THE OPTIMIST CLASSES
IIT-JAM TOPPERS

8 AIR

MANOJ KUMAR SINGH

9 AIR

ABHAY

12 AIR

PAWAN

15 AIR

SATYAM

21 AIR

SOUMIL GIRISH SAHU

29 AIR

BHOOMIJA

31 AIR

AKSHIT AGGARWAL

32 AIR

SHIKHAR CHAMOLI

33 AIR

RAVI SINGH ADHIKARI

44 AIR

GAURAV JHA

56 AIR

SWAPNIL JOSHI

65 AIR

LOKESH BHATT

75 AIR

GOPESH VISHVAKARMA

77 AIR

VAIBHAV

80 AIR

SHASWAT CHAMOLI

CSIR-NET-JRF RESULTS 2022

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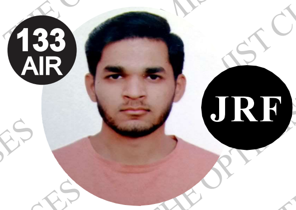


ALANKAR
UP15000162

SAHIL RANA
HR09000108

JAYESTHI
RJ11000161

DASRATH
RJ06000682

VIVEK
UK01000439

UZAIR AHMED
UP02000246

SURYA PRATAP SINGH
RJ06000232

HIMANSHU
UP10000095

CHANDAN
RJ09000159

SAIKHOM JOHNSON
MN01000196

AJAY SAINI
RJ06001744

VIKAS YADAV
RJ06001102

JYOTSNA KOHLI
UK02000262

SHYAM SUNDAR
RJ06000615

THE OPTIMIST CLASSES

AN INSTITUTE FOR NET-JRF/GATE/IIT-JAM/JEST/TIFR/M.Sc ENTRANCE EXAMS

CONTACT: 9871044043

CSIR-UGC-NET/JRF-JUNE 2018
PREVIOUS YEAR QUESTION
PHYSICAL SCIENCES

21. Consider the following ordinary differential equation

$$\frac{d^2x}{dt^2}+\frac{1}{x}\left(\frac{dx}{dt}\right)^2-\frac{dx}{dt}=0$$

with the boundary conditions $x(t=0)=0$ and $x(t=1)=1$. The value of $x(t)$ at $t=2$ is

(a) $\sqrt{e-1}$ (b) $\sqrt{e^2+1}$ (c) $\sqrt{e+1}$ (d) $\sqrt{e^2-1}$

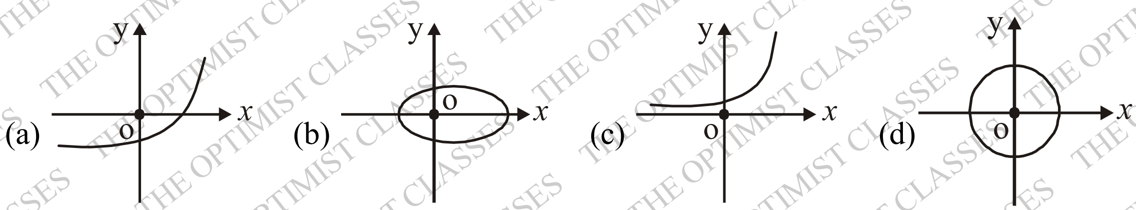
22. What is the value of a for which $f(x,y)=2x+3(x^2-y^2)+2i(3xy+ay)$ is an analytic function of complex variable $z=x+iy$.

(a) 1 (b) 0 (c) 3 (d) 2

23. Two particle A and B move with relativistic velocities of equal magnitude v, but in opposite directions, along the x-axis of an inertial frame of reference. The magnitude of the velocity of A, as seen from the rest frame of B, is

(a) $\frac{2v}{\left(1-\frac{v^2}{c^2}\right)}$ (b) $\frac{2v}{\left(1+\frac{v^2}{c^2}\right)}$ (c) $2v\sqrt{\frac{c-v}{c+v}}$ (d) $\frac{2v}{\sqrt{1-\frac{v^2}{c^2}}}$

24. Which of the following figures best describes the trajectory of a particle moving in a repulsive central potential $V(r)=\frac{\alpha}{r}$ ($\alpha>0$ is a constant)?



