

SET – D

Test Registration number:



THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA, VADODARA

PHYSICS DEPARTMENT; FACULTY OF SCIENCE

M.Sc. ENTRANCE TEST FOR THE ACADEMIC YEAR – 2024

SUBJECT: PHYSICS

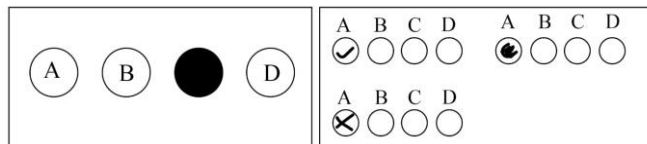
Time: 2:30 to 04:00 P.M.

Day & Date: Friday, 21 – 06 -2024

IMPORTANT INSTRUCTIONS:

1. This test booklet contains 50 MCQ'S. It should be opened only when instructed by the invigilator to do so.
2. Symbols used have their usual meanings.
3. Each correct answer carries TWO (2) marks. And for each wrong answer carries -1/4 (MINUS ONE FOURTH) marks.
4. Test registration number must be entered correctly in the OMR sheet given.
5. You are given an OMR answer sheet; mark your answer in the OMR either with the black pen or with the ball point pen. The circle must be filled completely, leaving no gaps.
6. After completing the test, return your OMR sheet. Make sure that you are not damaging the OMR sheet.
7. You can do the rough work/calculation in the blank papers at the end of the paper.

Correct way of marking Incorrect way of marking

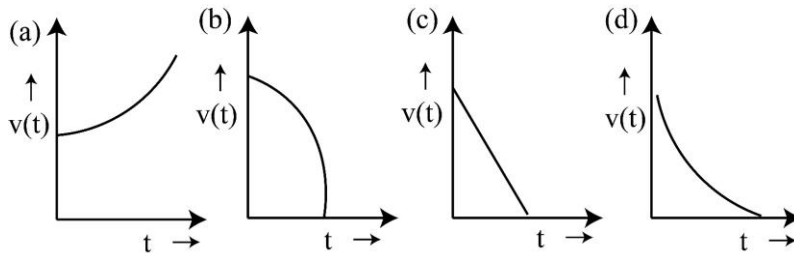


USEFUL PHYSICAL CONSTANTS

1. Acceleration due to gravity, $g = 9.81 \text{ m/sec}^2$
2. Avogadro number, $N_A = 6.022 \times 10^{23} / \text{mol}$
3. Boltzmann constant, $K_B = 1.38 \times 10^{-23} \text{ J/K}$
4. Charge of electron, $e = 1.6 \times 10^{-19} \text{ C}$
5. Gravitational constant, $G = 6.67 \times 10^{-11} \text{ N} - \text{m}^2/\text{kg}^2$
6. Mean radius of the earth, $R_e = 6.37 \times 10^6 \text{ m}$
7. Permittivity of vacuum, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$
8. Permeability of vacuum, $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$
9. Planck's constant, $h = 6.63 \times 10^{-34} \text{ J} - \text{s}$
10. Rest mass of electron, $m_e = 9.11 \times 10^{-31} \text{ kg}$
11. Rest mass of neutron, $m_n = 1.67 \times 10^{-27} \text{ kg}$
12. Rest mass of proton, $m_p = 1.67 \times 10^{-27} \text{ kg}$
13. Speed of light in vacuum, $C = 3 \times 10^8 \text{ m/s}$
14. Stefan – Boltzmann constant, $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$
15. Universal gas constant, $R = 8.31 \text{ J/mol-K}$
16. Value of γ for an ideal gas = 1.67

CHOOSE ONLY THE CORRECT OPTION:

- All natural processes are irreversible. This is a direct consequence of
 - First law of thermodynamics.
 - Second law of thermodynamics.
 - Third law of thermodynamics.
 - Gibb's paradox.
- The boundary value problem: $d^2y/dx^2 = y$, $y(0) = 0$, $y(\infty) = 0$
 - Has no solution
 - Has many possible solutions
 - Has a unique solution that is independent of x
 - Has the unique solution of the type $e^{-x} - e^x$.
- A particle travels in a medium along a horizontal linear path. The initial velocity of the particle is V_0 and the viscous force acting on it is proportional to its instantaneous velocity. In the absence of any other forces, which one of the following figures correctly represents the velocity of the particle as a function of time?



