A

Sr. No. 851

Paper Code : 18

PHYSICAL SCIENCES [Paper-III]

Signature and Name of Invigilator

1. (Signature) _____
   (Name) _____
2. (Signature) _____
   (Name) _____

OMR Sheet No. : .....
(To be filled by the candidate)

Roll No. | | | | | | | | | | |
(In Figures as per admission card)

Roll No. _____
(In words)

Time : 2½ Hours] **[Maximum Marks : 150**

Number of Pages in this Booklet : 16 **Number of Questions in this Booklet : 75**

Instructions for the Candidates

1. Write your roll number in the space provided on the top of this page.
2. This paper consists of seventy five multiple-choice type of questions.
3. At the commencement of examination, the question bookelt will be given to you. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as below :
   (i) Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Fault booklets due to pages/questions missing or duplicate or not in serial order or any other discrepancy should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given.
   (ii) After this verification is over, the OMR Sheet Number should be entered on this Test Booklet.
4. Each item has four alternative responses marked (A), (B), (C) and (D). You have to darken the oval as indicated below on the correct response against each item.
   Example : (A) (B) ● (D)
   where (C) is the correct response.
5. Your responses to the items are to be indicated in the Answer Sheet given inside the Paper I Booklet only. If you mark at any place other than in the ovals in the Answer Sheet, it will not be evaluated.
6. Read instructions given inside carefully.
7. Rough Work is to be done in the end of this booklet.
8. If you write your name or put any mark on any part of the test booklet, except for the space allotted for the relevant entries, which may disclose your identity, you will render yourself liable to disqualification.
9. You have to return the test question booklet and OMR Answer sheet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall.
10. Students can take home carbon copy of this OMR answer sheet.
11. Use only Blue/Black Ball point pen.
12. Use of any calculator or log table etc., is prohibited.
13. There is no negative marks for incorrect answers.

परीक्षार्थियों के लिए निर्देश

1. पहले पृष्ठ के ऊपर नियत स्थान पर अपना रोल नम्बर लिखिए।
2. इस प्रश्न-पत्र में पिच्चेत्तर बहुविकल्पीय प्रश्न हैं।
3. परीक्षा प्रारम्भ होने पर, प्रश्न-पुस्तिका आपको दे दी जायेगी। पहले पाँच मिनट आपको प्रश्न-पुस्तिका खोलने तथा उसकी निम्नलिखित जाँच के लिए दिये जायेंगे, जिसकी जाँच आपको अवश्य करनी है :
   (i) कवर पृष्ठ पर छपे निर्देशानुसार प्रश्न-पुस्तिका के पृष्ठ तथा प्रश्नों की संख्या को अच्छी तरह चैक कर लें कि ये पूरे हैं। दोषपूर्ण पुस्तिका जिनमें पृष्ठ/प्रश्न कम हों या दुबारा आ गये हों या सीरियल में न हों अर्थात् किसी भी प्रकार की त्रुटिपूर्ण पुस्तिका स्वीकार न करें तथा उसी समय उसे लौटाकर उसके स्थान पर दूसरी सही प्रश्न-पुस्तिका ले लें। इसके लिए आपको पाँच मिनट दिये जायेंगे। उसके बाद न तो आपको प्रश्न-पुस्तिका वापस ली जायेगी और न ही आपको अतिरिक्त समय दिया जायेगा।
   (ii) इस जाँच के बाद OMR पत्रक की क्रम संख्या इस प्रश्न-पुस्तिका पर अंकित कर दें।
4. प्रत्येक प्रश्न के लिए चार उत्तर पत्रक विकल्प (A), (B), (C) तथा (D) दिये गये हैं। आपको सही उत्तर के दीर्घवृत्त को पेन से भरकर काला करना है जैसा कि नीचे दिखाया गया है।
   उदाहरण : (A) (B) ● (D)
   जबकि (C) सही उत्तर है।
5. प्रश्नों के उत्तर केवल प्रश्न पत्र I के अन्दर दिये गये उत्तर-पत्रक पर ही अंकित करने हैं। यदि आप उत्तर पत्रक पर दिये गये दीर्घवृत्त के अलावा किसी अन्य स्थान पर उत्तर चिह्नांकित करते हैं, तो उसका मूल्यांकन नहीं होगा।
6. अन्दर दिये गये निर्देशों को ध्यानपूर्वक पढ़ें।
7. कच्चा काम (Rough Work) इस पुस्तिका के अन्तिम पृष्ठ पर करें।
8. यदि आप उत्तर-पुस्तिका पर अपना नाम या ऐसा कोई भी निशान करते हैं तो परीक्षा के लिये अयोग्य घोषित कर दिये जायेंगे।
9. आपको परीक्षा समाप्त होने पर प्रश्न-पुस्तिका एवं OMR उत्तर-पत्रक निरीक्षक महोदय को लौटाना आवश्यक है और परीक्षा समाप्ति के बाद उसे अपने साथ परीक्षा भवन से बाहर न लेकर जायें।
10. परीक्षा समाप्ति पर परीक्षार्थी OMR उत्तर-पत्रक की कार्बन कापी अपने साथ ले जा सकते हैं।
11. केवल नीले/काले बाल प्वाईंट पेन का ही इस्तेमाल करें।
12. किसी भी प्रकार का संगणक (केलकुलेटर) या लाग टेबल आदि का प्रयोग वर्जित है।
13. गलत उत्तरों के लिए कोई अंक काटे नहीं जाएँगे।

