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1M3N20213 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2020

MPH3E05 – Experimental Techniques

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section-A
Answer all Twelve Questions
Each question carries a weightage of 1

1. Give the properties and functions of the oil in oil sealed rotary vacuum pump.
2. What is meant by traps in vacuum system?
3. What is a capacitance manometer and give its pressure range.
4. What are Multi layer optical filters?
5. Explain the principles of phase stability in a synchro cyclotron.
6. What are the various factors to be considered in choosing a particular nuclear technique for the elemental analysis?
7. What is meant by energy straggling? How does it affect the spectrum of ion scattered from a target?
8. Explain the term kinematical factor and give its importance.

(8x 1 =8 Weightage)

Section-B
Answer any Two Questions
Each question carries a weightage of 5

9. With the help of a diagram explain the various parts and working of Turbo molecular pump. Compare it with an oil diffusion pump.
10. Discuss the glow discharge technique for thin film preparation. Also explain the quartz crystal method to find the thickness of thin films.
11. Discuss the basic principles of operation of cyclotrons, synchro-cyclotron and synchrotron. What are the essential differences among them? What limits the maximum energy obtainable from each?
12. Describe the principle and working of PIXE technique for elemental analysis. Compare its features the other similar techniques.

(2 x 5=10 Weightage)

Section-C
Answer any Four Questions
Each question carries a weightage of 3

13. A fifteen stage turbo molecular pump with blade tip velocity of 500 m/s has a compression ratio at 25°C for N_2 of 7.7×10^8. What is the compression ratio of the pump when it is pumping hydrogen?
14. A quartz crystal monitor indicates a change in frequency of 1600Hz when an aluminium film of density 2.7gm/cm^3 is deposited on its face. Determine the film thickness if the quartz crystal is 0.2mm is thick and the density of quartz is 2.3gm/cm^3. Estimate the starting frequency of the crystal
15. Proton of energy 0.5MeV is injected in to a 50 MeV linear accelerator powered by a 200 MHz, RF supply. Find the approximate length of the first and last drift tubes.
16. Explain how the X-ray diffraction pattern shows structure of the crystal.
17. A beam of X-rays of wavelength 0.071 nm is diffracted by (110) plane of rock salt with lattice constant of 0.28 nm. Find the glancing angle for the second-order diffraction.
18. An alpha particle with a momentum 53 MeV/c is scattered at an angle 60^0 by the coulomb field of a stationary uranium nucleus (A=238). Find the impact parameter.
19. Derive Bragg's law for X-ray diffraction and explain how to calculate the lattice constants using XRD pattern.

(4 x 3 =12 Weightage)

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1M3N20214 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2020

MPH3C09 – Quantum Mechanics – II

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(8 Short questions, each answerable within 7.5 minutes)

Answer all questions, each carry weightage 1

1. What are the differences between time independent and time dependent perturbation theory ?
2. What is *Zeeman effect* ? How can we study it using perturbation theory ?
3. What is the condition of *detailed balancing*?
4. Explain the significance of *Optical theorem.*
5. Define scattering cross section and scattering amplitude. Establish the relation between them.
6. *Bohr-Sommerfeld quantization* condition is a natural consequence of WKB approximation. Justify.
7. What is the *non-relativistic limit* of Dirac equation.
8. How the spin of the electron arises as a natural consequence of the Dirac equation.

$(8 \times 1 = 8$ weightage)

Section B

(4 Essay questions, each answerable within 30 minutes)

Answer ANY TWO questions, each carry weightage 5

9. Show that there is no first order Stark effect for the ground state of Hydrogen atom. Apply the degenerate state perturbation theory to calculate the linear Stark effect in the first excited state $(n = 2)$ of Hydrogen atom.
10. Discuss the interaction of electromagnetic radiation with atoms. What is the criterion for a *Dipole approximation* ?
11. In partial wave analysis, show that the effect of scattering by a central potential is to shift the phase of each outgoing partial wave. Obtain scattering cross section in terms of phase shifts.

12. Starting with Dirac Hamiltonian, derive the commutation relations for Dirac matrices and find the free particle solution.

$(2 \times 5 = 10$ weightage)

Section C

(7 Problem questions, each answerable within 15 minutes)

Answer ANY FOUR questions, each carry weightage 3)

13. A harmonic oscillator with a Hamiltonian $\hat{H} = \frac{\hat{p}^2}{2m} + 9\hat{x}^2$ is perturbed by a potential $V(x) = 18x$. Find the shift in energy values in the second order perturbation and compare them with exact eigenvalues.

14. Starting from a Gaussian trial wave function, obtain the ground state energy of Hydrogen atom using variational method

15. Using Bohr-Sommerfeld quantisation rule, find the eigen values of a one-dimensional harmonic oscillator.

16. Use the WKB approximation to calculate the energy levels of a spinless particle of mass m moving in a one-dimensional box with walls at $x = 0$ and $x = L$ (infinite well)

17. The differential scattering cross section in a certain case is given by

$$\sigma(\theta) = \alpha + \beta \cos\theta + \gamma \cos^2\theta$$

Deduce the total scattering cross section and show that it is consistent with the optical theorem.

18. Show that Dirac matrices are unimodular and that they anti-commute with each other by choosing a pair.

19. Find the current, charge density and continuity equation associated with Dirac equation.

$(4 \times 3 = 12$ weightage)

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1M3N20215 (Pages : 2) Reg. No:.....

