

Ph.D. Entrance Examination of PHYSICS

Q1. Which of the following is a tensor of order '0'.

- a) $\vec{A} + \vec{B}$
- b) $\vec{A} - \vec{B}$
- c) $\vec{A} \cdot \vec{B}$
- d) $\vec{A} \times \vec{B}$

Q2. The inverse Laplace transform of $\frac{s+1}{s^2-4}$ is given by

- a) $\cos 2x + \frac{1}{2} \sin 2x$
- b) $\cos x + \frac{1}{2} \sin x$
- c) $\cosh x + \frac{1}{2} \sinh x$
- d) $\cosh 2x + \frac{1}{2} \sinh 2x$

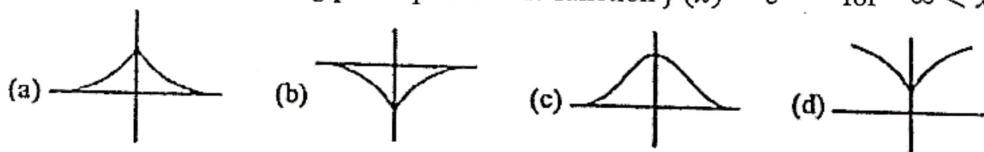
Q3. The residue of the function $f(z) = 1/z(z+2)^2$ at $z = -2$ is

- a) $-1/4$
- b) $-1/2$
- c) $-\pi i/2$
- d) $4\pi i$

Q4. The trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules are exact for polynomial of order

- a) 1,2,4 respectively
- b) 1,2,3 respectively
- c) 1,3,4 respectively
- d) 2,3,4 respectively

Q5. Which of the following plot represent the function $f(x) = e^{-|x|}$ for $-\infty < x < \infty$



Q 6. Consider a Hamiltonian system with a potential energy function given by $V(x) = x^2 - x^4$. If a particle of mass $m=1$ oscillates about a stable point, then time period of oscillation is given by

- a) $\sqrt{2}\pi$
- b) 2π
- c) $\pi/\sqrt{2}$
- d) $\pi/2$

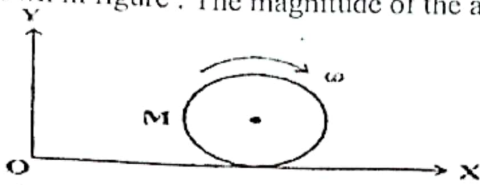
Q 7. If a generalized co-ordinate has the dimensions of momentum, the generalized velocity will have the dimensions of

- a) Acceleration
- b) Torque
- c) Velocity
- d) Force

Q8. A particle is moving in an inverse square force field. If the total energy of the particle is positive, then trajectory of the particle is

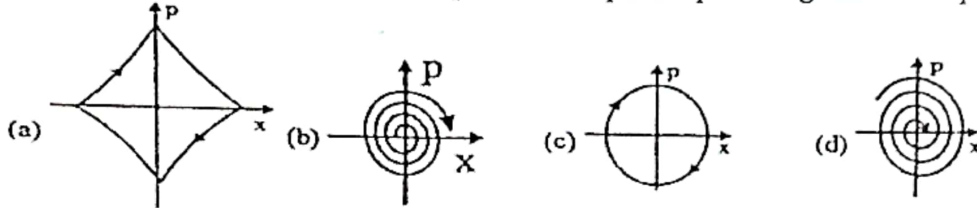
- a) Circular
- b) Elliptical
- c) Parabolic
- d) Hyperbolic

Q9. A disc of mass M and radius R is rolling with angular velocity ω on a horizontal plane as shown in figure. The magnitude of the angular momentum of the disc about the origin O is



- a) $\frac{1}{2}MR^2\omega$ b) $MR^2\omega$
 c) $\frac{3}{2}MR^2\omega$ d) $2MR^2\omega$

Q 10. A bob of a simple pendulum, which undergoes small oscillations, is immersed in water. Which of the following figure best represents the phase space diagram for the pendulum



Q 11. A conducting sphere of radius R has charge Q on its surface. If the charge on the sphere is doubled and its radius is halved, the energy associate with the electric field will

- a) Increase four times b) Increase eight times
 c) Remain the same d) Decrease four times

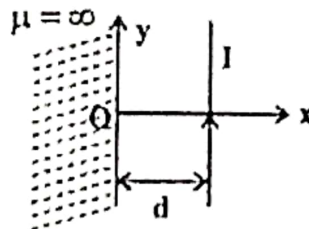
Q 12. A charge $-q$ is kept at a distance of $2R$ from the center of a grounded conducting sphere of radius R . The image charge and its distance from the center are, respectively

- a) $-q$ and $R/2$
 b) $-q/2$ and $R/4$
 c) $-q/2$ and $R/2$
 d) $+q/2$ and $R/2$

Q 13. Which of the following magnetic vector potential gives rise to uniform magnetic field $-B_0\hat{k}$?

