HPPSC
PGT

Previous Year Paper
(Physics) Paper-II
11 Apr, 2024

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO

TBC : RT/SL/PHY/P2/2024 **Booklet No :** 2160

ROLL NO.	1	1	0	4	0	4	0	0

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Time Allowed : 2 Hours] [Maximum Marks : 100

IMPORTANT INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, CANDIDATE SHOULD CHECK THAT THIS TEST BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number, Application No. and Test Booklet Series A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet with blue or black ball pen. Any error detected in the scanned data of the Answer Sheet due to wrong encoding of either Application No. or Roll No. or both by the candidate, his/her Answer Sheet shall not be evaluated and shall be rejected straight away.
3. You have to enter your Roll Number in the space provided in the Test Booklet. DO NOT write anything else on the Test Booklet. Sheet(s) for rough work is/are appended in the Test Booklet at the end.
4. This Test Booklet contains **100** items (questions). Each question (item) comprises four (A, B, C, D) responses/ answers. The candidate will have to encode/blacken with blue/black ball pen on the circle of the option he/ she thinks is correct in OMR answer sheet. You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose ONLY ONE response for each item. IN CASE THE CANDIDATE DOES NOT WANT TO ANSWER A QUESTION TO AVOID NEGATIVE MARKING, HE/SHE SHALL HAVE TO ENCODE/BLACKEN THE OPTION "E" IN THE OMR ANSWER SHEET AS UNDER :

Response				If you do not want to answer a question, darken the option (E).
(A)	(B)	(C)	(D)	(E)
IF ANY ANSWER IS LEFT BLANK AND NONE OF THE OPTION IS ENCIRCLED/BLACKENED THEN IT WILL ALSO RESULT IN NEGATIVE MARKING.				

5. You shall have to mark responses ONLY on the separate OMR Answer Sheet provided. See directions in the OMR Answer Sheet. All items carry equal marks.
6. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the OMR Answer Sheet as per entries given in their downloaded Admission Letter.
7. After you have completed filling in all your responses on the OMR Answer Sheet and the examination has concluded, you will have to hand over Original Copy of OMR Answer Sheet to the Invigilator only. You are permitted to take away with you Test Booklet & candidate's copy of OMR Answer Sheet only.
8. There shall be *NEGATIVE* marking for wrong answer(s) marked by the candidate as under :–
   (*a*) For each question for which a wrong answer has been given by the candidate, one-fourth (0.25) of the marks assigned to that question will be deducted as penalty.
   (*b*) If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above for that question also i.e. one-fourth (0.25) of the marks assigned to that question will be deducted as penalty.
   (*c*) If a question is left blank i.e. no circle is blackened/encoded by the candidate, there will be same penalty as above for that question i.e. one-fourth (0.25) of the marks assigned to that question will be deducted as penalty.
   (*d*) Where there are two correct answers instead of one correct answer out of four options (A, B, C, D) of a question, all those candidates who will encircle/blacken any one of these two correct answers will be awarded marks allotted to that question.
9. No marks shall be awarded for scrapped question.

USE OF MOBILE PHONE OR COMMUNICATION DEVICE IS STRICTLY BANNED IN THE EXAMINATION

1. NCTE was established in which year ?

(A) 1993

(B) 1994

(C) 1995

(D) 1996

2. What type of candidate should be employed as teacher ?

(A) The one, who possess good communication skills with minimum professional qualification

(B) The one, who is good with the content and communication skill

(C) The one, who possesses educational and professional qualifications with higher order

(D) The one, who has requisite educational and professional qualifications and loves the learners

3. Which is the first school for a child's education ?

(A) Society (B) Friends

(C) Family (D) School

4. Schools are basically social institutions as :

(A) They preserve and instill the values of our culture in future generations

(B) They suggest ways and means for social progress

(C) They suggest solutions to social problems

(D) They are established by the society

5. Teaching, the profession of those who give instruction especially in a/an :

(A) Elementary

(B) Secondary

(C) University level

(D) All of the above

6. Which one of the following policy document was called the 'Magna Carta' of Western education system in India ?

(A) Macaulay's Minute of 1835

(B) Indian Education Commission Report of 1882

(C) Charles Woods Despatch of 1854

(D) Releigh Commission Report of 1902

7. The third quadrant in MOOCs is :

(*a*) Assessment

(*b*) References

(*c*) Video

(*d*) Web links

Choose the correct answer from the options given below :

(A) (*a*) and (*b*) only

(B) (*b*) and (*c*) only

(C) (*c*) and (*d*) only

(D) (*b*) and (*d*) only

8. According to John Dewey, the responsibility of schools is to prepare students for :

(A) Present life

(B) Future life

(C) Entrepreneurship

(D) Research

9. ..... means communication without words.

(A) Object communication

(B) Written communication

(C) Oral communication

(D) Non-verbal communication

10. The word communication is derived from communis (Latin) which means :

(A) Common
(B) Message
(C) Community
(D) Oral speech

11. Exchange of ideas between two or more persons is :

(A) Understanding
(B) Telling
(C) Communication
(D) Speaking

12. For a teacher teaching a class with large strength, which of the techniques is best ?

(A) Debate, discussions, practical
(B) Group work with a lecture
(C) Lecture and class notes
(D) Self-study and asking questions

13. In MOOCs (Massive Open Online Courses), an initiative under NME-ICT Programme, the fourth quadrant is related to :

(A) e-content
(B) Self-Assessment
(C) e-tutorial
(D) Web Resources

14. You are training in public speaking and debate. Which of the following characteristics can you not expect to develop ?

