PHYSICAL SCIENCES
Paper – II

1. What is the directional derivative of the function $\phi = x^2 - y^2 + 2z^2$ at the point P(1, 2, 3) in the direction of the line PQ, where Q is the point (5, 0, 4) ?

(A) $-28/\sqrt{21}$ (B) $28/\sqrt{21}$

(C) $\sqrt{21}/28$ (D) $-\sqrt{21}/28$

2. If $\vec{F}$ is a conservative force field, then the value of curl $\vec{F}$ is

(A) 0 (B) 1 (C) $\vec{\nabla}\vec{F}$ (D) –1

3. A matrix is given by $M = \frac{1}{\sqrt{2}}\begin{pmatrix} i & 1 \\ 1 & i \end{pmatrix}$. The eigenvalues of the matrix M are

(A) Real and positive (B) Purely imaginary with modulus 1

(C) Complex with modulus 1 (D) Real and negative

4. If $g_{\mu\upsilon}$ is covariant fundamental tensor of rank 2 and $g^{\upsilon\sigma}$ is the contravariant fundamental tensor of rank 2, then their product $g_{\mu\upsilon}\, g^{\upsilon\sigma}$ is

(A) contravariant tensor of rank 4

(B) covariant tensor of rank 4

(C) zero

(D) δ_{μ}^{σ}

5. Consider the Bessel's equation ($\upsilon = 0$), $\frac{d^2y}{dz^2} + \frac{1}{z}\frac{dy}{dz} + y = 0$.

Which one of the following statements is correct ?

(A) Equation has regular singular points at z = 0 and z = ∞.

(B) Equation has two linearly independent solutions that are entire.

(C) Equation has an entire solution and a second linearly independent solution singular at z = 0.

(D) Limit z → ∞ taken along x-axis exists for both the linearly independent solutions.

6. The generating function $F(x, t) = \sum_{n=0}^{\infty} P_n(x)t^n$ for the Legendre Polynomials $P_n(x)$ is $F(x, t) = (1 - 2xt + t^2)^{½}$. The value of $P_3(-1)$ is

(A) 5/2

(B) 3/2

(C) +1

(D) –1

7. The residue of $\frac{z}{(z-a)(z-b)}$ at infinity is

(A) –1

(B) +1

(C) –i

(D) +i

8. For the Fourier series of the following function of period 2π

$$f(x) = \begin{cases} 0 & -\pi < x < 0 \\ 1 & 0 < x < \pi \end{cases}$$

The ratio (to the nearest integer) of the Fourier coefficients of the first and the third harmonic is

(A) 1

(B) 2

(C) 3

(D) 6

9. The Fourier transform $F[\delta(x - a)] = \exp(-2\pi i a \upsilon)$ will correspond to

(A) $\delta(x - a) - \delta(x + a)$

(B) a constant

(C) $\frac{1}{2}[\delta(x - a) + i\,\delta(x + a)]$

(D) $\frac{1}{2}[\delta(x - a) + \delta(x + a)]$

10. The inverse transformation of $e^{-\sqrt{s}}$ is

(A) $\frac{1}{2\sqrt{\pi}} \frac{e^{-1/4t}}{t^{3/2}}$

(B) $\frac{1}{\sqrt{\pi}} \frac{t^{3/2}}{e^{-1/4t}}$

(C) $-{}^{1}\!/_{4t} \big/ t^{3/2}$

(D) $t^{3/2}/e^{-1/4t}$

11. Bessel's function $J_{1/2}$ is given by

(A) $\sqrt{\frac{2\pi}{x}}\sin x$

(B) $\sqrt{\frac{2\pi}{x}}\cos x$

(C) $\sqrt{\frac{x}{2\pi}}\cos x$

(D) $\sqrt{\frac{2}{\pi x}}\sin x$

12. The local truncation error in Heun's method is of the order of

(A) h^2

(B) h^3

(C) h^4

(D) h^5

13. **Assertion (A)** : Newton's first law of motion is a special case of the Newton's second law of motion.

Reason (R) : The state of rest can be considered as a special case of state of uniform motion when $\vec{V} = 0$.

(A) Assertion (A) is true, but Reason (R) is false

(B) Assertion (A) is false, but Reason (R) is true

(C) Both Assertion (A) and Reason (R) are true; and Reason (R) is correct explanation of Assertion (A)

(D) Both Assertion (A) and Reason (R) are true; but Reason (R) is not correct explanation of Assertion (A)

14. Newton's first law of motion introduces the concept of

i. State of rest

ii. Force

iii. Inertia.

Choose correct option from the following.

