Seat No.	

M.Phil/Ph.D. Entrance Examination, September - 2019
PHYSICS

Day and Date : Wednesday, 18 - 09 - 2019　　　　　　　**Total Marks : 100**

Time : 01.00 p.m. to 03.00 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) As per Lande's rule, the interval ratio for ^3P terms is given by
   A) 1 : 2　　　　　　　　　　　B) 2 : 3
   C) 3 : 4　　　　　　　　　　　D) 4 : 5

2) When the Zeeman pattern of two-electron systems in viewed $\perp$ to the magnetic field (H) direction, the S components are
   A) Plane polarized $\perp$ to H direction　　B) Plane polarized $\parallel$ to H direction
   C) Circularly polarized　　　　　　　D) Forbidden

3) The electronic band spectra of a diatomic molecule arise due to transitions between
   A) Electronic states of the two atoms
   B) Vibrational levels associated with two electronic states
   C) Rotational levels associated with two vibrational states
   D) Vibrational and Rotational levels associated with two electronic states

P.T.O.

4) The value of *m* and *n* for which the transformations are $Q = q^\alpha \cos \beta p$ and $p = q^\alpha \sin \beta p$ represents canonical transformation are :

A) $m = 1; n = 2$

B) $m = \frac{1}{2}; n = 2$

C) $m = 2; n = \frac{1}{2}$

D) $m = 2; n = 1$

5) For the transformation $Q = \log (1 + q^{\frac{1}{2}} \cos p); p = 2 (1 + q^{\frac{1}{2}} \cos p)q^{\frac{1}{2}} \sin p$, the generating function is

A) $-(e^Q - 1)^2 \tan p$

B) $(e^Q - 1)^2 \tan p$

C) $(e^Q - 1)^2 \cot p$

D) $-(e^Q - 1)^2 \cot p$

6) 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) $Q = p \; P = -q$

7) A particle of mass m moves in a potential $V(x) - \frac{1}{2}m\omega^2 x^2 + \frac{1}{2}m\mu v^2$ where *x* is the position coordinate, *v* is the speed and ω and μ are constants. The canonical (conjugate) momentum of the particle is

A) $p = m(1 + \mu)v$

B) $p = mv$

C) $p = m\mu v$

D) $p = m(1 - \mu)v$

8) The Lagrangian for a simple pendulum is given by :

$$L = \frac{1}{2}ml^2\dot{\theta}^2 - mgl(1 - \cos\theta)$$

Hamiltonian's equation are then given by

A) $\dot{p}_\theta = -mgl\sin\theta, \dot{\theta} = \dfrac{p_\theta}{ml^2}$

B) $\dot{p}_\theta = mgl\sin\theta, \dot{\theta} = \dfrac{p_\theta}{ml^2}$

C) $\dot{p}_\theta = -m\theta, \dot{\theta} = \dfrac{p_\theta}{m}$

D) $\dot{p}_\theta = -\left(\dfrac{g}{l}\right)\theta, \dot{\theta} = \dfrac{p_\theta}{ml}$

9) An electric field associated with an electromagnetic radiation is $\bar{E} = (\hat{x}E_x + \hat{y}E_y)e^{i(kz-\omega t)}$ If $E_y = iE_x$ then the electromagnetic radiation is

A) Plane polarized

B) Circularly polarized

C) Elliptically polarized

D) Unpolarized

10) An electron enters a uniform magnetic field region with its velocity perpendicular to the direction of the field. In the field region, the trajectory of the electron is

A) Linear

B) Circular

C) Parabolic

D) Hyperbolic

11) In free space, an infinite grounded conducting plane is placed in x-y plane. The force experienced by point charge q at a point $(0,0,d)$ $d > 0$ is

A) $\overline{0}$

B) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q^2}{d^2}\hat{z}$

C) $\dfrac{1}{16\pi\varepsilon_0}\dfrac{q^2}{d^2}\hat{z}$

D) $\dfrac{-1}{16\pi\varepsilon_0}\dfrac{q^2}{d^2}\hat{z}$

12) A matrix M is of the form: $M = \begin{bmatrix} 0 & a \\ -a* & 0 \end{bmatrix}$. If the det M = 1, the most general value of a is, Where θ is a real parameter

A) $\cos\theta$
B) $\sin\theta$

C) $\exp(i\theta)$
D) $\cosh\theta$

13) The particular integral of the inhomogeneous linear differential equation $\dfrac{dy}{dx} - y = x$ is given by

A) e^x
B) xe^x

C) $-x - 1$
D) $x + 1$

14) The eigenvalues of (2×2) matrix $\begin{bmatrix} 2 & 3 \\ 1 & 0 \end{bmatrix}$ are

A) 0, 2

B) 1, 3

C) 3, –1

D) $1 + i, 1 - i$

15) The symmetry term in semi empirical mass formula is due to

A) Non equality of proton number Z and neutron number N

B) Non spherical shape of nuclei

C) Charge independence of nuclear force

D) Non zero value of quadrupole moment of nuclei

16) Which of the following reactions is allowed one?

A) $p + p \rightarrow k^+ + \Sigma^+$
B) $p + p \rightarrow k^+ + p + \wedge^0$

C) $\pi^- + p \rightarrow \Sigma^+ + K^0$
D) $\pi^- + p \rightarrow \pi^0 + \wedge^0$

17) Alpha particles and protons of the same kinetic energy are passed through a gold foil. What is the ratio of their Coulomb scattering intensity?

