Entrance Examinations 2025

Ph.D. Physics

Marks: 70

Time: 2.00 hrs.

Hall Ticket No.: [ ]

I. Please enter your Hall Ticket Number on Page 1 of this question paper and on the OMR sheet without fail.

II. Read carefully the following instructions:

1. This Question paper has two parts: PART - A and PART - B.
2. PART-A consists of 20 objective type questions related to Research Methodology.
3. PART-B consists of 20 objective type questions related to Physics.
4. Each question carries 1.75 marks. There is no negative marking
5. Answers are to be marked on the OMR answer sheet following the instructions provided there upon. An example is shown below

100. (A) (B) (C) ●

6. Only Scientific Calculators are permitted. Mobile phone based calculators are not permitted. Logarithmic tables are not allowed.
7. Hand over the OMR sheet at the end of the examination.
8. No additional sheets will be provided. Rough work can be done in the question paper itself in the space provided at the end of the booklet.

This book contains 17 pages

III. Values of physical constants:
$c = 3 \times 10^8$ m/s; $h = 6.63 \times 10^{-34}$ J.s; $k_B = 1.38 \times 10^{-23}$ J/K
$e = 1.6 \times 10^{-19}$ C; $\mu_0 = 4\pi \times 10^{-7}$ Henry/m; $\varepsilon_0 = 8.85 \times 10^{-12}$ Farad/m

E-1

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Blank sheets are provided for rough work at the end of this booklet

E-1

Part A

1. A function $f(x)$ has a Fourier series representation as $f(x) = \sum_1^\infty a_n \sin nx + \sum_0^\infty b_n \cos nx$. The number of nonzero coefficients for the function $f(x) = 8\cos^2 x$ is

   [A] 8

   [B] 4

   [C] 1

   [D] 2

2. A motorist travels in a straight line with a velocity v for a distance d, followed by a distance $2d$ with a velocity $2v$. The average velocity is

   [A] v

   [B] $v/2$

   [C] $3v/2$

   [D] $3v/4$

3. Consider a curve defined by $y = f(x)$. If the slope of the tangent at x is proportional to x, the curve is

   [A] a circle

   [B] an ellipse

   [C] a straight line

   [D] a parabola

4. A forgetful secretary prepares three letters and three address labels. Then, the labels are pasted randomly on the letters. The probability that at least one letter reaches the right address is

   [A] 1/3

   [B] 2/3

   [C] 1/2

   [D] 1/6

5. A random variable x can take two values -1 and +1. On drawing the random variable ten times, $x = +1$ comes seven times. The mean value $\langle x \rangle$, and the variance $\langle x^2 \rangle - \langle x \rangle^2$ of the random variable, respectively are

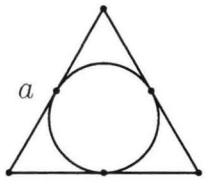
   [A] 0.4, 0.4

   [B] 0.4, 0.84

   [C] 4, 8.4

   [D] 0.5, 0.5

6. The area of the circle touching the mid points of the sides of an equilateral triangle of side a, as shown, is



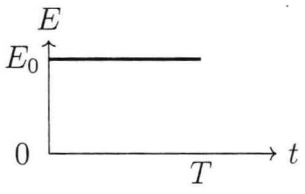
[A] $\frac{\pi a^2}{12}$

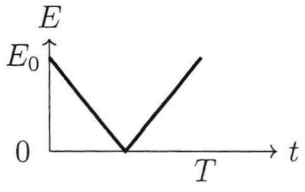
[B] $\frac{\pi a^2}{6}$

[C] $\frac{\pi a^2}{4}$

[D] $\frac{\pi a^2}{3}$

7. A particle is thrown vertically upwards, carrying an energy E_0. After a time T, it reaches the ground, traversing a vertical path. The energy of the particle as a function of the time t is given by

[A]


[B]


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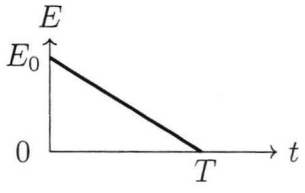

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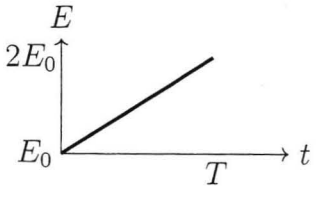


