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M3N16219 (Pages :2) Reg. No:.........................

Name: ....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2016

PHY3C09 - Quantum Mechanics

(2015 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

PART A

Answer **all** questions

All questions carry 1 weightage

1. Obtain the condition for validity of WKB approximation.
2. In WKB approximation, why we need connection formula.
3. Obtain the expression for transition probability when a system is perturbed by a potential $v(x,t)$
4. What is dipole approximation.
5. Obtain Schrodinger equation from Ritz variation principle.
6. Discuss how we can get correct eigen value by Ritz variational principle.
7. Show that Schrodinger equation is not Lorentz invariant.
8. Obtain the expression for Dirac matrices.
9. Discuss the stability of Dirac vacuum.
10. Why we say about the helicity of neutrinos instead of its spin.
11. What is meant by second quantization. Why it is called second quantization?.
12. Obtain the expression for canonical momentum of the Schrodinger field.

(12 x 1 = 12)

PART B

Answer any **two** questions

Each question carry 6 weightage

13. Discuss variation method for the evaluation of eigen values. Obtain the ground state energy of hydrogen atom by variation method.
14. Use WKB method to calculate transmission and reflection coefficient for a particle penetrating through an arbitrary potential V (x).
15. Obtain the expression for Fermi's Golden rule.
16. What are the drawbacks of Klein-Gorden equation. Discuss how these problems are resolved in Dirac theory.

(2 x 6= 12)

PART C

Answer any **four** questions

Each question carries 3 weightage

17. Calculate eigen values of a matrix $\begin{pmatrix} 1 & 0 & 3 \\ 5 & 2 & 1 \\ 0 & 6 & 3 \end{pmatrix}$ by perturbation method.

18 In the functional defined as $E\left[|\psi\rangle\right] = \dfrac{\langle\psi|\hat{H}|\psi\rangle}{\langle\psi|\psi\rangle}$

If $|\psi\rangle$ is orthogonal to ground state $|\psi_0\rangle$, show that $E\left[|\psi\rangle\right] > E_1$, the first excited state.

19 One dimensional harmonic oscillator of charge *e* is perturbed by an electric field

$$E = 2E_0 \cos \omega t$$

Show that transition can take place only to the first excited state.

20 Obtain Bohr- sommerfeld quantization condition from WKB method.

21 Show that (σ . **a**) (σ .b) = (**a.b**) + iσ . (**a** x **b**) . Where σ are Pauli's spin marrices and **a** and **b** are polar three vectors.

22 Show that $\left(\bar{\psi}\gamma^{\mu}\gamma^{\nu}\psi\right)$ behaves like a second rank tensor under Lorentz transformation .

(4 x 3 = 12)

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1M3N16220 (Pages :2) Reg. No:.......................

Name: ....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2016

PHY3C10 - Nuclear and Particle Physics

(2015 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Section A

(Answer all questions. Each question carries weightage 1)

1. What is meant by g factor? State the values of g factors for orbital motions of neutron and proton.
2. Distinguish between neutron-proton and proton-proton scatterings.
3. Explain tensor potential.
4. State the meanings of monopole, dipole, quadrupole and octupole vibrations. What are the possible modes for a nucleus?
5. What are the important differences between alpha and beta decays?
6. Distinguish between Fermi decay and Gamow-Teller decay. What are the possible changes in nuclear spins in these cases?
7. What is internal conversion? How does it differ from beta decay?
8. What is the reason for the difference in the fissionable properties of U^{235} and U^{238}?
9. A meson at rest decays to two spin ½ particles. Discuss the motions of the two particles.
10. What is the reason for the stability of a proton against decay?
11. The isospin projection and strangeness quantum number of a baryon are 1 and -1 respectively. Find its charge.
12. What is the quark content of Δ^{++}? How can you account for Pauli's exclusion principle in the case of quarks in Δ^{++}?

