

ENTRANCE EXAMINATION FOR ADMISSION, MAY 2011.

M.Phil./Ph.D. (PHYSICS)

COURSE CODE : 255/122

Register Number :

*Signature of the Invigilator
(with date)*

COURSE CODE : 255/122

Time : 2 Hours

Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you -1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

1. If $\sqrt{a+ib} = x+iy$, then a possible value of $\sqrt{a-ib}$ is
 (A) x^2+y^2 (B) $\sqrt{x^2+y^2}$ (C) $x+iy$ (D) $x-iy$
2. The rank of the matrix $\begin{pmatrix} 7 & -1 \\ 2 & 1 \end{pmatrix}$ is
 (A) 9 (B) 2 (C) 1 (D) 5
3. If $u = f(x, y)$ then with usual notations, $u_{xy} = u_{yx}$ if
 (A) u is continuous (B) u_x is continuous
 (C) u_y is continuous (D) u, u_x, u_y are continuous
4. The order and degree of the differential equation are $\frac{d^2y}{dx^2} = \left[4 + \left(\frac{dy}{dx} \right)^2 \right]^{3/4}$
 (A) 2, 1 (B) 1, 2 (C) 2, 4 (D) 4, 2
5. The set of positive even numbers, with usual multiplication forms
 (A) a finite group (B) only a semi group
 (C) only a monoid (D) an infinite group
6. If $\begin{vmatrix} \alpha & -\beta & 0 \\ 0 & \alpha & \beta \\ \beta & 0 & \alpha \end{vmatrix} = 0$, then
 (A) $\frac{\alpha}{\beta}$ is one of the cube roots of unity (B) α is one of the cube roots of unity
 (C) β is one of the cube roots of unity (D) None of these
7. The differential equation whose solution is $Ax^2 + By^2 = 1$, where A and B are arbitrary constant is of
 (A) First order and second degree (B) First order and first degree
 (C) Second order and first degree (D) Second order and second degree

8. If $y = \sec^{-1} \frac{x+1}{x-1} \sin^{-1} \frac{x-1}{x+1}$, then $\frac{dy}{dx}$ is
- (A) 1 (B) $\frac{x-1}{x+1}$ (C) $\frac{x+1}{x-1}$ (D) 0
9. Which of the following matrices does not have an inverse?
- (A) $\begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$ (B) $\begin{bmatrix} 1 & 1 \\ 2 & 2 \end{bmatrix}$ (C) $\begin{bmatrix} 1 & 0 \\ 2 & 2 \end{bmatrix}$ (D) $\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$
10. The relation between Beta and Gamma functions is
- (A) $B(l, m) = \frac{\Gamma(l)\Gamma(m)}{\Gamma(l+m)}$ (B) $B(l, m) = \frac{\Gamma(l)\Gamma(m)}{\Gamma(l-m)}$
- (C) $B(l, m) = \frac{\Gamma(l+m)}{\Gamma(l)\Gamma(m)}$ (D) $B(l, m) = \frac{\Gamma(l-m)}{\Gamma(l)\Gamma(m)}$
11. If $F(t) = t^{-1/2}$, then Laplace transform of $F(t)$ is
- (A) $\sqrt{\frac{\pi}{s}}$ (B) $\frac{\pi}{s^{3/2}}$ (C) $\sqrt{\frac{s}{\pi}}$ (D) None
12. What is the angle between x-axis and a force represented by $\hat{F} = 2\hat{i} + 3\hat{j} + 4\hat{k}$?
- (A) $\cos^{-1} \frac{3}{\sqrt{29}}$ (B) $\cos^{-1} \frac{4}{\sqrt{29}}$ (C) $\cos^{-1} \frac{5}{\sqrt{29}}$ (D) $\cos^{-1} \frac{2}{\sqrt{29}}$
13. The directionality of the laser beam is due to
- (A) Stimulated emission (B) Cavity design of the laser
- (C) Both (A) and (B) (D) None of the above
14. He-Cd laser also decays radiatively via the lasing transition at 325.0 nm (with transition probability = $7.8 \times 10^5 \text{ s}^{-1}$) and also at 313 nm with transition probability = $1.6 \times 10^5 \text{ s}^{-1}$. The lifetime of the associated upper energy level would be
- (A) $1.06 \times 10^{-6} \text{ s}$ (B) $6.2 \times 10^{-6} \text{ s}$ (C) $1.2 \times 10^{-6} \text{ s}$ (D) $1.6 \times 10^{-6} \text{ s}$

