MODEL PAPER – 5

Time : 3 Hours + 15 Minutes] **[Total Marks : 70**

INSTRUCTIONS TO THE CANDIDATES :

1. Candidates are required to give their answers in their own words as far as practicable.
2. Figure in the right hand margin indicate full marks.
3. While answering the questions, candidate should adhere to the word limit as far as practicable.
4. 15 Minutes of extra time has been allotted for the candidates to read the questions carefully.
5. This question paper is divided into two sections—**SECTION – A** and **SECTION – B**.
6. In **SECTION – A** there are **70 Objective Type Question**, out of which only 35 objective questions be answered. Darken the circle with blue/black ball pen against the correct option on OMR Sheet provided to you. Do not use Whitener/Liquid/Blade/ Nail on OMR paper, otherwise the result will be invalid.
7. In **SECTION – B**, there are **20 Short Answer Type Question** (each carrying 2 marks), out of which any 10 questions are be answered.

   Apart from this, there are **6 Long Answer Type Question** (Each Carrying 5 marks), out of which 3 questions are to be answered.
8. Use of any electronic device is prohibited.

SECTION – A : Objective Type Questions

Directions : *There are 70 Objective Type Questions, out of which only 35 objectives questions to be answered. For each question, mark the correct option on the OMR answer sheet.*

$35 \times 1 = 35$

1. In step-up transformer, the value of current in secondary coil compared to primary coil is :
(A) equal (B) less
(C) more (D) none of these

2. The dispersive power of a prism depends on :
(A) Angle of incidence
(B) Nature of material of prism
(C) Refracting angle of prism
(D) Angle of prism

3. The critical angle for total internal reflection of a ray from any medium to vacuum is 30°. Then velocity of light in the medium will be :
(A) 3×10^8 m/s (B) 1.5×10^8 m/s
(C) 6×10^8m/s (D) 4.5×10^8 m/s

4. LASER action needs :
(A) High temperature (B) Semiconductor
(C) High pressure (D) Number inversion

5. The temperature coefficient of a semi-conductor is :
(A) Positive (B) Negative
(C) Zero (D) Infinity

6. A charge '*q*' placed at the centre on the line joining two charges '*Q*' will be in equilibrium if '*q*' will be equal to :
(A) $\frac{Q}{2}$ (B) $-\frac{Q}{4}$ (C) –4Q (D) $+\frac{Q}{4}$

7. The radius of a circular current loop is made double and the current is made half. The magnetic moment of the loop will become :
(A) Halved (B) Doubled
(C) Four times large (D) None of these

8. The nucleus of any atom is made up of :
(A) proton (B) proton and electron
(C) α-particle (D) proton and neutron

9. For resonance condition in any L-C-R circuit, the phase difference between applied voltage and current is :
(A) π (B) $\frac{\pi}{2}$ (C) $\frac{\pi}{4}$ (D zero

10. Three capacitors of capacitance 6 μF are available. The minimum and maximum capacitances obtained are :
(A) 3 μF, 12 μF (B) 2 μF, 12 μF
(C) 2 μF, 18 μF (D) 4 μF, 18 μF

11. Dimension of charge is :
(A) AT (B) AT^{-1}
(C) $A^{-1}T$ (D) AT^2

12. Surface charge density of a conductor is σ, Electric field near it is :
(A) $\frac{\sigma}{2\epsilon_0}$ (B) $\frac{\sigma}{\epsilon_0}$ (C) $\frac{2\sigma}{\epsilon_0}$ (D) $\frac{\sigma}{3\epsilon_0}$

13. Coulombian force is :
(A) Central force (B) Electric force
(C) both 'A' and 'B' (D) None of these

14. The intensity of electric field at any point on the surface of a charged conductor is :
(A) zero
(B) perpendicular to the surface
(C) tangetial to the surface
(D) at 45° to the surface

15. The value of ϵ_r in air is :
(A) zero (B) infinity
(C) 1 (D) 9×10^9

16. The stored energy, of a capacitor charged to 100 V is 1 J. Capacitance of the capacitor is

(A) 2×10^4 F (B) 2×10^{-4} F

(C) 2×10^2 F (D) 2×10^{-2}F

17. The dielectric constant of water is :

(A) 80 (B) 60 (C) 1 (D) 42.5

18. The surface density of charge is measure :

(A) Cm^{-1} (B) Cm^{-2}

(C) Cm^{-3} (D) JC^{-1}

19. The power of electric circuit is :

(A) $V . R$ (B) $V^2 . R$

(C) V^2/R (D) V^2RI

20. A hot wire ammeter measures :

(A) average value of alternating current

(B) root mean square value of alternating current

(C) instantaneous value of alternating current

(D) peak value of alternating current

21. Wheatstone bridge compares :

(A) resistances (B) currents

(C) potential differences (D) All of these

22. Value of green colour code on carbon resistance is :

(A) 3 (B) 4

(C) 5 (D) 6

23. Kirchhoff's first and second laws for electrical circuits are consequences of :

(A) conservation of energy

(B) conservation of electrical charge and energy respectively

(C) conservation of electric charge

(D) neither conservation of energy nor electric charge

24. Work function of Copper is of the order of :

(A) electron volt (eV) (B) joule

(C) watt (D) volt

25. The power of the electrical circuit :

(A) V^2R (B) V^2/R

(C) VR (D) V^2RI

26. Iron is :

(A) paramagnetic (B) diamagnetic

(C) ferromagnetic (D) non-magnetic

27. Nickel is :

(A) diamagnetic (B) paramagnetic

(C) ferromagnetic (D) none of these

28. Expression of force on a charge q moving with velocity $\vec{V}$ in a magnetic field $\vec{B}$ is :

(A) $\vec{F}_m = q(\vec{V} \times \vec{B})$ (B) $\vec{F}_m = q(\vec{B} \times \vec{V})$

