PHYSICAL SCIENCES
Paper - II
OCT–11/02

Signature of Invigilators

1. .....

2. .....

Roll No. ☐☐☐☐☐☐
(In figures as in Admit Card)

Roll No. .....

.....
(in words)

Time Allowed : 75 Minutes] **[Maximum Marks : 100**

Instructions for the Candidates

1. Write your Roll Number in the space provided on the top of this page.
2. This paper consists of **fifty (50)** multiple choice type questions. **All** questions are compulsory.
3. Each item has upto four alternative responses marked (A), (B), (C) and (D). The answer should be a capital letter for the selected option. The answer letter should entirely be contained within the corresponding square.

   Correct method [A] Wrong method [A] OR [A]
4. Your responses to the items for this paper are to be indicated on the ICR Answer Sheet under Paper II only.
5. Read instructions given inside carefully.
6. Extra sheet is attached at the end of the booklet for rough work.
7. You should return the test booklet to the invigilator at the end of paper and should not carry any paper with you outside the examination hall.
8. There shall be no negative marking.
9. Use of calculator or any other electronic devices is prohibited.

પરીક્ષાર્થીઓ માટે સૂચનાઓ :

૧. આ પાનાની ટોચમાં દર્શાવેલી જગ્યામાં તમારો રોલનંબર લખો.

૨. આ પ્રશ્નપત્રમાં બહુવૈકલ્પિક ઉત્તરો ધરાવતા કુલ **પચાસ (૫૦)** પ્રશ્નો આપેલા છે. બધા જ પ્રશ્નો ફરજિયાત છે.

૩. પ્રત્યેક પ્રશ્ન વધુમાં વધુ ચાર બહુવૈકલ્પિક ઉત્તરો ધરાવે છે. જે (A), (B), (C) અને (D) વડે દર્શાવવામાં આવ્યા છે. પ્રશ્નનો ઉત્તર કેપીટલ સંજ્ઞા વડે આપવાનો રહેશે. ઉત્તરની સંજ્ઞા આપેલ ખાનામાં બરાબર સમાઈ જાય તે રીતે લખવાની રહેશે.

   ખરી રીત : [A] ખોટી રીત : [A] અથવા [A]

૪. આ પ્રશ્નપત્રના જવાબ આપેલ ICR Answer Sheet ના Paper II વિભાગની નીચે આપેલ ખાનાઓમાં આપવાના રહેશે.

૫. અંદર આપેલ સૂચનાઓ કાળજીપૂર્વક વાંચો.

૬. આ બુકલેટની પાછળ આપેલું પાનું રફ કામ માટે છે.

૭. પરીક્ષા સમય પૂરો થઈ ગયા પછી આ બુકલેટ જે તે નિરીક્ષકને સોંપી દેવી. કોઈપણ કાગળ પરીક્ષા ખંડની બહાર લઈ જવો નહીં.

૮. ખોટા જવાબ માટે નેગેટિવ ગુણાંકન પ્રથા નથી.

૯. કેલ્કયુલેટર અને ઈલેકટ્રોનિક યંત્રોનો પ્રયોગ કરવાની મનાઈ છે.

SEAL

PHYSICAL SCIENCES

PAPER-II

Note : This paper contains **FIFTY (50)** multiple-choice/Assertion and Reasoning/ Matching questions, each question carrying **TWO (2)** marks. Attempt **All** the questions.

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1. The dimensions of Planck's constant are :

