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M.Phil./Ph.D. Entrance Examination, August - 2018
PHYSICS

Day and Date : Wednesday, 08 - 08 - 2018**Total Marks : 100****Time : 1.00 p.m. to 3.00 p.m.**

- Instructions :**
- 1) All questions are compulsory.
 - 2) Each question carries 2 marks.
 - 3) Answers should be marked in the given OMR answer sheet by darkening the appropriate option.
 - 4) Use black ball point pen only for marking the circle. Do not make any stray mark on the OMR Answer Sheet.
 - 5) Follow the instructions given on OMR Sheet.
 - 6) Rough work shall be done on the sheet provided at the end of question paper.
 - 7) Only non programmable calculators are allowed.

- 1) The normalized ground state wave function of a hydrogen atom is given by,

$$\psi(x) = \frac{1}{4\pi} \frac{2}{a^{3/2}} e^{-r/a}, \text{ where } a \text{ is the Bohr radius and } r \text{ is the hydrogen distance}$$

of the electron from the nucleus, located at the origin. The expectation value

$$\left\langle \frac{1}{r^2} \right\rangle \text{ is}$$

A) $\frac{8\pi}{a^2}$

B) $\frac{4\pi}{a^2}$

C) $\frac{4}{a^2}$

D) $\frac{2}{a^2}$

- 2) The ground state energy of a quantum mechanical system is always
- A) Suppressed (lowered) due to second order perturbation
 - B) Suppressed (lowered) due to first order perturbation
 - C) Raised due to second order perturbation
 - D) Raised due to first order perturbation
- 3) The eigenvalues of Hermitian operator must be
- A) Complex
 - B) Real
 - C) Positive
 - D) Negative
- 4) Which of the following is not a consequence of Heisenberg uncertainty principle?
- A) Absence of electrons in atomic nuclei
 - B) Extra stability of benzene molecule
 - C) Repulsive part of van der Waal's interaction
 - D) Antisymmetric nature of wave function of electrons
- 5) A particle is in simple harmonic motion along the x axis. The amplitude of the motion is x_m . At one point in its motion its kinetic energy is $K = 5J$ and its potential energy (measured with $U = 0$ at $x = 0$) is $U = 3J$. When it is at $x = x_m$, the kinetic and potential energies are:
- A) $K = 5J$ and $U = 3J$
 - B) $K = 5J$ and $U = -3J$
 - C) $K = 8J$ and $U = 0$
 - D) $K = 0$ and $U = 8J$
- 6) In a central force field, the trajectory of a particle of mass m and angular momentum L in plane polar coordinate is given by, $\frac{1}{r} = \frac{m}{L^2}(1 + \epsilon \cos \theta)$ where, ϵ is the eccentricity of the particle's motion. Which one of the following choices for ϵ gives rise to a parabolic trajectory?
- A) $\epsilon = 0$
 - B) $\epsilon = 1$
 - C) $\epsilon < 1$
 - D) $\epsilon > 1$

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- 7) A particle of mass m is constrained to move in a vertical plane along a trajectory given by $x = A \cos\theta$ and $y = A \sin\theta$ where A is constant. The Lagrangian of the particle is
- A) $\frac{1}{2}mA^2\dot{\theta}^2 - mgA\cos\theta$ B) $\frac{1}{2}mA^2\dot{\theta}^2 - mgA\sin\theta$
C) $\frac{1}{2}mA^2\dot{\theta}^2$ D) $\frac{1}{2}mA^2\dot{\theta}^2 + mgA\cos\theta$
- 8) If p and q are the position and momentum variables, which one of the following is NOT a canonical transformation?
- A) $Q = \alpha p$ and $P = \frac{1}{\alpha} p$ for $\alpha \neq 0$
B) $Q = \alpha q + \beta p$ and $P = \beta q + \alpha p$ for α, β real and $\alpha^2 - \beta^2 = 1$
C) $Q = p$ $P = q$
D) $Q = p$ $P = -q$
- 9) At a surface current, which one of the magneto static boundary condition is not correct?
- A) Normal component of the magnetic field is continuous
B) Normal component of the vector potential is continuous
C) Tangential component of the magnetic vector potential is continuous
D) Tangential component of the magnetic vector potential is not continuous
- 10) The Poynting vector $S = \frac{1}{\mu_0} (\mathbf{E} \times \mathbf{B})$ has the dimension of
- A) Energy B) Energy/area
C) Power D) Power/area

