PHYSICS

Q1. Which one of the following four vectors can be written as the gradient of a scalar?

(a) $\mathbf{F_1} = \mathbf{z}\,x^2$ (b) $\mathbf{F_2} = \mathbf{x}yz + \mathbf{y}zx$ (c) $\mathbf{F_3} = \mathbf{x}z + \mathbf{y}x + \mathbf{z}xy$ (d) $\mathbf{F_4} = \mathbf{x}x + \mathbf{y}y + \mathbf{z}z$

where $\mathbf{F_1}, \mathbf{F_2}, \mathbf{F_3}$ and $\mathbf{F_4}$ are vectors; $\mathbf{x}, \mathbf{y}$ and $\mathbf{z}$ are unit vectors; x, y and z are rectangular cartesian coordinates.

Q2. Which one of the following recurrence relations is true for the Hermite polynomial ?

(a) $2nH_{n-1}(x) + dH_n(x)/dx = 0$ (b) $2xH_n(x) - 2nH_{n-1}(x) - H_{n+1}(x) = 0$

(c) $2xH_n(x) = 2n\,H_{n-1}(x) + H_n(x)$ (d) $nH_{n-1}(x) = dH_n(x)/dx$

Q3. Consider the following differential equation

$$x^2 d^2y/dx^2 + xdy/dx + (x^2 - 4)y = 0$$

Which one of the following is true for the solution of this equation?

(a) $[y]_{x=0} = 1$ (b) $[dy/dx]_{x=0} < 0$ (c) $[y]_{x=0} = 0$ (d) None of these

Q4. Consider the following differential equation

$$(1 - x^2)d^2y/dx^2 - 2xdy/dx + 12y = 0$$

Which one of the following can be a possible solution of this equation?

(a) $(5x^3 - 3x)/2$ (b) $(35x^4 - 30x^2 + 3)/8$ (c) $(3x^2 - 1)/2$ (d) None of these

Q5. Evaluate the following integral by applying Cauchy's residue theorem

$$\int_0^\infty \frac{dx}{1 + x^4}$$

Which one of the following is the correct result of integration?

(a) $/\sqrt{2}$ (b) $/2\sqrt{2}$ (c) $/4\sqrt{2}$ (d) $\sqrt{2}$

Q6. The generating function of canonical transformation

$$q = (2P/m\ )^{\frac{1}{2}} \sin Q \quad \text{and } p = (2P\,m\ )^{\frac{1}{2}} \cos Q$$

is

(a) $(m\ q^2/2)\cot Q$ (b) $m\ q \cos Q$ (c) $q \tan Q$ (d) $q \sin Q$

Q7. Two identical simple pendulums each of length 0.1m are connected by a light spring of spring constant 2.2 N/m. If mass of each bob is 0.1 kg, then the ratio of frequencies in same and out of phase vibration is

(a)5/6 (b) 6/7 (c) 3 /4 (d) 2/3

Where $g = 10\text{m/sec}^2$

Q8. The action is written as

(a) $\int_{t_1}^{t_2} \sum_k p_k \dot{q}_k \, dt$ (b) $\int_{t_1}^{t_2} \sum_k p_k q_k \, dt$ (c) $\int_{t_1}^{t_2} \sum_k \dot{p}_k \dot{q}_k \, dt$ (d) $\int_{t_1}^{t_2} \sum_k \dot{p}_k q_k \, dt$

Which one of the above is correct?

Q9. If $Q = q \cos p$ and $P = q \sin p$ represents a canonical transformation then   and   are

(a) ½ and 2 (b) 1 and ½ (c) ½ and ½ (d) 2 and 1

Q10. [**J**, (**r.p**)] is equal to which one of the following?

(a) r (b) 0 (c) p (d) r^2

where **J** is the total angulr momentum and **p** is linear momentum.

Q11. Which is the expression for electrostatic energy density in MKS system ?

(a) $E^2/2$ (b) $D^2/2$ (c) **E.D**/2   (d) **E.D**/2

Where **E, D** are electric field, Electric displacement vectors and E,D are their magnitudes.

Q12. A non-magnetic conducting medium has conductivity g. The medium is subjected to a time dependent magnetic field of induction vector **B**(**r**,t). Assume that there is no accumulation of charge. Use Maxwell's equation **∇ X E** = - **B**/ t. Which of the following is satisfied by the eddy current density **J** ?

