TEST SERIES CSIR-NET/JRF JUNE 2018

BOOKLET SERIES D

FULL LENGTH TEST - I

Paper Code 05 **Test Type: TEST SERIES**

PHYSICAL SCIENCES

Duration: 3:00 Hours

Date: 04-06-2018

Maximum Marks: 200

Read the following instructions carefully:

* Single Paper Test is divided into **three** Parts.

Part - A: This part shall carry 20 questions. The candidate shall be required to answer any 15 questions. Each question shall be of **2 marks.**

Part - B: This part shall contain 2**5** questions covering the topics given in the Part 'B' of syllabus. The candidates are required to answer any 20 questions. Each question shall be of **3.5 Marks.**.

Part - C: This part shall contain **30** questions from Part - C of the syllabus. The candidates are required to answer any 20 questions. Each question shall be of **5 Marks**.

* Darken the appropriate bubbles with HB pencil/Ball Pen to write your answer.

* There will be negative marking @25% for each wrong answer.

* The candidates shall be allowed to carry the Question Paper Booklet after completion of the exam.

* For rough work, blank sheet is attached at the end of test booklet.

PART-A

1. A batsman has a contain average in 11 innings. In the 12^{th} innings, he scores 90 runs and his average decreases by 5. After the 12^{th} innings what is his average?
(a) 145 (b) 130 (c) 135 (d) none

2. 12 Men can complete one-third of the work in 8 days. In how many days can 16 men complete that work?
(a) 18 days (b) 12 days (d) 14 days (d) 24 days

3. Two trains leave from Jaipur at 8 : 30 AM and 9.00 AM for Delhi and travel at speed of 60 kmph and 75 kmph, respectively. How many km away from Jaipur will the two trains meet?
(a) 125 km (b) 150 km (c) 175 km (d) 200 km

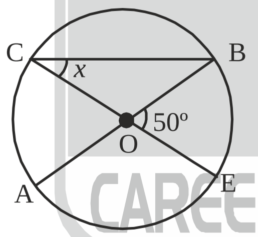
4. A man walking at a speed of 5 km/hr reaches his target 5 minute late. If he walks at a speed of 6 km/hr, he reaches on time. Then the distance of his target from his house is
(a) 2.3 km (b) 2.5 km (c) 2.4 km (d) 2.6 km

5. Two men A and B walk from P to Q, a distance of 21 km, at 3 and 4 kms an hour respectively. B reaches Q, returns immediately and meets A at R. The distance from P to R is
(a) 12 km (b) 14 km (c) 16 km (d) 18 km

6. The cost of an article was Rs. 75. The cost was fisrt increased by 20% and later on it was reduced by 20%. The percent cost of the article is
(a) Rs. 72 (b) Rs. 60 (c) Rs. 75 (d) Rs. 79

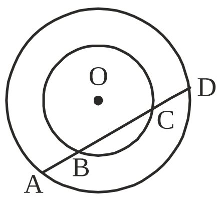
7. The distance between two parallels chords of length 8 cm each in a circle of diameter 10 cm is
(a) 6 cm (b) 7 cm (c) 8 cm (d) 5.8 cm

8. In the following figure O is the centre of the circle. Then x is (If $\angle BOE = 50^o$)



(a) 35º (b) 25º (c) 15º (d) 5º

9. If a line intersects two co-centric circles with centre O at A, B, C and D. Then which of the following statement is correct



(a) AB + CD = BC (b) AD = 2BC (c) $AD = \frac{3}{2}AC$ (d) AB = CD

10. A circle is inscribed in an equilateral triangle of side 8 cm. The area of the portion between the triangle and the circle is
(a) 11 cm^2 (b) 10.95 cm^2 (c) 10 cm^2 (d) None

11. A cube of sides 3 cm is melted and smaller cubes of sides 1 cm are formed. Then the number of small cubes are

(a) 21 (b) 23 (c) 27 (d) 25

12. A rectangular sheet with dimensions 22m×10m is rolled into a cylinder. So, that the smaller side becomes the height of the cylinder. Then the volume of the cylinder is

(a) 385 m^3 (b) 375 cm^2 (c) 365 m^3 (d) 355 m^3

13. The greatest number that will divide 55, 127 and 175. So, as to leave the same remainder in each case is

(a) 24 (b) 25 (c) 27 (d) none

14. If x is less then 2, then which of the following statement is always true?

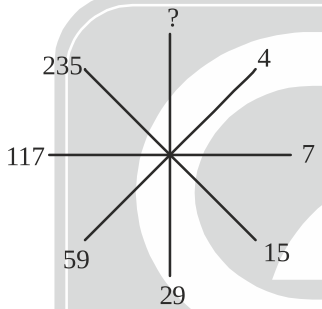
(a) x is negative (b) $2x$ is greater than or equal to x

(c) x^2 is greater than or equal to x (d) none

15. Seema is nineteenth from right and she is eight to the right from Suman and who is fifteenth from left. Then how many students are there in a row?