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2020

MPH3C10 – Nuclear and Particle Physics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

SECTION A

Answer *ALL* questions. Each carries *ONE* weightage

1. What is meant by angular momentum of a nucleus?
2. A neutron-proton bound state is stable while a proton-proton or a neutron-neutron system is not stable. Why?
3. Distinguish between the mechanisms of alpha and beta decays.
4. How the magnetic moments of nuclei are calculated using the single particle shell model?
5. Compare the energy released in nuclear fission and nuclear fusion.
6. What is meant by quenching in a GM tube?
7. State the CPT theorem.
8. What are resonance particles? Give examples.

(8 × 1 = 8 weightage)

SECTION B

Answer any *TWO* questions. Each carries *FIVE* weightage.

9. Discuss the Fermi theory of beta decay and explain Fermi- Kurie plot.
10. Describe the different terms in the expression for binding energy of a nucleus, according to the liquid drop model. Derive the Von-Weizsacker semi-empirical mass formula.
11. Discuss in detail Ge(Li), Si(Li) and surface barrier nuclear detectors.
12. Explain the different conservation laws followed by elementary particles, taking suitable examples.

(2 × 5 = 10 weightage)

SECTION C

Answer any *FOUR* questions. Each carries *THREE* weightage

13. A phase shift of 30^0 is observed when a beam of particles of energy 0.1 MeV is scattered by a target. When the beam energy is changed, the phase shift changed to 60^0. Assuming that only s-wave scattering is relevant and that the cross-section does not change with energy, calculate the the beam energy in the second case.

14. The radioactive nuclide ${}_6C^{11}$ undergoes a β^+ decay to give ${}_5B^{11}$. If the maximum energy of the emitted positron is 0.960 MeV, calculate the Q-value of the decay. Given the atomic mass of C^{11} = 11.011434 amu and that of B^{11} = 11.009305 amu.

15. Predict the spin-parity assignments for the ground states and first excited states of the isotopes ${}_{28}Ni^{57}$ and ${}_{32}Ge^{73}$ using the single particle shell model.

16. Calculate the energy liberated (in MeV) when two deuterium nuclei fuse to form a helium nucleus. Given the mass of deuterium nucleus = 2.01478 amu and that of helium nucleus = 4.00388 amu.

17. An organic quenched GM tube has the following characteristics:
Working voltage =1000 V, diameter of anode = 0.2 mm,
diameter of cathode = 2 cm, maximum life-time = 10^9 counts. What is the maximum radial field and how long will it last if used 30 hour per week of 3000 counts per minute?

18. Identify the process that is not allowed by strong interaction, but allowed by weak interaction from the following:

(a) $K^0 + \pi^0 \rightarrow \overline{K_0} + \pi^+ + \pi$ (b) $p + n \rightarrow d + p + \bar{p}$

(c) $\Delta^+ + K^0 \rightarrow p + n$ (d) $p + \Delta^+ \rightarrow \bar{n} + \Delta^{++}$

19. Give the quark structure and spins of the following particles using the quark model
p, n, Δ^0, π^+, Σ^0, and Ξ^0

(4 × 3 = 12 weightage)

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1M3N20216 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2020

MPH3C11 – Solid State Physics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

Answer all questions, each carry weightage 1

1. What is Ewarld sphere? How is it constructed?
2. Discuss the origin of band gap in semiconductors
3. State Bloch theorem and write its significance
4. Discuss the various dielectric polarization mechanisms.
5. Explain the significance of Hall coefficient.
6. Distinguish between displacive transition and order-disorder theories in explaining properties of ferroelectric materials
7. Explain the significance of Neel's temperature in antiferromagnetism.
8. What are Cooper pairs and explain how they are formed?

(8x1=8 weightage)

Section B

Answer ANY TWO questions, each carry weightage 5

9. What is Madelung interaction? Discuss the nature of cohesion and obtain the expression for cohesive energy of an ionic crystal.
10. Obtain the vibrational spectrum of a linear diatomic lattice and show that the spectrum consists of two branches. Also discuss the main features of these branches.
11. Discuss the Langevin's theory for a paramagnetic gas and obtain the relation for susceptibility
12. Discuss single particle tunneling and derive current density of super conductor across a junction in the absence of electric and magnetic field

(2x5=10 weightage)

Section C

Answer ANY FOUR questions, each carry weightage 3

13. Explain the crystal structure of diamond. Also find the packing fraction
14. The velocity of sound in a solid is of the order of 10^3 m/s. Find the frequency of sound Wave $\lambda = 10\ \overset{0}{A}$ for a (i) mono atomic system, and a (ii) acoustic waves and optical waves in a diatomic system containing identical atoms with inter atomic spacing 2.5 $\overset{0}{A}$.
15. The Debye temperature of diamond is 2230K. Calculate the Debye frequency and molar heat capacity at 10K.
16. Show that average energy of electrons in a solid at absolute kelvin is $3/5^{th}$ of Fermi energy.
17. Explain the properties of $BaTiO_3$.
18. The London penetration depths for lead (Pb) at 3K and 7.1K are respectively 39.6 nm and 173 nm. Calculate its transition temperature as well as penetration depth at 0K.
19. Write a short note on spin waves and magnon in ferromagnets.

(4 x 3 = 12 weightage)