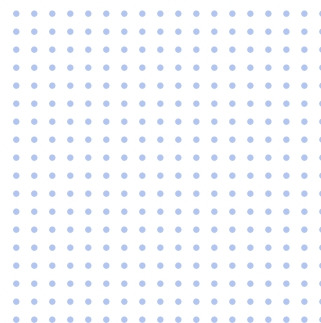




FOR KUET EXAM PREPARATION

KUET 2024 Question Paper · M.Sc. Physics

EXAM	YEAR	TYPE	SUBJECT
KUET	2024	Question Paper	M.Sc. Physics

Sr. No. 261

ENTRANCE TEST-2024**SCHOOL OF PHYSICAL & MATHEMATICAL SCIENCES****PHYSICS**

Question Booklet Series

A

Total Questions : 60

Time Allowed : 70 Minutes

Roll No. :

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Instructions for Candidates :

1. Write your Entrance Test Roll Number in the space provided at the top of this page of Question Booklet and fill up the necessary information in the spaces provided on the OMR Answer Sheet.
2. OMR Answer Sheet has an Original Copy and a Candidate's Copy glued beneath it at the top. While making entries in the Original Copy, candidate should ensure that the two copies are aligned properly so that the entries made in the Original Copy against each item are exactly copied in the Candidate's Copy.
3. All entries in the OMR Answer Sheet, including answers to questions, are to be recorded in the Original Copy only.
4. Choose the correct / most appropriate response for each question among the options A, B, C and D and darken the circle of the appropriate response completely. The incomplete darkened circle is not correctly read by the OMR Scanner and no complaint to this effect shall be entertained.
5. Use only blue/black ball point pen to darken the circle of correct/most appropriate response. In no case gel/ink pen or pencil should be used.
6. Do not darken more than one circle of options for any question. A question with more than one darkened response shall be considered wrong.
7. There will be '**Negative Marking**' for wrong answers. Each wrong answer will lead to the deduction of 0.25 marks from the total score of the candidate.
8. Only those candidates who would obtain positive score in Entrance Test Examination shall be eligible for admission.
9. Do not make any stray mark on the OMR sheet.
10. Calculators and mobiles shall not be permitted inside the examination hall.
11. Rough work, if any, should be done on the blank sheets provided with the question booklet.
12. OMR Answer Sheet must be handled carefully and it should not be folded or mutilated in which case it will not be evaluated.
13. Ensure that your OMR Answer Sheet has been signed by the Invigilator and the candidate himself/herself.
14. At the end of the examination, hand over the OMR Answer Sheet to the invigilator who will first tear off the original OMR sheet in presence of the Candidate and hand over the Candidate's Copy to the candidate.

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[Turn over]

SEAL

1. A unit cell of a lattice has the following primitive vectors :

$$\vec{a}_1 = \frac{a}{2}(\hat{i} + \hat{j})$$

$$\vec{a}_2 = \frac{a}{2}(\hat{j} + \hat{k})$$

$$\vec{a}_3 = \frac{a}{2}(\hat{i} + \hat{k})$$

The reciprocal lattice corresponding to the above direct lattice is

- (A) Face centred cubic
(B) Body centred cubic
(C) Simple cubic
(D) Hexagonal
2. Which of the following statement is correct for an anomalously dispersive medium ?
- (A) Phase velocity of waves, v_p is greater than the Group velocity, v_g
(B) Phase velocity of waves, v_p is equal to the Group velocity, v_g
(C) Phase velocity of waves, v_p is less than the Group velocity, v_g
(D) $\frac{dv_p}{d\lambda} < 0$, where λ represents the wavelength
3. The quantum mechanical operator for the kinetic energy of radial motion for a free particle is given by :

(A) $\frac{\hbar}{2m} \left[-\frac{d^2}{dr^2} - \frac{2}{r} \frac{d}{dr} \right]$

(B) $-\frac{\hbar^2}{2m} \left[-\frac{d^2}{dr^2} - \frac{2}{r} \frac{d}{dr} \right]$