(a) $\vec{\nabla}^2 \vec{J} = \left(\dfrac{g}{\sim_0}\right)\dfrac{\partial \vec{J}}{\partial t}$ (b) $\vec{\nabla}^2 \vec{J} = \left(\dfrac{1}{g\sim_0}\right)\dfrac{\partial \vec{J}}{\partial t}$ (c) $\vec{\nabla}^2 \vec{J} = \left(g\sim_0\right)\dfrac{\partial \vec{J}}{\partial t}$ (d)

$\vec{\nabla}^2 \vec{J} = \left(\dfrac{\sim_0}{g}\right)\dfrac{\partial \vec{J}}{\partial t}$

Q13. Which one of the following is Coulomb gauge ?

(a) **∇.A** = 0 (b) **∇.A** +   / t = 0 (c) **∇.A** +(1/c)   / t = 0 (d) none of these

Q14. Skin depth or penetration depth for an electromagnetic wave entering a conducting medium is given by which of the following expressions?

(a)   = c/(μ   )$^{1/2}$ (b)   = c/(2 μ)$^{1/2}$ (c)   = c/(2   )$^{1/2}$ (d)   = c/(2 μ   )$^{1/2}$

Q15. Uncertainty principle is the consequence of which of the following?

(a) Wave nature of particle   (b) particle nature of wave

(c) wave-particle duality   (d) particle-particle interaction

Q16. Consider an anharmonic one dimensional oscillator whose Hamiltonian is given by

$H = p^2/2m + kx^2/2 + x^4$

The unperturbed Hamiltonian consists of first two terms and x^4 represents the perturbation which is assumed to be extremely small. The ground state wave function of the unperturbed Hamiltonian is given by

$_0(x) = (k/\quad)^{1/4} \exp(-kx^2/2\quad)$

Which of the following is the first order correction to energy ?

(a) $3a\quad/(4k)$ (b) $3a(\quad)^2/(4k^2)$ (c) $a(\quad)^2/k^2$ (d) $a(\quad)^2/(2k^2)$

Q17. A stationary state is that for which the probability of finding the particle at a point is:

(a) Dependent of time (b) independent of time (c) dependent on 'x'

(d) independent of 'x'

Which of the above is correct?

Q18. Which of the following is the value of $[J_z, J_-]$?

(a) J_- (b) J_- (c) - J_- (d) - J_+

Q19. Anomalous Zeeman effect is observed when the source is placed in which of the following?

(a) Strong magnetic field (b) weak magnetic field (c) electric field

(d) non-uniform magnetic field

Q20. If $|_m>$ and $|_n>$ be two eigen vectors corresponding to the operator   belonging to different eigen values $_m$ and $_n$ respectively, then which of the following is correct?

(a) $<_m|_n> = 1$ (b) $<_m|_n> = -1$ (c) $<_m|_n> = 0$ (d) $<_m|_n> > 0$

Q21. Which one of the following is the value of $[x, \quad/x]$?

(a) 1 (b) –1 (c) 0 (d) - 2

Q22. Two observables are said to be compatible , if their corresponding operators

(a) Commute with each other (b) anticommute with each other
(b) do not commute with each other (d) none of these

which one of the above is correct?

Q23. Which one of the following represents the ground state wave function of an electron in the hydrogen atom?

(a) $(1/ a_0^3)^{0.5} \exp(-r/a_0)$ (b) $(/a_0^{3/2})^{0.5} \exp(-r/a_0)$

(c) $(a_0^3/2)^{0.5} \exp(-r/2a_0)$ (d) $(a_0) \exp(-r/a_0)$

Q24. Which one of the following represents the energy of the linear harmonic oscillator in the nth quantum state?

(a) $(n + ½)$ (b) n   (c) $/2n$ (d) none of these

Q25. The Schrodinger picture is useful when describing the phenomenon with

(a) Time dependent Hamiltonian (b) time independent Hamiltonian

(c) no Hamiltonian   (d) none of these

Which one of the above is true?

Q26. Gibb's paradox can be removed by

(a) Multiplying the number of quantum states by N!
(b) Adding the number of quantum states with N!
(c) Dividing the number of quantum states by N!
(d) Subtracting the number of quantum states with N!

Which one of the above is correct?

Q27. Canonical ensemble is defined as a system in thermal contact with a heat reservoir. Which one of the following are the fixed parameters?

