Ph. D. Entrance Test – 2015
Subject: Physics
Paper – I

Important: *Please consult your Admit Card/Roll No. slip before filling your Roll Number on the Test Booklet and Answer Sheet.*

Roll No.   *In Figure*   *In Words*

O.M.R. Answer Sheet Serial No.

Signature of Candidate: *Signature of Invigilator:*

Time: 60 Minutes   Number of Questions: 50   Maximum Marks: 50

DO NOT OPEN THE SEAL ON THE BOOKLET UNTIL ASKED TO DO SO.

INSTRUCTIONS:

1. Write your Roll No. on the Questions Booklet and also on the OMR Answer Sheet in the space provided and nowhere else.
2. Enter the Question Booklet Serial No. on the OMR Answer Sheet. Darken the corresponding bubbles with **Black Ball Point/Black Gel Pen.**
3. Do not make any identification mark on the Answer Sheet or Question Booklet.
4. Please check that this Question Booklet contains **50** Questions. In case of any discrepancy, inform the Assistant Superintendent within 10 minutes of the start of Test.
5. Each question has four alternative answer (A,B,C,D) of which only one is correct. For each question, darken only one bubble (A or B or C or D), whichever you think is the correct answer, on the Answer Sheet with **Black Ball Point/Black Gel Pen. There shall be no negative marking for wrong answers.**
6. If you do not want to answer a question, leave all the bubbles corresponding to that question blank in the Answer Booklet. No marks will be deducted in such cases.
7. Darken the bubbles in the OMR Answer Sheet according to the Serial No. of the question given in the Question Booklet.
8. If you want to change an already marked answer, erase the shade in the darkened bubble completely.
9. For rough work only the blank sheet at the end of the Question Booklet be used.
10. The Answer Sheet is designed for computer evaluation. Therefore, if you do not follow the instructions given on the Answer Sheet, it may make evaluation by the computer difficult. **Any resultant loss to the candidate on the above account, i.e. not following the instructions completely, shall be of the candidate only.**
11. After the test, hand over the Question Booklet and the Answer Sheet to the Assistant Superintendent on duty.
12. In no case the Answer Sheet, the Question Booklet, or its part or any material copied/noted from this Booklet is to be taken out of the examination hall. Any candidate found doing so would be expelled from the examination.
13. A candidate who creates disturbance of any kind or changes his/her seat or is found in possession of any paper possibly of any assistant or found giving or receiving assistant or found using any other unfair means during the examination will be expelled from the examination by the Centre Superintendent/Observer whose decision shall be final.
14. **Communication equipment such as mobile phones, pager, wireless set, scanner, camera or any electronic/digital gadget etc., is not permitted inside the examination hall. Use of calculators is not allowed.**
15. The candidates will not be allowed to leave the Examination Hall/Room before the expiry of the allotted time.

(Hindi and Punjabi versions enclosed)

1. The percentage of area of Gaussian distribution with centroid μ and standard deviation σ, within the $x = x = \mu + \sigma$ and $x = \mu + \sigma$ is approximately equal to
   (A) 90 %
   (B) 68 %
   (C) 95 %
   (D) 100/e

2. In GM counter experiment the measured data is 3605, the three sigma statistical error in the measured data will be
   (A) 180
   (B) 60
   (C) 120
   (D) 1440

3. Which of the following sets does not contain all numbers with 4 significant digits
   (A) 1234, 123400, 123.4
   (B) 1001, 1000., 10.10
   (C) 1100, 1000., 1010
   (D) 100.0, 0.0001010, 1001

4. If error in a measured variable X is ΔX, the error in the $Log_e X$ will be
   (A) $\Delta X/X$
   (B) $Log_e (\Delta X)/X$
   (C) $Log_e (\Delta X)$
   (D) $X Log_e (\Delta X)$

5. An amplifier with 288 ohm internal resistance is connected to an 8 ohm speaker through a transformer. For transfer of maximum power available from amplifier to speaker, the primary to secondary turn ratio of the transformer should be
   (A) 1:36
   (B) 36:1
   (C) 6:1
   (D) 1:6

