Signature of Invigilators

1. .....

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PHYSICAL SCIENCE
Paper II

Roll No. | | | | | |

(In figures as in Admit Card)

Roll No. .....

.....

(In words)

JY—04/2

Name of the Areas/Section (if any).....

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. One 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.

SEAL

પરીક્ષાર્થીઓ માટેની સૂચનાઓ :

૧. આ પાનાની ટોચમાં દર્શાવેલી જગ્યામાં તમારો રોલ નંબર લખો.

૨. આ પ્રશ્નપત્રમાં કુલ **પચાસ (50)** બહુવૈકલ્પિક ઉત્તરો ધરાવતા 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] , [A]

૪. આ પ્રશ્નપત્રના જવાબ આપેલ ICR Answer Sheet ના Paper II વિભાગની નીચે આપેલ ખાનાંઓમાં 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.

PHYSICAL SCIENCE
PAPER-II

Note : This paper contains **fifty (50)** multiple-choice questions. Each question carrying **two (2)** marks. Attempt *All* the questions.

1. The number of independent solutions for third order linear differential equation could be :

   (A) 1 (B) 2

   (C) 3 (D) 4

2. The trace of an N × N unit matrix is :

   (A) Zero (B) N^2

   (C) 2N (D) N

3. In central force motion, if the force is attractive inverse square then :

   (A) <K.E.> = <P.E.> (B) <K.E.> = –<P.E.>

   (C) <K.E.> = –½<P.E.> (D) <K.E.> = ½<P.E.>

4. A satellite in an elliptical orbit around earth has perigee at 500 miles from the surface of earth and apogee at 2000 miles from the surface of earth. Radius of earth = 4000 miles and maximum speed of satellite = 16,000 miles/hour. Then its speed at apogee is :

   (A) 16,000 miles/hour (B) 14,000 miles/hour

   (C) 12,000 miles/hour (D) 8,000 miles/hour

5. The potential energy of the body with mass m, constrained to move on a straight line is kx^4, where k is constant. The body moves from x_1 at time t_1 to x_2 at time t_2. Which of the following is an extremum corresponding to this motion ?

   (A) $\int_{t_1}^{t_2} \left(\frac{1}{2}mv^2 - kx^4\right)dt$ (B) $\int_{t_1}^{t_2} \frac{1}{2}mv^2\,dt$

   (C) $\int_{x_1}^{x_2} \left(\frac{1}{2}mv^2 + kx^4\right)dt$ (D) $\int_{t_1}^{t_2} mxv\,dt$

6. Which of the following defines a conservative force $\vec{F}$?

(A) $\frac{d\vec{F}}{dt} = 0$ (B) $\vec{\nabla} \cdot \vec{F} = 0$

(C) $\vec{\nabla} \times \vec{F} = 0$ (D) $\oint \vec{F} \cdot d\vec{r} \neq 0$

7. The dispersion relation of a certain wave is $\omega = \sqrt{c^2k^2 + m^2}$ where ω is the angular frequency, k is the wave vector, c is the velocity of light and m is a constant. The group velocity v of the wave has the following properties.

(A) $v \to 0$ as $k \to 0$ and $v \to c$ as $k \to \infty$

(B) $v \to c$ as $k \to 0$ and $v \to \infty$ as $k \to \infty$

(C) $v \to 0$ as $k \to 0$ and $v \to \infty$ as $k \to \infty$

(D) $v \to c$ as $k \to 0$ and $v \to c$ as $k \to \infty$

8. Two particles approach each other with different velocities. After collision, one of them is found to have momentum $\vec{p}$ in their center of mass frame. In the same reference frame, the other particle must have momentum :

(A) zero (B) $-\vec{p}/2$

(C) $-\vec{p}$ (D) $-2\vec{p}$

9. The number of independent vibrational modes of CO_2 molecules are :

(A) 2 (B) 3

(C) 4 (D) 5

10. There is an infinitely long (along z–axis) uniformly charged cylinder of radius R. Then the electric field produced by such a cylinder is described as :

(A) $|\vec{E}| \propto r$ for $r < R$ and $|\vec{E}| \propto 1/r$ for $r > R$.

(B) $|\vec{E}| \propto \ln r$ for $r < R$ and $|\vec{E}| \propto 1/r^2$ for $r > R$.

(C) $|\vec{E}|$ = constant for $r < R$ and $|\vec{E}| \propto 1/r$ for $r > R$.

(D) $|\vec{E}| = 0$ for $r < R$ and $|\vec{E}| \propto 1/r$ for $r > R$.

