Instructions :

1. There are **4** Sections and total **60** questions in this question paper.
2. Symbols used in this question paper have their usual meanings.
3. Log table or simple electronic calculator can be used.
4. Write new Section on a new page. Follow the sequence.

SECTION A

- **Questions 1 to 16 are multiple choice questions. Each carries ONE mark. Choose correct answer (a, b, c, d) from the given alternatives and write it. 16**

(1) The electric force acting between two point charges kept at a certain distance in vacuum is α. If the same two charges are kept at the same distance in a medium of dielectric constant k, the electric force acting between them is .....

(a) α (b) $k\alpha$ (c) $k^2\alpha$ (d) $\frac{\alpha}{k}$

(2) A particle having mass m and charge q, is initially kept stationary in a uniform electric field E. It is then released. Calculate the kinetic energy of the particle, when it travels distance y.

(a) qEy^2 (b) qE^2y (c) qEy (d) q^2Ey

(3) There are 200 turns per centimeter length of a very long solenoid. When 2.5 A current passes through it, magnetic field at its centre, on its axis is ..... T.

(a) 3.14×10^{-2} (b) 628×10^{-2} (c) 12.56×10^{-2} (d) 6.28×10^{-2}

(4) The maximum amount of current which can be drawn from the battery, whose emf is equal to 12 V and having 0.4 Ω internal resistance will be equal to .....

(a) 24 A (b) 30 A (c) 4.8 A (d) 48 A

(5) Thermoelectric constants of a thermocouple are α and β. Thermoelectric power for this thermocouple at inversion temperature is .....

(a) α (b) $-\alpha$ (c) $\frac{\alpha}{\beta}$ (d) $-\frac{\alpha}{\beta}$

(6) If a charged particle is moving through a uniform magnetic field, then its .....

(a) both momentum and kinetic energy change.
(b) momentum changes but kinetic energy does not change.
(c) momentum and kinetic energy do not change.
(d) kinetic energy changes but momentum does not change.

(7) A magnetic needle hung using a silk fibre oscillates in earth's magnetic field. If the temperature of this needle is raised beyond the Curie temperature of the material of the needle, then

(a) the needle will stop oscillating.
(b) the periodic time of the oscillations will decrease.
(c) the periodic time of the oscillations will increase.
(d) the periodic time of the oscillations will not change.

(8) Maximum value of current is obtained in an A. C. circuit with resonant frequency when L = 0.5 H and C = 8 μF. The angular frequency of the alternating voltage will be ... rad/s.
(a) 500 (b) 5×10^5 (c) 4000 (d) 5000

(9) If V_g , V_x and V_m are velocity of the γ - rays, X - rays and microwave respectively in space, then
(a) $V_g < V_x < V_m$ (b) $V_g > V_x > V_m$ (c) $V_g > V_x < V_m$ (d) $V_g = V_x = V_m$

(10) Tube - length in case of compound microscope is .....
(a) distance between two lens (b) $f_o + f_e$ (c) $f_o - f_e$
(d) distance between second focal point of the object and the first focal point of the eye - piece

(11) The radius of second orbit in an atom of hydrogen is R. What is its radius in the third orbit ?
(a) 3 R (b) 2.25 R (c) 9 R (d) $\frac{R}{3}$

(12) In Fraunhoffer diffraction by a single slit, width of the slit is 0.01 cm. The wavelength of light normally incident on the slit is 6000 A°. The angular distance from the second maximum is ..... rad.
(a) 0.15 (b) 0.015 (c) 0.0075 (d) 0.03

(13) If De Broglie's wavelength of a proton and α particle is the same, then ..... physical quantity should be the same for both.
(a) velocity (b) energy (c) frequency (d) momentum

(14) Half life of a radioactive element is 5 min. In 20 min. ..... % of the substance will remain undecayed.
(a) 6.25 (b) 2.5 (c) 75 (d) 93.75

(15) The value of the depletion capacitance ..... on increasing the reverse bias.
(a) increases (b) becomes zero (c) decreases (d) does not change

(16) The maximum electron density of a layer of the ionosphere is $\frac{1}{9} \times 10^{12}$ m^{-3}. The critical frequency of this layer is .....
(a) 9 MHz (b) 6 MHz (c) 3 MHz (d) 3 GHz

SECTION B

- **Questions 17 to 32 are very short questions, each carrying ONE mark. 16**

(17) How many electrons will make 10 μe of negative charge ?