25. Consider the three vecotrs $\vec{v}_1=2\hat{i}+3\hat{k}, \vec{v}_2=\hat{i}+2\hat{j}+2\hat{k}$ and $\vec{v}_3=5\hat{i}+\hat{j}+a\hat{k}$ where $\hat{i},\hat{j}$ and $\hat{k}$ are the standard unit vectors in a three-dimensional Euclidean space. These vectors will be linearly dependent if the value of a is

(a) $\frac{31}{4}$ (b) $\frac{23}{4}$ (c) $\frac{27}{4}$ (d) 0

26. The Fourier transform $\int_{-\infty}^{\infty} dx f(x) e^{ikx}$ of the function $f(x) = e^{-|x|}$

(a) $-\dfrac{2}{1+k^2}$ (b) $-\dfrac{1}{2(1+k^2)}$ (c) $\dfrac{2}{1+k^2}$ (d) $\dfrac{2}{(2+k^2)}$

27. The value of the integral

$$\int_{-\pi/2}^{\pi/2} dx \int_{-1}^{+1} dy.\delta(\sin 2x)\delta(x-y) \text{ is}$$

(a) 0 (b) $\dfrac{1}{2}$ (c) $\dfrac{1}{\sqrt{2}}$ (d) 1

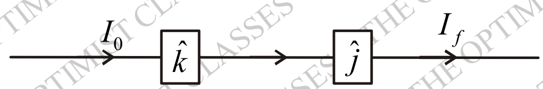
28. A particle moves in the one-dimesional potential $V(x) = ax^6$, where $a > 0$ is a constant. If the total energy of the particle is E, its time period in a periodic motion is proportional to

(a) $E^{-1/3}$ (b) $E^{-1/2}$ (c) $E^{1/3}$ (d) $E^{1/2}$

29. Two point charges $+2Q$ and $-Q$ are kept at point with Cartesian coordinates (1,0,0) and (2,0,0) respectively, in front of an infinite grounded conducting plate at $x = 0$. The potential at $(x,0,0)$ for $x \gg 1$ depends on x as

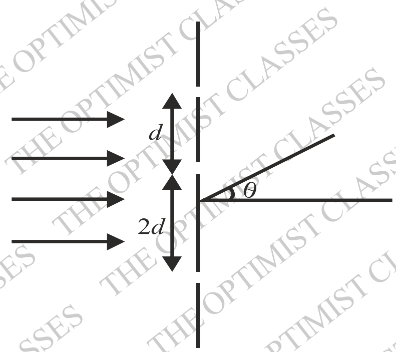
(a) x^{-3} (b) x^{-5} (c) x^{-2} (d) x^{-4}

30. Two Stern-Gerlach apparatus S_1 and S_2 are kept in a line (x-axis). The directions of their magnetic fields are along the positive z- and y- axes, respectively. Each apparatus only transmits particles with spins aligned in the direction of its magnetic field. If an initially unpolarized beam of spin $-\frac{1}{2}$ particles passes through this configuration, the ratio of intensities $I_0 : I_f$ of the initial and final beams, is



(a) 16:1 (b) 2:1 (c) 4:1 (d) 1:0

31. The following configuration of three idential narrow slits are illuminated by monochromatic light of wavelength λ (as shown in the figure below). The intensity is measured at an angle θ (where θ is the angle with the incident beam) at a large distance from the slits. If $\delta = \dfrac{2\pi d}{\lambda}\sin\theta$, the intensity is proportional to



(a) $2\cos\delta + 2\cos 2\delta$

(b) $3 + \dfrac{1}{\delta^2}\sin^2 3\delta$

(c) $3 + 2\cos\delta + 2\cos 2\delta + 2\cos 3\delta$

(d) $2 + \dfrac{1}{\delta^2}\sin^2 3\delta$

32. A particle of mass m, kept in a potential $V(x) = -\frac{1}{2}kx^2 + \frac{1}{4}\lambda x^4$, (where k and λ are positive constants), undergoes small oscillations about an equilibrium point. The frequency of oscillations is

(a) $\frac{1}{2\pi}\sqrt{\frac{2\lambda}{m}}$ (b) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (c) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$ (d) $\frac{1}{2\pi}\sqrt{\frac{\lambda}{m}}$

33. The Hamiltonian of a spin $\frac{1}{2}$ particle in a magnetic field $\vec{B}$ is given by $H = -\mu\vec{B}.\vec{\sigma}$, where μ is a real constant and $\vec{\sigma} = (\sigma_x, \sigma_y, \sigma_z)$ are the Pauli spin matrices. If $\vec{B} = (B_0, B_0, 0)$ and the spin state at time $t = 0$ is an eigenstate of σ_x, then of the expectation values $\langle\sigma_x\rangle$, $\langle\sigma_y\rangle$ and $\langle\sigma_z\rangle$

