BHU MSc Entrance 2019

No. of Questions: 120 **Time: 2 Hours**

Full Marks: 360

Note: (1) Attempt as many questions as you can. Each question carries 3 marks. One mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

Q1. Consider a linear collection on N independent spin $1/2$ particles, each at fixed location. The entropy of the system is:

(a) 0 (b) $\frac{Nk_B}{2}\ln 2$ (c) $Nk_B \ln 2$ (d) $\frac{Nk_B}{2}$

Q2. The path of a particle situated on the rim of a wheel moving along a surface (wheel is rotating) as observed by an observer standing on the earth near the wheel will be:

(a) linear (b) elliptical (c) circular (d) cycloidal

Q3. Which of the following is not correct for the first order phase transition?

(a) Gibbs function changes discontinuously at phase transition temperature

(b) Volume changes during phase transition

(c) There is change in entropy during phase transition

(d) First order derivatives of Gibb's function change discontinuously at phase transition temperature

Q4. A term of the type $\frac{\partial T}{\partial q_k}$, where T and q_k are the kinetic energy and a generalized coordinate, respectively, if occurring in equation of motion of a system is called a

(a) generalized momentum (b) potential

(c) generalized velocity (d) fictitious force

Q5. What is the major factor for determining whether a medium is free space, lossless dielectric, loss of dielectric or good conductor?

(a) Reflection coefficient (b) Attenuation constant

(c) Loss tangent (d) Constitutive parameters $(\sigma, \in_1, \mu)$

Q6. In the diffraction pattern due to a single slit, the width of the central maximum will be:

(a) Larger for wide slit (b) Larger for narrow slit

(c) Less for narrow slit (d) Less for wide slit

Q7. The unit vectors $\hat{\theta}$ and $\hat{\phi}$ (where θ and ϕ are the polar and the azimuthal angles, respectively), in the spherical coordinate system, under the operation of inversion (i.e., reflection through the origin) have:

(a) odd parity and even parity, respectively (b) both odd parity

(c) even parity and odd parity, respectively (d) both even parity

Q8. If in a capillary tube, the rate of flow of a liquid is measured by collecting $100\,ml$ of liquid in $100\sec$ in a measuring flask. If the least count of the volume of the measuring flask be 1 ml and the least count of the stop watch used for measuring the time be $0.01\sec$, then the uncertainty in the rate of flow of the liquid will be:

(a) 1.01 (b) 10^{-4} (c) 10^{-6} (d) 1.01×10^{-2}

Q9. When a small magnetic field H is applied to a magnetic material, the intensity of magnetization is proportional to:

(a) H (b) $H^{1/2}$ (c) H^2 (d) H^{-2}

Q10. States of thermodynamic equilibrium can be described in terms of

(a) Macroscopic thermodynamic coordinates

(b) Microscopic coordinates

(c) Macroscopic thermodynamic coordinates that involve time also

(d) Microscopic coordinates that involve time also

Q11. The distance between the Sun and the Earth is 1 astronomical unit ($1\,AU$). Jupiter takes about 11.9 earth years to orbit around the Sun. The distance between the Sun and Jupiter, in AU, is about

(a) 11.9 (b) 7.2 (c) 3.5 (d) 5.2

Q12. Number of bound states for the system $V(x) = -V_0\delta(x-a), V_0 > 0$ is

(a) depends on the value of V_0a^2 (b) 0

(c) infinite (d) 1

Q13. About Stern-Gerlach Experiment, which one is not true?

(a) It is observed with atoms whose ground state is ${}^2S_{1/2}$

(b) It is observed with atoms whose ground state is ${}^1S_0$

(c) It is possible with both atoms and ions

(d) Gives evidence of electron spin

Q14. The dominant mode for rectangular waveguide is:

(a) TM_{11} (b) TE_{101} (c) TE_{11} (d) TE_{10}

Q15. The value of $\left\langle \frac{1}{r} \right\rangle$ in the $\psi_{1,0,0}(r,\theta,\phi)$ state of a hydrogen atom is (a_0 is Bohr radius):

(a) $\frac{1}{2a_0}$ (b) a_0 (c) $\frac{1}{a_0}$ (d) 0

Q16. Radio waves in the frequency range $3\,MHz - 30\,MHz$ propagate through which mode of propagation?

(a) Surface mode (b) Sky wave or ionospheric mode

(c) Ground mode (d) Space wave mode

Q17. Which of the following is a Hermitian operator?

