1. The value of the integral

$$\int_{-\infty}^{\infty} \frac{\sin^2 x}{x^2} dx$$

is :

(a) $\frac{\pi^2}{2}$ (b) 0

(c) $\frac{\pi^2}{9}$ (d) 2π

2. The Fourier transform of a Gaussian function is of the form :

(a) Exponential (b) Lorentzian

(c) Gaussian (d) Screened coulomb

3 The real part of $\log(3+4i)$ is :

(a) $\log 2$ (b) $\log 3$

(c) $\log 4$ (d) $\log 5$

4 Particular integral of the first order linear differential equation

$$\frac{dy}{dx} = x + y$$

is given by :

(a) $y(x) = -x - 1$ (b) $y(x) = x + 1$

(c) $y(x) = x - 1$ (d) $y(x) = -x + 1$

5 Eigenvalues of the matrix

$$\begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$$

are :

(a) $1, -1$ (b) $-1, -i$

(c) $i, -i$ (d) $1+i, 1-i$

6 $\nabla\left(\frac{1}{|\vec{r}|}\right)$ is given by :

(a) $\frac{1}{r}\hat{r}$ (b) $\frac{1}{r^3}(\hat{\imath}+\hat{\jmath}+\hat{k})$

(c) $\frac{\vec{r}}{r^3}$ (d) $r(\hat{\imath}-\hat{\jmath}-\hat{k})$

7 If a coin is tossed four times, what is the probability that two heads and two tails will result?

(a) $\frac{3}{8}$ (b) $\frac{1}{2}$

(c) $\frac{5}{8}$ (d) $\frac{3}{4}$

8 Which of the following defines a conservative force?

(a) $\vec{\nabla} \cdot \vec{F} = 0$ (b) $\vec{\nabla} \times \vec{F} = 0$

(c) $\oint \vec{F} \cdot \overrightarrow{dr} = 0$ (d) $\frac{d\vec{F}}{dt} = 0$

9 Consider the three vectors :

$\vec{a} = \hat{\imath} + \hat{\jmath} + \hat{k}$

$\vec{b} = \hat{\imath} - \hat{\jmath} + \hat{k}$ and

$\vec{c} = \hat{\imath} - \hat{\jmath} - \hat{k}$

Which of the following statements is true?

(a) $\vec{a}, \vec{b}, \vec{c}$ are linearly independent

(b) $\vec{a}, \vec{b}$ are linearly dependent

(c) $\vec{b}, \vec{c}$ are at right angles to each other

(d) $\vec{a}$ and $\vec{c}$ are parallel

10 The moment of inertia of a thin disc of radius R about an axis passing though its center and perpendicular to the plane of the disc is :

(a) MR^2 (b) $\frac{2}{3}MR^2$

(c) $\frac{3}{2}MR^2$ (d) $\frac{1}{2}MR^2$

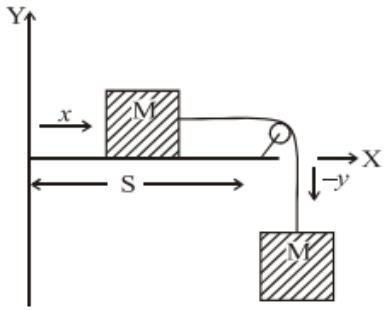
11 A thin rigid rod of length ' l ' is moving inside a sphere of radius R($R > l$) such that both of its ends are in contact with the inner surface of the sphere. The degree of freedom of the rod are :

(a) Four (b) Three

(c) Two (d) One

12 For a system shown in figure given below, the Lagrangian function is given by :

(V = 0, at $y = 0$)



(a) $L = M\dot{y}^2 + Mgy$

(b) $\mathrm{L} = \frac{1}{2}\mathrm{M}\dot{y}^2 + \mathrm{Mgy}$

(c) $L = \frac{1}{2}M\dot{y}^2 - Mg(y - x)$

(d) $\mathrm{L} = \mathrm{M}\dot{y}^2 + \mathrm{Mg}(y - x)$

13 "Hamiltonian H is not equal to the total energy E (sum of kinetic and potential energies)" holds true for a system characterized with :

(a) conservative forces and time independent constraints

(b) conservative forces and time dependent constraints

(c) dissipative forces and time independent constraints

(d) for every system irrespective of the nature of forces and constraints

14 A particle moves under the action of force $\bar{\mathrm{F}} = -\frac{1}{r^n}\hat{r}$. The particle moves in a closed orbit, if :

