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

# 23-0009-AU TEST BOOKLET

## PHYSICS

## PAPER – I

**Time Allowed: 3 hours** | **Maximum Marks: 300**

### INSTRUCTIONS TO CANDIDATES

*Read the instructions carefully before answering the questions*: -

1. This Test Booklet consists of 16(sixteen) pages and has 75 (seventy-five) items (questions).
2. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
3. **Please note that it is the candidate's responsibility to fill in the Roll Number and other required details carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet and the Separate Answer Booklet. Any omission/discrepancy will render the OMR Answer Sheet and the Separate Answer Booklet liable for rejection.**
4. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
5. Use **only Black Ball Point Pen** to fill the OMR Answer Sheet.
6. This Test Booklet is divided into 4 (four) parts – **Part – I, Part – II, Part - III** and **Part – IV.**
7. All three parts are **Compulsory.**
8. **Part-I consists of Multiple Choice-based Questions.** The answers to these questions have to be marked in the **OMR Answer Sheet** provided to you.
9. **Part-II, Part-III and Part-IV consist of Conventional Essay-type Questions.** The answers to these questions have to be written in the separate **Answer Booklet** provided to you.
10. In Part-I, each item (question) comprises of 04 (four) responses (answers). You are required to select the response which you want to mark on the OMR 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.
11. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over to the Invigilator *only the OMR Answer Sheet and the Answer Booklet(s)*. You are permitted to take the Test Booklet with you.
12. **Penalty for wrong answers in Multiple Choice-based Questions:**

THERE WIL BE **PENALTY** FOR WRONG ANSWERS MARKED BY A CANDIDATE.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to the question will be deducted as penalty.

(ii) 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 to the question.

(iii) If a question is left blank. i.e., no answer is given by the candidate, there will be no penalty for that question.

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## PART-I
## (Multiple Choice-based Questions)

*Instructions for Questions 1 to 50:*

- *Attempt all questions. Each question carries 3 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*

*[3x50=150]*

1. The time period of plane of oscillation of Foucault pendulum at equator is:
   (a) Zero
   (b) Infinite
   (c) 24 Hours
   (d) 12 hours

2. A light and a heavy body have equal kinetic energy; which one of two has greater momentum?
   (a) Light body
   (b) Heavy body
   (c) Both have same momentum
   (d) None of the above

3. Moment of inertia of a solid sphere about its diameter is equal to
   (a) $MR^2$
   (b) $\frac{1}{2}MR^2$
   (c) $\frac{2}{3}MR^2$
   (d) $\frac{2}{5}MR^2$

4. Reduced mass of two particle system having equal masses ($m$) will be given by:
   (a) 0
   (b) $m/2$
   (c) $m$
   (d) $2m$

5. How many postulates are there for the special theory of relativity?
   (a) 2
   (b) 3
   (c) 4
   (d) 1

6. The particle moving with velocity of light has a rest mass equal to _____
   (a) infinity
   (b) $M_0$
   (c) 0
   (d) $2M_0$

7. The unit of volume strain is -
   (a) $m$
   (b) $m^2$
   (c) $m^3$
   (d) None of the above.

8. The relation between $Y$,$K$ and $\sigma$ is given by:
   (a) $Y = 3K(1 - 3\sigma)$
   (b) $Y = 3K(1 - 2\sigma)$
   (c) $Y = 2K(1 - 3\sigma)$
   (d) $Y = K(1 - 3\sigma)$

9. The energy conservation law for a flowing fluid is called the _____
   (a) Bernoulli's theorem
   (b) Continuity equation
   (c) Poiseuille Law
   (d) Stock law

10. The unit $N/m^2$ is also called as:
   (a) pascal
   (b) dyne
   (c) bar
   (d) barye

11. In case of Newton's ring, the central ring will be dark in _____
   (a) the reflected system of light
   (b) the transmitted system of light
   (c) the reflected as well as the transmitted system
   (d) case the plano-convex lens is silvered

12. In Fresnel's biprism, coherent sources are formed due to _____
   (a) Reflection
   (b) Multiple Reflection
   (c) Division of amplitude
   (d) Division of wave front

13. For which colour is the fringe width minimum in a Young's double slit experiment?
   (a) Red
   (b) Green
   (c) Violet
   (d) Yellow

14. In Michelson interferometer if the mirror is displaced by a distance **0.0059 *mm*** then **20 fringes** are displaced at the center. Determine the wavelength of light used.
   (a) 5900 Å
   (b) 5950 Å
   (c) 6000 Å
   (d) 5800 Å

15. The formula for a half period zone in Fresnel diffraction is given by -
   (a) $\frac{nb}{\lambda}$
   (b) $\lambda b\pi$
   (c) $\frac{\lambda}{nb}$
   (d) $2\lambda\pi$

16. The intensity of the principal maxima of a grating having $N$-slits is proportional to -
   (a) $1/N$
   (b) $N$
   (c) $N^2$
   (d) $\sqrt{N}$

17. If $n$ is the order of the principal maximum and $N$ is the total number of grooves in the grating that are actually illuminated by the source, then the resolving power of a grating is equal to:

(a) $nN$ (c) $n/N$

(b) $N/n$ (d) $\sqrt{nN}$

18. The angle between plane of vibration and plane of polarization is equal to:

(a) 0° (c) 45°

(b) 90° (d) 180°

19. Which of the following statement is INCORRECT in respect of a Laser beam?

(a) Laser beam is monochromatic. (c) Laser beam is coherent

(b) Laser beam is unidirectional. (d) Laser beam is non-coherent.