11. The non–existence of magnetic monopole is a consequence of :

(A) $\vec{\nabla}\cdot\vec{J}+\partial\rho/\partial t=0$ (B) $\vec{\nabla}\cdot\vec{B}=0$

(C) $\vec{\nabla}\times\vec{E}=-\partial\vec{B}/\partial t$ (D) $\vec{\nabla}\times\vec{E}=\rho/\epsilon_0$

12. In a place where electric field $\vec{E}$ and magnetic field $\vec{B}$ are finite. A charged particle projected along the x–axis with speed v, passes undeflected and with uniform speed. We may conclude that :

(A) Such a situation is impossible

(B) x–component of $\vec{E}$ as well of x–component of $\vec{B}$ must be zero

(C) If $\vec{E}$ is along y–axis, $\vec{B}$ must be along the z–axis

(D) If $\vec{B}$ is along x–axis, $\vec{E}$ must be along the y–axis

13. A charge Q is kept at the corner of a cube. Then the flux through each side, not containing the charge is :

(A) $\frac{Q}{6\varepsilon_0}$ (B) $\frac{Q}{3\varepsilon_0}$

(C) $\frac{Q}{24\varepsilon_0}$ (D) $\frac{Q}{\varepsilon_0}$

14. Poynting's vector at the surface of a long current carrying wire, with length L, radius R, potential difference V between the ends of the wire and current I is :

(A) Pointing out from the surface of wire

(B) Pointing in the direction of wire

(C) Pointing inwards at the surface of the wire

(D) always zero as the current is constant

15. The velocity of electromagnetic wave in vaccum is given by :

(A) $1/\varepsilon_0\mu_0$ (B) $\frac{1}{\sqrt{\varepsilon_0\mu_0}}$

(C) $\sqrt{\varepsilon_0\mu_0}$ (D) ε_0/μ_0

16. The power radiated by an oscillating electric dipole is :

(A) Maximum along the direction of dipole and zero in the plane perpendicular to the dipole

(B) Zero along the dipole direction and maximum in the plane perpendicular to the dipole

(C) Uniformly distributed in all directions

(D) is always only along the dipole direction and zero in any other direction

17. An EM wave is incident normally on the surface between two dielectric media with refractive indices n_1 and n_2 respectively. If the incident wave is from medium with refractive index n_1 then :

(A) EM wave is total internally reflected if $n_2 < n_1$

(B) Reflection coefficient is $\left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$

(C) EM wave is total internally reflected if $n_1 < n_2$

(D) reflected wave is circularly polarized if the incident wave is plane polarized

18. A charge Q is placed upon a capacitor C, at a potential difference V. The potential energy stored in the capacitor is given by :

(A) $\frac{1}{2}$ QV^2 (B) $\frac{1}{2}$ CV

(C) $\frac{1}{2}$ VC^2 (D) $\frac{1}{2}$ Q^2/C

19. The electrical pontential in a region of space is given by $\phi = \phi_0 \exp(-ax^2)$, where ϕ_0 and a are constants. The charge density in the region is :

(A) zero

(B) $2a\varepsilon_0 x\phi$

(C) $2a\varepsilon_0\phi\ (1-2ax^2)$

(D) $2a\varepsilon_0\phi\ (1+2ax^2)$

20. If A and B are canonically conjugate pair of dynamical variables, quantum mechanically :

(A) $AB + BA = 0$

(B) $AB - BA = ih$

(C) $AB + BA = ih$

(D) $AB - BA = 0$

21. In the quantum mechanical context, for orbital angular momentum $\vec{L} \times \vec{L}$ is equal to :

(A) zero

(B) L^2

(C) $ih\vec{L}$

(D) infinite

22. The zero point energy of the linear harmonic oscillator :

(A) $\frac{1}{2}h w_c$

(B) $\frac{1}{2}n h w_c$

(C) $\left(n+\frac{1}{2}\right)h w_c$

(D) $n h w_c$

23. The eigen functions of L^2 are (here L is orbital angular momentum) :

(A) Gaussian functions

(B) Spherical harmonics

(C) Bloch functions

(D) Bessel functions

24. The total number of degenerate states for the second excited state of hydrogen atom are :

(A) 2

(B) 3

(C) 4

(D) 9

25. The eigenvalues of the exchange operator for a system of identical particles are :

(A) ± 1 (B) 0 and 1

(C) 0 and -1 (D) 0 and ∞

26. The momentum transfer in an elastic scattering of particles :

(A) depends on scattering angle

(B) does not depend on scattering angle

(C) Zero

(D) cannot be evaluated

27. In the stark effect the perturbation is due to :

(A) magnetic field

(B) electromagnetic radiation

(C) thermal excitations

(D) electric field

28. According to optical theorem the total scattering cross section is equal to :

(A) $4\pi/k$ (B) $f(0)$

(C) $\frac{4\pi}{k}$ Im $f(0)$ (D) $\frac{4\pi}{k} f(\theta,\phi)$

29. The eigenvectors (spinors) of Pauli's spin matrices are :

(A) 2×1 matrices

(B) 2×2 matrices

(C) 3×3 matrices

(D) 4×4 matrices

30. Which one of the following phase shifts will give information about p–wave scattering ?

(A) δ_0 (B) δ_1

(C) δ_2 (D) δ_3

31. A solid ball of metal has a spherical cavity inside it. The ball is now heated what will happen to the volume of the cavity ?