(a) Only $\langle\sigma_x\rangle$ changes with time (b) Only $\langle\sigma_y\rangle$ changes with time

(c) Only $\langle\sigma_z\rangle$ changes with time (d) All three change with time

34. A particle of mass m is constrained to move in a circular ring to radius R. When a perturbation $V' = \frac{a}{R^2}\cos^2\phi$ (where a is a real constant) is added, the shift in energy of the ground state, to first order in a, is

(a) a/R^2 (b) $2a/R^2$ (c) $a/(2R^2)$ (d) $a/(\pi R^2)$

35. A particle of mass m is confined in a three-dimensional box by the potential

$$V(x, y, z) = \begin{cases} 0, & 0 \le x, y, z \le a \\ \infty, & \text{otherwise} \end{cases}$$

The number of eigenstates of Hamiltonian with energy $\frac{9\hbar^2\pi^2}{2ma^2}$ is

(a) 1 (b) 6 (c) 3 (d) 4

36. The electric field $\vec{E}$ and the magnetic field $\vec{B}$ corresponding to the scalar and vector potentials, $V(x, y, z, t) = 0$ and $\vec{A}(x, y, z, t) = \frac{1}{2}\hat{k}\mu_0 A_0 (ct - x)$, where A_0 is a constant, are

(a) $\vec{E} = 0$ and $\vec{B} = \frac{1}{2}\hat{j}\mu_0 A_0$ (b) $\vec{E} = -\frac{1}{2}\hat{k}\mu_0 A_0 c$ and $\vec{B} = \frac{1}{2}\hat{j}\mu_0 A_0$

(c) $\vec{E} = 0$ and $\vec{B} = -\frac{1}{2}\hat{j}\mu_0 A_0$ (d) $\vec{E} = \frac{1}{2}\hat{k}\mu_0 A_0 c$ and $\vec{B} = -\frac{1}{2}\hat{j}\mu_0 A_0$

37. The electric field of a plane wave in a conducting medium is given by

$$\vec{E}(z,t) = \hat{i}E_0 e^{-z/3a}\cos\left(\frac{z}{\sqrt{3}a} - \omega t\right),$$

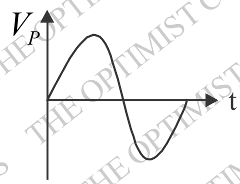
where ω is the angular frequency and $a > 0$ is a constant. The phase difference between the magnetic field $\vec{B}$ and the electric field $\vec{E}$ is

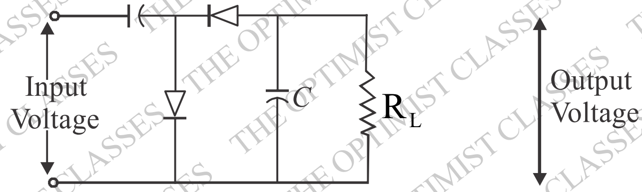
(a) $30°$ and $\vec{B}$ lags behind $\vec{B}$ (b) $30°$ and $\vec{B}$ lags behind $\vec{E}$

(c) $60°$ and $\vec{E}$ lags behind $\vec{B}$ (d) $60°$ and $\vec{B}$ lags behind $\vec{E}$

38. Which of the following statements concering the coefficient of volume expansion α and the isothermal compressibilty κ of a solid is true?
(a) α and κ are both intensive variables.
(b) α is an intensive and κ is an extensive variable.
(c) α is an extensive and κ is an intensive variable.
(d) α and κ are both extensive variables.

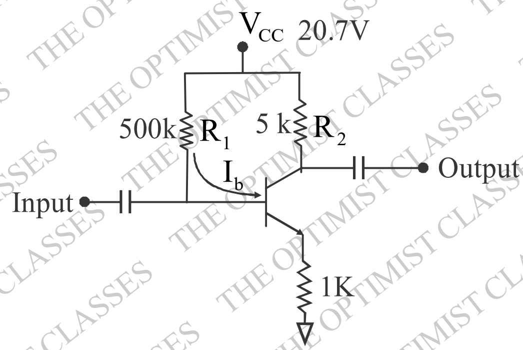
39. A sinusoidal signal with a peak voltage V_p and average value zero, is an input to the following circuit.





Assuming ideal diodes, the peak value of the output voltage across the load resistor R_L, is
(a) V_p (b) $V_p/2$ (c) $2V_p$ (d) $\sqrt{2}V_p$

40. In the following circuit, the value of the common-emitter forward current amplification factor β for the transistor is 100 and V_{BE} is $0.7\ V$.