20. Which of the following is used in line communication?

(a) Coaxial cable. (c) Optical fiber.

(b) Waveguide. (d) All of the above.

21. Laplacian operator is a -

(a) Scalar function (c) Scalar and vector function

(b) Vector function (d) None of the above

22. The electric field intensity ($E$) due to an electric dipole at a distance ($r$) from its center varies as:

(a) $\frac{1}{r^2}$ (c) $\frac{1}{r^4}$

(b) $\frac{1}{r^3}$ (d) $\frac{1}{r}$

23. The unit of relative permittivity is -

(a) $F/m$ (c) $A^2s^4/kgm^3$

(b) $C^2/Vm$ (d) None of the above

24. The magnetic susceptibility of ferromagnetic material is

(a) positive and high (c) positiveand low

(b) negative and high (d) negativeand low

25. The maximum magnetic field inside a solenoid, is _____
    (a) at its center
    (b) at its ends
    (c) away from it
    (d) at all points

26. Z parameters of a circuit are _____
    (a) open circuit admittance parameters
    (b) short circuit admittance parameters
    (c) open circuit impedance parameters
    (d) short circuit impedance parameters

27. Ampere's law in differential form is given by:
    (a) $\nabla \times \vec{B} = \mu_0 \vec{I}$
    (b) $\nabla \cdot \vec{B} = \mu_0 \vec{I}$
    (c) $\nabla \times \vec{B} = \mu_0 \vec{J}$
    (d) $\nabla \cdot \vec{B} = \mu_0 \vec{J}$

28. The inductance of a coil depends upon _____
    (a) the number of turns of coil
    (b) the type of core
    (c) the spacing between the turns
    (d) all of the above

29. Time constant for any R-C circuit and R-L circuit is equal to ____ and ____ respectively.
    (a) RC, L/R
    (b) RC, R/L
    (c) R/C, LR
    (d) C/R,LR

30. The intrinsic impedance of free space is approximately equal to _____
    (a) 77 Ω
    (b) 377 Ω
    (c) 277 Ω
    (d) 177Ω

31. Poynting vector for electromagnetic wave is given by:
    (a) $\vec{P} = \vec{E} \times \vec{B}$
    (b) $\vec{P} = \vec{E} \times \vec{H}$
    (c) $\vec{P} = \vec{E} \cdot \vec{B}$
    (d) $\vec{P} = \vec{E} \cdot \vec{H}$

32. In an open AC circuit, the load is _____.
    (a) finite
    (b) zero
    (c) infinite
    (d) none of the above

33. The displacement current arises due to _____
    (a) flow of electrons only
    (b) flow of holes only
    (c) flow of both electrons and holes
    (d) time varying electric field

34. The quality factor of a parallel LCR circuit does not depend on its -
    (a) R
    (b) C
    (c) L
    (d) Frequency

35. Entropy of a system signifies the _____
    (a) volume of a system
    (b) shape of a system
    (c) disorder of a system
    (d) pressure of a system

36. The average energy of a system _____, on doing work under adiabatic interaction.
    (a) remains unchanged
    (b) decreases
    (c) increases
    (d) cannot be determined

37. Which of the following is an example of irreversible process?
    (a) Joule Thomson expansion.
    (b) Carnot's cycle.
    (c) Slowing moving adiabatic process.
    (d) None of the above.

38. At **triple point,** _____
    (a) all the three phases co-exist
    (b) all the three phases are absent
    (c) the melting point rises three times
    (d) the volume of the substance become three times

39. Diffusion in gases is mainly due to the:
    (a) Temperature gradient.
    (b) Pressure gradient.
    (c) Concentration gradient.
    (d) Velocity gradient.