(a) $-\frac{d^2}{dx^2}$ (b) $\frac{d}{dx}$ (c) $\hat{x}\hat{p}_x$ (d) $i\frac{d^2}{dx^2}$

Q18. The minimum number of lines in plane diffraction grating required to just resolve the sodium doublet ($5890\,\overset{0}{\mathrm{A}}$ and $5896\,\overset{0}{\mathrm{A}}$) in first order is:

(a) 246 (b) 982 (c) 1964 (d) 491

Q19. The de-Broglie wavelength of a $10\,KeV$ electron is equal to

(a) $1.23\,\overset{0}{\mathrm{A}}$ (b) $123\,\overset{0}{\mathrm{A}}$ (c) $0.123\,\overset{0}{\mathrm{A}}$ (d) $12.3\,\overset{0}{\mathrm{A}}$

Q20. In the inversion curve for a gas, in the region of cooling:

(a) Joule-Kelvin coefficient is negative (b) Joule-Kelvin coefficient is positive

(c) None of the three (d) Joule-Kelvin coefficient is zero

Q21. The spacing between two adjacent longitudinal modes in a plane laser resonator having separation between two mirrors, $d = 10\,cm$ is:

(a) $3000\,MHz$ (b) $2000\,MHz$ (c) $1000\,MHz$ (d) $1500\,MHz$

Q22. If the volume of a cube of side L_0 is L_0^3 as observed by an observer at rest relative to it, the volume as observed from a reference frame moving with uniform velocity $0.8\,c$ in a direction parallel to an edge of the cube will be:

(a) $0.216L_0^3$ (b) $0.512\,L_0^3$ (c) L_0^3 (d) $0.6\,L_0^3$

Q23. If in a ballistic galvanometer, θ_0 be the throw in the absence of damping and θ_1 be the first throw after $\frac{T}{4}$ sec (where T is the time period of oscillations in ballistic galvanometer) then the correct relation between, θ_0, θ_1 and logarithmic decrement λ of the galvanometer will be:

(a) $\theta_0 = \theta_1 e^{-\lambda/2}$ (b) $\theta_1 = \theta_0 e^{\lambda/2}$

(c) $\theta_1 = \theta_0 (1+\lambda/2)$ (d) $\theta_0 = \theta_1\left(1+\frac{\lambda}{2}\right)$

Q24. The divergence of the vector field $\vec{P} = x^2 yz\hat{i} + xy\hat{j}$ is:

(a) $2xy+z$ (b) x^2y+xz (c) $xz+yz$ (d) $2xyz+x$

Q25. Circularly polarized light is produced if, the amplitudes of the ordinary and extraordinary rays are equal and there is phase difference of

(a) 0° (b) 45° (c) 180° (d) 90°

Q26. Which of the following is optically active substance?

(a) Tourmaline (b) Calcite

(c) Quartz (d) Sodium Chloride

Q27. With what velocity an electron should move so that its kinetic energy equals its rest mass energy?

(a) $\frac{\sqrt{3}}{2}C$ (b) $\frac{\sqrt{3}}{4}C$ (c) $\frac{2}{3}C$ (d) $\frac{C}{2}$

Q28. When a single slit is replaced by double shit arrangement, the intensity of central maximum is increased by:

(a) 16 times (b) 2 times (c) 8 times (d) 4 times

Q29. If the peak value of rectified voltage from a full wave rectifier is $15V$, the approximate value of average rectified voltage will be:

(a) $\frac{15}{\sqrt{2}}$ volt (b) $15\sqrt{2}$ volt (c) 9.50 volt (d) 4.75 volt

Q30. At constant temperature, the internal energy of a Van der Waals gas:

(a) Is independent of volume of the gas

(b) Is invertionaly proportional to the volume V of the gas

(c) Remains constant

(d) Is proportional to volume V of the gas

Q31. The doublet splitting of the first excited state of H - atom due to spin orbit interaction $\left({}^2P_{3/2} \to {}^2P_{1/2}\right)$ is $0.365\ \text{cm}^{-1}$. What is the corresponding separation for L_i^{++} atom?

(a) $9.855\,\text{cm}^{-1}$ (b) $29.565\ \text{cm}^{-1}$ (c) $1.095\,\text{cm}^{-1}$ (d) $3.285\,\text{cm}^{-1}$

Q32. The distribution function $f\left(E\right)$ for a photon gas is given by

(a) $\left(e^{-E/K_BT}+1\right)^{-1}$ (b) e^{-E/K_BT}

(c) $\left(e^{E/K_BT}+1\right)^{-1}$ (d) $\left(e^{E/K_BT}-1\right)^{-1}$

Q33. In Newton's rings experiment with two different media between the glass surface, the nth rings have diameters as $10:7$. The ratio of the refraction indices of two media are:

(a) $49:100$ (b) $10:7$ (c) $100:49$ (d) $7:10$

Q34. In a plane transmission grating the angle of diffraction for the second order principal maxima for wavelength $5000\overset{0}{\text{A}}$ is 30^0. The number of lines per cm of the grating surface is:

(a) 7500 (b) 1500 (c) 10000 (d) 5000

Q35. The nuclei ${}_6C^{13}$ and ${}_7N^{14}$ can be described as:

(a) isobars (b) isotopes of nitrogen

(c) isotopes of carbon (d) isotones

Q36. An electron is confined to a box of length L. If the length of the box changes to $2L$, how would the uncertainty of momentum of electron will change:

(a) It will remain same (b) It will be twice

(c) It will be one fourth (d) It will be half

Q37. A certain JFET has transconductance $4\,mS$ with an extermal ac drain resistance $1.5\,k\Omega$, what is the ideal voltage gain?

(a) 60 (b) 6 (c) 2.6×10^{-6} (d) 3.75×10^{5}

Q38. Displacement x^j is a contravariant vector. The work done by a force is an invariant scalar. Therefore, force and hence momentum are:

(a) Both covariant vectors

(b) A covariant vector and a contravariant vector respectively

(c) Both contravariant vectors

(d) A mixed tensor of rank 2 and a contravariant vector respectively

Q39. When a wire is stretched to double its length:

(a) Longitudinal strain is unity

(b) Its radius is halved

(c) Stress is equal to two times Young's modulus

(d) Young's modulus is equal to thrice the energy per unit volume

Q40. The de-Broglie wavelength λ associated with an electron of energy V electron volt is:

(a) $\lambda = \dfrac{0.1227}{\sqrt{V}}\,nm$ (b) $\lambda = \dfrac{1.227}{\sqrt{V}}\,nm$

(c) $\lambda = \dfrac{1.227}{V}\,nm$ (d) $\lambda = \dfrac{12.27}{\sqrt{V}}\,nm$

Q41. The value of Lande g-factor for ${}^2P_{3/2}$ state is:

(a) $\dfrac{3}{2}$ (b) $\dfrac{4}{3}$ (c) 2 (d) $\dfrac{2}{3}$

Q42. The continuous X - ray spectrum is the result of

(a) Inverse photoelectric effect (b) Photoelectric effect

(c) Compton effect (d) Raman effect

Q43. At cut off the JFET channel is:

(a) Reverse biased

(b) Completely closed by depletion region

(c) At its widest point

(d) Extremely narrow

Q44. $\psi_{n,l,m}(r,\theta,\phi)$ is the eigen function of the hydrogen atom problem. The eigen values of the operator $\sin\left(a\frac{\partial}{\partial\phi}\right)$ corresponding to the eigen function $\psi_{3,2,-2}(r,\theta,\phi)$ is:

(a) $-\sin(2a)$ (b) $\sin(2a)$ (c) $\sinh(2a)$ (d) $-\sinh(2a)$

Q45. The orbital magnetic dipole moment of an electron in hydrogen like atom is $\sqrt{2}\mu_b$. What is the state of the electron?

(a) P (b) D (c) S (d) F

Q46. At 4^0C for water, $C_P = C_V$ because:

(a) $\left(\frac{\partial P}{\partial V}\right)_T = 0$ (b) None of the three

(c) $\left(\frac{\partial P}{\partial T}\right)_V = 0$ (d) $\left(\frac{\partial V}{\partial T}\right)_P = 0$

Q47. Which of the following is not correct about Pauli-Spin matrices $\vec{\sigma} = \sigma_x\hat{i} + \sigma_y\hat{j} + \sigma_z\hat{k}$?

(a) $\sigma^2 = I$ (b) $\sigma_x\sigma_y = -i\sigma_z$ (c) $Tr(\sigma) = 0$ (d) $\{\sigma_x, \sigma_y\} = 0$

Q48. The only possible real eigen value of a Skew-Hermitian matrix is:

(a) 0 (b) 1

(c) none, i.e., no real eigen values (d) -1

Q49. If two cylinders (one hollow and other solid) of same length, mass and material are given, then, to twist the cylinders through the same angle:

(a) More torque is needed for the hollow cylinder than the solid one

(b) Couple per unit twist for solid cylinder will be more than the hollow one

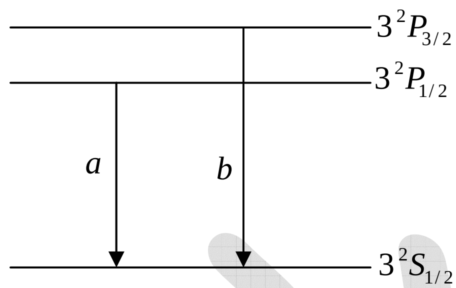
(c) Couple per unit twist for solid as well as hollow cylinders will be the same