6. Tri-state logic used in an 8085 microprocessor is
   (A) +5 V, 0V, and high impedance state
   (B) +5 V, -5V, and low impedance state
   (C) +5V, 2.5V, 0 V
   (D) -5V, 0V, +5V

7. In the Laplace s-domain, the equivalent of an inductor with no initial current and an uncharged capacitor are resistances of values
   - (A) $1/Ls$ and $1/Cs$, respectively
   - (B) Ls and Cs, respectively
   - (C) Ls and $1/Cs$, respectively
   - (D) $1/Ls$ and Cs, respectively

8. Choose which statement is false
   - (A) Proton and neutron form an isospin doublet
   - (B) π^+, π^-, π^0 form an isospin triplet.
   - (C) K^+, K^-, K^0 form an isospin triplet.
   - (D) ρ^+, ρ^- and ρ^0 form an isospin triplet

9. In SiO_2 optical fibre generally used for communication purposes, the preferred wavelength used lies in
   - (A) Visible region
   - (B) UV region
   - (C) IR region
   - (D) X-ray region

10. Depletion capacitance for a varactor pn junction is mainly contributed by the
    - (A) holes injected and stored in the n-region due to their finite lifetime, and it increases with increase in forward current.
    - (B) holes injected and stored in the p-region due to their finite lifetime, and it decreases with increase in forward current.
    - (C) depletion region where no charge carriers are present, and it increases with voltage.
    - (D) depletion region where no charge carriers are present, and it decreases with voltage.

11. Natural shape of the energy distribution in an atomic level is
    - (A) Gaussian
    - (B) Lorenzian
    - (C) Maxwillian
    - (D) Poisson

12. In the β^+ decay,
    - (A) the recoiling nucleus, β particle and neutrino are emitted in a plane.
    - (B) the recoiling nucleus, β particle and neutrino are emitted in a straight line
    - (C) the recoiling nucleus moves in a direction out of the plane of emission of the β^- particle and neutrino.
    - (D) the recoiling nucleus, β particle and antineutrino are emitted in a plane.

13. The secondary cosmic rays reaching the earth mainly consist of
    (A) muons, electrons and positrons
    (B) ^{14}C nuclei
    (C) pions, positrons and electrons
    (D) 92% protons, rest are deuterons, alpha particles and heavier nuclei.

14. For producing and measuring the vacuum of the order of 10^{-2} torr, it is preferred to use
    (A) rotary pump and pirani gauge, respectively.
    (B) diffusion pump and pirani gauge, respectively.
    (C) diffusion pump and penning gauge, respectively.
    (D) adsorption pump and penning gauge, respectively.

15. The character of the $4^+ \rightarrow 2^+$ gamma transition is
    (A) magnetic octupole
    (B) electric octupole
    (C) electric quadrupole
    (D) magnetic dipole

16. For a system of identical particles of mass m and number density ρ (=N/V) at a temperature T with the mean thermal wavelength $\lambda = h\,(2\pi\,mk_BT)^{-1/2}$, the classical statistics reduces to quantum statistics under the condition
    (A) $\rho^{1/3}\lambda^3 \approx 1$
    (B) $\lambda \rho^{1/3} \gg 1$
    (C) $\rho \lambda^3 \ll 1$
    (D) $\lambda \rho^{1/3} = 0$

17. A system consists of N distinguishable particles, each of which can occupy one of the two non-degenerate states differing by 0.05 eV in energy. If the system is at thermal equilibrium at room temperature, the fraction of particles in the higher energy state is, approximately,
    (A) $e^{-0.05}$
    (B) e^{-4}
    (C) e^{-2}
    (D) zero

18. The number of atoms in 1 cm^3 of Ge or Si semiconductor is of the order of
    (A) 10^{22}
    (B) 10^{16}
    (C) 10^8
    (D) 10^{30}

