DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

TBC : *AKG-APCC-PHYSICS*

Time Allowed : 2 Hours]   [Maximum Marks : 100

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.

2. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write **anything** else on the Test Booklet.

3. This Test Booklet contains **100** items (questions). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.

4. You have to mark all your responses ONLY on the separate Answer Sheet provided. No erasing/correction fluid is allowed.

5. All items carry equal marks.

6. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.

7. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator *only the Answer Sheet*. You are permitted to take away with you the Test Booklet.

8. Sheets for rough work are appended in the Test Booklet at the end.

9. **Penalty for wrong answers :**
    THERE WILL BE PENALTY (NEGATIVE MARKING) FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.
    (*i*)   There are four alternatives for the answers to every question. For each question for which a wrong answer has been given by the candidate, **one fourth (0.25)** of the marks assigned to that question will be deducted as penalty.
    (*ii*) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answer happen to be correct and there will be same penalty as above for that question.
    (*iii*) If a question is left blank i.e. no answer is given by the candidate, there will be **no penalty** for that question.

10. Use and carrying of Mobile Phone and Electronic Gadget is prohibited in Examination Hall.

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1. The unitary operator corresponding to an infinitesimal rotation (θ) about an arbitrary axis $\hat{n}$ is given by :

(A) $I + \dfrac{i\theta}{\hbar}\hat{n}.\vec{J}$

(B) $\theta\hat{n}.\vec{J}$

(C) $I + \theta\hat{n}.\vec{J}$

(D) $\dfrac{\theta}{\hbar}\hat{n}.\vec{J}$

2. The matrix representation of the operator J^2 for $j = \dfrac{1}{2}$ is given by :

(A) $\begin{pmatrix} 1/2 & 0 \\ 0 & 1/2 \end{pmatrix}$

(B) $\begin{pmatrix} 3/4 & 0 \\ 0 & 3/4 \end{pmatrix}$

(C) $\begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}$

(D) $\begin{pmatrix} 0 & 3/4 \\ 3/4 & 0 \end{pmatrix}$

3. The value of the Clebsch-Gordan coefficient $(j_1\, j_2\, j_1 + j_2;\, j_1\, j_2)$ is :

(A) 1

(B) $j_1 + j_2$

(C) j_1

(D) j_2

4. Find the normalization constant of the wave function $\phi(x) = e^{-ax^2}$, a is a constant, over the domain $-\infty \leq x \leq \infty$.

$$\left(\text{Given, } \int_{-\infty}^{\infty} e^{-2ax^2}\, dx = \sqrt{\dfrac{\pi}{2a}} \right)$$

(A) $\left(\dfrac{\pi}{a} \right)^{1/2}$

(B) $\left(\dfrac{\pi}{2a} \right)^{1/4}$

(C) $\left(\dfrac{2a}{\pi} \right)^{1/4}$

(D) $\left(\dfrac{a}{\pi} \right)^{1/2}$

5. The value of the commutator $\left[\hat{z}, \dfrac{d}{dz}\right]$ is :

(A) 1

(B) 0

(C) –1

(D) $\hbar$

6. Which of the following situations corresponds to Heisenberg representation ?

(A) The state vector changes with time but the operator remains constant.

(B) The operator changes with time but the state vector remains constant.

(C) Both state vector and operator change with time.

(D) Both state vector and operator do not change with time.

7. Which of the following wave functions has (have) odd parity ?
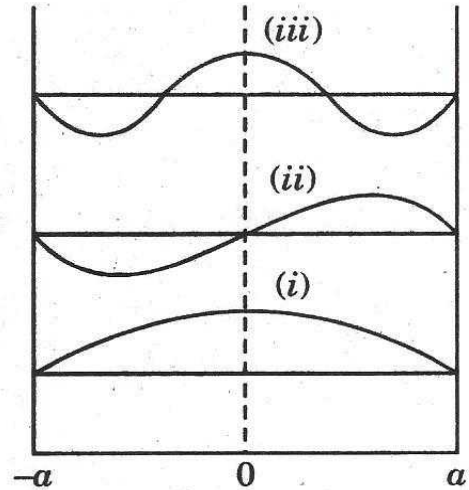
(A) (*i*) only

(B) (*iii*) only

(C) (*ii*) and (*iii*)

(D) (*ii*) only

8. For an electron in a one-dimensional infinite square well potential of width 1.0 Å, find the separation between two lowest energy levels :

(A) 56.5 eV

(B) 83.4 eV

(C) 95.2 eV

(D) 113.3 eV

9. The ground state of ^8_4Be is unstable and decays into two alpha particles with a half life $\tau_{1/2} = 1.0 \times 10^{-6}$ s. Find the relative orbital angular momentum of the alpha particles and estimate the particle decay width of the ^8_4Be ground state.

