

020/2016

Maximum : 100 marks

Time : 1 hour and 15 minutes

- The ratio of mobility of holes to mobility of electrons is :
(A) 1:2 (B) 2:1
(C) 1:1 (D) 1:3
- What happens to the Fermi level if an intrinsic semiconductor is doped with acceptor atoms?
(A) Unaffected (B) Slightly raised
(C) Slightly lowered (D) Considerably lowered
- PIN diodes are used in which frequency range?
(A) 20Hz-20kHz (B) Less than 100Hz
(C) 20kHz-40kHz (D) Greater than 300MHz
- Which of the following is not true for a common collector amplifier?
(A) Current gain is high (B) Voltage gain is high
(C) Output impedance is very low (D) Input impedance is very high
- The coefficient of the term $(z - 1)^2$ in the Taylor's series of the function $(z) = 1/(z^2 - 9)$ about the point $z = 1$ is :
(A) $-\frac{1}{32}$ (B) $\frac{1}{32}$
(C) $\frac{3}{128}$ (D) $-\frac{3}{128}$
- If the uncertainty in the velocity of a particle is equal to its velocity, what is the order of uncertainty in its location?
(A) P (B) λ
(C) $\frac{P}{m}$ (D) $\frac{P}{2m}$
- The energy of the particle in three dimensional cubic box of length L is given by $\frac{21\pi^2\hbar^2}{2mL^2}$, then the degeneracy of the state is :
(A) 1 (B) 3
(C) 6 (D) 12

8. If the operators A and B commute with H and $[A, B] = C$, where C is another operator, then :
- (A) $[H, C] = H$ (B) $[H, C] = 0$
 (C) $[H, C] = C$ (D) $[H, C] = 1$
9. If the quantum mechanical operators of two observables of a system do not commute, then :
- (A) The observables are said to be incompatible
 (B) The observables are said to be compatible
 (C) Observables must be time independent
 (D) Total energy of the system must be negative
10. How much energy is required to remove an electron from $n = 8$ state of hydrogen atom?
- (A) 0.21 eV (B) -0.21 eV
 (C) 13.6 eV (D) 27.2 eV
11. The ground state of a linear harmonic oscillator is :
- (A) Trigonometric function (B) Gaussian function
 (C) Hyperbolic function (D) Bessel function
12. The mass m of a moving particle is $\frac{2m_0}{\sqrt{3}}$, where m_0 is its rest mass. The linear momentum of the particle is :
- (A) $2m_0c$ (B) $\frac{2m_0}{\sqrt{3}}$
 (C) $2m_0$ (D) $\frac{m_0c}{\sqrt{3}}$
13. Consider a 6 particle system with 5 particles arranged as a regular pentagon with the 6th particle at the centre. If all the 5 particles are connected to the central one by rigid rods, then the number of degrees of freedom for the system is :
- (A) 13 (B) 6
 (C) 5 (D) 18
14. The homogeneity of time leads to the law of conservation of :
- (A) Linear momentum (B) Angular momentum
 (C) Energy (D) Parity

15. If a particle move in a horizontal plane in a central force potential $U(r)$, which of the following physical quantities are conserved :

- (A) Angular momentum only
- (B) Energy only
- (C) Both angular momentum and energy
- (D) Linear momentum and energy

16. Which of the following is wrong?

- (A) $[L^2, L_z] = 0$
- (B) $[L_z, L_x] = \hbar L_y$
- (C) $[L_x, L_y] = \hbar L_z$
- (D) $[L_x, L_z] = -\hbar L_y$

17. For what value of α and β do the equations $Q = q^\alpha \cos \beta p$, $p = q^\alpha \sin \beta p$, represent a canonical transformation :

- (A) $\alpha = 2; \beta = \frac{1}{2}$
- (B) $\alpha = 2; \beta = 2$
- (C) $\alpha = \frac{1}{2}; \beta = 2$
- (D) $\alpha = 2; \beta = 1$

18. If a particle has rest mass m_0 and velocity $\frac{c}{2}$, then the momentum of the particle is :

- (A) $m_0 c$
- (B) $2m_0 c$
- (C) $\frac{m_0 c}{\sqrt{2}}$
- (D) $\frac{m_0 c}{\sqrt{3}}$

19. If all the surfaces are closed in a region containing volume V , then which of the following theorem is applicable?

- (A) Stokes theorem
- (B) Green's theorem
- (C) Gauss Divergence theorem
- (D) DeMorgans theorem