19. A non-relativistic charged particle has an acceleration 'a'. The power radiated by it is proportional to
    (A) a
    (B) a^2
    (C) a^3
    (D) $1/a$

20. A waveguide behaves as a
    (A) high Pass filter
    (B) low Pass filter
    (C) band Pass filter
    (D) all Pass filter

21. Transverse electric (TE) waves have
    (A) magnetic field component H in the direction of propagation
    (B) electric field component E in the direction of propagation
    (C) magnetic field component H in the direction of propagation and no component of electric field E in this direction
    (D) electric field component E in the direction of propagation and no component of magnetic field H in this direction

22. According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is
    (A) Greater than the mean velocity
    (B) Equal to the mean velocity
    (C) Equal to root mean square velocity
    (D) Less than the root mean square velocity

23. According to the liquid drop model, the volume energy, surface energy and Coulomb energy (ϵ and a_3 being positive constants) contributions to binding energy are
    (A) $a_1A, -a_2A^{2/3}$ and $-a_3Z(Z-1)A^{-1/3}$, respectively.
    (B) $a_1, -a_2A^{1/3}$ and $-a_3Z^2A^{-1/3}$, respectively.
    (C) $a_1A, a_2A^{2/3}$ and $-a_3Z^2(Z-1)A^{-1/3}$, respectively.
    (D) $a_1A, -a_2A^{1/2}$ and $-a_3 Z(Z-1)A^{-2/3}$, respectively

24. Cholesteric, Smectic and Nematic are types of
    (A) Polymers
    (B) Superconductors
    (C) Nano-materials
    (D) Liquid crystals

(4)

25. Which of the following particles is unstable
   (A) Neutron
   (B) Proton
   (C) Neutrino
   (D) Antineutrino

26. The p electrons in Nitrogen atom have spins
   (A) ↑↑↓
   (B) ↑↓↓
   (C) ↑↓↑
   (D) ↑↑↑

27. The quark model content of the neutron is
   (A) uud
   (B) uuu
   (C) udd
   (D) ddd

28. The condition for the Bragg reflections of x-rays (wavelength $=\lambda$) from an atomic lattice with set of parallel adjacent planes separated by distance, d, is
   (A) $\lambda < d$.
   (B) $\lambda > d$.
   (C) $\lambda \leq 2d$.
   (D) $\lambda \geq 2d$.

29. In a grand canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then
   (A) A can exchange only energy with B
   (B) A can exchange only particles with B
   (C) A can exchange neither energy nor particles with B
   (D) A can exchange both energy and particles with B

30. The electric field part of an electromagnetic wave in a medium is represented by $E_x = 0$; $E_y = 2.5$ N/C $\cos[(2\pi \times 10^6$ rad/s)t $- (\pi \times 10^{-2}$ rad/m)x]; $E_z = 0$. The wave is:
   (A) moving along x-direction with frequency 10^6 Hz and wave length 100 m.
   (B) moving along x-direction with frequency 10^6 Hz and wave length 200 m.
   (C) moving along –x-direction with frequency 10^6 Hz and wave length 200 m.
   (D) moving along y-direction with frequency $2\pi \times 10^6$ Hz and wave length 200 m.

31. In sodium atom, 4d - 4p transitions has how many components (spectral lines)?

    (A) 1
    (B) 2
    (C) 3
    (D) 0 as it is forbidden

32. The exciting line in an Raman spectroscopy experiment is at 5000 Å and the observed Stokes line is 5100 Å. The wavelength of anti-Stokes line is

    (A) 4900 Å
    (B) 5200 Å
    (C) 4896 Å
    (D) 4904 Å

33. The RMS value of $i(t) = 20[1 + \sin(-t)]$ is

    (A) 20.4
    (B) 10.2
    (C) 17.3
    (D) 204

34. The Laplace transform function f(t) is F(s), then Laplace transform of its first derivative w.r.t. 't' is

    (A) $s F(s) + f(0)$
    (B) $s F(s)$
    (C) $s F(s) - f(0)$
    (D) $s^2 F(s) - f(0)$

