January 2009 Paper-II

1. In a box there are 10 Alphabet cards with the letters 3 A's. 4 M's and 3N's. One draws three cards one after another and places these cards on the table in the order they has been drawn. The probability that the words "MAN" will appear is

   (a) $\frac{2}{5}$ (b) $\frac{1}{3}$

   (c) $\frac{3}{8}$ (d) $\frac{1}{20}$

2. Let $|\bar{a}| = |\bar{b}| = |\bar{a} - \bar{b}| = 1$Then the angle between $\bar{a}$ and $\bar{b}$ is

   (a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$

   (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

3. $(-1 + i)^7 =$ .....

   (a) $8\,(1 + i)$ (b) $-8(1 + i)$

   (c) $8\,(1 - i)$ (d) $-8(1 - i)$

4. If the C is denoted a positively oriented circle $|z| = R$ then

   $\oint \frac{1}{z}\, dz = \cdots$

   (a) Zero (b) 2π

   (c) $2\pi i$ (d)$2\pi R$

5. Which of the following statement is false about a function $f(x) = |x|$?

   (a) f is continuous everywhere

   (b) f is differentiable everywhere

   (c) f is even function

   (d) Range of f is set of non-negative real number

6. A function f(x) is increasing at that x for which

   (a) $f'(x) > 0$

   (b) $f'(x) < 0$

   (c) $f'(x) = 0$ and $f''(x) > 0$

   (d) $f'(x) = 0$ and $f''(x) < 0$

7. Which of the following is not necessarily true for the conservative force field f .

   (a)$\nabla . \bar{f} = 0$ Everywhere in its domain

   (b)$\nabla \times \bar{f} = 0$ Everywhere in its domain

   (c) $\oint \bar{f}. d\bar{l}$ For any closed loop C. lying in its domain

   (d) Scalar function $\emptyset$ such that $\bar{f} = \nabla\emptyset$ exists at every point in its domain.

8. Residue of $f(z) = \frac{\sin z}{z^4}$ at the origin is ....

   (a) $\frac{1}{6}$ (b) $-\frac{1}{6}$

   (c) $\frac{1}{120}$ (d) $-\frac{1}{120}$

9. A rigid disc can rotate and slip on a $2 - d$ surface. The number of degrees of freedom of the system is

   (a) 2 (b) 3

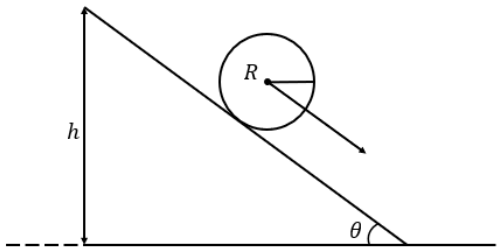
   (c) 4 (d) 1

10. A cannon is firing shells with a fixed nozzle velocity from the origin at an angle of elevation 45^0 from ground level so that each shell has a range $x = R$. One of the shells explodes into Two equal fragments when it is at the highest point of its trajectory. If both fragments hit the x-axis at the same time and one falls at $x = 3R$, the other falls at

    (a) $x = -R$ (b) $x = R$

    (c) $x = 0$ (d) $x = 6R$

11. A disc of radius R rolls down an inclined plane without slipping the disc is released from rest. What is, the angular velocity 'ω' of the disc when its center of mass losses a height h?



(a) $\omega = \sqrt{\frac{2gh}{R^2}}$ (b) $\omega = \sqrt{\frac{gh\cos\theta}{R^2}}$

(c) $\omega = \frac{hc}{R^2}$ (d) $\omega = \sqrt{\frac{g}{R}}$

c is the speed of light and
g is the acceleration due to gravity.

12. Which of the following equation represents wave motion?

(a) $y = a\sin\omega t.\, e^{ax}$

(b) $y = a\sin(\omega t - \emptyset).\, e^{-\beta x}$

(c) $y = a\sin(\omega t + \emptyset)\sin hx$

(d) $y = a\sin(kx - \omega t)$

13. For a two particles system, the.
Lagrangian is

$$L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2) - kx + \frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) - kx$$

The cyclic coordinates of the system are

(a) x and y (b)r and θ

(c)x and r (d) y and θ

14. A car moving at high speed on a flat road turns right. Which one of the following is true?

(a) Both the right wheels will leave the road.

