S/SO/2013/01
PHYSICS

Roll No.	BOOKLET NO.	1353
Candidate should write his/her Roll No. in the box above. ↑	Total No. of Questions : **150**	

Time : **2** Hours]	No. of Printed Pages : **40**	[Total Marks : **300**

INSTRUCTIONS FOR CANDIDATES

1. *All* questions are compulsory.
2. *All* questions carry equal marks.
3. The question paper contains **150** questions. The examinee should verify that the requisite number of questions are printed in the question paper, otherwise he should ask for another question paper.
4. The cover page indicates the number of printed pages in the question paper. The examinee should verify that the requisite number of pages are attached in the question paper, otherwise he should ask for another question paper.
5. Read carefully the instructions given on the answer sheet supplied and indicate your answers accordingly.
6. Kindly make necessary entries on the answer sheet only at the places indicated and nowhere else.
7. Examinees should specially pay attention that **2** marks will be awarded for correct answer.
8. Examinees should do all rough work on the space meant for rough work on the last page of the question paper and nowhere else, not even on the answer sheet.

1. The independent solutions of the equation

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$$

are :

(A) e^{2x} and e^{-x} (B) e^{2x} and e^{x}

(C) $\frac{1}{x}$ and x^2 (D) $\sin 2x$ and $\cos 2x$

2. A vector $(x + 2y)\hat{i} + (2y - z)\hat{j} + (2x + az)\hat{k}$ is solenoidal if the constant a is :

(A) 0 (B) 3

(C) 2 (D) –3

3. The Cauchy's integral $\int_C \frac{zdz}{(a - z^2)(z + 1)}$, where C is the circle $|z| = 2$, has value :

(A) $\frac{\pi}{5}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{9}$ (D) 1

4. If a function $f(z)$ is expanded such as $f(z) = A_0 + (z - z_0)A_1 + (z - z_0)^2A_2 + \ldots\ldots$ Regular part $+ \frac{B-1}{z - z_0} + \frac{B-2}{(z - z_0)^2} + \cdots$ principal part, where $A_n = \frac{1}{n!}\left[f^n(z)\right]_{z_0}$ and $B_m = \frac{1}{2\pi i}\oint f(z)(z - z_0)^m dz$ is analytic at $z = z_0$, then above expansion becomes :

(A) Laurent expansion (B) Simply Taylor expansion

(C) Fourier expansion (D) None of these

5. The trace of a 3 × 3 matrix is 2. Two of its eigenvalues are 1 and 2. The third eigenvalue is :

(A) –1 (B) 0

(C) 1 (D) 2

6. $\nabla^2\left(\frac{1}{r}\right)$ is equal to :

(A) 1 (B) –1

(C) 0 (D) –2

7. The value of $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^2}$ using Fourier series is :

(A) $\frac{1}{2}$ (B) $\frac{\pi^2}{8}$

(C) $\frac{\pi^2}{6}$ (D) $\frac{\pi^2}{2}$

8. S_{ij} and A_{ij} represent a symmetric and an antisymmetric real valued tensor respectively in three dimensions. The number of independent components of S_{ij} and A_{ij} are :

(A) 3 and 6 respectively
(B) 6 and 3 respectively
(C) 6 and 6 respectively
(D) 9 and 6 respectively

9. Which one of the following is Fourier sine transforms ?

(A) $\sqrt{\frac{2}{\pi}} \int_0^\infty f_c(x) \cos kx \, dx$
(B) $\sqrt{\frac{2}{\pi}} \int_{-\infty}^\infty f_c(x) \cos kx \, dx$
(C) $\sqrt{\frac{2}{\pi}} \int_0^\infty f_s(x) \sin kx \, dx$
(D) None of these

10. For cubic polynomial which takes the following values

$y(0) = 1$, $y(1) = 0$, $y(2) = 1$ and $y(3) = 10$,

then $y(4)$ is :

(A) 24
(B) 33
(C) 36
(D) 42

11. There are four machines and it is known that exactly two of them are faulty. They are tested, one by one, in a random order till both the faulty machines are identified. Then the probability that only two tests are needed is :

(A) $\frac{1}{3}$

(B) $\frac{1}{2}$

(C) $\frac{1}{6}$

(D) $\frac{1}{4}$

12. A rigid body is rotating with angular velocity, ω about a fixed axis, if v is the velocity of a point of the body, then curl v is :

(A) ω

(B) ω^2

(C) $2\omega^2$

(D) 2ω

13. The scalar projection of vector

$\vec{a} = 2\hat{i} - 3\hat{j} + 6\hat{k}$ on vector

$\vec{b} = \hat{i} + 2\hat{j} + 2\hat{k}$ is :

(A) $\frac{8}{5}$

(B) $\frac{8}{3}$

(C) $\frac{8}{7}$

(D) $\frac{8}{9}$

14. The Stokes' theorem is :

(A) $\iint_S \vec{A} \cdot \vec{ds} = \oint_C \vec{A} \cdot \vec{dr}$

(B) $\oint_C \vec{A} \cdot \vec{dr} = \iint_S (\text{Curl}\,\vec{A}) \cdot \vec{ds}$

(C) $\iint_S \vec{A} \cdot \vec{ds} = \iiint_V (\text{div}\,\vec{A})\, dV$

(D) $\iint_S \vec{A} \cdot \vec{ds} = \iiint_S (\text{grade}\,\vec{A})\, dV$

15. The momentum of a charged particle moving in electromagnetic field is :

(A) mv

(B) $e\phi + \frac{eA}{C}$

(C) $mv + \frac{e}{C}A$

(D) None of these

16. Two photons are emitted in opposite directions by a light source. The velocity of one photon relative to the other is :

(A) c

(B) $2c$

(C) Zero

(D) $\sqrt{2}c$

17. $\nabla \cdot \vec{D} = \rho$ is based on :

(A) Ampere's law

(B) Faraday's law

(C) Ohm's law

(D) Gauss's law

18. Lagrangian equation of motion for compound pendulum is :

(A) $\frac{1}{2}I\dot{\theta}^2 - mgl\cos\theta$

(B) $\frac{1}{2}I\dot{\theta}^2 + mgl\cos\theta$

(C) $\frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) + \frac{1}{2}I\dot{\theta}^2 - mgl\cos\theta$

(D) $\frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) + \frac{1}{2}I\dot{\theta}^2 + mgl\cos\theta$

19. Hamilton's canonical equations of motion are :

(A) $\dot{q}_i = \frac{\partial H}{\partial P_i}$ and $\dot{p}_i = \frac{\partial H}{\partial q_i}$

(B) $\dot{q}_i = \frac{\partial H}{\partial P_i}$ and $\dot{p}_i = -\frac{\partial H}{\partial q_i}$

(C) $q_i = \frac{\partial H}{\partial \dot{p}_i}$ and $p_i = \frac{\partial H}{\partial \dot{q}_i}$

(D) $q_i = \frac{\partial H}{\partial \dot{p}_i}$ and $p_i = -\frac{\partial H}{\partial \dot{q}_i}$

20. A transducer is any device which :

(A) Converts energy in one form into another form

(B) Retains data in its memory

(C) is used in transformers

(D) cannot detect a change in physical quantity by itself

21. A particle of mass m moves in a central force field defined by $\vec{F} = -k\frac{\vec{r}}{r^4}$, if E is the total energy supplied to the particle, then its speed is given by :

(A) $\frac{k}{mr^2} + \frac{2E}{m}$

(B) $\frac{k}{mr^2} - \frac{2E}{m}$

(C) $\sqrt{\frac{k}{mr^2} + \frac{2E}{m}}$

(D) $\sqrt{\frac{k}{mr^2} - \frac{2E}{m}}$

22. In Rutherford's scattering cross-section, the differential scattering cross-section is inversely proportional to :

(A) $\sin\frac{\theta}{2}$

(B) $\sin^2\frac{\theta}{2}$

(C) $\sin^3\frac{\theta}{2}$

(D) $\sin^4\frac{\theta}{2}$

23. In Stern-Garlach experiment :

(A) Both electric and magnetic field were applied

(B) Only non-uniform magnetic field was applied

(C) Only non-homogenous electric field was applied

(D) Only uniform magnetic field was applied

24. An electron spinning about its axis possesses a magnetic dipole moment and its value is :

(A) $\frac{e\hbar}{m}$ (B) $\frac{e\hbar}{2m}$

(C) $\frac{e\hbar}{4m}$ (D) 1

25. The ionisation potential of the hydrogen atom is 13.6 volt. The first excitation potential of the hydrogen atom is :

(A) 10.2 eV (B) 13.6 eV

(C) 10.2 V (D) –13.6 eV

26. de-Broglie wavelength is :

(A) $\lambda = \frac{h}{\sqrt{mk}}$ (B) $\lambda = \frac{h}{\sqrt{2mqV}}$

(C) $\lambda = \frac{h}{\sqrt{2mkT}}$ (D) $\lambda = \frac{h}{\sqrt{mkT}}$

27. If the Lagrangian of system does not explicitly depend on the time, and transformation equations do not depend on time also. Then the total energy of the system is :

(A) Not conserved (B) Zero

(C) Conserved (D) None of these

28. The group velocity v_g and phase velocity v_p is related by $v_g = v_p - \lambda \frac{dv_p}{d\lambda}$. For normal dispersive medium :

(A) $v_g < v_p$

(B) $v_g > v_p$

(C) $v_g = v_p$

(D) None of these

29. The value of the Poisson bracket $[\vec{a} \cdot \vec{r}, \vec{b} \cdot \vec{p}]$, where $\vec{a}$ and $\vec{b}$ are constant vectors is :

