SET – C

Registration number:

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA, VADODARA

PHYSICS DEPARTMENT; FACULTY OF SCIENCE

M.Sc. ENTRANCE TEST FOR THE ACADEMIC YEAR 2025 – 27.

Day &Date of Examination: FRIDAY 13 – 06 -2025 Time: 2:30 to 04:00 P.M.

IMPORTANT NOTES:

1. ***Choose the most suitable option from the given options***.
2. The question paper contains 50 MCQ'S with one correct answer for each.
3. Symbols used have their usual meanings.
4. Each correct answer carries TWO (2) marks.
5. Each wrong answer carries -1/4 (MINUS ONE FOURTH) marks.
6. You are given an OMR answer sheet; mark your answer in the OMR either with the dark pencil or with the ball point pen.
7. After completing the test, return your OMR sheet. Make sure that you are not damaging the OMR sheet.
8. You can do the rough work/calculation in the blank papers at the end of the paper.

USEFUL PHYSICAL CONSTANTS

1. Acceleration due to gravity, $g = 9.81\ m/sec^2$
2. Avogadro number, $N_A = 6.022 \times 10^{23}$ /mol
3. Boltzmann constant, $K_B = 1.38 \times 10^{-23}$ J/K
4. Charge of electron, $e = 1.38 \times 10^{-19}$ C
5. Gravitational constant, $G = 6.67 \times 10^{-11}\ N - m^2/kg^2$
6. Mean radius of the earth, $R_e = 6.37 \times 10^6$ m
7. Permittivity of vacuum, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
8. Permeability 0f vacuum, $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$
9. Planck's constant, $h = 6.63 \times 10^{-34}$ J – s
10. Rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg
11. Rest mass of neutron, $m_n = 1.67 \times 10^{-27}$ kg
12. Rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg
13. Speed of light in vacuum, $C = 3 \times 10^8$ m/s
14. Stefan – Boltzmann constant, $\sigma = 5.67 \times 10^{-8}\ W/m^2\ k^4$
15. Universal gas constant, R = 8.31 J/mol-k
16. Value of γ for an ideal gas = 1.67

1. A 220V, 100W bulb is connected to a 110V source. Calculate the power consumed by the bulb.

   (a) 10 W (b) 15 W (c) 20 W (d) 25 W

2. The work done in moving a body over a smooth inclined plane does not depend on which of the following?

   (a) Mass of the body
   (b) Height of the inclined plane
   (c) Slope of the inclined plane
   (d) All of the above

3. Which one of the following quantities is invariant under Lorentz transformation?

   (a) Charge density (b) Charge (c) Current (d) Electric field

4. The probability current density for the real part of the wave function is

   (a) 1 (b) ħk/m (c) ħk/2m (d) 0

5. What will be the most suitable combination of three resistors A = 2Ω, B = 4Ω, C = 6Ω so that (22/3) Ω is equivalent resistance of combination?

   (a) Parallel combination of A & C connected in series with B
   (b) Parallel combination of A & B connected in series with C
   (c) Series combination of A & C connected in parallel with B
   (d) Series combination of B & C connected in parallel with A

6. For the two statements given here, choose the correct answer from the given options. The statements are:

   Statement – I: A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase if the charge is positive.
   Statement – II: An electric dipole is placed in a non – uniform electric field. The net electric force on the dipole will not be zero.

   (a) Both statement – I & Statement – II are true.
   (b) Both statement – I & Statement – II are false.
   (c) Statement – I is true but statement – II is false.
   (d) Statement – I is false but statement – II is true.