15. Emission of light waves from moving atoms leads to
 - (A) Natural broadening
 - (B) Doppler broadening
 - (C) Crystal broadening
 - (D) No broadening
16. Lasing transition at 632.8 nm wavelength in He-Ne gas laser is due to
 - (A) He transition
 - (B) Ne transition
 - (C) From the cavity mirror of the laser
 - (D) None of the above
17. Nd : YAG laser is an example of
 - (A) 2-level system
 - (B) 3-level system
 - (C) 6-level system
 - (D) 4-level system
18. The minimum emission linewidth of an electronic transition is given by
 - (A) Natural broadening
 - (B) Doppler broadening
 - (C) Inhomogeneous broadening
 - (D) Isotope broadening
19. Doppler broadening of the emission line-width in a laser results in
 - (A) Gaussian lineshape
 - (B) Lorentzian lineshape
 - (C) Sigmoidal lineshape
 - (D) All of the above
20. The rate of spontaneous transition (per unit volume) from upper level E_2 to lower level E_1 is proportional to
 - (A) Einstein A_{21} coefficient
 - (B) Einstein B_{21} coefficient
 - (C) Einstein B_{21} Coefficient and N_2 (number density of atoms in level 2)
 - (D) Einstein A_{21} Coefficient and N_2 (number density of atoms in level 2)
21. In double slit interference experiment one of the slits is covered by thin mica sheet whose refractive index is 1.58. Separation between two slit is 0.1 cm and the distance from the screen is 50 cm. Because of mica sheet, the central fringe shifts by 0.2 cm. The thickness of mica sheet is
 - (A) 6.7×10^{-4} cm
 - (B) 1.6×10^5 m⁻¹
 - (C) 1.6×10^5 m
 - (D) 6.7×10^{-4} cm⁻¹

22. A 3MW laser beam ($\lambda_0 = 6 \times 10^{-5} \text{ m}$ and beam width $2a = 1 \text{ cm}$) is incident on the lens of focal length of 5 cm , then, the intensity at focal plane of the lens is approximately
- (A) $3.33 \times 10^{-16} \text{ m}^2/\text{W}$ (B) $3 \times 10^{16} \text{ W/m}^2$
 (C) $10^{-10} \text{ m}^2/\text{W}$ (D) 10^{10} W/m^2
23. The divergence due to diffraction limited He-Ne laser ($\lambda_0 = 0.6328 \text{ } \mu\text{m}$) having an Gaussian output of $\omega_0 = 5 \text{ } \mu\text{m}$ is given as
- (A) 2.3° (B) 3.3° (C) 1.3° (D) 4.6°
24. Which of the following is correct statement?
- (A) Probability of stimulated emission is identical to the probability of spontaneous emission
 (B) Probability of stimulated emission is identical to the probability of spontaneous absorption
 (C) Probability of stimulated absorption is identical to the probability of spontaneous emission
 (D) None of the above
25. The virtual work done in any dynamical system is
- (A) > 0 (B) < 0 (C) 0 (D) infinity
26. The Hamiltonian of a SHO is
- (A) $(1/2)mv_x + (1/2)kx$ (B) $(1/2)mv_x^2 + (1/2)kx^2$
 (C) $(1/2)mv_x^2 - (1/2)kx^2$ (D) $mv_x^2 - kx^2$
27. In Hamilton's principle the action is defined as
- (A) $\int \delta L dt$ (B) $\delta \left(\int L dt \right)$ (C) $\int L dt$ (D) $\delta L dt$
28. In a central field, the minimum energy path cannot be one of the following
- (A) ellipse (B) parabola (C) circle (D) straight line