(a) N, V, μ (b) V, T (c) N, T (d) N, V, T

Where N is the total number of particles, μ is the chemical potential, T is the absolute temperature and V is the volume of the system
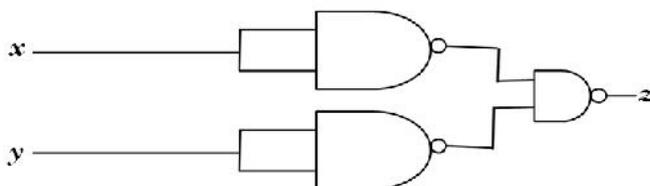
Q28. A logic circuit is shown below with inputs A, B, C and output F.
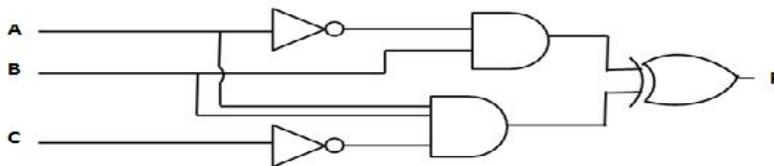
Which one of the following is the Boolean function corresponding to F?

(a) A'B + ABC' (b) A'B * ABC' (c) (A'B). (ABC') (d) (A' + B) * ABC'

Q29.Look at the following combination of NAND gates in which x,y are the inputs

and z is the output. This combinational circuit behaves like a

(a) XOR gate (b) AND gate (c) OR gate (d) NOR gate

Q30. Which one of the following is the classical value of molar electronic specific heat?

(a) 1.5R (b) 0.5R (c) 3R (d) 4.5R
    Where R is the gas constant.

Q31. Intrinsic concentration of charge carriers in a semiconductor varies with temperature as

(a) T (b) T^2 (c) $T^{3/2}$ (d) 1/T

Which one of the above is correct?

Q32. Which of the following statements is true?

(a) In optical branch two masses move in same direction
(b) In acoustical branch, both mass move in opposite directions
(c) In optical branch, two masses move in opposite directions
(d) When the ratio of masses in diatomic lattice increases, the width of forbidden frequency gap increases

Q33. The effective mass of electron is given by which of the following expressions?

(a) $\hbar^2/(d^2E/dk^2)$ (b) $\hbar^2 d^2E/dk^2$ (c) $(d^2E/dk^2)/\hbar^2$ (d) dE/dk

In the above, E is the energy and k is the wave vector.

Q34. Which of the following represents the ratio of magnetic moment M to the maximum magnetic moment M_s in case of paramagnetic substances for J=1/2 and J= infinity ?

(a) tanha, L(a)   (b) cotha, tanha   (c) L(a), cotha   (d) cotha, L(a)

where L(a) is the Langevin function

Q35. ψ_{111} and ψ_{112} are the wave functions of electron in the two energy states 111 and 112 respectively in a cubical box of side a. Which one of the following is the correct expression for ψ_{111}/ψ_{112} ?

(a) $\sin(\pi z/a)/\sin(2\pi z/a)$ (b) $\sin(2\pi z/a)/\sin(\pi z/a)$ (c) $\sin(\pi x/a)/\sin(\pi y/a)$

(d) $\sin(2\pi y/a)/\sin(2\pi z/a)$

Q36. The electric quadrupole moment of a nucleus arises due to which of the following reasons?

(a)Non-uniform distribution of electric charges (b) uniform distribution of electric charges

(c) presence of neutrons (d) None of these

Q37. The nucleus will be stable against spontaneous fission if

(a) $z^2/A > 45$ (b) $z^2/A = 45$ (c) $z^2/A < 45$ (d) None of these

Which one of the above is the correct answer?

Q38. Rotational spectrum of even-even nucleus in the ground state is characterized by which of the following?

(a) Same parity for all energy levels (b) increase in angular momentum by 2

(c) increase in spacing between adjacent levels with increase in spin (d) all of these

Q39. Which of the following interactions is responsible for the formation of electron-positron pair from gamma rays?

(a) Strong (b) electromagnetic (c) weak (d) gravitational

Q40. The strange particles are produced in strong interaction and decay through which of the following interactions?

(a) Weak (b) strong (c) electromagnetic (d) none of these

Q41. Which one of the following is true in a β⁻ decay?

(a) n → p + e- + ν   (b) n → p + e- + ν' (c) p + e- → n + ν   (d) n → p + e-

In the above, ν' represents antineutrino.

Q42. The half life $T_{1/2}$ and mean life τ of a nucleus are related to each other by which of the following relations?

(a) $T_{1/2} = 0.693$ τ   (b) $T_{1/2} = τ/0.693$ (c) $T_{1/2} = 2$ τ   (d) $T_{1/2} =$ τ

Q43. The number of protons and neutrons in the most stable nuclei are respectively

(a) even - even (b) even-odd (c) odd - even (d) odd - odd

Which one of the above is correct?

Q44. Which one of the following is the isospin quantum number for proton and neutron?

(a) 1/2 (b) 3/2 (c) 1 (d) 0

Q45. The neutron in the quark model is composed of

(a) u-u-d quarks (b) u-d-d quarks (c) u'-u-d quarks (d) u-d-d' quarks

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