Paper Code : [18]

Paper-III [PHYSICAL SCIENCES]

Note : • **This paper contains Seventy Five (75) multiple choice questions, each question carrying two (2) marks.**

नोट : • **इस प्रश्नपत्र में पिच्हेत्तर (75) बहुविकल्पीय प्रश्न हैं। प्रत्येक प्रश्न के दो (2) अंक हैं।**

1. With which boundary conditions the ordinary Green's function does not exist for the differential equation $\frac{d^2\psi}{dx^2} = f(x)$:

(A) $\psi(0) = 0 = \psi(a)$ (B) $\psi'(-1) = 0, \psi'(1) = 0$

(C) $\psi'(0) = \psi(0), \psi'(1) = -\psi(1)$ (D) $\psi(0) = 0$ *and* $\psi'(1) = 0$

2. Determine the second characteristic coordinate of the follwoing partial differential equation if its first such coordinate is y/x :

$$x^2\frac{\partial^2\phi}{\partial x^2} + 2xy\frac{\partial^2\phi}{\partial x\partial y} + y^2\frac{\partial^2\phi}{\partial y^2} = 0$$

(A) xy (B) x/y

(C) x (D) y

3. Sides of a cube of unit length are kept at zero temperature with its initial temperature given by xyz. The sulsequent temperature distribution is obtained as :

$$\psi = A\sum_{r,s,p=1}^{\infty}(-1)^{r+s+p+l}\frac{1}{rsp}\sin(r\pi x)\sin(s\pi y)\sin(p\pi z)\times e^{-mrspt}$$

where $mrsp = h^2\pi^2\left[r^2 + s^2 + p^2\right]$

Find the value of constant A

(A) $\frac{8}{\pi^3}$ (B) 8

(C) $\frac{\pi^3}{8}$ (D) $8\pi^3$

4. In a laterally insulated, 2 metre rod with the boundary conditions :

$\psi(0,t) = 0;\ \psi(2,t) = 100$

and the initial condition ψ (x, 0) = 100 sin π x/4

The temperature distribution function has been obtained as :

$$\psi(x,t) = 2A\sin\frac{\pi x}{4}e^{-n^2\pi^2h^2t/16} + Ax$$

the value of A is :

(A) 100 (B) 50

(C) 25 (D) none of these

5. In reference of Forward difference operator (Δ) & backward difference operator (∇), what is the vlaue of $(1 + \Delta)(1 - \nabla)$?