35. The transfer function of a circuit with input given across inductor (L) and capacitor (C) and output taken across capacitor is

    (A) $(1/Lc)^{1/2}$
    (B) $(1/LCs^2)^{1/2}$
    (C) L/C
    (D) $(LCs^2+1)^{-1}$

36. The group velocity of electromagnetic waves moving with phase velocity c in a dispersive medium of refractive index n is given by

(A) $\dfrac{c}{\omega + n\dfrac{dn}{d\omega}}$

(B) $\dfrac{c}{\omega + n\dfrac{d\omega}{dn}}$

(C) $\dfrac{c}{n + \omega\dfrac{dn}{d\omega}}$

(D) $\dfrac{c}{n + \omega\dfrac{d\omega}{dn}}$

37. Consider the n=4 state of hydrogen atom. The maximum magnitude L of the orbital angular momentum state of the system is

(A) $4\hbar$

(B) $3\hbar$

(C) $\sqrt{12}\,\hbar$

(D) $16\,\hbar$

38. Value of the integral $\int_0^3 x\,\delta(x+1)\,dx$ is

(A) 1

(B) 0

(C) -1

(D) 3

39. In case of quantum mechanical one dimensional simple harmonic oscillator, the number of nodes in the wave function with principal quantum number n=3 is

(A) 1

(B) 2

(C) 3

(D) 4

(7)

40. $\psi_1 (x), \psi_2 (x)$ are two quantum mechanical wave functions. The orthogonality relation between them is

(A) $$\int_{-\infty}^{\infty} [\psi_1^*(x) \psi_2 (x) + \psi_2^*(x) \psi_1 (x)] dx = 1$$

(B) $$\int_{-\infty}^{\infty} \psi_1^*(x) \psi_2 (x) dx = 1$$

(C) $$\int_{-\infty}^{\infty} \psi_1^*(x) \psi_2 (x) dx = 0$$

(D) $$\int_{-\infty}^{\infty} \psi_1^*(x) \psi_2 (x) dx = \infty$$

41. The Lyman series transitions fall in the region of

(A) Ultraviolet
(B) Visible
(C) infra red
(D) radio frequency range

42. According to the shell model, the ground state spin of the ^{15}F nucleus is

(A) 5/2
(B) 3/2
(C) 1/2
(D) 7/2

43. In rotational spectrum of a diatomic molecule (for example CO), the first rotational line is observed at (Here B is rotational constant in cm^{-1}).

(A) B
(B) 2B
(C) 4B
(D) 4B – 3

44. Which of the following is not Boson?

(A) Pion
(B) Photon
(C) Muon
(D) Z^0

(8)

45. Gauge vector bosons acquiring mass through spontaneous breaking of local symmetry is known as
  (A) Goldstone mechanism
  (B) Higgs mechanism
  (C) Cabbibo mechanism
  (D) CIM mechanism

46. The particles which mediate the force between the neutron and proton are
  (A) Photons
  (B) quarks
  (C) Gluons
  (D) mesons

47. The logic expression $\overline{AB} + \overline{AC}$ is equivalent to
  (A) $A + B + C$
  (B) ABC
  (C) $B + C$
  (D) $A + B$

48. In a degenerate n type semiconductor material, the Fermi level, is
  (A) in valence band
  (B) in conduction band
  (C) at the centre in between valence and conduction bands
  (D) very near valence band

49. A 12 bit ADC is used to convert analog voltage of 0 to 10 V into digital. The resolution is
  (A) 2.44 mV
  (B) 24.4 mV
  (C) 1.2 V
  (D) none of the above

50. The Zeeman pattern of a line consists of 6 equidistant components. The upper state term is known to be $^2P_{3/2}$, then the lower state term is
  (A) $^2S_{1/2}$
  (B) $^2P_{1/2}$
  (C) $^2D_{5/2}$
  (D) $^2D_{3/2}$

x ─x ─x─x