29. A particle of mass m is moving on a spherical surface. The angular momentum corresponding to ϕ is
 (A) $mr^2 \theta$ (B) $mr^2 \theta \phi$ (C) $mr^2 \sin^2 \theta \phi$ (D) $mr^2 \sin^2 \theta \theta$
30. If a real velocity $(1/2 r^2 \dot{\theta})$ is constant, the Lagrangian is $L =$
 (A) $(\frac{1}{2})m(r^2 + r^2 \dot{\theta}^2)$ (B) $(\frac{1}{2})m(r^2 + r \dot{\theta}^2)$
 (C) $(\frac{1}{2})m(r^2 - r^2 \dot{\theta}^2) - V(r)$ (D) $(\frac{1}{2})m(r^2 \dot{\theta}^2)$
31. Hamilton-Jacobi equation is
 (A) $q + \partial H / \partial p = 0$ (B) $p + \partial H / \partial q = 0$
 (C) $S + \partial H / \partial t = 0$ (D) $H + \partial S / \partial t = 0$
32. The conjugate momentum p corresponding to the generating function $F_1 = (\frac{1}{2})q^2 \cot Q$ is
 (A) $q \sin Q$ (B) $q \tan Q$ (C) $q \cot Q$ (D) $q^2 \operatorname{cosec} Q$
33. In Newtonian mechanics the speed of a particle is
 (A) less than c (B) equal to c (C) more than c (D) any value
34. Two electrons are ejected in opposite direction from a radioactive source at rest in laboratory and speed of each electron is $0.67c$. The speed of one electron seen by other in relativistic mechanics is
 (A) 0 (B) $1.34c$ (C) $0.92c$ (D) $0.67c$
35. The Doppler shift in the wavelengths of H_α (6561 \AA) line from a Star which is moving away from the Earth with a velocity 300 km/s is approximately
 (A) -6.561 \AA (B) $+6.561 \text{ \AA}$ (C) -3.453 \AA (D) $+3.453 \text{ \AA}$
36. The relativistic mass of an electron (rest mass 0.5 MeV) accelerated through potential difference of 2 MV is
 (A) 2.5 MeV (B) 1.5 MeV (C) 1 MeV (D) 0.5 MeV
37. The order parameter of a superconductor is
 (A) critical field (B) critical temperature
 (C) energy gap (D) coherent length

38. The condition for Polarization catastrophe (symbol with conventional meaning) is
 (A) $\sum (n_i \alpha_i) / \mu_0 = -1$ (B) $(\sum n_i \alpha_i) / \mu_0 = 0$
 (C) $(\sum n_i \alpha_i) / \mu_0 = \text{infinity}$ (D) $(\sum n_i \alpha_i) / \mu_0 = +1$
39. The effective mass of hole (m^*) is given by the expression (E , K and h represents energy, wave vector and Plank's constant respectively)
 (A) $h \partial E / \partial K$ (B) $\partial K / \partial E$
 (C) $h^2 (\partial^2 K / \partial^2 E) / 4\pi^2$ (D) $h^2 (\partial^2 E / \partial^2 K) / 4\pi^2$
40. Thermal conductivity (K) of solid is related to Lorentz number (L), current density (J) and electric field (E) by the expression
 (A) $K = LJE$ (B) $K = LJ/E$ (C) $K = LE/J$ (D) $K = JE/L$
41. The Debye's frequency of a metal with Debye temperature 450 K is
 (A) 10^3 Hz (B) 10^{10} Hz (C) 10^{13} Hz (D) 10^{15} Hz
42. The slope of the plot $\ln p$ vs. $1/T$ of an intrinsic semiconductor is
 (A) $-E_g/2 k_B$ (B) $-E_g/k_B$ (C) $+E_g/k_B$ (D) $+E_g/2k_B$
43. In the Brillouin function $B_J(x)$ of a ferromagnet, the $x \rightarrow 0$ corresponds to
 (A) ferromagnetic phase (B) paramagnetic phase
 (C) Curie temperature (D) maximum moment
44. The electronic specific heat of Al ($E_F = 11.7 \text{ eV}$) at room temperature is
 (A) 0.009 J/K (B) 0.09 J/K (C) 0.9 J/K (D) 9.0 J/K
45. For $\text{Ni}^{2+} (3d^8)$ ion the effective magnetic moment is
 (A) $2.49 \mu_B$ (B) $4.59 \mu_B$ (C) $5.59 \mu_B$ (D) $6.49 \mu_B$
46. The carrier concentration of intrinsic Ge ($E_g = 0.67 \text{ eV}$, $m_e^* = 0.12 m_e$, $m_h^* = 0.28 m_e$) at 300 K is
 (A) $5 \times 10^{17}/\text{m}^3$ (B) $5 \times 10^{18}/\text{m}^3$ (C) $5 \times 10^{19}/\text{m}^3$ (D) $5 \times 10^{-19}/\text{m}^3$