(A) Concept

(B) Control over emotions

(C) Using language creatively

(D) Voice modulation

15. Given below are two statements : one is labelled as Assertion (A) and other is labelled as Reason (R) :

Assertion (A) : MOOCs are learner-centric courses

Reason (R) : MOOCs can be accessed by a learner in the presence of his/her teacher.

In the light of the above statements, choose the correct answer from the options given below :

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true and (R) is NOT the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true

16. 'Buniyadi Shiksha' plan is based on ..... plan.

(A) Mahatma Gandhi's

(B) Rabindranath Tagore's

(C) Dr. Radhakrishnan's

(D) Maulana Abul Kalam Azad's

17. Who became the first Minister of Education in the Indian Government ?

(A) Maulana Abul Kalam Azad

(B) Shri M. C. Chagla

(C) Shri Humayun Kabir

(D) Dr. K. L. Shrimali

18. The most effective method of character-formation is :

(A) Teaching virtues through religious books

(B) Organizing specialists' lectures on importance of values in life

(C) Teaching by high character teachers

(D) Rewarding virtuous, behaviors and presenting high character models in the schools

19. Teaching models are prescriptive teaching strategies designed to accomplish particular :

(A) Instructional goals

(B) Teaching skills

(C) Lessons

(D) Interests

20. What are the three components of the educational process ?

(A) Education, teacher and books

(B) Teacher, student and education

(C) Teaching, learning and practice

(D) Direction, instruction and skill

21. $\hat{A}$ and $\hat{B}$ are two quantum mechanical operators. If $\left[\hat{A}, \hat{B}\right]$ stands for the commutator of $\hat{A}$ and $\hat{B}$, then $[[A, B], [B, A]]$ is equal to :

(A) Zero

(B) $\hat{A}\hat{B}\hat{A}\hat{B} - \hat{B}\hat{A}\hat{B}\hat{A}$

(C) $\hat{A}\left(\hat{A}\hat{B} - \hat{B}\hat{A}\right) - B\left(\hat{B}\hat{A} - \hat{A}\hat{B}\right)$

(D) $\left(\left|\hat{A}, \hat{B}\right|\right)^2$

22. A beam of monoenergetic particles having speed v is described by the wave function $\psi(x) = u(x) \exp(ikx)$ where $u(x)$ is a real function. This corresponds to a current density :

(A) v

(B) $u^2(x)v$

(C) $u^2(x)$

(D) Zero

23. The commutator $[L_x, y]$ where L_x, is the x-component of the angular momentum operator and y is the y-component of the position operator, is equal to :

(A) $l\hbar z$ (B) $l\hbar x$

(C) $l\hbar y$ (D) Zero

24. A particle of mass m is confined in the ground state of a 1D box, extending from $x = -2L$ to $x = +2L$. The wave function of the particle in this state is $\psi(x) = \psi_0 \cos\frac{\pi x}{4L}$, where ψ_0 is constant. The normalization factor ψ_0 of this wave function is :

(A) $\sqrt{\frac{1}{4L}}$ (B) $\sqrt{\frac{1}{L}}$

(C) $\sqrt{\frac{2}{L}}$ (D) $\sqrt{\frac{1}{2L}}$

25. The de Broglie wavelength of particles of mass m with average momentum p at temperature T in 3D is given by :

(A) $\lambda = \frac{h}{\sqrt{3mk_BT}}$ (B) $\lambda = \frac{h}{\sqrt{2m}}$

(C) $\lambda = \frac{h}{\sqrt{2mk_BT}}$ (D) $\lambda = \frac{h}{\sqrt{2k_BT}}$

26. Which one of the following relations is true for Pauli matrices σ_x, σ_y and σ_z ?

(A) $\sigma_x \sigma_y = \sigma_y \sigma_x$ (B) $\sigma_x \sigma_y = -\sigma_y \sigma_x$

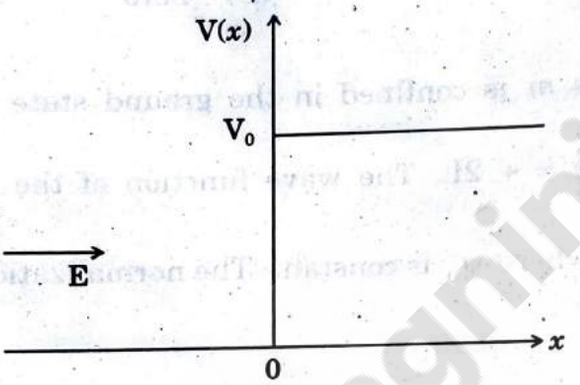
(C) $\sigma_x \sigma_y = \sigma_z$ (D) $\sigma_x \sigma_y = i\sigma_z$

27. An electron with energy E is incident from left on a potential barrier given by :

$$V(x) = 0 \text{ for } x < 0$$

$$= V_0 \text{ for } x > 0$$

as shown in the figure



For $E < V_0$, the space part of the wave function for $x > 0$ is of the form :

(A) $e^{-\alpha}$ (B) $e^{\alpha x}$

(C) $e^{i\alpha x}$ (D) $e^{-i\alpha x}$

28. If x and p are the x-components of the position and momentum operators, respectively of a particle the commmutator $[x^2, p^2]$ is :