20. A spherically symmetric charge distribution is given by $\rho(r) = \rho_0 \left(\frac{1-r^2}{a^2} \right)$, if the value of r is between 0 and a and $\rho(r) = 0$, if r is greater than a . if $8\pi a^2 \rho_0 = k$, then the total charge of the distribution is :

- (A) $\frac{k}{15}$
- (B) $\frac{k a}{17}$
- (C) $\frac{k a}{15}$
- (D) Zero

21. What happens to velocity of light as it travels from a denser medium to a rarer medium?
- (A) Decreases (B) Increases
(C) Remains the same (D) Cannot predict.
22. Gibbs paradox in statistical mechanics is related to the additive property of :
- (A) Energy (B) Momentum
(C) Entropy (D) Temperature
23. The rms speed of hydrogen gas molecules at STP is v m/s. The gas is heated at constant volume till the pressure become 9 times its original value. What will be the new rms speed?
- (A) $3v$ (B) $9v$
(C) $18v$ (D) $\frac{v}{3}$
24. A canonical ensemble represents :
- (A) An equilibrium system with a fixed volume which can exchange energy and matter with the surroundings
(B) An equilibrium system with a fixed volume and a fixed number of particles which can exchange energy with the surroundings
(C) An isolated system
(D) A system at constant pressure
25. What is to a nuclear physicist as Hydrogen is to an Atomic physicist?
- (A) Neutron (B) Deuteron
(C) Deuterium (D) Proton
26. Which of the following statement about nuclear force is wrong?
- (A) Spindependent
(B) Charge symmetric
(C) Always attractive
(D) Depends on the momentum of the nucleons
27. The relation between mean life τ and half-life $T_{\frac{1}{2}}$ of a radioactive sample is :
- (A) $\tau = 2T_{\frac{1}{2}}$ (B) $\tau = \frac{T_{\frac{1}{2}}}{2}$
(C) $\tau = \frac{T_{\frac{1}{2}}}{0.693}$ (D) $\tau = 0.693T_{\frac{1}{2}}$

28. The ratio of energies of thermal neutrons to slow neutrons in keV is :
- (A) $25 \times 10^{-6} : 1$ (B) $1 : 10^3$
 (C) $1 : 10^6$ (D) $1 : 25 \times 10^{-6}$
29. Residue of the function $f(z) = \frac{z^2}{(z^4 + 4)}$ at $z = 2i$ is :
- (A) $e^{\frac{3ix}{4}}$ (B) e^{ix}
 (C) $e^{\frac{3ix}{2}}$ (D) $e^{\frac{ix}{2}}$
30. The electric field due to a charge q is given by $E = \frac{qr}{r^2}$. The value of the surface integral $\iint E \cdot dS$ depends on :
- (A) The area of the surface
 (B) The radial distance r
 (C) The shape of the surface
 (D) The charge
31. The field of magnetic vector B is always :
- (A) Irrotational (B) Solenoidal
 (C) Non-solenoidal (D) Both irrotational and non-solenoidal
32. Eight electric dipoles of charges of magnitude 'e' are placed inside a cube. The total electric flux coming out of the cube will be :
- (A) $\frac{8e}{\epsilon_0}$ (B) $\frac{16e}{\epsilon_0}$
 (C) $\frac{e}{\epsilon_0}$ (D) Zero
33. A point charge is placed at the centre of a spherical Gaussian surface. The electric flux crossing the surface will change if :
- (A) The sphere is replaced by a cube of different volume and surface area
 (B) The point charge is moved off from the centre but still remains inside the sphere
 (C) The point charge is moved just to the outside of the sphere
 (D) Another point charge is placed just outside the sphere

