PHYSICS

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for CLASS 12

Total No. of Questions : 96] *Solved Question Paper : 2022* [Marks : 70
Time : 3 Hr. 15 Min.]

PHYSICS

Section–A (Objective Type Questions)

Question Nos. 1 to 70 have four options, out of which only one is correct. You have to mark your selected option, on the OMR-Sheet. Answer any 35 questions.
35 × 1 = 35

1. Intensity of electric field at a point is
(A) $E = Fq$ (B) $E = F/q$
(C) $E = \frac{1}{2}Fq$ (D) $E = q/F$ Ans.—(B)

2. Surface density of charge is
(A) $\sigma = \frac{Q}{A}$ (B) $\sigma = \frac{Q}{l}$
(C) $\sigma = \frac{Q}{V}$ (D) $\sigma = Q.A$ Ans.—(A)

3. Capacity of spherical condenser is
(A) $C = 4\pi \in_0 \left(\frac{rR}{r-R}\right)$ (B) $C = 4\pi \in_0 \left(\frac{rR}{r+R}\right)$
(C) $C = 4\pi \in_0 \left(\frac{r^2R}{r-R}\right)$ (D) $C = 4\pi \in_0 \left(\frac{rR^2}{r-R}\right)$
Ans.—(A)

4. ${}^1\mu_2$ is equal to
(A) $\frac{\mu_2}{\mu_1}$ (B) $\frac{\mu_1}{\mu_2}$ (C) $\mu_2.\mu_1$ (D) $\frac{1}{\mu_1.\mu_2}$
Ans.—(A)

5. Image formed on retina is
(A) real and erect (B) real and inverted
(C) virtual and erect (D) virtual and inverted
Ans.—(B)

6. The magnification power of Astronomical Telescope is
(A) $\frac{f_o}{f_e}$ (B) $-\frac{f_o}{f_e}$ (C) $-\frac{f_e}{f_o}$ (D) $\frac{f_e}{f_o}$
Ans.—(B)

7. Which of the following is the cause of formation of rainbow?
(A) Scattering (B) Diffraction
(C) Dispersion (D) Refraction Ans.—(D)

8. Which of the following is correct for short magnet?
(A) $(B)_{axial} = (B)_{equatorial}$
(B) $(B)_{axial} = 2(B)_{equatorial}$
(C) $(B)_{equatorial} = 2(B)_{axial}$
(D) $(B)_{axial} = 3(B)_{equatorial}$ Ans.—(B)

9. Expression for the time-period of a magnet oscillating in a uniform magnetic field is
(A) $T = 2\pi\sqrt{\frac{I}{B_H}}$ (B) $T = 2\pi\sqrt{\frac{I}{MB_H}}$
(C) $T = 2\pi\sqrt{\frac{MB_H}{I}}$ (D) $T = 2\pi\sqrt{MB_H}$
Ans.—(B)

10. Which of the following relations is correct for earth's magnetic field (B_H) and frequency of magnetic needle (n)?
(A) $n^2 \propto B_H$ (B) $n \propto B_H$
(C) $n \propto B_H^2$ (D) $n^2 \propto \frac{1}{B_H}$ Ans.—(A)

11. Which of the following is correct for tangent law?
(A) $B = B_H \tan\theta$ (B) $B = B_H^2 \tan\theta$
(C) $B = \sqrt{B_H}\tan\theta$ (D) $B = B_H \tan^2\theta$ Ans.—(A)

12. Relative permeability is equal to
(A) $\frac{\mu}{\mu_o} = \mu_r$ (B) $\frac{\mu_o}{\mu} = \mu_r$
(C) $\mu_r = \mu.\mu_o$ (D) $\sqrt{\mu_o\mu} = \mu_r$ Ans.—(A)

13. Which of the following relations is correct?
(A) $B^2 = B_H^2 + B_V^2$ (B) $B^2 = B_H^2 - B_V^2$
(C) $B^2 = B_V^2 - B_H^2$ (D) $B = \frac{B_V}{B_H}$ Ans.—(A)

