M.Tech. Entrance Test – 2013 (AKU, Patna)

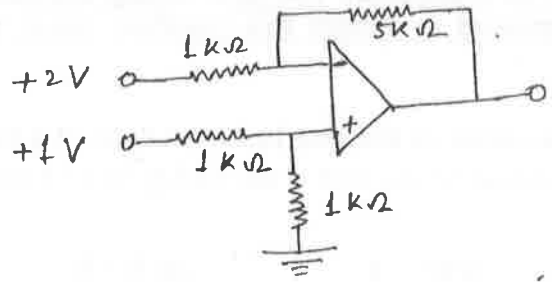
Subject:- Physics

Time: - 1½ Hrs. **Full marks: 50**

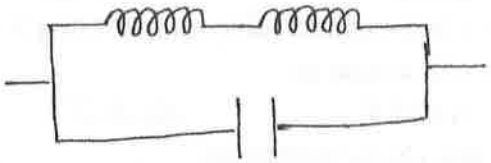
INSTRUCTIONS: -There are four options given for a question. You have choose the correct option/s. Candidates are required to submit this Question paper with answer book.

1. The kinetic energy of a free electron at a corner of the first Brillouin Zone of a two – dimensional square lattice is larger than that of an electron at the mid-point of a side of the zone by a factor b. The value of b is:
   (a) $b = \sqrt{2}$ (b) $b = 2$ (c) $b = 4$ (d) $b = 8$
2. For a three-dimensional crystal having N primitive cell with a basis of patoms, the number of optical branches is:
   (a) 3 (b) 3p (c) 3p – 3 (d) 3 – 3p
3. In a powder diffraction pattern recorded from a face-centred cubic sample using X-rays, the first peak appears at 30^o. The second peak will appear at:
   (a) 32.8^o (b) 33.7^o (c) 34.8^o (d) 35.3^o
4. If $\vec{g}$ is a reciprocal lattice vector, the Bragg's law can be written as:
   (a) $\vec{k}+\vec{g} = 0$ (b) $\overrightarrow{2k}.\vec{g} + g^2 = 0$ (c) $\overrightarrow{2k}.\vec{g} + k^2 = 0$ (d) $\vec{k} \,.\, \vec{g} = 0$
5. Electronic contribution to the specific heat of a metal at low temperature is:
   (a) An exponential function of T (b) A linear function of T
   (c) Zero (d) None of these.
6. Germanium having a forbidden gap of 0.72 ev is irradiated with monochromatic radiation. The wavelength required that would be sufficient to creat an electron hole pair will be:
   (a) 1700 A^o (b) 17250 A^o (c) 17500 A^o (d) None of these
7. If the Fermi energy of silver at OK is 5ev, the mean energy of electron in silver at OK is :
   (a) 6 eV (b) 12 eV (c) 1.5 eV (d) 3 eV
8. On lightly doping an intrinsic semiconductor with donor impurities, the electron carrier concentration is the conduction band is found to increase from η to ηf. If $\mu\eta$ and μp are the mobilities of electrons and holes respectively, the conductivity of the doped semiconductor will be:
   (a) $\eta e\,(f\mu_\eta + f\mu_p)$ (b) $\eta e\,(f\mu_\eta + \mu_p)$ (c) $\eta e f\mu_\eta$ (d) $\eta e\,(\mu_\eta + \mu_p)$
9. A junction field effect transistor behaves as a :
   (a) Voltage – controlled Current Source
   (b) Voltage – controlled Voltage Source
   (c) Current – Controlled Voltage Source
   (d) Current – Controlled Current Source

10. The high input impedence of field effect transistor (FET) amplifier is due to:
    (a) The pinch – off voltage
    (b) Its very low gate current
    (c) The source and drain being far apart
    (d) The geometry of the FET
11. The output V_o of the ideal op-amp circuit shown in the figure is



    (a) – 7V (b) – 5V (c) 5V (d) 7V
12. The tank circuit of a Hartley oscillator is shown in the figure. If M is the mutual inductance between the inductors, the oscillation frequency is



    (a) $\frac{1}{2\Pi\sqrt{(L_1+L_2+2M)C}}$ (b) $\frac{1}{2\pi\sqrt{(L_1+L_2-2M)C}}$
    (c) $\frac{1}{2\Pi\sqrt{(L_1+L_2+M)C}}$ (d) $\frac{1}{2\pi\sqrt{(L_1+L_2-M)C}}$
13. Which bridge is used to determine frequency?
    (a) Anderson bridge (b) De sauty's bridge
    (c) Wien's bridge (d) Campbell's bridge
14. A bipolar junction transistor with one junction forward biased and either the collector or emitter open, operates in the
    (a) Cut-off rejion (b) Saturation rejion
    (c) Pinch – off rejion (d) Active rejion
15. While measuring the phase difference between the signals $V_1(t) = 10 \sin wt$ and $V_2(t) = 10 \sin (wt+1)$, the lissajuns pattern observed on CRO was a circle.
    The value of Φ is:
    (a) 0 (b) $\frac{\pi}{4}$ (c) $\frac{\Pi}{2}$ (d) π
16. An 8 bit counter type A/D converter makes at least 8000 conversions per second. The clock frequency is
    (a) 2 MHz (b) 8 MHz (c) 1 MHz (d) 4 MHz
17. Mutual interaction forces between two particles can change:
    (a) The linear momentum but not the kinetic energy.
    (b) The kinetic energy but not the linear momentum.
    (c) The linear momentum as well as the kinetic energy.
    (d) Neither the linear momentum nor the kinetic energy.