(A) $2i\hbar(xp - px)$ (B) $2i\hbar(xp + px)$

(C) $i\hbar(xp + px)$ (D) $i\hbar(xp - px)$

29. The recoil momentum of an atom is P_A when it emits an infra-red photon of wavelength 1500 nm, and it is P_B when it emits a photon of visible wavelength 500 nm. The ratio P_A/P_B is :

(A) 1 : 3

(B) $1:\sqrt{3}$

(C) 1 : 2

(D) 3 : 2

30. Let $\bar{L}$ and $\bar{p}$ be angular and linear momentum operators, respectively, for a particle. The commutator (L_x, P_y) gives :

(A) Zero

(B) $i\hbar p_x$

(C) $-i\hbar p_z$

(D) $i\hbar p_z$

31. The electric quadrupole of an odd proton nucleus is $\frac{(2j-1)}{2(j+1)} < r^2 >$; where j is the total angular momentum. Given R_0 = 1.2 fm, what is the value in barn, of the quadrupole moment of $^{27}_{13}Al$ nucleus in the shell model ?

(A) 0.044

(B) 0.023

(C) 0.915

(D) 0.009

32. Of the nuclei of mass number A = 125, the binding energy calculated from the liquid drop model is maximum for (given that the coefficients for the Coulomb and the asymmetry energy are a_c = 0.7 MeV and a_{sym} 22.5 MeV) is a :

(A) $^{125}_{54}Xe$

(B) $^{125}_{53}I$

(C) $^{125}_{52}Te$

(D) $^{125}_{51}Sb$

33. Which of the following three quark states (qqq), denoted by X, cannot be a possible baryon ? The corresponding electric charge is indicated in the superscript :

(A) X^{++} (B) X^{+}

(C) X^{--} (D) X^{-}

34. Consider the scattering of neutrons by protons at very low energy due to nuclear potential of range r_0. Given that $\cot\left(kr_0+\delta\right)\approx(-)\frac{\gamma}{K}$; where δ is the phase shift, K the wave number and $(-\gamma)$ the logarithmic derivative of deuteron ground state wave function, the phase shift is :

(A) $\delta\approx-\frac{\gamma}{K}-kr_0$ (B) $\delta\approx-\frac{k}{\gamma}-kr_0$

(C) $\delta\approx\frac{\pi}{2}-kr_0$ (D) $\delta\approx-\frac{\pi}{2}-kr_0$

35. The nuclear spin and parity (based on Shell model), ground state of the following nuclei :

^{19}F and ^{23}Na are :

(A) $(5/2)^+, (3/2)^+$ (B) $(1/2)^+, (3/2)^+$

(C) $(3/2)^-, (3/2)^-$ (D) $(5/2)^-, (5/2)^-$

36. Low energy collision (s-wave scattering) of pion (π^+) with deuteron (d) results in the production of two proton $\left(\pi^+ + d \rightarrow p + p\right)$. The relative orbital angular momentum (in units of $\hbar$) of the resulting two-proton system for this reaction is :

(A) 3 (B) 2

(C) 0 (D) 1

37. Which one of the following is a fermion ?

(A) α particle
(B) $^{7}_{4}Be$ nucleus
(C) Hydrogen atom
(D) Deuteron

38. In the decay, $\mu^+ \rightarrow e^+ + \upsilon_e + X$, particle X is :

(A) π^0
(B) N
(C) υ_υ
(D) $\overline{\upsilon_\mu}$

39. What is 1 fm in GeV^{-1} ?

(A) $\approx 5\,GeV^{-1}$
(B) $\approx 50\,GeV^{-1}$
(C) $\approx 10\,GeV^{-1}$
(D) $\approx 100\,GeV^{-1}$

40. The cross-section to make b-quarks at LEP with E_{CM} = 91.2 GeV was $\sigma(e^-e^+ \rightarrow b\bar{b}) = 4.5\,nb$. How many $(e^-e^+ - \rightarrow bb)$ events were produced with an integrated luminosity of $\int L dt$ = 100 pb^{-1} ?

(A) 450
(B) 4,500
(C) 45,000
(D) 4,50,000

41. The term symbol ground state of oxygen will be :

(A) $^3P_2$
(B) $^3P_0$
(C) $^1S_0$
(D) $^3S_2$

42. Nuclear spin of bismuth atom is 9/2. The number of levels into which a $^2D_{5/2}$ term of bismuth splits due to I – J interaction :

(A) 7
(B) 6
(C) 5
(D) 4

43. For a p^2 configuration, the states obtained are $^1S_0$, $^1D_2$ and $^3P_{0,1,2}$; which one is the ground state ?

(A) $^1S_0$ (B) $^1D_2$

(C) $^3P_0$ (D) $^3P_2$

44. The value of g factor for $^5D_4$ term is :

(A) ½ (B) 3/2

(C) 1 (D) 0

45. The number of normal Zeeman splitting components of $^1P \rightarrow {}^1D$ transition is :

(A) 3 (B) 4

(C) 5 (D) 6

46. The $J = 1 \leftarrow J = 0$ transition in HCl occurs at 20.68 cm^{-1}; regarding the molecule to be rigid rotator, the wavelength of transition $J = 15 \leftarrow J = 14$ is :

(A) 310.2 cm (B) 31.02 m

(C) 32 μm (D) 3 μm

47. The Zeeman Pattern of a line contains 9 equidistant components. The upper state is $^3P_2$ (L – S coupling). The lowest state term is :