(A) $\vec{a}\vec{b}$

(B) $\vec{a} - \vec{b}$

(C) $\vec{a} + \vec{b}$

(D) $\frac{\vec{a}}{\vec{b}}$

30. The mass of an electron is double its rest mass then the velocity of the electron is :

(A) $\frac{c}{2}$

(B) $2c$

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

(D) $\sqrt{\frac{3}{2}}c$

31. Which is invariant under a Galilean transformation ?

(A) Displacement

(B) Velocity

(C) Momentum

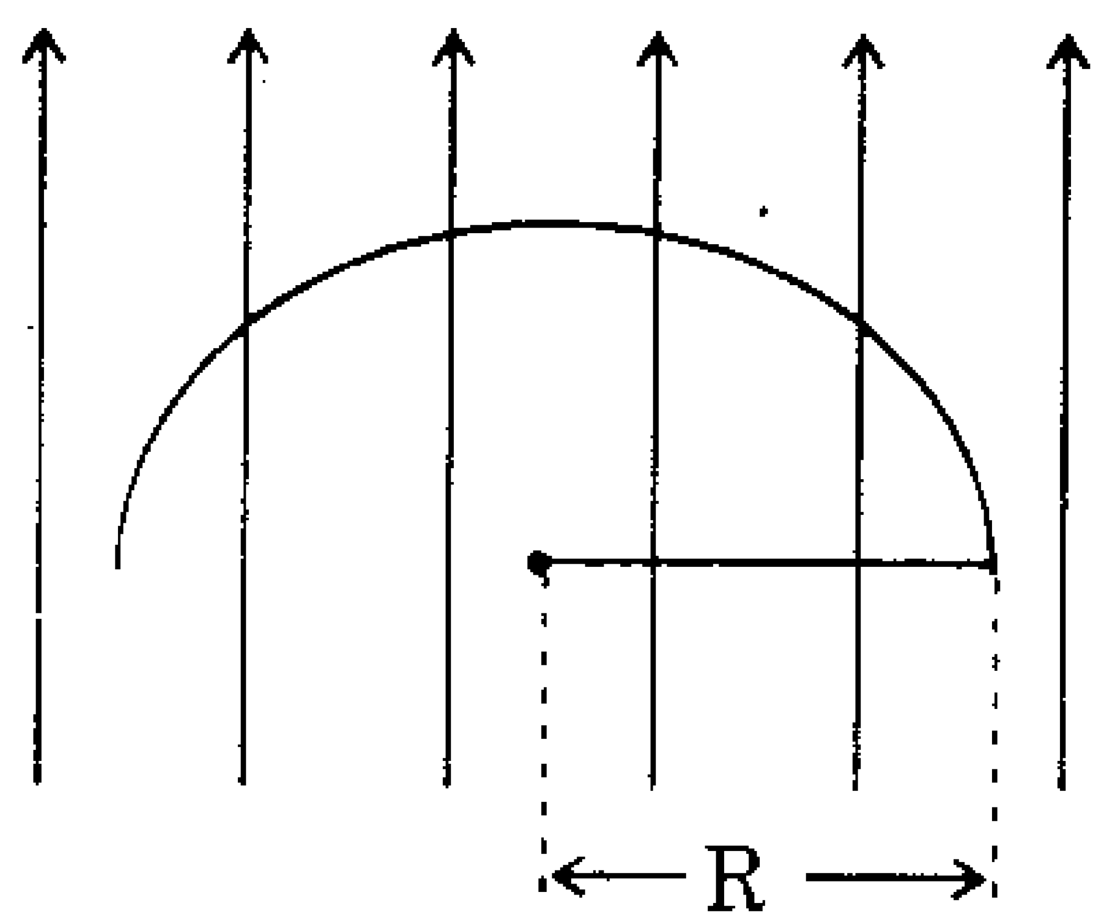
(D) Force

32. Ampere's law is modified by :

(A) Gauss (B) Faraday

(C) Maxwell (D) Dirac

33. The electric-flux passing through a hemi-spherical surface of radius R placed in an electric field E with the axis parallel to the field is :



(A) $\pi R^2 E$ (B) $2\pi R^2 E$

(C) $2\pi R E$ (D) $2\pi R^3 E$

34. In electromagnetic wave the phase difference between electric and magnetic field vectors $\vec{E}$ and $\vec{B}$ (except in conducting medium) is :

(A) $\frac{\pi}{2}$ (B) 0

(C) π (D) $\frac{\pi}{4}$

35. The energy per unit time, per unit area transported by the electromagnetic fields is expressed as :

(A) $\bar{S} = \frac{1}{\mu_0}(\bar{E} \times \bar{B})$ (B) $\bar{S} = \bar{E} \times \bar{B}$

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

36. For a linear quadrupole the electric field varies as the power of distance r is :

(A) $\frac{1}{r^2}$ (B) $\frac{1}{r^3}$

(C) $\frac{1}{r^4}$ (D) $\frac{1}{r}$

37. The physical meaning of $\vec{\nabla} . \vec{B} = 0$ is that :

(A) An isolated monopole exists

(B) An isolated monopole does not exist

(C) Both (A) and (B) above

(D) None of the above

38. Which is the *incorrect* statement about the electromagnetic wave ?

(A) The electromagnetic field vectors $\vec{E}$ and $\vec{B}$ are mutually perpendicular and they are also perpendicular to the direction of propagation of electomagnetic wave

(B) The field vectors $\vec{E}$ and $\vec{H}$ are in same phase

(C) The field vectors $\vec{E}$ and $\vec{H}$ are along the same direction

(D) Electromagnetic waves are transverse in nature

39. The characteristic impedance of free space in general is given by :

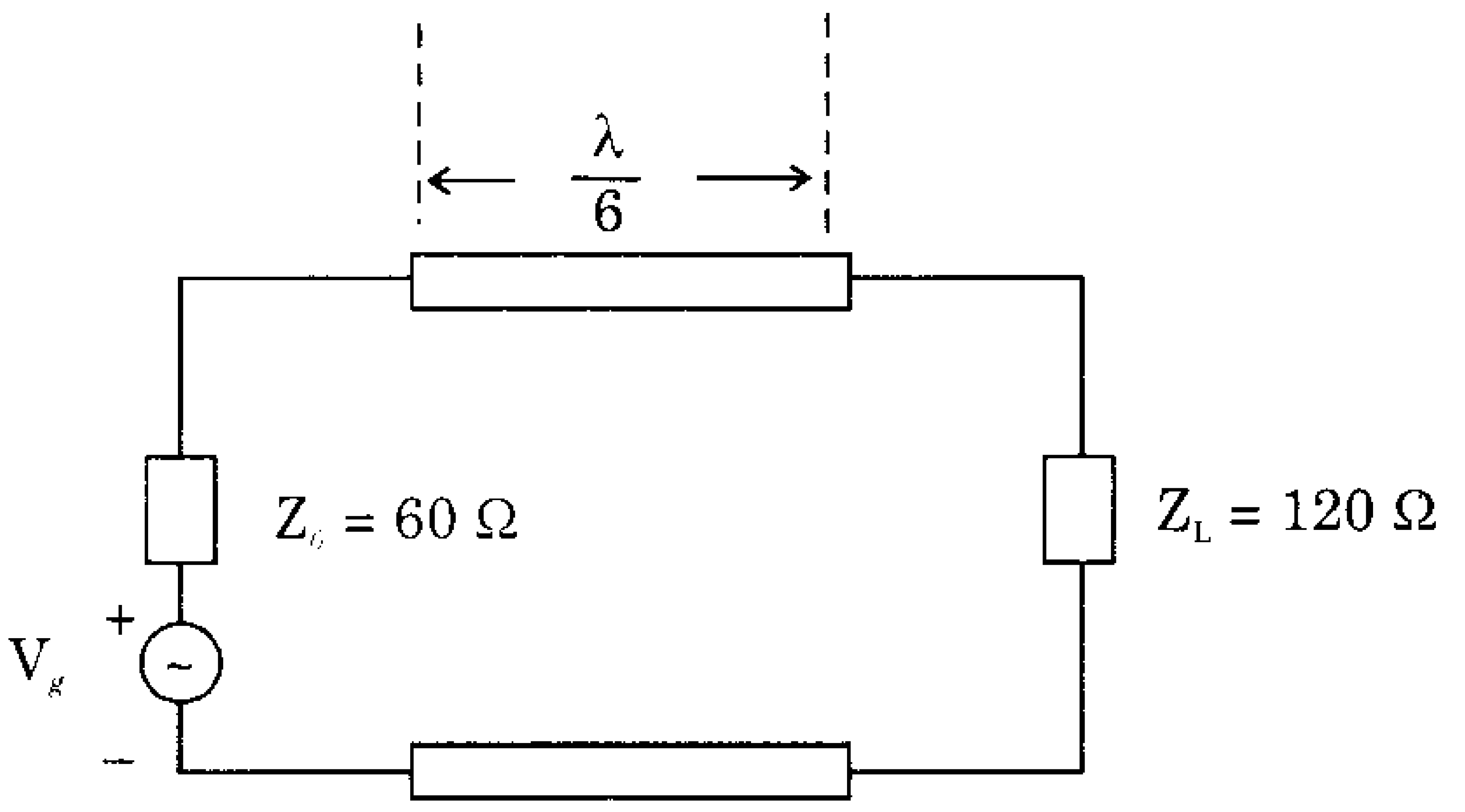
(A) $\frac{E}{H} = \sqrt{\frac{\mu_0}{\epsilon_0}}$

(B) $\frac{H}{E} = \sqrt{\frac{\mu_0}{\epsilon_0}}$

(C) $E \times H = \sqrt{\mu_0 \times \epsilon_0}$

(D) $E \times H = \sqrt{\frac{\mu_0}{\epsilon_0}}$

40. Consider the lossless transmission line shown in the following figure :



The standing wave ratio is :