(b) Both the left wheels will leave the road

(c) all the four wheels will remain on the road

(d) only front right wheel will leave the road.

15. Mass of moving particles is two times of its rest-mass. The velocity of the particle is

(a) $\frac{C}{2}$ (b) C

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

16. The shape of the earth is not perfectly spherical, (it is Flattened at the poles) because

(a) It rotates about its axis.

(b) It revolves about the sun.

(c) The Gravitational pull of the sum is stronger at the equator than at the pole

(d) The Atmospheric pressure is not uniform

17. Uniform Surface charge densities $+2\sigma$ and -3σ are given on the planes $z = a$ and $z = -a$ respectively, The fields at point A ($z = 2a$). B ($z = 0$) and C ($z = -2a$) on the Z-axis are respectively

(a) $\frac{\sigma\hat{k}}{2\epsilon_0}, \text{zero}, \frac{\sigma\,\hat{k}}{2\epsilon_0}$ (b) $\frac{-\sigma\hat{k}}{2\epsilon_0}, \frac{-5\,\sigma\,\hat{k}}{2\epsilon_0}, \frac{\sigma\,\hat{k}}{2\epsilon_0}$

(c) $\frac{-\sigma\,\vec{\hat{k}}}{2\epsilon_0}, \frac{-5\,\sigma\,\hat{k}}{2\epsilon_0}, \frac{-\sigma\,\hat{k}}{2\epsilon_0}$ (d) $\frac{\sigma\hat{k}}{\epsilon_0}, \frac{5\,\sigma\,\hat{k}}{\epsilon_0}, \frac{\sigma\,\hat{k}}{\epsilon_0}$

18. A conducting sphere of radius 'a' has a charge Q on it. If a point charge $-Q$ is brought to a distance 2a from its center, the potential of the sphere will be

(a) $\frac{Q}{8\pi\epsilon_0 a}$ (b) $-\frac{Q}{8\pi\epsilon_0 a}$

(c) $\frac{Q}{2\pi\epsilon_0 a}$ (d) Zero

19. Gauss's law states that the surface integral of $\vec{E}$ over a closed surface S is $\frac{1}{\epsilon_0}$ times the charge enclosed within S.

(a) Must be only due to the charges enclosed in S.

(b) Can be due to enclosed Charges and any other charges outside S.

(c) Must be due to enclosed charges and charges outside S.

(d) Can be due to enclosed charges and outside charge provided the outer charges add up to zero.

20. The dimensions of $\frac{E}{B}$ in terms of mass M, length L and time T are:
(a) $L\,T^{-2}$ (b) $M^0\,L^0T^0$
(c) $ML\,T^{-2}$ (d) $L\,T^{-1}$

21. A magnetic needle is kept in a non-uniform magnetic field. It experiences
(a) a force and a torque

(b) a force but not a torque

(c) A torque but not a force

(d) Neither a force nor a torque

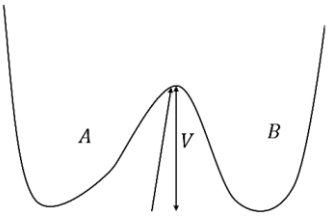
22. If ϵ_0 and μ_0 are the electric permittivity and magnetic permeability in a free space and ϵ and μ are the corresponding quantities in a medium, then the refractive index of the medium is
(a) $\sqrt{\frac{\epsilon\mu}{\epsilon_0\mu_0}}$ (b) $\sqrt{\frac{\epsilon_0\mu_0}{\epsilon\mu}}$
(c) $\frac{\epsilon\mu}{\epsilon_0\mu_0}$ (d) $\frac{\epsilon_0\mu_0}{\epsilon\mu}$

23. Four charges equal to Q are placed at the four corners of a square and a charge q is placed at its center. If the system is in equilibrium then the value of q
(a) $\frac{-Q}{4}\left(1+2\sqrt{2}\right)$ (b) $\frac{Q}{4}\left(1+2\sqrt{2}\right)$
(c) $\frac{-Q}{2}\left(1+2\sqrt{2}\right)$ (d) $\frac{Q}{2}\left(1+2\sqrt{2}\right)$