(A) $^3P_0$ (B) $^3S_1$

(C) $^3D_0$ (D) $^3S_0$

48. Which of the molecule is IR inactive but Raman active ?

(A) HCl

(B) H_2O_2

(C) O_2

(D) CH_3Cl

49. The ground state electronic configuration of the rare earth ion (Nd^{3+}) is $[Pd]4f^3 5s^2 5p^6$. The g factor for this is 8/11. The effective magnetic moment in units of Bohr magneton μ_B is :

(A) 5.82 μ_B

(B) 3.62 μ_B

(C) 0 μ_B

(D) 4.82 μ_B

50. The fine structure splitting between $2\ ^2P_{3/2}$ and $2\ ^2P_{1/2}$ levels in the hydrogen atom is 0.4 cm^{-1}, the corresponding splitting in Li^{2+} will approximately be :

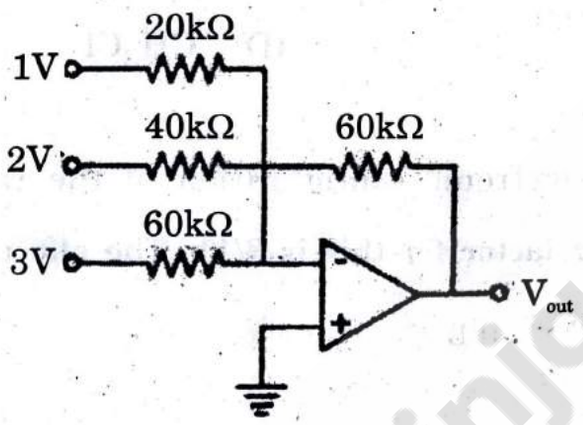
(A) 1.2 cm^{-1}

(B) 10.8 cm^{-1}

(C) 32.4 cm^{-1}

(D) 36.8 cm^{-1}

51. What is the output of the following circuit ? Assume that the op-amp is powere from ± 15 V supply :



(A) + 6V

(B) − 9V

(C) − 6V

(D) + 9V

52. An Op-amp has a common mode gain of 0.01 and a differential gain of 105. Its CMRR would be :

(A) 10^7

(B) 10^{-5}

(C) 10^{-7}

(D) 10^5

53. In differential amplifier differential gain is 20000 and CMRR is 80 dB. What is the common-mode gain ?

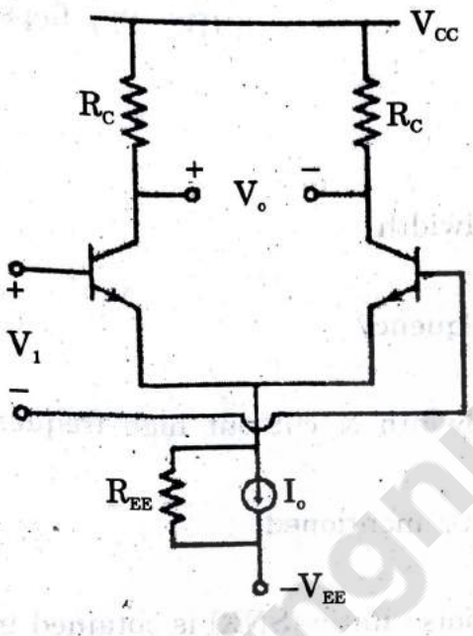
(A) 1

(B) 0.5

(C) 2

(D) 0

54. In the differential amplifier shown in the figure, the magnitudes of the common-mode and differential-mode gains are Acm and Ad, respectively. If the resistance R_{EE} is increased, then :



(A) Acm increases

(B) Common mode rejection ratio increases

(C) Ad increases

(D) Common mode rejection ratio decreases

55. An emitter bias Dual Input Balanced Output differential amplifier has VCC = 20V, β = 100, VBE = 0.7V, RE = 1.3 kΩ. Find IE.

(A) 1 mA

(B) 0 mA

(C) 2.1 mA

(D) 7.42 mA

56. The truth table for an S-R flip-flop has how many valid entries ?

(A) 1

(B) 2

(C) 3

(D) 4

57. Whose operations are fastest among the following ?

(A) Combinational circuits

(B) Sequential circuits

(C) Latches

(D) Flip-flops

58. To avoid aliasing :

(A) Reduce the bandwidth

(B) Cut out high frequency

(C) Reduce the bandwidth & cut out high frequency

(D) None of the above mentioned

59. The better Signal to Noise Ratio (SNR) is obtained in a Pulse Code Modulation (PCM) by :

(A) Increasing Quantization levels

(B) Reducing bandwidth

(C) Increasing clock

(D) None of the above

60. In optical communication system what is the Zero dispersion wavelength ?

(A) 1300 nm

(B) 630 nm

(C) 400 nm

(D) 1800 nm

61. Regarding cobalt, the correct option is :

(A) Hexagonal axis is the direction of easy magnetization at room temperature

(B) Anisotropy energy is the mechano-crystalline energy

(C) The anisotropy energy density is given by $K_1 \sin^2\theta + K_2\sin^4\theta$ where θ is the angle the magnetization makes with the easy-magnetization axis

(D) Both (A) and (C) are true

62. Consider the following three concepts and then choose the correct option :

(*i*) Bloch walls in a crystal are a transition layers that separate adjacent domains magnetized in different directions