(A) Only (i) is true

(B) Only (ii) is true

(C) Only (ii) and (iii) are true

(D) (i), (ii) and (iii) are true

15. Choose the appropriate example for the forces.

a. $\vec{F} = m\vec{a}$
   a = constant

b. $\vec{F} = \vec{F}(\bar{r})$

c. $\vec{F} = \vec{F}(t)$

d. $\vec{F} = \vec{F}(\vec{r})$

i. The frictional force experienced by a particle moving in a viscous medium

ii. The force experienced by a particle due to earth's gravity, near the surface of earth

iii. The force experienced by a charged particle in an alternating field

iv. The force experienced by a particle performing linear simple harmonic motion

	a	b	c	d
(A)	ii	iv	iii	i
(B)	i	iii	iv	ii
(C)	iii	iv	i	ii
(D)	iv	i	ii	iii

16. If a particle of mass m moving under a conservative force oscillates between x_1 and x_2, the period of oscillation is
(Here v(x) is the potential energy.)

(A) $T = \int_{x_1}^{x_2} \left[\frac{2}{v(x_2) - v(x_1)}\right] dx$

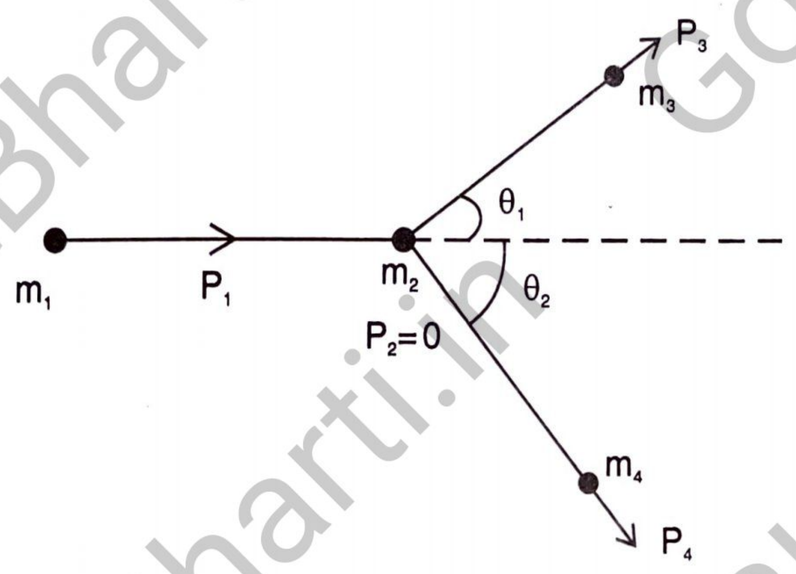
(B) $T = \int_{x_1}^{x_2} \left[\frac{v(x_2) - v(x_1)}{2}\right] dx$

(C) $T = \int_{x_1}^{x_2} \left[\frac{v(x_2) - v(x_1)}{2m}\right]^{1/2} dx$

(D) $T = \int_{x_1}^{x_2} \left[\frac{m}{2\{v(x_2) - v(x_1)\}}\right]^{1/2} dx$

17. In the case of inelastic collisions, a particle of mass m_1 collides with a particle of mass m_2 initially at rest. After collision, these particles fly apart as different particles of masses m_3 and m_4, respectively (see figure).

The amount of kinetic energy absorbed or released in this process is



(A) $Q = \dfrac{P_1^2}{2m_1} - \dfrac{P_3^2}{2m_3} - \dfrac{P_4^2}{2m_4}$

(B) $Q = \dfrac{P_1^2}{2m_1} + \dfrac{P_3^2}{2m_3} + \dfrac{P_4^2}{2m_4}$

(C) $Q = \left(\dfrac{P_1}{2m_1}\right)^2 - \left(\dfrac{P_3}{2m_3} + \dfrac{P_4}{2m_4}\right)^2$

(D) $Q = \left(\dfrac{P_1}{2m_1}\right)^2 + \left(\dfrac{P_3}{2m_3} + \dfrac{P_4}{2m_4}\right)^2$

18. When $\dfrac{v}{c} < \dfrac{1}{10}$, the classical expressions for kinetic energy and linear momentum may be used with an error of