(A) 0; 1.32 eV

(B) 1; 2.65 eV

(C) 2; 3.01 eV

(D) 0; 4.57 eV

10. The parity of spherical harmonics $y_{lm}(\theta, \varphi)$ is given by :

(A) $(-1)^m$

(B) $(-1)^{l+m}$

(C) $(-1)^l$

(D) $(-1)^{l-m}$

11. If the angular momentum operator, $\vec{J}'$, is the difference of two angular momentum operators $\vec{J_1}$ and $\vec{J_2}$, then :

(A) $\left[J'_x, J'_y \right] = i\hbar J'_z$

(B) $\left[J'_x, J'_y \right] = i\hbar \left(J_{1z} + J_{2z} \right)$

(C) $\left[J'_x, J'_y \right] = 0$

(D) $\left[J'_x, J'_y \right] = i\hbar \left(J_{1z} - J_{2z} \right)$

12. An electron is in a state represented by the wave function :

$$\psi = \frac{1}{\sqrt{4\pi}} \left(\cos\theta + e^{-1\varphi} \sin\theta \right) R(r),$$

$$\int_0^\infty \left| R(r) \right|^2 r^2 dr = 1.$$

What are the possible eigen values of L_z operator ?

(A) $\frac{1}{\sqrt{4\pi}} \hbar, \hbar$

(B) $0, -\hbar$

(C) $\hbar, 2\hbar$

(D) $0, -\frac{\hbar}{2}$

13. Find the number of splitted levels of $1P \rightarrow 1S$ transition of an atom placed in a magnetic field along z-axis :

(A) no splitting

(B) 2

(C) 3

(D) 4

14. When a particle moves under the action of a central force, then :

(A) its orbital angular momentum is conserved

(B) the motion takes place along a straight line

(C) the areal velocity does not remain constant

(D) the particle is a fermion

15. A particle of mass m moves under a force whose potential is $V(r) = Kmr^3$ (K > 0), then for what kinetic energy will the orbit be a circle of radius R about the origin ?

(A) $mR^3/2$

(B) $3KmR^2/2$

(C) $3MR^2/2$

(D) $3KmR^3/2$

16. Which of the following is *correct* in the case of Rutherford scattering cross-section ?

(A) It is inversely proportional to $\csc^4 \theta/2$

(B) It is inversely proportional to the charge on the target nucleus

(C) It is inversely proportional to the charge on the projectile

(D) It is inversely proportional to the square of the initial kinetic energy

17. A particle of mass m falls a given distance z_0 in time $t_0 = (2z_0/g)^{1/2}$ and the distance travelled in time t is given by $z = at + bt^2$, where constants a and b are such that the time t_0 is always the same. The integral $\int_0^{t_0} L\, dt$ (L is Lagrangian of the system) is an extremum for real values of the coefficients only when :

(A) $a = 0$ and $b = g/2$

(B) $a = g/2$ and $b = 0$

(C) $a = g/4$ and $b = g/2$

(D) $a = g/2$ and $b = g/4$

18. The value of

$$\sum_{k=1}^{n} \{p_k, q_i\}\left[p_k, p_j\right] +$$

$$\sum_{k=1}^{n} \{q_k, q_i\}\left[q_k, p_j\right]$$

is :

(A) 1

(B) 0

(C) –1

(D) –2

19. Two identical simple pendulums, each of length 0.5 m, are connected by a light string (as shown). The force constant of the spring is 2 N/m and the mass of each bob is 0.1 kg. Initially one pendulum was clamped and the other was oscillating. When the clamp is removed, find the periods of two normal modes of the system :
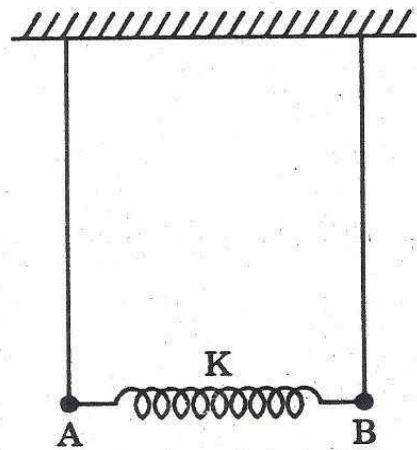
(A) 1.42s, 0.75s

(B) 3.82s, 2.41s

(C) 2.61s, 1.43s

(D) 2.95s, 0.96s

20. A proton with a momentum of 1.0 GeV/c is passing through a gas at high pressure. The index of refraction of the gas can be changed by changing the pressure. Find the minimum value of index of refraction at which the proton will emit Cerenkov radiation :

   (A) 1.37

   (B) 1.26

   (C) 1.11

   (D) 1.02

21. Which of the following is *true* for Schottky diode ?

   (A) It is a bipolar device, having both electrons and holes as majority carriers.

   (B) It has thick depletion layer.

   (C) The delay due to hole-electron recombination is present.

   (D) It has low noise figure.