(18) Define electrostatic potential.

(19) Give the statement of Kirchhoff's second law.

(20) Resistance of ammeter is G Ω. To increase current capacity n times, obtain the value of shunt resistance.

(21) What is depolarizing action ?

(22) Give the statement of Ampere's circuital law.

(23) On which factors do the magnetization intensity depend ?

(24) What is series resonance in L.C.R. series resonance circuit ? **OR** What are L.C. oscillations ?

(25) State definition and unit of energy density in electromagnetic waves. **OR** Write down dimensional expression of $\sqrt{\mu_r \varepsilon_r}$, where μ_r = relative permeability and ε_r = relative permittivity.

(26) Draw only the ray diagram to obtain the image of the object placed normally on the axis of a convex spherical refracting surface.

(27) Write 'accurate definition of diffraction'. **OR** State the Brewster's law.

(28) Write a formula for angular resolution of the telescope.

(29) Write the revolutionary ideas of Planck for cavity oscillators.

(30) Draw circuit symbol for NPN transistor.

(31) What is tranducer ? **OR** What is modulation ?

(32) Write two types of communication channel. **OR** What is transponder ?

SECTION C

- **Questions 33 to 48 are short answer type questions, each carrying TWO marks. 32**

(33) Write down an equation of energy stored in a capacitor. Obtain the equation for the energy stored in a capacitor in terms of energy density.

(34) Explain mobility. **OR** Explain Peltier effect.

(35) Write definition of the electric current density. Write usefulness of electric current density in flow of electric charges. Obtain the relation between current density and electric field.

(36) Explain what are ferromagnetic substances and soft ferromagnetic substances.

(37) Using Ampere's circuital law, obtain the equation of magnetic intensity of a solenoid.

OR

Obtain an equation of Lorentz force.

(38) Write Faraday's law of electromagnetic induction when a conducting rod is moving perpendicularly into a magnetic field. Explain the reason behind the origin of induced emf.

(39) Write an expression for complex current (i) in L - C - R (A. C.) series circuit. Compare with Ohm's law and explain reactance and impedance.

(40) Write a note on : Green house effect.

(41) Explain total internal reflection and derive formula showing relation between refractive index and critical angle.

(42) Explain polarization by reflection. Also explain σ components and π components.

(43) Explain the first maximum in the case of a Fraunhoffer diffraction by a single slit and obtain necessary condition for it.

(44) Explain with diagram, experimental arrangement of Davison - Germer's experiment.

OR

What is photoelectric effect ? Explain Hertz's experiment.

(45) Give explanation of X - ray spectrum and obtain $\lambda_{min} = \frac{hc}{eV}$

OR

Write down four uses of LASER light.

(46) What is meant by mean lifetime of a radioactive substance ? Obtain an expression showing relation between radioactive decay constant and mean lifetime.

(47) What is called integrated circuit (IC) ? Explain three types of integrated circuits.

(48) Write a note on simplex and full duplex communication.

SECTION D

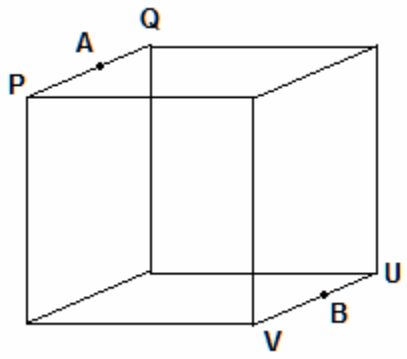
- **Answer the questions 49 to 60 as directed, each carrying THREE marks.**

36

(49) An electric dipole of moment P is placed in a uniform electric field E. The dipole is rotated through a very small angle θ from equilibrium and is released. Prove that it executes simple harmonic oscillations with frequency $f = \frac{1}{2\pi}\sqrt{\frac{PE}{I}}$, where I = moment of inertia of the dipole.