40. The behaviour of real gas and ideal gas is the same at _____
    (a) high temperature
    (b) low pressure
    (c) high temperature and low pressure
    (d) low temperature and high pressure

41. Which of the following is the abnormal liquid helium?
    (a) He I
    (b) He II
    (c) He III
    (d) He IV

42. In Clausius-Clapeyron equation the value of $dp/dT$ for melting of ice is _____
    (a) zero
    (b) positive
    (c) negative
    (d) none of the above

43. According to Dulong-Petit's law
    (a) $C_v = 3R$
    (b) $C_v = 3R/2$
    (c) $C_v = R$
    (d) $C_v = 2R/3$

44. The degree of freedom of a bird flying in the sky is:
    (a) 1
    (b) 5
    (c) 3
    (d) 6

45. The relation between entropy $S$, thermodynamic probability $W$ and Boltzmann constant $k_B$ is given by:
    (a) $S = k_B \log_e W$
    (b) $S = k_B \log_{10} W$
    (c) $W = k_B \log_e S$
    (d) $W = k_B \log_{10} S$

46. Which of the following formulae gives the specific heat for a metal at very low temperatures?
    (a) $C = AT^2 + BT$
    (b) $C = AT + BT^3$
    (c) $C = A/T + BT^3$
    (d) $C = AT + BT3$

47. The wave function of a particle with **spin of $\frac{1}{2}$(half-integer)** is _____
    (a) symmetrical
    (b) anti-symmetrical
    (c) both symmetrical and anti-symmetrical
    (d) None of the above

48. At absolute temperature i.e.,$\boldsymbol{T = 0\ K}$, the probability that a state $\boldsymbol{0.50\ eV}$ above the Fermi level would be occupied, is equal to:
    (a) 0.5
    (b) *zero*
    (c) $e^{-1/2}$
    (d) $e^{1/4}$

49. Photons have an spin.
    (a) integer
    (b) double integer
    (c) half integer
    (d) none of the above

50. For shorter wavelengths, the Planck's radiation law reduces to _____
    (a) Wien's Law
    (b) Rayleigh-Jean's Law
    (c) Kirchoff's Law
    (d) Stefan's Law

## PART-II
## (Short Answer-type Questions)

*Instructions for Questions 51 to 63:*

- *Write the answers in short for any 10 (TEN)out of the thirteen questions.*
- *Each question carries 5 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

*[5x10=50]*

51. An Alfa particle, accelerating by 200 KV potential, moving towards gold nucleus (Z = 79). What will be the shortest distance between gold nucleus and Alfa Particle?
52. What are the differences between elastic and inelastic collision? Give one example of each.
53. Write a short note on Viscosity. What is being transported in Viscosity thermal conduction and diffusion.
54. Define Length Contraction. A rod is moving with 0.8C velocity making $60^0$ from its length. Determine the percentage contraction in length.
55. What do you understand by stationary waves?
56. What do you mean by the phenomenon of spherical aberration?
57. Discuss coherent sources. Why interference cannot produce by two different sources.
58. What is the difference between Fresnel and Fraunhofer diffraction?
59. Explain optical activity. What is the difference between half wave plate and quarter wave plate?
60. What do you understand by hysteresis?
61. What is the necessity of using rms value for AC?
62. What do you understand by total internal reflection?
63. Write a short note on negative temperature.

## PART-III
## (Long Answer-type Questions)

*Instructions for Questions 64 to 71:*

- *Answer any 5 (FIVE)out of the eight questions.*
- *Each question carries 10 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

*[10x5=50]*

64. State and prove the theorems of parallel and perpendicular axes. How are they useful in calculating Moment of Inertia of a solid cylinder?

65. Calculate the ratio of Einstein coefficient and probability ratio for spontaneous emission and stimulated emission of light of $10^{15}$Hz frequency from atoms at 300 K.

66. Prove the Laws of Reflection and Refraction using Huygen's principle. In a thin planeconvex lens, the radius of curvature of convex surface is 30 cm. Determine the focal distance of the lens if the reflective index of material of lens is 1.6.

67. Discuss the principle, construction, working and theory of a transformer.

68. How will you achieve low temperatures by adiabatic demagnetization? Explain the principle of adiabatic demagnetization.

69. Mean free path of a molecule in a gas at temperature T and Pressure P is 4 X $10^7$. Determine the mean free path at (i) Pressure P/2, Temperature 2T and (ii) Pressure 2P, temperature T/2.

70. Derive the expressions for the potential and electric field due to an electric dipole.

71. Discuss the elastic constants for an isotropic solid.

## PART-IV
## (Essay-type Questions)

*Instructions for Questions 72 to 75:*

- *Answer any 2 (TWO)out of the four questions.*
- *Each question carries 25 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

***[25x2= 50]***

72.

(a) Derive the formula for reduced mass of two particle system having masses $M_1$ and $M_2$. Also discuss it when (i) $M_1 > M_2$ (ii) $M_1 < M_2$ (iii) $M_1 \sim M_2$

(b) Explain in detail (i) the principal of Holography (ii) Recording and reconstruction of the image.

73.

(a) Solve the Laplace equation to determine potential and electric field between two charged parallel plates having potential $V_1$ and $V_2$. ($V_1 > V_2$ )

(b) What are the differences between Fermi-Dirac and Bose-Einstein distribution law? Explain in detail.

74.

(a) Discuss the motion of a particle under central force and determine the equations of motion of particle.

(b) Discuss in detail the Fresnel diffraction for circular aperture with mathematical analysis.

75.

(a) State and derive Biot-Savart Law. Give the importance and applications of Biot-Savart Law.

(b) Explain in detail the Electromagnetic Field Tensor.