22. A transistor has its emitter current increased from 15 mA to 20 mA. This caused an increase in base current from 0.32 mA to 0.48 mA. Find the a.c. current gain in common base configuration :

   (A) 0.97

   (B) 0.73

   (C) 0.56

   (D) 0.37

23. Find the operating point for the bias circuit given below :

   (Given, V_{CC} = 9 V, R_B = 50 kΩ, R_C = 250 Ω, R_E = 500 Ω, $β$ = 80)
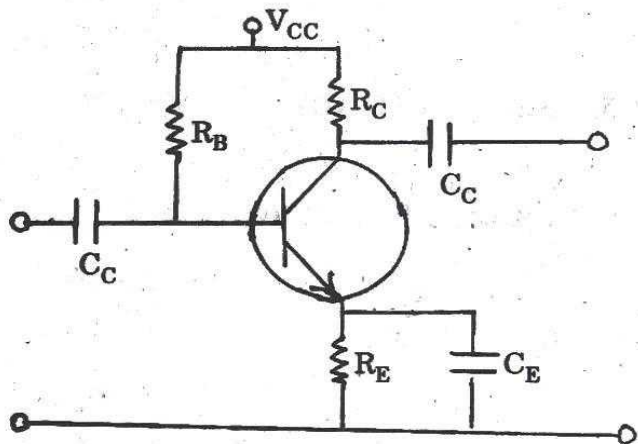
   (A) I_C = 8 mA, V_{CE} = 3 V

   (B) I_C = 6 mA, V_{CE} = 6 V

   (C) I_C = 4 mA, V_{CE} = 10 V

   (D) I_C = 2 mA, V_{CE} = 12 V

24. An amplifier has a band width of 200 kHz and a voltage gain of 40. What will be its band width if 5% negative feedback is introduced ?

(A) 200 kHz

(B) 250 kHz

(C) 430 kHz

(D) 600 kHz

25. Subtract $(10101)_2$ from $(11001)_2$ by 2's complement method :

(A) $(00100)_2$

(B) $(01000)_2$

(C) $(10100)_2$

(D) $(00001)_2$

26. Convert the decimal number 0.34 into octal number :

(A) $(0.2560)_8$

(B) $(0.2430)_8$

(C) $(0.3650)_8$

(D) $(0.6310)_2$

27. Simplify the following expression using the laws of Boolean algebra :

$$(A + B)(A + \bar{B})(\bar{A} + C)$$

(A) ABC

(B) AB

(C) AC

(D) BC

28. An insulating sphere of radius R carries a charge density :

$$\sigma(r) = \frac{\sigma_0}{\sqrt{3}}\left(R^2 - r^2\right); \ r < R$$

The predominant term for the electric field at a distance d far away from the charge distribution behaves as :

(A) $1/d$

(B) $1/d^2$

(C) $1/d^3$

(D) $1/d^4$

29. A spherical conductor of radius R is placed in a uniform electric field E along the z-axis. The potential at a point $P(r, \theta)$ $(r > R)$ is given by :

$$V(r, \theta) = -2Er \sin \theta + \frac{ER^2}{r} \sin \theta$$

Find the charge density on the sphere at $\theta = 30°$.

(A) $\dfrac{3\varepsilon_0 E}{2}$

(B) $\dfrac{3\sqrt{3}\varepsilon_0 E}{2}$

(C) $\dfrac{\varepsilon_0 E}{2}$

(D) $\dfrac{\sqrt{3}\varepsilon_0 E}{2}$

30. During the melting of ice into water at constant pressure, which of the following thermodynamic quantities does not show discontinuous change across the phase transition ?

(A) Internal energy

(B) Helmholtz free energy

(C) Gibbs free energy

(D) Entropy

31. The following are the equations of state of two different thermodynamic systems :

$3RN_1T_1 = 2U_1$ and $5RN_2T_2 = 2U_2$, where N_i, T_i and U_i $(i = 1, 2)$ are, respectively, the mole number, temperature and internal energy of the system i. If U_t is the total energy of the two systems in contact at thermal equilibrium, then the ratio $\dfrac{U_1}{U_t}$ is :

(A) $\dfrac{5N_2}{3N_1 + 5N_2}$

(B) $\dfrac{3N_1}{3N_1 + 5N_2}$

(C) $\dfrac{N_1}{N_1 + N_2}$

(D) $\dfrac{N_2}{N_1 + N_2}$

32. The entropy S of a thermodynamic system is related to the internal energy U and volume V as :

$$S = aU^{3/4}V^{1/4},$$

where a is a constant. The Gibbs potential for this system is :

(A) 3UV/4T

(B) $aU/3$

(C) zero

(D) US/4V

33. The relation between the pressure (P) and the number density (ρ) of a thermodynamic system is given by :

$$P = \alpha\rho + \beta\rho^2,$$

where α and β are constants. Find the work done on the system when it is compressed in such a way that its number density is increased from ρ_0 to $2\rho_0$. (Take V_0 as the initial volume of the system)

(A) $\alpha\rho_0 V_0$

(B) $(\alpha + \beta\rho_0)\rho_0 V_0$

(C) $\left(\dfrac{3\alpha}{2} + \dfrac{7\rho_0\beta}{3}\right)\rho_0 V_0$

(D) $(\alpha \ln 2 + \beta\rho_0)\rho_0 V_0$

34. Which of the following graphs shows the qualitative behaviour of the free energy (f) of a ferromagnet in an external magnetic field (M), at a constant temperature, but less than the critical temperature ?

