PAPER – II

PHYSICAL SCIENCES

Note : Attempt all the questions. Each question carries *two* (2) marks.

1. If $A \times B = ab\sin\theta$ then $B \times A$ is

1) $-ab\sin\theta$ 2) $ab\sin\theta$

3) $ab\cos\theta$ 4) $-ab\cos\theta$

2. If ϕ and ψ are harmonic functions, then from Green's function $\int_s \phi \frac{\partial \psi}{\partial n} ds$ is

1) $\int_s \psi \frac{\partial \phi}{\partial n}$ 2) 0

3) $\int_s \phi \frac{\partial \psi}{\partial n}$ 4) $\phi\psi$

3. The rank of matrix $\begin{bmatrix} a & -1 & 0 \\ 0 & a & -1 \\ -1 & 0 & a \end{bmatrix}$ is 2 for a equal to

1) 3 2) 1

3) 2 4) 4

4. The normalization of Hermite polynomial $H_n(x)$ yields,

1) $2^n \pi^{1/2} n!$

2) $\pi^{1/2} n!$

3) $2^n \pi\ n!$

4) $2\ \pi^{1/2} n!$

5. Laplace transform of $(1 - e^t)/t$ is :

1) $\left(\frac{s-1}{s}\right)$

2) $\log\left(\frac{s}{s-1}\right)$

3) $\left(\frac{s}{s-1}\right)$

4) $\log\left(\frac{s-1}{s}\right)$

6. The expansion of $f(z) = \frac{1}{(z-1)(z-2)}$ in the region $|z| < 1$

1) $\frac{1}{2} - \frac{3}{4}z + \frac{7}{8}z^2 \ldots$

2) $\frac{1}{2} + \frac{3}{4}z + \frac{7}{8}z^2 \ldots$

3) $\frac{1}{2}z + \frac{3}{4}z^2 + \frac{7}{8}z^3 \ldots$

4) $\frac{1}{2} - \frac{3}{4}z - \frac{7}{8}z^2 \ldots$

7. If Cauchy-Riemann condition are satisfied then,

1) Partial derivatives are continuous

2) Partial derivatives are zero

3) Partial derivatives are discontinuous

4) Partial derivatives are not possible

8. The measure of spread of an arbitrary probability distribution from its mean value $\langle X \rangle$ is given by,

1) $P(|x - \langle X \rangle| \leq k\sigma) \leq 1/k^2$

2) $P(|x^2 - \langle X \rangle| \geq k\sigma) \leq 1/k^2$

3) $P(|x^2 - \langle X^2 \rangle| \leq k\sigma) \leq 1/k^2$

4) $P(|x - \langle X \rangle| \geq k\sigma) \leq 1/k^2$

9. If there exist holonomic constraints, expressed in k equation in the form $f(r_1, r_2, r_3 \ldots\ldots t) = 0$ then the system is said to have

1) 3N-K degrees of freedom

2) 3N degrees of freedom

3) K degrees of freedom

4) 3N-f degrees of freedom

10. The conservation of linear momentum in the absence of applied force requires the validity of

1) Weak law of action and reaction

2) Strong law of action and reaction

3) Law of inertia

4) Newton's second law

11. Which one of the following is true for ellipse?

1) $e > 1$

2) $e = 1$

3) $e < 1$

4) $e = 0$

12. In neutron-proton scattering for which $m_1 = m_2$, the scattering angle in the laboratory system is equal to

1) twice the scattering angle in centre of mass system

2) thrice the scattering angle in centre of mass system

3) the scattering angle in centre of mass system

4) half the scattering angle in centre of mass system

13. Atwood's machine is an example of

1) Conservative system with non- holonomic and scleronomic constraint

2) Non-Conservative system with holonomic and scleronomic constraint

3) Conservative system with holonomic and scleronomic constraint

4) Conservative system with holonomic and Rheonomic constraint

14. The path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a

1) Sphere

2) Sigmoid

3) Cycloid

4) Catenary of revolution

15. A massless spring having force constant k has masses m_1 and m_2 attached at its two ends. The frequency of oscillation is

1) $\omega = \sqrt{\frac{k(m_1 + m_2)}{m_1 m_2}}$

2) $\omega = \sqrt{\frac{k(m_1 - m_2)}{m_1 m_2}}$

3) $\omega = \sqrt{\frac{m_1 m_2}{k(m_1 - m_2)}}$

4) $\omega = \sqrt{\frac{m_1 m_2}{k(m_1 + m_2)}}$

16. When only one single frequency is involved in the solution of equations of motion then the coordinate appearing in it will be called