(C) $\vec{F}_m = \frac{(\vec{B} \times \vec{V})}{q}$ (D) $\vec{F}_m = \frac{(\vec{V} \times \vec{B})}{q}$

29. A cyclotron can be used to produce high energy :

(A) neutrons (B) deutrons

(C) β particles (D) α particles

30. Which of the following has higher magnetic susceptibility :

(A) diamagnetic (B) paramagnetic

(C) ferromagnetic (D) None of these

31. Moving charge produces :

(A) Only electric field

(B) Only magnetic field

(C) Both electric and magnetic field

(D) None of these

32. Unit of flux of magnetic field is :

(A) tesla (B) henry

(C) weber (D) joule-second

33. The unit of reactance is :

(A) mho (B) ohm

(C) farad (D) ampere

34. One henry is equal to :

(A) 10^3 mH (B) 10^6 mH

(C) 10^{-3} mH (D) 10^{-6} mH

35. The working of a dynamo is based on the principle of :

(A) Heating effect of electric current

(B) Electromagnetic Induction

(C) Chemical effect of electric current

(D) None of the above

36. The dimensional formula of impedance is :

(A) $[ML^2T^{-2}A^{-2}]$ (B) $[ML^2T^{-3}A^{-2}]$

(C) $[ML^2T^{-2}A^{-1}]$ (D) $[ML^2T^{-2}A^{-3}]$

37. Which of the following relations is correct for power factor?

(A) Power factor = True average power × Apparent average power

(B) Power factor = $\frac{\text{Apparent average power}}{\text{True average power}}$

(C) Power factor = $\frac{\text{True average power}}{\text{Apparent average power}}$

(D) Power factor = $\frac{1}{2}$ [True average power × Apparent average power]

38. Quantity that remains unchanged in a transformer is :

(A) frequency (B) current

(C) voltage (D) None of these

39. The power factor of L-R circuit is :

(A) $R + WL$ (B) $\frac{R}{\sqrt{R^2 + W^2L^2}}$

(C) $R\sqrt{R^2 + W^2L^2}$ (D) WL/R

40. The value of $(\mu_0 \epsilon_0)^{-\frac{1}{2}}$ is :

(A) 3×10^7 m/s (B) 3×10^8 m/s

(C) 3×10^9 m/s (D) 3×10^{10} m/s

41. The wave impedance of free space is :

(A) zero (B) 376.6 Ω

(C) 33.66 Ω (D) 3.76 Ω

42. The energy of an electromagnetic radiation is 13.2 KeV. This radiation is related to which region of spectrum ?

(A) Visible (B) X-rays

(C) Ultra violet (D) Infrared

43. On increasing the length of the tube of compound microscope, magnifying power :

(A) increases (B) decreases

(C) does not change (D) becomes zero

44. The lens which is used to remove short sightedness is :

(A) concave (B) convex

(C) cylindrical (D) plano-convex

45. When a ray of light enters a glass slab, its wavelength :

(A) increase (B) decrease

(C) remains unchanged (D) data are not complete

46. Which of the following is correct for Astronomical telescope?

(A) $f_o = f_e$ (B) $f_o > f_e$

(C) $f_o < f_e$ (D) $f_o << f_e$

47. The power of convex lens of focal length 20 cm in dioptre is :

(A) 4 (B) 5

(C) 3 (D) 2

48. Velocity of light in vacuum is c. Its value in glass ($\mu = 3/2$) will be:

(A) $\frac{3c}{2}$ (B) $\frac{2c}{3}$ (C) $\frac{4c}{3}$ (D) $\frac{c}{2}$

49. Which of the following is conserved when light waves interefere ?

(A) phase (B) intensity

(C) amplitude (D) none of these

50. Who first suggested that the propagation of light can be explained without reference to ether ?

(A) Huygens (B) Einstein

(C) Foucault (D) Maxwell

51. Optical fiber communication is based on which of the following phenomena :

(A) Total Internal reflection (B) Scattering

(C) Reflection (D) Interference

52. A bi-convex lens can form a virtual image if the object is placed

(A) between the lense and its focus

(B) at the focus

(C) between f and $2f$

(D) at infinity

53. Blue colour of sky is due to :

(A) scattering (B) interference

(C) polarisation (D) diffraction

54. Definite value of energy possessed by a quantum of radiation is called :

(A) Proton (B) Photon

(C) Deuteron (D) Lepton

55. Which one among the following shows particle nature of light ?

(A) Photoelectric effect (B) Interference

(C) Refraction (D) Polarization

56. X-rays are :

(A) deflected by an electric field

(B) deflected by a magnetic field

(C) deflected by both electric and magnetic fields

(D) not deflected by electric and magnetic fields

57. Dimention of plank constant is :

(A) ML^2T^{-1} (B) ML^2T^{-2}

(C) MLT^{-1} (D) MLT^2

58. The minimum angular momentum of electron in Hydrogen atom will be :

(A) $\frac{h}{\pi}$Js (B) $\frac{h}{2\pi}$Js

(C) $h\pi$. Js (D) 2π h Js

59. β–rays are fast moving :