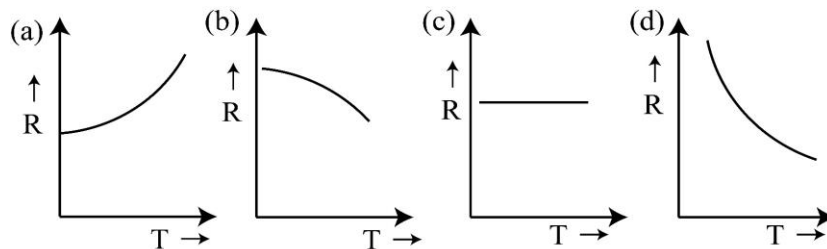
- Consider a particle of mass m following a trajectory given by $x = x_0 \cos \omega_1 t$ and $y = y_0 \sin \omega_2 t$, where x_0 , y_0 , ω_1 & ω_2 are constants of appropriate dimensions. The force on the particle is
 - Central only if $\omega_1 = \omega_2$.
 - Central only if $x_0 = y_0$ & $\omega_1 = \omega_2$.
 - Always central
 - Central only if $x_0 = y_0$ & $\omega_1 \neq \omega_2$.
- The highest order of polynomial integrand for which Simpson's $1/3^{\text{rd}}$ rule is exact is
 - First
 - Second
 - Third
 - Fourth
- Given $i = \sqrt{-1}$, then i^i is
 - Purely real
 - Purely imaginary
 - Of the form $x + iy$ with $x \neq 0$, $y \neq 0$
 - Not defined

7. One mole of an ideal gas with average molecular speed V_{θ} is kept in a container of fixed volume. If the temperature of the gas is increased such that the average speed gets doubled, then
- (a) The mean free path of the gas molecule will increase.
 - (b) The mean free path of the gas molecule will not change.
 - (c) The mean free path of the gas molecule will decrease.
 - (d) The collision frequency of the gas molecule with wall of the container remains unchanged.
8. Stern-Gerlach experiment is important because it gives experimental verification of
- (a) Quantization of energy of atom
 - (b) Orbital motion of electron
 - (c) Electron spin
 - (d) Sommerfeld model of atom
9. In case of geostationary satellite the
- (a) Rotation of the earth and the revolution of the satellite will be in the same direction.
 - (b) Rotation of the earth and the revolution of the satellite will be in the opposite direction.
 - (c) Angular velocity of the earth's rotation and the angular velocity of the revolution of the satellite will be equal and be in the same direction.
 - (d) Angular velocity of the earth's rotation and the angular velocity of the revolution of the satellite will not be equal.
10. If a generalized coordinate has the dimensions of momentum, the generalized velocity will have the dimension of
- (a) Velocity
 - (b) Acceleration
 - (c) Force
 - (d) Torque.
11. For a system at constant temperature and volume, which of the following statements is correct at equilibrium?
- (a) The Helmholtz free energy attains a local minimum.
 - (b) The Helmholtz free energy attains a local maximum.
 - (c) The Gibbs free energy attains a local minimum.
 - (d) The Gibbs free energy attains a local maximum.

12. Which of the following statements is incorrect?

- (a) Indistinguishable particles obey Maxwell – Boltzmann statistics.
- (b) All particles of an ideal Bose gas occupy a single energy state at $T = 0$ K.
- (c) The integral spin particles obey Bose – Einstein statistics.
- (d) Photons obey Fermi – Dirac statistics.

13. Temperature dependence of resistivity of a metal can be best described by



14. Two point charges $+Q_1$ & $+Q_2$ are fixed with a finite distance between them. It is desired to put a third charge Q_3 in between these two charges on the line joining them so that the charge Q_3 is in equilibrium. This is

- (a) Possible only if Q_3 is positive.
- (b) Possible only if Q_3 is negative.
- (c) Possible irrespective of the sign of Q_3 .
- (d) Not possible at all.

15. In a cyclic process

- (a) Work done is zero.
- (b) Work done by the system is equal to the quantity of heat given to the system.
- (c) Work done does not depend on the quantity of heat given to the system.
- (d) The internal energy of the system increases.

