1M3N18212 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2018

MPHY3E1(6) - Experimental Techniques

(2016 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Section A

Answer all questions.

Each question carries 1weightage.

1. Explain the principle of electronic system in a Cock-croft accelerator.
2. What do you mean by "distance of closest approach"? Give its relevant relations indicating the notations.
3. Explain the use of chevron-baffle assembly.
4. How neutrons are classified on the basis of energy? Explain the sources and energy of neutrons used for NAA process.
5. What is the physical basis of antireflection coatings? Give one application.
6. What do you mean by regenerative cooling? What is its importance?
7. What are the uses of multilayer thin film systems in optical devices?
8. What do you imply by Rietveld structure refinement?
9. What are zeolites ? How is it useful in vacuum pumping?
10. Briefly give the working principle of magnetic thermometer.
11. Explain the advantages of flash evaporation thin film deposition technique.
12. Briefly give the details of Pelletron.

(12 x 1 = 12 Weightage)

Section B

Answer any two questions

(Each question carries 6 Weightage)

13. Give the constructional details of turbomolecular pump. What are its underlying physical principles? Briefly explain its air expulsion mechanism.
14. Explain the basic steps involved in the nuclear demagnetization to yield micro Kelvin temperatures.
15. Explain the design and physical principles of the following accelerators.
    A) Cock-Croft Walton accelerator, B) Microtron accelerator

16. What the acronym PIXE stands for? Give an account of the instrumentation of PIXE and explain how it is used for analysing aerosol samples.

(2 x 6 = 12 Weightage)

Section C

Answer any four questions.

Each question carries 3 Weightage

17. A quartz crystal monitor indicates a change in frequency of 1600Hz when an Aluminium film of areal density 2.7gm/cm^2 is deposited on its face. Determine the film thickness. If the quartz crystal is 0.2mm thick and the density of the quartz is 2.3gm/cm^3, estimate its initial frequency.

18. The compression ratio for nitrogen in a particular Turbomolecular pump is 10^8. What will be the ratio for hydrogen gas? If the rotor speed is doubled what will be the new values of the ratio for the two gases?

19. Illustrate the experimental set up for Kammerlingh Onne's Helium liquefier.

20. In an RBS experiment with helium ions of energy 1MeV on a target of Gold (A=201), the projectile ions are scattered at an angle of 180°. Calculate the distance of closest approach.

21. A telescope lens (n=1.50) is coated with an antireflection thin film (n=1.38) to increase the transmission of normally incident light of wavelength 5800Å. What minimum film thickness should be deposited on the lens to maximise the transmission?

22. A proton accelerator consists of 200 drift tubes. The rf electric field has a frequency of 500 MHz. The average potential when the protons cross the accelerating gap is 1.5x10^3 kV. If the protons are injected into the machine at 2MeV energy, calculate the final energy and the length of the last drift tube.

(4 x 3 =12 Weightage)

1M3N18213 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2018

MPHY3B09 - Quantum Mechanics - II

(2016 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Section A

Answer ***all*** questions

Each question carries ***1 Weightage***

1. WKB approximation fails at the classical turning point. Explain.
2. Bohr Sommerfeld quantization rule is a natural consequence of WKB approximation. Justify.
3. What is meant by degenerate and non degenerate cases?
4. Why the hydrogen atom in the ground state does not show a first order stark effect?
5. The result of the variation method always gives an upper limit for the ground state energy of the system. Why?
6. Explain how the variational method can be used to find out the excited state of a system.
7. Obtain the expression for transition probability between two states in the harmonic perturbation case.
8. What is dipole approximation?
9. Give the properties of Dirac matrices.
10. How did Dirac explain the positive probability of negative energy states?
11. How will you quantize the Schrodinger field for a system of bosons?
12. Write down the Lagrangian density associated with Klein-Gordon field.

(12 x 1 =12 Weightage)

Section B

Answer *any two* questions

Each question carries *6 Weightage*

13. Estimate the ground state energy of Helium atom by variational method.
14. Derive an expression for the transmission coefficient using WKB approximation method by taking the penetration through a potential barrier problem.
15. Discuss the spin – orbit interaction in the context of Dirac's theory.
16. Outline the perturbation theory for the time evolution of a system. Obtain Fermi's Golden rule for a constant perturbation switched on at t = 0.

(2 x 6 =12 Weightage)

Section C

Answer *any four* questions

Each question carries *3 Weightage*

17. A hydrogen atom is placed in a time dependent electric field $\mathbf{E} = E(t)\hat{k}$. Calculate all four matrix elements H'_{ij} of the perturbation $H' = eEz$ between the ground state and the first excited states.
18. The unperturbed Hamiltonian of a system is $H_0 = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 x^2$. If a small perturbation $V' = \begin{cases} \lambda x & \text{for } x > 0 \\ 0 & \text{for } x \leq 0 \end{cases}$ acts on the system, evaluate the first order correction to the ground state energy.
19. Prove that the probability density associated with the Dirac equation is positive definite.
20. Show that matrix $\sigma' = \begin{pmatrix} \sigma & 0 \\ 0 & \sigma \end{pmatrix}$ is not a constant of motion.
21. Estimate the ground state energy of a one-dimensional harmonic oscillator of mass m and angular frequency ω using a Gaussian trial function.
22. If the Lagrangian density of a fermion is given by $L = \bar{\psi}(\gamma_\mu \partial_\mu + m)\psi + \alpha|\bar{\psi}\psi|^2$, derive its Hamiltonian density.