The base current I_B is
(a) 40 μA (b) 30 μA (c) 44 μA (d) 33 μA

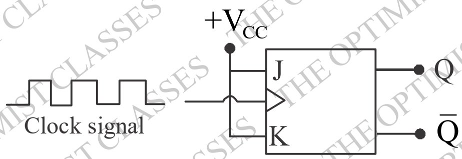
41. The number of ways of distributing 11 indistinguishable bosons in 3 different energy levels is
(a) 3^{11} (b) 11^3 (c) $\frac{(13)!}{2!(11)!}$ (d) $\frac{(11)!}{3!(8)!}$

42. The van der Waals equation for one mole of a gas is $\left(p+\frac{a}{V^2}\right)(V-b)=RT$. The corresponding equation of state of n moles of this gas at pressure P, volume V and temperature T, is
(a) $\left(p+\frac{an^2}{V^2}\right)(V-nb)=nRT$ (b) $\left(p+\frac{a^2}{V^2}\right)(V-nb)=nRT$
(c) $\left(p+\frac{an^2}{V^2}\right)(V-nb)=RT$ (d) $\left(p+\frac{a}{V^2}\right)(V-nb)=RT$

43. In a system of N distinguishable particles, each particle can be in one of two states with energies 0 and $-E$, respectively. The mean energy of the system at temperature T, is

(a) $-\frac{1}{2}N\left(1+e^{\varepsilon/k_BT}\right)$ (b) $-NE\left(1+e^{\varepsilon/k_BT}\right)$ (c) $-\frac{1}{2}NE$ (d) $-NE\left(1+e^{-\varepsilon/k_BT}\right)$

44. In the following JK flip-flop circuit, J and K inputs are tied together to $+V_{CC}$. If the input is a clock signal of frequency f, the frequency of the output Q is



(a) f (b) $2f$ (c) $4f$ (d) $\frac{f}{2}$

45. Which of the following gates can be used as a parity checker ?
(a) an OR gate
(b) a NOR gate
(c) an exclusive OR (XOR) gate
(d) an AND gate

PART - C

46. Which of the following statement is true for a real orthogonal matrix with determinant +1 ?
(a) the modulus of each of its eigenvalues need not be 1, but their product must be 1
(b) at least one of its eigenvalues is +1
(c) all of its eigenvalues must be real
(d) none of its eigenvalues must be real

47. A particle of mass m moves in a central potential $V(r)=-\frac{k}{r}$ in an elliptic orbit $r(\theta)=\frac{a(1-e^2)}{1+e\cos\theta}$, where $0\le\theta<2\pi$ and a and e denote the semi-major axis and eccentricity, respectively. If its total energy is $E=-\frac{k}{2a}$, the maximum kinectic energy is

(a) $E(1-e^2)$ (b) $E\frac{(e+1)}{(e-1)}$ (c) $E/(1-e^2)$ (d) $E\frac{(1-e)}{(1+e)}$

48. The Hamiltonian of a one-dimensional system is $H=\frac{xp^2}{2m}+\frac{1}{2}kx$, where m and k are positive constants. The corresponding Euler-Lagrange equation for the system is
(a) $m\ddot{x}+k=0$
(b) $m\ddot{x}+2\dot{x}+kx^2=0$
(c) $2mx\ddot{x}-m\dot{x}^2+kx^2=0$
(d) $mx\ddot{x}-2m\dot{x}^2+kx^2=0$

49. A hollow waveguide supports transverse electric (TE) modes with the dispersion relation $k=\frac{1}{c}\sqrt{\omega^2-\omega_{mn}^2}$ where ω_{mn} is the mode frequency. The speed of flow of electromagnetic energy at the mode frequency is

(a) c (b) ω_{mn}/k (c) 0 (d) ∞

50. The energy of a free relativistic particle is $E=\sqrt{|\vec{P}|^2c^2+m^2c^4}$, where *m* is its rest mass, $\vec{p}$ is its momentum and *c* is the speed of light in vacuum . The ratio v_g/v_p of the group velocity v_g of a quantum mechanical wave packet (describing this particle) to the phase velocity v_p is

(a) $|\vec{P}|c/E$ (b) $|\vec{P}|mc^3/E^2$ (c) $|\vec{P}|^2c^2/E^2$ (d) $|\vec{P}|c/2E$