(A) 2.15

(B) 1.99

(C) 1.75

(D) 2.05

41. To match a transmission line the stub matching is used when :

(A) It is possible to control the terminating impedance of line

(B) It is not possible to control the terminating impedance of line

(C) The characteristic impedance is not fixed

(D) None of the above

42. A wave is propagated in a parallel plane guide operating in TE mode at a frequency of 6 Gc/s. The separation between planes is 7.5 cm. Then the cut-off wavelength for the dominant mode is :

(A) 5.30 cm (B) 5.77 cm

(C) 1.25 cm (D) 2.55 cm

43. If ρ is the reflection coefficient, the standing wave ratio's on a transmission line is given by :

(A) $S = \frac{1-|\rho|}{1+|\rho|}$ (B) $S = \frac{1+|\rho|}{1-|\rho|}$

(C) $S = (1+|\rho|) \cdot (1-|\rho|)$ (D) None of these

44. The radiative magnetic field strength due to a short doublet is given as $dH = \frac{I_0 dl \sin\theta}{2\lambda r} \cos\omega\,(t - r/c)$ ampere turn/meter corresponding electric field will be :

(A) $dE = 30\pi \frac{I_0 dl \sin\theta}{2\lambda r} \cos\omega(t - r/c)$

(B) $dE = 90\pi \frac{I_0 dl \sin\theta}{\lambda r} \cos\omega(t - r/c)$

(C) $dE = 100\pi \frac{I_0 dl \sin\theta}{2\lambda r} \cos\omega(t - r/c)$

(D) $dE = 60\pi \frac{I_0 dl \sin\theta}{\lambda r} \cos\omega(t - r/c)$

45. The radiation resistance of thin linear antenna for half wave antenna (or half wave dipole) is :

(A) $R_{\lambda/2} = \frac{320}{\lambda^2}\left(\frac{\lambda}{2}\right)^2$

(B) $R_{\lambda/2} = \frac{320}{\lambda^2}\left(\frac{\lambda}{4}\right)^2$

(C) $R_{\lambda/2} = \frac{160}{\lambda^2}\left(\frac{\lambda}{2}\right)^2$

(D) $R_{\lambda/2} = \frac{160}{\lambda^2}\left(\frac{\lambda}{4}\right)^2$

46. The direction gain for an antenna which has a radiation resistance 70 ohms, a loss resistance of 10 ohms, and a power gain of 15 is :

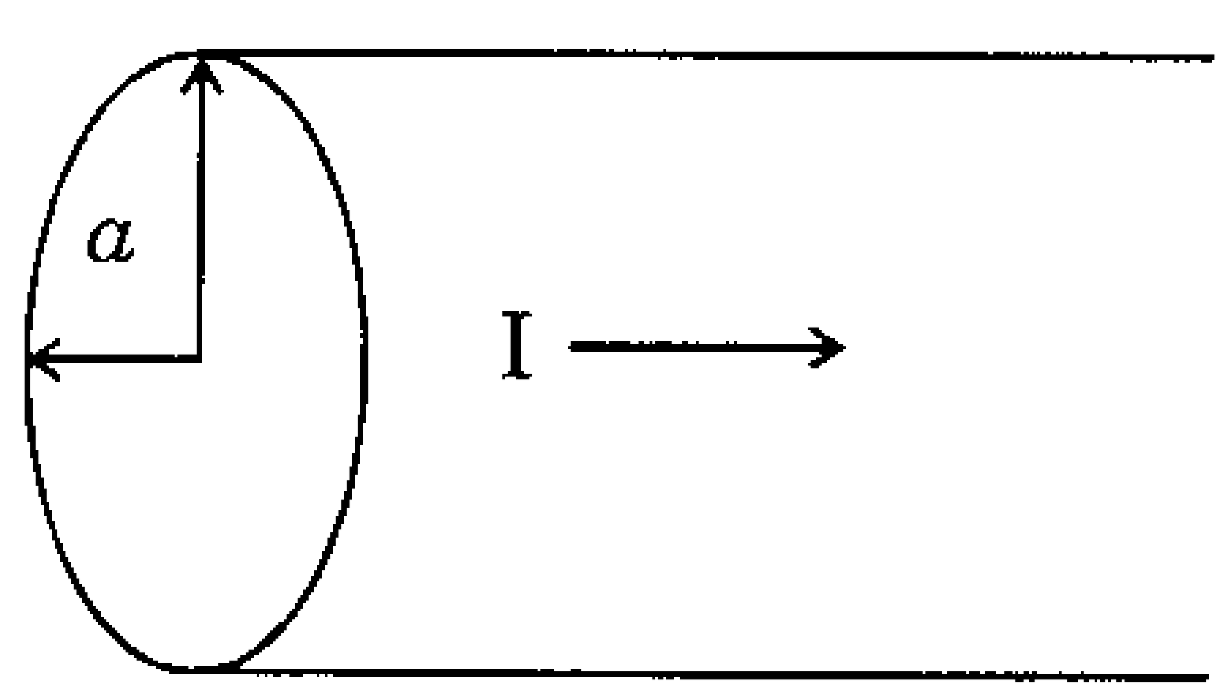
(A) 17.54

(B) 17.08

(C) 17.14

(D) 15.35

47. If the current density in the wire is shown is proportional to the distance from axis $\vec{J} = k\vec{r}$ (k is some constant). The total current in wire is :



(A) $\frac{\pi k a^3}{3}$

(B) $\frac{2\pi k a^3}{3}$

(C) $2\pi k a^3$

(D) $2\pi k a^2$

48. A wave guide section in a microwave circuit will act as a :

(A) Low pass filter (B) Band-pass filter

(C) High pass filter (D) Band-stop filter

49. Guide wavelength (λ_g), cut-off wavelength (λ_c) and free-space wavelength (λ_0) of a wave guide are related as :

(A) $\frac{1}{\lambda_0^2} = \frac{1}{\lambda_c^2} + \frac{1}{\lambda_g^2}$ (B) $\frac{1}{\lambda_0^2} = \frac{1}{\lambda_g^2} - \frac{1}{\lambda_c^2}$

(C) $\frac{1}{\lambda_g^2} = \frac{1}{\lambda_0^2} + \frac{1}{\lambda_c^2}$ (D) $\frac{1}{\lambda_c^2} = \frac{1}{\lambda_o^2} + \frac{1}{\lambda_g^2}$

50. An electromagnetic wave is to pass through an interface separating two media having dielectric constants $\in_1$ and $\in_2$ respectively. If $\in_1 = 4\in_2$, the wave will be totally reflected if angle of incidence is :

(A) 0° (B) 30°

(C) 45° (D) 60°

51. Two wave functions ψ_1 and ψ_2 are orthogonal if :

(A) $\int \psi_2^* \psi_1 d\tau = 0$

(B) $\int \psi_2^* \psi_1 d\tau = 1$

(C) $\int | \psi_2^2 | d\tau = 0$

(D) $\int | \psi_1^2 | d\tau = 1$

52. The time-dependent Schrödinger wave equation is given by :

(A) $\left(\frac{-\hbar}{2m}\nabla + V\right)\psi = i\hbar\frac{\partial\psi}{\partial t}$

(B) $\left(\frac{\hbar^2}{2m}\nabla^2 - V\right)\psi = i\hbar\frac{\partial\psi}{\partial t}$

(C) $\left(\frac{-\hbar^2}{2m}\nabla^2 + V\right)\psi = i\hbar\frac{\partial\psi}{\partial t}$

(D) None of the above

53. Neglecting variation of mass with velocity, the wavelength associated with electron having a kinetic energy, E is proportional to :

(A) $E^{1/2}$

(B) E

(C) $E^{-1/2}$

(D) E^{-2}

54. The expectation value of p for the wave function $\psi_{(x)} = \sqrt{\frac{2}{L}}\sin\frac{\pi x}{L}$ in the region $0 < x < L$ and $\psi(x) = 0$ for $|x| > L$ is :

(A) Zero

(B) $\frac{\pi\hbar^2}{L^2}$

(C) $\frac{\pi\hbar}{L}$

(D) None of these

55. Ehronest's theorem states that :

(A) The motion of a wave packet not agrees with the motion of the corresponding classical particle

(B) Schrödinger equation leads to the classical laws of motion on the average

(C) Schrödinger equation does not lead to the Newton's law of motion on the average

(D) None of the above

56. What is the value of $[\hat{L}_+, \hat{L}_-]$ for Ladder operators $\hat{L}_+$ and $\hat{L}_-$?

(A) $2\hbar L_Z$

(B) Zero

(C) $-\hbar\hat{L}_-$

(D) $\hbar\hat{L}_+$

57. The wave function in the ground state of hydrogen atom is given as $\psi = Ae^{-r/a_0}$, where r measures distance from nucleus and a_0 is constant. The value of A is :

(A) $\frac{1}{\sqrt{\pi a_0}}$

(B) $\frac{1}{\sqrt{\pi a_0^2}}$

(C) $\frac{1}{\sqrt{\pi a_0^5}}$

(D) $\frac{1}{\sqrt{a_0^3 . \pi}}$

58. The condition for the validity of Born-approximation is :

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

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

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

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

59. If a simple harmonic oscillator is in its normal state, then the probability of finding the particle outside the classical limits is approximated :