14. Which of the following is correct for speed of electromagnetic wave in vacuum?
(A) $c = \sqrt{\mu_0 \in_0}$ (B) $c = \frac{1}{\sqrt{\mu_0 \in_0}}$
(C) $c = \sqrt{\frac{\mu_0}{\in_0}}$ (D) $c = \sqrt{\frac{\in_0}{\mu_0}}$ Ans.—(B)

15. The focal length of a lens of capacity 4 dioptre is
(A) 0.25 m (B) 0.25 cm
(C) 0.35 m (D) 0.35 cm Ans.—(A)

16. Which of the following is correct for dispersive power?

(A) $\omega = \frac{\mu_v - \mu_r}{\mu_y - 1}$ (B) $\omega = \frac{\mu_r - \mu_v}{\mu_y - 1}$

(C) $\omega = \frac{\mu_y - 1}{\mu_v - \mu_r}$ (D) $\omega = \frac{\mu_y - 1}{\mu_r - \mu_v}$ Ans.—(A)

17. If the focal length of a glass lens $\left(\mu = \frac{3}{2}\right)$ in air is f_a and in water $\left(\mu = \frac{4}{3}\right)$ is f_w then

(A) $f_w = f_a$ (B) $f_w = 2f_a$
(C) $f_w = 3f_a$ (D) $f_w = 4f_a$ Ans.—(D)

18. Which of the following relations is correct for intensity of scattered light (I) and wavelength of light (λ)?

(A) $I \propto \frac{1}{\lambda}$ (B) $I \propto \frac{1}{\lambda^2}$ (C) $I \propto \frac{1}{\lambda^3}$ (D) $I \propto \frac{1}{\lambda^4}$

Ans.—(D)

19. Which of the following is correct for charge on an electron?

(A) $e = 1.602 \times 10^{-16}$ C (B) $e = 1.602 \times 10^{-17}$ C
(C) $e = 1.602 \times 10^{-18}$ C (D) $e = 1.602 \times 10^{-19}$ C

Ans.—(D)

20. Which of the following is the work-function of sodium?

(A) $\phi_0 = 2.55$ eV (B) $\phi_0 = 2.65$ eV
(C) $\phi_0 = 2.75$ eV (D) $\phi_0 = 2.85$ eV Ans.—(C)

21. Number of neutrons in nucleus is

(A) $A + Z$ (B) $A - Z$

(C) $Z + \frac{A}{2}$ (D) Z Ans.—(B)

22. The expression for real average power in an alternating current circuit is

(A) $P_{av} = E_{rms} \cos\phi$ (B) $P_{av} = I_{rms} \cos\phi$
(C) $P_{av} = E_{rms}\, I_{rms} \sin\phi$ (D) $P_{av} = E_{rms}\, I_{rms} \cos\phi$

Ans.—(D)

23. Power factor is equal to

(A) $\frac{R}{Z}$ (B) $\frac{Z}{R}$ (C) $R \cdot Z$ (D) $W \cdot L$

Ans.—(A)

24. Phase difference in (L-R) Circuit is

(A) $\sin^{-1}\left(\frac{\omega L}{R}\right)$ (B) $\cos^{-1}\left(\frac{\omega L}{R}\right)$

(C) $\tan^{-1}\left(\frac{\omega L}{R}\right)$ (D) $\tan^{-1}\left(\frac{R}{\omega L}\right)$ Ans.—(C)

25. Transformation ratio in transformer is

(A) $\frac{V_S}{V_P}$ (B) $\frac{V_P}{V_S}$ (C) $\frac{1}{V_S . V_P}$ (D) $\frac{1}{I_S . I_P}$

Ans.—(A)

26. Dimensional formula of R.C. is

(A) $M^0L^0T^{-1}$ (B) $M^0L^0T^{-2}$ (C) $M^0L^0T^0$ (D) M^0L^0T

Ans.—(D)

27. S.I. unit of pole strength is

(A) Am^{-1} (B) Am^{-2} (C) Am (D) Fm

Ans.—(C)

28. Work done in the deflection of a magnet in a uniform magnetic field is

(A) $W = MB\ (1 - \sin\theta)$
(B) $W = MB \sin\theta$
(C) $W = MB\ (1 - \cos\theta)$
(D) $W = MB \cos\theta$ Ans.—(C)