(A)

(B)

(C)

(D)
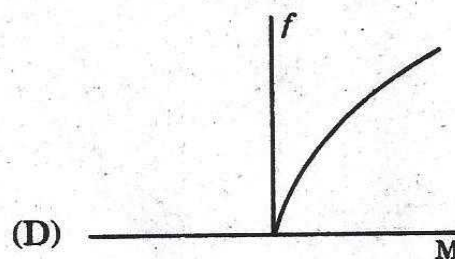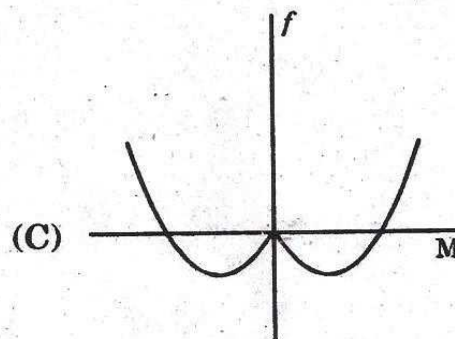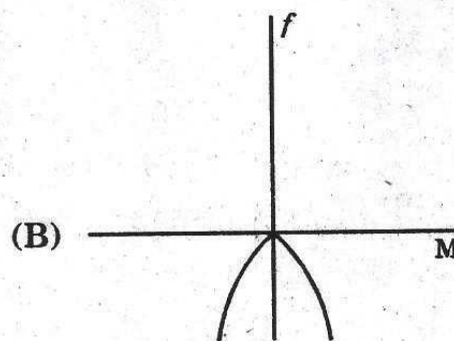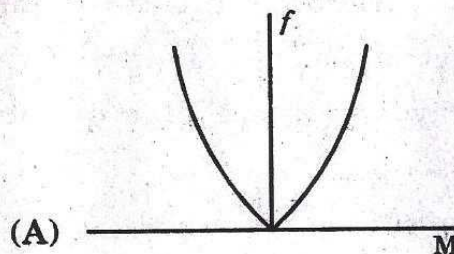
35. X-ray of wavelength λ is reflected from the (111) plane of a simple cubic lattice. If the lattice constant is equal to the wavelength, the corresponding Bragg angle is :

(A) $\dfrac{\pi}{6}$

(B) $\dfrac{\pi}{4}$

(C) $\dfrac{\pi}{3}$

(D) $\dfrac{\pi}{8}$

36. The mean free path of fast neutrons in lead is about 5.0 cm. Find the total neutron cross-section of lead (atomic mass number ~ 200, density ~ 10 gm/cm^3).

(A) 6.6×10^{-24} cm^2

(B) 3.7×10^{-22} cm^2

(C) 1.3×10^{-20} cm^2

(D) 0.6×10^{-18} cm^2

37. H_α line is due to the transition :

(A) from $n = 3$ state to $n = 2$ state of H-atom

(B) from $n = 3$ state to $n = 2$ state of helium atom

(C) from $n = 2$ state to $n = 1$ state of H-atom

(D) from $n = 2$ state to $n = 1$ state of helium atom

38. Which of the following properties is related to metallic crystals ?

(A) Due to symmetrical arrangements of the negative ions in a space lattice, metals are crystalline.

(B) Melting points of metallic crystals are lower than those of the electrovalent crystals.

(C) Metallic crystals have low thermal conductivity.

(D) Metallic crystals are not opaque to light.

39. If an electron remains in an excited state for 10^{-8} s, the uncertainty in the energy of that state would be of the order of :

(A) 1.3×10^{-3} eV

(B) 5.6×10^{-4} eV

(C) 6.9×10^{-6} eV

(D) 3.3×10^{-8} eV

40. The experimental results from Bragg's method have shown that if X-rays from a palladium anticathode are used, the first order reflection maxima occurred at 5.9°, 8.4° and 5.2° for (100), (110) and (111) planes, respectively. Find the ratio of the interplanar spacing of the respective planes.