- a) $B_0z\hat{k}$
 b) $\frac{B_0}{2}(y\hat{i} + x\hat{j})$
 c) $\frac{B_0}{2}(-y\hat{i} + x\hat{j})$
 d) $-B_0x\hat{j}$

Q.14 A long thin wire carrying current 'I' lies parallel to and at a distance 'd' from a semi-infinite slab of iron of infinite permeability ($\mu = \infty$) as shown in the figure given below. The force per unit length on the wire is



- a) $\frac{\mu_0 I^2}{2\pi d} \hat{y}$ b) $\frac{\mu_0 I^2}{2\pi d} \hat{x}$
 c) $\frac{\mu_0 I^2}{4\pi d} \hat{z}$ d) $\frac{\mu_0 I^2}{4\pi d} \hat{x}$

- Q 15. Find the value of commutator $[L_z, \cos\phi]$ where ϕ is azimuthal angle and $\cos\phi$ is operator
- 0
 - $i\hbar\sin\phi$
 - $i\hbar\cos\phi$
 - $-i\hbar\sin\phi$

- Q 16. If σ_x, σ_y and σ_z are Pauli spin matrix related to x, y and z direction then value of $(\sigma_x + \sigma_y)^2$ is
- $2I$
 - $4I$
 - $2I + 2i\sigma_z$
 - $2I - 2i\sigma_z$

- Q17. Using the WKB approximation the allowed energies of the nth state (for large n) of particle of mass m moving in the potential $V(x) = kx^8$, where k is any constant, is given by

- $E_n \sim n^{4/5}$
- $E_n \sim n^{4/3}$
- $E_n \sim n^{5/4}$
- $E_n \sim n^{8/5}$

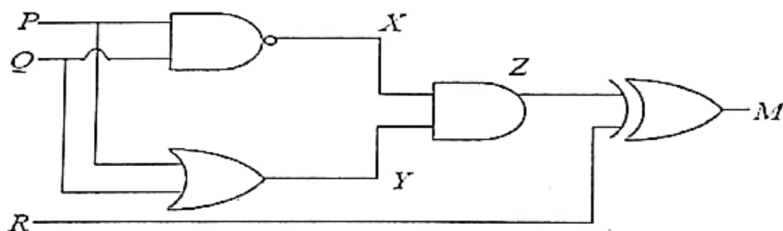
- Q18. Which quantity is said to be degenerate when $H\Psi_n = E_n\Psi_n$?

- Eigen vector
- Eigen value
- Eigen functions
- operators

- Q19. A hydrogen atom is in the state $\psi = \sqrt{\frac{8}{21}}\psi_{200} - \sqrt{\frac{3}{7}}\psi_{310} + \sqrt{\frac{4}{21}}\psi_{321}$ where n, l, m in ψ_{nlm} denote the principal, orbit and magnetic quantum numbers respectively. If energy is measured on state what will be the probability to get lower energy eigen value?

- $\frac{8}{21}$
- $\frac{3}{7}$
- $\frac{4}{21}$
- $\frac{13}{21}$

- Q20. Which of the following Boolean expression correctly represents the relation between P, Q, R and M?

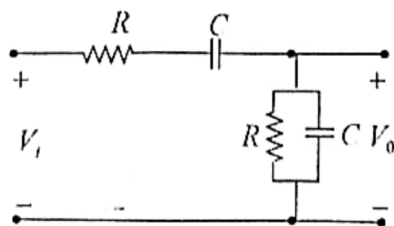


- $M = (P \text{ OR } R) \text{ XOR } R$
- $M = (P \text{ AND } Q) \text{ XOR } R$
- $M = (P \text{ NOR } Q) \text{ XOR } R$
- $M = (P \text{ XOR } Q) \text{ XOR } R$

- Q 21. An oscillator differ from an amplifier because

- it has more gain
- it requires no input signal
- it requires no DC supply
- it always has the same output

- Q.22 The RC circuit shown in the figure is



- a) A low pass filter
- b) A high pass filter
- c) A band pass filter
- d) A band reject filter

Q 23. The voltage output from a transducer has a steady value of 0.95V with a fluctuating component of 0.35 V r.m.s. If the noise figure of the transducer is 1.3. What is the signal to noise ratio in the measured quantity ?

- a) 0.35
- b) 3.5
- c) 0.95
- d) 9.5

Q 24. Assume that the potential energy between a pair of atoms in the field of each other is given by $U(r) = -\frac{\alpha}{r^6} + \frac{\beta}{r^{12}}$. The equilibrium interatomic separation will be

- a) $\frac{2\beta}{\alpha}$
- b) $\frac{\beta}{\alpha}$
- c) $(\frac{\alpha}{2\beta})^{1/6}$
- d) $(\frac{2\beta}{\alpha})^{1/6}$