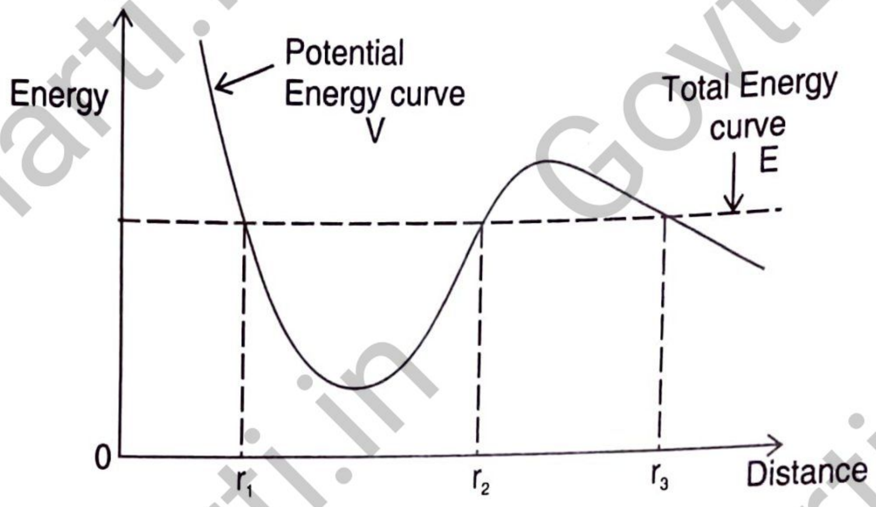
(A) 10%

(B) zero

(C) 0.1%

(D) less than 1%

19. The energy curve for the motion of a particle in an arbitrary potential field is shown in the following figure. Choose the correct statement.



(A) The motion of the particle is bounded for the region $r < r_1$.

(B) The motion of the particle is bounded for the region $r_1 \leq r \leq r_2$.

(C) The motion of the particle is bounded for the region $r_2 < r < r_3$.

(D) The motion of the particle is bounded for the region $r \geq r_3$.

20. Consider a system of light strings stretched with force F having n equal masses m placed along it with equal spacing of interval l. For small transverse oscillations of the particles,

i. The slowest mode is the one in which all particles are oscillating in the same direction.

ii. The fastest mode has the adjacent particles oscillating in opposite directions.

(A) Only (i) is true

(B) Only (ii) is true

(C) Both (i) and (ii) are true

(D) None of the above

21. The Jacobi identity is

(A) $[u, [v, w]] + [v, [w, u]] + [w, [u, v]] = 0$

(B) $[u, [v, w]] + [v, [w, u]] + [w, [u, v]] \neq 0$

(C) $[u, [w, v]] + [v, [w, u]] + [w, [u, v]] = 0$

(D) $[u, [w, v]] + [v, [w, u]] + [w, [v, u]] = 0$

22. The Hamiltonian's canonical equations of motion in terms of Poisson Brackets are

(A) $\dot{q} = [H, p], \dot{p} = [H, q]$

(B) $\dot{q} = [p, H], \dot{p} = [q, H]$

(C) $\dot{q} = [H, q], \dot{p} = [H, p]$

(D) $\dot{q} = [q, H], \dot{p} = [p, H]$

23. The state of the system in classical mechanics can be obtained if

(A) Position x(t) at time t is known

(B) Velocity v(t) at time t is known

(C) Both position x(t) and velocity v(t) at time t are known

(D) Any of position x(t) and velocity v(t) at time t is known

24. If the wavelength of an electromagnetic wave is 1 nm, then the frequency of the electromagnetic wave is

(A) 3×10^{17} Hz

(B) 3×10^{16} Hz

(C) 1.5×10^{16} Hz

(D) 1.5×10^{17} Hz

25. How much is the inductance of a coil that induces 10 volt when its current changes at a rate of 4 Ampere per second ?

(A) 0.1 H

(B) 40 H

(C) 4 mH

(D) 2.5 H

26. Which of the following is not electromagnetic wave ?

(A) Radiowaves

(B) X-rays

(C) Infrared waves

(D) Ultrasound waves

27. A plane electromagnetic wave passes from air ($n_1 = 1.0$) into water ($n_2 = 1.33$). If absorption by water is negligible, then its reflectivity will be