16. If the magnetic monopole existed, then which of the following Maxwell's equations will be modified?

- (a) $\text{div } \mathbf{D} = \rho$
- (b) $\text{div } \mathbf{B} = 0$
- (c) $\text{curl } \mathbf{E} = -\partial \mathbf{B} / \partial t$
- (d) $\text{curl } \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$

17. Which of the following statement is correct?

- (a) Only charged particles in motion are accompanied by matter waves.
- (b) No particle in motion whether charged or uncharged is accompanied by matter waves.
- (c) No particle whether rest or in motion is ever accompanied by matter waves.
- (d) Only sub – atomic particles in motion are accompanied by matter waves.

18. Atomic spectra is an example of

- (a) Line spectra
- (b) Continuous spectra
- (c) Band spectra
- (d) Both line and continuous spectra

19. Which one of the following elementary particles is called baryon?

- (a) Electron
- (b) μ – Meson
- (c) π – Meson
- (d) Neutron

20. Which of the following condition on electrostatic potential V is incorrect?

- (a) Must be zero if boundary is earthed.
- (b) Must go to zero at infinite if charge distributions are finite.
- (c) Must be constant throughout any conductor.
- (d) Must be discontinuous across any boundary.

21. Sound waves in air cannot exhibit

- (a) Polarization
- (b) Scattering
- (c) Interference
- (d) Diffraction

22. Maxwell's electromagnetic equations are valid under all conditions except one and that is

- (a) They do not apply to non – isotropic media.
- (b) They do apply to non – homogeneous media.
- (c) They do not apply to the media which move with respect to system of coordinate.
- (d) They do not apply to non – linear media.

23. When a negative charge is placed at the centre of the sphere, the direction of electric field on the Gaussian surface is

- (a) Radially outward. (b) Radially inward.
(c) Along the tangent to the surface. (d) None of the above.

24. For a pure semiconductor, correct statement is

- (a) The Fermi level lies near the valance band.
(b) The Fermi level lies near the conduction band.
(c) The Fermi level lies at the centre of forbidden gap and does not depend upon temperature.
(d) The Fermi level lies at the centre of forbidden gap at absolute zero temperature but it shifts towards conduction band as temperature rises above the absolute zero.

25. Octal equivalent of decimal number 478_{10} is

- (a) 736_8 (b) 673_8 (c) 637_8 (d) 367_8

26. A collimated white light source illuminates the slits of a double slit interference setup and forms the interference pattern on a screen. If one slit is covered with a blue filter, which one of the following statements is correct?

- (a) No interference pattern is observed after the slit is covered with the blue filter
(b) Interference pattern remains unchanged with and without the blue filter
(c) A blue interference pattern is observed
(d) The central maximum is blue with colored higher order maxima

27. The depletion region is created by

- (a) Ionization (b) Diffusion
(c) Recombination (d) All of the above

28. Wien-bridge oscillators are based on

- (a) Positive feedback (b) Negative feedback
(c) The piezoelectric effect (d) High gain

29. Nuclear fusion requires very high temperature because

- (a) All nuclear reactions absorb energy
- (b) The binding energy must be supplied from an external source
- (c) The mass deficit must be supplied
- (d) None of the above

30. The decay chain of the nucleus ${}_{92}^{238}\text{U}$ involves eight α - decays & six β - decays. The final nucleus at the end of the process will have

- (a) $Z = 82$ & $A = 206$
- (b) $Z = 82$ & $A = 224$
- (c) $Z = 88$ & $A = 206$
- (d) $Z = 76$ & $A = 206$

31. In an experiment carried out on a new material. The isothermal compressibility is found to be negative for the temperature range $\theta \leq T \leq T_c$. From this we can conclude that, in the range $\theta \leq T \leq T_c$, the system

- (a) Is a superconductor
- (b) Is a ferromagnet
- (c) Is a metal
- (d) Has not achieved thermodynamic equilibrium

32. For a wave in a medium the angular frequency ω & the wave vector k are related by the relation $\omega^2 = (\omega_0^2 + c^2k^2)$, where ω_0 and c are constants. The product of group and phase velocities, i.e., $V_g V_p$ is