(A) zerc (B) $\Delta - \nabla$

(C) 1 (D) $E + E^{-1}$

6. Using Runga-Kutta method with $e = 0(h^3)$ carry out the solution of differential equation :

$\frac{dy}{dx} + 2yx = 4$ if $y(0) = 0.2$ for two steps by choosing $h = 0.1$

(A) $y_1 = .595353;\ y_2 = .971994$ (B) $y_1 = .297676;\ y_2 = .853145$

(C) $y_1 = 1.190706;\ y_2 = 1.943988$ (D) none of these

7. Using Simpson's rule, find the volume of solid of revolution formed by rotating about x-axis, the area betwen the x-axis, the lines x = 0 and x = 1 and a curve through the points with coordinates :

x = 0, y = 1, x = 0.25, y = 0.9896; x = 0.5, y = 0.9589; x = 0.75, y = 0.9089 and x = 1, y = 0.8415

(A) 2.530279 (B) 2.820379

(C) 1.820379 (D) 3.820379

8. Which of the following arrays is a tensor ?

(A) $\begin{pmatrix} -xy & -y^2 \\ x^2 & -xy \end{pmatrix}$ (B) $\begin{pmatrix} y^2 & -xy \\ -xy & x^2 \end{pmatrix}$

(C) $\begin{pmatrix} xy & x^2 \\ x^2 & -xy \end{pmatrix}$ (D) $\begin{pmatrix} -xy & -y^2 \\ x^2 & xy \end{pmatrix}$

9. Which of the following statements about a class of a finite group is not correct ?

(A) All elements of the class have same order.

(B) Characters of all elements in any representations are the same.

(C) A class always forms a sub group.

(D) Traces of matrices forming a class are equal.

10. Find the correct form of canonical transformations :

(A) $p_i = \frac{\partial F_1}{\partial q_i}$; $P_i = \frac{\partial F_1}{\partial Q_i}$

(B) $p_i = -\frac{\partial F_1}{\partial q_i}$; $P_i = -\frac{\partial F_1}{\partial Q_i}$

(C) $p_i = \frac{\partial F_1}{\partial q_i}$; $P_i = -\frac{\partial F_1}{\partial Q_i}$

(D) $p_i = \frac{\partial F_1}{\partial q_i}$; $P_i = +\frac{\partial F_1}{\partial Q_i}$

11. What is the condition for a transformation to be canonical :

(A) Variance of a Poisson brackets.

(B) Invariance of Poisson brackets and [Q, P] = 1

(C) Variance of Poisson brackets and [Q, P] = 1

(D) Invariance of Poisson brackets and [Q, P] = 0

12. Poisson brackets of all constants of motion with H must be :

(A) 1

(B) 0

(C) ∞

(D) any constant

13. Under certain conditions Noether's theorem leads to following conservation statement :

(A) $\frac{d}{dt}\left(\frac{dL}{\partial \dot{q}_i}\right) \neq 0$

(B) $\frac{\cdot}{p_i} = 1$

(C) $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) = 0$

(D) $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \dot{p}_i = 1$

14. The Hamilton-Jacobi equation, when H is not an explicit function of time t is given by :

(A) $\frac{\partial S}{\partial t} - H\left(q_i, \frac{\partial S}{\partial q_i}\right) = 0$

(B) $\frac{\partial S}{\partial t} + H\left(q_i, \frac{\partial S}{\partial q_i}\right) = 0$

(C) $\frac{\partial S}{\partial t} = 0$

(D) $\frac{\partial S}{\partial t} + H\left(q_i, \frac{\partial S}{\partial q_i}\right) \neq 0$

where S represents the Hamilton's principal function.

15. If $\vec{F}$ is a rule that governs the evolution of a dynamical system. Then which of the following is corred for dissipative dynamical system :

(A) $\vec{\nabla}.\vec{F} = 0$ (B) $\vec{\nabla}.\vec{F} < 0$

(C) $\vec{\nabla}.\vec{F} > 0$ (D) none of above

16. In case of a dissipative dynamical system, a fixed point is represented by dimension :

(A) 0 (B) 1

(C) 2 (D) 3

17. Discrete time dynamical systems are governed by :

(A) any mathematical relation (B) exponential functions

(C) differential equations (D) difference equations

18. The Layapunov exponents (λ) describes the divergence or convergence of trajectories in different direction of phase space for a dynamical system. What is the sum of all Lyapunov exponents for ($\sum\lambda$) for a dissipative dynamical system ?