   (A) $[M^1\ L^2\ T^{-1}]$ (B) $[M^0\ L^1\ T^1]$

   (C) $[M^0\ L^2\ T^{-2}]$ (D) $[M^1\ L^1\ T^1]$

2. If exp $(i\ \alpha\ A)$ has to be unitary for any Hermitian matrix A, then α should be :

   (A) Imaginary (B) Complex

   (C) Real (D) Infinite

3. The Laplace transform of '0' is :

   (A) 1 (B) 0

   (C) s (D) $\frac{1}{s}$

4. Which of the following corresponds to $\sqrt{i}$, when $i = \sqrt{-1}$?

   (A) $\frac{1}{\sqrt{2}}(1+i)$ (B) $\frac{1}{\sqrt{2}}(1-i)$

   (C) -1 (D) 0

5. The order of the Legendre differential equation is :

   (A) 1 (B) 2

   (C) -1 (D) 0

6. The unit of the Lagrangian is :

   (A) Newton (B) Joule

   (C) Meter (D) Coulomb

7. The Lagrangian of the particle of mass 'm' executing simple harmonic motion in one dimension can be given as :

(A) $\frac{p^2}{2m}$ (B) $\frac{p^2}{2m} + \frac{1}{2} kx^2$

(C) $\frac{p^2}{2m} - \frac{1}{2} kx^2$ (D) $\frac{1}{2} kx^2$

8. The reduced mass of 6 particles of equal mass 'm' is :

(A) m^6 (B) m

(C) $6m$ (D) $m/6$

9. The D'Alembertian operator in four-space is defined as :

(A) ∇^2 (B) $\frac{1}{c^2} \frac{\partial^2}{\partial t^2}$

(C) $\nabla^2 + \frac{1}{c^2} \frac{\partial^2}{\partial t^2}$ (D) $\nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2}$

10. The number of independent components in the case of symmetric moment of inertia tensor are :

(A) 3 (B) 6

(C) 9 (D) 2

11. The electric (E) and magnetic (B) field amplitudes associated with an electromagnetic radiation from a point source behave at a distance r from the source is :

(A) $E \propto 1/r$, $B \propto 1/r$

(B) E = constant , B = constant

(C) $E \propto 1/r^2$, $B \propto 1/r$

(D) $E \propto 1/r^3$, $B \propto 1/r^2$

12. Two parallel large metal plates carry +Q and –Q respectively. A test charge placed between them experiences a force $\vec{F}$. Now the plates are moved apart so that the separation between them is doubled. The force on test charge will now be :

(A) $\vec{F}/2$

(B) $\vec{F}/4$

(C) $\vec{F}/\sqrt{2}$

(D) $\vec{F}$

13. Electric field is called conservative field. Which of the following relation is responsible for its conservative nature ?

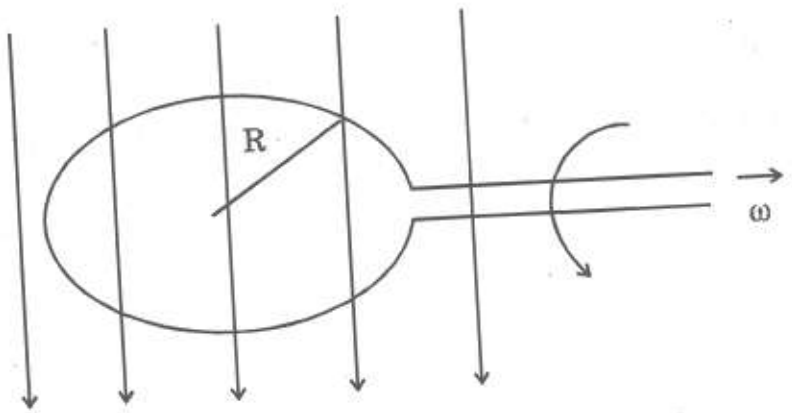
(A) $\vec{\nabla} . \vec{E} = \rho / \epsilon_0$

(B) $\vec{\nabla} . \vec{E} = 0$

(C) $\vec{\nabla} \times \vec{E} = 0$

(D) $\nabla^2 \vec{E} = 0$

14. A circular wire loop of radius R, rotates with an angular speed ω, in a uniform magnetic field as shown in the figure



If the emf ϵ induced in the loop is $\epsilon_0 \sin \omega t$, then the angular speed of the loop is :

(A) $\epsilon_0 R/B$

(B) $\epsilon_0 /(\pi BR^2)$

(C) $2\pi \epsilon_0 /R$

(D) $\epsilon_0^2 /(BR^2)$

15. The magnitude of the electric field due to an electric quadrupole, at a large distance from the quadrupole varies as :

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

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

16. The De Broglie wavelengths of a proton and alpha particle are equal. The ratio of their velocities is :

(A) 2 : 1 (B) 4 : 1

(C) 1 : 4 (D) 1 : 2

17. If E_1 is the energy of the lowest state of a one-dimensional potential box of length 'a' and E_2 is the energy of the lowest state when the length is halved, then :