7. The period of oscillation of a linear harmonic oscillator is 1 sec. Its zero point energy is

   (a) 2h (b) h (c) h/2 (d) Data is insufficient

8. Ursa Major (Saptarishi) seen in the sky is

   (a) An asteroid (b) A Binary star (c) A Comet (d) A Constellation

9. The binding energy per nucleon is observed to be almost the same for many nuclides. This indicates that the strong nuclear forces are

   (a) Saturated (b) Short range (c) Attractive (d) Charge independent

10. Though there is a finite probability of finding a particle anywhere in a one dimensional potential well yet, in its lowest energy state, it has the maximum chance to be found

    (a) Very close to the walls
    (b) Exactly at the centre between the walls
    (c) Midway between the walls and the centre
    (d) Equal chances to be anywhere in the well

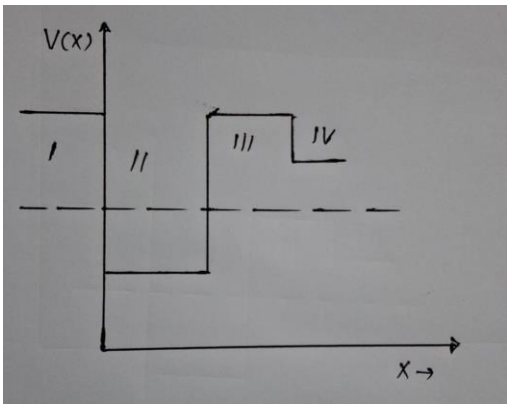
11. In a p – n junction, a free hole diffuses from p – region to n – region. This means that a

    (a) Covalent bond is broken on the n- side and the electron freed from the bond jumps to the conduction band
    (b) Conduction electron on the p – side jumps to the broken bond to complete it.
    (c) Covalent bond is broken on n – side and electron freed from the bond jumps to the broken bond on the n – side to complete it.
    (d) Covalent bond is broken on p – side and electron freed from the bond jumps to the broken bond on the n – side to complete it.

12. The kinetic energy of a particle executing SHM is plotted against its displacement in the space. The two dimensional plot represents

    (a) A circle (b) A parabola (c) An ellipse (d) A hyperbola

13. The potential V(x) in a quantum mechanical problem varies as shown below. For a particle of energy E shown by dashed line, which of the statement is true.



(a) The wave function is exponentially decaying in the regions I,III & IV, and oscillatory in II.
(b) The wave function is oscillatory everywhere.
(c) The wave function is oscillatory in regions I & II, while exponentially decaying in II & IV.
(d) The wave function is exponentially decaying in the regions I & III, and oscillatory in II & IV.

14. An electromagnetic wave propagates in such a fashion that the

(a) Direction of ray is always the same as the direction of propagation vector K.
(b) Direction of electric field E is always perpendicular to the direction of propagation vector K.
(c) Direction of electric field E is always the same as that of the displacement current D.
(d) Direction of displacement vector D is always perpendicular to propagation vector K.

15. Interference fringes for light are explained on wave theory. But photoelectric effect is explained on photon concept. It means that (Choose the most appropriate answer)

(a) Wave theory is good for larger λ and photon concept for smaller λ.
(b) Light may alternately behave as photons and waves to show both kinds of phenomena.
(c) Light simultaneously has photon and wave character, with probability waves governing the distribution of photons.
(d) The conflict between the two observations is not yet resolved in physics.

16. Which of the following is true about an atomic reactor?

(a) D_2O is preferred over H_2O as moderator because of its higher mass.
(b) Cadmium rod increases the power when it is pushed further inside the core.
(c) In every fission of a uranium 235 nucleus, the same number of neutrons is released.
(d) Slowing down of neutrons produced in fission is needed because slower neutrons are more effective in causing fissions.

17. Binary numbers need more places in counting because

(a) They are always big numbers.
(b) Any number of zeros can be added in front of them.
(c) The binary base is small.
(d) 0's and 1's need to be properly spaced.

18. Joule – Thomson cooling pertains to

(a) Expansion under constant pressure difference.
(b) Expansion against vacuum.
(c) Evaporation under reduced pressure.
(d) Adiabatic expansion.

19. If the electron and proton have same kinetic energy, which of the two will have greater wavelength?

(a) Electron
(b) Proton
(c) Both will have same wavelength
(d) None of the above

20. Which of the following statement is true with respect of the formation of stable structure?

(a) Only attractive forces are necessary.
(b) Attractive forces must dominate at large distance and repulsive forces should dominate at short distances.
(c) Attractive forces should dominate over repulsive forces at all distances.
(d) Repulsive forces must be long ranged.