(A) 60% (B) Zero

(C) 80% (D) 16%

60. If two operators $\hat{A}$ and $\hat{B}$ have same eigen-functions, what is the value of [A, B] ?

(A) 1 (B) 0

(C) $\hat{A}\psi + \hat{B}\psi$ (D) None of these

61. The product of two Hermitian operators is Hermitian, if :

(A) They commute (B) They do not commute

(C) Both (A) and (B) are true (D) None of these

62. The norm of the state $|a>$ is defined to follow the property :

(A) for every $|b>$, $<b|a> \leq 0$

(B) $<a|a> \geq 0$

(C) for every $|b>$, $(<b|a>| + <b|a>) \geq 0$

(D) $<a|a> > 0$

63. The ground energy eigen-function of a one-dimensional linear harmonic oscillator is :

(A) Parabolic function

(B) Elliptical function

(C) Gaussian function

(D) Linear function

64. The most probable distance of the electron from the nucleus in the normal state of hydrogen atom is equal to :

(A) Bohr's radius a_0

(B) $\frac{a_0^3}{4}$

(C) $3a_0^2$

(D) $\frac{a_0}{2}$

65. Which one of the following is correct for operators σ_x, σ_y, σ_z in Pauli-spin matrices for electron ?

(A) $[\sigma^2, \sigma_x] \neq 0$

(B) $[\sigma_x, \sigma_y] = 2i\sigma_z$

(C) $[\sigma_z, \sigma_x] = 0$

(D) $\sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 0$

66. If J_x, J_y, J_z are angular momentum operators and $J_+ = J_x + iJ_y$ and $J_- = J_x - iJ_y$, then :

(A) $[J^2, J_\pm] = i\hbar$ (B) $[J^2, J_\pm] = 2\hbar J_z$

(C) $[J^2, J_\pm] = 0$ (D) $[J^2, J_\pm] = \frac{i\hbar}{2}$

67. Klein-Gordan equation for a free particle is :

(A) $(-\hbar^2c^2\nabla^2 + m^2c^4)\psi = -\hbar^2\frac{\partial^2\psi}{\partial t^2}$

(B) $(\hbar^2c^2\nabla^2 - m^2c^4)\psi = -\hbar^2\frac{\partial^2\psi}{\partial t^2}$

(C) $(-\hbar c\nabla^2 + m^2c^4) = -\hbar\frac{\partial\psi}{\partial t}$

(D) None of the above

68. According to quantum mechanics, for the particle moving in a box :

(A) The energy levels are discrete and equispaced

(B) The energy levels are continuous

(C) The energy levels are discrete but not equispaced

(D) The energy is always zero

69. The wavelength associated with an electron subjected to potential difference 10 kV is :

(A) 0.122 Å (B) 0.353 Å

(C) 0.456 Å (D) 12.20 Å

70. The electrons are emitted from a metal surface when light falling on it has a minimum :

(A) Velocity

(B) Wavelength

(C) Charge

(D) Energy

71. The confined form of first and second law of thermodynamics is (P = Pressure, V = Volume, T = temperature, U = Internal energy, S = entropy, Q = Quantity of heat) :

(A) $TdS = dU + PdV$

(B) $dQ = TdS + PdV$

(C) $TdS = dU - PdV$

(D) $dU = TdS + dQ$

72. The work done W during an isothermal process in which the gas expands from an initial volume V_1 to a final volume V_2 is :

(A) $R(V_2 - V_1)\log_e\left(\frac{T_1}{T_2}\right)$

(B) $RT\log_e\left(\frac{V_1}{V_2}\right)$

(C) $R(T_2 - T_1)\log_e\left(\frac{V_2}{V_1}\right)$

(D) $RT\log_e\left(\frac{V_2}{V_1}\right)$

73. Which of the following Maxwell's relation leads to Clausius-Clapeyron equation (symbols have their usual meanings) ?

(A) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial V}\right)_V$

(B) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$

(C) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

(D) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

74. In a micro-canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then :

(A) A can exchange only energy with B

(B) A can exchange only particles with B

(C) A can exchange both energy and particles with B

(D) A can exchange neither energy nor particles with B

75. If ψ_{111} and ψ_{112} are the wave functions of the electrons in the two energy states 111 and 112 respectively in a cubical box of side a, then $\frac{\psi_{111}}{\psi_{112}}$ is :

(A) $\sin\frac{\pi z}{a} \Big/ \sin\frac{2\pi z}{a}$

(B) $\sin\frac{2\pi z}{a} \Big/ \sin\frac{\pi z}{a}$

(C) $\sin\frac{\pi x}{a} \Big/ \sin\frac{\pi y}{a}$

(D) $\sin\frac{2\pi y}{a} \Big/ \sin\frac{2\pi z}{a}$

76. The spacing between the nth energy level and next higher level in a one-dimensional potential box increased by :

(A) $(2n - 1)$

(B) $(2n + 1)$

(C) $(n - 1)$

(D) $(n + 1)$

77. The normalized wave function for a particle in a rectangular box of dimensions a, b, c is :

(A) $\psi_n = \sqrt{\frac{abc}{4}} \sin\frac{n_x \pi x}{a} \sin\frac{n_y \pi y}{b} \sin\frac{n_z \pi z}{c}$

(B) $\psi_n = \sqrt{\frac{2}{abc}} \sin\frac{n_x \pi x}{a} \sin\frac{n_y \pi y}{b} \sin\frac{n_z \pi z}{c}$

(C) $\psi_n = \sqrt{\frac{4}{abc}} \sin\frac{n_x \pi x}{a} \sin\frac{n_y \pi y}{b} \sin\frac{n_z \pi z}{c}$

(D) None of the above

78. According to Debye's theory of specific heat at very low temperature, specific heat is proportional to :

(A) T

(B) T^2

(C) T^3

(D) Independent of T

79. If the partition function is given by z and $\beta = \frac{1}{kT}$, then mean energy $\in$ is :

(A) $-\frac{\partial \log z}{\partial \beta}$

(B) $\frac{\partial \log z}{\partial \beta}$

(C) $\frac{\log z}{\beta}$

(D) None of these

80. The specific heat of metals can be expressed as :

(A) T^3

(B) $AT + BT^2$

(C) $AT^2 + BT^3$

(D) $AT + BT^3$

81. In the process of phase transition :

(A) Gibbs' potential function remains constant

(B) Only entropy remains constant

(C) Only volume remains constant

(D) Only temperature remains constant

82. In Joule-Thomson experiment, for a real gas :

(A) The enthalpy remains constant

(B) The energy remains constant

(C) The entropy decreases

(D) Enthalpy decreases

83. In statistical physics, the absolute temperature T of a system is related to the total number of accessible states Ω as :

(A) $k\mathrm{T} = \frac{\partial \Omega}{\partial \mathrm{E}}$

(B) $k\mathrm{T} = \frac{\partial \log \Omega}{\partial \mathrm{E}}$

(C) $\frac{1}{k\mathrm{T}} = \frac{\partial \Omega}{\partial \mathrm{E}}$

(D) $\frac{1}{k\mathrm{T}} = \frac{\partial \log \Omega}{\partial \mathrm{E}}$

84. A perfectly black body is radiating at T_1 K. Its radiation rate is to be increased to 16 times. What will be temperature T_2 K for this ?