(A) $1 : \dfrac{1}{\sqrt{2}} : \dfrac{2}{\sqrt{3}}$

(B) $\dfrac{1}{\sqrt{2}} : \dfrac{1}{\sqrt{3}} : \dfrac{1}{\sqrt{5}}$

(C) $1 : \dfrac{1}{\sqrt{3}} : \dfrac{1}{\sqrt{5}}$

(D) $1 : \dfrac{1}{2} : \dfrac{1}{3}$

41. Some of the factors on which the choice of conducting materials depends, are given below :

(i) Resistance against corrosion

(ii) Temperature coefficient of resistance

(iii) Flexibility and abundance

(iv) Resistivity to chemicals and weathers

(v) Oxidation characteristics
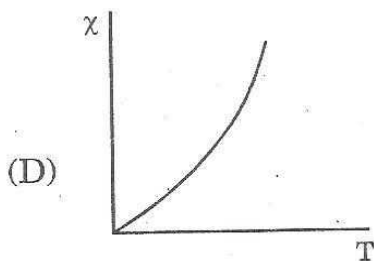
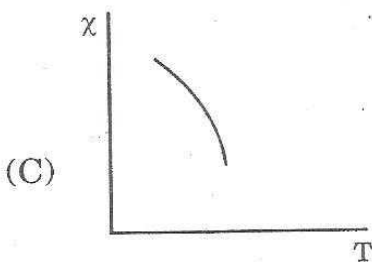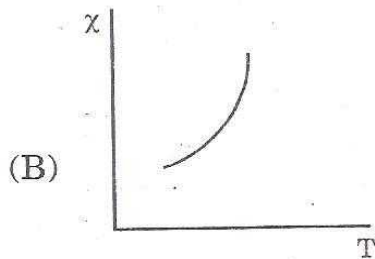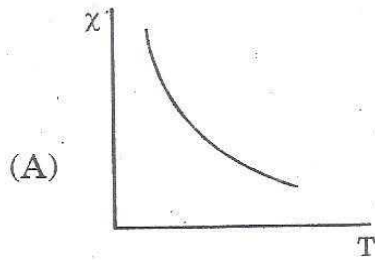Choose the *correct* answer from the following :

(A) all are correct

(B) only (i), (ii) and (iii) are correct

(C) only (iii), (iv) and (v) are correct

(D) only (v) is correct

42. Which of the following graphs represents the variation of magnetic susceptibility (χ) with temperature (T) for a ferromagnetic substance ?

(A)

(B)

(C)

(D)

43. A fibre-optic link is operated at a wavelength of 1.3 μm. Find the maximum bit-rate of a 25 km line made from a multimodal step-index fibre. Given, $n_1 = 1.47$ and $n_2 = 1.46$.

(A) 1.5×10^{-6}

(B) 3.2×10^{-5}

(C) 4.9×10^{-4}

(D) 6.3×10^{-3}

44. If $\hat{a}$ and $\hat{b}$ are two unit vectors and θ is the angle between them, find the value of θ such that $\hat{a} + \hat{b}$ is also a unit vector :

(A) $\dfrac{\pi}{2}$

(B) $\dfrac{\pi}{3}$

(C) $\dfrac{\pi}{4}$

(D) $\dfrac{\pi}{6}$

45. Round off the number 754126 to four significant figures, then find the percentage error :

   (A) 3.45×10^{-3}

   (B) 1.29×10^{-4}

   (C) 2.35×10^{-5}

   (D) 5.69×10^{-6}

46. Using the recurrence relation for Legendre polynomials, $(2n + 1)P_n = P'_{n+1} - P'_{n-1}$ [$P'_1 = P_0 = 1$ and $P'_0 = 0$], find the value of the sum, $P_0 + 3P_1 + 5P_2 + \dots\dots + (2n + 1)P_n$.

   (A) $P'_{n+1} - P'_n$

   (B) $P'_n - P'_{n-1}$

   (C) $P'_{n+1} + P'_n$

   (D) $P'_n + P'_{n-1}$

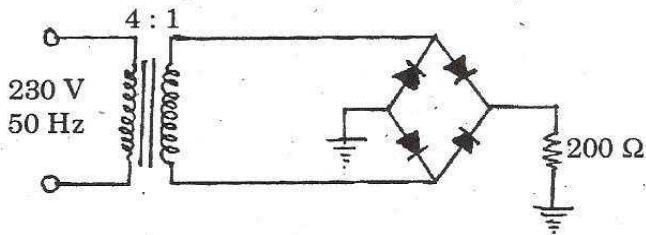47. Which of the following graphs represents the spherical Bessel function of order zero ?

   (A)

   (B)

   (C)

   (D)
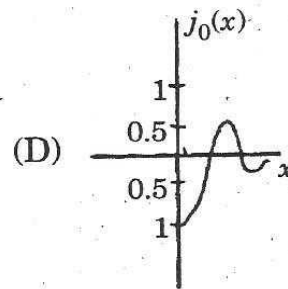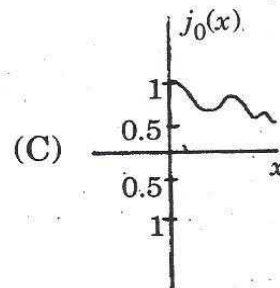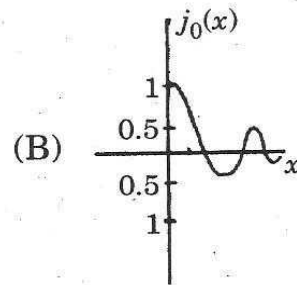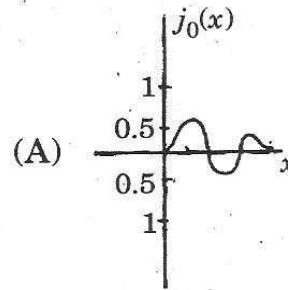
48. Which of the following set of vectors does *not* form a basis for R^3 ?