(A) photons (B) protons

(C) electrons (D) neutrons

60. Which of the following is correct for radioactive element?

(A) $T_a = \frac{\lambda}{0 \cdot 6931}$ (B) $T_a = \frac{1}{\lambda}$

(C) $T_a = (0.6931)\lambda$ (D) $T_a = \frac{1}{\lambda^2}$

61. Bohr's frequency condition is :

(A) $E_1 - E_2 = \frac{1}{2}hv$ (B) $E_1 - E_2 = hv$

(C) $E_1 - E_2 = 3hv$ (D) $E_1 - E_2 = \frac{3}{2}hv$

62. The number of Photons of frequency 10^{14} Hz in radiation of 6.62 J will be :

(A) 10^{10} (B) 10^{15}

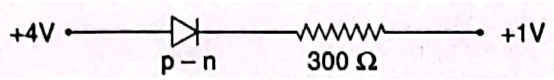
(C) 10^{20} (D) 10^{25}

63. Time during which the amount of radioactive substance becomes half of its inital amount is called.
(A) Average life (B) Half life
(C) Decay constant (D) Time period

64. Binary of decimal number 25 is :
(A) $(1100)_2$ (B) $(1001)_2$
(C) $(11001)_2$ (D) $(11101)_2$

65. Which of the following is correct for fundamental gate?
(A) AND, OR, NOT (B) AND, OR
(C) NAND, NOR (A) OR, NOT

66. In the circuit given below the value of the current is :



(A) 0A (B) 10^{-2}A
(C) 10^{2}A (D) 10^{-3}A

67. The Boolean expression for NOR gate is :
(A) $\overline{A \cdot B} = Y$ (B) A + B = Y
(C) A . B = Y (D) $\overline{A + B} = Y$

68. The truth table shown is of :

Input		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

(A) OR gate (B) AND gate
(C) NOR gate (D) None of these

69. From which layer of atmosphere are radio waves reflected ?
(A) Ionosphere (B) Mesosphere
(C) Chromosphere (D) None of the above

70. Modulation is of :
(A) 2 types (B) 3 types
(C) 4 types (D) 5 types

SECTION – B : Non-Objective Type Questions

SHORT ANSWER TYPE QUESTIONS

Directions : *Questions Nos. 1 to 20 are short Answer Type. Each question carries 2 marks. Answer and ten question on your copy.* 10 × 2 = 20

1. **What are 'α' and 'β' parameters of transistor ? What is their relation ?**
2. **Define the term 'electric flux'. Write its S.I. unit.**
3. **Define Relative permittivity.**
4. **Explain that Kirchoff's second law is law of conservation of energy.**
5. **Explain Seeback effect.**
6. **What is hysteresis in a magnetic material? Draw a typical hysteresis loop (Without explanation).**
7. **Write Biot-savart's law for the magnetic field due to a current-element.**
8. **Write dimension of coefficient of induction.**
9. **Name the factors responsible for decreasing the efficiency of transformer.**
10. **Write Brewster law of polarisation of light.**
11. **Find the expression for deviation by a prism of a ray incident at angle of incidence *i* after its emergence from the Prism.**
12. **Explain use of ionosphere in communication.**
13. **Write decimal equivalent of summation of binary numbers 1110 and 10111.**
14. **Explain emission of γ-ray.**
15. **What do you mean by the impedence of LCR-circuit ?**
16. **Distinguish between *p*-type and *n*-type semiconductors on the basis of energy band diagram.**
17. **A circular coil of wire consisting of 100 turns each of radius 8.0 cm carries a current of 0.40 A. What is the magnitude of the field $\vec{B}$ at the centre of the coil ?**
18. **Explain Solar Cell.**
19. **What do you mean by Paschen Series?**
20. **Define dielectric dipole moment and find an expression for the potential energy of electric dipole in a uniform electric field.**

LONG ANSWER TYPE QUESTIONS

Directions : *Questions Nos. 21 to 26 are Long Answer Type Questions. Answer any 3 Out of them.* 3 × 5 = 15

21. **Find the condition for the resonance in L-C-R Series or parallel circuit. Derive expression for resonant frequency.**
22. **Explain Rutherford experiment of α-scattering. How the distance of closest approach can be estimated by this.**
23. **What are postulates of Bohr's atomic model? Estimate energy of an atom in nth orbit on the basis of Bohr's theory.**
24. **What are defects of vision ? Give causes and remedies of defects of vision.**
25. **How will you use a meter bridge to measure an unknown resistance ? Draw the necessary circuit diagram. Explain the principle of the experiment. Give the formula used.**
26. **Describe amplitude modulation and frequency modulation. Derive an expression for covering range of transmission tower.**

ANSWER WITH EXPLANATION

SECTION – A

OMR ANSWER-SHEET

1.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	36.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	37.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	38.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	39.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	40.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	41.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	42.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	43.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	44.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	45.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	46.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	47.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	48	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	49.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	50.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
16.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	51.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	52.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	53.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	54.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	55.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	56.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	57.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	58.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	59.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	60.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	61.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	62.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	63.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	64.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	65.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
31.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	66.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
32.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	67.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
33.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	68.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
34.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	69.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
35.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	70.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