(A) 3.3%

(B) 2.0%

(C) 2.33%

(D) 5.43%

28. The characteristic impedance of a transmission line is expressed as

(A) $\sqrt{\left(\frac{R+j\omega L}{G+j\omega C}\right)}$

(B) $\sqrt{\left(\frac{G+j\omega C}{R+j\omega L}\right)}$

(C) $\sqrt{\left(\frac{R+j\omega C}{G+j\omega L}\right)}$

(D) $\sqrt{\left(\frac{G+j\omega L}{R+j\omega C}\right)}$

29. The magnetic field at the center of a circular loop with radius (R), which carries a steady current (I) is given as

(A) $\frac{\mu_0 I}{R}$

(B) $\frac{\mu_0 I}{4R}$

(C) $\frac{\mu_0 I}{2R}$

(D) $\frac{\mu_0 I}{\pi R}$

30. The electrostatic pressure just outside a conductor surface is expressed as

(A) $P = \varepsilon_0 E^2$

(B) $P = \frac{\varepsilon_0}{2} E^2$

(C) $P = \varepsilon_0 E$

(D) $P = \frac{E}{\varepsilon_0}$

31. Poynting vector is expressed as

(A) $\vec{S} = \vec{E} \times \vec{B}$

(B) $\vec{S} = \varepsilon_0 (\vec{E} \times \vec{B})$

(C) $\vec{S} = \mu_0 (\vec{E} \times \vec{B})$

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

32. When a charge particle (with 3×10^{-19} Coulomb charge and 3×10^{8} m/s velocity) enters perpendicular to magnetic field of 1 Tesla, then the magnetic force will be

(A) 9×10^{11} Newton

(B) 1×10^{27} Newton

(C) 9×10^{-11} Newton

(D) 3×10^{-11} Newton

33. If in an electromagnetic wave $\vec{E}$ and $\vec{B}$ are in phase and mutually perpendicular, then their (real) amplitude are related as

(A) $\vec{B}_0 = \frac{1}{c} \vec{E}_0$

(B) $\vec{B}_0 = c \vec{E}_0$

(C) $\vec{B}_0 = c^2 \vec{E}_0$

(D) $\vec{B}_0 = \frac{1}{c^2} \vec{E}_0$

34. If a charged particle (with charge = q) is accelerated with a voltage (V) enters perpendicular to the magnetic field (B), then the radius of the circular path of the charged particle is

(A) $r = \frac{1}{B} \sqrt{\frac{2mV}{q}}$

(B) $r = \frac{1}{B} \sqrt{\frac{2mq}{V}}$

(C) $r = B \sqrt{\frac{2mV}{q}}$

(D) $r = B \sqrt{\frac{2mq}{V}}$

35. In SI system, the unit of angular momentum is

(A) J.s
(B) J/s
(C) J
(D) W

36. For Ladder operator

i. $[a, a^\dagger] = 0$
ii. $[a, a^\dagger] = 1$
iii. $[a^\dagger a, a^\dagger] = a^\dagger$
iv. $[a^\dagger a, a] = -a$

Choose the correct statement.

(A) Only i and ii are true
(B) Only ii and iii are true
(C) Only iii and iv are true
(D) Only ii, iii and iv are true

37. For a hydrogen atom, 1s state wave function is given by

$\psi_{1s} = N \exp\left(-\frac{r}{a_0}\right)$.

The value of N is

(A) $\sqrt{\frac{x}{a_0^3}}$
(B) $\frac{1}{\sqrt{\pi a_0^3}}$
(C) π
(D) 1

38. The Raising and Lowering operators for simple harmonic oscillators are

(A) Hermitian
(B) Commutative
(C) Non-commutative
(D) Inverse

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39. If $\propto$ is the Dirac matrices, then $\sigma_x \sigma_y =$

(A) Σ^2

(B) Σ_x

(C) $i\,\Sigma_z$

(D) $i\,\Sigma_{xy}$

40. The spin (s) of the Dirac particle is

(A) $s = \frac{1}{2}$

(B) $s = \frac{1}{2}\hbar$

(C) $s = \hbar\Sigma$

(D) $s = \frac{1}{2}\hbar\Sigma$

41. Which of the following equation is known as Klein-Gorden equation ?

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

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

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

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

42. _______ perturbation theory is used to represent v and w of perturbed Hamiltonian in terms of unperturbed eigenfunctions u_m and eigenvalues E_m.

(A) Schrodinger

(B) Schrodinger-Dirac

(C) Klein-Gorden

(D) Rayleigh-Schrodinger

43. If $\vec{L}$ is the angular momentum given by $\vec{L} = L_x\hat{i} + L_y\hat{j} + L_z\hat{k}$, the value of $\vec{L}\times\vec{L}$ is

(A) $i\hbar L$

(B) $i\hbar L_z$

(C) L_z

(D) Zero

44. If five non-interacting fermions have to be adjusted in first excited state of 1D-harmonic oscillator of angular frequency ω, then the total energy of the system is

(A) $\frac{5\hbar\omega}{2}$

(B) $\frac{11\hbar\omega}{2}$

(C) $\frac{15\hbar\omega}{2}$

(D) $\frac{10\hbar\omega}{2}$

45. Every matrix representative of a component J which satisfies relation $J \times J = iJ$ have

(A) zero trace

(B) non-zero trace

(C) non-zero, but positive trace

(D) unit trace

46. A system consists of 10^{24} atoms and is at a temperature of 300 K. Assuming that there is no interatomic energy in the system, its total internal energy is