(A) (1, 0, 0), (1, 1, 0), (1, 1, 1)

(B) (1, 1, 2), (1, 2, 5), (5, 3, 4)

(C) (2, 1, 4), (1, –1, 2), (3, 1, –2)

(D) None of the above

49. In the bridge type circuit, as shown, the diodes are assumed to be ideal. Find the d.c. output voltage :

(A) 24 V

(B) 36 V

(C) 44 V

(D) 52 V

50. Find V_{CB} in the silicon transistor circuit, as shown (Take, $\beta = 150$) :
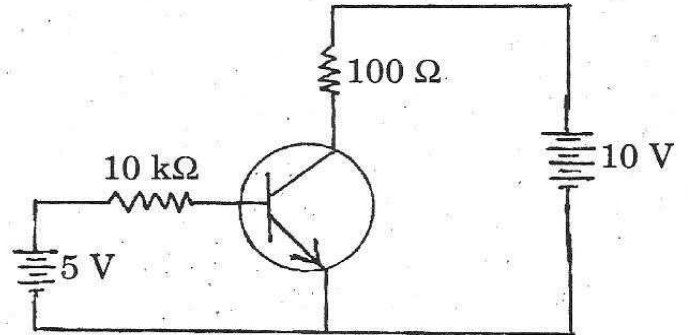
(A) 1.37 V

(B) 2.85 V

(C) 3.96 V

(D) 4.59 V

51. How would you detect 500 MeV γ-rays with :

(A) Proportional counter

(B) Hydrogen bubble chamber

(C) Shower counter (BGO)

(D) Geiger counter

52. Which specific interface parameter of pure liquids is given by the rate of change of surface tension with temperature at constant pressure ?

(A) Gibbs function

(B) Helmholtz function

(C) Entropy

(D) Enthalpy

53. Estimate the magnetic energy for an electron in the $2p$ state of a hydrogen atom :

(A) 1.9×10^{-20} J

(B) 2.4×10^{-22} J

(C) 3.7×10^{-24} J

(D) 9.1×10^{-17} J

54. The spectra that arise from transitions between the molecular rotational states are in the :

(A) infrared region

(B) visible region

(C) ultraviolet region

(D) microwave region

55. Identify the Yukawa potential in the following :

(A) $V(r) = -V_0 e^{-r^2/r_0^2}$

(B) $V(r) = -V_0$ for $r \le r_0$, and 0 otherwise

(C) $V(r) = -V_0 \dfrac{e^{-r/r_0}}{r/r_0}$

(D) $V(r) = -V_0 e^{-r/r_0}$

56. If $\vec{S_p}$ and $\vec{S_n}$ are the spins of proton and neutron, respectively, then the eigen value of $(\vec{S_n} \cdot \vec{S_p})$ for the triplet state is :

(A) $\dfrac{1}{4}$

(B) $\dfrac{3}{4}$

(C) $-\dfrac{1}{4}$

(D) $-\dfrac{3}{4}$

57. Nordheim's rules are used to predict the ground state spins of :

(A) even-even nuclei

(B) odd-odd nuclei

(C) odd-even nuclei

(D) neutron/proton rich nuclei

58. The commutator of two Hermitian operators is a :

(A) Hermitian operator

(B) Skew-Hermitian operator

(C) Null operator

(D) Projection operator

59. The eigen values of an anti-Hermitian operator are :

(A) real

(B) zero

(C) purely imaginary

(D) either purely imaginary or equal to zero

60. Find the value of the following integral :

$$\int_1^6 (x^2 - 3x + 1)\, \delta[2(x-3)]\, dx$$

(A) zero

(B) 3

(C) $\dfrac{1}{2}$

(D) $\dfrac{3}{2}$

61. A particle of mass m moves in a vertical plane along a given curve in a gravitational field. The equations of motion in parametric form are :

$$x = x(s) \text{ and } z = z(s).$$

Find the Lagrange's equation of motion :

(A) $\dfrac{d}{dt}\left[m\left(x'^2 + z'^2\right)\dot{s}\right] -$

$\qquad m\dot{s}^2\left(x'x'' + z'z''\right)mgz' = 0$

(B) $m\left(x'^2 + z'^2\right)\ddot{s} + m\dot{s}\left(x' + z'\right) -$

$\qquad mgz = 0$

(C) $\dfrac{d}{dt}\left[m\left(x'^2 + z'^2\right)\ddot{s}\right] +$

$\qquad m\ddot{s}\left(x'' + z''\right)mgz'' = 0$

(D) $m\left(x' + z'\right)\dot{s} + \left(x + z\right) +$

$\qquad mgz' = 0$

62. The Hamiltonian,

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

leads to the following equation :