29. The Value of $\vec{B}$ on the surface of the earth is

(A) 10^{-1} tesla (B) 10^{-2} tesla
(C) 10^{-3} tesla (D) 10^{-5} tesla Ans.—(D)

30. Electromagnetic moment of current carrying coil is

(A) $\vec{m} = \frac{N\vec{A}}{I}$ (B) $\vec{m} = \frac{\vec{A}}{NI}$

(C) $\vec{m} = NI\vec{A}$ (D) $\vec{m} = \frac{I\vec{A}}{N}$ Ans.—(C)

31. Which of the following is correct for galvanometer constant?

(A) $\frac{C}{NAB}$ (B) $\frac{C(B)}{NA}$

(C) $C\left(\frac{A}{NB}\right)$ (D) $C\left(\frac{N}{AB}\right)$ Ans.—(A)

32. Resistance of ideal ammeter is

(A) infinity (B) zero (C) 100 ohm (D) 50 ohm

Ans.—(B)

33. S.I. unit of magnetic flux is

(A) weber (B) watt (C) tesla (D) joule

Ans.—(A)

34. Lenz's law is the result of which principle of conservation?

(A) Current (B) Momentum
(C) Energy (D) Charge Ans.—(C)

35. Inductive reactance is

(A) $X_L = 2\pi fL$ (B) $X_L = 2\pi f^2 L$
(C) $X_L = 2\pi fL^2$ (D) $X_L = 2\pi f^2 L^2$ Ans.—(A)

36. Magnifying power of simple microscope is

(A) $M = 1 - \frac{D}{f}$ (B) $M = 1 + \frac{D}{f}$

(C) $M = 1 - \frac{f}{D}$ (D) $M = 1 + \frac{f}{D}$ Ans.—(B)

37. Power of two lenses in contact is

(A) $P = P_1 + P_2$ (B) $P = P_1 \times P_2$

(C) $P = \frac{P_1}{P_2}$ (D) $P = P_1 (P_2 + P_1)$

Ans.—(A)

38. If $\mu_g = 3/2$ and $\mu_w = 4/3$ then ${}^{w}\mu_g$ is

(A) 2 (B) $\frac{1}{2}$ (C) $\frac{9}{8}$ (D) $\frac{8}{9}$

Ans.—(C)

39. Critical angle for glass is
(A) 20° (B) 30°
(C) 48° (D) 42°(nearly) Ans.—(D)

40. Nature of electromagnetic waves is
(A) transverse (B) longitudinal
(C) both (A) and (B) (D) electrical Ans.—(A)

41. The refractive index of material of the Prism is

(A) $\mu = \frac{\sin(A+\delta_m)}{\sin A/2}$ (B) $\mu = \frac{\sin A/2}{\sin(A+\delta_m)}$

(C) $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin A/2}$ (D) $\mu = \frac{\sin A/2}{\sin\left(\frac{A+\delta_m}{2}\right)}$

Ans.—(C)

42. Optical path is equal to
(A) Refractive index × Length of path

(B) $\frac{\text{Refractive index}}{\text{Length of path}}$ (C) Length of path

(D) $\frac{\text{Length of path}}{\text{Refractive index}}$

Ans.—(A)

43. Which of the following is not electromagnetic wave?
(A) Light waves (B) X-rays
(C) Sound waves (D) Infrared rays Ans.—(C)

44. Critical angle for transparent medium diamond is
(A) 48.75° (B) 41.14°(C) 37.31° (D) 24.41°

Ans.—(D)

45. Energy of photon is equal to

(A) $h\nu$ (B) $\frac{h}{\nu}$ (C) $\sqrt{h\nu}$ (D) $\sqrt{\frac{h}{\nu}}$

Ans.—(A)

46. Intensity of a Magnetising field (H) is equal to

(A) $\frac{B_0}{\mu_0}$ (B) $\frac{\mu_0}{B_0}$ (C) $B_0\mu_0$ (D) $\sqrt{B_0\mu_0}$

Ans.—(A)

47. Which of the following is correct for step-up transformer?
(A) $V_S < V_P$ (B) $V_S > V_P$
(C) $V_S = V_P$ (D) $V_S << V_P$ Ans.—(B)