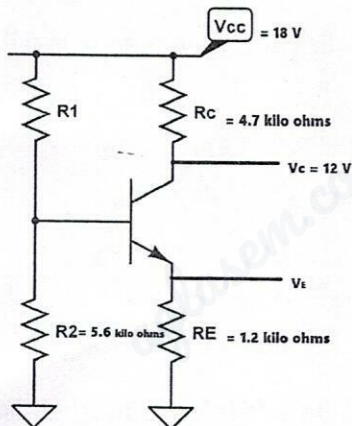
(C) $\frac{\hbar^2}{2m} \left[-\frac{1}{r^2} \frac{d^2}{dr^2} - \frac{d}{dr} \right]$

(D) $-\frac{\hbar^2}{2m} \left[-\frac{1}{r^2} \frac{d^2}{dr^2} - \frac{d}{dr} \right]$

At low temperatures, the behaviour of the electronic contribution to the specific heat, C_v of a normal metal will depend as a function of temperature T :

- (A) C_v is proportional to T
(B) C_v is proportional to T^3
(C) C_v is proportional to T^2
(D) C_v is inversely proportional to T
5. Which of the following is not the fundamental principle of quantum mechanics ?
- (A) Principle of superposition of states
(B) Bohr angular momentum quantization principle
(C) Pauli exclusion principle
(D) Uncertainty Principle
6. Which of the following is correct in Fresnel type of diffraction ?
- (A) The distance between the source or the observation screen or both of them are at an infinite distance from the diffracting aperture
(B) The distance between the source or the observation screen or both of them are at finite distances from the diffracting aperture
(C) The wave fronts falling on the diffracting aperture or reaching the observation screen will be plane wave fronts
(D) None of the above statements is correct

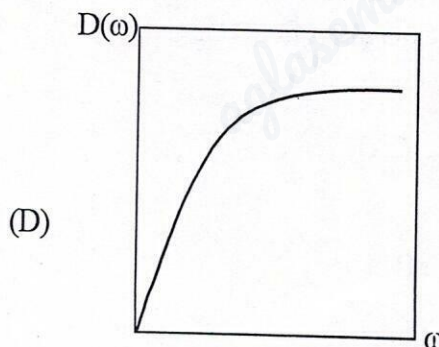
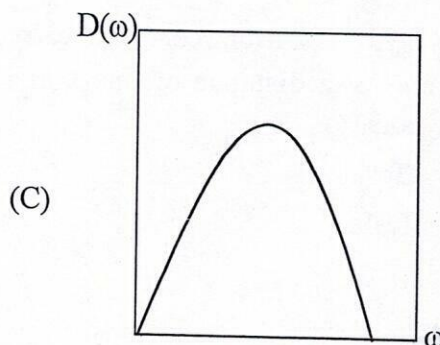
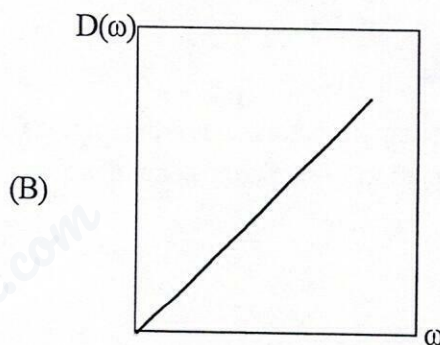
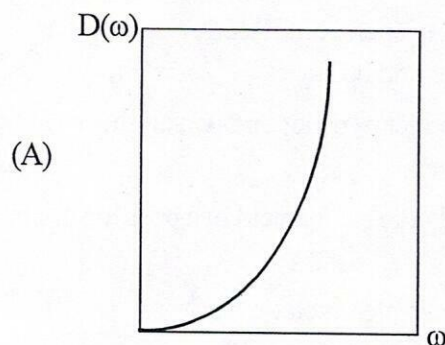
7. In the given circuit employing a voltage-divider biasing method, the value of emitter voltage V_E is approximately equal to :