(A) $\sum\lambda < 0$ (B) $\sum\lambda = 0$

(C) $\sum\lambda > 0$ (D) $\sum\lambda$ = any possible value

19. Retarded potentials are obtained by integrating the Poisson's equation (for scalar and vector potentials) at retarded time. These Poisson's equations are given by :

(A) $\nabla^2 V = -\rho/\epsilon_0$; $\nabla^2 \vec{A} = \mu_0 \vec{J}$ (B) $\nabla^2 V = -\rho/\epsilon_0$; $\nabla^2 \vec{A} = -\mu_0 \vec{J}$

(C) $\nabla^2 V = +\rho/\epsilon_0$ (D) $\nabla^2 V = +\rho/\epsilon_0$; $\nabla^2 A = -\mu_0 \vec{J}$

20. The Power radiated by an electric dipole is proportional to the frequency by :

(A) w (B) w^2

(C) w^3 (D) w^4

21. The energy radiated by an oscillating electric dipole is determined by the Poynting vector $\left(\vec{S}\right)$:

(A) $\vec{S} = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right)$ (B) $\vec{S} = \frac{2}{\mu_0}\left(\vec{E} \times \vec{B}\right)$

(C) $\vec{S} = \epsilon_0 \vec{E}$ (D) $\vec{S} = \frac{1\vec{B}}{\mu_0}$

22. Boundary conditions in case of a wave guide are :

(A) $E'' = 0 ; B'' = 0$

(B) $E'' = 0 ; B^{\perp} \neq 0$

(C) $E'' = 0 ; B^{\perp} = 0$

(D) $E^{\perp} = 0 ; B'' \neq 0$

23. The power radiated by electric and magnetic dipole can be compared by :

(A) $\frac{\text{Pmagnetic}}{\text{Pelectric}} = \left(\frac{m_0}{p_0 c}\right)$

(B) $\frac{\text{Pmagnetic}}{\text{Pelectric}} = \left(\frac{m_0}{p_0 c} + 1\right)$

(C) $\frac{\text{Pmagnetic}}{\text{Pelectric}} = \left(\frac{m_0}{p_0 c} + 1\right)^2$

(D) $\frac{\text{Pmagnetic}}{\text{Pelectric}} = \left(\frac{m_0}{p_0 c}\right)^2$

where m_0 and p_0 are magnetic and electric dipole moments respectively.

24. Transverse electric and magnetic (TEM) waves are supported by :

(A) hollow wave guide

(B) coaxial transmission line

(C) both (a) and (b)

(D) neither of (a) and (b)

25. Condition for the validity of Born approximation is :

(A) $\frac{1}{k^2}\left|\int_0^{\infty}\left(e^{2ikr} - 1\right)V(r)dr\right|^2 << 1$

(B) $\frac{1}{k^2}\left|\int_0^{\infty} e^{ikr} V(r)dr\right|^2 << 1$

(C) $\frac{1}{k^2}\left|\int_0^{\infty} re^{ikr} V(r)dr\right|^2 << 1$

(D) $\frac{1}{k^2}\left|\int_0^{\infty} \frac{e^{ikr}}{r} V(r)dr\right|^2 << 1$

26. Spir Orbit coupling is defined by :

(A) $U_m = \pm\frac{\mu_B B}{2}$

(B) $U_m = \pm\frac{\mu_B B}{3}$

(C) $U_m = \pm\frac{\mu_B B}{4}$

(D) $U_m = \pm\mu_B B$

27. Split-orbit coupling splits the 2p state in the hydrogen atom into following number of substates:

(A) 2

(B) 3

(C) 4

(D) 1

28. What are the possible orientations of $\vec{J}$ for the $j = 3/2$ state that correspond to $l = 1$?

(A) $-3/2, -1/2$ (B) $-1/2, 1/2$

(C) $-3/2, -1/2, 1/2$ (D) $-3/2, -1/2, 1/2, 3/2$

29. WKB approximation is an approximate method for the solution of :

(A) any equation (B) partial differential equation

(C) ordinary differential equation (D) any differential equation

30. The complete wave function in the theory of Scattering is represented as :

(A) $\underset{\sim}{\psi}_{r\to\infty} \to e^{i\vec{k}.\vec{r}} + f(\theta,\phi)\frac{e^{-i\vec{k}.\vec{r}}}{r}$ (B) $\underset{\sim}{\psi}_{r\to\infty} \to e^{-i\vec{k}.\vec{r}} + f(\theta,\phi)\frac{e^{i\vec{k}.\vec{r}}}{r}$