21. Consequences of uncertainty principle include

(a) Finite width of a spectral line.
(b) Tunneling effect
(c) Absence of electrons inside the nucleus.
(d) All of the above.

22. Diamond and graphite are both basically carbon. Based on its properties which of the following is true?

(a) They have different crystal structure.
(b) The hardness of the diamond is quite large compared to that of the graphite.
(c) Graphite behaves more or less like a black body.
(d) All of the above.

23. If the earth stops rotating about its axis then,

(a) The apparent weight of a man on the equator will increase
(b) The apparent weight of a man on the pole will increase.
(c) The apparent weight of a man on the equator will decrease.
(d) There will no be any change in the apparent weight anywhere on the earth's surface.

24. A bullet of 10g is fired with a velocity of 1200 m/s and strikes a wall with a velocity of 400 m/s. The loss in energy while overcoming the resistance of air is

(a) 2300 J (b) 1500 J (c) 6400 J (d) 7800 J

25. Statement A: The temperature of the gas remains unaltered when it undergoes an adiabatic expansion.

Statement B: Heat energy is exchanged between a system and its surrounding during an adiabatic process.

(a) Only A is true
(b) Only B is true
(c) Both A and B are true
(d) Both A and B are false

26. Consider the following statements:

(1) Mechanical waves require a material medium for their propagation.
(2) Mechanical waves do not require a material medium for their propagation.
(3) In longitudinal waves, particle of the medium vibrate in the direction of wave motion.
(4) In longitudinal waves, particle of the medium vibrate perpendicular to the direction of wave motion.

Which of the following statements are correct?

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

27. In the most general case, which one of the following quantities is not a second order tensor?

(a) Stress (b) Strain (c) Moment of inertia (d) pressure

28. In a Carnot cycle _____. (Where, Q_1 is the heat absorbed by the gas from reservoir at temperature T_1 and Q_2 is the heat released by the gas to the reservoir at temperature T_2.)

(a) $Q_1/Q_2 = T_1/T_2$ (b) $Q_1/Q_2 = T_2/T_1$

(c) $Q_1 – Q_2)/Q_2 = T_1/T_2$ (d) $(Q_1 – Q_2)/Q_2 = T_2/T_1$

29. Choose the correct option from the following options given below:

(a) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net – force.
(b) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non – uniform mass distribution in Thomson's model.
(c) A classical atom based Rutherford's model is doomed to collapse.
(d) The positively charged part of the mass in Rutherford's model but not in Thomson's model.

30. In Bohr's atomic model of hydrogen, let K, P & E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transitions to a higher level.

(a) All K, P & E will increase. (b) K decreases, P & E will increase
(c) P decreases, K & E will increase (d) K increases, P & E will decrease

31. Choose the correct statement from the following:

(a) Silicon is a direct band gap semiconductor.
(b) Conductivity of metals decreases with increase in temperature.
(c) Conductivity of semiconductor decreases with increase in temperature.
(d) Gallium Arsenide is an indirect band gap semiconductor.

32. The vector $\mathbf{P} = \mathbf{A} \times (\mathbf{B} \times \mathbf{C})$ is

(a) Perpendicular to **A**.
(b) Coplanar with **B** & **C**.
(c) Perpendicular to **A**, **B** & **C** all.
(d) Both (a) & (b)

33. The interaction between the neighboring dipoles, in the absence of external magnetic field, is negligible in the case of a

(a) Diamagnetic material
(b) Paramagnetic material
(c) Anti – ferromagnetic material
(d) Ferromagnetic material

34. The three axes of a crystal lattice mutually perpendicular and its two lattice parameters are equal ($\boldsymbol{a = b \neq c}$). The crystal system is

(a) Monoclinic (b) Tetragonal (c) Orthorhombic (d) Hexagonal

35. In thermo dynamical process, which of the following is/are integrable i.e. a path independent function or a state function