(A) $\ddot{x} + r\dot{x} + \omega^2 x = 0$

(B) $\ddot{x} - r\dot{x} - \omega^2 x = 0$

(C) $\ddot{x} + r\dot{x}^2 - \omega^2 x = 0$

(D) $\ddot{x} - r\dot{x} + \omega^2 x = 0$

63. A particle describes a circular path under the influence of an attractive central force directed towards a point O on the circle. The magnitude of the force is inversely proportional to (Take r as the distance of the particle from O)

(A) r

(B) r^3

(C) r^5

(D) r^7

64. If the plane of oscillation of Foucault's pendulum rotates by an angle of $\theta°$ in one hour, then the value of θ in terms of the latitude (φ) of the place is given by :

(A) $15° \sin \varphi$

(B) $15° \cos \varphi$

(C) $5° \sin \varphi$

(D) $5° \cos \varphi$

65. A spaceship moving away from the earth with velocity 0.5c fires a rocket whose velocity relative to the spaceship is 0.5c away from the earth. Find the velocity of the rocket as observed from the earth.

(A) zero

(B) 0.5c

(C) 0.7c

(D) 0.8c

66. Which of the following motions is connected with a saddle point ?

(A) oscillatory

(B) aperiodic

(C) damped oscillatory

(D) non-oscillatory

67. If a charge distribution has the charge density given by :

$$\rho = q\{\delta(x - 3) - \delta(x + 3)\},$$

find the electric field at (6, 0, 0) :

(A) $\dfrac{q}{72\pi\varepsilon_0}\hat{x}$

(B) $\dfrac{q}{36\pi\varepsilon_0}\hat{x}$

(C) $\dfrac{3q}{8\pi\varepsilon_0}\hat{x}$

(D) $\dfrac{2q}{9\pi\varepsilon_0}\hat{x}$

68. A proton of energy 1.0 MeV is constrained to move in a circular orbit of radius 100 mm under the action of the magnetic field. The required magnetic field is :

(A) 5.2 T

(B) 2.9 T

(C) 3.6 T

(D) 1.4 T

69. Which of the following forces is (are) conservative ?

(i) $\vec{F} = e^{-r^2/R^2}\hat{r}$

(ii) $\vec{F} = \left(x^3\hat{y} - y^3\hat{z}\right)$

(iii) $\vec{F} = \left(x^3\hat{x} + y^3\hat{y}\right)$

(iv) $\hat{\varphi}/r$

(A) only (iii) and (iv)

(B) only (ii)

(C) only (i)

(D) only (i) and (iii)

70. The range of the potential between two hydrogen atoms is ~4 Å. For a gas in thermal equilibrium, estimate the temperature below which the atom-atom scattering is essentially s-wave :

(A) 6.3 K

(B) 4.1 K

(C) 1.0 K

(D) 0.6 K

71. An atom is capable of existing in two states : a ground state of mass M and an excited state of mass M + Δ. If the transition from ground to excited state proceeds by the absorption of a photon, what must be the photon frequency in the laboratory where the atom is initially at rest ?

(A) $\dfrac{\Delta c^2}{h}\left(1 + \dfrac{\Delta}{2M}\right)$

(B) $\dfrac{\Delta c^2}{h}\left(1 - \dfrac{\Delta}{2M}\right)$

(C) $\dfrac{\Delta c^2}{h}\left(1 + \dfrac{2M}{\Delta}\right)$

(D) $\dfrac{\Delta c^2}{h}\left(1 - \dfrac{2M}{\Delta}\right)$

72. Estimate the Doppler width of an emission line of wavelength 5000 Å emitted by Argon (A = 40; Z = 18) at 300 K :

(A) 8.44×10^{-5} Å

(B) 3.44×10^{-3} Å

(C) 1.44×10^{-2} Å

(D) 5.41×10^{-1} Å

73. In radio astronomy, hydrogen atoms are observed in which radiative transitions occur from $n = 109$ to $n = 108$. Find the wavelength of the radiation emitted in this transition.

(A) 1.3 cm

(B) 2.2 cm

(C) 3.9 cm

(D) 5.8 cm

74. To penetrate the Coulomb barrier of a light nucleus, a proton must have a minimum energy of the order of :

(A) 1.0 GeV

(B) 1.0 MeV

(C) 1.0 KeV

(D) 1.0 eV

75. Neutrons of kinetic energy 1000 eV are incident on a target composed of carbon. If the inelastic cross section is 400×10^{-24} cm^2, find the maximum value of the elastic cross section.