8. The probability that an integer chosen randomly is of the form $8n + 7$ (where n can take any integer value) is

[A] 1/7

[B] 1/8

[C] 1/56

[D] 7/8

E-1

9. Consider an ensemble of N classical particles in one dimension, with the total energy given by

$$E = \sum_{i=1}^{N} \left[\frac{p_i^2}{2m} + \frac{1}{2} k x_i^2 \right].$$

The average internal energy of the system at a temperature T is

[A] $3Nk_BT/2$

[B] Nk_BT

[C] $3Nk_BT$

[D] $Nk_BT/2$

10. Consider a line S described by the equation $y = ax + c$. The differential equation that represents the normal (perpendicular) to S is

[A] $\frac{dy}{dx} = -a$

[B] $\frac{dy}{dx} = \frac{1}{a}$

[C] $\frac{dy}{dx} = -\frac{1}{a}$

[D] $\frac{dy}{dx} = a$

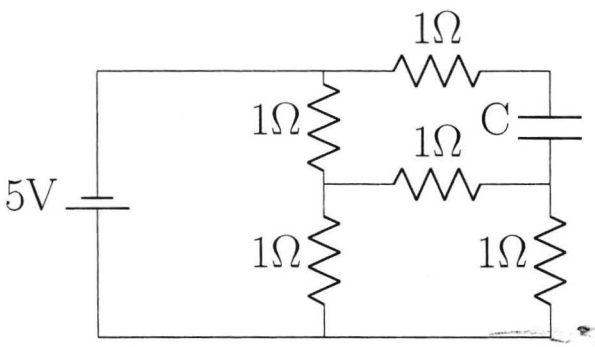
11. The potential difference across the capacitor C, when it is fully charged, shown in the circuit is

[A] 5V

[B] 4V

[C] 3V

[D] 1V



12. A box contains 5 red balls and 3 blue balls. The probability, that two balls drawn randomly are both red, is

[A] 5/8

[B] 5/16

[C] 5/14

[D] 5/7

E-1

13. The Fourier transform of a Gaussian function is

[A] a Gaussian

[B] a Lorentzian

[C] an exponential function

[D] a sine function

14. A flux of photons, with a wavelength of 632 nm, is incident on a metal, and ejects out 200 electrons per second. Now, if the wavelength of the source is changed to 316 nm, then

[A] 400 electrons per second will be ejected from the metal

[B] 100 electrons per second will be ejected from the metal

[C] 200 electrons per second will be ejected from the metal

[D] no electrons will be ejected from the metal

15. Consider a vector field given by $\vec{A}(\vec{r}) = -zy\hat{i} + xz\hat{j} + 5\hat{k}$. Then, $(\vec{\nabla} \times \vec{A}) \cdot \hat{k}$ is

[A] 5

[B] $2z$

[C] $2x$

[D] $2y$

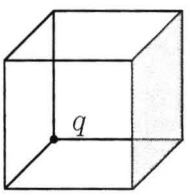
16. A charge q is placed at the back corner of the cube as shown. The electric flux through the shaded surface is

[A] $\frac{q}{\varepsilon_0}$

[B] $\frac{q}{6\varepsilon_0}$

[C] $\frac{q}{12\varepsilon_0}$

[D] $\frac{q}{24\varepsilon_0}$



17. The eigenvalues of the matrix $\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ are

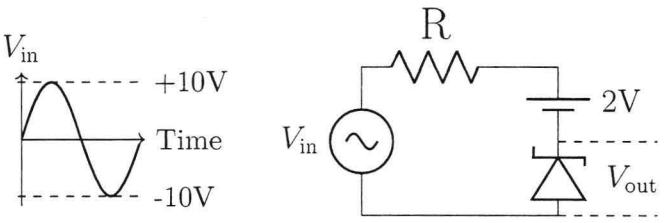
[A] 0, 2

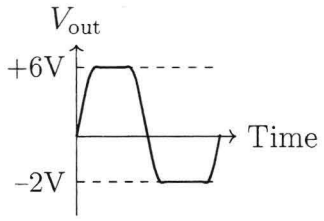
[B] 1, 2

[C] 1, 1

[D] 1, -1

18. The circuit shown consists of a battery, a resistor, and an ideal Zener diode with breakdown voltage $V_Z = 6V$. If V_{in} is a sinusoidal wave from, then V_{out} across the Zener diode is