24. A charged particle with q enter a region of constant , uniform and mutually orthogonal field $\vec{E}$ and $\vec{B}$ with a non-relativistic velocity $\bar{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$ and comes out without any change in magnitude or direction of $\bar{v}$. then $\bar{v} =$
(a) $\frac{\vec{E}\times\vec{B}}{E^2}$ (b) $\frac{\vec{B}\times\vec{E}}{E^2}$
(c) $\frac{\vec{E}\times\vec{B}}{B^2}$ (d) $\frac{\vec{B}\times\vec{E}}{B^2}$

25. Two long wire separated by distance d carry same amount current in the same direction. They exert a force F per unit length on each other. If current in each wire is doubled and separation distance is also doubled, the new value of the force per unit length exerted by each on the other is ...
(a) $\frac{F}{2}$ (b) 2F
(c) $\frac{F}{8}$ (d) 8F

26. For the following symmetric double well potential , a particle with energy $E < V_0$ moves form A to B in time T. The particle will move from A to B and then B to A in times



(a) 3T (b) 2T
(c) $\frac{T}{2}$ (d) $\frac{3T}{2}$

27. A 2-D quantum mechanics particle is confined to move inside a square of side L. its wave function is proportion to

(a)sin(kx)sin(ky) (b) sin(kx) cos(ky)

(c) cos(kx) sin(ky) (d) cos(kx) cos(ky)

Where $k = 2n\pi/L$, n integer .

28. A two-electron atom is in a corresponding to angular Momentum numbers $l_1 = 3.$ and $l_2 = 2$ for the two electrons respectively. The total angular momentum quantum number L can have the values.

(a) 0, 1, 2,3 (b) 0, 1, 2, 3,4,5

(c)2,3,4 (d) 1,2, 3,4,5

29. What are the eigenvalues of the operator $H = \sigma P$ where σ are the three Pauli spin matrices and p is the momentum vector?

(a) P_x and P_y (b) $P_x \pm i\, P_y$

(c) $\pm\ |P_{\sim}|$ (d) $\pm\ (P_x + P_y + P_z)$

30. A particle of energy E is incident from left on a rectangular potential barrier of width a and height Vo > E. The probability of the particle tunnelling through the barrier is

(a) Monotonic function of E.

(b) Oscillating function of E

(c) Decreases as a decreases

(d) Oscillates as a increases

Which one of the above Statements Is true?

31. A 3-D quantum mechanical particle is confined to a box of volume V. the ground state energy of the particle is proportional to

(a) V (b) $V^{-3/2}$

(c) $V^{-2/3}$ (d) V^2

32. Lx, Ly, Lz are angular momentum operators $L_x \pm iL_y$ $[L_{\pm}, L_z]$ is equal to

(a) $-\hbar L_+$ (b) $\hbar L_+$

(c) $-\hbar L_-$ (d) $\hbar L_+$

33. The de Broglie wavelength of a Helium atom at 300 K is 0.6 A^0. Hence the de Broglie wavelength of neon atom which is five time heavier than He atom, at 600 K is

(a) 6 A^0 (b) 0.06 A^0

(c) $0.6 \times \sqrt{10}\ A^0$ (d) $0.6/\sqrt{10}\ A^0$

34. Consider a system of N identical, independent, 3 dimensional harmonic Oscillators with the same vibrational frequency ω. The system is held at a temperature T. treating the oscillators as classical, the molar specific heat of the system is

(a) $\frac{3}{2}R$ (b) 3NK

(c) $\sqrt{\frac{3}{2}}R$ (d) 3R

35. Consider an system of 4 identical undisguisable particles with single particle partition function as Z. The partition function of system

(a) z^4 (b) 4z

(c) $\frac{z^4}{4!}$ (d) $\frac{4\,z^4}{4!}$

36. For a two dimension degenerate Fermi gas , the density of states is propositional to the following function of energy ∈

(a) ϵ (b) $\epsilon^{-\frac{1}{2}}$

(c) ϵ^0 (d) ϵ^1

37. A Fermi Gas (with Fermi Temperature T_F) at Temperature T is Degenerate if

(a) $T = T_F$ (b) $T \gg T_F$

(c) $T \ll T_F$ (d) $T \to \infty$

38. For the joule – Thomson effect to produce a cooling effect for a gas the initial temperature T. of the gas must be
(a) T > Inversion temperature of the gas