- (A) 2.25 V
(B) 1.54 V
(C) 12 V
(D) 2.54 V
8. Which of the following statement is not correct ?
(A) One of the most important characteristics of the FET is its low input impedance
(B) FETs are more temperature stable than BJTs
(C) The output impedance of FETs is similar in magnitude to that of conventional BJTs
(D) There is no direct electrical connection between the gate terminal and the channel of a MOSFET
9. A quantized lattice vibration mode (phonon) can be represented by a harmonic oscillator, which has a characteristic frequency ω , wave vector q , then according to quantum theory, the energy of the oscillator is given by

- (A) $E = \frac{h\omega}{2\pi} \left(n + \frac{1}{2} \right)$
(B) $E = \frac{h\omega}{2\pi} (n+1)$
(C) $E = \frac{h\omega}{4\pi} \left(n + \frac{1}{2} \right)$
(D) $E = \frac{h\omega}{4\pi} (n+1)$

10. If the dispersion relation between ω and q is $\omega = uq$, where 'u' is the velocity of sound, then the plot of phonon density of states as a function of frequency is best represented by :



11. If n_0 and p_0 denote the equilibrium electron and hole densities in a semiconductor, then the product, $n_0 p_0$:
- Does not depend on Temperature
 - Depends on Band gap energy only
 - Does not depend on Effective mass of electrons and holes
 - The product $n_0 p_0$ depends on all the above parameters
12. An electric charge can be held in a position of stable equilibrium :
- by a purely electrostatic field
 - by a mechanical force
 - by a magnetic field
 - none of the above
13. If $\mathbf{P}$ is the polarization vector and $\mathbf{E}$ is the electric field, then in the equation $\mathbf{P} = \alpha \mathbf{E}$, α in general is :
- scalar
 - vector
 - tensor
 - none of the above
14. The magnetic field due to a long conductor carrying 30,000 amperes at a distance of one meter is approximately equal to:
- 3×10^{-3} Tesla
 - 6×10^{-3} Tesla
 - 0.6 Tesla
 - 0.3 Tesla
15. The force on a small electric current loop of magnetic moment μ in a magnetic field $\mathbf{B}$ is given by :
- $\mathbf{F} = (\mu \times \nabla) \cdot \mathbf{B}$
 - $\mathbf{F} = (\mu \times \nabla) \times \mathbf{B}$
 - $\mathbf{F} = (\mathbf{B} \times \nabla) \times \mu$
 - $\mathbf{F} = (\nabla \times \mathbf{B}) \times \mu$
16. A steady dc current I is established in a simple LR series circuit as shown in figure 1. As the switch S is suddenly opened, the energy $\frac{1}{2} LI^2$, which was stored in the circuit when the current I was present, will

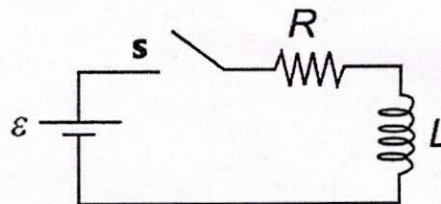
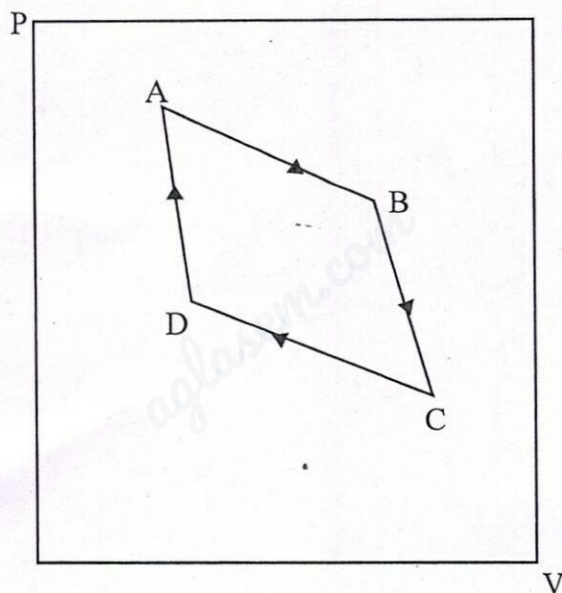