47. The ground state of configuration of $\text{Mn}^{3+} (3d^4)$ ion is
 (A) $^2D_{3/2}$ (B) $5D_4$ (C) 5D_0 (D) $^4F_{3/2}$
48. A superconductor ($T_c = 10\text{K}$, critical magnetic field at 0K is 0.08 Tesla) follows the relation $H_C(T) = H_0 [1 - (T/T_c)^2]$. The critical field at 5 K is
 (A) 0 Tesla (B) 0.02 Tesla (C) 0.03 Tesla (D) 0.06 Tesla
49. Rotational and centrifugal constants of HCl molecule are 10.593 cm^{-1} and $5.3 \times 10^{-4}\text{ cm}^{-1}$. The vibrational frequency of the molecule is
 (A) 299.52 cm^{-1} (B) 2995.2 cm^{-1} (C) 29.95 cm^{-1} (D) None
50. The bending vibrations of N- atomic non-linear molecule is given by
 (A) $2N-5$ (B) $2N-4$ (C) $3N-5$ (D) None
51. In FT-IR spectra which of the following molecules has a lower frequency
 (A) CH (B) CCl (C) We can't say (D) CBr
52. An electronic transition takes place so rapidly that a vibrating molecule does not change its internuclear distance appreciably during the transition. This is known as
 (A) Franck-Condon principle (B) Paschen-Back effect
 (C) Born-Oppneheimer approximation (D) None
53. "A molecular motion in which all the atoms oscillate with the same frequency and pass through their equilibrium position simultaneously" is known as
 (A) Orbital angular momentum (B) Normal modes
 (C) Larmor frequency (D) None
54. If molecule has a centre of symmetry then Raman active modes are infrared inactive and vice versa. This is
 (A) Stoke's law (B) Pauli exclusion principle
 (C) Mutual Exclusion Principle (D) None

55. In X-ray absorption spectra if transition from L- shell ($n=2$) to O-shell ($n=5$) takes place, the transition in x-ray notation is then
 (A) L_γ (B) L_α (C) L_β (D) None
56. In nuclear quadrupole resonance the set of nuclear energy levels are
 (A) Magnetic nature (B) Electromagnetic nature
 (C) None (D) Electric nature
57. In any system having an odd number of unpaired electrons, the zero field ground state is at least two fold degenerate. This statement is
 (A) Jahn-Teller theorem (B) Kramer's theorem
 (C) Larmor's theorem (D) None
58. If B is the rotational constant of a given molecule, the first three lines in rotational Raman spectra are at
 (A) $4B, 8B, 12B$ (B) $6B, 10B, 14B$ (C) $2B, 4B, 6B$ (D) None
59. The mass spectrograph directly yields a value for
 (A) mass of a photon (B) mass of a neutron
 (C) masses of isotopes of elements (D) mass to charge ratio of ions
60. An electron and a proton are moving at the same speed in circular paths in the same uniform magnetic field. The radius of the path of the proton is
 (A) the same as that of the electron
 (B) about 2000 times larger than that of the electron
 (C) a little larger than that of the electron
 (D) smaller than that of the electron
61. What name is given to the class of subatomic particles which include the proton, the neutron, and several heavier particles, such as the lambda, the sigma and the omega.
 (A) photons (B) leptons (C) mesons (D) baryons

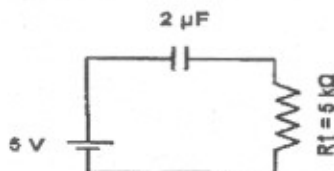
62. If the half-life of a radioisotope is 2 days, after how many days is the quantity reduced to 12.5% of its original amount?
- (A) 4 days (B) 6 days (C) 8 days (D) 10 days
63. A gluon is the carrier of which one of the following forces of nature?
- (A) Strong force (B) Weak force
(C) Both strong and weak forces (D) Electromagnetic force
64. The ground state energy of positronium is most nearly equal to
- (A) -27.2 eV (B) 13.6 eV (C) -6.8 eV (D) -3.4 eV
65. When the beta decay of Co-60 nuclei is observed at low temperatures in a magnetic field that aligns the spins of the nuclei, it is found that the electrons are emitted preferentially in a direction opposite to the Co-60 spin direction. Which of the following invariance is violated by this decay?
- (A) Gauge invariance (B) Time invariance
(C) Translation invariance (D) Reflection invariance
66. According to the Standard Model of elementary particles, which of the following is NOT a composite object?
- (A) Muon (B) Pi-meson (C) Neutron (D) Deuteron
67. The half-life of a π^+ meson at rest is 2.5×10^{-8} second. A beam of π^+ mesons is generated at a point 15 metres from a detector. Only half of the π^+ mesons live to reach the detector. The speed of the π^+ mesons is (c is the speed of light)
- (A) $(\frac{1}{2})c$ (B) $[\sqrt{(2/5)}]c$ (C) $[2/\sqrt{(5)}]c$ (D) $2c$
68. What is the quark content of a neutron?
- (A) UD (B) DU (C) UUD (D) DDU
69. In the theory of angular momentum, which of the following operators is a Casimir operator?
- (A) J_x (B) J_+ (C) J^2 (D) J_z

