# August 2006 Paper –II

1. The value of the following continued fractions
$$4+\cfrac{1}{4+\cfrac{1}{4+\cdots\ldots\ldots}}$$
(a) $[4+\sqrt{5}]$ (b) $[2-\sqrt{5}]$
(c) $[2+\sqrt{5}]$ (d) $[4-\sqrt{5}]$

2. An urn contains 4 red balls, 5 Blue balls, 6 White balls. A ball is drawn at random from. The probability that the chosen ball is blue is
(a) $\frac{1}{3}$ (b) $\frac{2}{5}$
(c) $\frac{1}{5}$ (d) $\frac{1}{10}$

3. If $f(x) = \log_e x$ and $g(x) = \log_{10} x$
(a)$f < g$ For all $x, 0 < x < \infty$
(b)$f > g$ For all $x, 0 < x < \infty$
(c)$f > g$ For all $0 < x < 1 f < g$ For all $1 < x < \infty$
(d)$f < g$ For $0 < x < 1 f > g$ For all $0 < x < \infty$

4. The Divergence of the two vectors
$\vec{a} = x\vec{i}$ And $\vec{b} = y\vec{k}$ Where $\vec{i}$ $\vec{j}$ and $\vec{k}$
Are the unit Cartesian vector is respectively
(a) 1,0 (b) 0,1
(c) 0,0 (d) 1,1

5. An $n \times n$ unitary matrix with Complex elements is completely described by real independent parameters, where m is
(a) $n^2$ (b) $n(n+1)$
(c) $n(n-1)$ (d) $2n$

6. The possible eigenvalues of a real orthogonal matrix and of a unitary matrix are respective
(a) $\pm 1$ ; $e^{i\theta}\theta$ is Real (b) $\pm 1, \pm 1$
(c) $e^{i\theta}$ ; $e^{i\theta}\theta$ is Real (d) $\pm 1$ ; $\pm 1 \pm i$

7. Consider the function $f(x) = 3\sin x, 0 < x < \pi, f(x+\pi) = f(x)$ the function will has a Fourier series having
(a) Sine terms and period $\pi$
(b) Cosine terms and period $\pi$
(c) Sine terms and period $2\pi$.
(d) Both sine and cosine terms

8. If the real part of an analytic function $f(z)$ is $u(x,y) = x^4 - 6x^2y^2 + y^4$, then $f(z)$
(a) $z^4$ (b) $|z|^4$
(c) $z^2 z^{*2}$ (d) $z^3 z^*$

9. The function $\frac{1}{(z-1)^{\frac{1}{2}}}$
(a) is analytic in the region $|z| < 2$.
(b) Has a pole at $z = 1$
(c) Has branch points at $z = 1$ and infinity
(d) Has an essential singularity at $z = 1$

10. Given a Lagrangian
$$L = \frac{1}{2}m(\vec{r})^2 + \frac{1}{2}kx^2$$
The equations of motion are
(a) $m_{\ddot{x}} - kx = 0 \quad m_{\ddot{y}} = 0 \quad m_{\ddot{z}} = 0$
(b) $m_{\ddot{x}} + kx = 0 \quad m_{\ddot{y}} = 0 \quad m_{\ddot{z}} = 0$
(c) $m_{\ddot{r}} + kr = 0 \quad \frac{d}{dt}mr^2\dot{\theta} = 0$
(d) $m(\ddot{x} + \ddot{y} + \ddot{z}) - kx = 0$

11. Consider two bodies of-the same Mass moving around a massive body under a central force. One particle moves in an elliptic orbit of semi major axis a and semi minor axisb. Other body moves in a circular orbit of radiusa. Then,

(a) Period of the elliptic motion is greater than the period of circular motion

(b) Period of the elliptic motion is same as the circular motion.

(c) Period of the circular motion is greater than the period of the elliptic motion

(d) Period of the elliptic motion depends on the ratio (a/b) whereas the period of the circular motion depends on its radius a

12. Hamiltonian for the free particle is

(a) $H = \frac{1}{2}mu^2$ (b) $H = \frac{1}{2}mu^2 + \frac{1}{2}kx^2$

(c) $H = \frac{P^2}{2m}$ (d) $H = cp$

Where the symbols have their usual meanings

13. Two masses of 200gm and 300gm are separated by a light rod 50 cm in length. The distance of the centre of mass from the 200gm mass is

(a) 10 cm (b) 20 cm
(c) 30 cm (d) 40 cm

14. The impact parameter s associated with the Scattering of a particle of mass m, energy E and angular momentum l, by a center of force is given by

(a) $s = \frac{l}{\sqrt{2mE}}$ (b) $s = l\sqrt{2mE}$

(c) $s = \frac{E}{\sqrt{2ml}}$ (d) $s = \frac{E^2}{2ml^2}$

15. A frame rotates with respect to a fixed frame with an angular velocityω. To find the force in the fixed frame, we have to add the following forces in the rotating frame.