Figure 1

- be converted into heat energy through resistance R
 - be converted into electric energy
 - be radiated in the form of electromagnetic waves
 - still be stored in the circuit
17. The electric field of an electromagnetic wave in vacuum is given by :
- $$E_x = 0, E_z = 0, E_y = 10 \cos \left(2\pi \times 10^8 t - \frac{2\pi}{3} x \right)$$
- where E is in V/m, t in seconds and x in meters. Which of the following statements is correct ?
- The wave is propagating along the negative x direction with frequency 10^8 Hz and wavelength 3 m.
 - The wave is propagating along the negative x direction with frequency 10^8 Hz and wavelength 6 m.
 - The wave is propagating along the positive x direction with frequency 10^8 Hz and wavelength 3 m.
 - The wave is propagating along the positive x direction with frequency 10^8 Hz and wavelength 6 m.

18. A Carnot engine has a cycle pictured below :



Which of the following statement is not correct ?

- (A) AB and CD are isothermal processes
 (B) DA and BC are adiabatic processes
 (C) Work is put in during the processes CD and DA; it is extracted in the processes AB and BC
 (D) If the above is a steam engine with $T_{in} = 450$ K, operating at room temperature, its efficiency is equal to $1/2$
19. Which statistics would be appropriate in solving the problem for density of electrons and holes in semiconducting Silicon at room temperature ? (silicon band gap is approx. 1eV)
- (A) Classical Maxwell-Boltzmann
 (B) Fermi-Dirac
 (C) Bose-Einstein
 (D) Both Bose-Einstein and Classical Maxwell-Boltzmann

20. A system of two energy levels E_1 and E_2 is populated by N particles at temperature T . If the particles populate the energy levels according to the classical distribution law, then the average energy per particle is given by :

- (A) $\frac{E_1 e^{-\frac{E_1}{kT}} + E_2 e^{-\frac{E_2}{kT}}}{E_1 + E_2}$
 (B) $\frac{E_1 e^{-\frac{E_1}{kT}} + E_2 e^{-\frac{E_2}{kT}}}{E_2 e^{-\frac{E_1}{kT}} + E_1 e^{-\frac{E_2}{kT}}}$
 (C) $\frac{E_1 e^{-\frac{E_1}{kT}} + E_2 e^{-\frac{E_2}{kT}}}{e^{-\frac{E_1}{kT}} + e^{-\frac{E_2}{kT}}}$
 (D) $\frac{E_2 e^{-\frac{E_1}{kT}} + E_1 e^{-\frac{E_2}{kT}}}{e^{-\frac{E_1}{kT}} + e^{-\frac{E_2}{kT}}}$

21. According to the van der Waal's equation of state for an ideal gas, the critical temperature, pressure and volume are related to each other by the following relation :