(*ii*) Bloch walls are sinusoidal

(*iii*) Bloch walls move in an applied field in a non-linear fashion

(A) (*i*) and (*ii*) are correct

(B) (*ii*) and (*iii*) are correct

(C) (*i*) and (*iii*) are correct

(D) (*i*), (*ii*) and (*iii*) are in conformity

63. Amorphous ferromagnetic alloys have :

(A) Low coercivity

(B) Low hysteresis losses

(C) Low permeability

(D) Both (A) and (B)

64. Exceptionally good permanent magnets can be obtained from alloys of rare earth metals with :

(A) Mn (B) Ba

(C) Ni (D) Both (A) and (C)

65. Point out the wrong statement :

(A) Bubble memories are volatile

(B) Cu-Zn is a more favourable alloy system as compared to Cu-Cd

(C) As the number of electrons is increased, a point is reached where it is easier to accommodate additional electrons in the Brillouin zone of the bcc lattice as compared to that of fcc lattice

(D) The ordered structure has extra diffraction lines not possessed by disordered structures

66. A potential colossal magneto-resistance (CMR) commercialization relies on :

(A) Increasing the Curie temperature beyond room temperature

(B) Achieving CMR at 1 Tesla

(C) Achieving CMR at 10^{-2} Tesla

(D) Both (A) and (C) are required

67. Carbon nano tubes are suitable scaffold materials for :

(A) Brain

(B) Bone tissue engineering

(C) Cartilage

(D) Both (B) and (C)

68. The process of molecular beam epitaxy requires :

(A) Ultra high vacuum and a heated crystalline substrate

(B) Species supplied by atomic or molecular beams

(C) Arrangement for flash evaporation

(D) Only (A) and (B) and not (C)

69. The dielectric function is period in one, two or three spatial dimensions, for :

(A) Photonic crystals

(B) Natural crystals

(C) Incidental nanomaterials

(D) Engineered nanomaterials

70. The electric field $\vec{E}$ (in V/m) at the point (1, 1, 0) due to a point charge of + 1 μC located at (–1, 1, 1) (coordinates in metres) is :

(A) $\frac{10^{-6}}{20\sqrt{5}\pi\varepsilon_0}(2\hat{i}-\hat{k})$

(B) $\frac{10^{-6}}{20\pi\varepsilon_0}(2\hat{i}-\hat{k})$

(C) $\frac{-10^{-6}}{20\sqrt{5}\pi\varepsilon_0}(2\hat{i}-\hat{k})$

(D) $\frac{-10^{-6}}{20\pi\varepsilon_0}(2\hat{i}-\hat{k})$

71. A plane electromagnetic wave is given by :

$$\vec{E} = E_0 \left(\hat{x} + e^{i\delta}\hat{y}\right) \exp\ \{i(kz - \omega t)\}$$

At a given location the number of times $\vec{E}$ vanishes in one second is :

(A) an integer near $\frac{\omega}{\pi}$ when $\delta = n\pi$ and zero when $\delta \neq n\pi$, n is an integer

(B) an integer near $\frac{\omega}{\pi}$ and is independent of δ

(C) an integer near $\frac{\omega}{2\pi}$ when $\delta = n\pi$ and zero when $\delta \neq n\pi$, n is an integer

(D) an integer near $\frac{\omega}{2\pi}$ and is independent of δ

72. A plane wave of wavelength λ is travelling in a direction making an angle 30° with positive x-axis and 90° with positive y-axis. The $\vec{E}$ field of the plane wave can be represented as (E_0 is a constant).

(A) $\vec{E} = \hat{y}E_0 \exp\left[j\left(\omega t - \frac{\sqrt{3\pi}}{\lambda}x - \frac{\pi}{\lambda}z\right)\right]$

(B) $\vec{E} = \hat{y}E_0 \exp\left[j\left(\omega t - \frac{\pi}{\lambda}x - \frac{\sqrt{3\pi}}{\lambda}z\right)\right]$

(C) $\vec{E} = \hat{y}E_0 \exp\left[j\left(\omega t + \frac{\sqrt{3\pi}}{\lambda}x + \frac{\pi}{\lambda}z\right)\right]$

(D) $\vec{E} = \hat{y}E_0 \exp\left[j\left(\omega t - \frac{\pi}{\lambda}x + \frac{\sqrt{3\pi}}{\lambda}z\right)\right]$

73. Molecular refractivity of a substance with molecular weight W is given by (symbols have usual meanings) :

(A) $A_m = \frac{W}{\rho}\left(\frac{n^2-1}{n^2+2}\right)^2$

(B) $A_m = \frac{W}{\rho}\left(\frac{n^2-1}{n^2+2}\right)$

(C) $A_m = \frac{W}{\rho}\left(\frac{n^2-1}{n^2+2}\right)^{\frac{1}{2}}$

(D) $A_m = \sqrt{\frac{W}{\rho}}\left(\frac{n^2-1}{n^2+2}\right)$

74. A circular waveguide and a rectangular waveguide have the same cut-off frequency for dominant mode. The ratio of their areas is :

(A) 1 : 1

(B) 2.16 : 1

(C) 1 : 3

(D) 4 : 1

75. The net charge density (λ) in the frame S is zero. In frame S' moving with a velocity v relative to S along the x-axis, the charge density (λ') will be (n is the number of electrons per unit length of the conducting wire) :