(a) 41 (b) 40 (c) 39 (d) 42

16. The missing number is



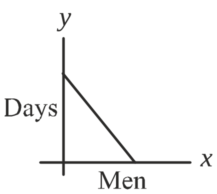
(a) 327 (b) 386 (c) 468 (d) 469

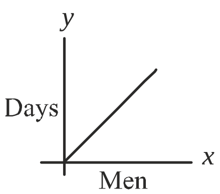
17. Out of 120 applications for a post, 70 are male and 80 have a driver's license. What is the ratio between the minimum to maximum number of males having drivers license?

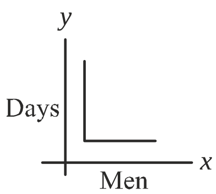
(a) 1 to 2 (b) 2 to 3 (c) 3 to 7 (c) 5 to 7

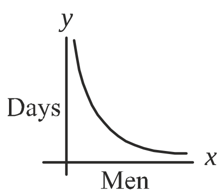
18. Consider the following diagram

x men working at constant speed, do a job in y days, which one of these diagram shows the relation between x and y?

(a) 

(b) 

(c) 

(d) 

19. As you go down into a well, your weight

(a) increases slightly (b) decrease slightly

(c) remains exactly the same (d) None of the above

20. It was sunday on January 1, 2006. What was the day of the week January 1, 2010?

(a) Sunday (b) Saturday (c) Friday (d) Wednesday

PART-B

21. The value of the following integral

$$\oint_C \frac{1+\cos z}{(z-\pi)^2}dz$$

where C is curve defined by the equation $|z| = R$, will be

(a) $2\pi i$ (b) 0 (c) $2\pi Ri$ (d) πRi

22. The Fourier Transform of the function

$$f(x,y) = \begin{cases} 1 & \text{for } |x| < \frac{1}{2}, |y| < \frac{1}{2} \\ 0 & \text{otherwise} \end{cases}$$

will be proportional to

(a) $\frac{\sin(k_x/2)}{(k_x/2)}\frac{\sin(k_y/2)}{(k_y/2)}$ (b) $\frac{\sin(k_x)}{(k_x)}\frac{\sin(k_y)}{(k_y)}$

(c) $\frac{\cos(k_x/2)}{(k_x/2)}\frac{\cos(k_y/2)}{(k_y/2)}$ (d) $\frac{\cos(k_x)}{(k_x)}\frac{\cos(k_y)}{(k_y)}$

23. The value of the integral

$$\int_0^\infty t^2\, e^{-2t}\cos(3t)\,dt$$

is

(a) $\frac{46}{13^3}$ (b) $-\frac{46}{13^3}$ (c) $\frac{92}{13^3}$ (d) $-\frac{92}{13^3}$

24. Let $\sigma_x, \sigma_y, \sigma_z$ are the Pauli spin matrices respectively. The operator $e^{\sigma_x+\sigma_y}$ can be expressed as

(a) $e^{\sigma_x}\cdot e^{\sigma_y}$ (b) $e^{\sigma_x}\cdot e^{\sigma_y}\cdot e^{-i\sigma_z}$ (c) $e^{\sigma_x}\cdot e^{\sigma_y}\cdot e^{i\sigma_z}$ (d) $e^{\sigma_x}\cdot e^{\sigma_y}\cdot e^{-2i\sigma_z}$

25. Suppose 10 non-interacting spin-½ fermions are placed under the following potential

$$V(r) = \frac{1}{2}m\omega^2 r^2$$

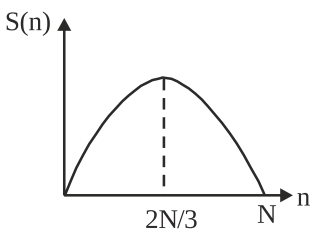
The ground state energy of the system, will be

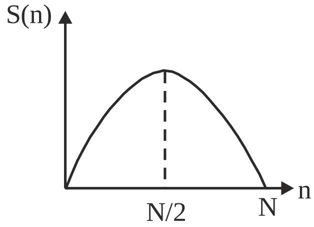
(a) $35\,\hbar\omega$ (b) $30\,\hbar\omega$ (c) $25\,\hbar\omega$ (d) $20\,\hbar\omega$