18. A particle is moving on an elliptical path under inverse square law of force of the forna $F(r) = -K/r^2$. The eccentricity of the orbit is :
(a) A function of total energy (b) independent of total energy
(c) a function of kinetic energy (d) independent of angular momentum.

19. The total angular momentum of a system of particles is conserved when:
(a) the internal torque is zero (b) the external torque is zero
(c) the external torque is constant (d) the torque changes with time.

20. Whenever the Langrangian for a system does not contain a co-ordinate q_k explicitly then:
(a) q_k is a cyclic-coordinate
(b) p_k is a cyclic co-ordinate
(c) the generalized momentum is not a constant of motion
(d) q_k is always zero

21. The homogeneity of time leads to the law of conservation of :
(a) the linear momentum (b) the angular momentum (c) energy (d) parity

22. In case of a linear triatomic molecule of XY_2 type eigen frequencies W_1, W_2 and W_3 can be represented by:
(a) $W_1 = W_2 = W_3$ (b) $W_1 = 0, W_2 = W_3$
(c) $W_1 \neq W_2 \neq W_3$ (d) $W_1 = W_2 \neq W_3$.

23. An electron gains energy so that its mass becomes zm_o. Its speed is :
(a) $\frac{\sqrt{3}}{2}c$ (b) $\frac{3}{4}c$ (c) $\frac{3}{2}c$ (d) $\sqrt{\frac{3}{2}}c$.

24. The expression for the relativistic energy of a particle is:
(a) m^2c^2 (b) $\sqrt{p^2c^2 + m_o^2c^4}$ (c) $(m-m_o)c^2$ (d) $p^2c^2 + m_o^2c^4$

25. The wavelength associated with an electron subjected to a potential difference of 1.25 KV is :
(a) 0.04 A° (b) 0.4 A° (c) 4.0 A° (d) 4.4 A°

26. An electron has a speed of 1.05×10^4 m/s within the accuracy of 0.01%. The uncertainty in the position of the electron is:
(a) 1.1×10^{-4} m (b) 11×10^{-4} m (c) 0.11×10^{-4} m (d) 0.011×10^{-4} m

27. The energy of a particle in one-dimensional rigid box of side L is:
(a) $\frac{n^2h^2}{8mL^2}$ (b) $\frac{8mL^2}{n^2h^2}$ (c) $\frac{nh^2}{8mL^2}$ (d) $\frac{n^2h^2}{8m^2L^2}$

28. The lowest energy of one – dimensional harmonic oscillator is :
(a) $\frac{3}{2}\hbar w$ (b) $-½\hbar w$ (c) $\frac{1}{2}\hbar w$ (d) $\hbar w$

29. The quantum mechanical operator for energy is :
(a) $ih\frac{\partial}{\partial t}$ (b) $i\hbar\frac{\partial}{\partial t}$ (c) $\frac{\hbar}{i}\frac{\partial}{\partial t}$ (d) $-i\hbar\frac{\partial}{\partial t}$

30. The wave function of hydrogen atom in ground state (1S) is :

(a) $\psi(1S) = \frac{1}{\sqrt{\pi}}(\frac{1}{\alpha_o})^{3/2} e^{-r/\alpha_o}$

(b) $\psi(1S) = \frac{1}{\pi}(\frac{1}{\alpha_o})^{3/2} e^{-r/\alpha_o}$

(c) $\psi(1S) = (\frac{1}{\pi\alpha_o})^{1/2} e^{-r/\alpha_o}$

(d) $\psi(1S) = \frac{1}{\sqrt{\pi}}(\frac{1}{\alpha_o})^{3/2} e^{-r^2/\alpha_o^2}$.

31. The splitting of energy levels caused by a uniform external electric field is called:

(a) Stark effect (b) Zeeman effect

(c) Paschen-back effect (d) None of these.

32. The X – component of orbital angular momentum L_x is represented as:

(a) $\frac{\hbar}{i}(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y})$ (b) $\frac{\hbar}{i}(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z})$

(c) $\frac{\hbar}{i}(x\frac{\partial}{\partial z} - z\frac{\partial}{\partial x})$ (d) None of these

33. A D/A converter is to have a full – scale output voltage of 10V and a resolution less than 40 mV. The number of bits required are

(a) 250 (b) 8 (c) 7 (d) 6

34. A carnot engine has an efficiency of $\frac{1}{6}$. On reducing the sink temperature by 65°C, the efficiency becomes $\frac{1}{3}$. What is the source temperature?