(A) $T_2 = 16\ T_1$

(B) $T_2 = 8\ T_1$

(C) $T_2 = 2\ T_1$

(D) $T_2 = 4\ T_1$

85. The Einstein's relationship between the diffusion constant, D and mobility for electron (μ_n) is :

(A) $\frac{D_n}{\mu_n} = \frac{e}{k_B T}$

(B) $\frac{D_n}{\mu_n} = \frac{k_B T}{e}$

(C) $\frac{D_n}{\mu_n} = \frac{2k_B T}{e}$

(D) $\frac{D_n}{\mu_n} = k_B T - E$

86. The current density J_0 of electrons through any conductor carrying current is given as :

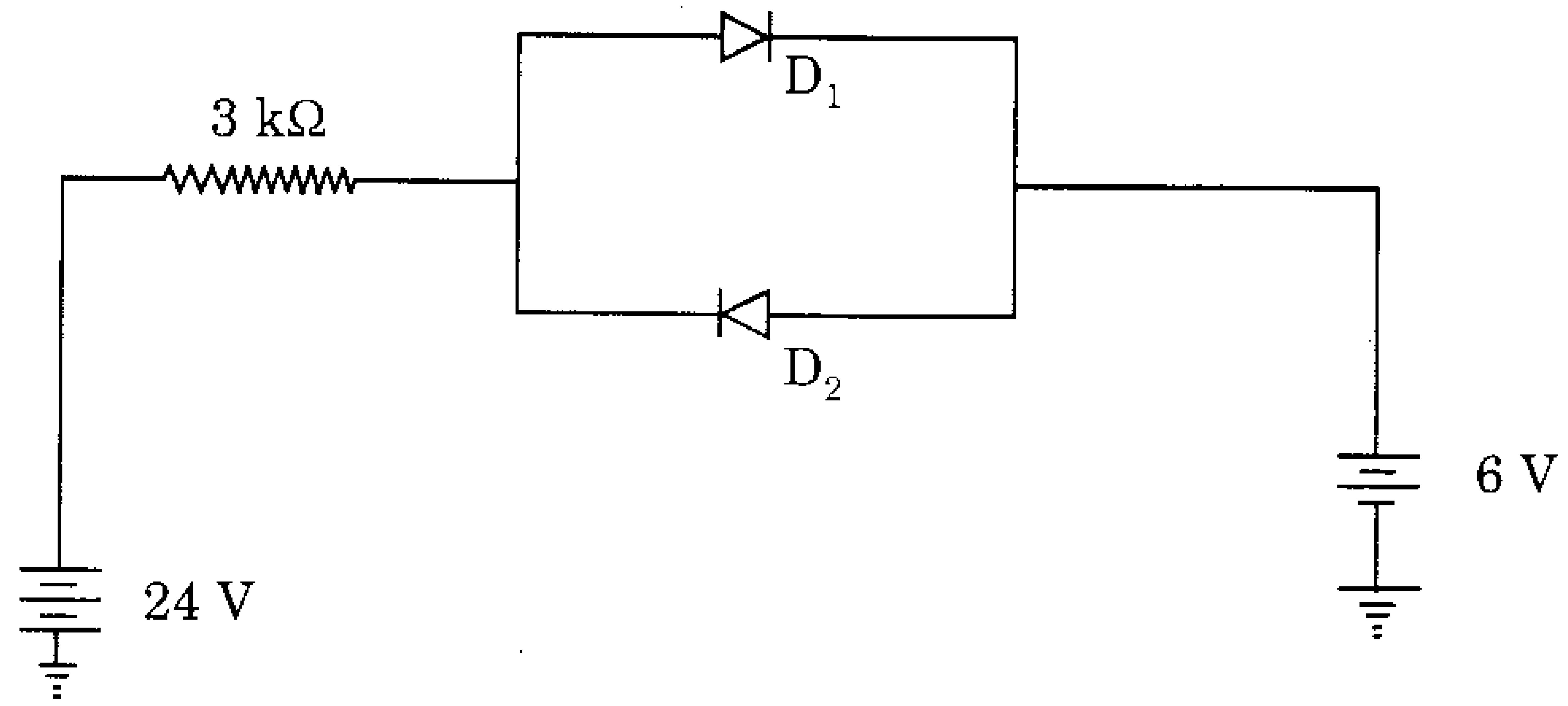
(A) $J_0 = \frac{ne\tau E}{m}$

(B) $J_0 = \frac{ne\tau E^2}{m}$

(C) $J_0 = \frac{ne^2\tau E}{m}$

(D) $J_0 = \frac{e^2\tau E}{m}$

87. The current I in the given circuit shown below (assume that the diodes is made up of silicon, knee-voltage = 0.7 V and the forward resistance to be zero) is :



(A) 3.75 mA

(B) 5.76 mA

(C) 8.00 mA

(D) 1.60 mA

88. If X is the total width of the depletion layer in a junction diode, the transition capacitance (C_j) is proportional to :

(A) X

(B) X^2

(C) $\frac{1}{X^2}$

(D) $\frac{1}{X}$

89. A transistor is said to be in a quiescent state when :

(A) it is unbiased

(B) no current flows through it

(C) no signal is applied to the input

(D) emitter junction is just biased equal to collector junction

90. The potential divider biasing is used in amplifier to :

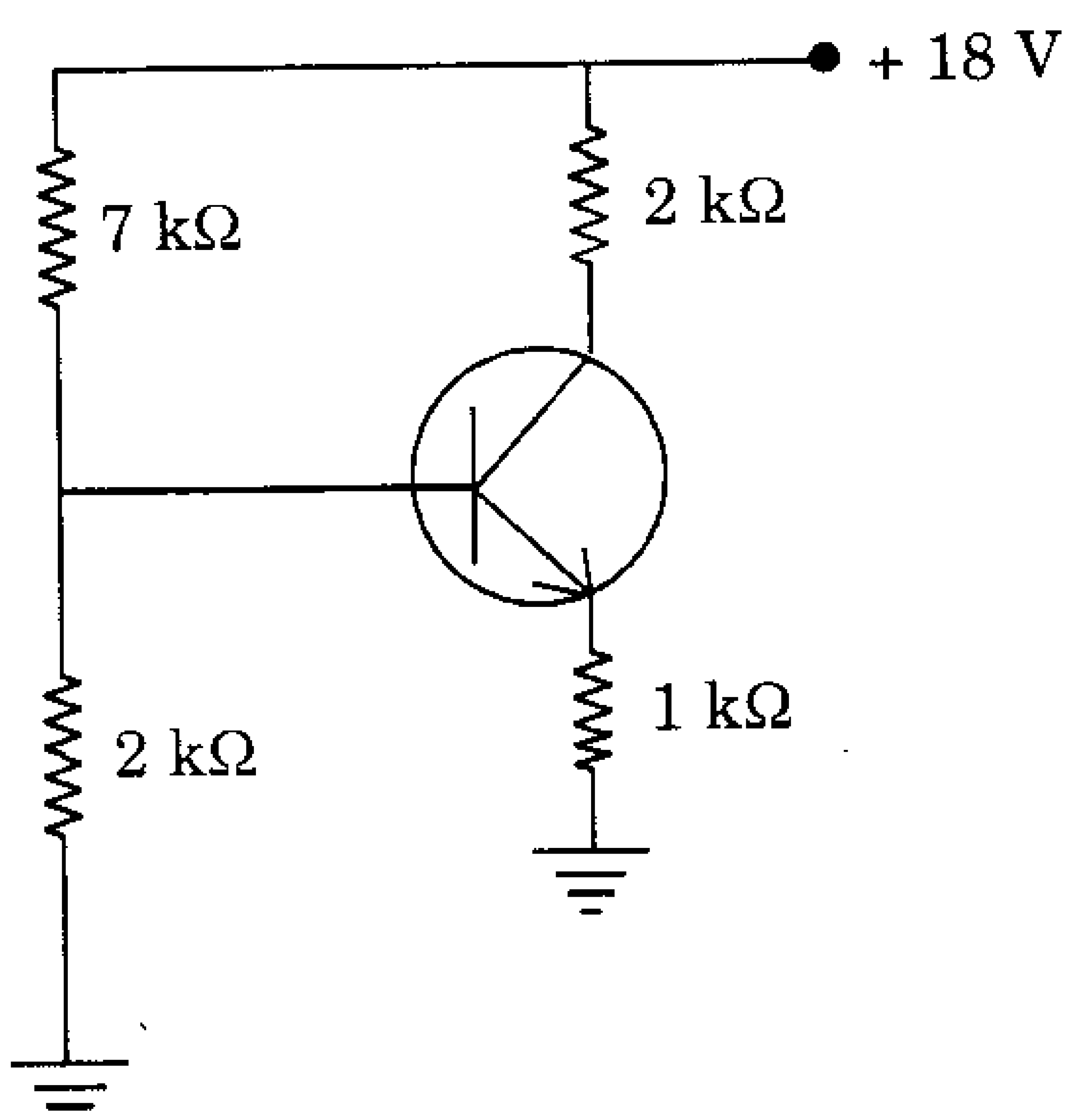
(A) limit the input ac signal going to the base

(B) reduce dc base current

(C) reduce the cost of circuitry by limiting the numbers of resistors

(D) make the operating point almost independent of β

91. A potential divider circuit is shown below neglecting V_{BE}, the emitter current will be :



(A) 2 mA (B) 4 mA

(C) 1 mA (D) None of these

92. For common-emitter amplifier circuit the input impedance is :

(A) $Z_{in} = h_{ie} - \dfrac{h_{re}h_{fe}}{h_{oe} + \dfrac{1}{r_L}}$

(B) $Z_{in} = \dfrac{h_{re}h_{fe}}{h_{oe} + r_L}$

(C) $Z_{in} = \dfrac{h_{fe}}{1 + h_{oe} + r_L}$

(D) $Z_{in} = \dfrac{-h_{fe}}{\left(h_{oe} + \dfrac{1}{r_L}\right)}$

93. The Junction field effect transistor (JFET) is :

(A) A current controlled device

(B) A unipolar device

(C) A voltage-controlled device

(D) Both (B) and (C)

94. Which of the following is *not* a characteristic of the UJT ?

(A) Intrinsic stand-off ratio

(B) Negative resistance

(C) Peak-point voltage

(D) Bilateral conduction

95. A certain op-amp has bias current of 50 μA and 49.3 μA. The input off set current is :

(A) 99.3 μA

(B) 49.7 μA

(C) 700 *n*A

(D) None of these

96. For a step input, the output of an integrator is :

(A) A pulse

(B) A triangular waveform

(C) A spike

(D) A ramp

97. In a 8085, microprocessor system with memory mapped I/O :

(A) I/O devices have 8 bit addresses

(B) I/O devices are accessed using IN and OUT instructions

(C) There can be a maximum of 256 input devices and 256 output devices

(D) Arithmetic and logic operations can be directly performed with the I/O data

98. For a mode-16 synchronous counter if propagation delay time (t_{pd}) for each flip-flop is 50 ns and t_{pd} for each AND gate is 20 ns. Then the maximum frequency f_{max} that can be used is :

(A) 14.3 MHz (B) 5 MHz

(C) 10 MHz (D) 3.5 MHz

99. The output frequency for a counter which has 14 stable states 0000 through 1101 and the input frequency is 30 kHz, is :

(A) 7.5 kHz (B) 2.14 kHz

(C) 420 kHz (D) None of these

100. A JK flip-flop with J = 1 and K = 1 has a 10 kHz clock input. The Q output is :

(A) Constantly high (B) Constantly low

(C) A 10 kHz square wave (D) A 5 kHz square wave

101. A mod-12 ripple counter is designed with four JK flip-flop A, B, C and D provided with clear input. The input clock is given to flip-flop A and output is taken from D flip-flop. In order that this circuit functions as a MOD-12 counter, the NAND gate input should be :