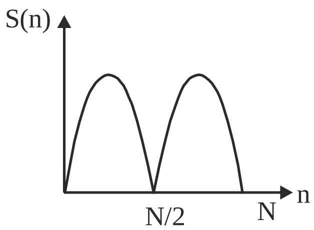
26. Consider a system of large number of N localized identical particles at temperature T. This system is placed in an uniform magnetic field B where each particle has spin-3/2. The entropy of the system as $T \to 0$ and $T \to \infty$ respectively are

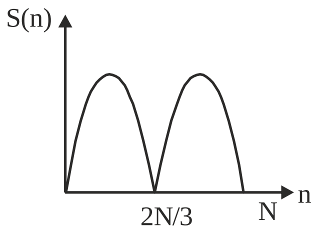
(a) $Nk_B \ln 4, 0$ (b) $0, Nk_B \ln 4$ (c) $4Nk_B \ln N, 0$ (d) $0, 4Nk_B \ln N$

27. Consider a system of $N >> 1$, non-interacting particles, each fixed in position and carrying a magnetic moment μ, which is immersed in a magnetic field H. Each particle may then exist in one of the two energy state $E = 0$ or $E = 2\mu H$. The sketch of the entropy $S(n)$ with n where n is the number of particles in the upper state is

(a) 

(b) 

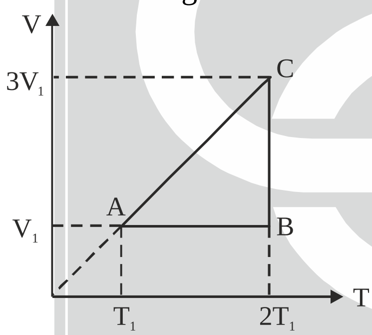
(c) 

(d) 

28. Consider four Ising spins at the vertices of a square which interact with each other with a ferromagnetic Ising interaction of strength J. The maximum and minimum possible energies, respectively, are

(a) 2J and –6J (b) 2J and 0 (c) 2J and –2J (d) 0 and 6J

29. A cyclic process for 1 mole of an ideal gas is shown the V-T diagram below:



The ratio of the work done in process BC and process AC is

(a) $\frac{2}{\ln 3}$ (b) $2\ln 3$ (c) $\frac{1}{2\ln 3}$ (d) $\ln 3$

30. The velocity of a particle moving in the positive direction of the axis varies as $v = 4\sqrt{x}$. Assuming that at the moment $t = 0$, the particle was located at the point $x = 0$. The mean velocity of particle, averaged over the time that the particle takes to cover the first s metres of the path $\langle v \rangle = \alpha\sqrt{s}$. The value of α is

(a) 4 (b) 8 (c) 2 (d) 1

31. A π meson with a momentum of $5m_\pi c$ makes an elastic collision with a proton $\left(m_p = 7m_\pi\right)$ which is initially at rest. The velocity of the centre of mass reference frame will be approximately close to :

(a) 0.5 c (b) 0.3 c (c) 0.6 c (d) 0.4 c

32. A particle of mass m collides elastically with another particle of same mass which is at rest. If in the lab frame the first particle scatters at an angle 30º to initial direction of motion. Then in centre of mass frame, the angle of scattering will be

(a) 90º (b) 120º (c) 30º (d) 60º

33. A cylinder of radius a and mass m rolls down an inclined plane making an angle θ with the horizontal. Equation of motion of the system is

(a) $\frac{3}{2}\ddot{x}+g\sin\theta=0$ (b) $\frac{3}{4}\ddot{x}-g\sin\theta=0$ (c) $\frac{3}{2}\ddot{x}-g\sin\theta=0$ (d) $\ddot{x}-g\sin\theta=0$

34. Consider a two dimensional system whose Largrangian is given by

$$L=\frac{13}{2}m\dot{x}^2+3m\dot{y}^2-mg\left(x+2y\right)$$

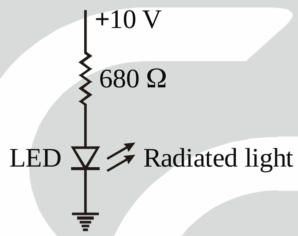
Let H be the Hamiltonian of the system, then the value of Poisson bracket $\{x, H\}$ is

(a) $\frac{p_y}{12m}$ (b) $\frac{p_y}{18m}$ (c) $\frac{p_x}{26m}$ (d) $\frac{p_x}{13m}$

35. A Zener diode has the following properties :
1. It is properly doped crystal diode with sharp breakdown.
2. It is reverse biased.
3. Its forward characteristics are just that of ordinary diode.
4. Its reverse characteristics are like ordinary diode.