(b) T = Inversion temperature of the gas

(c) T is not related to inversion temperature of the gas

(d) T < inversion temperature of the gas

39. A gas of weakly interacting Magnetic ions, each with magnetic moment $\vec{\mu}_j$ corresponding to the orbit angular momentum $\vec{j}$ is subjected to an external magnetic field $\vec{H}$. The number of microstate accessible to each of the atom is
(a) J(J + 1) (b) 2J + 1

(c)2J (d)2J − 1

40. Consider a system consisting or two particles, each of which can be in any one of 3 quantum states of energies $0, \in, 3 \in$. The system is in contact with a heat reservoir at temperature T. The partition function, in case the particles are Fermions, will be
(a) $Z = e^{-\epsilon/kT} + e^{-3\epsilon/kT} + e^{-4\epsilon/kT}$

(b) $Z = 3\, e^{-\epsilon/kT}$

(c) $Z = e^{-3\epsilon/kT}$

(d) $Z = 1 + 2e^{-\beta\epsilon/kT} + 2e^{-3\beta\epsilon}$

41. The equation $PV = \frac{2}{3}\vec{E}$ valid For a gas of material particles irrespective of the statistics obeyed by them. Here, P is the pressure, V the volume and $\vec{E}$ the mean energy of the gas. For a photon gas, the radiation pressure is expressed as

(a) $\vec{P} = \frac{1}{3}\frac{\vec{E}}{V}$ (b) $\vec{P} = \frac{4}{3}\frac{\vec{E}}{V}$

(c) $\vec{P} = \frac{2}{3}\frac{\vec{E}}{V}$ (d) $\vec{P} = \frac{\vec{E}}{V}$

42. For measuring temperature below 77K following devices should be used.
(a) Thermocouples

(b) Resistance Thermometer

(c) Quartz thermometer

(d) Optical pyrometer

43. RTDs (Resistance Temperate Devices) based on platinum are used for temperature measurement because
(a) It is chemically inert

(b) it has linear response

(c) It is linear and chemically inert

(d) It offers wide range for Temperature measurement

44. Bandwidth of CRO for X-t mode is specified by
(a) Bandwidth of horizontal amplifier

(b) Bandwidth of vertical amplifier

(c) Frequency of time base generator

(d) Bandwidth of the horizontal amplifier and frequency of time base generator

45. A voltage source has voltage V with 10 K ohm resistance. The voltage is measured by voltmeter having 90 K ohm resistance. The error involved in the measurement is
(a) 10% (b) 1%

(c) 0.1% (d) 0.01%

46. In a piezo electric crystal used in gas lighter
(a) Mechanical energy is converted into electrical energy

(b) Electrical energy is converted into mechanical energy

(c) Electrical energy is converted into magnetic energy

(d) Magnetic energy is converted into electrical energy

47. For resolving two very small wavelength difference one of the following instruments should be Used
(a) Michelson interferometer

(b) Fabry- Perot interferometer

(c) Fresnel's baptism

(d) Lummer and Gerlach plate

48. A monochromatic X-ray beam of wavelength λ is incident on a single crystal. It produces four fold diffracted spots on the film of a Laue camera. Assuming that the spots arise from {110} of a simple cubic crystal of lattice constant a, the wavelength of X- rays should be
(a) $\lambda = \frac{a}{2}$ (b) $\lambda = a$

(c) $\lambda = 2a$ (d) $\lambda > a$

49. The cut-off wavelength λ_{min} for Continuous X-rays is given by relation
(a) $\lambda_{min} = \frac{hc}{e\,V_A}$ (b) $\lambda_{min} = \frac{e\,V_A}{hc}$

(c) $\lambda_{min} = \frac{e\,c}{V_A.h}$ (d) $\lambda_{min} = \frac{V_A.c}{e.h}$

50. The divergence of the light beam is maximum for
(a) Copper Vapor Laser

(b) Helium Neon Laser

(c) Nd: YAG Laser

(d) Semiconductor Laser.

Answer Key				
1. d	2. c	3. c	4. c	5. a
6.	7. a	8. b	9. d	10. d
11. b	12. d	13. d	14. a	15. c
16. a	17. a	18. a	19. a	20. d
21. a	22. a	23. a	24.	25. b
26. b	27. a	28.	29. c	30. c
31.	32. a	33. d	34.	35. c
36. c	37. c	38. d	39. b	40. a
41. a	42. c	43.	44. b	45. a
46. a	47. b	48.	49. a	50. c