(C) $\underset{\sim}{\psi}_{r\to\infty} \to e^{i\vec{k}.\vec{r}} + f(\theta,\phi)\frac{e^{i\vec{k}.\vec{r}}}{r}$ (D) $\underset{\sim}{\psi}_{r\to\infty} \to e^{i\vec{k}.\vec{r}} + f(\theta,\phi)\frac{e^{i\vec{k}.\vec{r}}}{2r}$

where symbols have their usual meaning.

31. Differential scattering cross section $d\sigma(\theta, \phi)$ is related to scattering amplitude $f(\theta, \phi)$ as :

(A) $d\sigma(\theta,\phi) \propto f(\theta,\phi)$ (B) $d\sigma(\theta,\phi)$ is independent of $f(\theta,\phi)$

(C) $d\sigma(\theta,\phi) \propto f^2(\theta,\phi)$ (D) $d\sigma(\theta,\phi) \propto f^3(\theta,\phi)$

32. For the rigid sphere of radius a, the scattering cross section at high energies is given as :

(A) $2\pi a^2$ (B) πa^2

(C) $3\pi a^2$ (D) $4\pi a^2$

33. Klein Gordon equaiton is represented as :

(A) $\frac{1}{C^2}\frac{\partial^2\psi}{\partial t^2} + \nabla^2\psi - \left(\frac{mc}{\hbar}\right)^2\psi = 0$ (B) $\frac{1}{C^2}\frac{\partial^2\psi}{\partial t^2} - \nabla^2\psi + \left(\frac{mc}{\hbar}\right)^2\psi = 0$

(C) $\frac{1}{C^2}\frac{\partial^2\psi}{\partial t^2} - \nabla^2\psi + \left(\frac{mc}{\hbar}\right)^2\psi = 0$ (D) $\frac{1}{C^2}\frac{\partial^2\psi}{\partial t^2} + \left(\frac{mc}{\hbar}\right)^2\psi = 0$

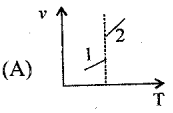
34. The Hamiltonian of the atom in presence of electromagnetic radiation is given by $H = H_0 + H^1$, where :

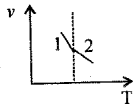
(A) $H_0 = \frac{\hbar^2}{2m}\nabla^2 + V(x); H' = \frac{ie\hbar}{mc}\vec{A}.\vec{\nabla}$ (B) $H_0 = -\frac{\hbar^2}{2m}\nabla^2 + V(x); H' = \frac{ie\hbar}{2mc}\vec{A}.\vec{\nabla}$

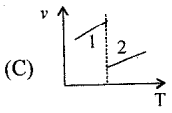
(C) $H_0 = -\frac{\hbar^2}{2m}\nabla^2 + V(x); H' = \frac{ie\hbar}{mc}\vec{A}.\vec{\nabla}$ (D) $H_0 = \frac{\hbar^2}{2m}\nabla^2 + V(x); H' = \frac{ie\hbar}{mc}\vec{A}.\vec{\nabla}$

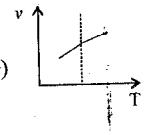
where $\hbar = \frac{h}{2\pi}$, and other symbols have their usual meaning.

35. Graph betwen specific volume (v) and temperature (T) for second order phase transition is given by :

(A) 

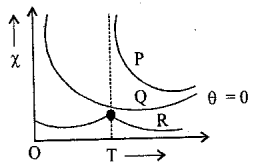
(B) 

(C) 

(D) 

36. When liquid oxygen is poured down close to a strong bar magnet, the oxygen stream is :
(A) attracted towards the higher field as it is paramagnetic.
(B) repelled towards the lower field as it is paramegnetic.
(C) attracted towards the higher field as it is diamagnetic.
(D) repelled towards the lower field as it is dia magnetic.

