

Reg. No. :.....

Model Question Paper for Entrance Examination
Ph.D Admission in Physics
University of Calicut
Department of Physics

Maximum Marks: 100

Duration: 2 hours.

Part A

Answer All Questions. Each question carries 2 marks. Circle the most appropriate choice **in the given answer sheet**.

1. A meteorite, 80,000 km away from the earth, is moving towards the earth at 2000 m/s . Ignoring air friction, what will be its velocity on impact?
A. $1.09 \times 10^8\text{ m/s}$ B. $1.09 \times 10^{-4}\text{ m/s}$ C. $1.04 \times 10^4\text{ m/s}$ D. $1.04 \times 10^{16}\text{ m/s}$
2. A uniform flux of particles is incident upon a fixed hard sphere of radius a . The particles that strike the sphere are reflected elastically. What will be the differential scattering cross section.
A. πa^2 B. $\frac{4}{3}\pi a^2$ C. $2\pi a^2$ D. None of these
3. All functions whose Poisson's bracket with Hamiltonian vanish must be
A. involving time explicitly B. constant of motion C. both A and B D. None of these
4. $\int_0^\infty \frac{x^{-a}}{1+x} dx, 0 < a < 1$ is equal to
A. $\pi/\cos(\pi a)$ B. $\sin(\pi a)/\pi$ C. $\cos(\pi a)/\pi$ D. $\pi/\sin(\pi a)$
5. If $f(z) = u(x, y) + i v(x, y)$, then $f^*(z^*)$ is
A. $u(x, y) + i v(x, y)$ B. $u(x, y) - i v(x, y)$ C. $u(x, -y) - i v(x, -y)$ D. $u(x, -y) + i v(x, -y)$
6. Inverse Laplace transform of $s/(s^2 + a^2)^2$ is equal to
A. $\frac{1}{2a} \sinh(at)$ B. $\frac{1}{2a} t \sin(at)$ C. $\frac{1}{2a} t \cosh(at)$ D. $\frac{1}{2a} \cos(at)$
7. Which of the following is not an eigen value of the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$?
A. -1 B. 0 C. 1 D. 2
8. A plane electromagnetic wave traveling in free space is incident normally on a glass plate of refractive index 1.5. If there is no absorption by the glass, its reflectivity is
A. 16% B. 50% C. 20% D. 4%

9. The electromagnetics fields are invariant with respect to the gauge transformations (in SI) :
- A. $\vec{A}' = \vec{A} + \nabla\chi, \phi' = \phi - \frac{\partial\chi}{\partial t}$ B. $\vec{A}' = \vec{A} - \nabla\chi, \phi' = \phi - \frac{\partial\chi}{\partial t}$ C. $\vec{A}' = \vec{A} - \nabla\chi, \phi' = \phi - \frac{1}{c}\frac{\partial\chi}{\partial t}$ D. $\vec{A}' = \vec{A} + \nabla\chi, \phi' = \phi - \frac{1}{c}\frac{\partial\chi}{\partial t}$
10. When the thermal de Broglie wavelength is of the order of the inter-particle distance, the gas can be considered to be as
- A. Fermi Gas B. Bose gas C. Maxwell-Boltzmann gas. D. Either A or B
11. Consider two identical particles. Each particle can be found in one of the three possible quantum states, 0, E, and 3E. What is the ratio of probability that the two particles are found in the same state to the probability that the two particles are found in different states in BE statistics?
- A. 0 B. 0.5 C. 1 D. 2
12. Development of quantum mechanics of matter is related to
- A. Electron diffraction experiment B. Photo electric effect C. Special theory of relativity D. None of these
13. Only operators depend on time in
- A. Schrödinger picture B. Heisenberg picture C. Interaction picture D. None of these
14. Wave function of linear harmonic oscillator is
- A. Hermite polynomials B. Legendre polynomials C. Lagurre polynomials D. None of these
15. Pauli exclusion principle follows from
- A. Symmetric wave function B. Anti-symmetric wave function C. no definite symmetry of wavefunction D. None of these
16. The Hall coefficient, R_H is
- A. $ne\mu$ B. $ne^2\sigma/T$ C. $-1/(ne^2)$ D. $-1/(ne)$
17. In the AC Josephson effect, the current oscillates with a frequency, ω given by
- A. $2eV^2/\hbar$ B. $3e^2V^2/(k_B T)$ C. $2eV/\hbar$ D. $k_B^2 T/R$
18. A 3-MV Van de Graaff generator is equipped to accelerate protons, deuterons, doubly ionized ^3He particles, and alpha-particles. What is the maximum energy available from this machine for alpha-particles?
- A. 6 MeV B. 3 MeV C. 0 MeV D. 10 MeV
19. The electrostatic force between the earth and the moon can be ignored, because
- A. it is much smaller than the gravitational force. B. the bodies are electrically neutral. C. of the tidal effect. D. earth is neutral and moon is charged.