1) Normal coordinate

2) Generalized coordinate

3) Single coordinate

4) Normal coordinate of system

17. According to the Gauss's theorem the electrostatic field E at a point r due to a point charge q is defined as

1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\vec{r}$

2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}\vec{r}$

3) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}\hat{r}$

4) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

18. If a long straight conductor carries a current of λ per unit length, then the electric field at a distance r from the centre of the conductor is

1) $\frac{\lambda}{2\pi\varepsilon_o r}$

2) $\frac{\lambda}{2\pi\varepsilon_o r^2}$

3) $\frac{\lambda}{4\pi\varepsilon_o r}$

4) $\frac{\lambda}{4\pi\varepsilon_o r^2}$

19. If current in a conductor increases, then according to Lenz's law self-induced voltage will

1) aid the increasing current

2) tend to decrease the amount of current

3) produce the current opposite to the increasing current

4) aid the applied voltage

20. The force between two straight parallel wires carrying currents I_a and I_b is proportional to (where r is the distance between the wires)

1) $\frac{I_a I_b}{r^2}$

2) $\frac{I_a I_b}{r}$

3) $\frac{I_a I_b}{r^3}$

4) $\left(\frac{I_a I_b}{r}\right)^2$

21. The wave equation for electric field in vacuum is

1) $\nabla^2 E - \mu_o \varepsilon_o \frac{\partial^2 E}{\partial t^2} = 0$

2) $\nabla^2 E + \mu_o \varepsilon_o \frac{\partial^2 E}{\partial t^2} = 0$

3) $\nabla^2 E - \frac{\partial^2 E}{\partial t^2} = 0$

4) $\nabla^2 E - c^2 \frac{\partial^2 E}{\partial t^2} = 0$

22. When EM wave is incident on a dielectric, it is

1) fully transmitted

2) fully reflected

3) partially reflected and partially transmitted

4) fully polarized

23. Refractive index of a material is approximately equal to square root of

1) ε_o 2) μ_o

3) $\varepsilon_o \mu_o$ 4) ε_o / μ_o

24. Which is a valid description of a linearly polarized wave with a diagonal orientation?

1) two linearly polarized waves that are orthogonal and in phase

2) two linearly polarized waves that are orthogonal and out of phase by 90°

3) two out-of-phase elliptically polarized waves with opposite rotations

4) none of these

25. The de-Broglie wavelength of a material particle which is in thermal equilibrium at temperature T is :

1) $\lambda = \frac{h^2}{\sqrt{2mkT}}$

2) $\lambda = \frac{h}{\sqrt{3mkT}}$

3) $\lambda = \frac{2h^2}{\sqrt{3mkT}}$

4) $\lambda = \frac{h^3}{\sqrt{2mkT}}$

26. Every moving particle is associated with a wave packet, which

1) travels with the speed of light

2) has equal size as the particle

3) travels with the same speed of the particle

4) is imaginary

27. If E_1 is the energy of the lowest state of a one dimensional potential box of length l and E_2 is the energy of the lowest state when the length of the box is doubled. Then,

1) $E_2 = 2E_1$

2) $E_2 = \frac{E_1}{2}$

3) $E_2 = \frac{E_1}{4}$

4) $E_2 = 4E_1$

28. The commutation relation $\left[\hat{H}, \hat{p}_x\right]$ is

1) $-i\hbar\dfrac{\partial V(x)}{\partial x}$

2) $-\dfrac{\hbar}{i}\dfrac{\partial V(x)}{\partial x}$

3) $-i\dfrac{\partial V(x)}{\partial x}$

4) $-\dfrac{\hbar^2}{i}\dfrac{\partial V(x)}{\partial x}$

29. The eigenvalue of the operator $\hat{J}_z$ is

1) $m\hbar$ 2) $m^2\hbar$

3) $m\hbar^2$ 4) $\hbar$

30. The wave function of a hydrogen atom is denoted by $\psi(r,\theta,\varphi)$. Then the shape of the atomic orbital is determined by