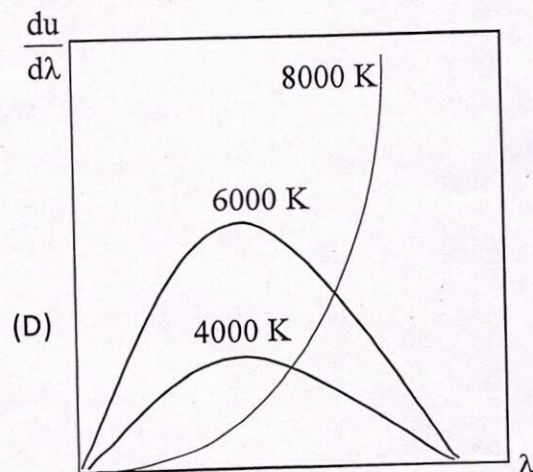
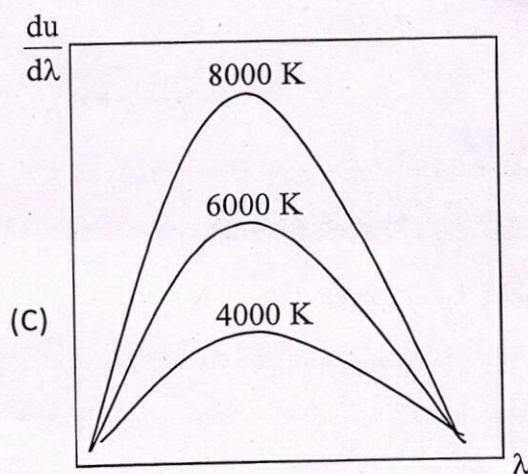
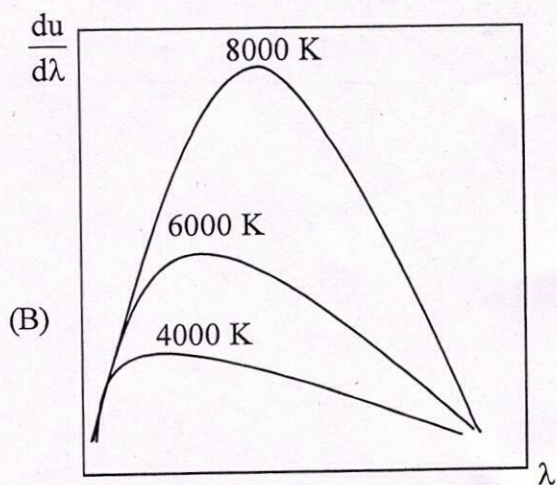
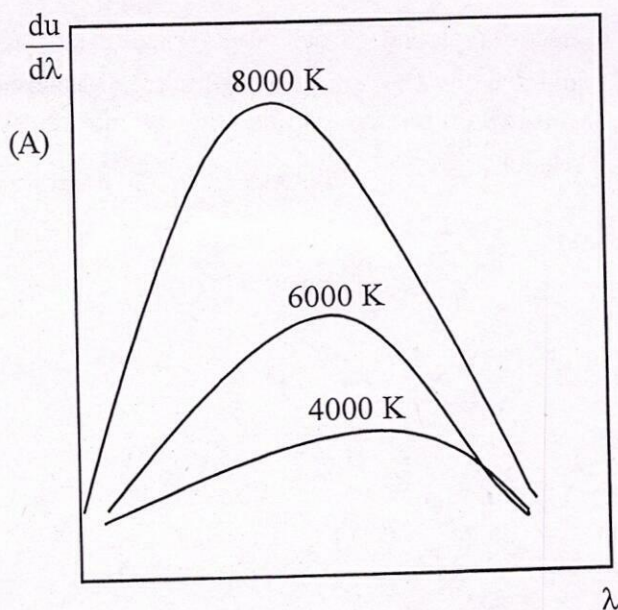
- (A) $\frac{p_c V_c}{RT_c} = \frac{8}{27}$
 (B) $\frac{p_c V_c}{RT_c} = \frac{8}{3}$
 (C) $\frac{RT_c}{p_c V_c} = \frac{8}{27}$
 (D) $\frac{RT_c}{p_c V_c} = \frac{8}{3}$

where R is Universal gas constant.

22. Which of the following statement is not correct ?

- (A) According to second law of thermodynamics, for a mechanically isolated system at constant temperature, the Helmholtz free energy never increases
- (B) Helmholtz free energy provides a link between Statistical mechanics and thermodynamics.
- (C) At constant temperature and pressure, a spontaneous change of the system will occur in the direction of increasing Gibbs energy
- (D) At constant temperature and pressure, a spontaneous change of the system will occur in the direction of decreasing Gibbs energy

23. Which of the following graphs represents the variation of spectral energy density with wavelength at different temperatures for the Blackbody radiation ?