(a) 1, 2, 3 and 4 (b) 1, 2, 4 (c) 1, 2 and 3 (d) 3 and 4

36. The light emitting diode (LED), shown in the below figure has a voltage drop of 2V. The current flowing through LED is



(a) 11.8 mA (b) 0.0147 mA (c) 2.941 mA (d) 0.0176 mA

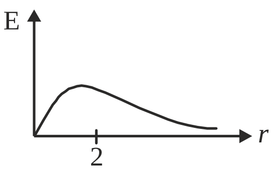
37. The minimum number of NAND gates required to implement $A+A\bar{B}+A\bar{B}C$ is

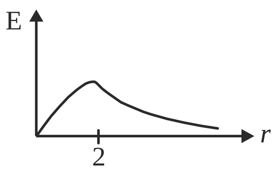
(a) 0 (b) 1 (c) 4 (d) 7

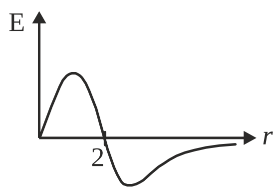
38. A particle of unit mass and unit charge is thrown with initial velocity $\vec{v}=\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{j}\right)$ in a uniform field $\vec{B}=1\hat{k}$ from origin. After what time the particle will reach the point $\left(0, \sqrt{2}, 0\right)$

(a) 1.57 sec (b) 3.14 sec (c) 6.28 sec (d) 12.56 sec

39. A sphere radius $R = 2$ has charge density $\rho=c\left(r-r^2\right)$. The electric field varies with r as

(a)


(b)


(c)


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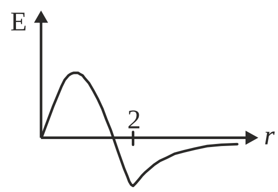


40. A circular wire loop of radius r is placed in magnetic field which varies with time as $B=B_0e^{-kt}T$. The direction of magnetic field is perpendicular to the plane of loop. The induced current (A) in the loop at $t = 2$ sec is
(resistance of loop = R)

(a) $\frac{\pi r^2 B_0}{Re^{2k}}$ (b) $\frac{\pi r^2 kB_0}{Re^{2k}}$ (c) $\frac{\pi r^2 kB_0}{Re^{2k}}$ (d) $\frac{\pi rB_0k\, e^{2k}}{R}$

41. An electromagnetic wave travelling in vacuum is incident on a conducting medium of refractive index $n = 1+2i$. The phase change in transmitted wave is

(a) $\tan^{-1} 2$ (b) 45^o (c) $\tan^{-1}\frac{1}{2}$ (d) 60^o

42. Let $|\psi\rangle = C_1|1\rangle + C_0|0\rangle$ (where C_0 and C_1 are constants with $|C_1|^2 + |C_0|^2 = 1$) be a linear combination of the wavefunctions of the ground state and first excited state of the 1-D harmonic oscillator. The values of C_0, C_1 for which $\langle x\rangle$ is minimum, are

(a) $C_0 = \frac{1}{\sqrt{2}}, C_1 = \frac{1}{\sqrt{2}}, \langle x\rangle_{\min} = \sqrt{\frac{\hbar}{2m\omega}}$ (b) $C_0 = \frac{1}{\sqrt{2}}, C_1 = -\frac{1}{\sqrt{2}}, \langle x\rangle_{\min} = -\sqrt{\frac{\hbar}{2m\omega}}$

(c) $C_0 = \frac{1}{\sqrt{3}}, C_1 = -\sqrt{\frac{2}{3}}, \langle x\rangle_{\min} = -\sqrt{\frac{\hbar}{2m\omega}}$ (d) $C_0 = 0, C_1 = 0, \langle x\rangle_{\min} = 0$

43. Which of the following quantity is continuous in second order phase transition?

(a) G (b) $\left(\frac{\partial G}{\partial P}\right)_T$ (c) $\left(\frac{\partial G}{\partial T}\right)_P$ (d) $\left(\frac{\partial^2 G}{\partial T^2}\right)_P$

44. Consider a particle with normalized wave function

$$\psi(x) = \begin{cases} N\, x\, e^{-\alpha x/2} & \text{if } 0 \le x < \infty \\ 0 & \text{elsewhere} \end{cases}$$

α is a positive real constant and $N = \sqrt{\frac{\alpha^3}{2}}$. The uncertainty product, $\Delta x \Delta p$, is