[A]


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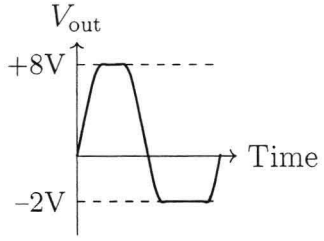

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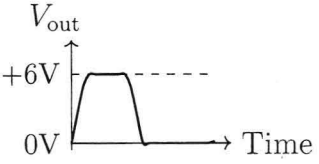

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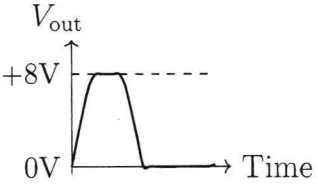


19. Consider the integral $I = \oint_C \dfrac{\sin z}{2z - \dfrac{\pi}{3}}\, dz$, where the contour C is a unit circle $|z| = 1$.

The value of I is

[A] 0

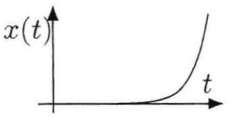
[B] $\pi i/2$

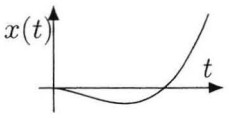
[C] πi

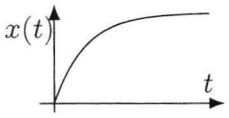
[D] $\pi i/4$

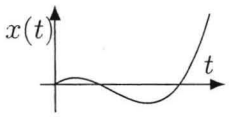
E-1

20. Consider the differential equation $c_1\dfrac{dx}{dt} + c_2x = c_3$, where c_1, c_2, and c_3 are real positive constants. The curve that represents a solution of the equation, with the initial condition $x(0) = 0$, is

[A] 

[B] 

[C] 

[D] 

Part B

21. Consider a vector field given by $\vec{A}(\vec{r}) = \hat{z}A_0\Theta(a-r)$, where A_0 is a constant, and $\Theta(a-r)$ is a Heaviside step function. Then, $\vec{\nabla}\cdot\vec{A}$ is

[A] zero everywhere

[B] nonzero for $r > a$

[C] nonzero for $r < a$

[D] nonzero on the surface at $r = a$

22. Consider two functions, $f(x) = 2x^2$ and $g(x) = x^4$. Then, the Wronskian is

[A] zero for all x, and the functions are linearly dependent

[B] zero for $x = 0$, and the functions are linearly dependent

[C] nonzero for $x \neq 0$, and the functions are linearly independent

[D] nonzero for all x, and the functions are linearly independent

23. An electromagnetic wave propagates in the z-direction, with the electric field given by $\vec{E} = E_0\cos(kz-\omega t)\hat{x}$. The instantaneous force on a particle with a charge q, moving with a velocity $\vec{u} = u_0\hat{z}$ in free space is

[A] $qE_0\cos(kz-\omega t)\hat{x}$

[B] zero

[C] $qE_0(1-\frac{u_0}{c})\cos(kz-\omega t)\hat{x}$

[D] $qE_0(1-\frac{u_0}{c})\cos(kz-\omega t)\hat{y}$

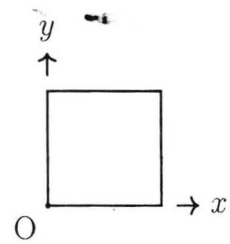
24. A square loop of wire with sides of length a, lies in the first quadrant of the xy-plane, with one corner at the origin O as shown. In this region, there is a magnetic field given by $\vec{B}(\vec{r},t) = ky^3t^2\hat{z}$, where k is a constant. The emf induced in the loop is

[A] $-ka^5t^2/2$

[B] $-ka^5t/2$

[C] $-3ka^4t^2/4$

[D] $-ka^4t^3/3$



25. In the multipole expansion of the electric potential due to a localised charge distribution, the dipole and quadrupole terms depend on the distance r from the charge distribution, respectively as

