Part-I [Physics]

1. State Gauss's law. Derive an expression for the electric field due to an infinite line charge and infinite sheet. [Deduce Coulomb's law from Gauss's law and electric field due to conducting sphere.]
2. Electric field due to a dipole.
3. Potential due to dipole on axial and equatorial line.
4. Electric field due to dipole general expression.
5. Derive an expression for capacitance, principle of capacitor, and expression for capacitance of parallel plate with or without dielectric.
6. Derive an expression for the torque experienced by dipole in uniform electric field?
7. Explain equipotential surfaces and their characteristics?
8. What is meant by quantization of charge?
9. What is an electric dipole and electric dipole moment?
10. State Coulomb's law, express in vector form, define unit charge.
11. Properties of electric lines of force and define electric flux, its units.
12. Work done in rotating a dipole in uniform electric field and its potential energy?
13. What is current, drift velocity, find relation between current and drift velocity?
14. Ohm's Law, VI curve, $R = \rho l/A$, Temp. dependence of resistance, temp coefficient of resistance.
15. A wire of resistance R is stretched so that its length becomes double, what is new resistance?
16. EMF and potential difference.
17. State and explain Kirchhoff's rules and obtain balance condition for Wheatstone bridge.
18. Magnetic force acting on a charged particle, its circular path, and expression for radius and time period.
19. State Biot Savart law. Obtain expression for magnetic field due to circular coil (Straight conductor).
20. Torque on a current loop and construction and working of moving coil galvanometer. Define current sensitivity.
21. Torque on a current loop and construction and working of moving coil galvanometer. Define voltage sensitivity.
22. State Ampere's circuital law. Apply it on straight conductor and solenoid.
23. Difference between para, dia, and ferromagnetic materials (properties). Domain theory of ferromagnetism.
24. Construction and working of moving coil galvanometer? Also explain current sensitivity and voltage sensitivity.
25. Explain Ampere's circuital law? Also determine magnetic field because of:
    (i) Straight thin infinite current-carrying conductor.
    (ii) Thick infinite current-carrying conductor.
    (iii) Solenoid.
    (iv) Toroid.
26. **Magnetic Flux:**
    $\Phi B = B \cdot A$ ....(1)
    $\Phi B = |B| \, |A| \cos \theta$ ....(2)

27. Factors on which flux depends:
    (a) Field crossing the loop.
    (b) Area of the loop.
    (c) Angle between ñ and **B**.
28. SI unit:
    $\Phi = Tm^2$
    1 Weber = 1 Tm^2.
29. **Faraday's 1st Law:**
    When the magnetic flux linked to a closed loop (or closed circuit) changes, an EMF is induced in the loop, which lasts as long as the flux through the loop keeps on changing.
30. **Faraday's 2nd Law:**
    "The EMF induced in a closed loop is directly proportional to the rate at which the flux changes through the loop."
    $|\varepsilon| \propto |d\Phi/dt|$
    => $|\varepsilon| = |d\Phi/dt|$
    => $\varepsilon = -d\Phi/dt$
31. **Meaning of –ve sign:**

- Negative sign gives the sense of induced EMF in the loop.
- Its meaning is that the induced EMF opposes the change in flux through the loop.

32. **Lenz's Law:**
    Lenz's law gives the direction of induced EMF in a loop.
    According to this law:
    "The EMF induced in any loop due to change in flux through it has a direction which opposes the change that has produced it."
33. **Lenz's Law follows:**

- The law of conservation of energy.
- An external source has to work to change the flux through the loop and produce EMF or current in the loop.

34. **Derive mirror formula for a concave mirror.**
    Relation between position of object (u), position of image (v) & focal length (f) of the mirror.
    Sign Conventions:
    (i) All distances are measured from the pole.
    (ii) Distances measured in the direction of incident light are taken as positive & distances opposite to the direction of the light are taken as negative.
    (iii) Heights above P-axis taken as +ve & below P-axis are taken as –ve.
    $1/f = 1/u + 1/v$

35. An object is placed in front of a concave mirror of focal length 10 cm at a distance of 30 cm. Find the position & nature of the image formed.
36. Derive lens maker's formula.
   Assumptions:

- Lens is thin & all distances are measured from the optical center.
- Aperture is small.
- Object is point-sized & placed on the P-axis.

37. What is real and apparent depth?
38. What is total internal reflection? Derive relation for the critical angle. Discuss any two applications.
39. **Mirage:** It is an optical illusion observed generally in deserts when an inverted image of an object is observed along with the object itself on a hot day.
40. **Optical Fiber:** A thin strand of plastic or glass used to transmit signals in the form of light over a long range and distances.
41. Prove for a prism (Prism Formula):
   $\mu = (\sin (A + \delta m)/2) / (\sin A/2)$
42. What is dispersion of light? Discuss its causes.
43. What is angular dispersion & dispersive power?
44. Power of a lens?
45. What is a compound microscope with the help of a labeled diagram? Show image formation. Derive expression for its magnifying power.
46. Explain the construction and working of an astronomical telescope. Derive the expression for magnifying power.
47. What is a wavefront, and what are its various types?
48. State Huygens Principle and explain the laws of reflection and refraction using Huygens principle.
49. Describe Young's double-slit experiment. How can we find the position of bright and dark bands? Write down the expression for fringe width.
50. What is diffraction of light? Explain diffraction due to a single slit. What is the width of the central maximum?
51. What are coherent sources of light? What are the conditions for sustained interference of light?
52. Discuss the photoelectric effect and Einstein's photoelectric equation.
53. Laws of photoelectric emission.
54. Define threshold frequency, wavelength, stopping potential, and the effect of frequency on stopping potential.
55. Discuss the matter-wave nature of particles and de-Broglie relation.
56. Postulates of Bohr's model and expression for radius and energy.
57. Binding energy and binding energy curve and its variation with mass number.
58. Define nuclear fission and nuclear fusion reactions.
59. Define nuclear force and its properties.
60. On the basis of band theory of solids, explain the difference between conductors, semiconductors, and insulators.
61. What is doping? Discuss extrinsic and intrinsic semiconductors.
62. Working of PN junction as a diode.
63. PN junction as a rectifier.
64. Displacement current in a capacitor.
65. Explain the electromagnetic spectru