ANSWER

1. (B)	2. (B)	3. (B)	4. (D)	5. (B)
6. (B)	7. (B)	8. (D)	9. (D)	10. (C)
11. (A)	12. (B)	13. (C)	14. (B)	15. (C)
16. (B)	17. (A)	18. (B)	19. (C)	20. (B)
21. (A)	22. (C)	23. (B)	24. (A)	25. (B)
26. (C)	27. (C)	28. (A)	29. (D)	30. (C)
31. (C)	32. (A)	33. (B)	34. (A)	35. (B)
36. (B)	37. (C)	38. (A)	39. (B)	40. (B)
41. (B)	42. (B)	43. (A)	44. (A)	45. (B)
46. (B)	47. (B)	48. (B)	49. (D)	50. (D)
51. (A)	52. (A)	53. (A)	54. (B)	55. (A)
56. (D)	57. (A)	58. (B)	59. (C)	60. (B)
61. (B)	62. (C)	63. (B)	64. (C)	65. (A)
66. (C)	67. (D)	68. (D)	69. (A)	70. (B)

SECTION – B

1. A transistor 'α' is the current gain defined as the ratio of change in collector current to change in emitter current in the common base configuration, while 'β' is the current gain in the CE configuration. It is defined as a change in the current of the collector to the current of the base.

Relation between α and β parameters :

The parameter α can be written as

$$\alpha = \frac{I_c}{I_e}$$

and the parameter β can be written as :

$$\beta = \frac{I_c}{I_b}$$

$\because \; I_e = I_b + I_c$

Now, we will divide the equation by I_c on both sides and we get,

$$\therefore \quad \frac{I_e}{I_c} = \frac{I_b}{I_c} + 1 \quad \text{[Divide } I_c \text{ on both sides]}$$

$$\Rightarrow \quad \frac{1}{\alpha} = \frac{1}{\beta} + 1$$

$$\Rightarrow \quad \frac{1}{\beta} = \frac{1}{\alpha} - 1 = \frac{1-\alpha}{\alpha}$$

$$\Rightarrow \quad \beta = \frac{\alpha}{1-\alpha}$$

2. Electric flux through an area is the product of magnitude of area and the component of electric field vector normal to it :

$$\Phi_E = \Delta S(E\cos\theta) = \vec{E}.\Delta\vec{S}$$

SI unit is $NC^{-1}\,m^2$.

3. It is defined as the ratio of electric force between two charges at certain distance in vacuum to the force between same charges at same distance in any medium. It is denoted by ε_r.

$$\boxed{\varepsilon_r = \frac{F_V}{F_m}}$$

Where,

F_V = Force between charges in vacuum

F_m = Force between charges in medium

4. According to Kirchoff's second law or Kirchoff's voltage law, the directed sum of potential difference in any loop is zero. i.e. the sum of emf in any loop is equal to the sum of potential drops in that loop.

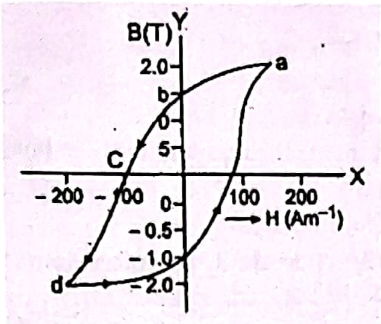
$$\sum_{i=1}^{n} V_i = 0$$

This law is based on the conservation of energy whereby voltage is defined as the energy per unit charge. The total energy gained per unit charge must be equal to the amount of energy lost per unit charge. Hence it obey the law of conservation of energy since the charge is conserved.

5. Two metallic strips, made of different metals are joined at the ends to form a loop. If the function are kept at different temperatures. There is an electric current in the loop. This effect is called the seeback effect and the e.m.f. developed is called seeback e.m.f. or thermo e.m.f.

6. When a ferromagnetic material is placed inside magnetic field having magnetic intensity 'n'. Then this material magnetised and magnetic intensity 'n' changes. Therefore magnetic field also changes.

Hyteresis loop :



7. According to Bio-Savart's law, the magnitude of the magnetic field dB due to a current element dl is proportional to the current I, the element length dl and sine of angle between current element and direction of r and inversely proportional to the square of distance r. i.e. $B = \frac{\mu_0}{4\pi}\frac{I\,dl\sin\theta}{r^2}$.

8. $[ML^2T^2A^2]$

9. There are following causes for decreasing the efficiency of transformer—

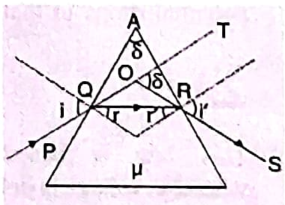
(i) Copper loss (ii) Iron loss
(iii) Flux decay (iv) Heterosis loss

10. According to the scientist if the light ray incidenced on the transparent medium at the polarising angle (i_p) then the refected ray becomes polarised.