(a) $2m\,\vec{w} \times \vec{v}$ And $m\vec{w} \times (\vec{w} \times \vec{r})$

(b) $2m\,\vec{w} \times \vec{v}$ And $-m\vec{w} \times (\vec{w} \times \vec{r})$

(c) $-2m\,\vec{w} \times \vec{v}$ And $-m\vec{w} \times (\vec{w} \times \vec{r})$

(d) $-2m\,\vec{w} \times \vec{v}$ And $m\vec{w} \times (\vec{w} \times \vec{r})$

Where $\vec{v}$ is the velocity of the particle in the rotating frame and $\vec{r}$ is it's positions

16. At any instant the total energy of the one dimensional simple harmonic oscillator with amplitudeA. Frequency $\omega_0$ and mass m

(a) $\frac{1}{2}m\omega_0{}^2$ (b) $\frac{1}{2}\ mA^2$

(c) $\frac{1}{2}m\omega_0^2A^2$ (d) $m\omega_0^2A^2$

17. Under the Lorentz transformation

(a) Newton's law and Maxwell equation are invariant

(b) Maxwell equation is invariant but Newton's law Non- invariant

(c) Newton's law and Maxwell equation are Non-invariant

(d) ) Maxwell equation are Non- invariant but Newton's law invariant

18. The bob of simple pendulum is charged. If an earthed metal plate is placed under it. then its time period as compared to an unchanged bob, will

(a) Decrease

(b) Increase

(c) Riemann unchanged

(d) Depend on the sign of charge on the bob

19. In a constant electric field $\vec{E}$. the electric displacement $\vec{D}$ in certain dielectric medium dielectric medium to be given by $\vec{D} = \epsilon_0\vec{E}$. This implies that the dielectric medium is

(a) Linear but anisotropic

(b) Nonlinear but isotropic

(c) Linear and isotropic

(d) Nonlinear and anisotropic

20. Among the phenomena of (a) Total internal reflection, (b) refraction, (c) dispersion and (d) polarization, the phenomena involved in the formation of a rainbow are

(a) a, b and c (b) c only

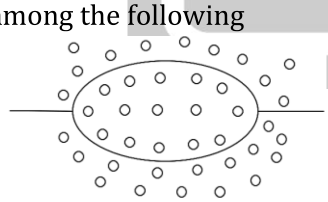
(c) b and c only (d) all four

21. Two identical bar magnets are kept parallel to each other at a distance d from each other with their North Pole pointing in opposite directions. The magnetic field at appoint far away from the system decreases as $\frac{1}{r^n}$ where n is

(a) 3 (b) 4

(c) 5 (d) 6

22. Consider a conducting loop kept in a uniform magnetic field which is directed into the page and perpendicular to it, as shown. In two situations, (i) the loop is pulled from both sides, and (ii) the loop is pulled only from one side. The correct statement among the following



(a) i) current will flow anticlockwise
(ii) no current

(b) i)Current will flow clockwise
(ii) no current

(c) i) no current ii) no current

(d) i) current will flow clockwise ii) current will flow anticlockwise

23. Maxwell modified Ampere's equation into Ampere-Maxwell, equation in 1860 s because Ampere's equation was

(a) Not valid for time-dependent EM fields

(b) Not invariant under Galilean transformation

(c) Not invariant under Lorentz transformation

(d) Not consistent with equation of continuity

24. A plane EM wave traveling in a medium is described by its electric field
$E = 100 \cos(6 \times 10^8 t + 4x) v/m.$
Where all quantities are in SI units. The dielectric constant of thee Medium will be

(a) 1.5 (b) 2.0

(c) 2.4 (d) 4.0

25. The E field of an EM wave is given by $\vec{E} = E_0(\vec{j} - \vec{k})e^{i(kx-wt)}$ the wave is Polarized along

(a) (1,0,0) (b) (0,1,1) )

(c) (0,1,-1) (d) (-1,0,1)

26. For spherically symmetric potential, the partial wave analysis gives

(a) $f(\theta) = \sum_{l=0}^{\infty} P_l \cos\theta$

(b) $\sigma = \sum_{l=0}^{\infty} \frac{2l+1}{k^2} P_l \cos\theta$

(c) $f(\theta) = \sum_{l=0}^{\infty} \frac{2l+1}{k} \sin\delta_1 e^{i\delta} P_l \cos\theta$