24. A Planck's oscillator is vibrating with frequency 1.5×10^{14} Hz at $T = 1800$ K, its average energy is approximately equal to :
- (A) 0.115 eV
(B) 0.225 eV
(C) 0.335 eV
(D) 0.135 eV
25. Six distinguishable particles are to be distributed over three non-degenerate levels of energies 0 eV, 1 eV and 2 eV. The total energy of distribution for which the probability is maximum is equal to:
- (A) 3 eV
(B) 6 eV
(C) 1 eV
(D) 9 eV
26. For a system in equilibrium at temperature T , the total energy is equally distributed among the several degrees of freedom and energy associated with each degree of freedom is equal to:
- (A) $\frac{k_B}{2} T$
(B) $\frac{3k_B}{2} T$
(C) $\frac{k_B}{2T}$
(D) $k_B T$
27. A certain gas, obeying simple kinetic theory, has coefficients of viscosity and diffusion as 1.95×10^{-5} Nsm $^{-2}$ and 1.22×10^{-5} m ^{2} s $^{-1}$ respectively. If the average molecular speed is 440 m/s, the mean free path is approximately equal to:
- (A) 10.22×10^{-8} m
(B) 1.83×10^{-8} m
(C) 8.32×10^{-8} m
(D) 3.82×10^{-8} m
28. Observer A observes two events that are spatially and temporally separated by 600 meters and 8×10^{-7} seconds, respectively. What velocity must observer B have relative to A for the events to appear simultaneous to B?
- (A) $v = 0.3 c$
(B) $v = 0.4 c$
(C) $v = 0.8 c$
(D) $v = 0.99 c$
29. A cube has a (proper) volume of 1000 cm ^{3} . The volume as determined by an observer O who moves at a velocity of $0.8c$ relative to the cube in a direction parallel to one edge is approximately equal to :
- (A) 600 cm ^{3}
(B) 6000 cm ^{3}
(C) 300 cm ^{3}
(D) 3000 cm ^{3}
30. Which of the following statements is not correct ?
- (A) If a particle is moving under the action of a position-dependent force, then the sum of its kinetic energy and potential energy remains constant throughout its motion
- (B) If a particle is moving under the action of a time-dependent force, then the sum of its kinetic energy and potential energy remains constant throughout its motion
- (C) If a particle is moving under the action of a time-dependent force, then the sum of its kinetic energy and potential energy does not remain constant
- (D) If the potential energy of a particle is independent of time, then the sum of its kinetic energy and potential energy is conserved

31. Which of the following statement is not correct ?
- The centre of gravity is the point through which the force of gravity acts on the body or a system
 - Centre of mass is a point at which the whole mass of a body can be assumed to act as a point mass
 - Centre of mass of a body will always be inside the body
 - Centre of mass of a body will not always coincide with the centre of gravity
32. The moment of inertia of a thin circular disk, having mass M and radius R , about its diameter is :
- $\frac{1}{4}MR^2$
 - $\frac{1}{2}MR^2$
 - $\frac{1}{3}MR^2$
 - MR^2
33. What type of body experiences rotational kinetic energy equal to half its translational kinetic energy when it is in a state of pure rolling ?
- Circular Ring
 - Solid Cylinder
 - Solid Sphere
 - Hollow Sphere
34. If total energy of moon, supposed to be moving in a circular orbit around the earth, is equal to E . Its potential energy is equal to :
- E
 - $E/2$
 - $2E$
 - E^2
35. Which of the following statement is correct ?
- The Earth's rotation causes a centrifugal force, which slightly counteracts the gravitational force, leading to an increase in the value of acceleration due to gravity at the equator
 - The effect of rotation of the earth on the value of g at the equator is minimum and at the poles is maximum
 - The effect of the Earth's rotation causes the value of g to be slightly lower at the equator and slightly higher at the poles compared to what it would be if the Earth were not rotating
 - Rotation of earth does not affect the value of acceleration due to gravity (g)
36. A particle is executing simple harmonic motion according to the following equation :
- $$y = 10 \sin\left(2\pi t - \frac{\pi}{3}\right)$$
- Its velocity is given by :
- $10 \cos\left(2\pi t - \frac{\pi}{3}\right)$
 - $20 \cos\left(2\pi t - \frac{\pi}{3}\right)$
 - $20\pi \cos\left(2\pi t - \frac{\pi}{3}\right)$
 - $10\pi \cos\left(2\pi t - \frac{\pi}{3}\right)$
37. The differential equation describing the motion of a damped harmonic oscillator of mass m is given as :
- $$\left(m \frac{d^2x}{dt^2} + c \frac{dx}{dt} + kx = 0\right), \text{ where } c \text{ is damping coefficient and } k \text{ the spring constant. The condition for critically damped oscillations is :}$$
- $c^2 - 2mk < 0$
 - $c^2 - 2mk = 0$
 - $c^2 - 4mk < 0$
 - $c^2 - 4mk = 0$