1) the angular part of $\psi(r,\theta,\varphi)$

2) the radial part of $\psi(r,\theta,\varphi)$

3) both 1 and 2

4) linear part of $\psi(r,\theta,\varphi)$

31. Which of the following relations gives the upper limit to the energy of n^{th} state using variational principle?

1) $\langle\psi|H|\psi\rangle$

2) $\langle\psi|H|\psi^*\rangle$

3) $\langle\psi|\hat{p}|\psi\rangle$

4) $\langle\psi|\hat{x}|\psi\rangle$

32. Which one of the following particles is described by a symmetric wave function?

1) Proton
2) Neutron
3) Muon
4) π -meson

33. The transition probability $W_{n\to k}$ by constant perturbation using time dependent perturbation theory is

1) $W_{n\to k} = \frac{|H'_{kn}|}{\hbar^2} t^2$
2) $W_{n\to k} = \frac{|H'_{kn}|^2}{\hbar^2} t^2$
3) $W_{n\to k} = \frac{|H'_{kn}|}{\hbar^2} t$
4) $W_{n\to k} = \frac{|H'_{kn}|}{\hbar} t$

34. Consider a proton moving at $2\times10^5\,\mathrm{ms}^{-1}$ velocity. The uncertainty in measuring the position of the particle is :

1) $2.5\times10^{-15}\,\mathrm{m}$
2) $1.6\times10^{-13}\,\mathrm{m}$
3) $2.9\times10^{-15}\,\mathrm{m}$
4) $1.2\times10^{-13}\,\mathrm{m}$

35. The entropy of a system S, is related to the accessible phase space volume Γ by $S = k_B \ln\Gamma(E,N,V)$ where E, N and V are the energy, number of particles and volume respectively. From this, one can conclude that Γ

1) does not change during evolution to equilibrium
2) oscillates during evolution to equilibrium
3) is a maximum at equilibrium
4) is a minimum at equilibrium

36. Velocity of molecules based on Maxwell's law of distribution is

1) greater than the mean velocity
2) equal to root mean square velocity
3) less than the root mean square velocity
4) equal to the mean velocity

37. A fluid at high pressure is throttled through a narrow porous opening in a region of lower pressure without any transfer of heat. In such process the

1) Entropy does not change

2) Gibbs free energy does not change

3) Enthalpy of fluid is constant

4) Entropy is decreased

38. Three identical spin $\frac{1}{2}$ fermions are to be distributed in two non-degenerate distinct energy levels. The number of ways this can be done is

1) 6 2) 4

3) 10 4) 2

39. An electric current of 3 amp flows through a resistance of 10 ohm. It is being cooled by running water and kept at temperature 300 K. The change in entropy per second of the resistance is

1) 1 J/deg 2) 0.5 J/deg

3) No change 4) 2 J/deg

40. The change in internal energy of the gas is directly proportional to

1) change in volume

2) change in pressure

3) change in temperature

4) change of pressure and volume

41. Which of the following is not an exact differential?

1) dQ(Q = heat absorbed)

2) dU(U = internal energy)

3) dS(S = entropy)

4) dF(F = free energy)

42. Two stars A and B emit maximum radiation at 3500 Å and 4900 Å, respectively. The temperature of two stars A and B are in the ratio

1) 7:5 2) 1:7

3) 3:2 4) 2:5

43. In a voltage divider biased *npn* transistor. If the upper voltage-divider resistor (the one connected to Vcc) opens, which one of the following will occur?

1) The transistor into cutoff

2) The transistor goes into saturation

3) The transistor burns out

4) The supply voltage is too high

44. When transistors are used in digital circuits they usually operate in the

1) active region

2) breakdown region

3) saturation and cutoff region

4) linear region

45. An output which is proportional to the addition of two or more inputs is from which type of amplifier?

1) differentiator

2) difference

3) summing

4) analog substractor

46. The resolution of a D/A converter is approximately 0.4% of its full-scale range. It is a

1) 8-bit converter

2) 10-bit converter

3) 12-bit converter

4) 16-bit converter

47. When a program is being executed in an 8085 microprocessor, its program counter contains

1) the number of instruction in the current program that have already been executed

2) the total number of instructions in the program being executed

3) the memory address of the instruction that is being currently executed

4) the memory address of the instruction that is to be executed next

48. Power in a circuit is measured by measuring a current through the resistor. The current is measured with an accuracy of ± 1.5% and the tolerance band of the resistor ±0.5%. The errors are limiting or guarantee errors. The accuracy with which power is measured is

1) ±1.125%
2) ±3.5%
3) ± 2%
4) ± 2.5%

49. A diode for which you can change the reverse bias, and thus vary the capacitance is called a

1) varactor diode
2) tunnel diode
3) zener diode
4) switching diode

50. The principal of least squares states that

1) The sum of the residuals is minimum

2) The average sum of two groups should be minimum

3) The sum of the squares of the residuals should be minimum

4) The sum of the squares of the residuals should be maximum

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ROUGH WORK

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