(A) 12.4 J

(B) 12.4 kJ

(C) 4.12 kJ

(D) 4.12 J

47. A heat pump working on Carnot cycle maintains the inside temperature of a house at 22°C by supplying 450 kJ/s. If the outside temperature is 0°C, the heat taken in kJ/s from the outside air is approximately

(A) 487

(B) 417

(C) 470

(D) 467

48. An oil bath kept at 27°C is being supplied heat at the rate of 100 JS^{-1}. Assuming the process to be quasi-static, the rate of increase of entropy of the system is approximately

(A) 0.33 $JK^{-1}S^{-1}$

(B) 0.33 $JK^{-1}S^{-2}$

(C) 3.7 $JK^{-1}S^{-2}$

(D) 3.7 $JK^{-1}S^{-1}$

49. For an energy state E of a photon gas, the density of state is proportional to

(A) E

(B) E^2

(C) $\sqrt{E}$

(D) $E^{3/2}$

50. At high temperature, entropy of spin half system is equal to

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

(B) 2NK

(C) NK

(D) $NK\ln 2$

51. Which statistics would be appropriate for the description of density of electrons and holes in semiconducting Ge at room temperature (Ge bandgap ≈ 1 eV) ?

(A) Classical Maxwell-Boltzmann statistics

(B) Fermi-Dirac statistics

(C) Bose-Einstein statistics

(D) It can be described by both Fermi-Dirac statistics and Bose-Einstein statistics

52. A white-dwarf star is thought to constitute a degenerate gas system at a uniform temperature much below the Fermi temperature. This system is stable against gravitational collapse so long as the electrons are

(A) Relativistic

(B) Non-relativistic

(C) Relativistic as well as Non-relativistic

(D) Independent of velocity

53. Value of fugacity, z of boson gas can take any value

(A) between 0 and 1

(B) above 1

(C) below zero

(D) between 0 and ∞

54. The ground state energy E_0 of the system in terms of the Fermi energy E_F and the number of electrons N is given by

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

(B) $\frac{5}{3}NE_F$

(C) $\frac{3}{5}NE_F$

(D) $\frac{1}{3}NE_F$

55. Consider a photon gas enclosed in a volume V and in equilibrium at temperature T. How the number of photons in the volume depends upon the temperature ?

(A) T^3

(B) T^2

(C) T

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

56. A one dimensional quantum harmonic oscillator (whose ground state energy is $\hbar\omega/2$) is in thermal equilibrium with a heat bath at temperature T. What is the partition function ?

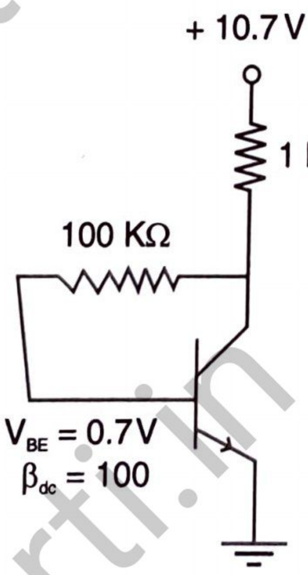
(A) $z = \sinh(\hbar\omega/2)$

(B) $z = 2/\sinh(\hbar\omega/2)$

(C) $z = \cosh(\hbar\omega/2)$

(D) $z = 2/\cosh(\hbar\omega/2)$

57. The collector current in the circuit given below is



(A) 5 mA

(B) 0.5 mA

(C) 1 mA

(D) 10 mA

58. Voltage gain and lower 3 dB cut-off frequency of a basic amplifier are 60 dB and 1.0 KHz respectively. If 10% negative feedback is introduced in the basic amplifier, then the lower 3 dB cut-off frequency of the negative feedback amplifier will be

(A) 60 Hz
(B) 11 Hz
(C) 1.1 KHz
(D) 9.9 Hz

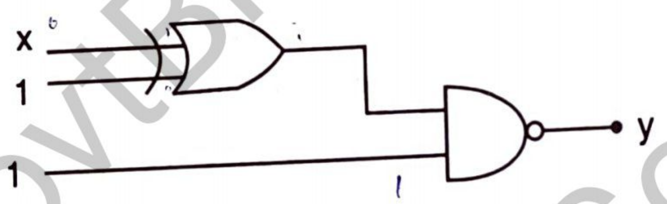
59. The number of minterms that can be generated by n variables is equal to