48. Inductive reactance for direct current is

(A) zero (B) infinity(C) ωL (D) $\frac{1}{\omega L}$

Ans.—(A)

49. Electromagnetic moment of current carrying coil is

(A) $NI\vec{A}$ (B) $\frac{N\vec{A}}{I}$ (C) $\frac{N}{I\vec{A}}$ (D) $\frac{I\vec{A}}{N}$

Ans.—(A)

50. The S.I. unit of electric intensity is
(A) NC (B) N/C (C) $N.C^2$ (D) N/C^2

Ans.—(B)

51. Which of the following is correct for current density?

(A) $J = I.A$ (B) $J = \frac{I}{A}$

(C) $J = \frac{A}{I}$ (D) $J = I^2A$ Ans.—(B)

52. Which of the following is correct for mobility?

(A) $\mu = \frac{V_d}{E}$ (B) $\mu = \frac{E}{V_d}$

(C) $\mu = V_d.E$ (D) $\mu = E^2.V_d$ Ans.—(A)

53. Which of the following is correct?
(A) 1 watt = 1 Js^{-1} (B) 1 watt = 1 Vs^{-1}
(C) 1 watt = 1 sV^{-1} (D) 1 watt = 1 Fs^{-1}

Ans.—(A)

54. Colour code of carbon resistance for blue colour is
(A) 3 (B) 4 (C) 5 (D) 6

Ans.—(D)

55. Ampere-hour is the unit of
(A) power (B) charge
(C) energy (D) potential difference

Ans.—(B)

56. Which of the following is correct for Lorentz force?

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

(C) $\vec{F} = (\vec{E} + \vec{V} \times \vec{B})$ (D) $\vec{F} = q(\vec{E} + \vec{B} \times \vec{V})$

Ans.—(A)

57. The permittivity of free space is
(A) 8.85×10^{-12} F/m (B) 8.85×10^{-11} F/m
(C) 8.85×10^{12} F/m (D) 8.85×10^{11} F/m

Ans.—(A)

58. S.I. unit of electric dipole is

(A) CN (B) Cm (C) C (D) $\frac{C}{m}$

Ans.—(B)

59. The vector form of Coulomb's law is

(A) $\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1q_2}{\left|\vec{r}\right|^3}\vec{r}$ (B) $\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1q_2}{\left|\vec{r}\right|^3}$

(C) $\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1q_2}{r^2}\vec{r}$ (D) $\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1q_2}{\left|\vec{r}\right|^2}\vec{r}$

Ans.—(A)

60. The capacity of any conductor is

(A) $C = q.v$ (B) $C = \frac{v}{q}$

(C) $C = \frac{1}{2} q.v$ (D) $C = \frac{q}{v}$ Ans.—(D)

61. Energy of a charged conductor is

(A) $E = \frac{1}{2} C.V$ (B) $E = \frac{1}{2} CV^2$

(C) $E = \frac{1}{2} C^2V$ (D) $E = C.V$ Ans.—(B)

62. If n capacitors of equal capacity C_1 are connected in parallel, the equivalent capacity will be

(A) $C = \frac{n}{C_1}$ (B) $C = \frac{C_1}{n}$

(C) $C = nC_1$ (D) $C = n^2C_1$ Ans.—(C)

63. Dielectric strength for air is

(A) 3×10^6 Vm^{-1} (B) 4×10^6 Vm^{-1}

(C) 5×10^6 Vm^{-1} (D) 10^6 Vm^{-1} Ans.—(A)

64. Which of the following relations is correct for mass and energy ?

(A) $m = E$ (B) $m^2 = E$

(C) $mc^2 = E$ (D) $m = \frac{\sqrt{E}}{2}$ Ans.—(C)

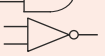
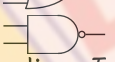
65. Binary number of decimal number $(8)_{10}$ is

(A) $(1000)_2$ (B) $(1001)_2$

(C) $(111)_2$ (D) $(110)_2$ Ans.—(A)

66. Symbol of NAND gate is

(A)  (B) 

(C)  (D)  Ans.—(D)