20. A Geiger counter consists of a 10 mm diameter grounded tube with a wire of 50 μm diameter at +2000 V in the center. What is the electrical field at the wire?
A. 200^2 kV/cm B. 151 kV/cm C. $1.5 \times 10^9 \text{ kV/cm}$ D. 1 kV/cm
21. The conversion of oxygen to ozone takes place because of
A. the release of energy B. the absorption of energy C. the solar energy D. the atmospheric pollution
22. Balmer series of lines are in
A. Visible spectra B. Infra-red spectra C. Ultra-violet spectra D. Hydrogen spectra
23. For a two level system, the population of atoms in the upper and lower levels are 3×10^{18} and 0.7×10^{18} , respectively. If the coefficient of stimulated emission is $3.0 \times 10^5 \text{ m}^3/\text{W s}^3$ and the energy density is $9.0 \text{ J/m}^3 \text{ Hz}$, the rate of stimulated emission will be
A. $6.3 \times 10^{16} \text{ s}^{-1}$ B. $4.1 \times 10^{16} \text{ s}^{-1}$ C. $2.7 \times 10^{16} \text{ s}^{-1}$ D. $1.8 \times 10^{16} \text{ s}^{-1}$
24. Maxwell's inductance-capacitance bridge is used for measurement of inductance of
A. low Q coils B. high Q coils C. low and medium Q coils D. medium Q coils
25. A 5 bit D/A converter has a current output. The digital input is 10100 and the output current corresponding to this is 10 mA . What will be the output current for a digital input of 11101 ?
A. 14.5 mA B. 10.5 mA C. 29.0 mA D. None of these

Part B

Answer any 10 questions. Each question carries 5 marks.

1. Use a 3 particle interaction to show that mass is an additive entity.
2. Express $\partial/\partial x$ in spherical polar coordinates.
3. Obtain the orthogonality relation for the Legendre functions.
4. Write the Boltzmann equation and hence obtain the Vlasov equation.
5. Show that one dimensional Bose-Einstein condensation is not possible for a free particle system.
6. Consider a system made of two components A and B with N_i particles in each component ($i = 1, 2$). Each particle of component A has access to energies 0 and E_1 . Component B has access to energies levels 0 and E_2 . Assuming all particles to be mutually independent, find an expression for the specific heat of the system.
7. Obtain an expression for the magnetic moment of a particle from the relativistic equation.

8. Obtain the Clebsch-Gordon coefficients for the coupling of two spin half particles.
9. Obtain the Lagrangian density for Schrödinger equation and verify it. How do you quantise it?
10. Write a note on classification of ferroelectric crystals.
11. Give physical interpretation of the effective mass.
12. Write brief note on particle classification based on masses, interactions and statistics.
13. The fundamental and first overtone of vibration spectra of NO are centred at 1876.06 cm^{-1} and 3724.20 cm^{-1} . Calculate the dissociation energy of the molecule.
14. Discuss the different types of flip-flops and their applications.
15. With a suitable example, explain how analog computer can be constructed to perform the solution of a second order differential equation using operational amplifiers.

Answer-sheet for Part-A

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Entrance Examination for Ph.D Admission in Physics, March 2017

Department of Physics, University of Calicut

1. A. B. C. D.
2. A. B. C. D.
3. A. B. C. D.
4. A. B. C. D.
5. A. B. C. D.
6. A. B. C. D.
7. A. B. C. D.
8. A. B. C. D.
9. A. B. C. D.
10. A. B. C. D.
11. A. B. C. D.
12. A. B. C. D.
13. A. B. C. D.
14. A. B. C. D.
15. A. B. C. D.
16. A. B. C. D.
17. A. B. C. D.
18. A. B. C. D.
19. A. B. C. D.
20. A. B. C. D.
21. A. B. C. D.
22. A. B. C. D.
23. A. B. C. D.
24. A. B. C. D.
25. A. B. C. D.