(A) n
(B) 2^{n-1}
(C) 2^n
(D) 2^{n+1}

60. Simplified expression for the Boolean function $F = B'C' + ABC + BC'$ is

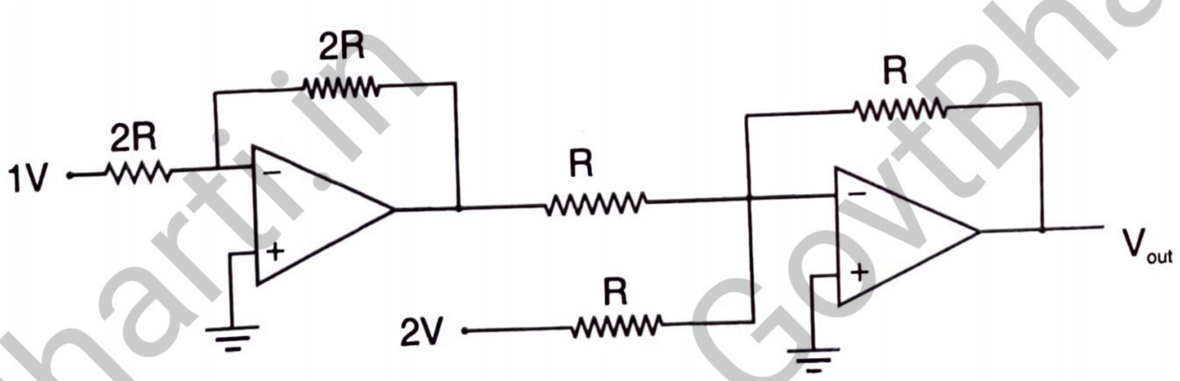
(A) $C + AB$
(B) $C' + AB$
(C) $C' + AB'$
(D) $C + A'B$

61. In the following circuit the output (y) is equal to



(A) x′
(B) x
(C) 0
(D) 1

62. The output voltage (V_{out}) in the network given below is



(A) 2V
(B) 3V
(C) –1V
(D) –2V

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63. How many Flip-Flops are required for the fabrication of a BCD ripple counter ?

(A) 1 (B) 2 (C) 3 (D) 4

64. Which type of sensor is used in metal detectors ?

(A) Inductive (B) Resistive
(C) Capacitive (D) Optical

65. Phase sensitive detector in lock-in-amplifier is also known as

(A) Voltage controlled oscillator (B) Amplifier
(C) Multiplier (D) Filter detector

66. In 8085 microprocessor the accumulator is a

(A) 9-bit register (B) 7-bit register
(C) 8-bit register (D) 6-bit register

67. If a RC network provide a phase shift of 45°, then how many such RC networks are required in the positive feedback section of phase shift oscillator ?

(A) 3 (B) 4
(C) 2 (D) 6

68. If the principal quantum number and the azimuthal quantum number in relativistic model of the atom are 3 and 1 respectively, then the magnitude of semi-minor axis b in terms of the semi-major axis a is given by

(A) $b = \frac{a}{3}$ (B) $b = \frac{2}{3}a$
(C) $b = \frac{a}{2}$ (D) $b = a$

69. For an atom in the state of $^2d_{5/2}$, the Lande g-factor should be

(A) 2 (B) 1.20
(C) 1.75 (D) 1.33

70. The spectral term for L = 2 and S = 1 is given by

(A) $^3d_3$

(B) $^3d_{5/2}$

(C) $^1d_{7/2}$

(D) $^2d_5$

71. The degeneracies of the s-states arising from the 3p term with spin orbital interaction are

(A) 1, 2, 3

(B) 3, 5, 7

(C) 2, 6, 10

(D) 1, 3, 5

72. The linear Stark-effect is possible in a hydrogen atom but not in a sodium atom because

(A) The principal quantum number for the ground state of the sodium atom is different from that of the hydrogen atom in the ground state

(B) The principal quantum number for the ground state of the sodium atom is same as that of the hydrogen atom in ground state

(C) The Azimuthal quantum number for the ground state of the sodium atom is same as that of the hydrogen in ground state

(D) (B) and (C) both are true

73. In the presence of a weak magnetic field, atomic hydrogen undergoes the transition $^2P_{1/2} \rightarrow {}^1S_{1/2}$, by emission of radiation. The spectral line corresponding to the transition

$$^2P_{1/2}\left(m_j = +\frac{1}{2}\right) \rightarrow {}^1S_{1/2}\left(m_j = -\frac{1}{2}\right)$$

is observed along the direction of the applied magnetic field. The emitted electromagnetic field is