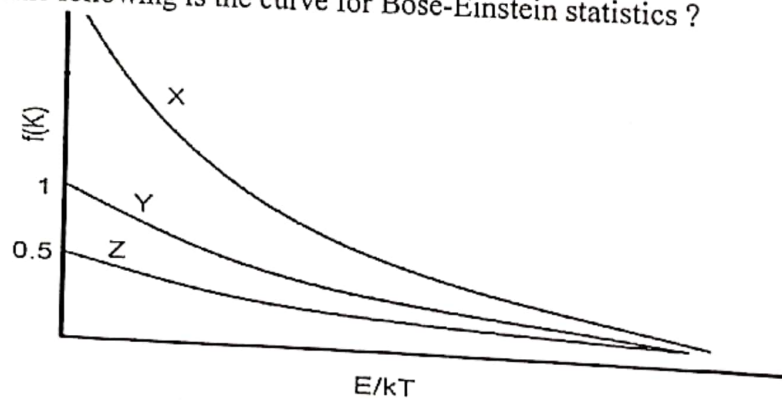
Q25. If Z be the partition function and $\beta = \frac{1}{kT}$ then the average energy of the system is given by

- a) $-\frac{\partial}{\partial \beta} \ln Z$
- b) $-\frac{\partial}{\partial \beta} \ln Z$
- c) $-\beta \frac{\partial \ln Z}{\partial \beta}$
- d) $\frac{\partial \ln Z}{\partial \beta \beta}$

Q 26. Consider a system whose three energy levels are given by 0, 0, ϵ and 2ϵ . The energy level ϵ is two-fold degenerate and the other two are non-degenerate. The partition function of the system with $\beta = 1/k_B T$ is given by

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

Q 27. Which of the following is the curve for Bose-Einstein statistics ?



- a) X
- b) Z
- c) Y
- d) None of the above

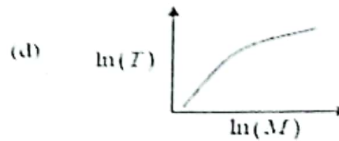
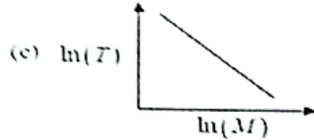
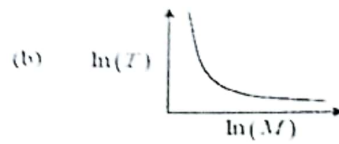
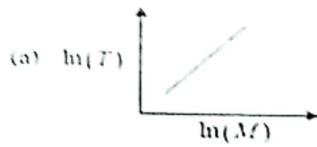
Q 28. The rotational energy levels of a diatomic molecule are

- a) Continuous
- b) Discrete and equispaced
- c) Discrete but not equispaced
- d) Nothing can be said

Q 29. The Lande g factor for 5F_2 state is

- a) 3
- b) 2/3
- c) 1
- d) 0

Q30. Isotope effect in superconductor is represented by



Q31. The ratio between third and first nearest neighbor in FCC lattice is

- a) $\frac{1}{\sqrt{3}}$ b) $\sqrt{3}$
 c) 2 d) $\frac{1}{2}$

Q32. If p represents the number of atoms in the primitive unit cell and N represents the total primitive unit cell in solid, then the number of optical modes of vibration in solid are

- a) $3N-3$ b) $3p-3$
 c) $3pN-3N$ d) $3pN-3$

Q33. The maximum radius of the interstitial sphere that can fit into the void between the body centered atom of bcc structure is

- a) $0.155 r$ b) $1.255 r$
 c) $2 r$ d) $3.551 r$

Q34. The number of Zeeman component components for ${}^1F_3 \rightarrow {}^1D_2$ transition are

- a) 15 b) 9
 c) 6 d) 3

Q35. Which one of the following electronic transitions in Neon is not responsible for LASER action in a Helium - neon laser .

- a) $6s \rightarrow 5p$ b) $5s \rightarrow 4p$
 c) $5s \rightarrow 3p$ d) $4s \rightarrow 3p$

Q36. The nuclear spins of ${}^6C^{14}$ and ${}^{12}Mg^{25}$ nuclei are

- a) zero and half integer b) half integer and zero
 c) an integer and half integer d) both half integers

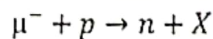
Q37. Decay of μ -meson support the concept of

- a) relativity of energy b) time dilation
 c) length contraction d) relativity of mass

Q38. The reaction $e^+ + e^- \rightarrow \gamma$ is forbidden because,

- a) Lepton number is not conserved
 b) Linear momentum is not conserved
 c) Angular momentum is not conserved
 d) Charge is not conserved

Q39. The unknown particle in the following reaction is



- a) $\bar{\nu}_e$ b) ν_e
 c) ν_μ d) $\bar{\nu}_\mu$

Q40. Three identical spin $-\frac{1}{2}$ fermions are to be distributed in three non-degenerate distinct energy levels. The number of ways this can be done is

- a) 30
 b) 20
 c) 6
 d) 1

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Answer Key for Ph.D. Entrance Examination of Physics

Q. No	Answer
1	c
2	d
3	a
4	b
5	a
6	a
7	d
8	d
9	c
10	b
11	b
12	d
13	d
14	c
15	b
16	a
17	b
18	c
19	a
20	d
21	b
22	c
23	b
24	d
25	b
26	c
27	c
28	c
29	c
30	c
31	b
32	c
33	a
34	a
35	c
36	c
37	b
38	b
39	c
40	b

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