51. In the function $P_n(x)e^{-x^2}$ of a real variable $x, P_n(x)$ is polynomial of degree *n*. The maximum number of extrema that this function can have is

(a) $n+2$ (b) $n-1$ (c) $n+1$ (d) n

52. The Green's function $G(x,x')$ for the equation $\frac{d^2y(x)}{dx^2}+y(x)=f(x)$, with the boundary values $y(0)=y\left(\frac{\pi}{2}\right)=0$, is

(a) $G(x,x')=\begin{cases} x\left(x'-\frac{\pi}{2}\right), & 0<x<x'<\frac{\pi}{2} \\ \left(x-\frac{\pi}{2}\right)x', & 0<x'<x<\frac{\pi}{2} \end{cases}$

(b) $G(x,x')=\begin{cases} -\cos x'\sin x, & 0<x<x'<\frac{\pi}{2} \\ -\sin x'\cos x, & 0<x'<x<\frac{\pi}{2} \end{cases}$

(c) $G(x,x')=\begin{cases} \cos x'\sin x, & 0<x<x'<\frac{\pi}{2} \\ \sin x'\cos x, & 0<x'<x<\frac{\pi}{2} \end{cases}$

(d) $G(x,x')=\begin{cases} x\left(\frac{\pi}{2}-x'\right), & 0<x<x'<\frac{\pi}{2} \\ x'\left(\frac{\pi}{2}-x\right), & 0<x'<x<\frac{\pi}{2} \end{cases}$

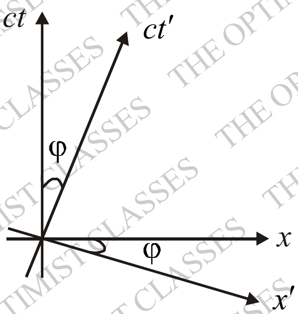
53. The fractional error in estimating the integral $\int_0^1 x\,dx$ using Simpson's $\frac{1}{3}$ rule, using a step size 0.1, is

nearest to

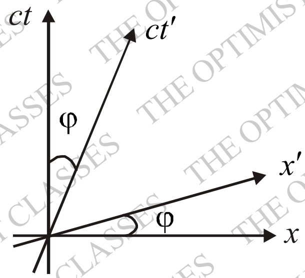
(a) 10^{-4} (b) 0 (c) 10^{-2} (d) 3×10^{-4}

54. An inertial frame K' moves with a constant speed v with respect to another inertial frame K along their common x-axis in the positive x-direction. Let (x, ct) and (x', ct') denote the space-time coordinates in the frame K and K', respectively. Which of the following space-time diagrams correctly describes the t'-axis ($x' = 0$ line) and the x'-axis ($t' = 0$ line) in the $x - ct$ plane ? (In the following figures $\tan\varphi = v/c$).

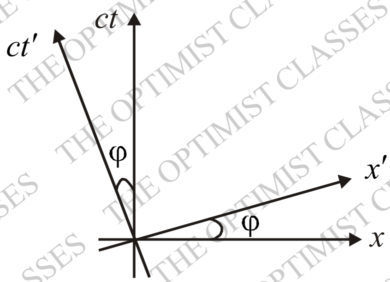
(a)



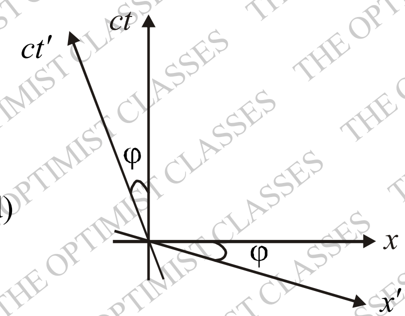
(b)



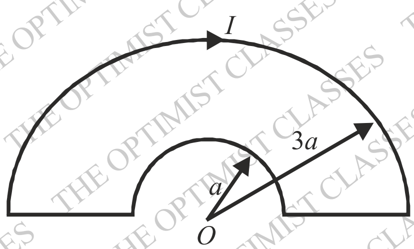
(c)



(d)



55. The loop shown in the figure below carries a steady current I.



The magnitude of the magnetic field at the point O is

(a) $\frac{\mu_0 I}{2a}$ (b) $\frac{\mu_0 I}{6a}$ (c) $\frac{\mu_0 I}{4a}$ (d) $\frac{\mu_0 I}{3a}$