[A] $1/r^2$ and $1/r^3$

[B] $1/r^2$ and $1/r^4$

[C] $1/r$ and $1/r^2$

[D] $1/r$ and $1/r^4$

26. If a Lagrangian is given as $L = \frac{1}{2}m[\dot{\eta}^2 + \dot{\xi}^2] - \frac{1}{2}[(k_1 + k_2)\eta^2 + (k_1 - k_2)\xi^2]$, where k_1, k_2 are constants, the Hamiltonian is given by

[A] $\frac{1}{2m}[p_\eta^2 + p_\xi^2] - \frac{1}{2}(k_1 + k_2)\eta^2 - \frac{1}{2}(k_1 - k_2)\xi^2$

[B] $\frac{1}{2m}[p_\eta^2 + p_\xi^2] - \frac{1}{2}(k_1 + k_2)\eta^2 + \frac{1}{2}(k_1 - k_2)\xi^2$

[C] $\frac{1}{2m}[p_\eta^2 + p_\xi^2] + \frac{1}{2}(k_1 + k_2)\eta^2 - \frac{1}{2}(k_1 - k_2)\xi^2$

[D] $\frac{1}{2m}[p_\eta^2 + p_\xi^2] + \frac{1}{2}(k_1 + k_2)\eta^2 + \frac{1}{2}(k_1 - k_2)\xi^2$

27. Two balls are connected by a thin wire passing through a hole in a table. The balls cannot pass through the hole, so that one ball is constrained to move on the surface of the table, while the other ball can only move vertically up or down. If the length of the wire is constant, then, the number of degrees of freedom of the combined system is

[A] 1

[B] 2

[C] 3

[D] 4

28. Consider the process $K^- + p \rightarrow \pi^- + \Sigma^{*+}$. The strangeness of the Σ^{*+} hyperon is

[A] -1

[B] 0

[C] -2

[D] -3

29. The radial size of the nucleus is proportional to $A^{1/3}$, where A is the mass number. In the liquid drop model of the nucleus, the surface energy term contributing to the binding energy is proportional to

[A] A

[B] $A^{1/2}$

[C] $A^{1/3}$

[D] $A^{2/3}$

E-1

30. Consider 4 non-interacting spins with magnetic moment μ that can point either parallel or antiparallel to the magnetic field B. If the total energy is $E = -2\mu B$, then the probability that a particular spin is parallel to the magnetic field is

[A] 1/4

[B] 1/2

[C] 3/4

[D] 0

31. An atom has two energy levels with energies 0 and $k_B T_0$. At a finite temperature $T << T_0$, the heat capacity of N atoms is

[A] $Nk_B\left(\frac{T_0}{T}\right)^2 \exp\left(-\frac{T_0}{T}\right)$

[B] $Nk_B\left(\frac{T}{T_0}\right)^2 \exp\left(-\frac{T_0}{T}\right)$

[C] $N^2k_B^2\left(\frac{T_0}{T}\right)^2 \exp\left(-\frac{T_0}{T}\right)$

[D] $N^2k_B^2\left(\frac{T}{T_0}\right)^2 \exp\left(-\frac{T}{T_0}\right)$

32. The Miller indices of a plane, that intercepts the crystal axes at $3a, b/2$, and $3c$ respectively, are

[A] (161)

[B] (611)

[C] (116)

[D] (323)

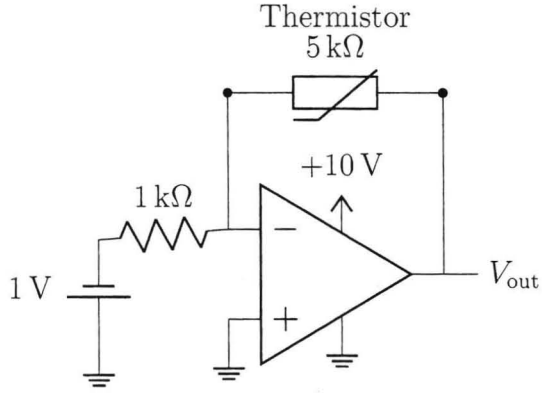
33. The circuit shown is for an ideal inverting OP-AMP, with a thermistor in the feedback path. At 30^0C, the thermistor has a resistance of 5 kΩ. The resistance of the thermistor decreases by 0.25 kΩ for every 1^0C raise in the temperature. If the temperature increases to 45^0C, the output voltage V_{out} is