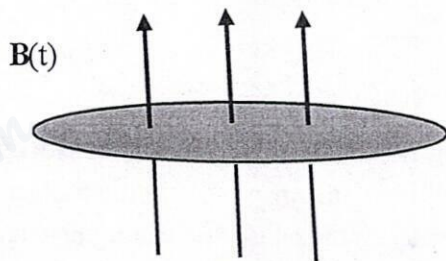
38. The divergence of the function : $\vec{v} = \frac{\hat{r}}{r^2}$ is equal to :

- (A) 1
- (B) 0
- (C) 3
- (D) -1

39. A parallel plate capacitor, immersed in a liquid of resistivity ρ , permittivity ϵ and permeability μ , is driven by a voltage $V_0 \cos(2\pi f t)$. The ratio of the amplitudes of conduction current to displacement current is equal to :

- (A) $\frac{1}{2\pi\epsilon\rho}$
- (B) $\frac{1}{2\pi f \epsilon \mu \rho}$
- (C) $\frac{1}{2\pi f \epsilon \rho}$
- (D) $\frac{1}{2\pi f \epsilon \mu}$

40. A uniform magnetic field $B(t)$, pointing straight up, fills the shaded circular region of the figure given below. If B is increasing with time, the induced electric field



- (A) runs anticlockwise as seen from above
- (B) runs clockwise as seen from above
- (C) runs parallel to the direction of B
- (D) runs antiparallel to the direction of B

41. In which of the following thermodynamic processes, heat is neither absorbed nor released by the system ?

- (A) Isothermal process
- (B) Isobaric process
- (C) Adiabatic process
- (D) Isochoric process

42. Which of the following statements is not correct ?

- (A) The second law of thermodynamics states that the total entropy of an isolated system can never decrease over time; it can only remain constant or increase
- (B) During solidification the entropy of the system (the substance undergoing solidification) decreases
- (C) The decrease in entropy during solidification appears to violate the second law of thermodynamics
- (D) The entropy released into the surroundings due to the heat transfer during solidification outweighs the decrease in entropy within the system itself

43. Fraunhofer diffraction pattern from a single narrow slit of width 'd' has an intensity distribution which is given by :

- (A) $I = I_0 \frac{\sin^2 \alpha}{\alpha^2}$
- (B) $I = I_0 \frac{\sin \alpha}{\alpha}$
- (C) $I = I_0 \alpha^2 \sin^2 \alpha$
- (D) $I = I_0 \frac{\sin^2 \alpha}{\alpha}$

where $\alpha = \pi d \frac{\sin \theta}{\lambda}$

44. A given Zone-plate has radii, $r_n = 0.1\sqrt{n}$. For a light of wavelength 5×10^{-5} cm, the position of most intense focal point will be at distance :
- (A) 100 cm
(B) 200 cm
(C) 150 cm
(D) 300 cm
45. To resolve D_1 and D_2 of sodium ($\Delta\lambda = 6 \text{ \AA}$) in the first order, a diffraction grating is used. The total number of lines on the grating must be at least:
- (A) 1000
(B) 400
(C) 600
(D) 800
46. As one goes away from the centre of an atom, the electron density :
- (A) Decreases like a Gaussian
(B) Decreases exponentially
(C) Oscillates with slowly decreasing amplitude
(D) Decreases linearly
47. A beam of neutral atoms passes through a Stern-Gerlach apparatus. Five equally spaced lines are observed. The total angular momentum of the atom is:
- (A) $\frac{h}{2\pi}\sqrt{8}$
(B) $\frac{h}{2\pi}\sqrt{10}$
(C) $\frac{h}{2\pi}\sqrt{6}$
(D) $\frac{h}{2\pi}\sqrt{2}$
48. To penetrate the Coulomb barrier of a light nucleus, a proton must have a minimum energy of the order of :
- (A) 1 GeV
(B) 1 TeV
(C) 1 KeV
(D) 1 MeV
49. The quark composition of neutrons and protons is respectively:
- (A) uud and udd
(B) udd and uud
(C) $u\bar{u}\bar{d}$ and $u\bar{d}\bar{d}$
(D) $u\bar{d}\bar{d}$ and $u\bar{u}\bar{d}$
50. In a photoelectric experiment the photoelectrons stopping potential depends on:
- (A) The frequency of incident light and the nature of the cathode material
(B) The intensity of the incident light
(C) Only the frequency of the incident light
(D) Nature of cathode material
51. According to Heisenberg's principle involving position and momentum, the minimum uncertainty in momentum of an electron, if uncertainty in its position is 50 pm (picometers), is:
- (A) $5.27 \times 10^{-25} \text{ kgms}^{-1}$
(B) $5.27 \times 10^{-25} \text{ gms}^{-1}$
(C) $1.054 \times 10^{-25} \text{ kgms}^{-1}$
(D) $1.054 \times 10^{-25} \text{ gms}^{-1}$
52. A body is vibrating simultaneously in two perpendicular directions with simple harmonic motions of equal frequency. If the phase angle is equal to $\pi/2$, then the path traced by the body is :
- (A) An ellipse
(B) A straight line
(C) A Circle
(D) None of the above