(a) $\frac{\hbar}{2}$ (b) $\frac{\hbar}{\sqrt{2}}$ (c) $\frac{\sqrt{3}\,\hbar}{2}$ (d) $\frac{\hbar}{\sqrt{3}}$

45. A particle in a potential $V(x)$ has definite energy, $E = -\frac{\hbar^2 a^2}{2m}$ and its eigenfunction is given by

$$\psi(x) = \begin{cases} N\, xe^{-ax}, & \text{if } 0 \le x < \infty \\ 0, & \text{elsewhere} \end{cases}$$

where N and a are positive real constants. The potential energy that satisfies the energy E and $\psi(x)$ is

(a) $V(x) = \begin{cases} \frac{-a\hbar^2}{mx}, & 0 \le x < \infty \\ \infty, & \text{elsewhere} \end{cases}$ (b) $V(x) = \begin{cases} \frac{-a\hbar^2}{4mx}, & 0 \le x < \infty \\ \infty, & \text{elsewhere} \end{cases}$

(c) $V(x) = \begin{cases} \frac{-a\hbar^2}{mx}, & 0 \le x < \infty \\ 0, & \text{elsewhere} \end{cases}$ (b) $V(x) = \begin{cases} \frac{-a\hbar^2}{4mx}, & 0 \le x < \infty \\ 0, & \text{elsewhere} \end{cases}$

PART-C

46. Let $v(x,y)=e^{x}\sin y-e^{y}\sin x-\frac{1}{2}x^{2}+\frac{1}{2}y^{2}$ be the imaginary part of the complex analytic function $f(z)=u(x,y)+iv(x,y)$. The real part $u(x,y)$ will be

(a) $e^{x}\cos y-e^{y}\cos x+2xy+C$ (b) $-e^{x}\cos y+e^{y}\cos x-2xy+C$

(c) $e^{x}\cos y+e^{y}\cos x+xy+C$ (d) $e^{x}\cos y+e^{y}\cos x-xy+C$

47. A 3×3 matrix M has $Tr[M]=6$, $Tr[M^{2}]=38$ and $Tr[M^{3}]=144$. Which of the following can be a possible set of eigenvalues of M?

(a) {–1, 3, 4} (b) {–2, 3, 5} (c) {2, 2, 2} (d) {6, 0, 0}

48. A random walker takes a step of unit length along positive x-axis with a probability 2/3 and a step of unit length along negative x-axis with a probability 1/3. The uncertainty in the displacement of the walker after n steps, will be

(a) $\frac{2}{3}\sqrt{2n}$ (b) $\frac{1}{3}\sqrt{2n}$ (c) $2\sqrt{\frac{2n}{3}}$ (d) $\sqrt{\frac{2n}{3}}$

49. The general solution of the second order differential equation

$(D^{2}+5D+6)y=2t$

will be of the form

(a) $A e^{-2t}+B e^{-3t}+t-\frac{5}{18}$ (b) $A e^{-2t}+B e^{-3t}-\frac{t}{3}-\frac{5}{18}$

(c) $A e^{-2t}+B e^{-3t}+\frac{t}{3}-\frac{5}{18}$ (d) $A e^{-2t}+B e^{-3t}-t+\frac{5}{18}$

50. A particle of mass m moves in one-dimension under the influence of the potential $V(x)=-\alpha\delta(x)$, where α is a positive constant. The wavefunction of the particle in momentum space, will be (unnormalized form)

(a) $\exp\left[-\frac{m\alpha}{\hbar^{2}}|p|\right]$ (b) $\exp\left[-\frac{m\alpha}{\hbar^{2}}p^{2}\right]$ (c) $\frac{1}{\sqrt{\frac{p^{2}}{\hbar^{2}}+\left(\frac{m\alpha}{\hbar^{2}}\right)^{2}}}$ (d) $\sin\left(\frac{m\alpha}{\hbar^{2}}p\right)$

51. Consider a spinless particle of m, which is moving in a 1-D infinite potential well, with walls at $x=0$ and $x=a$. The position operator $\hat{x}(t)$ can be written as

(a) $\hat{x}(0)+\frac{t}{m}\hat{p}_{x}(0)$ (b) $\hat{x}(0)-\frac{t}{m}\hat{p}_{x}(0)$

(c) $\hat{x}(0)$ (d) $\hat{x}(0)-\frac{i\hbar}{m}\hat{p}_{x}(0)$

52. An electron in H-atom, is in the 3p state whose radial wavefunction is given by

$$R_{31}(r)=\frac{8}{9\sqrt{6a_{0}^{3}}}\left(1-\frac{r}{6a_{0}}\right)\left(\frac{r}{3a_{0}}\right)e^{-r/3a_{0}}$$