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- 11) An electromagnetic wave going through vacuum is described by $E = E_0 \cos(kz - \omega t)$ and $B = B_0 \cos(kz - \omega t)$. The relation between E_0 and B_0 is
- A) $E_0 B_0 = \frac{\omega}{k}$ B) $E_0 B_0 = \omega k$
C) $E_0 k = B_0 \omega$ D) $E_0 \omega = B_0 k$
- 12) The displacement current arises due to
- A) Positive charges only
B) Negative charges only
C) Both Positive and negative charges
D) Time varying electric field
- 13) The trace of an antisymmetric matrix is
- A) Real B) Zero
C) Pure imaginary D) Unity
- 14) A 3×3 matrix has elements such that its trace is 11 and its determinant is 36. The eigen values of the matrix are all known to be positive integers. The largest eigen values of the matrix is
- A) 18 B) 12
C) 9 D) 6
- 15) $f(t) = e^{-at^2}$ is a Gaussian function. Its Fourier transform is
- A) Gaussian B) Polynomial
C) Trigonometric D) Lorentzian

- 16) The expression $\left(\frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2} + \frac{\partial^2}{\partial x_3^2} + \frac{\partial^2}{\partial x_4^2} \right) \frac{1}{(x_1^2 + x_2^2 + x_3^2 + x_4^2)}$ is proportional to,
- A) $\delta(x_1 + x_2 + x_3 + x_4)$ B) $\delta(x_1)\delta(x_2)\delta(x_3)\delta(x_4)$
- C) $(x_1^2 + x_2^2 + x_3^2 + x_4^2)^{-3/2}$ D) $(x_1^2 + x_2^2 + x_3^2 + x_4^2)^{-2}$
- 17) In the β -decay of neutron $n \rightarrow p + e^- + \bar{\nu}_e$, the anti neutrino $\bar{\nu}_e$ escapes detection. Its existence is inferred from the measurement of
- A) Energy distribution of electrons
- B) Angular distributions of electrons
- C) Helicity distribution of electrons
- D) Forward-backward asymmetry of electrons
- 18) Which one of the following sets corresponds to fundamental particles?
- A) Proton, electron and neutron
- B) Proton, electron and photon
- C) Electron, photon and neutrino
- D) Quark, electron and meson
- 19) The nuclear fission due to an absorption of a slow neutron is an example of
- A) Compound nuclear reaction B) Direct reaction
- C) Neutron scattering reaction D) Quantum mechanical tunneling
- 20) The quark structure of Δ^{++} is
- A) UUU B) UdS
- C) SSS D) ddd

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- 21) According to the Lande's rule, the interval ratio for 3F terms is given by
- A) 1 : 2 B) 2 : 3
C) 3 : 4 D) 4 : 5
- 22) According to classical theory, the frequency shift of Raman lines of a diatomic molecule is
- A) $\nu/2$ B) ν
C) 2ν D) 4ν
- 23) The classical statistics reduces to quantum statistics under the following condition
- A) $\rho\lambda^3 = 1$
B) $\rho\lambda^3 \gg 1$
C) $\rho\lambda^3 \ll 1$
D) $\rho = 0$

where ρ is the number density of the particles $\rho = \frac{N}{V}$ and λ is the

$$\text{thermal de-Broglie wavelength } \lambda = \sqrt{\frac{h^2}{2\pi mkT}}$$

- 24) In isotherms of liquid-gas transition (van der Waals curves) of real gas
- A) maxima and minima points come closer with rise in temperature
B) maxima and minima points turn away with rise in temperature
C) there are no maxima and minima points in the region $T < T_c$.
D) there are maxima and minima points in the region $T > T_c$.