(A) Zero

(B) $ne\beta^2$

(C) $\frac{ne\beta^2}{\sqrt{1-\beta^2}}$

(D) $\frac{ne\beta^2}{2}$

76. A square waveguide carriers TE_{11} mode whose magnetic field is given by $H_z = H_o \cos\frac{px}{\sqrt{8}} \cos\frac{py}{\sqrt{8}} Am^{-1}$. The dimensions of waveguide are in cm. The cut-off frequency of the mode is :

(A) 3.5 GHz

(B) 7.5 GHz

(C) 9.5 GHz

(D) 15 GHz

77. To a close approximation, dispersion varies inversely as :

(A) Wavelength of radiation

(B) Square of the wavelength of radiation

(C) Cube of the wavelength of the radiation

(D) None of the above

78. The time average Poynting vector in watt/m^2 for a wave with $\vec{E} = 24e^{j(\omega t+\beta z)}a_y$ V/m in free space is :

(A) $-\frac{2.4}{\pi}\hat{a}_z$

(B) $\frac{2.4}{\pi}\hat{a}_z$

(C) $\frac{4.8}{\pi}\hat{a}_z$

(D) $-\frac{4.8}{\pi}\hat{a}_z$

79. The residue of $\frac{z^4}{(z-1^4)(z-2)(z-3)}$ at $z = 1$ is :

(A) $\frac{173}{15}$

(B) $\frac{175}{16}$

(C) $\frac{175}{17}$

(D) $\frac{176}{13}$

80. The matrix $\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{i}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \end{bmatrix}$ is :

(A) Only Hermitian

(B) Only unitary

(C) Hermitian and unitary

(D) Neither Hermitian nor unitary

81. The probability of finding a simple harmonic oscillator in normal state within and outside the classical limits are approximately :

(A) 16% and 84%

(B) 84% and 16%

(C) 74% and 26%

(D) 26% and 74%

82. The boundary condition for the differential equation $\frac{d^2y}{dx^2} = f(x)$ for which the ordinary Green function does not exist is :

(A) $\psi(0) = 0 = \psi(a)$

(B) $\psi'(-1) = 0, \psi'(1) = 0$

(C) $\psi'(0) = \psi(0), \psi(1) = -\psi'(1)$

(D) $\psi(0) = 0$ and $\psi'(1) = 0$

83. Which of the following is a holonomic constraint ?

(A) A particle sliding down a sphere from a point near the top under gravity

(B) A particle sliding down an ellipsoid under the influence of gravity

(C) The system of non-rotating pulleys with string of fixed length

(D) A sphere rolling down a rough inclined plane under the influence of gravity

84. A bead of mass m is free to slide on a smooth straight wire of negligible mass which is constrained to rotate in a vertical plane with constant angular speed ω about a fixed point. The Lagrangian is :

(A) $L = \frac{1}{2} m(\dot{x}^2 + \omega^2 x^2) - mgx \sin \omega t$

(B) $L = \frac{1}{2} m(\dot{x}^2 + \omega^2 x^2) + mgx$

(C) $L = \frac{1}{2} m(\dot{x}^2 + \omega^2 x^2) - mgx \cos \omega t$

(D) $L = \frac{1}{2} m\omega^2 x^2 + mgx \sin \omega t$

85. The Lagrangian of a spherical pendulum of mass m and effective length l is given by $L = \frac{1}{2} ml^2 (\dot{\theta}^2 + \sin^2 \theta \dot{\phi}^2) + mgl \cos\theta$. The cyclic coordinate and the corresponding conserved momentum are :

(A) $\theta, \frac{1}{2} ml^2 \dot{\theta}$

(B) $\varphi, \frac{1}{2} ml^2 \sin^2 \theta \, \dot{\varphi}$

(C) $\varphi, \frac{1}{2} ml^2 \sin^2 \theta \, \dot{\theta}$

(D) $\theta, \frac{1}{2} ml^2 \sin^2 \theta$

86. The curve connecting two points down which a particle will slide in minimum time :

(A) An arc of a circle

(B) A straight line

(C) A cycloid

(D) A parabola

87. In a torque free motion of a symmetrical top, the symmetry axis rotates about the fixed direction of the angular momentum with angular frequency :

(A) $\dot{\varphi} = \frac{I_3 \omega_3}{I_1 \cos\theta}$

(B) $\dot{\varphi} = \frac{I_1 \omega_3}{I_2 \cos\theta}$

(C) $\dot{\varphi} = \frac{(I_1 + I_2)\omega_3}{I_3 \cos\theta}$

(D) $\dot{\varphi} = \frac{I_3 \omega \cos\theta}{I_1}$

88. The probability of finding the particles at low energy for Fermi-Dirac statistics, Bose-Einstein statistics and Maxwell-Boltzmann statistics, exist the relations :

(A) $f_{BE} < f_{MB} > f_{FD}$

(B) $f_{BE} < f_{MB} < f_{FD}$

(C) $f_{BE} > f_{MB} < f_{FD}$

(D) $f_{BE} > f_{MB} > f_{FD}$

89. For a strongly degenerate fermions system, energy of highest occupied energy level at absolute zero, is given by :

(A) $\varepsilon_F = \frac{h^2}{8mk_B T}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$

(B) $\varepsilon_F = \frac{k_B T\, h^2}{8m}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$

(C) $\varepsilon_F = \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$

(D) $\varepsilon_F = \frac{2\pi h^2}{8m}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$

90. In conventional metals' contribution of conduction electrons to heat capacity is very much less than heat capacity of classical gas, and is given by :