A) 2

B) 3

C) 3/2

D) 4

18) 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

19) A state of a system with spherical symmetric potential has zero uncertainty in simultaneous measurements of operators L_x and L_y. Which of the following statement is true?

A) Such a state can never exist

B) The state must be $l = 0$ state

C) The state has $l = 1$ with $m = 0$

D) The state cannot be an eigen state of L^2 operator

20) Which of the following is an eigenfunction of Linear momentum operator $\dfrac{\hbar}{i}\dfrac{\partial}{\partial x}$, such that it describes a particle moving in free space in the direction of negative x-axis, with zero uncertainty in the linear momentum?

A) $\cos kx$

B) e^{ikx}

C) e^{kx}

D) e^{-ikx}

21) Three distinguishable particles have a total energy of 9ε. These particles are distributed over the energy state with energy 0, ε, 2ε, 3ε and 4ε. The total number of microstates will be

A) 3

B) 1

C) 10

D) 6

22) The critical temperature T_C, for the Bose-Einstein condensation depends on the density 'n' of the gas as

A) $n^{\frac{1}{3}}$

B) $n^{\frac{2}{3}}$

C) n

D) $n^{\frac{4}{3}}$

23) The Gibbs free energy 'G' of a system maintained at a temperature 'T' satisfies the following relation with the pressure 'P', the volume 'V', the internal energy 'U' and the entropy 'S' of the system

A) $G = PV - TS$

B) $G = U + PV - TS$

C) $G = U - PV + TS$

D) $S = - K_{\beta} l_n G$

24) Two identical indistinguishable particles are to be distributed over three energy states. The number of ways of distribution for Fermi gas and Bose gas respectively will be

A) 1, 3

B) 6, 3

C) 3, 6

D) 1, 6

25) Which of the following atoms cannot exhibit Bose-Einstein condensation, even in principle

A) $^{1}H_{1}$

B) $^{4}He_{2}$

C) $^{11}Na_{22}$

D) $^{40}K_{19}$

26) XRD intensity depends upon

A) Crystal Structure

B) Atomic positions

C) Occupancies

D) All of above

27) X-ray diffraction patterns are used for studying crystal structure of solids because

A) They have very high energy, hence they can penetrate through solids

B) They are electromagnetic radiation and hence do not interact with matter

C) Their wavelengths are comparable to inter-atomic distances

D) Their high frequency enables rapid analysis

28) The wavelength of Cu Kα radiation is _____ nm

    A)   0.1542   B)   0.1791

    C)   0.1937   D)   0.2291

29) In XRD analysis the unit cell parameters are calculated from

    A)   Background   B)   Peak positions

    C)   Peak intensity   D)   FWHM

30) The Miller indices h, k and 1 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

31) 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

32) IR spectroscopy provides valuable information about

    A)   molecular weight   B)   melting point

    C)   conjunction   D)   functional groups

33) 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

34) In DTA endothermic peak occurs due to

A) Oxidation B) Chemisorption

C) Melting D) Crystallization

35) Which of the following statements regarding IR spectroscopy is not correct ?

A) Infrared radiation is higher in energy than UV radiation.

B) Infrared spectra record the transmission of IR radiation.

C) Molecular vibrations are due to periodic motions of atoms in molecules and include bond stretching, torsional changes and bond angle changes.

D) Infrared spectra give information about bonding features and functional groups in molecules.

36) Both the current and potential are varied in _____ mode of electrodeposition.

A) Potentiodynamic B) Galvonostatic

C) Potentiostatic D) None of these

37) For _____ ionic product must be greater than solubility product.

A) Aggregation B) Precipitation

C) Dissociation D) Decomposition

38) In spray pyrolysis technique solution is converted into fine droplets according to which principle?

A) Bernoulli's B) Archimedes

C) Siphon D) Stokes

39) Sol-gel method of thin film deposition is _____ approach.

A) Bottom up B) Up bottom

C) Top down D) Down top

40) What is the nature of radiation pattern of an isotropic antenna?

A) Hyperbolic   B) Spherical

C) Elliptical   D) Dough-nut

41) 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

42) Which antennas are renowned as patch antennas especially adopted for space craft applications?

A) Aperture   B) Array

C) Lens   D) Microstrip

43) RF amplifiers are used in radio receivers for

A) improved image frequency rejection

B) improved rejection of adjacent unwanted signals

C) prevention of re-radiation of the local oscillator through the antenna of the receiver

D) all of the above

44) The frequency of a transition is 3.0×10^{15} Hz. What is the energy of this transition?

A) 0.124 eV

B) 1.240 eV

C) 12.40 eV

D) 124.0 eV

45) Newton-Raphson method of solution of numerical equation is not preferred when
   A) Graph of A (B) is vertical
   B) Graph of x (y) is not parallel
   C) The graph of $f(x)$ is nearly horizontal-where it crosses the x-axis.
   D) None of these

46) The abstract should include:
   A) An explanation of the statistical analysis employed
   B) Only the most relevant tables and diagrams
   C) A list of references
   D) None of these

47) 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

48) Testing hypothesis is a
   A) inferential statistics   B) descriptive statistics
   C) data preparation   D) data analysis

49) A reasoning where we start with certain particular statements and conclude with a universal statement is called
   A) Inductive reasoning   B) Abnormal reasoning
   C) Transcendental reasoning   D) Deductive reasoning

50) What is a Patent?
   A) An agreement between the inventor and the Government
   B) An agreement to the Government
   C) Document of the library
   D) An agreement between library and publisher

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Rough Work

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