(d) $\sigma = \sum_{l=0}^{\infty} \frac{2l+1}{k^2} \sin\delta_l \; e^{i\delta_1}$

Where k is the wave vector and $\delta_1$ is the phase shift

27. For a rotational level with quantum number J, the degeneracy of the level is
(a) J (b) $2J+1$
(c) 2 J (d) $2J-1$

28. For transition between Non- degenerate levels, the ratio of spontaneous emission to stimulated emission is
(a) $e^{\hbar w / k_B T}$ (b) $\frac{\partial \pi h\, v^3}{c^3}$
(c) 1 (d) $\frac{1}{137}$

29. If $(x, y)$ Represent position coordinates, Px , Py momenta, and Lx, Ly angular momenta of a microscopic particle, then which of the following pairs can be simultaneously measured?
(a) $L_x, P_y$ (b) $L_x, y$
(c) $L_x, x$ (d) $L_x, L_y$

30. Given a harmonic oscillator with Hamiltonian
$$H=\frac{{P_x}^2}{2m}+\frac{1}{2} m\, w^2 x^2$$
a perturbation
$H'=\alpha x^2$ where $2\alpha \gg mw^2$, is applied to it.
The exact energy Values of the oscillator are
(a) $\left(n+\frac{1}{2}\right) \hbar\omega + \hbar\sqrt{\frac{\alpha}{m}}$
(b) $\hbar\left(w+\sqrt{\frac{2\alpha}{m}}\right)$
(c) $\left(n+\frac{1}{2}\right) \hbar\omega'$ where $w' = \sqrt{w^2+\frac{2a}{m}}$
(d) $\left(n+\frac{1}{2}\right) \hbar\omega \left(1+\frac{\alpha}{m\, w^2}\right)$

31. Ground state of hydrogen atom s This atom is kept in a strong Electric field E along z axis. The Stark splitting in first order is
(a) Zero
(b) $-3\, E\, e\, \alpha_0$ where $a_0=\frac{h^2}{me^2}$
(c) $-3\, E\, e\, \alpha_0$
(d) Non zero but independent of E

32. If a particle with a momentum $\vec{p}$ is moving in a potential field V=V $(\overrightarrow{x})$ then by Ehrenfest theorem,
(a) $\frac{d\bar{r}}{dt}=\frac{i}{\hbar}[\vec{r}, H]$ & $\frac{d\bar{r}}{dL}=-\frac{i}{\hbar}[\vec{p}, V(\vec{x})]$
(b) $\frac{d\bar{r}}{dL}=-\frac{i}{\hbar}[\vec{r}, V(\vec{x})]$
(c) $\frac{d\bar{p}}{dL}=+\frac{i}{\hbar}[\vec{p}, \nabla V]$
(d) $\frac{d<\bar{p}>}{dL}=-<\nabla V(x)>$

33. Given a quantum harmonic mechanical average Oscillator, which of the following statements is true?
(a) $E_n=\left(n+\frac{1}{2}\right)\hbar\omega$ and states with $n=0,2,4, \ldots$ etc. have odd parity
(b) $E_n=\left(n+\frac{1}{2}\right)\hbar\omega$ and states with n have odd parity
(c) $E_n=\frac{1}{2} m\, w^2 A^2$ where A is amplitude of the oscillator
(d) $E_n=\left(n+\frac{1}{2}\right)\hbar\omega$ But the Eigen states do not have definite parity

34. Given the operators $p_x = p_x$ and $x = i\hbar \frac{\partial}{\partial p_x}$ the value.

(a) $[x, p_x] = -i\hbar$ (b) $[x, p_x] = xp_x$

(c) $[x, p_x] = -p_x, x$ (d) $[x, p_x] = i\hbar$

35. For N number of particles confined in a volume V at a temperatureT, equation oft state is given by $pV = N\,k_B T\,(1 + B(T)\frac{N}{V}$ Where B(T) is second viral coefficient and is a function of absolute temperature T only. n a process where Pressure and temperature are held constant, the work done in the process is Where $V_i$ is initial volume and $V_f$ is final volume

(a) $B\,(T)\,N^2 k_B T\left(\frac{1}{V_i} - \frac{1}{V_f}\right)$

(b) $Nk_B T\left(1 + \frac{B(T)N}{(V_i - V_f)^2}\right)(V_i - V_f)$

(c) $Nk_B T\left[1 + B(T)N\ln\left(\frac{V_i}{V_f}\right)\right]$

(d) $N^2 k_B T\,B\,(T)\ln\left(\frac{V_i}{V_f}\right)$

36. If E is internal energy, p is Pressure, and V is a volume of a gas confined in a container at temperature T, then, using combined form of the first and the second law of Thermodynamics,