(a) $n = -1$ or $n = 2$ (b) $n = 1$ or $n = -2$

(c) $n = -1$ or $n = -2$ (d) $n = 1$ or $n = 2$

15 Which of the following statements holds true for a freely rotating rigid body ?

(a) $\bar{\omega}$ and $\frac{d\bar{\mathrm{L}}}{dt}$ are perpendicular to each other

(b) $\bar{\omega}$ and $\frac{d\bar{\mathrm{L}}}{dt}$ are parallel to each other

(c) $\bar{\omega}$ and $\frac{d\bar{\mathrm{L}}}{dt}$ are antiparallel to each other

(d) $\bar{\omega}$ and $\frac{d\bar{\mathrm{L}}}{dt}$ do not have 0 specific relationship

16 A particle is at rest in a rotating frame of reference. The pseudoforce(s) acting on the particle is(are) :

(a) None of these

(b) Only the Coriolis force

(c) Only the centrifugal force

(d) Both the centrifugal and Coriolis forces

17 The electric field of an electromagnetic wave propagating in the free space is given by :

$$\vec{\mathrm{E}}(r,t) = \mathrm{E}_0\hat{z}\cos\left[200\sqrt{3}\pi x - 200\pi y - \omega t\right]$$

Then the wave vector $\vec{k}$ is given by :

(a) $200\frac{\sqrt{3}}{2}\pi\hat{x} - 200\pi\hat{y}$ (b) $400\pi\left[\frac{\sqrt{3}}{2}\hat{x} - \frac{1}{2}\hat{y}\right]$

(c) $200\sqrt{3}\pi\hat{x}$ (d) $-200\pi\hat{y}$

18 The Ampere's law in the case of free space takes the form :

(a) $\vec{\nabla} \times \vec{\mathrm{B}} = \mu_0\vec{\mathrm{J}}$

(b) $\vec{\nabla} \times \vec{\mathrm{B}} = \mu_0\vec{\mathrm{J}} + \epsilon_0\mu_0\frac{\partial\vec{\mathrm{E}}}{\partial \mathrm{t}}$

(c) $\vec{\nabla} \times \vec{\mathrm{B}} = \epsilon_0\mu_0\frac{\partial\vec{\mathrm{E}}}{\partial \mathrm{t}}$

(d) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} - \epsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t}$

19 An electric charge $+Q$ is placed at the center of a cube of sides 10 cm. The electric flux emanating from each of the face of the cube is :

(a) $\frac{Q}{\epsilon_0}$ (b) $\frac{Q}{10\epsilon_0}$

(c) $\frac{Q}{6\epsilon_0}$ (d) $\frac{10Q}{\epsilon_0}$

20 A field at certain point in the space is expressed as the potential function $V = 3x^2z - xy^3 + z$. Then the potential V at point $(2, -1, 1)$ is :

(a) 15 V (b) 13 V

(c) 0 V (d) 8 V

21 The electric displacement vector at the interface of two dielectric media with unit normal vector $\hat{n}_{12}$ from medium 1 to 2 and free surface charge density δ_s is given by :

(a) $\hat{n}_{12} \times (\overrightarrow{D_2} + \overrightarrow{D_1}) = \delta_s/\epsilon_0$

(b) $(\overrightarrow{D_2} - \overrightarrow{D_1}) \times \hat{n}_{12} = \delta_s/\epsilon_0$

(c) $(\overrightarrow{D_2} - \overrightarrow{D_1}) \cdot \hat{n}_{12} = \delta_s/\epsilon_0$

(d) $(\overrightarrow{D_2} - \overrightarrow{D_1}) \cdot n_{12} = \delta_s/\epsilon_0$

22 A plane polarized EM wave of frequency ω is incident at an angle θ in a rectangular wave guide of resonant frequency ω_{mn}. Then energy carried by the wave propagating inside the cavity will propagate with the group velocity of :

(a) $\frac{c}{\sqrt{1 - \left(\frac{\omega_{mn}}{\omega}\right)^2}}$ (b) $c\sqrt{1 - \frac{\omega_{mn}}{\omega}}$

(c) $\frac{c}{\sqrt{1 - \left(\frac{\omega_{mn}}{\omega}\right)}}$ (d) $c\sqrt{1 - \left(\frac{\omega_{mn}}{\omega}\right)^2}$

23 A plane polarized electromagnetic wave is incident normally on an interface separating two dielectrics with intrinsic impedance equal to z_1 and z_2. The reflection and transmission (Fresnel's) coefficients (R and T), respectively, are given as :