(d) More torque is needed for the solid cylinder than the hollow one

Q50. Using Debye's theory, atomic heat capacity of a solid at constant volume, C_V at high temperature is given by:

(a) $C_V = 3R$ (b) $C_V = \frac{3}{2}R$ (c) $C_V = 2R$ (d) $C_V = R$

Q51. The following transitions lead to the two components of sodium yellow line:



The ratio of intensities of the two lines b and a, $I_b : I_a$ is:

(a) $2:3$ (b) $3:2$ (c) $2:1$ (d) $1:2$

Q52. Two identical atoms of mass m are bound to each other by the Lennard-Jones potential, $V = \in\left[\left(\frac{r_0}{r}\right)^{12} - 2\left(\frac{r_0}{r}\right)^{6}\right]$. The frequency of small oscillations about the equilibrium is:

(a) $\sqrt{\frac{\in}{2mr_0^2}}$ (b) $6\sqrt{\frac{2\in}{mr_0^2}}$ (c) $\frac{\pi}{2}\Big/\sqrt{\frac{\in}{mr_0^2}}$ (d) $12\sqrt{\frac{\in}{mr_0^2}}$

Q53. The ground state spectroscopic term for ^{17}Cl atoms is:

(a) $^2S_{1/2}$ (b) $^2P_{1/2}$ (c) $^3P_0$ (d) $^2P_{3/2}$

Q54. For a two dimensional free electron gas, the electron density n and Fermi energy $\in_F$ are related as:

(a) $n = \frac{m\in_F}{2\pi\hbar^2}$ (b) $n = \frac{m\in_F}{\pi\hbar^2}$ (c) $n = \frac{(2m\in_F)^{3/2}}{3\pi^2\hbar^3}$ (d) $n = \frac{(2m\in_F)^{3/2}}{\pi\hbar}$

Q55. In an orthorhombic crystal, a lattice plane cuts intercepts of lengths $3a, -2b$ and $3c/2$ along three axes. The Miller indices of the plane are:

(a) $(2\ 3\ 4)$ (b) $(3\ 4\ 2)$ (c) $(1\ 3\ 4)$ (d) $(2\ \bar{3}\ 4)$

Q56. Which of the following values of Poisson's ratio can not be possible?

(a) -0.8 (b) -1.5 (c) 0.3 (d) 0.4

Q57. If N is the total number of rulings on the grating, n is the order of spectrum and λ is the wavelength of light, then, the resolving power of grating is:

(a) $\frac{N\lambda}{n}$ (b) $\frac{N}{n}$ (c) Nn (d) $Nn\lambda$

Q58. If a black body radiation enclosure expands, so that its volume becomes 64 times, the temperature of enclosure becomes:

(a) one fourth (b) four times (c) 16 times (d) 8 times

Q59. For inverse square law forces, the mathematical statement of the virial theorem is (here $\langle T\rangle$ and $\langle V\rangle$ are the averages of kinetic and potential energies):

(a) $2\langle T\rangle=-\langle V\rangle$ (b) $2\langle T\rangle=\langle V\rangle$ (c) $\langle T\rangle=\langle V\rangle$ (d) $\langle T\rangle=-2\langle V\rangle$

Q60. Above Curie temperature, the ferromagnetic material behaves as:

(a) Ferromagnetic material (b) Diamagnetic material

(c) Antiferromagnetic material (d) Paramagnetic material

Q61. The loss of energy due to hysteresis when $5\,kg$ of iron is subjected for 1 hour to cyclic magnetic changes of frequency 25 cycles / sec, if the hysteresis loop represents a loss of $2.5\times10^3\,\text{erg}\,cm^{-3}\text{cycle}^{-1}$ and density of iron is $7.8\,gm\,cm^{-3}$, is

(a) $1.14\times10^3\,J$ (b) $1.24\times10^3\,J$ (c) $1.34\times10^3\,J$ (d) $1.44\times10^3\,J$

Q62. One solution (about $x=0$) of the differential equation $x^2\frac{d^2y}{dx^2}-3x\frac{dy}{dx}+4y=0$ is $y_1(x)=c_1x^2$, with c_1 a constant. A second linearly independent solution (with another constant c_2) is:

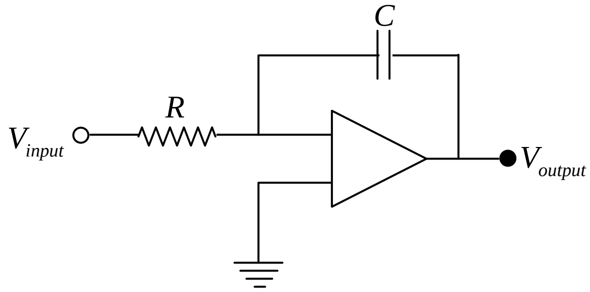
(a) $\frac{c_2}{x}$ (b) $c_2x^2\ln(x)$ (c) $c_2\ln(x)$ (d) c_1x^2