(a) $\left(\frac{\partial E}{\partial S}\right)_V = T$ and $\left(\frac{\partial S}{\partial V}\right)_E = \frac{p}{T}$

(b) $\left(\frac{\partial E}{\partial V}\right)_S = T$ and $\left(\frac{\partial S}{\partial E}\right)_V = \frac{p}{T}$

(c) $\left(\frac{\partial E}{\partial S}\right)_V = \frac{p}{T}$ and $\left(\frac{\partial S}{\partial V}\right)_E = \frac{p}{T}$

(d) $\left(\frac{\partial E}{\partial p}\right)_T = T$ and $\left(\frac{\partial S}{\partial V}\right)_T = E$

37. Average velocity of a molecule of a gas at an absolute temperatureT, as calculated by using Maxwell's velocity distribution is

(a) Zero (b) $\sqrt{\frac{k_B T}{m}}$

(c) $\sqrt{\frac{3\,k_B T}{m}}$ (d) $\sqrt{\frac{k_B T}{2m}}$

Where $k_B$ Boltzmann constant

38. If is a thermodynamic system has N particles at temperatureT, then the fluctuations in average Energy are proportional to

(a) $\frac{1}{N}$ (b) $\frac{1}{\sqrt{N}}$

(c) $\frac{1}{\sqrt[3]{N}}$ (d) N

39. A system has three identical particles, each of which can. have four distinct energy states. If they are fermions/bosons, the number of distinct microstates of The system is respectively

(a) 4, 14 (b) 14, 4

(c) 4, 20 (d) 20,4

40. Consider two silicon rods, one of n type and the other of p type. n Type rod has chemical potential $\mu_1$. and p type has chemical potential $\mu_2$ The two rods are fused at a common surface and a junction is formed with depletion layer at it. Then. in equilibrium state.

(a) $\mu_1 > \mu_2$ (b) $\mu_1 < \mu_2$

(c) $\mu_1 = 0 = \mu_2$ (d) $\mu_1 = \mu_2 > 0$

41. As the temperature of the black body increases, the maximum of the black body spectrum

(a) Shits towards higher wavelength

(b) Shifts towards lower wavelength

(c) Does not shift

(d) Shifts depending upon the spectrometer used

42. If TF is the Fermi temperature of a degenerate electron gas of density n, then for $T \ll T_F$ Corrections to the internal energy . $E_0$ Behave as

(a) $\left(\frac{T}{T_F}\right) E_0$ (b) $\left(\frac{T}{T_F}\right)^2 E_0$

(c) $\left(\frac{T}{T_F}\right)^3 E_0$ (d) $\left(\frac{T}{T_F}\right)^4 E_0$

43. In LASER condition of population inversion is necessary for

(a) Excitation (b) Light amplification

(c) Feedback mechanism (d) Active medium

44. Conversion of radiation energy Into electrical power is done by

(a) Photo tube

(b) Photo multiplier be

(c) Photo Conductive cell

(d) Photo voltaic cell

45. In order display two simultaneous events on oscilloscope scree one should uses

(a) Dual trace oscilloscope

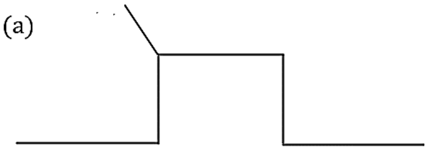
(b) Dual beam oscilloscope

(c) Two identical oscilloscopes

(d) Oscilloscope with external 11 input facility

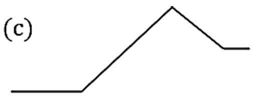
46. Time base circuit of oscilloscope generates following output wave form.

(a)

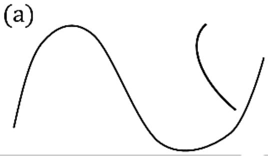


(b)

(c)



(a)



47. Maximum power is transferred to the load when

(a) Source resistance is double of load resistance.

(b) Source resistance is equal load resistance

(c) Source resistance is half the load resistance.

(d) Source resistance is negligible compared to load resistance

48. Q meter circuit works on the principle of

(a) Wheatstone bridge (b) Series resonance

(c) Parallel resonance (d) Comparison

49. Sensitivity of a strain gauge is given by

(a) $K = \frac{\Delta R/l}{\Delta l/R}$ (b) $K = \frac{\Delta R/R}{\Delta l/l}$

(c) $K = \frac{\Delta R\, \Delta l}{Rl}$ (d) $K = \frac{\Delta l/l}{\Delta R/R}$

50. Sensitivity of a pressure gauge is decided by

(a) Lowest pressure it can measure

(b) Highest pressure it can measure

(b) Lowest change in pressure it can measure

(d) Largest change in pressure it can measure

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