(A) $\frac{N k_B T}{\varepsilon_F}$

(B) $\frac{\pi^2 N}{2}\frac{k_B^2 T}{\varepsilon_F}$

(C) $\frac{\pi^2 N}{2}\frac{k_B T}{\varepsilon_F}$

(D) $3/2\ Nk_B T$

91. For a system containing N number of non-interacting particles, entropy of the system in terms of partition function is given by :

(A) $S = U + Nk_B T\ ln\ Z$

(B) $S = Nk_B\ ln\ Z$

(C) $S = -Nk_B T\ ln\ Z$

(D) $S = \frac{U}{T} + Nk_B\ ln\ Z$

92. A neutron star may be regarded as :

(A) A degenerate neutron Fermi gas

(B) A degenerate neutron classical gas

(C) A non-degenerate neutron Fermi gas

(D) A degenerate electron Fermi gas

93. Average energy of a Planck's oscillator is given by :

(A) $h\upsilon$

(B) $\frac{8\pi\upsilon^2}{e^{h\upsilon/kt}-1}$

(C) $\frac{h\upsilon}{e^{h\upsilon/kt}-1}$

(D) $\frac{k\mathrm{T}}{e^{h\upsilon/kt}-1}$

94. For a system of N particles, if υ is the degrees of freedom per particle and potential energy reference level is u_0, then the total internal energy of a system is given by :

(A) $\mathrm{E} = \mathrm{N}u_0 + \frac{\mathrm{N}\upsilon}{2}k\mathrm{T}$

(B) $\mathrm{E} = \frac{3\upsilon}{2}\mathrm{N}k\mathrm{T}$

(C) $\mathrm{E} = \mathrm{N}u_0 + \frac{3}{2}\upsilon\mathrm{N}k\mathrm{T}$

(D) $\mathrm{E} = \frac{\mathrm{N}\upsilon}{2}k\mathrm{T}$

95. In case of degenerate bosons system all the boson occupies in lowest possible energy state up to condensation temperature (Tc) and above Tc chemical potential μ of the boson system as a function of temperature is given by :

(A) $\mu = 0$ and does not depend on temperature

(B) $\mu = -\left(\frac{k_B\mathrm{T}}{\mathrm{N}}\right)^{3/2}$

(C) $\mu = -\left(\frac{k_B\mathrm{T}}{\mathrm{N}}\right)^{1/2}$

(D) $\mu = -\frac{k_B\mathrm{T}}{\mathrm{N}}$

96. Using Simpson's rule with interval $h = 0.5$, the value of integral $\int_0^1 \frac{1}{1+x}\,dx$ correct to three decimal places is :

(A) 0.693

(B) 0.936

(C) 0.581

(D) 0.185

97. Using the trapezoidal rule for the data below, the area bounded by the curve and the x-axis from $x = 7.47$ to 7.52 is :

x	$f(x)$
7.47	1.93
7.48	1.95
7.49	1.98
7.50	2.01
7.51	2.03
7.52	2.06

(A) 0.996

(B) 0.0996

(C) 0.6994

(D) 0.891

98. Applying the Runge-Kutta fourth order method, an approximate value of y when $x = 0.2$, given that $\frac{dy}{dx} = x + y$ and $y = 1$ when $x = 0$.

(A) 1.2428

(B) 1.3876

(C) 2.1428

(D) 3.8761

99. Consider the following table, the value of x, correct to two decimal places for which y is maximum :

x	y
1.2	0.9320
1.3	0.9636
1.4	0.9855
1.5	0.9975
1.6	0.9996

(A) 1.38

(B) 1.48

(C) 1.58

(D) 1.51

100. Given $\frac{dy}{dx} = 1 + y^2$, where $y = 0$ when $x = 0$, the value of $y(0.2)$ is :

(A) 0.2027

(B) 0.4228

(C) 0.6841

(D) 0.3029

PROVISIONAL ANSWER KEY (PAPER-II) (SAT)							
Name of the post: Lecturer (School New) Physics							
Date of Exam:11-04-2024				**Time : 02:00 - 04:00 PM**			
Series : A		**Series : B**		**Series : C**		**Series : D**	
Q. No.	**Answer**	**Q. No.**	**Answer**	**Q. No.**	**Answer**	**Q. No.**	**Answer**
1	**A**	1	**A**	1	**B**	1	**A**
2	**A**	2	**B**	2	**A**	2	**D**
3	**A**	3	**C**	3	**C**	3	**C**
4	**D**	4	**B**	4	**B**	4	**A**
5	**A**	5	**A**	5	**D**	5	**D**
6	**B**	6	**C**	6	**C**	6	**C**
7	**A**	7	**B**	7	**A**	7	**A**
8	**B**	8	**C**	8	**C**	8	**A**
9	**A**	9	**B**	9	**A**	9	**D**
10	**D**	10	**C**	10	**A**	10	**A**
11	**A**	11	**B**	11	**D**	11	**C**
12	**C**	12	**A**	12	**C**	12	**C**
13	**C**	13	**C**	13	**D**	13	**B**
14	**B**	14	**B**	14	**D**	14	**B**
15	**B**	15	**D**	15	**A**	15	**B**
16	**D**	16	**C**	16	**D**	16	**A**
17	**B**	17	**A**	17	**D**	17	**A**
18	**D**	18	**C**	18	**D**	18	**D**
19	**A**	19	**A**	19	**A**	19	**A**
20	**D**	20	**A**	20	**D**	20	**B**
21	**A**	21	**D**	21	**A**	21	**A**
22	**B**	22	**C**	22	**A**	22	**A**
23	**C**	23	**D**	23	**B**	23	**A**
24	**B**	24	**D**	24	**B**	24	**D**
25	**A**	25	**A**	25	**C**	25	**A**
26	**C**	26	**D**	26	**B**	26	**B**
27	**B**	27	**D**	27	**C**	27	**A**
28	**C**	28	**D**	28	**A**	28	**B**
29	**B**	29	**A**	29	**B**	29	**A**
30	**C**	30	**D**	30	**C**	30	**D**
31	**B**	31	**A**	31	**B**	31	**A**
32	**A**	32	**A**	32	**B**	32	**C**
33	**C**	33	**B**	33	**C**	33	**C**
34	**B**	34	**B**	34	**A**	34	**B**
35	**D**	35	**C**	35	**B**	35	**B**
36	**C**	36	**B**	36	**C**	36	**D**
37	**A**	37	**C**	37	**A**	37	**B**
38	**C**	38	**A**	38	**D**	38	**D**
39	**A**	39	**B**	39	**C**	39	**A**
40	**A**	40	**C**	40	**B**	40	**D**
41	**D**	41	**B**	41	**D**	41	**A**