According to this law the tangent of the polarising angle is equal to the Refracting index of the transparent medium.

i.e. $\boxed{\tan i_p = \mu}$

11. Let incident ray PQ incident at Q and refracted along QR and emergent along RS.



Here i = angle of incidence
i' = emergent angle
r = refraction angle of Q
r' = incidence angle at R

For refraction through face AB

$\sin i = \mu \sin r$

For refraction through face AC

$\mu \sin r' = \sin i'$

Deviation through prism

$$\delta = (i - r) + (i' - r') = (i + i') - (r + r')$$

From fig, $A + \left(\frac{\pi}{2} - r\right) + \left(\frac{\pi}{2} - r'\right) = \pi$

$r + r' = A$

Now $s = i + i' - A$

12. Ionosphere reflects the transmitted radio waves back to the earth's surface. Thus it helps in transmitting the radio message round the curve of the earth.
Waves of frequencies from 1500 kHz to 30 Mhz are reflected by it.

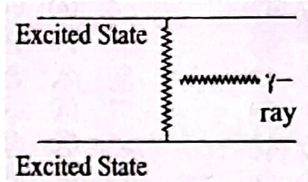
13.

$$\begin{array}{r} 1110 \\ +10111 \\ \hline 100101 \\ \hline \end{array}$$

$(100101)_2 = 1 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$

$= 32 + 0 + 0 + 4 + 0 + 1 = (37)_{10}$

14. Gamma (γ) decay is spontaneous process of emission of high energy photon from radioacitivity nucleus.



When a radioactive nucleus emits α and β particle the daughter nucleus is excited to higher energy state. This excited nucleus jumps to the ground state by emitting γ rays.

15. **Impedence**—The effective resistance offered to the flow of current by the LCR-circuit is called its **impedence.** It is given by

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}$$

16. In a p-type semiconductor the forbidden energy gap decreases due to raising of valence band level; while in n-type semiconductor the forbidden energy gap decreases due to lowering of conduction band level.

17. $I = 0.40$ A; $a = 8$ cm $= 0.08$ m, $n = 100$

$$B = \frac{\mu_0}{4\pi}\cdot\frac{2\pi nI}{a} = 10^{-7} \times \frac{2\pi \times 100 \times 0.40}{0.08}$$

$$B = 3.14 \times 10^{-4}\ T$$

18. **Solar Cell**—It is a p-n junction diode semiconductor device which converts solar energy into electric energy. It's working principle depends upon photo voltaic effect,

where the appearance of a forward bias voltage across a p-n junction which is illuminated with sun-light is known as photovaltaic effect.

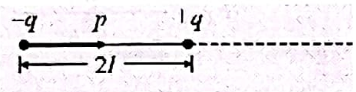
19. **Paschen Series**—Paschen series are the series of lines in the spectrum of the hydrogen atom which corresponds to transitions between the state with principle quantum number n = 3 and successive higher states.

20. **Electric Dipole Moment** : The product of the distances between two charges or any of charge of electric dipole is called electric dipole moment. Its S.I. unit of C-m.

Potential Energy of Electric Dipole in an Electrid Field : Electric dipole is brought from infinity into an electric field such that its dipole moment p always remains at the direction of electric field such that its dipole moment p always remains in the direction of electric intensity E. In electric field work will be done by an external agency on charge + q and by the field itself on charge (–q) has to cover more distance (= 2l) than charge (+ q), hence net work done by field is more than the work done on (+q) by external agency.

Hence extra work done on charge (–q) by the field

= Force on chanrge (–q) × additional distance



$= -qE \times 2l = -pE$

where ($p = q \times 2l$) is electric dipole moment of depole.

This work is called potential energy of dipole placed in an electric field and parallel to the field. This energy is denoted by U_0.

$\therefore \quad U_0 = -pE$

21. **L–C–R Circuit :**

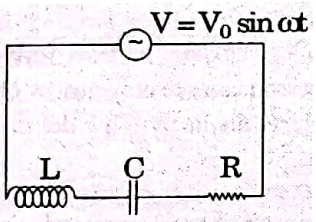


Figure shows an inductor, a capacitor and a resistor connected in series with an AC source and the vector diagram to find the steady-state current.

The resultant of $1/\omega C$ and ωL is

$$X = X_c - X_L = \left(\frac{1}{\omega C} - \omega L\right) \quad \text{... (1)}$$

in the direction of the positive y-axis. This is the net reactance of the circuit. The resultant of the vector for R and that for the reactance $\left(\frac{1}{C\omega} - L\omega\right)$ has a magnitude

$$Z = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2} \quad \text{... (2)}$$

which is the impedance of the circuit. This resultant makes an angle φ with the x-axis where

$$\tan\varphi = \frac{\frac{1}{\omega C} - \omega L}{R} \quad \text{... (3)}$$

The steady-state current in the circuit is given by

$$i = \frac{\varepsilon_0}{\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}} \sin(\omega t + \varphi)$$

where φ is given by equation (3).

If $X_c = 1/\omega C$ is greater than $X_L = \omega L$, the vector for the net reactance $X_c - X_L$ is along the positive Y-axis. From equation (3), the phase factor φ is positive. Thus, the current leads the emf. If $X_c < X_L$, the vector for the net reactance is along the negative Y-axis and φ is negative. In this case, the current lags behind the emf. If $X_L = X_c$, the net reactance is zero. It behaves as purely resistive circuit and the vector for Z is along the X-axis. The current is in phase with the emf in this case.