(A) 0.9×10^{-13} cm^2

(B) 1.3×10^{-17} cm^2

(C) 3.2×10^{-19} cm^2

(D) 1.9×10^{-21} cm^2

76. Using the nuclear shell model, predict the ground state spin and parity of $^{13}_{7}$N nucleus.

(A) $\frac{1}{2}+$

(B) $\frac{3}{2}+$

(C) $\frac{1}{2}-$

(D) $\frac{3}{2}-$

77. Which of the following reactions is allowed ?

(A) $\mu^+ \rightarrow e^+ + \gamma$

(B) $p + p \rightarrow p + \Sigma^+ + K^-$

(C) $p \rightarrow e^+ + \nu_e$

(D) $\pi^+ \rightarrow \mu^+ + \nu_\mu$

78. The quark structure of Δ^+ is :

(A) uud

(B) duu

(C) uuu

(D) sdd

79. A muon at rest lives 10^{-6} s and its rest mass is 100 MeV/c^2. How energetic must a muon be to reach the earth's surface if it is produced high in the atmosphere (say ~10^4 m up) ?

(A) 3.3 GeV

(B) 1.5 GeV

(C) 0.7 GeV

(D) 0.05 GeV

80. Find the threshold energy (kinetic energy) for a proton beam to initiate the reaction, $p + p \rightarrow \pi^0 + p + p$, with a stationary target.

(A) 1.2 GeV

(B) 930 MeV

(C) 620 MeV

(D) 280 MeV

81. Which raja of Nurpur princely state built the Taragarh fort within the territory of Chamba princely state ?

(A) Prithvi Singh

(B) Rajrup Singh

(C) Jagat Singh

(D) Udai Singh

82. Which lake is the source of Bhaga river ?

(A) Chandratal

(B) Surajtal

(C) Una-so

(D) Nako

83. In which district of H.P. is Kiarda dun valley ?

(A) Chamba

(B) Solan

(C) Mandi

(D) Sirmaur

84. Which commission was set up by the H.P. Government in 2011 to look into the benami land deals in the state ?

(A) D.P. Sood Commission

(B) Bhawani Singh Commission

(C) L.S. Panta Commission

(D) V.K. Sharma Commission

85. With which region of H.P. is Jad tribe mainly associated ?

(A) Pangi

(B) Kinnaur

(C) Lahaul

(D) Spiti

86. Which of the following Himachali was a member of the Constituent Assembly of India ?

(A) Bakshi Tek Chand

(B) Sarla Sharma

(C) N.C. Mehta

(D) Chandresh Kumari

87. At which place in Lahul-Spiti District of H.P. there is a Yak breeding farm ?

(A) Lari

(B) Trilokinath

(C) Udaipur

(D) Kunjam

88. In what ratio is the cost of H.P. Himalayan watershed project is shared between the world bank and the state government ?

(A) 90 : 10

(B) 80 : 20

(C) 75 : 25

(D) 50 : 50

89. Which of the following is *not* covered in H.P. under the restricted weather based crop insurance scheme ?

(A) Ginger

(B) Tomato

(C) Mushroom

(D) Potato

90. At which place in Mandi District of H.P. a Government ITI has been made functional during 2016-17 ?

(A) Mohin

(B) Kotrupi

(C) Jiyani

(D) Chhatri

91. What name is given to the deliberations and programmes organised by the followers of Gurmeet Ram Rahim Singh's Sacha Sauda ?

(A) Naam Charcha

(B) Kaam Charcha

(C) Dhaam Charcha

(D) Dhyan Charcha

92. When was Goods and Services Tax (GST) launched by the Government of India ?

(A) April 01

(B) May 01

(C) July 01

(D) August 01

93. How many new cities have been added to the Smart Cities Mission of Government of India in June 2017 ?

(A) 15

(B) 20

(C) 25

(D) 30

94. Which of the following Indian state has the longest border with Bangladesh ?

(A) West Bengal

(B) Meghalaya

(C) Mizoram

(D) Asom

95. Which Indian cricketer was the leading run scores in ICC Women World Cup match against Australia at Bristol in July 2017 ?

(A) Mithali Raj

(B) Sushma Verma

(C) Harman Preet Kaur

(D) Sudha Singh

96. In which state of the U.S. is Charlottesville which witnessed white supremacist violence in August 2017 ?

(A) Kansas

(B) Illionis

(C) Virginia

(D) Arkansas

97. How many pro-democracy activists in Hong Kong were sentenced to varying terms of Jail around August 2017 for demanding democratic reforms ?

(A) Three

(B) Nine

(C) Twelve

(D) Eighteen

98. Who is the Prime Minister of Iraq (Aug. 2017) ?

(A) Haider al-Abadi

(B) Farzaneh Sharafbani

(C) Hussein Fereidoun

(D) Hassan Rauhani

99. Which of the following is *not* a member of forum for economic cooperation called G-20 ?

(A) Canada

(B) Australia

(C) New Zealand

(D) Saudi Arabia

100. To which country does Garbine Muguruza, who won the 2017 women's single tennis final at Wimbledon Championship, belong ?

(A) Slovakia

(B) Spain

(C) Britain

(D) Croatia