(a) $\frac{2z_2}{z_1 + z_2}$ and $\frac{z_2 - z_1}{z_1 + z_2}$ (b) $\frac{z_2 - z_1}{z_1 + z_2}$ and $\frac{z_2}{z_1 + z_2}$

(c) $\frac{z_2 - z_1}{z_1 + z_2}$ and $\frac{2z_2}{z_1 + z_2}$ (d) $\frac{2z_2}{z_1 + z_2}$ and $\frac{z_1 + z_2}{z_1 - z_2}$

24 If the divergence of a vector potential at a point $(\vec{\nabla} \cdot \vec{A})$ in the fluid is non-zero and takes positive value, then which of the following is correct?

(a) The fluid is expanding

(b) The fluid density is decreasing with time

(c) The point acts as a source of fluid

(d) Statements (a), (b) and (c) all are correct

25 The electric field of an elecromagnetic wave is described by the relation :

$$\vec{E}(r, t) = (\hat{e}_1 E_1 + \hat{e}_2 E_2) \cdot e^{i(\vec{k} \cdot \vec{r} - \omega t)}$$

where $\hat{e}_1$ and $\hat{e}_2$ are two mutually orthogonal unit vectors both perpendicular to $\vec{k}$; E_1 and E_2 are the electric field components along the two directions. What type of polarization state does this wave represent ?

(a) Plane polarized

(b) Left circularly polarized

(c) Right circularly polarized

(d) Elliptically polarized

26 A harmonic oscillator is perturbed by a perturbation potential αx^3.
The ground state energy of the oscillator to a first order in perturbation is :

(a) $\hbar\frac{\omega}{2}$ (b) $\hbar\frac{\omega}{2}+\alpha$

(c) $\frac{3}{2}\hbar\omega+\alpha$ (d) $\frac{\hbar\omega}{2}+\alpha^3$

27 The value of operator $\vec{r}\cdot\vec{p}-\vec{p}\cdot\vec{r}$ in quantum mechanics is :
(a) $i\hbar$ (b) zero
(c) $3i\hbar$ (d) $\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}\right)$

28 a and $a^+$are annihilation and creation operators for one dimensional harmonic oscillator. Then $aa^+a^+a \mid n>$ equals :
(a) $n^2 \mid n>$ (b) $(n+1)^2 \mid n>$

(c) $n(n+1) \mid n>$ (d) $\sqrt{n(n+1)} \mid n>$

29 The ground state energy shift due to a non-zero perturbing potential is zero in first order perturbation. Which of the following is correct?
(a) $\Delta E > 0$ in second order perturbation

(b) $\Delta E = 0$ in second order perturbation

(c) $\Delta E < 0$ in second order perturbation

(d) $\Delta E = 0$ in all orders of perturbation

30 The parity of wave function ψ is associated with which of the following transformation?
(a) Space inversion

(b) Space translation

(c) Space rotation

(d) Space exchange of two particles

31 What is the degeneracy of the third excited state for a particle in 3dimensional isotropic Harmonic oscillator potential. (Ground state is not an excited state) :
(a) 10 (b) 6

(c) 4 (d) 3

32 The eigenvalues of a Hermitian operator must be:
(a) Real (b) Complex

(c) Positive (d) Negative

33 In quantum mechanics three-dimensional normalized wave function $\psi(r)$ of a particle :
(a) is dimensionless

(b) has dimension of (energy x time)

(c) has dimension of energy

(d) has dimension of (length) $-^{-3/2}$

34 Particles with energy $E > V_0$ are incident from side with negative x, on step potential $V = 0$ for $x < 0$ and $V = V_0$ for $x > 0$.
The wave function is given by :

$$\psi(x) = Ae^{ik_1x} + Be^{ik_1x}\ x < 0$$
$$= Ce^{ik_2x} + De^{-ik_2x}\ x > 0$$

Then :
(a) Reflection coefficient $R = 0$

(b) Transmission coefficient$T = \frac{C^*C}{A^*A}$

(c) Transmission coefficient$T = \frac{C^*C+D^*D}{A*A+B^*B}$

(d) Reflection coefficient $= \frac{B^*B}{A^*A}$

35 A constant volume ideal gas thermometer is in thermal equilibrium with a system A at temperature T_A and measures a pressure p_A. When the same thermometer is brought in thermal equilibrium with another system B, the measured pressure is $2p_A$. The temperature of the system B is :
(a) T_A (b) $T_A/2$