If we vary the angular frequency ω of the AC source, the peak current

$$i_0 = \frac{\varepsilon_0}{\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}}$$

also varies. It is maximum when

$$\frac{1}{\omega C} - \omega L = 0$$

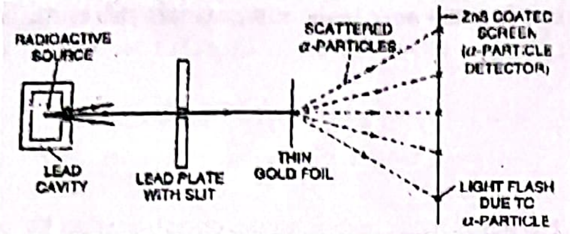
or, $$\omega = \sqrt{\frac{1}{LC}}$$

The corresponding frequency is

$$V = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} \quad \text{... (4)}$$

This frequency is known as the *resonant frequency* of the given circuit. The peak current in this case is $i_0 = \varepsilon_0 / R$ and the reactance is zero.

22. In Rutherford's experiment of α-scattering, he bombarded α-particles (He^{++}) on gold foil & he, found that almost α-particles crosses by scattering through at an angle from its original path and one α-particle out of 8000 scattered through an angle of 180°.



Angle of scattering of α-particle depends on impact parameter perpendicular distance between the velocity vector & nucleus of the atom is impact parameter.

On the basis of α-scattering experiment Rutherford conclude that.

(i) Almost space of an atom be empty.

(ii) A heavy + *ve* charge exist at the centre of atom & that point is called nucleus of the atom.

(iii) Size of nucleus be $\frac{1}{1000}$ times that of atom.

(iv) Since almost space of atom will be empty hence electron will revolve on circular path around the nucleus.

Closest Approach of α-particles : As α-particle approaches the nucleus its kinetic energy converted into potential energy of the α-particle and nucleus system. Hence we can write

$$\frac{1}{2}mv^2 = \frac{1}{4\pi \epsilon_0}\frac{2e\tau e}{r_0}$$

$$r_0 = \frac{1}{4\pi \epsilon_0}\frac{4\tau e^2}{mv^2}$$

where r_0 is closest approach.

23. Niels Bohr has proposed few postulates for atomic structure :

(a) Atoms be spherical & heavy + *ve* charge be exist at the centre of atom is called nucleus.

(b) Electrons will revolve around the nucleus on circular path only in permitted orbits & these orbit are stable.

(c) Required centripetal force for the circular motion of electron be provided by electrostatic force of attraction between electron and nucleus.

(d) Electron will revolve in only those orbit whose angular momentum be integral multiple $h\left(\frac{h}{2\pi}\right)$

i.e., $$mvr = \frac{nh}{2\pi}$$

where n = 1, 2, 3, ...

n = principal quantum no.

Energy of nth orbit : As we know electron revolves around the nucleus in a circular path so, electron has kinetic energy & potential energy both.

∴ The total energy of electron

$$E = E_k + E_p$$

$$E_p = -\frac{Ke^2}{r}$$

$$E_p = -\frac{Ke^2}{n^2h^2} \times 4\pi^2 me^2k$$

$$= -\frac{K^2e^2 4\pi^2 me^2}{n^2h^2} = \frac{-4\pi^2 me^4k^2}{n^2h^2}$$

$$E_k = \frac{1}{2}mv^2$$

$$v = \frac{e^2}{2nh \epsilon_0} = \frac{k2\pi e^2}{nh}$$

$$E_k = \frac{1}{2}m\left(\frac{k2\pi e^2}{nh}\right)^2$$

$$E_k = \frac{1}{2}m\frac{K^2 4\pi^2 e^4}{n^2h^2}$$

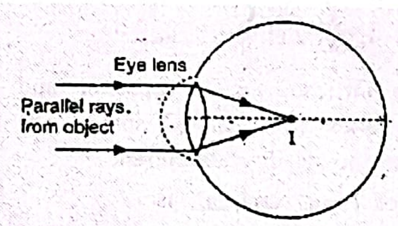
$$E_k = \frac{1}{2}\frac{4\pi^2 me^4 k^2}{n^2h^2}$$

As $$E = E_K + E_P = \frac{1}{2}\frac{4\pi^2 me^4k^2}{n^2h^2} - \frac{4\pi^2 me^4k^2}{n^2h^2}$$

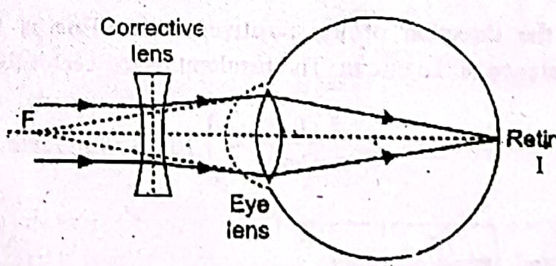
$$E = \boxed{E = \frac{-4\pi^2 me^4k^2}{2n^2h^2}}$$

24. Due to growing age or otherwise, eye may suffer the following defects :

(i) Myopia or shortsightedness : Myopia is the defect of eye in which a person can see only nearby objects, but fails to see the far away objects distinctly. This defect is due to



(a) Image formation by myopic eye



(b) Corrected myopia

(a) decrease in focal length of the eye lens.

(b) spreading of the eye-sphere.

Due to these reasons the image is formed in front of the retina.