(A) A and C (B) A and D

(C) B and D (D) C and D

102. To serially shift a byte of data into a shift register, there must be :

(A) One clock-pulse

(B) One load pulse

(C) Eight clock pulses

(D) One clock pulse for each 1 in the data

103. The minimum number of resistors required in a 4-bit D/A network of weighted-resistor type is :

(A) 4 (B) 8

(C) 15 (D) 16

104. The error in a D/A convertor may be caused due to :

(A) Quantization

(B) A large number of 1's in the input

(C) A large number of 0's in the input

(D) Error in resistance values

105. Data that are stored at a given address in a random access memory (RAM) is lost when :

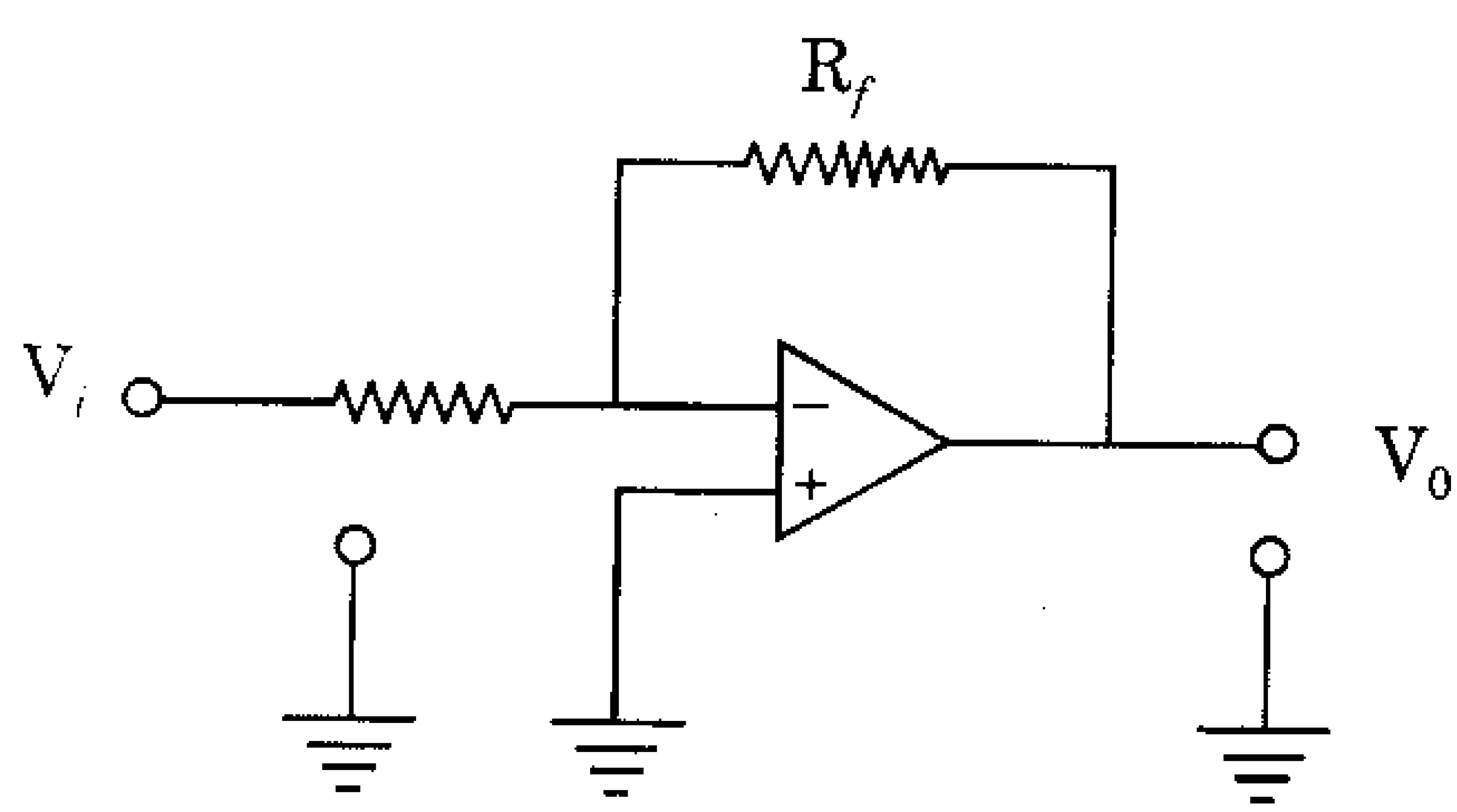
(A) Power goes off

(B) The data are read from the address

(C) New data are written at the address

(D) Both (A) and (C)

106. A circuit using an Op-Amp shown below is :



(A) Voltage series feedback

(B) Voltage shunt feedback

(C) Current shunt feedback

(D) Current series feedback

107. For obtaining maximum power from a solar cell, it should be operated on :

(A) the knee of the V-I characteristics

(B) horizontal part of the curve

(C) falling portion of the V-I characteristics

(D) any part of the V-I characteristics as power does not depend on it

108. Which of the following statements is *wrong* for a photodiode ?

(A) A photodiode is a reverse biased P-N junction

(B) Higher the illumination level, greater is the reverse current of a photodiode

(C) The current in it is mainly due to the flow of majority carriers

(D) It has a dark current which flows when no light is incident

109. The impurity commonly used for realising the base region of a silicon n-p-n transistor is :

(A) Gallium (B) Nitrogen

(C) Boron (D) Phosphorous

110. The most suitable gates to check whether the number of ones in a digital word is even or odd is :

(A) EX-OR gate (B) NAND gate

(C) NOR gate (D) AND, OR and NOT gates

111. The number of diad axes of symmetry elements that are present in a cubic crystal are :

(A) 1 (B) 3

(C) 6 (D) 5

112. The nearest neighbour distance in the case of bcc structure is :

(A) $\frac{a\sqrt{3}}{2}$ (B) $\frac{a\sqrt{2}}{2}$

(C) $\frac{2a}{\sqrt{3}}$ (D) $\frac{2a}{\sqrt{2}}$

113. If n is the number of atoms in the unit cell of the cubic system, N_A and M_A are the Avogadro's number and atomic weight respectively and ρ is the density of the element, then the lattice constant a is given by :

(A) $\left[\frac{M_A \rho}{n N_A}\right]^{1/3}$ (B) $\left[\frac{n N_A}{M_A \rho}\right]^{1/3}$

(C) $\left[\frac{n M_A}{N_A \rho}\right]^{1/3}$ (D) $\left[\frac{\rho N_A}{M_A n}\right]^{1/3}$

114. A plane intercepts at a, $b/2$, $3c$ in a simple cubic unit cell. The Miller indices of the plane are :

(A) (1 3 2) (B) (2 6 1)

(C) (3 6 1) (D) (1 2 3)

115. The length of H–H bond is :

(A) 0.074 nm (B) 0.01 nm

(C) 0.037 nm (D) 2 nm

116. Transition temperature T_C and cricital field H_C for a superconductor are related as :

(A) $H_C = H_0(T_C - 1)$

(B) $H_C = H_0(T_C + 1)$

(C) $T_C = T_0\left[1 - \left(\frac{H_0}{H_C}\right)^2\right]$

(D) $H_C = H_0\left[1 - \left(\frac{T}{T_C}\right)^2\right]$

117. Soft superconductors observe :

(A) Meissner effect

(B) Silsbee's rule

(C) Both (A) and (B)

(D) None of these

118. In a ferromagnetic material, susceptibility is :

(A) Very small and positive

(B) Very small and negative

(C) Very large and positive

(D) Very large and negative

119. The temperature below which certain materials are antiferromagnetic and above which they are paramagnetic is called :

(A) Curie temperature

(B) Neel temperature

(C) Transition temperature

(D) Weiss temperature

120. Which of the following materials is used for making permanent magnet ?

(A) Platinum cobalt (B) Alnico V

(C) Carbon steel (D) All of these

121. Non-sinusoidal waveforms :

(A) have low mark-to-space ratio

(B) are much easier to generate

(C) are unfit for digital operation

(D) are departure from sine wave form

122. Which of the following relation gives Wiedemann-Franz law ?

(A) $\frac{k}{\sigma} = LT$ (B) $\frac{\sigma}{k} = LT$

(C) $\frac{k}{\sigma} = \frac{L}{T}$ (D) $\frac{\sigma}{k} = \frac{L}{T}$

123. Temperature coefficient of resistance is :

(A) $\frac{1}{R}\frac{dR}{dT}$ (B) $\frac{dR}{dT}$

(C) $\frac{1}{R}\frac{dT}{dR}$ (D) $R\frac{dT}{dR}$

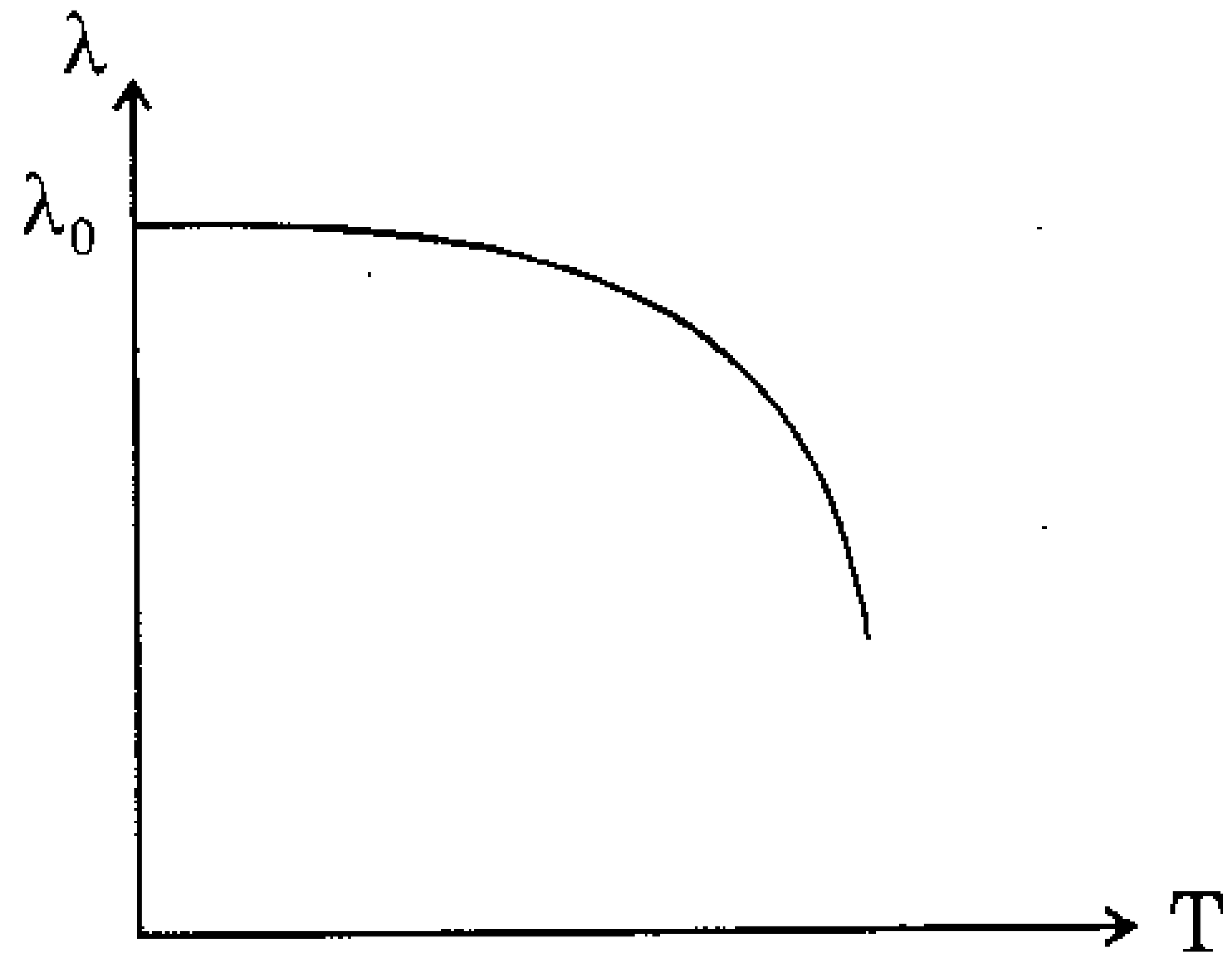
124. The quanta of energy in elastic wave is called a :

