spin angular momentum (d) None of these

(3) Define 1 Nuclear magnetron.

(a) $\frac{e\hbar}{2m_pc^2}$ (b) $\frac{e\hbar}{2m_pc}$

(c) $\frac{e\hbar^2}{2m_pc^2}$ (d) $\frac{e^2\hbar^2}{2m_pc^2}$

(4) Magnetic dipole moment of a nucleus in a definite parity state is _____ whereas electric dipole moment is _____.

(a) zero, non-zero (b) zero, zero

(c) Non-zero, non-zero (d) non-zero, zero

(5) Find the value of $\int p^1 \cos\theta . p^2 \cos\theta . d\cos\theta$

(6) If incident beam is moving along Z-direction, then what will be the value of Z-component of linear velocity becomes zero ?

(7) Write the dimensional formula for the differential scattering cross-section.

(8) Define effective range.

(9) Write two essential difference between *p-p* and *n-p* scattering.

(10) In case of *p-p* scattering, pure coulomb field nuclear phase shift is _____.

(11) Draw the noise spectrum of a typical laboratory environment.

(12) What is the principle of Lock-in amplifier. State its applications.

(13) For measurement of 1200 °C temperature, which transducer will be used ?

(14) Differentiate between Johnson noise and Flicker noise.