Remedy—To eliminate this defect a concave lens of suitable focal length is used. The equivalent focal length of concave lens and eye lens should be increased to a value such that the distinct image of far away objects is formed at the retina. If a myopic eye has a far point at F, then the parallel rays from infinity will be incident on concave lens and form its vertical image at F. This image will act as an object for eye lens and the final image (I) will be formed at the retina [Fig. (b)]. Clearly, for elimination of myopia the focal length of corrective concave lens will be equal to the distance of far point of myopic eye from the eye lens.

(ii) Farsightedness or Hypermetropia—Hypermetropia is the defect of eye in which a person can see only farther objects but fails to see nearer objects distinctly. This defect is due to

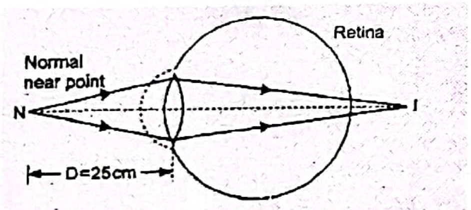
(a) Increase in focal length of eye lens.

(b) Contraction of eye-sphere.

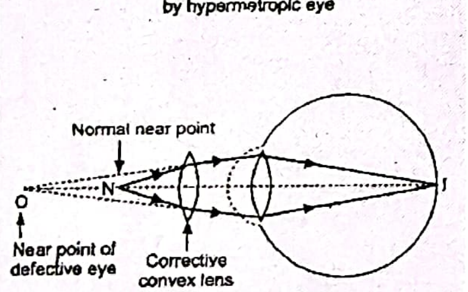
Due to these reasons the image of a nearby object is formed behind the retina.

Remedy : The near point of hypermetropic eye is displaced from $D = 25$ cm to some distant point. To eliminate this defect a convex lens of suitable focal length is used. The equivalent focal length of corrective convex lens and eye lens should be decreased to a value such that the distinct image of nearby objects is formed at the retina.

Suppose the near point of a normal eye is at N and that of a hypermetropic eye is at O. The corrective convex lens forms the image of near point (N) at point O, then this image will act as the object for eye lens and the final image (I) will be formed at the retina. Therefore the corrective lens enables to form the distinct image of near point (N) at retina.



(a) Image formation by hypermetropic eye



(b) Corrected hypermetropia

(iii) Presbyopia—In growing age, the eye lens loses its flexibility of changing the focal length. Consequently, the near point of an eye is displaced further and far point of the eye is displaced nearer, so that the eye is unable to see the nearby as well as far away objects. This defect of eye is called preshyopia.

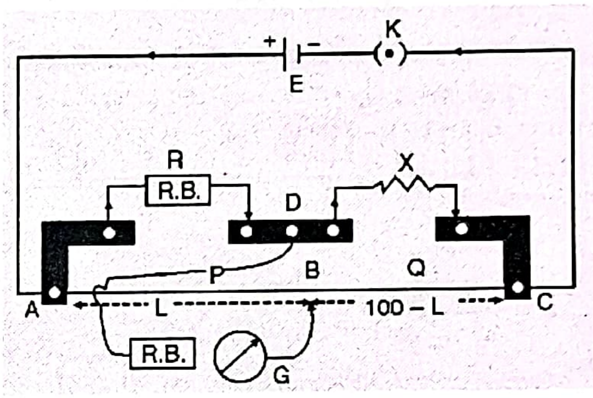
This defect may be eliminated by using bifocal lenses.

(iv) Astigmatism—The defect of eye in which horizontal and vertical objects at the same distance are not focused at the retina clearly is called **astigmatism.** This arises when the cornea is not spherical in shape. For example cornea could have a larger curvature in vertical plane than in horizontal plane.

If astigmated eye sees a wire mesh or a shirt having horizontal and vertical lines, then vertical and horizontal lines are not equally well focused; if vertical lines are well focused; the horizontal lines may appear distorted or curved and vice versa. This defect may occur along with the myopia or hypermetropia.

Remedy : The astigmation is corrected by using a cylindrical lens having a cylindrical surface of a desired radius of curvature with an appropriately directed axis.

25. The experiment is based on Wheatstone bridge principle. The circuit diagram is as shown below :



The connections are made as shown in figure. A resistance R is introduced from the resistance box and the key K is closed. The jockey is moved on the wire to the point where there is no deflection in the galvanometer. In such a case points B and D are at the same potential. The point B is called the 'null' point.

Let in this position AB = L cm then BC = (100 – L) cm.

Therefore, resistance of AB = P $\propto$ L and resistance of BC = Q $\propto$ (100 – L), hence

$$\frac{P}{Q} = \frac{L}{100-L} \quad \text{... (1)}$$

In the balanced state by the Wheatstone bridge Principle, we have

$$\frac{P}{Q} = \frac{R}{X} \quad \text{... (2)}$$

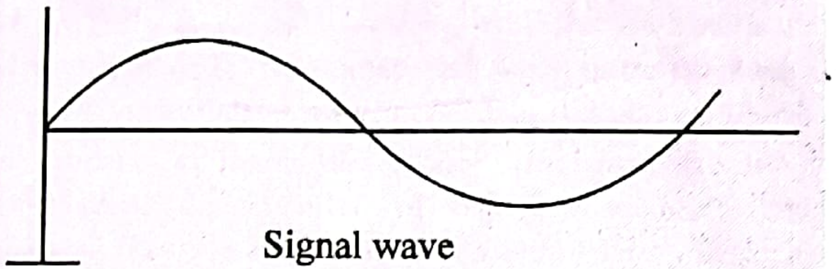
Substituting equation (1) in equation (2), we have