(A) $E_2 = E_1$ (B) $E_2 = 2E_1$

(C) $E_2 = 3E_1$ (D) $E_2 = 4E_1$

18. For the wave function $\Psi = A \exp i(kx - wt)$ the probability current density is :

(A) $\frac{\hbar w}{m} |A|^2$ (B) $\frac{\hbar m}{k} |A|^2$

(C) $\frac{\hbar k}{m} |A|^2$ (D) $\frac{\hbar k}{w} |A|^2$

19. The degeneracy of a three-dimensional harmonic oscillator is :

(A) n^2 (B) $\frac{1}{2}(2n+1)(2n+2)$

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

20. $\sigma_x, \sigma_y, \sigma_z$ are the Pauli spin matrices. Which one of the following relations is *true* ?

(A) $\sigma_x \sigma_y = i\sigma_z$ (B) $\sigma_x \sigma_y = \sigma_z$

(C) $\sigma_x \sigma_y = -i\sigma_x\sigma_y$ (D) $\sigma_x \sigma_y = \sigma_y\sigma_x$

21. Second order phase transition is characterized by :

(A) A latent heat

(B) A discontinuous change in the specific heat

(C) A change in volume

(D) Hysteresis during warming and cooling

22. In a grand canonical ensemble, a system could exchange with the reservoir :

(A) neither particles nor energy

(B) particles only but not energy

(C) energy only but not particles

(D) both particles and energy

23. The pressure of non-interacting Fermi gas with internal energy U at temperature T is :

(A) $P = \frac{3}{2} U/V$ (B) $P = \frac{2}{3} U/V$

(C) $P = \frac{3}{5} U/V$ (D) $P = \frac{1}{2} U/V$

24. The specific heat of an ideal Fermi gas in three dimension at very low temperature (T) varies as :

(A) T (B) $T^{3/2}$

(C) T^2 (D) T^3

25. In a case of a monatomic ideal gas containing N molecules, the specific heat at constant volume C_V of a gas at temperature T is :

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

(C) 2 NK (D) $\frac{3}{2}$ NK

26. A 6 V Zener diode has a power dissipation of 120 mW. The maximum safe current that can be allowed to flow through it is :

(A) 5 mA (B) 10 mA

(C) 20 mA (D) 40 mA

27. The resolution of a 4 bit R – 2R ladder network having R = 10 kΩ and V_{ref} = 10 V is :

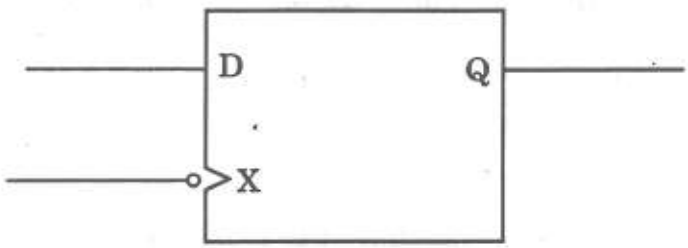
(A) 62.5 μA (B) 125.0 μA

(C) 0.25 mA (D) 1.0 mA

28. In an inverting amplifier configuration, if the value of feedback resistor is 10 kΩ, that of input resistor is 1 kΩ, then its gain would be :

(A) 11 (B) 10

(C) 0.1 (D) 1.0

29. 

is the symbol for :

(A) D-flip-flop with negative edge trigger

(B) D-flip-flop with level triggered clock

(C) RS flip-flop with inverted inputs

(D) JK flip-flop without clock

30. The stack pointer in a microprocessor :

(A) Contains the data from the stack

(B) Contains the address of the first element of stack

(C) Contains address of the last element of stack

(D) Contains the return address

31. A square wave signal can be mathematically represented as sum of :

(A) Sine waves (B) Triangular waves

(C) Random waves (D) Circular waves

32. To measure temperature electronically which of the following sensors/ transducers would be used :

(A) LVDT (B) Thermistor

(C) Pirani gauge (D) Anemometer

33. Scattered data points can be fitted to a line by using method of :

(A) least square (B) chi-square

(C) gamma-match (D) max-deviation

34. The sheet resistivity ρ_s of a sample of thickness t is measured by four probe method. The bulk resistivity ρ_b is given by :