(a) Internal energy (dU)
(b) Enthalpy (dH)
(c) Entropy (dS)
(d) All of the above

36. A circle of area πR^2 is made to move parallel to one of its diameters with a speed of 0.8c. as a result of Lorentz transformations, the area is decreased by (approximately)

(a) 20 % (b) 36 % (c) 40 % (d) 64 %

37. Choose the correct statement,

(a) A linearly polarized light on passing through a λ/4 plate can never stay a linearly polarized light.
(b) A circularly polarized white light on passing through a λ/4 plate becomes plane polarized light
(c) Circularly polarized monochromatic light after passing through λ/2 plate remains circularly polarized light
(d) Given an elliptically polarized light, it cannot be converted into a plane polarized light using a λ/4 plate

38. A sample magnetic material is kept in the region of a magnetic field. The magnetic field is suddenly withdrawn under adiabatic conditions. The change in temperature is observed due to

(a) Magnetic component of entropy
(b) Lattice component of entropy
(c) Photonic component of entropy
(d) Vibrations of atoms about their mean position

39. Proton and neutron are the two states of the same particle: the nucleon. The two states differ in

(a) Spin (b) Isospin (c) Z – component of spin (d) Z – component of Isospin

40. In change of state from a liquid to solid

(a) The average kinetic energy per degree of freedom remains unchanged.
(b) The average spacing between molecules always decreases.
(c) The potential energy of molecular interaction always increases.
(d) The latent heat is equal to the decrease in molecular potential energy exactly.

41. With p for proton and n for neutron, the nuclear forces have strengths in the order

(a) p - p > p – n > n – n
(b) n – n > p – n > p – p
(c) n – n > p – p > p – n
(d) n – n = p – p = p – n

42. A cyclotron accelerates particles of mass m, charge q. The energy of particle emerging is proportional to

(a) $q^2/2m$ (b) $q/2m^2$ (c) q^2/m^2 (d) q only

43. The function of a donor in extrinsic semiconductor is to

(a) Remove electrons from valance band.
(b) Add holes to valance band.
(c) Add electrons to valance band.
(d) Add electrons to conduction band.

44. A telescope has objective of focal length F and aperture diameter D; its eyepiece has these quantities as f and d respectively. If λ is the wavelength of light used, the resolving limit is

(a) 1.22λ/d (b) λ/D (c) 1.22λ/D (d) F/f

45. In Compton effect, photons of wavelength λ, frequency υ scatter at angle ϕ with modified wavelength λ', frequency υ'. Which of the following is true?

(a) λ' – λ varies with ϕ and also with the scatterer.
(b) υ – υ' is independent of the scattering material.
(c) λ' – λ varies with ϕ in proportion to (1 + cosϕ)
(d) λ' – λ is independent of the scatterer but varies with ϕ.

46. A circuit having a resistance R in series with a parallel combination of L & C is driven by an ac source of frequency $1/\sqrt{2\pi LC}$. The impedance offered by the circuit is

(a) Purely ohmic and very large (b) Inductive and low
(c) Capacitative and high (d) Complex and low

47. Two convex lenses of focal lengths f_1 & f_2 are separated by a distance d. the combination will work as a glass slab. If,

(a) $d > f_1 + f_2$ (b) $d < f_1 + f_2$
(c) $d = f_1 + f_2$ (d) None of the above

48. The strength of an electromagnet can be increased by increasing

(a) The cross – sectional area of the coil.
(b) The number of turns in the coil.
(c) The current in the coil.
(d) All of the above.

49. Without violating special theory of relativity.

(a) +No particle can travel faster than a photon in free space.
(b) Some particles can travel faster than light in some media.
(c) A photon cannot have rest mass.
(d) All of the above.

50. When a transistor is saturated

(a) The collector current is independent of base current.
(b) The base – collector is forward biased.
(c) Collector current continues to flow for a short time after the base – emitter junction is reverse biased.
(d) All of the above.