- 30) What is deemed a good measure of the quality of a journal?
- A) The impact factor
 - B) Citations
 - C) h-index
 - D) i-10 index
- 31) The purpose of research is:
- A) primarily to get more data
 - B) to extend the conceptual understanding of a topic
 - C) that the empirical work should be testing a theory
 - D) to produce work of publishable quality
- 32) Testing hypothesis is a
- A) inferential statistics
 - B) descriptive statistics
 - C) data preparation
 - D) data analysis
- 33) Both the current and potential are varied in ____ mode of electrodeposition.
- A) Potentiodynamic
 - B) Galvonostatic
 - C) Potentiostatic
 - D) None of these
- 34) Which process is used to deposit metals on glass, ceramic and plastic?
- A) Silk plating technique
 - B) Gas plating technique
 - C) Electroless plating technique
 - D) Electroplating technique

- 35) For ____ ionic product must be greater than solubility product.
- A) Aggregation
 - B) Precipitation
 - C) Dissociation
 - D) Decomposition
- 36) In galvanostatic mode of electrodeposition _____ is kept constant and potential is measured with respect to _____.
- A) Current and time
 - B) Voltage and time
 - C) Current and Voltage
 - D) All of these
- 37) What is the nature of radiation pattern of an isotropic antenna?
- A) Hyperbolic
 - B) Spherical
 - C) Elliptical
 - D) Dough-nut
- 38) Which type of ground wave travels over the earth surface by acquiring direct path through air from transmitting to receiving antennas?
- A) Surface wave
 - B) Space wave
 - C) Both surface & space
 - D) None of the above
- 39) In thermo gravimetric analysis (TGA), the change in weight of the sample may occur due to
- A) Gas desorption
 - B) Decomposition
 - C) Chemisorption
 - D) All of above
- 40) TGA-DTA analysis is carried out to know _____ of substance
- A) Crystal structure
 - B) Surface morphology
 - C) Contact angle
 - D) Decomposing temperature

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- 41) The wavelength of Cu $K\alpha$ radiation is _____ nm
- A) 0.1542 B) 0.1791
C) 0.1937 D) 0.2291
- 42) _____ is used as filter for Co target in x-ray tube.
- A) Ni B) Fe
C) Mn D) Nb
- 43) In XRD analysis the unit cell parameters are calculated from
- A) Background B) Peak positions
C) Peak intensity D) FWHM
- 44) The conditions for unit cell parameters; $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$ represent the _____ crystal system
- A) Triclinic B) Monoclinic
C) Tetragonal D) Orthorhombic
- 45) The Miller indices h, k, and l of parallel planes in a BCC lattice should satisfy which of the following X-ray diffraction reflection rules?
- A) h + k + l should be even
B) h, k, and l should all be either even or odd
C) h, k, and l should form Pythagoras triplet
D) all planes allow reflections
- 46) IR spectroscopy provides valuable information about
- A) molecular weight
B) melting point
C) conjunction
D) functional groups

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- 47) The wavenumber of a transition is 2000 cm^{-1} . In what part of the electromagnetic spectrum does this come?
- A) Microwave
B) Infrared
C) Ultraviolet-visible
D) Radiowave
- 48) According to the Beer-Lambert Law, on which of the following does absorbance not depend?
- A) Colour of the solution
B) Extinction coefficient of the sample
C) Solution concentration
D) Distance that the light has travelled through the sample
- 49) In _____ numerical method, we approximate the curve of a solution by the tangent in each interval.
- A) Picard
B) Euler
C) Newton
D) Runge Kutta
- 50) The convergence of _____ numerical method is sensitive to starting volume.
- A) False position
B) Gauss seidal
C) Newton-Raphson
D) Jacobi

x x x

Rough Work