(A) $\rho_b = \rho_s / t\ \Omega - m$ (B) $\rho_b = \rho_s . t\ \Omega - m$

(C) $\rho_b = \rho_s / 2t\ \Omega - m$ (D) $\rho_b = \rho_s / t^2\ \Omega - m$

35. For high input resistance of about 500 kΩ, the BJT configuration that should be used is :

(A) Common-emitter amplifier

(B) Common-base amplifier

(C) Common-collector amplifier

(D) R-C coupled amplifier

36. The frequency and wave number of a 300 nm line is :

(A) 10^3 MHz, 3333 cm^{-1} (B) 10^{15} Hz, 33333 cm^{-1}

(C) 10^{13} Hz, 33333 cm^{-1} (D) 10^{15} Hz, 3333 cm^{-1}

37. The total number of components observed for a $^2D_{3/2} - {}^2P_{3/2}$ transition in a weak magnetic field are :

(A) 6 (B) 10

(C) 12 (D) 14

38. The zero separation between consecutive vibrational levels of an anharmonic oscillator corresponds to :

(A) Zero point energy (B) Kinetic energy

(C) Potential energy (D) Dissociation energy

39. The Doppler broadening is proportional to :

(A) $\sqrt{T}$ (B) T

(C) T^2 (D) $T^{-1/2}$

where T is an absolute temperature of a source.

40. The sharp, principal, diffuse etc series appear in the spectra of :

(A) Alkali elements (B) Alkaline earth elements

(C) Hydrogen atom (D) Rare gas atoms

41. In case of intrinsic semiconductor Fermi energy lies :

(A) in the middle of the band gap

(B) near the conduction band edge

(C) near the valence band edge

(D) inside the conduction band

42. The density of orbitals for free electron gas in two dimension is :

(A) $\propto E^{1/2}$ (B) $\propto E^{-1/2}$

(C) $\propto E$ (D) Independent of E

43. For the X-ray diffraction of f.c.c. structure no peaks appear for indices for which :

(A) $h + k + l$ = odd integer

(B) $h + k + l$ = even integer

(C) h, k, l are partly odd and partly even

(D) all values of h, k, l

44. For n-type of semiconductor, the Hall coefficient R_H will be :

(A) +ve (B) –ve

(C) 0 (D) ∞

45. The low temperature heat capacity of insulators will be proportional to :

(A) T (B) T^2

(C) T^3 (D) T^4

46. In an experiment located deep underground the two types of cosmic rays that most commonly reach the experimental apparatus are :

(A) Positrons and electrons

(B) Alpha particles and neutrons

(C) Protons and electrons

(D) Muons and neutrinoes

47. The contribution to the total binding energy of the nucleus ${}^{A}_{Z}X$ by the surface term is proportional to :

(A) $A^{-1/3}$ (B) $A^{1/3}$

(C) $A^{2/3}$ (D) A

48. The decay chain for the ${}^{238}_{92}U$ nucleus involves eight α-decays and six β^- decays. The final nucleus at the end of the process will have :

(A) Z = 82, A = 206 (B) Z = 84, A = 224

(C) Z = 88, A = 206 (D) Z = 76, A = 200

49. The decay of a free neutron :

$$n \rightarrow p + e^- + \overline{\nu}_e$$

(A) does not occur because of strangeness conservation

(B) occurs in nature with a half life of about 1000 seconds

(C) does not occur because of energy conservation

(D) occurs in nature with half life of about 10^8 years

50. Which of the following is a pair of doubly magic muclei ?

(A) ${}^{56}_{26}Fe$ and ${}^{36}_{18}Ar$ (B) ${}^{208}_{82}Pb$ and ${}^{40}_{20}Ca$

(C) ${}^{16}_{8}O$ and ${}^{238}_{92}U$ (D) ${}^{194}_{78}Pt$ and ${}^{4}_{2}He$

ROUGH WORK

ROUGH WORK

ROUGH WORK

SEAL