42	**C**	42	**B**	42	**A**	42	**B**
43	**D**	43	**C**	43	**C**	43	**C**
44	**D**	44	**A**	44	**A**	44	**B**
45	**A**	45	**B**	45	**D**	45	**A**
46	**D**	46	**C**	46	**A**	46	**C**
47	**D**	47	**A**	47	**B**	47	**B**
48	**D**	48	**D**	48	**A**	48	**C**
49	**A**	49	**C**	49	**C**	49	**B**
50	**D**	50	**B**	50	**A**	50	**C**
51	**A**	51	**D**	51	**A**	51	**B**
52	**A**	52	**A**	52	**D**	52	**A**
53	**B**	53	**C**	53	**C**	53	**C**
54	**B**	54	**A**	54	**A**	54	**B**
55	**C**	55	**D**	55	**D**	55	**D**
56	**B**	56	**A**	56	**C**	56	**C**
57	**C**	57	**B**	57	**A**	57	**A**
58	**A**	58	**A**	58	**A**	58	**C**
59	**B**	59	**C**	59	**D**	59	**A**
60	**C**	60	**A**	60	**A**	60	**A**
61	**B**	61	**A**	61	**C**	61	**D**
62	**B**	62	**D**	62	**C**	62	**C**
63	**C**	63	**C**	63	**B**	63	**D**
64	**A**	64	**A**	64	**B**	64	**D**
65	**B**	65	**D**	65	**B**	65	**A**
66	**C**	66	**C**	66	**A**	66	**D**
67	**A**	67	**A**	67	**A**	67	**D**
68	**D**	68	**A**	68	**D**	68	**D**
69	**C**	69	**D**	69	**A**	69	**A**
70	**B**	70	**A**	70	**B**	70	**D**
71	**D**	71	**C**	71	**A**	71	**A**
72	**A**	72	**C**	72	**A**	72	**A**
73	**C**	73	**B**	73	**A**	73	**B**
74	**A**	74	**B**	74	**D**	74	**B**
75	**D**	75	**B**	75	**A**	75	**C**
76	**A**	76	**A**	76	**B**	76	**B**
77	**B**	77	**A**	77	**A**	77	**C**
78	**A**	78	**D**	78	**B**	78	**A**
79	**C**	79	**A**	79	**A**	79	**B**
80	**A**	80	**B**	80	**D**	80	**C**
81	**A**	81	**A**	81	**A**	81	**B**
82	**D**	82	**A**	82	**C**	82	**B**
83	**C**	83	**A**	83	**C**	83	**C**
84	**A**	84	**D**	84	**B**	84	**A**
85	**D**	85	**A**	85	**B**	85	**B**
86	**C**	86	**B**	86	**D**	86	**C**
87	**A**	87	**A**	87	**B**	87	**A**
88	**A**	88	**B**	88	**D**	88	**D**

89	**D**	89	**A**	89	**A**	89	**C**
90	**A**	90	**D**	90	**D**	90	**B**
91	**C**	91	**A**	91	**A**	91	**D**
92	**C**	92	**C**	92	**B**	92	**A**
93	**B**	93	**C**	93	**C**	93	**C**
94	**B**	94	**B**	94	**B**	94	**A**
95	**B**	95	**B**	95	**A**	95	**D**
96	**A**	96	**D**	96	**C**	96	**A**
97	**A**	97	**B**	97	**B**	97	**B**
98	**D**	98	**D**	98	**C**	98	**A**
99	**A**	99	**A**	99	**B**	99	**C**
100	**B**	100	**A**	100	**C**	100	**A**

Note : The candidate can file objections along with supporting documents / references against the provisional answer key through online mode only within a period of **05 (Five) days,** excluding the day of publishing of provisional answer key, i.e. w.e.f. 13-04-2024 to 17-04-2024. The candidate(s) filing objection(s) shall have to pay a non-refundable fee of Rs.100/- (Rupees One hundred only) per objected question subject to maximum of Rs.500/- (Rupees Five hundred only) in online mode for which the link will appear before final submission of objection(s). No other mode of filing objections and depositing fee, shall be entertained. Objection(s) without depositing the requisite fee shall not be considered / entertained.