The uncertainty in the radial position of the electron, will be

(a) $2.24a_0$ (b) $3.42\,a_0$ (c) $4.11\,a_0$ (d) $4.87\,a_0$

53. Consider a particle of mass m in a potential $V(x)=\frac{1}{2}(1+\lambda)kx^2\ (\lambda<<1)$. The change in the nth state energy, compared to the simple harmonic potential $\frac{1}{2}kx^2$, upto second order in λ, is

(a) $\left[\frac{1}{2}\lambda+\frac{1}{8}\lambda^2\right]\left(n+\frac{1}{2}\right)\hbar\omega$ (b) $-\frac{1}{8}\lambda^2\left(n+\frac{1}{2}\right)\hbar\omega$

(c) $\left[\frac{1}{2}\lambda-\frac{1}{4}\lambda^2\right]\left(n+\frac{1}{2}\right)\hbar\omega$ (d) $\left[\frac{1}{2}\lambda-\frac{1}{8}\lambda^2\right]\left(n+\frac{1}{2}\right)\hbar\omega$

54. Suppose that the energy of a particle can be represented by the expression $E(z)=az^4$ where z is a coordinate or momentum and can take on all values from 0 to $+\infty$. The average energy per particle for a system of such particles subject to Boltzmann statistics is

(a) k_BT (b) $\frac{1}{2}k_BT$ (c) $\frac{1}{4}k_BT$ (d) $\frac{1}{8}k_BT$

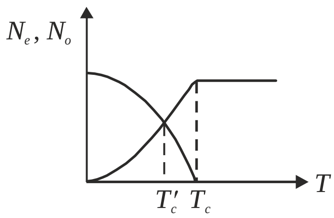
55. The energy levels of a half-harmonic oscillator is given by

$$E_n=\left(n+\frac{1}{2}\right)\hbar\omega \qquad \text{where } n=1,3,5,..........$$

If the system is consist of N such identical and distinguishable half-harmonic oscillators placed in contact with a thermal reservoir at temperature T, the partition function of the whole system is

(a) $\left(e^{\frac{\hbar\omega}{k_BT}}-e^{-\frac{\hbar\omega}{k_BT}}\right)^N$ (b) $\left(e^{\frac{\hbar\omega}{2k_BT}}+e^{-\frac{\hbar\omega}{k_BT}}\right)^N$ (c) $\left(e^{\frac{3\hbar\omega}{2k_BT}}+e^{-\frac{\hbar\omega}{2k_BT}}\right)^N$ (d) $\left(e^{\frac{3\hbar\omega}{2k_BT}}-e^{-\frac{\hbar\omega}{2k_BT}}\right)^N$

56. The diagram representing the variation of number of particles in the ground state N_o and in the excited state N_e with temperature T in Bose-Einstein condensation is shown below:



If T_c represents the temperature at which Bose-Einstein condensation occurs the value of the ratio of T'_c and T_c say x (where T'_c can be understood from the given diagram) satisfies which of the following equation?

(a) $x^2+2x+1=0$ (b) $x^3+x^2-2x+1=0$

(c) $x^3-x^2+2x-1=0$ (d) $x^2-2x-1=0$

57. Consider a satellite in a circular orbit around the earth. The properties of the satellite depend on the radius of the orbit r as follows: speed $v \propto r^a$, time period $T \propto r^b$, angular momentum $L \propto r^c$, and kinetic energy $K.E. \propto r^d$. Then ratio $\frac{bc}{ad}$ is

(a) $\frac{3}{4}$ (b) $\frac{3}{2}$ (c) $-\frac{3}{4}$ (d) $-\frac{3}{2}$

58. The Hamiltonian of a system is given by

$$H = \frac{p^2}{2m}e^{-rt} + \frac{1}{2}m\omega^2 x^2 e^{rt}$$

It describes the motion of

(a) A harmonic oscillator
(b) A damped harmonic oscillator
(c) An anharmonic oscillator
(d) A system with unbounded motion

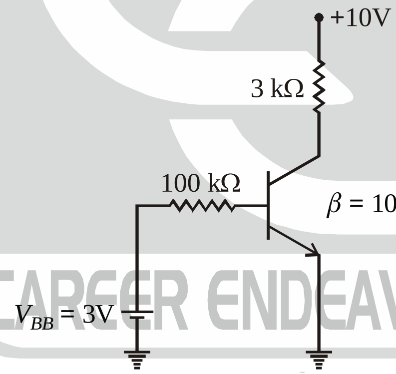
59. The transformation equations between two sets of coordinates are:

$$Q = p + iaq;\ P = \frac{p - iaq}{2ia},$$

where a is a constant and $i = \sqrt{-1}$. The generating function of this transformation is