(A) Photon (B) Phonon

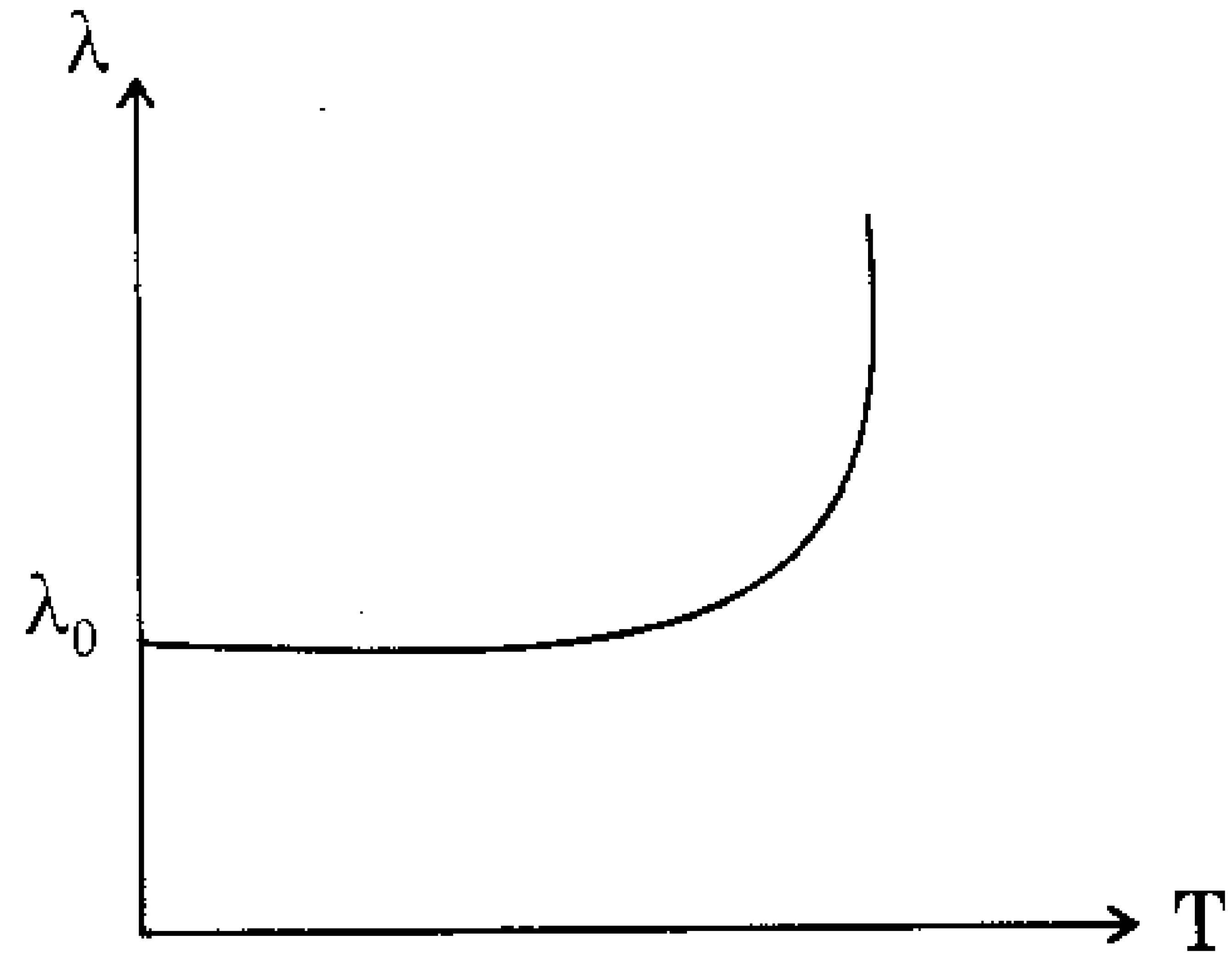
(C) Hyperon (D) Nucleon

125. The variation of penetration depth (λ) of the superconductor with temperature T is represented by graph is :

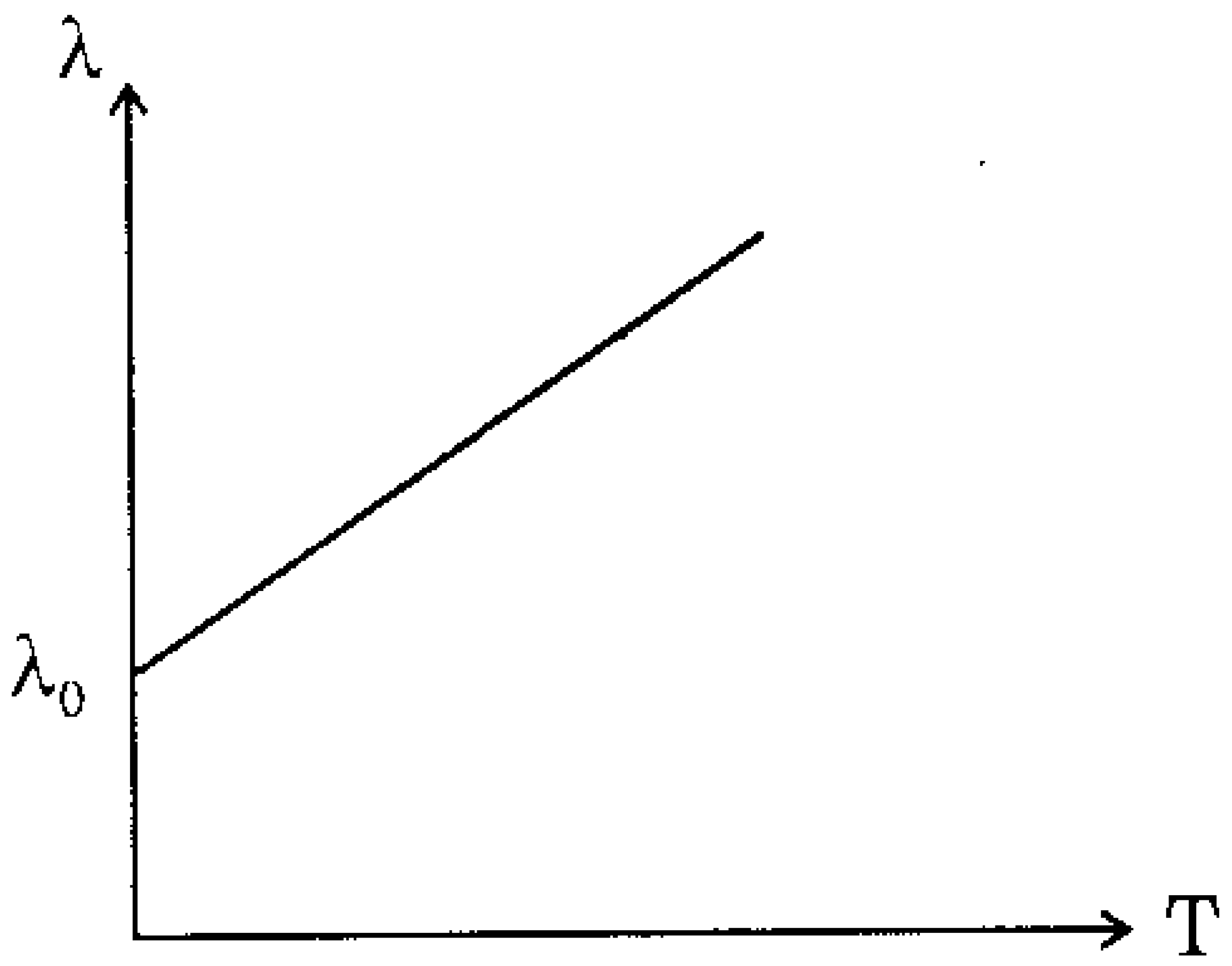
(A)