70. The ground state energy eigenfunction of one dimensional harmonic oscillator is $\psi_0(x) = N \exp(-\alpha^2 x^2)$, where N is
- (A) $\sqrt{\frac{\alpha}{\pi}}$ (B) $\sqrt{\frac{\alpha}{\sqrt{\pi}}}$ (C) $\frac{\alpha}{\pi}$ (D) $\frac{\alpha}{\sqrt{\pi}}$
71. The ratio of the de Broglie wave lengths of the electron in the first and the third orbits in the hydrogen atom is
- (A) 1 : 3 (B) 1 : 9 (C) 1 : 6 (D) 1 : 27
72. The ground state energy of hydrogen atom is -13.6 eV. What is the energy of the electron in its first excited state?
- (A) -13.6 eV (B) -27.2 eV (C) 0 eV (D) -3.4 eV
73. If one dimensional harmonic oscillator is perturbed by a time dependent perturbation given by $V = ax^2 \cos(\omega t)$. What are the selection rules with respect to transitions among the energy eigenstates?
- (A) $\Delta n = 0$ (B) $\Delta n = 0, \pm 2$ (C) $\Delta n = \pm 2$ (D) $\Delta n = 0, \pm 1$
74. Consider a two level system with states $|0\rangle$ and $|1\rangle$. If an operator A is such that $A|0\rangle = |1\rangle$ and $A|1\rangle = |0\rangle$. What is the corresponding matrix of A ?
- (A) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (B) $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$ (C) $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ (D) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
75. Given σ is the total cross section and $f(\theta)$ is the scattering amplitude and θ being the angle of scattering, for quantum mechanical elastic scattering by a spherically symmetric potential, then which of the following is true? Note that k is the magnitude of wave vector along the z-direction.
- (A) $\sigma = |f(\theta)|^2$ (B) $\sigma = \frac{4\pi}{k} |f(\theta=0)|^2$
- (C) $\sigma = \frac{4\pi}{k} \times \text{Im} |f(\theta=0)|$ (D) $\sigma = \frac{4\pi}{k} |f(\theta)|^2$
76. What is the degeneracy of n th excited state of three dimensional isotropic harmonic oscillator?
- (A) n^2 (B) $3n$ (C) $2n$ (D) $n+1$
77. A particle in one dimensional box of length L , is subjected to a perturbation given by $V = a \delta(x - L/2)$. What is the first order correction to the energy of $n = 2$ state?
- (A) 0 (B) $2a/L$ (C) $La/2$ (D) $-2a/L$

