NATIONAL INSTITUTE OF TECHNICAL TEACHERS TRAINING AND RESEARCH

(DEEMED TO BE UNIVERSITY UNDER DISTINCT CATEGORY)

CHANDIGARH

Ph.D. Entrance Examination - January 2025

Subject / Branch / Department :	**Physics (Applied Science)**
Roll No. :	
Candidate Name :	
Date of Examination :	

Maximum Marks: 25 (There is no negative marking)

Notes: (a) Only one option to be tick-marked out of the four options given as answer

(b) The Candidate must put his/her signature with date at the bottom of each page

(c) For any rough work, please use ONLY back-sides of pages which are left blank

Q1. What does the Cayley-Hamilton Theorem state?	
(a)	Every matrix satisfies its characteristic equation.
(b)	Determinant of a matrix is zero.
(c)	Matrices are invertible under addition.
(d)	Eigenvalues are always real.
Q2.	A particle of mass 2 kg is under a central force $F(r) = -k/r^2$, where $k = 8$ N•m². If it is moving in a circular orbit of radius 4 m, what is its angular velocity?
(a)	1 rad/s
(b)	2 rad/s
(c)	0.5 rad/s
(d)	4 rad/s
Q3.	A particle confined in a one-dimensional box of length L = 1 nm has an energy of 6.02 eV. What is the quantum number n of the particle?
(a)	1
(b)	2
(c)	3
(d)	4
Q4.	The residue theorem is used in:
(a)	Laplace transformations
(b)	Complex analysis

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(c)	Taylor series expansion
(d)	Fourier series
Q5.	The central limit theorem is fundamental in:
(a)	Statistical mechanics
(b)	Probability theory
(c)	Quantum mechanics
(d)	Electrodynamics
Q6.	The moment of inertia tensor is relevant to:
(a)	Non-inertial frames
(b)	Rigid body dynamics
(c)	Hamiltonian mechanics
(d)	Phase space analysis
Q7.	Which of the following describes a central force?
(a)	Force depends only on the distance from a fixed point.
(b)	Force depends on velocity.
(c)	Force is uniform in all directions.
(d)	Force depends on acceleration.
Q8.	The Lorentz transformation is used in:
(a)	Newtonian mechanics
(b)	General relativity
(c)	Special relativity
(d)	Quantum field theory
Q9.	A blackbody at temperature T = 3000 K emits radiation with peak wavelength λ_{max}. Using Wien's displacement law (λ_{max} T = 2.9×10^{-3} m•K), find λ_{max}.
(a)	966 nm
(b)	70 nm
(c)	680 nm
(d)	500 nm
Q10.	The variational principle relates to:
(a)	Generalized coordinates
(b)	Phase space
(c)	Stability analysis
(d)	Energy minimization
Q11.	Gauss's law relates to:
(a)	Magnetic fields

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(b)	Electric flux
(c)	Electromagnetic waves
(d)	Capacitance

Q12. The Biot-Savart law is used to calculate:

(a)	Electric fields
(b)	Magnetic fields
(c)	Gravitational forces
(d)	Dielectric constants

Q13. What is Fresnel's law associated with?

(a)	Diffraction
(b)	Reflection and refraction
(c)	Polarization
(d)	Waveguides

Q14. Which of these is a condition for electromagnetic wave propagation?

(a)	Maxwell's equations
(b)	Poisson equation
(c)	Navier-Stokes equation
(d)	Schrödinger equation

Q15. Polarization of light occurs when:

(a)	Electric field vectors are parallel.
(b)	Electric field vectors oscillate in a single plane.
(c)	Magnetic fields dominate.
(d)	Both a and c.

Q16. The uncertainty principle relates which two quantities?

(a)	Position and velocity
(b)	Position and momentum
(c)	Energy and velocity
(d)	Energy and frequency

Q17. The Dirac notation is used to describe:

(a)	State vectors
(b)	Probability density
(c)	Eigenvalues

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(d)	Commutators
Q18. The wavefunction of a particle contains information about its:	
(a)	Velocity
(b)	Momentum
(c)	Probability distribution
(d)	Mass
Q19. The variational method is primarily used in:	
(a)	Calculating eigenvalues
(b)	Solving differential equations
(c)	Estimating ground state energies
(d)	Evaluating Feynman diagrams
Q20. Spin-orbit coupling arises due to:	
(a)	Interaction of spin with magnetic fields.
(b)	Relativistic corrections in quantum systems.
(c)	External perturbations.
(d)	Interaction between angular momentum and spin.
Q21. What does the second law of thermodynamics imply?	
(a)	Energy conservation
(b)	Entropy always increases
(c)	Heat flows from cold to hot
(d)	Systems are always in equilibrium
Q22. The grand-canonical ensemble is characterized by constant:	
(a)	Temperature and volume
(b)	Energy and volume
(c)	Temperature and chemical potential
(d)	Volume and entropy
Q23. Blackbody radiation is described by:	
(a)	Planck's distribution law
(b)	Stefan-Boltzmann law
(c)	Wien's displacement law
(d)	All of the above

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Q24. A particle moves in a harmonic potential $V(x) = 1/2\ kx^2$. If k = 100 N/m and the amplitude of oscillation is 0.1 m, what is the total energy of the system?	
(a)	0.5 J
(b)	0.1 J
(c)	1.0 J
(d)	2.0 J
Q25. The chemical potential is zero for:	
(a)	Photons
(b)	Electrons
(c)	Protons
(d)	Neutrons

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ANSWERS KEY
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1. **(a)** Every matrix satisfies its characteristic equation.
2. **(b)** 2 rad/s.
3. **(c)** 3.
4. **(b)** Complex analysis.
5. **(b)** Probability theory.
6. **(b)** Rigid body dynamics.
7. **(a)** Force depends only on the distance from a fixed point.
8. **(c)** Special relativity.
9. **(a)** 966 nm.
10. **(d)** Energy minimization.
11. **(b)** Electric flux.
12. **(b)** Magnetic fields.
13. **(b)** Reflection and refraction.
14. **(a)** Maxwell's equations.
15. **(b)** Electric field vectors oscillate in a single plane.
16. **(b)** Position and momentum.
17. **(a)** State vectors.
18. **(c)** Probability distribution.
19. **(c)** Estimating ground state energies.
20. **(d)** Interaction between angular momentum and spin.
21. **(b)** Entropy always increases.
22. **(c)** Temperature and chemical potential.
23. **(d)** All of the above.
24. **(a)** 0.5 J.
25. **(a)** Photons.