বিদ্যাসাগর বিশ্ববিদ্যালয়

VIDYASAGAR UNIVERSITY

M.Sc. Examinations 2020
Semester IV
Subject: PHYSICS
Paper: PHS 402
(Theory)

Full Marks: 40 **Time: 2 hrs.**

Candidates are required to give their answers in their own words as far as practicable.

UNIT – PHS402.1 (Nuclear Physics-II)

Answer any one of the following:

1. (i) Show that the D-state probability in deuteron is roughly 4%. (ii) What are essential differences between low energy n-p and p-p scattering?
2. (i) Discuss the ground state of deuteron wave function (ψ_0) with the mixture of $^3S_1$ and $^3D_1$ states wave functions. (ii) Calculate the spin of deuteron nucleus.
3. Sow how far the liquid-drop model is successful in explaining why U^{235} is fissile to slow neutrons but U^{238} is not?
4. (i) Write the failures of the shell model. (ii) Find the spin, parity and magnetic moment of $_{16}S^{33}$ nucleus using shell model.
5. Derive the continuum theory of nuclear reaction by neutral particles.
6. (i) What is the isotopic spin of the deuteron? Justify your answer. (ii) Given that K and π-mesons have spin 0 show that one of the weak decay processes $K^+ \to \pi^+\pi^0$ and $K^+ \to \pi^+\pi^+\pi^-$ must violate parity conservation.
7. (i) Why the Breit-Wigner formula is called dispersion formula? (ii) A crystal spectrometer for neutrons uses a rock salt crystal with a grating space of 2.18 Å. The neutrons are detected at an angle of 15°. What is the energy of the neutrons selected in the first order diffraction?

8. In n-p scattering, S-wave scattering is predominant in the energy range below $10\,MeV$. Comments on this observation.
9. Write a short note on spin-orbit coupling in nuclear models.
10. (i) Why are the velocities of thermal neutrons in a reactor given by Maxwell distribution? (ii) We derived the Maxwell distribution for atoms in a gas, that don not interact with each other. How are these two things connected?
11. Why the energies of the neutrons generated from (α, n) sources are not mono-energetic ? What are the disadvantages of using radon in (α, n) sources for producing neutrons ?
12. How magic numbers are explained using shell model?

PHS – 402.2 (Quantum Field Theory)

Answer any One of the following questions

1. Discuss how one-dimensional spring-mass systems invoke the concept of classical fields.
2. Find the equation of motion and the conjugate momentum of field ϕ for the Lagrangian density: $L = A/2\,(\partial\phi/\partial t)^2 - B(\partial\phi/\partial x)^2$. Can we comment about the dimension of [B/A] from the resulting equation?
3. Find the equation of motions for the Lagrangian density: $L = -1/4\,F^{\mu\nu}F_{\mu\nu}$, where $F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$. Discuss physical significances of the resulting equations.
4. Find the equation of motions for the Lagrangian density: $L = -1/4\,F^{\mu\nu}F_{\mu\nu} - j^\nu A_\nu$, where j^ν is the four-vector current. Does this Lagrangian describe a massive field?
5. Find the Dirac equation for particle and antiparticle from the Lagrangian density: $L = i\bar{\Psi}\gamma^\mu\partial_\mu\Psi - m\bar{\Psi}\Psi$, the symbols have usual meanings.
6. State Noether's theorem and derive the expression of energy-momentum tensor ($T^{\mu\nu}$) for the scalar field ϕ.
7. Write down the Lagrangian density of free scalar field and find the zero'th component of energy-momentum tensor (T^{00}).
8. What is meant by Second Quantization? Prove the equal time commutation relation: $[\phi(x,t), \phi(\acute{x}, t)] = 0$
9. What is Normal ordering? Calculate the commutation relation: $[\hat{H}, \widehat{a_k}]$ where H is the Hamiltonian for free Klein-Gordon Field.
10. Find the expression of Noether's conserved charge for complex scalar field.
11. What are the Mandelstam variables? Show that one of those variables is related to centre of mass energy of collisions. Draw the Feynman diagrams of the scattering process: $\mathbf{e^-\,\gamma \rightarrow e^-\,\gamma}$
12. Briefly discuss local gauge invariance of massive Dirac field.