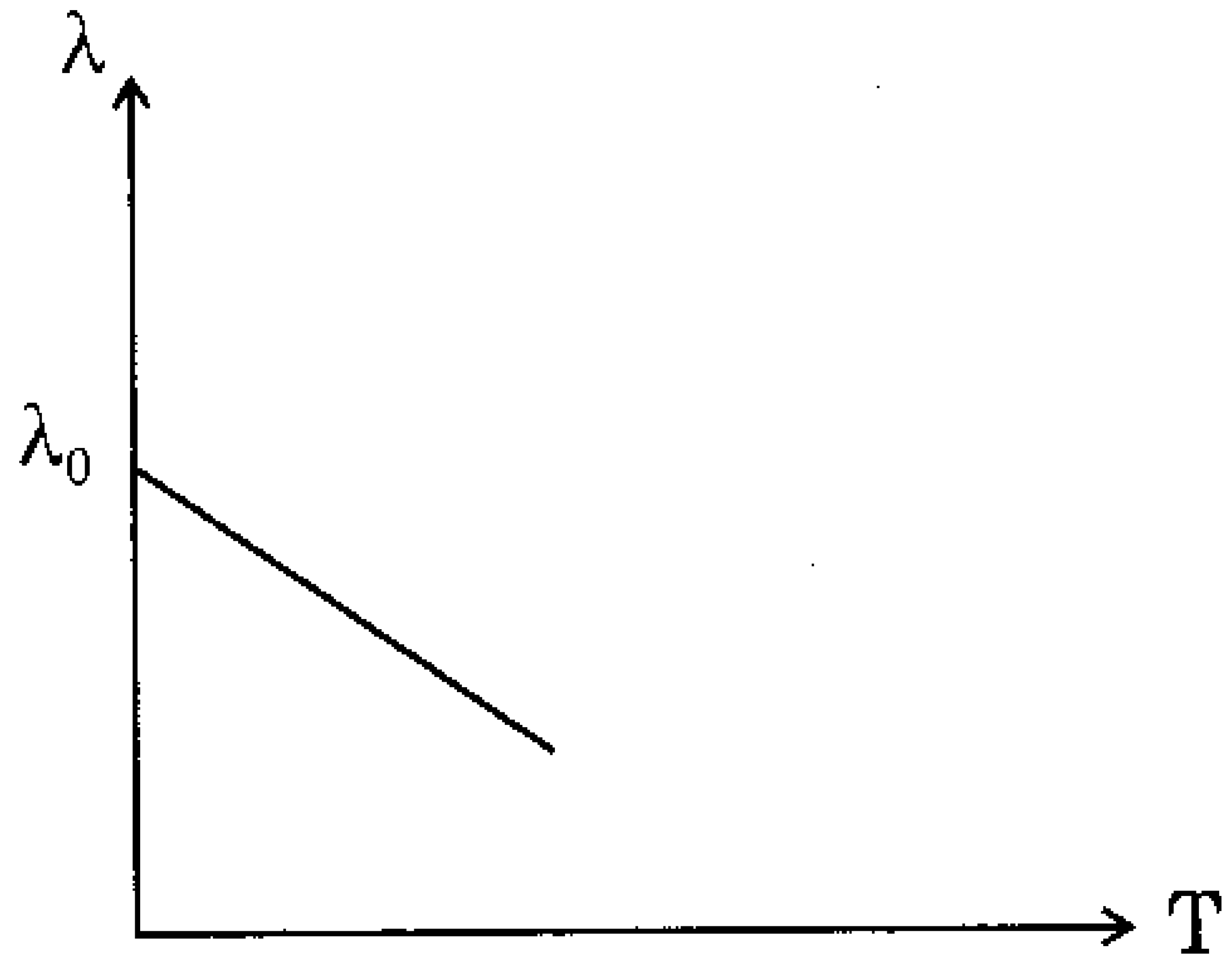
(B)



(C)



(D)



126. If $\vec{G}$ is a reciprocal lattice vector, the Bragg's law can be written as :

(A) $\vec{k} + \vec{G} = 0$ (B) $2\vec{k} \cdot \vec{G} + G^2 = 0$

(C) $2\vec{k} \cdot \vec{G} + k^2 = 0$ (D) $\vec{k} \cdot \vec{G} = 0$

127. A hexagonal structure has a symmetry element :

(A) One 6-fold rotation axis (B) Two 3-fold rotation axis

(C) Three-2-fold rotation axis (D) A 4-fold rotation-inversion axes

128. Which of the following metals crystallizes in fcc structure ?

(A) Aluminium (B) Zinc

(C) Sodium (D) Caesium chloride

129. In signal generators :

(A) Energy is created

(B) Energy is generated

(C) Energy is converted from a simple d.c. source into a.c. energy at some specific frequency

(D) All of the above

130. In a cathode ray tube (CRT) the focussing anode is located :

(A) Between pre-accelerating and accelerating anodes

(B) After accelerating anodes

(C) Before pre-accelerating anode

(D) None of the above

131. The resistance of a thermometer is 5 Ω at 30°C and 6.5 Ω at 60°C. Using linear approximation, the value of resistance temperature coefficient at 45°C is :

(A) 0.009/°C (B) 0.0085/°C

(C) 0.0087/°C (D) 0.001/°C

132. In a Q meter, distributed capacitance of coil is measured by changing the capacitance of the tuning capacitor. The values of tuning capacitors are C_1 and C_2 for resonant frequencies f_1 and $2f_1$ respectively. The value of distributed capacitance is :

(A) $\frac{C_1 - C_2}{2}$ (B) $\frac{C_1 - 4C_2}{3}$

(C) $\frac{C_1 - 2C_2}{3}$ (D) $\frac{C_1 - 3C_2}{2}$

133. The mean deviation $\bar{d}$ in terms of deviation from the mean value of n readings is :

(A) $\frac{\sum_{i=1}^{n} d_i}{n}$ (B) $\frac{\sqrt{\sum_{i=1}^{n} d_i^2}}{\sqrt{n}}$

(C) $\frac{\sum_{i=1}^{n} |d_i|}{n}$ (D) $\frac{\sqrt{\sum_{i=1}^{n} d_i^2}}{n}$

134. Frequency of an A.C. source can be measured by using :

(A) Anderson's bridge (B) Robinson's bridge

(C) De Sauty's A.C. bridge (D) Schering bridge

135. Hall effect is useful in determining :

(A) Neither the number of density of charge carriers nor their type

(B) The number density of charge carrier but not their type

(C) Not the number of charge carriers but their type

(D) The number density of charge carriers and also their type

136. The frequency dependence noise power (N.P.) and noise voltage (N.V.) is :

(A) N.P. $\propto \frac{1}{f}$ and N.V. $\propto \frac{1}{\sqrt{f}}$

(B) N.P. $\propto \frac{1}{\sqrt{f}}$ and N.V. $\propto \frac{1}{f}$

(C) Both N.P. and N.V. varies as $\frac{1}{f}$

(D) Both N.P. and N.V. varies as $\frac{1}{\sqrt{f}}$

137. The electric quadrupole moment in a nucleus arises due to :

(A) uniform distribution of electric charges within its periphery

(B) non-uniform distribution of electric charges within its periphery

(C) spherical symmetry of the nucleus

(D) none of the above

138. A nuclei having a mass number 56 or near about are :

(A) most stable

(B) not so stable

(C) lower average binding energy per nucleon

(D) none of the above

139. The magic nuclei are :

(A) 2, 8, 20, 50, 82 and 126 (B) 4, 8, 16, 50, 82 and 126

(C) 2, 8, 16, 50, 80 and 126 (D) none of these

140. The masses of hydrogen atom, a neutron and the $_2He^4$ atom in a.m.u. are 1.007825, 1.008665 and 4.002603 respectively. The minimum energy required to break a $_2He^4$ nucleus into free protons and neutrons are [given 1 a.m.u. = 931 MeV]

(A) 18.28 MeV (B) 28.28 MeV

(C) 2.28 MeV (D) None of these

141. A nuclei has an atomic mass M less than its mass number A, then its packing fraction is :

(A) negative (B) positive

(C) zero (D) none of these

142. According to the meson theory of nuclear forces :

(A) A neutron emits a (π^+) meson and is converted into a proton

(B) A neutron emits a (π^-) meson and is converted into a proton

(C) A neutron emits a (π^0) meson and is converted into a proton

(D) A nucleon cannot be converted into a proton

143. Which one of the following statements regarding photon is *wrong* ?

(A) Photon has zero rest mass

(B) Electric charge is zero

(C) Photon spin is zero

(D) Stable

144. The quarks are supposed to exist in the following number of flavours :

(A) six (B) four

(C) two (D) three

145. Which of the following decay is forbidden ?

(A) $\mu^- \to e^- + \nu_\mu + \nu_e^-$ (B) $\pi^+ \to \mu^+ + \nu_\mu$

(C) $\mu^+ \to e^+ + \nu_e$ (D) $\mu^- \to e^+ + e^- + e^-$

146. For meson particle π^-, the quark composition is :

(A) $u\bar{d}$ (B) $u\bar{u}$

(C) $\bar{u}d$ (D) $u\bar{s}$

147. The $_{92}U^{238}$ nucleus can be fissioned by neutrons having energy :

(A) above 1.0 MeV

(B) slow neutron having energy equal to 0.03 eV

(C) Both (A) and (B)

(D) Cannot be disintegrated

148. Which of the following elementary particles is a lepton ?

(A) Photon (B) π-meson

(C) μ-meson (D) Proton

149. Which of the following is *not* used as a moderator in a nuclear reactor ?

(A) H_2O (B) D_2O

(C) C (D) Al

150. The number of final states of electrons corresponding to momenta between p and $p + dp$ in Fermi theory of β-decay is :

(A) Independent of p (B) Proportional to pdp

(C) Proportional to p^2dp (D) Proportional to p^3dp