(a) 265 K (b) 350 K (c) 390 K (d) 400 K

35. Which one of the Manwell's thermodynamic relations given below leads to clansins – clapeyson equation?

(a) $(\frac{\partial T}{\partial V})_S = -(\frac{\partial P}{\partial S})_V$ (b) $(\frac{\partial T}{\partial P})_S = (\frac{\partial V}{\partial S})_P$

(c) $(\frac{\partial S}{\partial V})_T = (\frac{\partial P}{\partial T})_V$ (d) $(\frac{\partial S}{\partial P})_S = -(\frac{\partial V}{\partial T})_P$

36. Planck's law reduces to Rayleigh – Jeans law at extremely

(a) Large wavelengths and low temperatures

(b) Small wavelengths and high temperatures

(c) Large wavelengths and high temperatures

(d) Small wavelengths and low temperature

37. For a diatomic gas having 3 translational and 2 rotational degrees of freedom, the energy is given by

(a) $\frac{5}{2}KT$ (b) $\frac{3}{2}KT$ (c) $\frac{1}{2}KT$ (d) KT

38. In case of Bose – Einstein Condensation

(a) Number of particles increases in lower energy levels at low temperatures and high pressures

(b) Number of particles decreases in lower energy levels at low temperatures and high pressures

(c) Number of particles increases in lower energy levels at high temperatures and low pressures

(d) Number of particles decreases in lower energy levels at high temperatures and low pressures

39. Which of the relation between internal energy U and canonical partition function Z, is true?

(a) $U = \frac{\partial}{\partial T} logZ$ (b) $U = K_B T^3 \frac{\partial}{\partial T} logZ$

(c) $U = -KT\, logZ$ (d) $U = KT \frac{\partial}{\partial V} logZ$

40. The quantum statistics reduces to classical statistics under which of the following condition?

(a) $P\lambda^3 \simeq 1$ (b) $P\lambda^3 \gg 1$ (c) $P\lambda^3 \ll 1$ (d) $P = 0$

41. In statistical physics, the absolute temperature T of a system is related to the total number of accessible states Ω as :

(a) $KT = \frac{\partial \Omega}{\partial E}$ (b) $KT = \frac{\partial\, log\Omega}{\partial E}$ (c) $\frac{1}{KT} = \frac{\partial \Omega}{\partial E}$ (d) $\frac{1}{KT} = \frac{\partial\, log\Omega}{\partial E}$

42. Which one of the following electronic transitions in Neon is responsible for LASER action in a helium – neon laser?

(a) $68 \rightarrow 5p$ (b) $58 \rightarrow 4p$ (c) $58 \rightarrow 3p$ (d) $48 \rightarrow 3p$

43. Deutron in its ground state has a total angular momentum J = 1 and a positive parity. The corresponding orbital angular momentum L and spin S combinations are

(a) L = 0, S = 1 and L = 2, S = 0

(b) L = 0, S = 1 and L = 1, S = 1

(c) L = 0, S = 1 and L = 2, S = 1

(d) L = 1, S = 1 and L = 2, S = 1

44. The typical wavelengths emitted by diatomic molecules in purely vibrational, purely rotational transitions are respectively in the region of

(a) Infrared and Visible (b) Visible and Infrared

(c) Infrared and Microwave (d) Microwave and Infrared

45. The NMR spectrum of ethanol (CH_3CH_2OH) comprises of three branches of spectral lives. The number of spectral lives in the bunch corresponding to CH_2 group is

(a) 1 (b) 2 (c) 3 (d) 4

46. For a multi – electron atom, l, L and S specify the one electron orbital angular momentum, total orbital angular momentum and total spin angular momentum respectively. The selection rules for electric dipole transition between the two electronic energy levels, specified by l, L and S are

(a) $\Delta L = 0, \pm 1; \Delta S = 0; \Delta l = 0, \pm 1$

(b) $\Delta L = 0, \pm 1; \Delta S = 0; \Delta l = \pm 1$

(c) $\Delta L = 0, \pm 1; \Delta S = \pm 1; \Delta l = 0, \pm 1$

(d) $\Delta L = 0, \pm 1; \Delta S = \pm 1; \Delta l = \pm 1$

47. Assuming that the L – S coupling scheme is valid, the number of permitted transitions from $2P_{3/2}$ to $2S_{½}$ due to a weak magnetic field is

(a) 2 (b) 4 (c) 6 (d) 10

48. Ligh of wavelength 1.5 μm incident on a material with a characteristic Raman frequency of 20 x 10^{12} Hz results in a stokes – shifted line of wavelength
(a) 1.47 μm (b) 1.57 μm (c) 1.67 μm (d) 1.77 μm

49. The Laude g factor for the level $^3D_3$ is
(a) $\frac{2}{3}$ (b) $\frac{3}{2}$ (c) $\frac{3}{4}$ (d) $\frac{4}{3}$

50. The shortest wavelength produced in an X-ray tube operated at 2 million volts will be:
(a) $10^{-1}A^{\circ}$ (b) $10^{-2}A^{\circ}$ (c) $10^{-3}A^{\circ}$ (d) $10^{-4}A^{\circ}$