67. The relation between half-life time $T_{1/2}$ and decay constant is

(A) $T_{1/2} = 0.693/\lambda$ (B) $T_{1/2} = \frac{\lambda}{0.693}$

(C) $T_{1/2} = 0.693\lambda$ (D) $T_{1/2} = 0.693\lambda^2$

Ans.—(A)

68. Which of the following is correct for $\alpha-$ particle?

(A) electron

(B) electromagnetic radiation

(C) helium nucleus

(D) hydrogen nucleus Ans.—(C)

69. Which of the following equations is correct?

(A) ${}^{238}_{92}U \rightarrow {}^{234}_{90}U + {}^{4}_{2}He$ (B) ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

(C) ${}^{238}_{92}U \rightarrow {}^{239}_{90}Th + {}^{4}_{2}He$ (D) ${}^{238}_{92}U \rightarrow {}^{242}_{90}Th + {}^{4}_{2}He$

Ans.—(B)

70. Which of the following is the correct vector form of the equation of Biot-Savart law?

(A) $\vec{dB} = \frac{\mu_0}{4\pi} \frac{I(\vec{dl} \times \hat{r})}{r^2}$ (B) $\vec{dB} = \frac{\mu_0}{4\pi} \frac{I(\vec{dl})}{r^2}$

(C) $\vec{dB} = \frac{\mu_0}{4\pi} \frac{I(\vec{dl} \times \hat{r})}{r^3}$ (D) $\vec{dB} = \frac{\mu_0}{4\pi} \frac{I\hat{r}}{r^2}$ Ans.—(C)

Section–B
Short Answer Type Questions

Questions nos. 1 to 20 are short answer type. Answer any 10 questions. Each question carries 2 marks : $10 \times 2 = 20$

1. What do you mean by end-on-position of a magnet?

Ans.—If the point (where magnetic field to be determine) lies on the axis of the magnet, this situation is called end-on position.

2. Write the definition of electric potential.

Ans.—It is defined as the amount of workdone per unit positive test charge in moving it from infinity to that point.

3. What is electromagnetic wave?

Ans.—**Electromagnetic waves**—Such waves for which no material medium is needed for their transmission called electromagnetic waves.

Example—X-rays, γ-rays, heat radiation, radio waves etc.

4. What is Lorentz force?

Ans.—The force exerted on a moving charge in a magnetic field or electromagnetic field is called 'Lorentz force'. If a charge q is moving with velocity $\vec{v}$ in a magnetic field of induction $\vec{B}$ and electric field intensity $\vec{E}$, the Lorentz force $\vec{F}$ is given by,

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

The force exerted only by magnetic field is also called Lorentz force : $\vec{F}_m = q\vec{v} \times \vec{B}$

5. What is the principle of conservation of charge?

Ans.—**Principle of conservation of charge :** "Electric charge can not be created or destroyed"

Explanation : Suppose two bodies A and B having charges q_1 and q_2. They are placed in contact to each other, the charges becomes after contact q'_1 and q'_2.

According the principle of conservation of charge,

total charge before = total charge after

i.e. $q_1 + q_2 = q'_1 + q'_2$

6. What do you mean by apparent dip?

Ans.—**Apparent dip :** The angle between the magnetic meridian and the geographical meridian at a place is called apparent dip. When the dip circle does not lies on magnetic meridian.

7. Write down two uses of potentiometer.

Ans.—Potentiometer is used for (i) comparing the e.m.f of two cells (ii) determination of internal resistance of cell.

8. Explain parallel grouping of resistors.

Ans.—In parallel grouping of resistors, the potential difference of each resistors are same, but current be different.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The equivalent-resistance is always less than the individual resistance.

9. What do you mean by refractive index of medium?

Ans.—Refractive index of medium : It is the ratio of the speed of light in medium.

$$\therefore \text{ R.I. of medium } = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

It has no units.

10. Write the definition of wavefront.

Ans.—**Wavefront:** The locus of the wavelets is called wavefront.