34. A vector field F is said to be conservative if and only if :
- (A) F is the curl of some vector r
 (B) F can be represented as a gradient of a scalar function Φ
 (C) $\text{div}F = 0$
 (D) $\text{curl}F = F$
35. Which of the following involves the four concepts of discrete energy levels, Larmorprecession, space quantization and L-S coupling?
- (A) Paschen-Back effect (B) Frank-Hertz Experiment
 (C) Stern and Gerlach experiment (D) Zeeman effect
36. Which of the following molecules does not exhibit a rotational spectrum?
- (A) H_2 (B) CO
 (C) HCl (D) HBr
37. For a specimen of V_3Ga , the critical fields are 0.176T and 0.528T at 14K and 13K respectively. Calculate the transition temperature :
- (A) 13.5 K (B) 14.5 K
 (C) 15.5 K (D) 10.5 K
38. In which of the following cases an atom is expected to possess nuclear magnetic moment?
- (A) Number of protons and neutrons are equal
 (B) Nucleus has only protons
 (C) Nucleus has only neutrons
 (D) Number of neutrons and protons are unequal.
39. Gold at nano scale is :
- (A) Transparent (B) Red in colour
 (C) Blue in colour (D) An insulator
40. Which of the following is not an object oriented programming language?
- (A) Java (B) C++
 (C) C (D) Ruby
41. The point group of ammonia molecule is :
- (A) C_{2v} (B) C_{3v}
 (C) D_{3h} (D) Td
42. Number of microstates for d^3 configuration is :
- (A) 100 (B) 10
 (C) 1 (D) 120

43. What is the term symbol arising from the ground state electronic configuration of Na?
- (A) ${}^2S_{\frac{1}{2}}$ (B) ${}^2P_{\frac{1}{2}}$
 (C) ${}^2P_{\frac{3}{2}}$ (D) 2S_0
44. Which among the following is the strongest conjugate base?
- (A) CH_3COO^- (B) NO_3^-
 (C) SO_4^{2-} (D) Cl^-
45. Which among the following is thermodynamically the most stable allotropic form of carbon at normal temperatures and pressures?
- (A) Fullerene (B) Diamond
 (C) β -Graphite (D) α -Graphite
46. The oxidation number of P in pyrophosphorous acid is :
- (A) +2 (B) +1
 (C) +5 (D) +3
47. The strongest reducing agent amongst the following is :
- (A) BiH_3 (B) NH_3
 (C) AsH_3 (D) PH_3
48. A graphical representation of free energy vs. temperature for the formation of oxides of elements is :
- (A) Phase diagram (B) Ellingham diagram
 (C) Pourbaix diagram (D) Flow diagram
49. Siderite is an ore of :
- (A) Al (B) Zn
 (C) Pb (D) Fe
50. For noble gases, the electronic partition function has a value of :
- (A) 0 (B) 1
 (C) 2 (D) $\frac{1}{2}$
51. Cross Cannizzaro reaction is given by :
- (A) Acetaldehyde, Formaldehyde (B) Benzaldehyde, Acetaldehyde
 (C) Benzaldehyde, Formaldehyde (D) All of these
52. Iodoform test is not given by :
- (A) 3-Pentanone (B) 2-Pentanone
 (C) Acetaldehyde (D) Ethanol

53. Which of the following is not aromatic?
- (A) Benzene (B) Anthracene
(C) Cyclobutadiene (D) Thiophene
54. Aliphatic polyamides are generally known as :
- (A) Polypropylene (B) Terylenes
(C) Bakelite (D) Nylonones
55. Stereoisomer's resulting from the restricted rotation about the single bonds, where the rotational barrier is high enough to permit isolation of the isomeric species are called :
- (A) Atropisomers (B) Diastereomers
(C) Epimers (D) Anomers
56. An anomalous ORD (Optical Rotatory Dispersion) curve exhibits both a maximum and minimum, and a point of crossover. This effect in ORD is called :
- (A) Gauche effect (B) Anomeric effect
(C) Cotton effect (D) Stereoelectronic effect
57. Esters having an α -hydrogen atom on treatment with a strong base like sodium ethoxide gives a β -keto ester. Identify this reaction :
- (A) Claisen condensation (B) Darzen condensation
(C) Aldol condensation (D) Houben-Hoesch reaction
58. The heating of an acyl azide to an isocyanate is known as :
- (A) Beckmann rearrangement (B) Lossen rearrangement
(C) Allylic rearrangement (D) Curtius rearrangement
59. Anhydrous $AlCl_3$ is not used as a reagent in :
- (A) Friedel-Craft reaction (B) Birch reduction
(C) Gattermann Koch reaction (D) Fries migration
60. The hereditary shortage of ceruloplasmin resulting in the accumulation of copper in liver, kidneys and brain is :
- (A) Scurvy (B) Pernicious anaemia
(C) Wilson's disease (D) Beriberi
61. Which among the following is not a Haem metalloprotein?
- (A) Haemerythrin (B) Cytochromes
(C) Myoglobin (D) Haemoglobin