Q63. If E_H, J_x and B_Z are the Hall field, current density and magnetic field strength respectively, then Hall coefficient is give by:

(a) $R_H=\frac{E_H/J_x}{B_Z}$ (b) $R_H=\frac{B_Z}{E_H/J_x}$

(c) $R_H=\frac{J_x/E_H}{B_Z}$ (d) None of the three

Q64. The circuit shown is used for



(a) Integration (b) Differentiation

(c) Square wave generation (d) Summing

Q65. The work done by the force $\vec{F} = \left(4\hat{i} - 3\hat{j} + 2\hat{k}\right)N$ in giving a $1nC$ charge a displacement of $\left(10\hat{i} + 2\hat{j} - 7\hat{k}\right)m$ is:

(a) $64\,nJ$ (b) $60\,nJ$ (c) $20\,nJ$ (d) $100\,nJ$

Q66. A photon recoils back after striking an electron at rest. The change in the wavelength of the photon is:

(a) $0.048\,\overset{0}{A}$ (b) $0.24\,\overset{0}{A}$ (c) $0.024\,\overset{0}{A}$ (d) $0.48\,\overset{0}{A}$

Q67. $200\,MeV$ of energy is obtained in the fission of one nucleus of ^{235}U. A reactor is generating $1000\,kW$ power. The rate of nuclear fission in the reactor is:

(a) 2×10^{8} (b) 931 (c) 1000 (d) 3.125×10^{16}

Q68. A certain transistor is to be operated with $V_{CE} = 6V$. If its maximum power rating is $250\,mW$, what is the maximum collector current that it can handle?

(a) $1.5\,mA$ (b) $41.7\,mA$ (c) $4.17\,A$ (d) $1.5\,A$

Q69. In a radio wave if $E_0 = 10^{-4}V/m$, then the magnitude of magnetic field and pointing vector is:

(a) $3.3\times10^{-13}W/m^2, 1.3\times10^{-11}Watt/m^2$ (b) $10^{-4}W/m^2, 1.3\times10^{-11}Watt/m^2$

(c) $3.3\times10^{13}W/m^2, 1.3\times10^{11}Watt/m^2$ (d) $3.3\times10^{-13}W/m^2, 1.3\times10^{11}Watt/m^2$

Q70. If M is the mass of nucleus and A its atomic mass, then the packing fraction is

(a) $\dfrac{M+A}{M-A}$ (b) $\dfrac{M-A}{A}$ (c) $\dfrac{M-A}{M}$ (d) $\dfrac{M-A}{M+A}$

Q71. A clock keeps correct time. With what speed should it be moved relative to an observer so that it may seem to loose $20\sec$ in $100\sec$?

(a) $0.064\times10^{8}\,m/\sec$ (b) $2\times10^{8}\,m/\sec$

(c) $0.6\times10^{8}\,m/\sec$ (d) $1.8\times10^{8}\,m/\sec$

Q72. Polarization $\vec{P}$ and electric susceptibility χ are related as

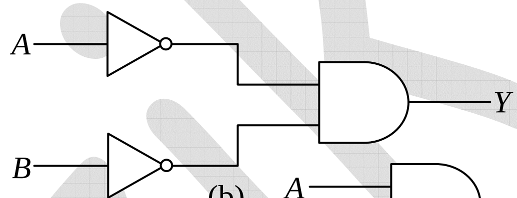
(a) $\vec{P}=\frac{\epsilon_0}{\chi}\vec{E}$ (b) $\vec{P}=\epsilon_0\,\chi\vec{E}$ (c) $\vec{P}=\chi\vec{E}$ (d) $\vec{P}=\epsilon_0^{-1}\,\chi\vec{E}$

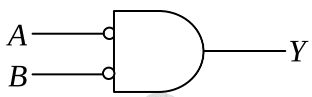
Q73. Specific heat of saturated steam is:

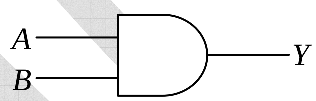
(a) Negative (b) 1 cal/gm-degree

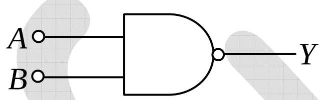
(c) Zero (d) Positive

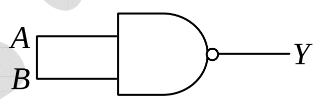
Q74. The correct equivalent symbol for the AND gate with inverted inputs shown below will be:



(a) 

(b) 

(c) 

(d) 

Q75. If the entropy of a system remains constant in a thermodynamic process, the process is known as:

(a) adiabatic (b) isochoric (c) isothermal (d) isobaric

Q76. The particle x in the following nuclear reaction is:

$${}^{9}_{4}Be+{}^{4}_{2}He\rightarrow{}^{12}_{6}C+x$$

(a) neutron (b) photon (c) proton (d) electron

Q77. The trigonometric identity for $\sin^3(x)$ can be interpreted as Fourier series expansion for that function. The first non-zero Fourier coefficient in that expansion is:

(a) 0.75 (b) 0.25 (c) -0.5 (d) 1

Q78. The separation between adjacent energy levels of a normal multiplet is in the ratio $3:5$. According to the Lande interval rule, what is the value of L?

(a) $L=4$ (b) $L=2$ (c) $L=1$ (d) $L=3$

Q79. For fission to take place, neutrons must have:

(a) very high energy (b) no kinetic energy

(c) very very low energy (d) thermal energy

Q80. In a waveguide, which condition always holds good?

(a) Phase velocity greater than C (b) Phase velocity $=C$

(c) Group velocity $=C$ (d) Phase velocity less than C

Q81. A solenoid has length l, number of turns N and area of cross-section A. Its self inductance L is:

(a) $L=\frac{\mu_0 NA}{l}$ (b) $L=\frac{\mu_0^2 NA}{l}$ (c) $L=\frac{\mu_0 N^2}{l}$ (d) $L=\frac{\mu_0 N^2 A}{l}$

Q82. Given the Bessel function: $J_0(x)=1-\frac{x^2}{2^2}+\frac{x^4}{2^2\cdot 2^4}-\frac{x^6}{2^2\cdot 2^4\cdot 2^6}+....,J_1(x)$ is given by:

(a) $\frac{x}{2}-\frac{x^3}{2^2\cdot 4}+\frac{x^5}{2^2\cdot 2^4\cdot 6}-....$ (b) $1+\frac{x^2}{2^2}+\frac{x^4}{2^2\cdot 4^4}+\frac{x^6}{2^2\cdot 2^4\cdot 6^2}+....$

(c) None of the three (d) $-\frac{x}{2}+\frac{x^3}{2^2\cdot 4}+\frac{x^5}{2^2\cdot 2^4\cdot 6}+.....$

Q83. If a particle is fixed on a rotating frame of reference, the fictitious force acting on the particle will be:

(a) Coriolis as well as centrifugal force (b) Centrifugal force only

(c) None of the three (d) Coriolis force only

Q84. The acceleration of a frame of reference, fixed on the earth's surface at the equator and rotating with the earth, once a day will be:

(a) $0.004\, m/\sec^2$ (b) $7.15\times 10^7\, m/\sec^2$

(c) $61.2\, m/\sec^2$ (d) $3.4\times 10^{-2}\, m/\sec^2$

Q85. In the TM mode:

(a) Magnetic field is always perpendicular to direction of propagation

(b) Magnetic field is always zero

(c) Magnetic field is always parallel to direction of propagation

(d) Electric field is always perpendicular to propagation

Q86. A micro canonical ensemble represents:

(a) An isolated system in equilibrium

(b) A system under constant external pressure

(c) A system that can exchange particles with its surroundings

(d) A system in contact with heat reservoir

Q87. A particle collides elastically with another particle at rest. If the masses of the particles be m_1 and m_2 respectively, then the fraction of kinetic energy transferred to the second will be maximum when:

(a) $\frac{m_2}{m_1}=0.5$ (b) $\frac{m_2}{m_1}=3$ (c) $\frac{m_2}{m_1}=1$ (d) $\frac{m_2}{m_1}=2$

Q88. The polarizability of atoms in the air molecule is $9.7\times10^{-41}cm^2/V$. The radius of the atom of an air molecule is:

(a) $9.6\times10^{-11}m$ (b) $9.6\times10^{-12}m$ (c) $9.6\times10^{-13}m$ (d) $9.6\times10^{-14}m$

Q89. Phase space area of a 1-d SHO with mass m, angular frequency ω and having energy between E and $2E$ is:

(a) $\frac{2\pi E}{\omega}$ (b) $\frac{\pi E}{\omega}$ (c) $\frac{4\pi E}{\omega}$ (d) 0

Q90. A coil of inductance $2\,mH$ and resistance 15Ω is connected in parallel with a capacitor of $0.01\,\mu F$. The peak oscillator current at resonance is:

(a) $1.41\,mA$ (b) $1.14\,mA$ (c) $2.14\,mA$ (d) $2.41\,mA$

Q91. If the volume of a cubic unit cell in Bravais lattice is V, the volume of the unit cell in reciprocal lattice will be:

(a) $\frac{8\pi^3}{V}$ (b) $\frac{V}{8\pi^3}$ (c) $\frac{2\pi}{V}$ (d) $\frac{V}{2\pi}$

Q92. The activity of a sample of radioactive material is A_1 at time t_1 and A_2 at time $t_2\left(t_2>t_1\right)$. Its mean life is T, then:

(a) $A_2=A_1e^{(t_1/t_2)^T}$ (b) $\frac{A_1-A_2}{t_2-t_1}=$ constant

(c) $A_2=A_1e^{(t_1-t_2)/T}$ (d) $A_1t_1=A_2t_2$

Q93. Lamb-Rutherford experiment showed that in hydrogen atom:

(a) $2^2P_{1/2}$ state has greater energy than $2^2S_{1/2}$ state

(b) $2^2S_{1/2}$ and $2^2P_{1/2}$ states have the same energy

(c) $2^2P_{1/2}$ state has lower energy than $2^2P_{3/2}$ state

(d) $2^2S_{1/2}$ state has greater energy than $2^2P_{1/2}$ state

Q94. The depletion region is created by:

(a) Ionization only

(b) Diffusion only

(c) Recombination only

(d) All the three viz. ionization, diffusion and recombination

Q95. The magnitude of Coriolis acceleration (expressed in terms of g, the acceleration due to earth's gravity) for a particle of mass m moving with a velocity $10^4 cm/s$ horizontally along earth's surface at the north pole is about:

(a) $1.5g$ (b) $0.15g$ (c) $0.0015g$ (d) g

Q96. The types of constraints on the mechanical system consisting of a cylinder rolling (and possibly sliding) down an inclined plane of angle α are:

(a) rheonomic and non-holonomic (b) rheonomic and holonomic

(c) scleronomic and holonomic (d) scleronomic and non-holonomic

Q97. In interference with coherent sources, the fringe width varies as:

(a) Directly as the separation between slits

(b) Inversely as wavelength

(c) Directly as wavelength

(d) Inversely as the distance between the slits and screen

Q98. $\int_0^{\infty} e^{-x}\frac{d}{dx}\left[\delta\left(x^2-4\right)\right]dx =$

(a) $-\frac{1}{4c^2}$ (b) $\frac{1}{4c^2}$ (c) 1 (d) $\frac{1}{4}\left(e^2+e^{-2}\right)$

Q99. Broad sources are required in:

(a) None of the three

(b) Biprism experiment

(c) Newton's ring experiment

(d) Both Biprism experiment and Newton's ring experiment

Q100. One liter atmosphere equals:

(a) 8.31 Joule (b) 0.082 Joule (c) 101 Joule (d) 1.01×10^{5} Joule

Q101. Mathematical formulation of the first law contains the idea of:

(a) The existence of an internal energy function

(b) The definition of heat as energy in transit by virtue of a temperature difference

(c) The principle of conservation of energy

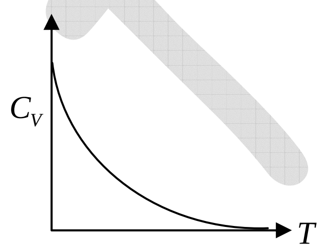
(d) All of the three

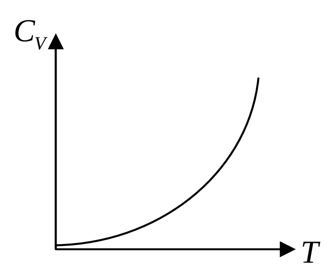
Q102. The Lagrangian of a simple pendulum, consisting of a bob of mass m suspended by a string of length l, executing oscillations of amplitude θ about the equilibrium position is given by:

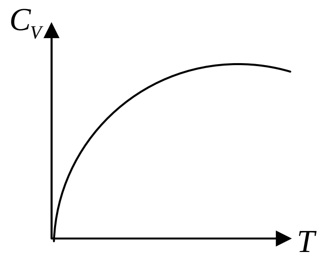
(a) $\frac{1}{2}ml^2\dot{\theta}^2 - mgl\cos\theta$ (b) $\frac{1}{2}ml^2\dot{\theta}^2 - mgl(1+\cos\theta)$

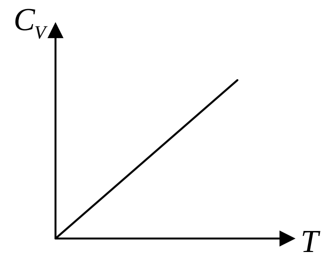
(c) $m\dot{\theta}^2 - \frac{g}{l}\sin\theta$ (d) $\frac{1}{2}ml^2\dot{\theta}^2 - mgl(1-\cos\theta)$