56. In the region far from a source, the time dependent electric field at a point (r, θ, ϕ) is

$$\vec{E}(r,\theta,\phi) = \hat{\phi} E_0 \omega^2 \left(\frac{\sin\theta}{r}\right) \cos\left[\omega\left(t - \frac{r}{c}\right)\right]$$

where ω is angular frequency of the source. The total power radiated (average over a cycle) is

(a) $\frac{2\pi}{3}\frac{E_0^2\omega^4}{\mu_0 c}$ (b) $\frac{4\pi}{3}\frac{E_0^2\omega^4}{\mu_0 c}$ (c) $\frac{4}{3\pi}\frac{E_0^2\omega^4}{\mu_0 c}$ (d) $\frac{2}{3}\frac{E_0^2\omega^4}{\mu_0 c}$

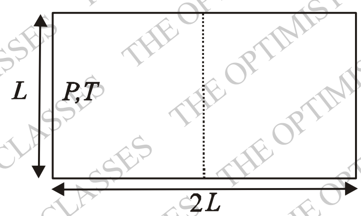
57. The pressure P of a system of N particles contained in a volumne V at a temperature T is given by $P = nk_B T - \frac{1}{2}an^2 + \frac{1}{6}bn^3$ where n is the number density and a and b are temperature independent constants. If the system exhibits a gas-liquid transition, the critical temperature is

(a) $\frac{a}{bk_B}$ (b) $\frac{a}{2b^2k_B}$ (c) $\frac{a}{2bk_B}$ (d) $\frac{a}{b^2k_B}$

58. Consider a particle diffusing in a liquid contained in a large box. The diffusion constant of the particle in the liquid is $1.0\times10^{-2}\ \text{cm}^2/\text{s}$. The minimum time after which the root-mean-squared displacement becomes more than 6 cm is

(a) 10 min (b) 6 min (c) 30 min (d) $\sqrt{6}$ min

59. A thermally insulated chamber of dimensions $(L, L, 2L)$ is partitioned in the middle. One side of the chamber is filled with n moles of an ideal gas at a pressure P and temperature T, while the other side is empty. At $t = 0$, the partition is removed and the gas is allowed to expand freely. The time to reach equilibrium varies as



(a) $n^{1/3}L^{-1}T^{1/2}$ (b) $n^{2/3}LT^{-1/2}$ (c) $n^0LT^{-1/2}$ (d) $nL^{-1}T^{1/2}$

60. Two signals $A_1\sin(\omega t)$ and $A_2\cos(\omega t)$ are fed into the input and the reference channels, respectively, of a lock-in amplifier. The amplitude of each signal is $1\,V$. The time constant of the lock-in amplifier is such that any signal of frequency larger thn ω is filtered out. The output of the lock-in amplifier is

(a) $2V$ (b) $1V$ (c) $0.5V$ (d) $0V$

61. The maximum intensity of solar radiation is at the wavelength of $\lambda_{\text{sun}} \sim 5000$ Å and corresponds to its surface temperature $T_{\text{sun}} \sim 10^4 K$. If the wavelength of the maximum intensity of an X-ray star is 5Å , its surface temperature is of the order of

(a) $10^{16} K$ (b) $10^{14} K$ (c) $10^{10} K$ (d) $10^7 K$

62. The full scale of a 3-bit digital-to-analog (DAC) converter is $7V$. which of the following tables represents the output voltage of this 3-bit DAC for the given set of input bits ?

(a)

Input bits	output voltage
000	0
001	1
010	2
011	3

(b)

Input bits	output voltage
000	0
001	1.25
010	2.5
011	3.75

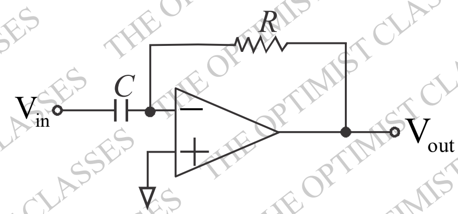
(c)

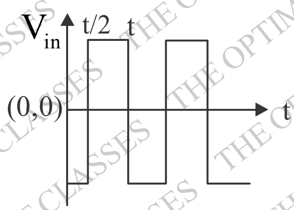
Input bits	output voltage
000	1.25
001	2.5
010	3.75
011	5

(d)

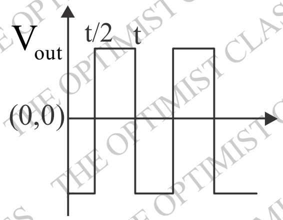
Input bits	output voltage
000	1
001	2
010	3
011	4

63. The input V_i to the following circuit is a square wave as shown in the following figure: Which of the waveforms V_0 best describes the output ?