$$\frac{R}{X} = \frac{1}{100-L} \quad \text{... (3)}$$

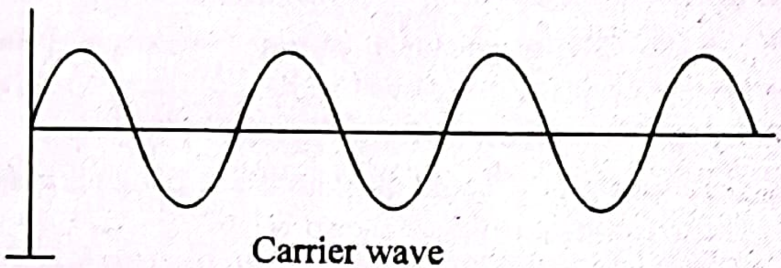
Rewriting equation (3), we have

$$X = \left(\frac{100-L}{L}\right)R$$

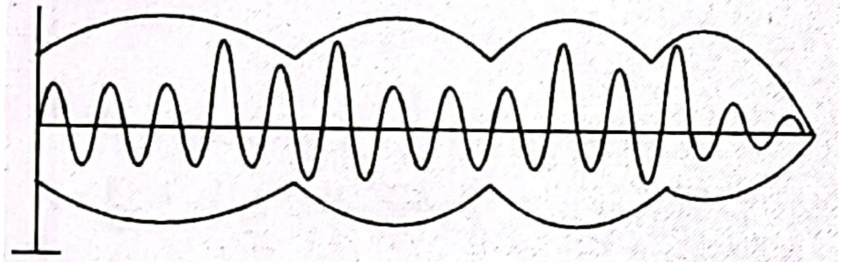
26. Amplitude modulation : If the amplitude of the carrier wave changes in accordance with the amplitude of the very low frequency wave i.e. signed (while frequency and phase of the carrier wave remain unchanged) then the modulation is known as amplitude modulation.



Signal wave

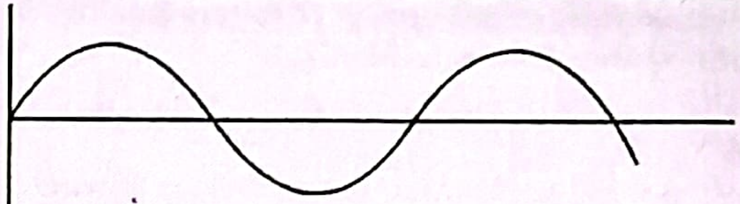


Carrier wave

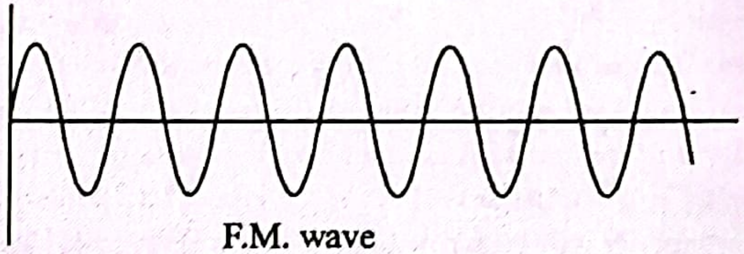


Amplitude modulated wave

Frequency modulation : If the frequency of the carrier wave changes in accordance with the frequency of the very low frequency wave (while amplitude and phase of carrier wave remain unchanged then the modulation is known as frequency modulation.

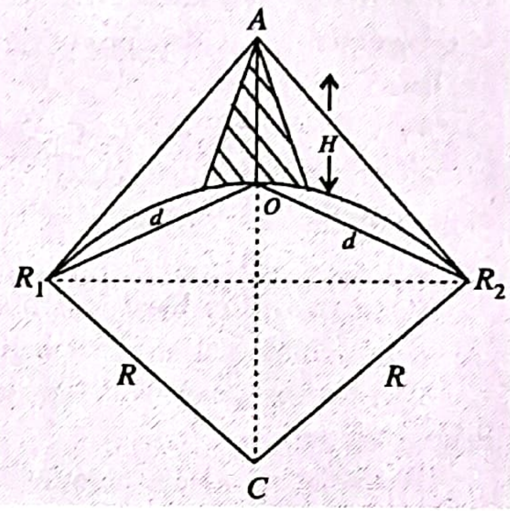


Modulating wave



F.M. wave

Consider a transmission tower is standing at a point on the surface of earth. Let the height of tower is 'H'.



Here, in this figure $OR = OR_q = d$

Assume the tower signal will receive in a circle of radius 'd'.

here in right angled triangle AR_1, C

$$(AC)^2 = (AR_1)^2 + (CR_1)^2$$

$$(H + R)^2 = (AR_1)^2 + R^2 \quad \text{... (1)}$$

in right angle $\angle AOR_1$

$$(AR_1)^2 = (AO)^2 + (OR_1)^2$$

$$(AR_1)^2 = H^2 + a^2 \quad \text{... (2)}$$

From eqn. (1) and (2)

$$H^2 + R^2 + qHR = H^2 + d^2 + R^2$$

$$qHR = d^2$$

$$d = \sqrt{2H}\, R$$

❑❑ ❑