(A) circularly polarized

(B) linearly polarized

(C) unpolarized

(D) not emitted along the magnetic field direction

74. In the microwave spectrum of identical rigid diatomic molecules, the separation between the spectral lines is recorded to be 0.7143 cm^{-1}. The moment of inertia of the molecule, in Kg-m^2 is

(A) 2.3×10^{-36}
(B) 2.3×10^{-40}
(C) 7.8×10^{-42}
(D) 7.8×10^{-46}

75. In a Raman scattering experiment, light of frequency υ from a laser is scattered by diatomic molecules having the moment of inertia I. The typical Raman shifted frequency depends on

(A) υ and I
(B) Only υ
(C) Only I
(D) Neither υ nor I

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

(A) 10 mm
(B) 8 cm
(C) 80 cm
(D) 10 m

77. The molecular spectra of two linear molecules O – C – O and O – C – S are recorded in the microwave region. Which of the following statement is correct ?

(A) Both the molecules would show absorption lines.
(B) Both the molecules would not show absorption lines.
(C) O – C – O would show absorption lines but not O – C – S.
(D) O – C – S would show absorption lines but not O – C – O.

78. The quantum numbers of two electrons in a two valence electron atoms are given in table

$n_1 = 6 \quad l_1 = 3 \quad s_1 = \frac{1}{2}$

$n_2 = 5 \quad l_2 = 1 \quad s_2 = \frac{1}{2}$

Assuming J-J coupling the possible values of J are

(A) 0, 1, 2, 3, 4
(B) 0, 2, 3, 4, 5
(C) 1, 2, 3, 4, 5
(D) 0, 1, 2, 5, 6

79. The potential energy of a diatomic molecule in terms of interatomic distance R is given by $U(R) = -\frac{A}{R^m} + \frac{B}{R^n}$

where A, B, m and n are constant characteristics for the MX-molecules. The potential energy U(R) is minimum at $R = R_e$ for

(A) $n < m$

(B) $n > m$

(C) $n = m$

(D) $n = 2m$

80. Concentration of Schottky imperfections in an ionic solid at a certain temperature T is given by

(Here E_p is the energy (in eV) required to remove an ion pair and other symbols have usual meaning.)

(A) $n = -N \exp\left(E_p/2KT\right)$

(B) $n = -N \exp\left(-E_p/2KT\right)$

(C) $n = N \exp\left(-E_p/2KT\right)$

(D) $n = \text{Exp}\left(-E_p/2KT\right)$

81. The energy of an edge dislocation is approximately given by

(A) $E \simeq lGb^2$

(B) $E \simeq \sqrt{lGb^2}$

(C) $E \simeq (1-\upsilon)/lGb^2$

(D) $E \simeq \frac{lGb^2}{1-\upsilon}$

82. The maximum allowed frequency $(\omega)_{max}$ for acoustic branch in a one dimensional diatomic lattice with force constant K is independent of lighter mass and given by

(A) 2K/M

(B) 2M/K

(C) $(2K/M)^{1/2}$

(D) $(2M/K)^{1/2}$

83. The first order Bragg's maximum of electron diffraction in a nickel crystal (d = 0.4086 Å) is found to occur at a glancing angle of 65°. What is the velocity of electrons ?

(A) 980.4×10^6 m/s

(B) 98.4×10^6 m/s

(C) 9.84×10^6 m/s

(D) 0.984×10^6 m/s

84. Using the tight binding model, energy-wave vector dispersion relation for a one dimensional crystal of lattice parameter 'a' is given by $E(\bar{K}) = E_o - \alpha - 2\beta \cos Ka$. What is the value of effective mass of electron m^* in terms of K ?

(A) $\hbar^2/2\alpha^2\beta \sin Ka$

(B) $\hbar^2/2\alpha\beta \sin Ka$

(C) $\hbar^2/2\alpha\beta \cos Ka$

(D) $\hbar^2/2\alpha^2\beta \cos Ka$

85. The Kronig-Penny potential with P << 1, the energy of the lowest band at K = 0 is

(A) $4\pi^2 ma/h^2P$

(B) $h^2P/4\pi^2 ma$

(C) $4\pi^2 mP/h^2a$

(D) $h^2a/4\pi^2 mP$

86. In a Hall effect experiment, a germanium crystal of length 0.2 cm, breadth 0.12 cm and thickness 0.22 cm is used. When a potential of 1.0 V is applied, a current of 2.5 mA flows along x-direction. When a magnetic field of 0.5 Tesla is applied along z-direction, a Hall voltage of 1.0 mV is found to develop. What is concentration of charge carriers ?