(a) $\frac{q}{2}(2Q - iaq)$ (b) $\frac{Q}{4a}(4aq + iQ)$ (c) $qQ - \frac{iaq^2}{2} + \frac{iQ^2}{4a}$ (d) $qQ - \frac{iaq^2}{2} - \frac{iQ^2}{4a}$

60. The transconductors g_m of the transistor used in the CE amplifier shown in the below circuit, operating at room temperature $(V_T = 25\text{ mV})$ is

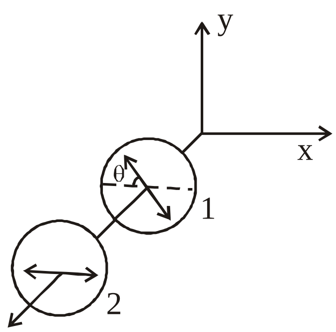


(a) 92 mA/V (b) 46 mA/V (c) 184 mA/V (d) 25 mA/V

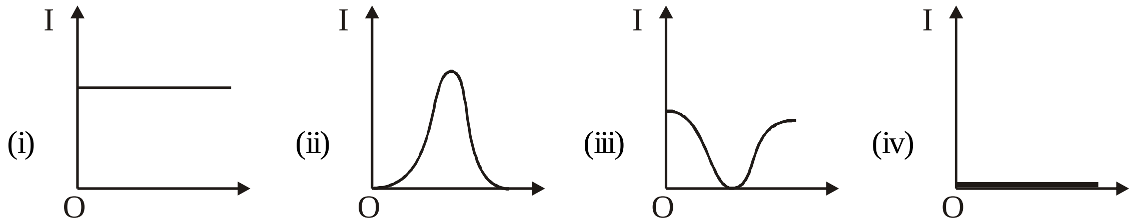
61. A pulse train with a frequency of 1 MHz is counted using a mod-1024 ripple counter built with J-K flip-flops. For proper operation of the counter, the maximum permissible propagation delay per flip-flop stage is

(a) 100 ns (b) 50 ns (c) 20 ns (d) 10 ns

62. A plane polarized electromagnetic wave with polarization along y-axis, is incident on a system of two polarizing sheets as shown below.



The polarization axis of polarizer 2 is fixed along the x-axis, while polarizer 1 can be rotated in the x-y plane. If θ is the angle between the polarization axes of polarizers 1 and 2, which of the following figures give the correct description of the intensity at the output of polarizer 2 as a function θ between zero and $\pi/2$?



(a) (i) (b) (ii) (c) (iii) (d) (iv)

63. A particle of charge q moves along x-axis with uniform velocity $v_0\hat{i}$. If at $t = 0$, particle is at $x = 0$ then scalar potential at $x < ct$ along x-axis at time t is

(a) $\dfrac{q\left(1+\dfrac{v_0}{c}\right)}{4\pi\epsilon_0\left(x-v_0t\right)}$ (b) $\dfrac{q}{4\pi\epsilon_0\left(x-v_0t\right)}$ (c) $\dfrac{q\left(1-\dfrac{v_0}{c}\right)}{4\pi\epsilon_0\left(x-v_0t\right)}$ (d) $\dfrac{q\left(1-\dfrac{v_0^2}{c^2}\right)}{4\pi\epsilon_0\left(x-v_0t\right)}$

64. In an inertial frame S, there is only a uniform electric field of strength 8 kV/m. Another inertial frame S' moves with velocity 0.6c at 45° to the direction electric field in S. The magnitude of electric field in S' is

(a) 4 kV/m (b) 6 kV/m (c) 7.5 kV/m (d) 9 kV/m

65. Light of wavelength 530 nm falls normally on diffraction grating with period 1.5 μm. The angle relative to normal at which the Fraunhofer maximum of highest order is observed is

(a) 30° (b) 45° (c) 60° (d) 75°

66. An experiment measures quantities a, b and c and X is calculated as

$$X = \frac{ab^2}{c^3}$$

If the percentage error in a, b, c are $\pm 1\%$, $\pm 5\%$, $\pm 2\%$ respectively, the percentage error in X will be

(a) 6% (b) 8% (c) 9% (d) 17%

67. The dispersion relation of electrons in BCC crystal is given as

$$E(k) = E_0 - \alpha - 8\beta\left(\cos\frac{k_x a}{2}\cos\frac{k_y a}{2}\cos\frac{k_z a}{2}\right)$$