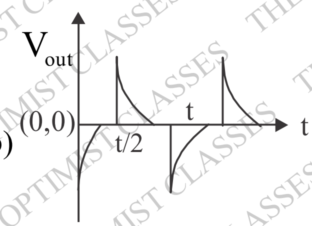




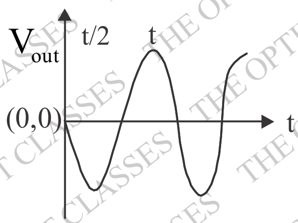
(a)



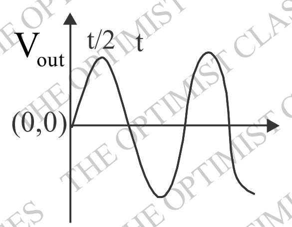
(b)



(c)



(d)



64. The n-th energy eigenvalue E_n of a one-dimensional Hamiltonian $H = \frac{p^2}{2m} + \lambda x^4$, (where $\lambda > 0$ is a constant) in the WKB approximation, is proportiaonal to

(a) $\left(n+\frac{1}{2}\right)^{4/3} \lambda^{1/3}$ (b) $\left(n+\frac{1}{2}\right)^{4/3} \lambda^{2/3}$ (c) $\left(n+\frac{1}{2}\right)^{5/3} \lambda^{1/3}$ (d) $\left(n+\frac{1}{2}\right)^{5/3} \lambda^{2/3}$

65. The differnital scattering cross section $d\sigma/d\Omega$ for the central potential $V(r) = \frac{\beta}{r} e^{-\mu r}$, where β and μ are positive constants, is calculated in the first Born approximation. Its dependence on the scattering angle θ is proportiaonal to (A is a constant below).

(a) $\left(A^2 + \sin^2\frac{\theta}{2}\right)$ (b) $\left(A^2 + \sin^2\frac{\theta}{2}\right)^{-1}$ (c) $\left(A^2 + \sin^2\frac{\theta}{2}\right)^{-2}$ (d) $\left(A^2 + \sin^2\frac{\theta}{2}\right)^{2}$

66. At $t = 0$, the wavefunction of an otherwise free particle confined between two infinite walls at $x = 0$ and $x = L$ is $\psi(x, t=0) = \sqrt{\frac{2}{L}}\left(\sin\frac{\pi x}{L} - \sin\frac{3\pi x}{L}\right)$. Its wavefunction at a later time is $t = \frac{mL^2}{4\pi\hbar}$

(a) $\sqrt{\frac{2}{L}}\left(\sin\frac{\pi x}{L} - \sin\frac{2\pi x}{L}\right)e^{-i\pi/6}$ (b) $\sqrt{\frac{2}{L}}\left(\sin\frac{\pi x}{L} + \sin\frac{3\pi x}{L}\right)e^{-i\pi/6}$

(c) $\sqrt{\frac{2}{L}}\left(\sin\frac{\pi x}{L} - \sin\frac{3\pi x}{L}\right)e^{-i\pi/8}$ (d) $\sqrt{\frac{2}{L}}\left(\sin\frac{\pi x}{L} + \sin\frac{3\pi x}{L}\right)e^{-i\pi/8}$

67. Sodium Choride (*NaCl*) crystal is a face-centered cubic lattice with a basis consisting of Na^+ and Cl^- ions separated by half the body diagonal of a unit cube. Which of the planes corresponding to the Miller indices given below will not give rise to Bragg reflection of *X*-rays ?

(a) (220) (b) (242) (c) (221) (d) (311)

68. The dispersion relation for the electrons in the conduction band of a semiconductor is given by $E = E_0 + \alpha k^2$ where α and E_0 are constants. If ω_c is the cyclotron resonance frequency of the conduction band electrons in a magnetic field *B*, the value of α is

(a) $\frac{\hbar^2\omega_c}{4eB}$ (b) $\frac{2\hbar^2\omega_c}{eB}$ (c) $\frac{\hbar^2\omega_c}{eB}$ (d) $\frac{\hbar^2\omega_c}{2eB}$

69. Hard disc of radius *R* are arranged in a two-dimensional triangular lattice. What is the fractional area occupied by the discs in the closest possible packing?