(12 x 1 = 12 weightage)

Section B

(Answer any two questions. The question carries weightage 6)

13 What are magic numbers? Give a theoretical explanation for the existence of magic numbers.

14. What is meant by binding energy of nucleus? Derive the semi empirical formula for nuclear mass.

15. Discuss the different fusion reactions responsible for energy production in stars.

16. Discuss the eight fold way of representing the hadrons. Also describe the representation of their resonance states.

(2 x 6 = 12 weightage)

Section C

(Answer any four questions. Each carries weightage 3)

17. Predict the spins and parities of the ground states of :
    (a) $_{19}K^{39}$
    (b) $_{8}O^{17}$
    (c) $_{5}B^{11}$

18 The energy of the 2^+ rotational level of Er^{166} is 80.85 keV.Find the moment of inertia of the nucleus. Compare with the value obtained by considering the nucleus as a rigid sphere. R_0=1.2 fm.

19. Energy released in the fission of U^{235} is 200 MeV. What would be the quantity of U^{235} used per year in a 5 MW nuclear reactor, if the efficiency of conversion=60%.

20. Indicate, with a brief explanation, whether the following reactions or decays can proceed through the strong, the electromagnetic or the weak interaction:
    (a) $\Xi^- \rightarrow \Lambda^0 + \pi^-$
    (b) $\pi^- + p \rightarrow \Lambda^0 + K^0$
    (c) $\Omega^- \rightarrow \overline{K}^0 + K^-$

21. Which of the following reactions cannot be a strong reaction:
    (a) $\pi^0 \rightarrow \gamma + \gamma$
    (b) $K^- + p \rightarrow \Lambda^0 + \pi^0$
    (c) $K^0 + p \rightarrow K^+ + n$

22. Calculate the Q value of the reaction in MeV;
    $H^3 + H^2 \rightarrow He^4 + n$
    $m(H^3) = 3.01699824$ u.
    $m(H^2) = 2.01473614$ u.
    $m(He^4) = 4.00387274$ u.
    $m(n) = 1.00899324$ u.

(4 x 3 = 12 weightage)

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M3N16221 (Pages :2) Reg. No:.........................

Name: ....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2016

PHY3C11 - Solid State Physics

(2015 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Part A

Answer **all** *questions*

Each question carries **1** *weightage.*

1. Explain the perfect crystalline state.
2. Briefly explain the symmetry elements in a crystal. What is the total number of crystallographic symmetry elements in a cubic system.
3. Describe the salient features of Diamond structure.
4. Give an account of Hydrogen bond.
5. Distinguish between acoustic branch and optical branch.
6. Prove that at high temperatures, an extrinsic semiconductor becomes intrinsic.
7. What is meant by effective mass of an electron in a lattice.
8. Describe the phenomenon of Hall effect. Mention four applications of this effect
9. State Hund's rules.
10. Briefly explain antiferromagnetism.
11. What are type I and type II superconductors?
12. Write a note on ferroelectric domains.

(12 x 1= 12 weightage)

Part B

Answer any **two** *questions*

Each question carries **6** *weightage*

13. Give an account of Debye model of lattice heat capacity and derive an expression for the same. How does it agree with experimental results at high and low temperatures ?

14 Find the solution of wave function of free electron gas in three dimensions. Arrive at an expression for Fermi energy.

15 Describe Langevin's theory of paramagnetism.

16 Discuss Landau theory of ferroelectric phase transitions.

(2 x 6 = 12 weightage)

Part C

Answer any **four** *questions*

Each question carries **3** *weightage*

17. Show that 5 fold rotation is not compatible with a two dimensional lattice.

18. Show that for a simple cubic lattice $\mathbf{d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}}$.

19. The density of Zinc is 7.13gm/cm^3 and it's atomic weight is 65.4. Calculate it's Fermi energy. The effective mass of free electron in Zinc is 7.7×10^{-31} Kg. Note that each atom has 2 valence electrons.

20. Calculate the number of states lying in an energy interval of 0.02 eV above Fermi energy for Sodium crystal of unit volume. $E_F = 3.22$ eV for Sodium.

21. The energy gap for Germanium is 0.67 eV. Calculate the intrinsic concentration of charge carriers.

22 Lead in the superconducting state has critical temperature of 6.2 K at zero magnetic field and a critical field of 0.064 Am^{-1} at 0K. Calculate the critical field at 4K.

(4 x 3 = 12 weightage)