53. A string of length 'L' is stretched between two ends. The wavelength, λ_n of standing waves on the string satisfy the following relation:
- (A) $L = \frac{n\lambda_n}{2}$
 (B) $nL = \frac{\lambda_n}{2}$
 (C) $L = \frac{n^2\lambda_n}{2}$
 (D) $n^2L = \frac{\lambda_n}{2}$
54. If the co-ordinates of the displacement of a particle of mass m are given by :
- $$x = 10 \cos(\omega t)$$
- $$y = 10 \sin(\omega t),$$
- then the particle follows :
- (A) An elliptical path
 (B) A circular path
 (C) A straight line
 (D) A parabolic path
55. The magnitude of typical h_{ie} -parameter for the small-signal transistor equivalent circuit in the region of operation for the common-emitter configuration is of the order of :
- (A) 1Ω
 (B) $1 \text{ k}\Omega$
 (C) $1 \text{ M}\Omega$
 (D) $100 \text{ k}\Omega$
56. How many RC networks capable of generating a 90° phase shift can be cascaded and linked to a Common Emitter amplifier to create an oscillator circuit ?
- (A) 6
 (B) 3
 (C) 2
 (D) 4
57. In a pn-junction diode, if the p-side of the junction is connected to the negative terminal and the n-side to the positive terminal of a battery then :
- (A) The junction is said to be reverse biased, and the width of the depletion region is increased
 (B) The junction is said to be forward biased, and the width of the depletion region is increased
 (C) The junction is said to be reverse biased, and the width of the depletion region is decreased
 (D) The junction is said to be forward biased, and the width of the depletion region is decreased
58. For an intrinsic semiconductor, the electrical conductivity is given by :
- (A) $\sigma_i = q(\mu_n + \mu_p) n_i^2$
 (B) $\sigma_i = q^2(\mu_n + \mu_p) n_i^2$
 (C) $\sigma_i = q(\mu_n + \mu_p) n_i$
 (D) $\sigma_i = q(\mu_n + \mu_p)^2 n_i$
- where μ_n and μ_p denote the electron and hole mobilities, respectively, and n_i is the intrinsic carrier density.
59. Which of the following is not correct about the application of a transistor ?
- (A) It can be used as an amplifier
 (B) It can be used as a rectifier in conventional applications
 (C) It can be used as an electronic switch
 (D) It can be used as an oscillator
60. The capacitance of two concentric spherical metal shells, with radii r_1 and r_2 is equal to :
- (A) $C = 4\pi \epsilon_0 \frac{r_1}{r_2}$
 (B) $C = 4\pi \epsilon_0 \left(\frac{r_1}{r_2} - \frac{r_2}{r_1} \right)$
 (C) $C = 4\pi \epsilon_0 \left(\frac{r_1}{r_2} - \frac{r_2}{r_1} \right)^2$
 (D) $C = 4\pi \epsilon_0 \left(\frac{r_2 r_1}{r_2 - r_1} \right)$