Q103. Partition function for a gas of photons is given as $z\alpha e^{AT^3}$. The specific heat of photon gas varies with temperature as:

(a)


(b)


(c)


(d)


Q104. During a quasi static process:

(a) The system is far away from a state of thermodynamic equilibrium

(b) The system is not in thermodynamic equilibrium

(c) None of the three

(d) The system is at all times infinitesimally near a state of thermodynamic equilibrium

Q105. Using Langevin's theory, the susceptibility χ of a paramagnetic substance is given by:

(a) $\chi = \frac{m^2 N \mu_0}{2kT}$ (b) $\chi = \frac{m^2 N \mu_0 T}{k}$ (c) $\chi = \frac{m^2 \mu_0}{3kT}$ (d) $\chi = \frac{m^2 N \mu_0}{3kT}$

Q106. Two inductors L_1 and L_2 are connected in such a way that their fluxes are in the opposite directions. The total inductance L will be:

(a) $L = L_1 + L_2 + M$ (b) $L = L_1 + L_2 - M$

(c) $L = L_1 + L_2 + 2M$ (d) $L = L_1 + L_2 - 2M$

Q107. The matrix, $A = \frac{1}{3}\begin{pmatrix} -2 & 1 & 2 \\ 2 & 2 & 1 \\ 1 & -2 & 2 \end{pmatrix}$ is

(a) Orthogonal (b) Symmetric (c) Singular (d) Skew-symmetric

Q108. The number of molecules present in the unit cell of sodium chloride is:

(a) 5 (b) 8 (c) 2 (d) 4

Q109. The magnetic flux density created by an infinitely long conductor carrying a current I at a radial distance R is:

(a) $\frac{\pi_0 I}{2\pi R}$ (b) $\frac{\pi_0 I}{2\pi R^3}$ (c) $\frac{4\pi R^2 I}{3}$ (d) $\frac{1}{2\pi R}$

Q110. The beam profile of a laser operating in TEM_{00} (fundamental mode) is:

(a) Lorentzian (b) Gaussian (c) Triangular (d) Voigt

Q111. The radius of the first zone plate of focal length $40\,cm$ for light of wavelength $4000\,\overset{0}{A}$ is:

(a) $0.4\,cm$ (b) $0.010\,cm$ (c) $0.04\,cm$ (d) $0.16\,cm$

Q112. Which of the following statements is correct?

(a) Absolute zero temperature can be achieved by adiabatic demagnetization only

(b) Absolute zero temperature can be achieved by isothermal magnetization only

(c) None of the three

(d) Absolute zero temperature can not be achieved by finite number of isothermal magnetization followed by adiabatic demagnetization

Q113. The moment of inertia of a solid circular cylinder of radius a and height h about the axis of the cylinder is:

(a) independent of both a and h (b) independent of its mass

(c) independent of a (d) independent of h

Q114. The ratio of isobaric volume expansivity and isothermal compressibility is given as:

(a) $\left(\frac{\partial V}{\partial T}\right)_P$ (b) $\left(\frac{\partial T}{\partial P}\right)_V$ (c) $\left(\frac{\partial P}{\partial T}\right)_V$ (d) $\left(\frac{\partial P}{\partial V}\right)_T$

Q115. The Clausius-Mossotti relation holds best for:

(a) Concentrate solutions (b) Gases & dilute solution

(c) Solids (d) Polar molecules

Q116. A movable mirror of Michelson's interferometer is moved through a distance of $0.06\,mm$ then 200 fringes cross the field of view. The wavelength of light is:

(a) $4000\,\overset{0}{\text{A}}$ (b) $8000\,\overset{0}{\text{A}}$ (c) $3000\,\overset{0}{\text{A}}$ (d) $6000\,\overset{0}{\text{A}}$

Q117. Which one of the following is not a linear operator?

(a) Parity (b) $\hat{x}^3$ (c) Time reversal (d) $i\hat{p}$

Q118. Density of states for a one dimensional Fermi system is proportional to:

(a) a constant (b) E (c) $E^{1/2}$ (d) $E^{-1/2}$

Q119. The spacing between principal planes of $NaCl$ crystal is $2.82\,\overset{0}{\text{A}}$. The first order Bragg reflection occurs at an angle of 10^0. The wavelength of X - rays is:

(a) $0.98\times10^{-10}\,m$ (b) $0.98\times10^{-7}\,m$

(c) $0.98\times10^{-8}\,m$ (d) $0.98\times10^{-9}\,m$

Q120. Consider a system of 3 fermions which can occupy any of the 4 available energy states with equal probability. The entropy of the system:

(a) $2k_B\ln 2$ (b) $k_B\ln 2$ (c) $2k_B\ln 4$ (d) $3k_B\ln 4$