The effective mass at Brillouin zone boundary is

(a) $-\dfrac{\hbar^2}{2\beta a^2}$ (b) $+\dfrac{\hbar^2}{2\beta a^2}$ (c) $-\dfrac{\hbar^2}{\beta a^2}$ (d) $-\dfrac{3\hbar^2}{2\beta a^2}$

68. Suppose that the dispersion relation of an optical phonon branch has the form $\omega(k) = \omega_0 - Ak^2$ near $k = 0$ in three dimension, then the density of state is proportional to the (for $\omega < \omega_0$)

(a) $(\omega_0 - \omega)^{1/2}$ (b) $(\omega_0 - \omega)^{-1/2}$ (c) $(\omega_0 - \omega)^{3/2}$ (d) $(\omega_0 + \omega)^{-1/2}$

69. The electrical conductivity of metal (X) is 75% of the electrical conductiviy of the metal (Y), while the electron density of (Y) is approximately 60% of the density of (X) and the Fermi velocity of conduction electron in x is double of the velocity of the conduction electron in (Y) then the ratio of mean free path $\frac{\ell_{(X)}}{\ell_{(Y)}}$ is

(a) 1.50 (b) 0.90 (c) 0.66 (d) 0.44

70. The fundamental band for CO molecule is centered at 2143.3 cm^{-1}, and the first overtone at 4259.7 cm^{-1}. The vibrational frequency for the molecule is

(a) $2.30\times10^{11}\ s^{-1}$ (b) $3.14\times10^{14}\ s^{-1}$
(c) $1.42\times10^{12}\ s^{-1}$ (d) $6.51\times10^{13}\ s^{-1}$

71. If total angular quantum number of Co(z = 27) is J_1 and for ionized Co^{3+} is J_2 for ground state terms, then the ratio J_1/J_2 is equal to

(a) $\frac{3}{2}$ (b) $\frac{3}{4}$ (c) $\frac{9}{8}$ (d) 1

72. An atom in the state $^2P_{3/2}$ is located in an external magnetic field of 1 KG (kilo-gauss). In terms of vector model, the angular velocity of precession of the total angular momentum of the atom in radians/sec is (Bohr magneton $\mu_B = 9.27\times10^{-24}$ J/T)

(a) 4.2×10^{8} (b) 1.2×10^{10} (c) 1.6×10^{9} (d) 3.5×10^{10}

73. A π^+-meson at rest decays into a μ^+-meson and a neutrino in 2.5×10^{-8} sec. Assuming that π^+-meson has kinetic energy equal to its rest energy, the distance would the meson travel before decaying as seen by an observer at rest is

(a) 7.5 m (b) 130 m (c) 6.5 m (d) 13 m

74. Which of the following reactions are allowed under the conservation of isospin, strangeness, baryon number and charge

(I) $p + p \longrightarrow K^+ + \Sigma^+$ (II) $p + \pi^- \longrightarrow \Sigma^0 + \eta^0$

(III) $\gamma + p \longrightarrow \pi^0 + p$ (IV) $K^- + p \longrightarrow \Lambda^0 + \eta^0$

(a) I and II (b) II, III and IV (c) III and IV (d) I, II, III and IV

75. According to the shell model, the nuclear magnetic moment of the $_{21}Sc^{41}$ nucleus is

(a) 3.79 μ_N (b) 5.79 μ_N (c) 1.49 μ_N (d) 4.79 μ_N

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ANSWER KEY

PART-A

1. (a)	2. (a)	3. (b)	4. (b)	5. (d)	6. (a)	7. (a)
8. (b)	9. (d)	10. (b)	11. (c)	12. (a)	13. (a)	14. (c)
15. (a)	16. (d)	17. (c)	18. (d)	19. (b)	20. (c)	

PART-B

21. (b)	22. (a)	23. (d)	24. (b)	25. (c)	26. (b)	27. (b)
28. (a)	29. (c)	30. (c)	31. (d)	32. (d)	33. (c)	34. (d)
35. (c)	36. (a)	37. (a)	38. (a)	39. (b)	40. (b)	41. (b)
42. (b)	43. (d)	44. (c)	45. (a)			

PART-C

46. (c)	47. (b)	48. (a)	49. (c)	50. (c)	51. (a)	52. (d)
53. (d)	54. (c)	55. (d)	56. (c)	57. (b)	58. (b)	59. (c)
60. (a)	61. (a)	62. (b)	63. (c)	64. (d)	65. (b)	66. (a)
67. (a)	68. (a)	69. (b)	70. (b)	71. (c)	72. (b)	73. (d)
74. (c)	75. (b)					