(A) Increase (B) Decrease

(C) No change (D) Shape will change

32. The internal energy U is a unique function of any state because change in U :

(A) Does not depend upon path

(B) Depends upon path

(C) Corresponds to an adiabatic process

(D) Corresponds to an isothermal process

33. The radiation emitted by a perfectly blackbody is proportional to the :

(A) T on ideal gas scale

(B) Fourth root of T on ideal gas scale

(C) Fourth power of T on ideal gas scale

(D) Source of T on ideal gas scale

34. The free electron theory explains electrical conduction on the basis of :

(A) number of electrons in each atom

(B) number of electrons only

(C) number of free electrons per unit volume

(D) change of electrons only

35. The first law of thermodynamics confirms the law of :

(A) Conservation of momentum of molecules

(B) Conservation of energy of molecules

(C) Flow of heat in a particular direction

(D) Conservation of heat energy and mechanical energy

36. Assuming that a certain star emits black body raditaion of 6000 K. The wavelength of maximum emission intensity per unit wavelength will be in the range of :

(A) 5000 Å (B) 2500 Å

(C) 3500 Å (D) 9900 Å

37. By using the Maxwell distribution of velocities one can evaluate the root mean square velocity U_r by :

(A) $\left(\frac{KT}{m}\right)^{1/2}$ (B) $\frac{3}{2}\left(\frac{KT}{m}\right)^{2}$

(C) $\left(\frac{3KT}{m}\right)^{1/2}$ (D) 3KTm

38. The degenerate electron gas follows :

(A) Maxwell Boltzmann statistics

(B) Bose–Einstein statistics

(C) Fermi–Dirac statistics

(D) None of the above

39. The discrete value of energy the atomic oscillators can have are :

(A) nhw^2 (B) $n^2 \cdot hw$

(C) nhw (D) $2nhw$

40. If the Debye's temperature of metal is 450K, the order of Debye frequency is :

(A) 10^{13} Hz (B) 10^{2} Hz

(C) 10^{23} Hz (D) 10^{-2} Hz

41. The shape of the output signal of a detector depends on :

(A) high voltage applied

(B) output RC time constant

(C) coupling capacitor and its resistance

(D) gas pressure in the detector

42. Time coincidence measurements are used for :

(A) measuring the background counts

(B) measuring the energy of the radiation

(C) measuring the pulse height of the radiation

(D) finding the desired events in the presence of a background

43. Best vaccum that can be attained with a rotary pump is :

(A) 10^{-3} Torr (B) 1 Torr

(C) 10^{-6} Torr (D) 10^{-10} Torr

44. The attenuation of γ–rays in matter is similar to :

(A) attenuation of x–rays

(B) attenuation of β–rays

(C) attenuation of neutrons

(D) attenuation of protons

45. The energy resolution of a semiconductor detector is better than the gas detector because :

(A) the atoms collide with each other in gas whereas in semiconductor they do not

(B) the amount of generated charge carriers is more in solid state detector

(C) the energy absorption is less in gas detectors

(D) semiconductor detector produce bigger output pulses

46. In a photomultiplier if each stage emits 4 secondaries per primary and there are ten stages, the gain is of the order of :

(A) 10^8 (B) 10^6

(C) 10^4 (D) 10^2

47. In Penning gauge megnet is used for :

(A) to increase the ionization probability

(B) to decrease the ionization probability

(C) to shield electromagnetic pick–up

(D) to protect from light exposure

48. The potential difference of 20 kV is applied to X–ray tube the minimum wavelength of the continuous spectrum is :

(A) 0.621 Å (B) 1.54 Å

(C) 3.2 Å (D) 1 μ

49. The reference voltage of an ADC is 1V. What is the smallest voltage step you can measure using a 12–bit converter :

(A) 24 μV

(B) 24 mV

(C) 3.9 mV

(D) 3.9 μV

50. The pre-amplifier is used for :

(A) increasing the gain of the circuit

(B) matching the impedance of device and signal measuring circuit.

(C) reducing the noise

(D) increasing the power

ROUGH WORK

ROUGH WORK