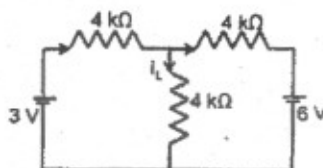
78. What is the exchange degeneracy of three identical fermions?
 (A) 2 (B) 3 (C) 5 (D) 6
79. The isotherms of Andrew's experiment explain that
 (A) Carbon dioxide is a perfect gas (B) A gas can be liquefied
 (C) There is continuity of state (D) Purity of gas
80. A mole of carbon dioxide is 44 amu and Avogadro number is 6.023×10^{23} per mole. Mass of one mole of gas is (in Kg)
 (A) 7.31×10^{-26} (B) 264×10^{-20}
 (C) 7.31×10^{-19} (D) 220×10^{-25}
81. In Carnot engine an amount of heat is released to the sink at the end of each cycle. After 10000 cycles the sink
 (A) expands
 (B) is compressed
 (C) remains at same temperature as it has infinite heat capacity
 (D) becomes hotter
82. The thermometer in which 'the colour of the source of heat is used to estimate the temperature' is
 (A) bolometer (B) copper constantan thermometer
 (C) calorimeter (D) pyrometer
83. An exchange interaction is expressed by following expression $H_{\text{exc}} = -J \sigma_i \cdot \sigma_j$. It represents
 (A) Ising model (B) Heisenberg model
 (C) William's model (D) Pauli model
84. The order parameter of a ferromagnetic phase transition is
 (A) Curie temperature (B) Magnetic susceptibility
 (C) Coercive field (D) Magnetic field
85. Time average is equal to space average in phase space is the basic idea of
 (A) ergodicity (B) non-equilibrium condition
 (C) irreversible process (D) isothermal process
86. Which of the following logic gates can be used as a programmable NOT gate?
 (A) NOT (B) NAND (C) EX-OR (D) OR

87. A decoded-ROM uses an 8 bit internal decoder and the size of each register is one byte (or 1 b). The memory capacity of this ROM is
 (A) 256 b (B) 64 b (C) 2 kb (D) 1 Gb

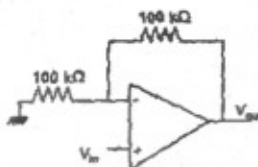
88. The circuit shown in figure is under study state. The voltage across the capacitor (V_c) and the resistance (V_R) are



- (A) $V_c = 0V$ and $V_R = 0V$ (B) $V_c = 0V$ and $V_R = 5V$
 (C) $V_c = 5V$ and $V_R = 0V$ (D) $V_c = 5V$ and $V_R = 5V$
89. Once it is conducting an SCR can be turned off only by
 (A) Reducing the gate current to zero (B) Reducing the anode current to zero
 (C) Applying reverse voltage on gate (D) It cannot be turned off at all.
90. The current I_L in the circuit shown in figure is



- (A) 0.25 mA (B) 0.5 mA (C) 0.75 mA (D) 1 mA
91. A transistor (BJT) is connected in emitter bias configuration. Then the collector current is supposed to be
 (A) independent of current gain and the base current
 (B) independent of current gain but it depends on base current
 (C) independent of base current but it depends on current gain
 (D) a function of both the current gain and the base current
92. The open loop gain of Op-Amp shown in figure is 100000 and V_{in} is 10 mV. Then V_{out} is



- (A) 1 kV (B) 1 MV (C) 10 mV (D) 20 mV

93. $\nabla^2 V = -4\pi\rho$ represents
 (A) Maxwell's equation (B) Laplace's equation
 (C) Poisson's equation (D) None of these
94. In the case of reflection and refraction of light at the dielectric interface
 (A) Tangential components of D and B are continuous
 (B) Tangential components of D and normal component of B are continuous
 (C) Normal component of D and tangential component of B are continuous
 (D) Normal components of D and B are continuous
95. The potentials which depend on the velocity of the particle is known as
 (A) Scalar potential (B) Vector potentials
 (C) Retarded potentials (D) Lienard-Wiechert potentials
96. Given the field $\vec{E} = \left(\frac{k}{r}\right)\hat{a}_r$ in cylindrical coordinates then the work needed to move a point charge Q from any radial distance r to a point at twice that radial distance is
 (A) $-kQ \ln 2$ (B) $-kr \ln 2$ (C) $-2k \ln Q$ (D) $-kQ \ln r$
97. Net outflow of flux through a closed surface enclosing a charge q is
 (A) q/ϵ_0 (B) l/q (C) q (D) $q/4\pi\epsilon_0$
98. A parallel plate capacitor has plate area A, separated by a distance d, and contains dielectric of permittivity ϵ . When a voltage $V_0 \sin \omega t$ is applied to its plate, the magnitude of the displacement current J_D and the conduction current J_C are
 (A) $J_D > J_C$ (B) $J_D < J_C$ (C) $J_D = J_C$ (D) $J_D = 0$
99. Maxwell's electromagnetic equations are valid under all conditions except one and that is they are not applicable to
 (A) non-isotropic media (B) non-homogeneous media
 (C) non-linear media (D) one of the above
100. When a charged particle moves in uniform electric field, the force acting on it is _____ the direction of field
 (A) perpendicular to (B) along
 (C) opposite to (D) None