(4 x 3 =12 Weightage)

1M3N18214 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2018

MPHY3B10 – Nuclear and Particle Physics

(2016 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Section A

Answer* all *questions

***Each has Weightage* 1**

1. Explain the terms mean radius and skin thickness in characterizing nuclear shape.
2. Define the term electric quadrupole moment.
3. What are the arguments in favor of exchange force model?
4. Why do we call the rotational model as adiabatic model?
5. What is quadrupole phonon?
6. What are universal Fermi interactions? Give an example for the case in which Fermi theory fails.
7. Using β decay energetics, show that neutrinos are massless.
8. Briefly discuss internal conversion.
9. What is meant by a compound nucleus? Give example for a compound nuclear reaction.
10. Write a short note on CNO cycle.
11. Explain the decay modes of pions and muons.
12. Write a short note on the lepton class of particles.

(12 x 1 = 12 Weightage)

Section B

Answer any* two *questions

***Each has weightage* 6**

13. Discuss in detail the main features of internucleon force.
14. Explain why the infinite square well and harmonic oscillator potentials are not good approximations to nuclear potential and obtain the realistic form of the shell model potential. Modify this potential to give the proper magic numbers
15. Discuss the energetics of a basic nuclear reaction.
16. What are quarks? Classify them and discuss their properties.

(2 x 6 = 12 Weightage)

Section C

Answer any **four** *questions*
Each has Weightage **3**

17. In positron decay, a proton in the nucleus becomes a neutron and its positive charge is carried away by the positron. A neutron, though, has a larger rest energy than a proton. How is that possible?

18. Predict the ground state spins and parities of the following nuclei using the shell model:

$$^{3}_{2}He\ ;\ ^{34}_{19}K\ ;\ ^{17}_{8}O$$

19. Calculate the Q-value of the reaction

$$p + He \rightarrow {}^{2}H + {}^{3}He$$

What is the threshold energy for protons incident on He ?

20. Calculate how many values of I_Z are possible for $I = 5/2$ and $I = 3$.

21. Check the possibility of the following interactions. Explain the violation of conservation laws if any in each.

(a) $\pi^+ + n^0 \rightarrow \Lambda + k^+$

(b) $p \rightarrow e^+ + \gamma$

(c) $e^+ + n \rightarrow p + \nu$

22. Give the quark constituents of the following particles and the quantum numbers associated with each

(a) K^+

(b) Δ^{++}

(c) Ξ^0

(4 x 3 = 12 Weightage)

1M3N18215 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2018

MPHY3B11 - Solid State Physics

(2016 Admission onwards)

Max. Time: 3 hours Max. Weightage: 36

Section A
(Answer all questions, each question carries 1 Weightage)

1. Find the lattice constant of a simple cubic lattice whose interplanar spacing for (111) plane is 2.5 A^0
2. What is a primitive lattice cell?
3. What is the essential condition for ionic bonding?
4. What is Vander Waals interaction?
5. What are phonons?
6. What is effective mass of an electron?
7. What is Hall effect?
8. What is polarisation catastrophe?
9. What are ferromagnetic domains
10. What are DC and AC Josephson effects ?
11. Explain flux quantization
12. Superconductors are diamagnets. Justify this statement

(12 x 1 = 12 Weightage)

Section B
Answer any two.
Each carries 6 Weightage

13. Using Kronig-Penney model obtain the wave equation of electron in a periodic potential
14. Obtain an expression for the product of electron concentration in conduction band and hole concentration in valence band
15. Explain Langevin theory of diamagnetism and obtain an expression for susceptability
16. Obtain the Clausius- Mossotti relation for dielectric constant and electronic polarizability

(2 x 6 = 12 Weightage)

Section C

Answer any four questions.
Each carries 3 Weightage

17. Show that packing fraction in the case of simple lattice is 0.52

18. The potential energy of a system of two atoms is given by

$$U(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$$

Find the bond length if $a = 6 \times 10^{-76}$ Jm^6 and $b = 6 \times 10^{-136}$ Jm^{12}.

19. A paramagnetic material which obeys Curies law has 10^{28} atoms/m^3. If its susceptibility at 340 K is 3×10^{-4} find its susceptibility at 500K.

20. The intrinsic carrier density of a semiconductor at room temperature is 2.0×10^{19} /m^3. The electron and hole mobilities are 0.36 and 0.19 m^2/V s respectively. Find the resistivity.

21. The penetration depth of lead at 5 K is 445 AU. Find the depth at 0 K if $T_c = 7.18K$

22. Find the frequency dependence of the electronic polarizability of an electron having the resonant frequency ω_0 treating the system as a simple harmonic oscillator.

(4 x 3 = 12 Weightage)