[A] 2.25 V

[B] 1.25 V

[C] -2.25 V

[D] -1.25 V



34. A one-dimensional harmonic oscillator is in the state given by $|\psi(t)\rangle = \cos\omega t\ |g\rangle + \sin\omega t\ |e\rangle$, where ω is the natural frequency of the oscillator, $|g\rangle$ is the ground state, and $|e\rangle$ is the first excited state. The energy expectation value in the state at $t = \dfrac{\pi}{4\omega}$ is

[A] $\hbar\omega/2$

[B] $3\hbar\omega/2$

[C] $\hbar\omega$

[D] $2\hbar\omega$

35. For a particle in a one-dimensional box with periodic boundary conditions, we have

[A] a doubly-degenerate ground state and non-degenerate excited states

[B] a non-degenerate ground state and doubly-degenerate excited states

[C] doubly-degenerate ground and excited states

[D] non-degenerate ground and excited states

36. Consider $n = 2$ energy levels of the hydrogen atom, including the spin-orbit coupling term $(\lambda/\hbar^2)\vec{L}\cdot\vec{S}$. For the energy levels $S_{\frac{1}{2}}$ and $P_{\frac{1}{2}}$, the energy level difference $E_{S_{\frac{1}{2}}} - E_{P_{\frac{1}{2}}}$ is

[A] $\lambda/2$

[B] $-\lambda/2$

[C] λ

[D] $-\lambda$

37. A laser with a wavelength of 532 nm is passing through water of refractive index 1.34. The minimum angle of incidence, for which the light is totally reflected from the interface with air, is

[A] 30.22^o

[B] 45.22^o

[C] 42.22^o

[D] 48.22^o

E-1

38. A linearly polarized light with an initial amplitude A_0, passes through a series of N polarizers. The first polarizer is aligned along the direction of the incident polarization. Each subsequent polarizer is tilted by an angle θ relative to the polarization axis of the previous polarizer. The amplitude of the transmitted light after passing through N polarizers is

[A] $A_0 \cos^{N-1}\theta$

[B] $A_0 \cos\{(N-1)\theta\}$

[C] $A_0[1 - \cos\{(N-1)\theta\}]$

[D] $A_0[1 - \cos^{N-1}\theta]$

39. Consider a one-dimensional lattice with two atoms per unit cell of masses m and M. For $m < M$, the ratio of the maximum and the minimum frequencies of the optical phonon branch is

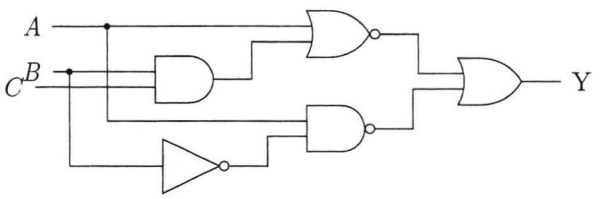
[A] $\sqrt{m/M}$

[B] $\sqrt{M/m}$

[C] $\sqrt{1 + \frac{m}{M}}$

[D] $\sqrt{1 + \frac{M}{m}}$

40. In the logic circuit shown, A, B, and C are the input signals.



The Boolean expression for the output is

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

[B] $\bar{A}B$

[C] $A\bar{B}$

[D] $A\bar{B} + CA$

E-1

Rough Work

Final key
24/6/2025

E-1

UNIVERSITY OF HYDERABAD

ENTRANCE EXAMINATIONS - 2025

PhD ADMISSIONS

SCHOOL OF PHYICS . Ph.D. PHYSICS

Question Number	Answer
1	D
2	C
3	D
4	B
5	B
6	A
7	A
8	B
9	B
10	C
11	B
12	C
13	A
14	C
15	B
16	D
17	A
18	C
19	B
20	C

Question Number	Answer
21	D
22	C
23	C
24	B
25	A
26	D
27	B
28	A
29	D
30	C
31	A
32	A
33	B
34	C
35	B
36	C
37	D
38	A
39	C
40	C

V. Nimmu

संकाय अध्यक्ष / Dean
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