(a) $\frac{\pi\sqrt{3}}{6}$ (b) $\frac{\pi}{3\sqrt{2}}$ (c) $\frac{\pi\sqrt{2}}{5}$ (d) $\frac{2\pi}{7}$

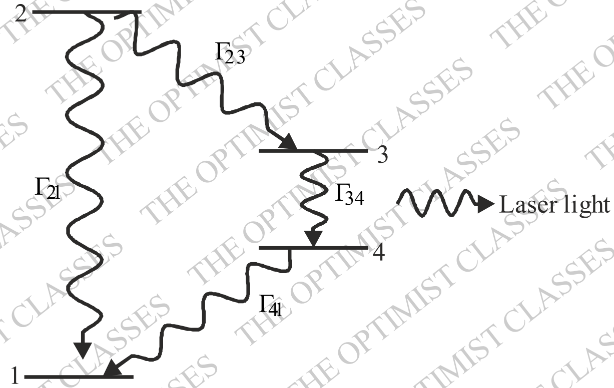
70. A photon of energy 115.62 *keV* ionizes a *K*-shell electron of a *Be* atom. One *L*- shell electron jumps to the *K*-shell to fill this vacancy and emits a photon of energy 109.2 *keV* in the process. If the ionization potential for the *L*-shell is 6.4 *keV*, the kinetic energy of the ionized electron is

(a) 6.42*KeV* (b) 12.82*keV* (c) 20*eV* (d) 32*eV*

71. The value of the Lande *g* - factor for a fine-structure level defined by the quantum number $L = 1, J = 2$ and $S = 1$, is

(a) $\frac{11}{6}$ (b) $\frac{4}{3}$ (c) $\frac{8}{3}$ (d) $\frac{3}{2}$

72. The electronic energy level diagram of a molecule is shown in the following figure,



Let Γ_{ij} denote the decay rate for a transition from the level to i to j. The molecules are optically pumed from level 1 to 2. For the transition from level 3 to level 4 to be a lassing transition, the decay rates have to satisfy

(a) $\Gamma_{21} > \Gamma_{23} > \Gamma_{41} > \Gamma_{34}$ (b) $\Gamma_{21} > \Gamma_{41} > \Gamma_{23} > \Gamma_{34}$

(c) $\Gamma_{41} > \Gamma_{23} > \Gamma_{21} > \Gamma_{34}$ (d) $\Gamma_{41} > \Gamma_{21} > \Gamma_{34} > \Gamma_{23}$

73. The reaction $^{63}\text{Cu}_{29} + p \rightarrow ^{63}\text{Zn}_{30} + n$ is followed by a prompt β-decay of zinc.
$^{63}\text{Zn}_{30} \rightarrow ^{63}\text{Cu}_{29} + e^{+} + \nu_e$. If the maximum energy of the position is 2.4 MeV, the Q-value of the original reaction in MeV is nearest to
[Take the masses of electrons, proton and neutron to be 0.5 MeV/c^2, 938MeV/c^2 and 939.5 MeV/c^2, respectively].

(a) –4.4 (b) –2.4 (c) –4.8 (d) –3.4

74. A deutron d captures charged pion π^- in the $l = 1$ state, and subsequently decays into a pair of neutrons (n) via strong interaction. Given that the intrinsic paritinsic of π^-, d and n are –1, +1 and +1 respectively, the spin wavefunction of the final state neutrons is

(a) linear combination of a singlet and a triplet (b) singlet

(c) triplet (d) doublet

75. Which of the following elementary particle processes does not conserve strangeness ?

(a) $\pi^0 + p \rightarrow K^+ + \Lambda^0$ (b) $\pi^- + p \rightarrow K^0 + \Lambda^0$

(c) $\Delta^0 \rightarrow \pi^0 + n$ (d) $K^0 \rightarrow \pi^+ + \pi^-$

ANSWER KEY

21. (c)	22. (a)	23. (b)	24. (c)	25. (a)	26. (b)	27. (b)
28. (a)	29. (d)	30. (c)	31. (c)	32. (c)	33. (d)	34. (c)
35. (c)	36. (b)	37. (*)	38. (a)	39. (c)	40. (*)	41. (c)
42. (a)	43. (d)	44. (d)	45. (c)	46. (b)	47. (b)	48. (c)
49. (c)	50. (c)	51. (c)	52. (b)	53. (b)	54. (b)	55. (b)
56. (b)	57. (c)	58. (a or c)	59. (c)	60. (d)	61. (d)	62. (a)
63. (*)	64. (a)	65. (c)	66. (d)	67. (c)	68. (d)	69. (a)
70. (c)	71. (d)	72. (*)	73. (a)	74. (b)	75. (d)	