(A) $6.5 \times 10^{20}/m^3$

(B) $65 \times 10^{20}/m^3$

(C) $0.65 \times 10^{20}/m^3$

(D) $0.065 \times 10^{20}/m$

87. The critical magnetic field for aluminium is 7.9×10^3 A/m. What is the critical current which can flow through a long thin superconducting wire of aluminium of diameter 10^{-4} m ?

(A) 0.248A

(B) 20.48A

(C) 200.48A

(D) 2.48A

88. When a metal enters the superconducting state, it

(A) becomes ordered and its free energy decreases

(B) becomes ordered and its free energy increases

(C) becomes disordered and its free energy decreases

(D) becomes disordered and its free energy increases

89. The number of point groups in a 2-dimensional crystal system is

(A) 5

(B) 10

(C) 15

(D) 20

90. The asymmetry term in the Weizsacker's semi-empirical mass formula is because of

(A) non-spherical shape of the nucleus

(B) non-zero spin of nucleus

(C) unequal number of protons and neutrons inside the nucleus

(D) odd number of protons inside the nucleus

91. According to nuclear shell model which includes spin orbit coupling, the spin and parity of the ground state of $_5B^{11}$ is

(A) $\frac{3^-}{2}$

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

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

(D) $\frac{1^+}{2}$

92. Arrange the following fundamental forces of nature in increasing order of their magnitude.

1. Weak
2. Strong
3. Gravitational
4. Electromagnetic

(A) 3, 2, 4, 1

(B) 3, 1, 4, 2

(C) 2, 4, 3, 1

(D) 2, 1, 4, 3

93. What must be the temperature of the gas of deuterons if the average kinetic energy of the deuterons has to be greater than the estimated barrier height ? (Barrier potential height B = 350 KeV) (Boltzmann constant K = 1.38×10^{-23} J/K)

(A) 10^6 K

(B) 0 K

(C) 10^9 K

(D) 10^3 K

94. Choose the particle with zero baryon number from the option given below.

(A) Proton
(B) Neutron
(C) Pion
(D) Δ^+

95. The correct matching pair of reaction with the conservation quantity is

(A) $P \rightarrow e^+ + \upsilon_e$ Baryon number
(B) $P \rightarrow e^+ + \bar{\upsilon}_e$ Lepton number
(C) $n + \pi^+ \rightarrow \pi^- + P$ Charge
(D) $n + \pi^+ \rightarrow \pi^0 + P$ Baryon number

96. The rate of energy loss by ionisation of a relativistic charged particle travelling through the matter is

(A) inversely proportional to its energy
(B) independent of energy
(C) proportional to its energy
(D) none of the above

97. A pion at rest decays into muon and neutrino $\pi \rightarrow \mu + \upsilon$. The relativistic velocity of muon (μ) in terms of m_π and m_μ is given by

(A) $\left(\frac{m_\pi^2 + m_\mu^2}{m_\pi^2 - m_\mu^2}\right)C$

(B) $\left(\frac{m_\pi^2 - m_\mu^2}{m_\pi^2 + m_\mu^2}\right)C$

(C) $\left(\frac{m_\pi^2}{m_\mu^2}\right)C$

(D) $\left(\frac{m_\mu^2}{m_\pi^2}\right)C$

98. Calculate the energy released in MeV from the nuclear reaction.

$$_5B^{10} + {_1H^2} \rightarrow {_5B^{11}} + {_1H^1}$$

$m(_5B^{10}) = 10.01605$ U

$m(_5B^{11}) = 11.01286$ U

$m(_1H^2) = 2.01472$ U

$m(_1H^1) = 1.00812$ U

(A) 19.114 MeV

(B) 9.114 MeV

(C) 0.009 MeV

(D) 12.021 MeV

99. The two nuclei can fuse together to form a helium nucleus (radius of deutarium nucleus $\gamma_0 = 1.5\times10^{-15}$ m(apprx.)). Find the potential energy (V) of repulsion between two nuclei.

(A) 0.88×10^{-11} Joule

(B) 0.77×10^{-13} Joule

(C) 0.66×10^{-10} Joule

(D) 0.155×10^{15} Joule

100. Calculate the mass of an electron accelerated to a kinetic energy of 2 MeV. ($m_0 = 9.1\times10^{-31}$ kg)

(A) 9.111×10^{-31} kg

(B) 35.555×10^{-31} kg

(C) 8.890×10^{-31} kg

(D) 44.655×10^{-31} kg

☺ જોડાઓ અમારી સાથે ☺

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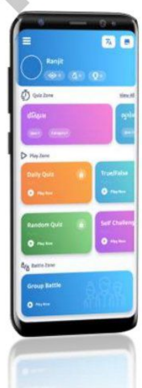

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