(50) A drop of water (spherically shaped) has 3×10^{-10} C amount of charge residing on it. 500 V electric potential exists on its surface. Calculate the radius of this drop. Two such drops (having identical charge and radius) combine to form a drop. Calculate the electric potential on the surface of the new drop. ($k = 9 \times 10^9$ S I)

(51) A cube is constructed using 12 wires of equal resistance as shown in the figure. Calculate the effective resistance between points A and B as shown in the figure. The resistance of each wire is equal to r. A and B are mid points of PQ and VU respectively.



OR

When a current of 3 A is passed for 100 minutes in a copper voltameter, the mass of copper deposited is 5.94 g. If atomic masses of copper and nickel are 63.57 gm/mole and 58.68 gm/mole respectively, find the electrochemical equivalent of nickel. Valency of copper and nickel are 2 each.

(52) Two small and similar bar magnets have magnetic dipole moment 1.0 Am^2 each. They are kept in a plane in such a way that their axes are perpendicular to one another. The distance between their centres is 2 m. Find the magnetic field at the midpoint of the line segment joining their centres.

(53) A conducting bar of 2 m length is allowed to fall freely from a 50 m high tower, keeping it aligned along east - west direction. Find the emf induced in the rod when it is 20 m below the top of the tower. g = 10 m/s^2. Horizontal component of earth's magnetic field is 0.7×10^{-4} T and angle of dip = 60°.

(54) The A. C. voltage and current in a L - C - R circuit are given by the following expression.

$V = 200\sqrt{2}\cos(3000t - 55°)$ V and $I = 10\sqrt{2}\cos(3000t - 10°)$ A.

Calculate the impedance and the resistance of the above circuit.

OR

For an A. C. circuit comprising of L - C - R in series, L = 10 H, ω = 100 rad/s, R = 100 Ω and power factor = 0.5. Calculate the capacitance of the circuit.

(55) Depth of a well is 5.5 m and refractive index of water is 1.33. If viewed from the top, by how much height would the bottom of the well appear to be shifted up ?

OR

Light of wavelength 5000 A° is incident on a slit of width 2 mm in Fraunhoffer diffraction. Find the width of second maximum on the screen placed at the focal plane of the lens of focal length 100 cm. The lens is placed close to the slit.

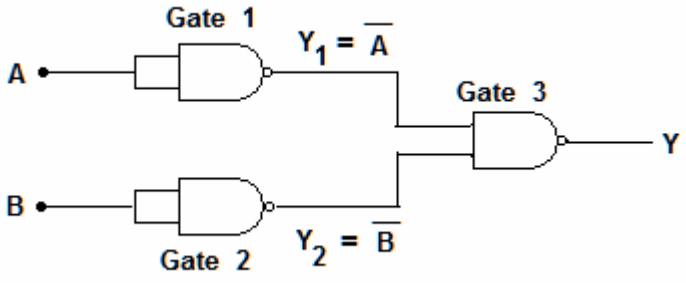
(56) Consider the radius of a nucleus to be 10^{-15} m. If an electron is assumed to be in such nucleus, what will be electron energy in MeV. Mass of electron = 9.1×10^{-31} kg, h = 6.6×10^{-34} Js.

(57) In an X - ray tube the p. d. between the anode and the cathode is 12.4 kV and current flowing is 2 mA. Find,
(i) the number of electrons striking the anode in 1 sec.
(ii) the speed of electrons while striking the anode.
(iii) minimum wavelength (λ_{min}) emitted.

(58) In a mixture of two radioactive elements A and B, the decay constant of A is 0.1 $(day)^{-1}$ and that of B is 0.2 $(day)^{-1}$. The initial activity of A is twice that of B. Find the activity of this mixture after 10 days. Initial activity of the mixture is 2 μCi.

(59) In a NPN transistor about 10^{10} electrons enter the emitter when it is connected to a battery. About 2 % of the electrons recombine with the holes in base. Calculate the values of I_E, I_B, I_C, α_{dc} and β_{dc}. e = 1.6×10^{-19} C.

(60) Show that the circuit drawn in the figure comprising of 3 **NAND** gates behaves as an **OR** gate.



OR

The current gain of a common base circuit is equal to α and the current gain of common emitter circuit is equal to β. Obtain $\alpha = \frac{\beta}{1+\beta}$ and $\beta = \frac{\alpha}{1-\alpha}$.