37. The dependeance of the magnetic suscptibility (χ) of a material with temperature (T) can be represented by $\chi \propto \frac{1}{T-\theta}$, where θ is the Curie-Weiss temperature. The plot of magnetic susceptibility versus temperature is sketched in the figure, as curves P, Q and R with curve Q having $\theta = 0$, which of the following statements is correct ?



(A) Curve R represents a paramagnet and Q a ferromagnet.
(B) Curve Q represents a ferromagnet and P an antiferromagnet.
(C) Curve R represents an antiferromagnet and Q a paramagnet.
(D) Curve R represents an antiferromagnet and Q a ferromagnet.

38. Which of the following is weakest magnetism ?

(A) para-magnetism (B) dia-magnetism

(C) ferro-magnetism (D) ferri-magnetism

39. In Bose-Einstein Condensating, when the chemial potential (μ) vanishes, critical temperature T_c is :

(A) $T_c = \frac{h^2}{2\pi mk}\left(\frac{n}{2.612}\right)^{2/3}$ (B) $T_c = \frac{h}{2\pi mk}\left(\frac{n}{2.612}\right)^{2/3}$

(C) $T_c = \frac{h^2}{2\pi mk}\left(\frac{n}{2.612}\right)^{3/2}$ (D) $T_c = \frac{h}{2\pi mk}\left(\frac{n}{2.612}\right)^{3/2}$

40. Any additional particle in degenerate Bose gas and degenerate fermi gas respectively goes directly to :

(A) Top, Bottom (B) Bottom, Top

(C) Top, Top (D) Bottom, Bottom

41. Which of the following is true about Brownian motion :

(A) The motion depends on the shape and size of the suspended particles.

(B) It depends on the nature of suspended particles.

(C) The motions are regular.

(D) The viscosity of the supporting fluid increases with increase in temperature.

42. The phenomenon of diffusion occurs in :

(A) gas only (B) liquid only

(C) solid only (D) all of the above

43. The VCUS with an impedance Z connectd from the output to input can be equivalently replaced by the circuit where Z is replaced by impedances Z_1 and Z_2 at the input and output ports respectively, then :

(A) $Z_1 = \frac{Z}{1-A}, Z_2 = \frac{AZ}{A-1}$ (B) $Z_2 = \frac{Z}{1+A}, Z_2 = \frac{AZ}{1+A}$

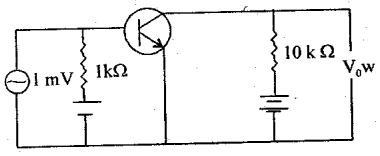
(C) $Z_1 = \frac{AZ}{1+A}, Z_2 = \frac{Z}{1-A}$ (D) $Z_1 = \frac{AZ}{A-1}, Z_2 = \frac{Z}{1-A}$

44. The possible solution for fitting a straight line to the four points (1, 1.7); (2, 1.8); (3, 2.3); (4, 3.2) in x-y plane using least square of curve fitting :

(A) $f(x) = 1 - \frac{1}{2}x$ (B) $f(x) = \frac{1}{2}x$

(C) $f(x) = 1 + x$ (D) $f(x) = 1 + \frac{1}{2}x$

45. In the following common emitter configuration on NPN transistor with current gain $\beta = 100$ is used. Find the output voltage of the amplifier in volts :



(A) 2V (B) 1V

(C) 100V (D) 20V

46. Which of the following is true for a phase-lock-loop ?

(i) It is controlled oscillator. (ii) It is a frequency demodulator.

(iii) It is high frequency sinusdoidal oscillator (iv) It is a phase detector.

(A) (i) & (iii) are correct. (B) (ii) & (iv) are correct.

(C) (i) & (iv) are correct. (D) (i) & (ii) are correct.

47. If the two amplifiers are cascaded then the overall noise factor will be :

(A) Decreases

(B) Increases as much as the sum of two noises

(C) Increase but not as sum of two noises

(D) Increases as much as the product of two noises

48. Which two of the following statements are corrrect ?

(A) Greater the frequency deviation in frequency modulation system, greater is the extent to which the noise is supressed.