(c) $2\ T_A$ (d) $T_A/\sqrt{2}$

36 Consider a process in which the volume of the system remains constant and the system is in thermal equilibrium with a heat reservoir at temperature T. Such a process is called :
(a) isothermal

(b) isobaric isothermal

(c) isochoric adiabatic

(d) isochoric isothermal

37 A Carnot engine operates between 600 K and 300 K with ideal gas as working medium. Its maximum efficiency will be :
(a) 0.5 (b) 0.8

(c) 1.2 (d) 1

38 A gaseous sytem of volume V is at pressure p and temperature T. A small change ΔV is made in the volume. If ΔQ is the change in the heat content of the system, the change Δu in the internal energy is given by :
(a) $\Delta u = p\Delta \mathrm{V} + \Delta$ (b) $\Delta u = p\Delta \mathrm{V} - \Delta \mathrm{Q}$

(c) $\Delta u = -p\Delta \mathrm{V} + \Delta \mathrm{Q}$ (d) $\Delta u = -p\Delta \mathrm{V} - \Delta \mathrm{Q}$

39 The chemical potential, in the classical limit is :
(a) zero (b) negative

(c) positive (d) complex quantity

40 The partition function z_{ij} of two independent systems i and j in thermal equilibrium with a reservoir at temperature T is given by :
(a) $z_{ij} = z_i \times z_j$ (b) $z_{ij} = z_i + z_j$

(c) $z_{ij} = z_i^{z_j}$ (d) $z_{ij} = z_i / z_j$

41 Considering the Maxwell-Boltzmann distribution of speeds of molecules, the root mean square speed of a molecular of mass m, at temperature T is :
(a) $\sqrt{\frac{3k\,\mathrm{T}}{m}}$ (b) $\sqrt{\frac{8k\,\mathrm{T}}{\pi m}}$

(c)0 (d) $\sqrt{\frac{2k\,\mathrm{T}}{m}}$

42 The number of distinct arrangements of 6 Bosons placed in 3 energy states are :
(a) 84 (b) 28

(c) 56 (d) 3^6

43 TTL output of the function generator is :
(a) Triangular wave

(b) Sine wave

(c) Square wave

(d) Triangular, sine and square waves

44 In an experiment, the voltage across a 10kΩ resistor is applied to CRO. The screen shows a sinusoidal signal of total vertical occupancy 3 cm and total horizontal occupancy of 2 cm. The front-panel controls of V/ div and time/div are on 2 V/div and 2 ms/ div respectively. Calculate the rms value of the voltage across the resistor :
(a) +3 V (b) −2.1213 V

(c) +2.1213 V (d) −3 V

45 When two rotary pumps are connected in parallel to a vacuum chamber, the ultimate pressure can be achieved is closest to :
(a) 1×10^{-3} torr (b) 0.1×10^{-3} torr

(c) 1×10^{-5} torr (d) 1×10^{-6} torr

46 Noise due to several amplifiers connected in series is :

(a) Additive (b) Subtractive

(c) Multiplicative (d) Logarithmic

47 In which counter for the detection of the thermal neutrons boron is introduced in the form of BF_3 ?

(a) Ionisation chamber

(b) Proportional counter

(c) G.M. counter

(d) Scintillation counter

48 In the Millikan's experiments, an oil drop carries four electronic charges and has a mass of 1.8×10^{-12} g. It is held almost at rest between two horizontal charged plates. 1.8 cm apart. What voltage must there be between the two charged plates ?

(a) 250 V (b) 300 V

(c) 496 V (d) 500 V

49 Metallic sodium has a bcc structure.
Its X-ray diffraction pattern does not contain lines corresponding to Bragg plane :

(a) (1 1 0) (b) (2 2 2)

(c) (2 0 0) (d) (2,2,1)

50 The movable mirror of Michelson's interferometer is moved through a distance of 0.02603 mm. The number of fringes shifted across the crosswire of a eyepiece of the telescope, if a wavelength of light 5200Å used is :

(a) 100 (b) 200

(c) 300 (d) 400 .

Answer Key				
1. None	2. c	3. d	4. a	5. d
6. *	7. a	8. b	9. a	10. d
11. b	12. a	13. c	14. a	15. d
16. b	17. b	18. c	19. c	20. a
21.	22. d	23. c	24. d	25. a
26. a	27. c	28. c	29. c	30. a
31. d	32. a	33. *	34. b	35. c
36. c	37. a	38.	39. b	40. a
41. a	42. c	43. c	44.	45. a
46. a	47. b	48. c	49. d	50. a