- (a) $0.25c^2$
- (b) $0.4c^2$
- (c) $0.5c^2$
- (d) c^2

33. The field of magnetic vector \mathbf{B} is always

- (a) Irrotational
- (b) Solenoidal
- (c) Non - Solenoidal
- (d) Both (a) & (c)

34. Which of the following statements is correct for NaCl crystal structure?

- (a) It is a simple cubic lattice with one atom basis
- (b) It is a face - centered cubic lattice with one atom basis
- (c) It is a simple cubic lattice with two atom basis
- (d) It is a face - centered cubic lattice with two atom basis

35. An ice cube of volume 10 cm^3 is floating over a glass of water of 10 cm^2 cross-section area and 10 cm height. The level of the water is exactly at the brim of the glass. Given that the density of ice is 10% less than that of water, what will be the situation when ice melts completely?

- (a) The level falls by 10% of the side of the cube.
- (b) The level falls by 10% of the original height of the water column
- (c) The level increases by 10% of the side of the cube and water spills out
- (d) There is no change in the level of the water.

36. The total number of Bravais lattice are

- (a) 7
- (b) 14
- (c) 21
- (d) 26

37. A spherical air bubble is embedded in a glass slab. It will behave like a

- (a) Cylindrical lens
- (b) Achromatic lens
- (c) Converging lens
- (d) Diverging lens

38. In a Canonical ensemble,

- (a) The energy and temperature are constant.
- (b) The entropy and the energy are constant.
- (c) The temperature and the density are constant.
- (d) The density and the entropy are constant.

39. In a crystal, a lattice plane cuts intercepts of $2a$, $3b$ and $6c$ along the axes where a , b , c are primitive vectors of the unit cell. The Miller indices of the given plane are

- (a) (321)
- (b) (231)
- (c) (123)
- (d) (213)

40. The effect used to study the energy levels of a homonuclear molecule is

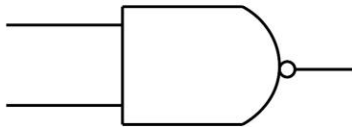
- (a) Stark effect
- (b) Zeeman effect
- (c) Paschen – Back effect
- (d) Raman effect

41. $L - S$ coupling occurs often in

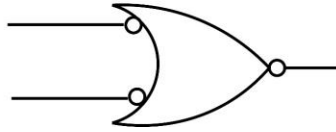
- (a) All atoms (b) Lighter atoms (c) Heavier atoms (d) None of these

42. The following figure (i) & (ii) represent respectively

(i)



(ii)



- (a) NOR , NOR (b) NOR, NAND (c) NAND, NAND (d) OR, NAND

43. Einstein's mass energy relation ($E = mc^2$) shows that

- (a) Mass disappear to reappears as energy.
(b) Mass and energy are two different forms of same entity.
(c) Energy disappears to reappears as mass.
(d) All of the above.

44. The volume of a nucleus in an atom is proportional to the

- (a) Mass number (b) Proton number (c) Neutron number (d) Electron number

45. Which of the following can be used to produce lowest temperature?

- (a) Liquefaction of N_2 . (b) Liquid **He**.
(c) Adiabatic demagnetization of paramagnetic salts. (d) None of these

46. Which one of the convergence is sensitive to starting value?

- (a) Newton – Raphson method (b) False Position
(c) Gauss – Seidel method (d) All of these

47. The engine of a train, emitting the sound of frequency ν_0 approaches an observer with constant speed. If the observer measures the frequencies as ν_1 when it is approaching and ν_2 while it is going away, the relation between the frequencies is given by

- (a) $\nu_1 = \nu_2 = \nu_0$ (b) $\nu_1 > \nu_0 > \nu_2$
(c) $\nu_1 < \nu_0 < \nu_2$ (d) $\nu_1 = \nu_2 \neq \nu_0$

48. A photon has the properties except

- (a) Zero intrinsic angular momentum (b) Its momentum is $h\nu/c$
(c) Its total energy is kinetic (d) It has zero rest mass.

49. When the distance between two mirrors in Michelson interferometer decreased is

- (a) The fringe pattern appears to collapse at the centre
(b) The fringe pattern expands
(c) The fringe pattern remains stable
(d) The shape of the fringe changes

50. The valence electrons do not directly determine the following property of a metal

- (a) Electrical conductivity (b) Thermal conductivity
(c) Shear modulus (d) Metallic luster

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