(B) Lower is the modulation frequency, smaller is the extent to which the noise is supressed.

(C) By employing a ratio-detector, appearance of noise in the receive output through amplitude fluctuation is completely checked.

(D) Noise effect is the same in frequency modulated wave and amplitude modulated wave.

49. Find the Fourier consine transform of e^{-x}.

(A) $\sqrt{\frac{2}{\pi}}\left(\frac{1}{1+n}\right)$ (B) $\sqrt{\frac{2}{\pi}}\left(\frac{1}{1+n^2}\right)$

(C) $\sqrt{\frac{2}{\pi}}(1+n)$ (D) $\sqrt{\frac{2}{\pi}}(1+n^2)$

50. Which is of the following transitions not possible ?

(A) $^2F_{5/2} \rightarrow {}^2D_{5/2}$ (B) $^2D_{3/2} \rightarrow {}^2P_{1/2}$

(C) $^2D_{3/2} \rightarrow {}^2S_{1/2}$ (D) $^2P_{1/2} \rightarrow {}^2S_{1/2}$

51. A laser beam emerging from a laser tube operating at 80nm has a cross-sectional diameter of 2mm. The diameter of the beam at a distane of 1 km is approximately given by :

(A) 10 mm (B) 8 cm

(C) 80 cm (D) 10 cm

52. The hyperfine splitting of the spectral lines of an atom is due to :

(A) The coupling between the spins of two or more electrons.

(B) The coupling between the spins and the orbital angular momenta of the electrons.

(C) The coupling between the electron spins and nuclear spin.

(D) The effect of external electromagnetic field.

53. Possible values of the total angular momentum quantum number of a single d-electron are :

(A) $j = \frac{5}{2}, \frac{3}{2}$ (B) $j = \pm 3, 2, 1, 0$

(C) $j = \pm 5/2, \pm 3/2$ (D) None of these

54. The NMR spectrum of compound $CH_3COCH_2C \equiv CCH_3$ is :

(A) a singlet with relative intensities of 3 : 2 : 3 respectively

(B) a doublet with relative intensities of 3 : 2 : 3 respectively

(C) a triplet with relative intensities of 3 : 2 : 3 respectively

(D) None of these

55. Pure vibrational spectrum of a diatomic molecule are when :

(A) It has a centre of symmetry

(B) It exhibit change in polarisability due to electronic transistion

(C) It has a permanent dipole moment

(D) It has no magnetic moments

56. The total number of Zeeman Components observed in an electronic transition $^2D_{5/2} \rightarrow {}^2P_{3/2}$ of an atom in a weak field is :

(A) 2 (B) 4

(C) 6 (D) 12

57. The Vibrational spectrum of a molecule exhibits a strong line with P and R branches at a frequency v_1 and a weaker line at a frequency v_2. The frequency v_3 is not shown up. Its vibrational Raman spectrum shows a stongly polarized line at frequency v_3 and and no feature at v_1 and v_2 :

(A) The molecule could be linear.

(B) The molecule lacks a center of inversion.

(C) v_1 arises from a symmetric stretching mode.

(D) v_3 arises from a banding mode.

58. In a crystal of N Primitive-Cells, each cell contains two monovalent atoms. The highest occupied energy band of the crystals is :

(A) one-fourth filled (B) one-third filled

(C) half filled (D) completely filled

59. The valence electrons do not directly determine the following property of a metal :

(A) Electrical Conductivity (B) Thermal Conductivity

(C) Shear modulus (D) Metallic lustre

60. For a conventional superconductor, which of the following statements is NOT true :

(A) Specific heat is discontinuous at transition temperature T_c.

(B) The resistivity falls sharply at T_c.

(C) It is diamagnetic below T_c.

(D) It is paramagnetic below T_c.

61. If the band gap of an alloy semiconductor is 2.96 eV. Then the wavelength of light emitted when electrons and hole recombine directly in materials will be :

(A) 3000 A° (B) 3250 A°

(C) 3125 A° (D) 2875 A°

62. A solid that transmits light in visible region and has a very low melting point possesses :

(A) metalic bonding (B) ionic bonding

(C) covalent bonding (D) Van der Waal's bonding

63. The classical value of Molar electronic specific heat is :

(A) 1.5 Ru (B) 0.5 Ru

(C) 3 Ru (D) $\frac{9}{2}$ Ru

64. The equilibrium concentration of a Frenkel defects in crystals is given by :

(A) $n_f = N\exp\left[\frac{-E_f}{kT}\right]$ (B) $n_f = NN'\exp\left[\frac{-E_f}{kT}\right]$

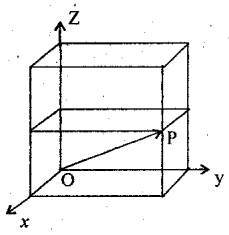
(C) $n_f = NN'\exp\left[\frac{-E_f}{2kT}\right]$ (D) $n_f = NN'\exp\left[\frac{-2E_f}{kT}\right]$

65. Which type of statistics is obeyed by atomic oscillators in Debye's theory of specific heat of solids :

(A) MB statistics (B) FD statistics

(C) BE statistics (D) all of the above

66. In Crystallographic notations the vector $\vec{OP}$ in the Cubic Cell shown in figure is :



(A) [221] (B) [122]

(C) [121] (D) [112]

67. Which of the following is not true about nuclear forces :

(A) nuclear forces are long range forces. (B) nuclear forces are charge independent.

(C) nuclear forces are mass independent. (D) nuclear forces depends on spin and parity.

68. Find the odd man out :

(A) Mesonic X-rays (B) Neutron scattering

(C) Electron scattering (D) Coulomb energies of mirror nuclei

69. If the nuclear radius of $^{27}_{13}Al$ is 3.6 Fermi, the approximate nuclear radius of $^{64}_{29}Cu$ in Fermi is :

(A) 6.4 (B) 4.8

(C) 2.7 (D) 2.4

70. The ground state of deuteron is a :

(A) mixture of $^3S_1$ and $^3D_1$ states (B) mixture of $^3S_1$ and $^3P_1$ states

(C) Pure $^3S_1$ state (D) Pure $^3P_1$ state

71. The ground state angular momentum and parity of ^{41}Ca are :

(A) $\frac{5^-}{2}$ (B) $\frac{7^-}{2}$

(C) $\frac{3^+}{2}$ (D) $\frac{5^+}{2}$

72. The fusion reaction

$_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + \text{Energy}$

is proposed to be used for the production of industrial power. Assuming the efficiency of the process to be 40%, find how many kilograms of deuterium will be consumed in a day for an output of 50,000 kw.

(Given : mass of $_1H^2 = 2.01478$ a.m.u and mass of $_2He^4 = 4.002604$ a.m.u)

(A) 1.56×10^{-2} kg (B) 15.6×10^{-2} kg

(C) 7.8×10^{-3} kg (D) None of these

73. Which of the following reaction is not allowed :

(A) $n \rightarrow p + \bar{e}$ (B) $\pi^+ \rightarrow \mu^+ + \nu_\mu$

(C) $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$ (D) $p + \bar{p} \rightarrow \pi^+ + \pi^+ + \pi^- + \pi^- + \pi^0 + \pi^0$

74. The unknown particle in the reaction given below, using conservation laws is :

$\pi^- + p \rightarrow k^0 + ...$

(A) n (B) $\wedge^0$

(C) k^0 (D) γ

75. Match the particles mentioned in column-I with the structures in quark model given in column-II

Column I	Column II
(i) K^+	(M) (suu)
(ii) Σ^+	(N) $(u\bar{s})$
(iii) π^+	(O) $(u\bar{d})$
(iv) Ω^-	(P) (sss)

(A) (i)-(N) ; (ii)-(M); (iii)-(O); (iv)-(P) (B) (i)-(M) ; (ii)-(N); (iii)-(O); (iv)-(P)

(C) (i)-(N) ; (ii)-(O); (iii)-(M); (iv)-(P) (D) (i)-(N) ; (ii)-(O); (iii)-(P); (iv)-(M)