11. Explain capacitive reactance.

Ans.—Capacitive reactance : The resistance is affered by the capacitor in a alternating current, called capacitive reactance. It is denoted by X_C. Its SI unit is Ohm.

$$X_C = \frac{1}{wc}$$

where C = capacity of capacitive

$$X_C = \frac{1}{2\pi fC}$$

$$\boxed{X_C \propto \frac{1}{f}}$$

12. Write colour code of carbon resistance for orange and yellow colours.

Ans.—Since colour table given as

	colour	code
B	Black	0
B	Brown	1
R	Red	2
O	Orange	3
Y	Yellow	4
G	Green	5
B	Blue	6
V	Violet	7
G	Gray	8
W	White	9

$\therefore$ Orange—3
Yellow—4

13. Explain magnetic moment.

Ans.—The product of the magnetic pole strength and magnetic length is celled magnetic moment. It is denoted by 'M'. Its magnitude is given by

$M = m(2l)$
M = pole strength
$2l$ = length of magnet
Its direction is south to north. It is a vector quantity. Its SI unit is Am^2.

14. Write the definition of angle of dip.

Ans.—Angle of dip : The angle between the earth magnetic field and the horizontal component of earth magnetic field is called Angle of dip. It is denoted by δ.

$$\delta = \tan^{-1}\left(\frac{B_V}{B_H}\right)$$

15. Explain dispersion of light.

Ans.—Dispersion of light mainly depends upon nature of material or refractive index of prism which is different for lights of different colour. For red light its value is the lowest and for violet light it is greatest. When white light ray passes through a thin prism, from formula $\delta = (\mu - 1)A$ the deviation of red ray is smallest and deviation of violet ray is greatest.

16. What do you mean by diffraction of light?

Ans.—**Diffraction of Light :** When rays of light incident on the sharp edge of obstracle, the light bends from it and penetrate the shadow of the obstracle. This phenomenon is called diffraction of light.

17. Write two properties of alpha (α) rays.

Ans.—Properties of alpha (α) : (i) α-particles are positive, (ii) α-particle has smallest penetrating power into materials.

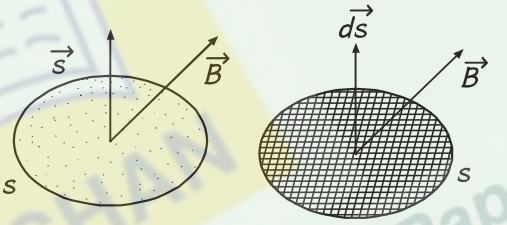
18. Explain binary number system.

Ans.—It is a code the uses only two basic symbols 0 (zero) and 1 (one). We count in binary number of system as follows : 0, 1, 10, 11 and so on. To avoid confusion with decimal number, these binary numbers are read as zero, one, one-zero, one-one, one-zero-one, one-zero-zero and so on.

19. Write down the definition and S.I. unit of magnetic flux.

Ans.—The scalar product of magnetic induction $\vec{B}$ with area vector $\vec{s}$ is known as magnetic flux over the given surface.

$$\phi = \vec{B} \cdot \vec{s}$$



If $\vec{B}$ is non-uniform over the surface, it is divided into large number of patches over each of which $\vec{B}$ is unique.

Then $\phi = \int\int_S \vec{B} \cdot \vec{ds}$

S.I. unit : 'Tm^2' which is called 'weber' is the S.I. unit of ϕ.

20. Write the truth table and Boolean expression of NOT and OR gate.

Ans.—*OR*-gate :

$A + B = C$
(Boolean Expression)

Truth Table of *OR*-gate

A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

NOT-gate : $Y = \overline{X}$
(Boolean Expression)

Truth Table of *NOT*-gate

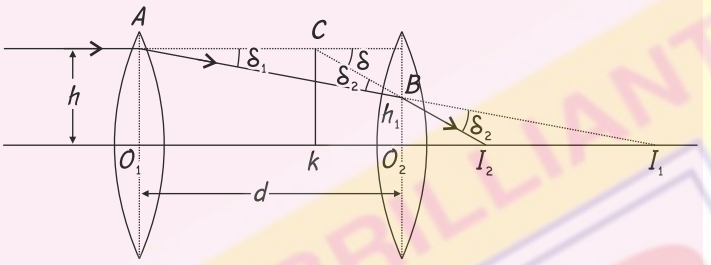
X	$Y = \overline{X}$
1	0
0	1

Long Answer Type Questions

Question Nos. 21 to 26 are Long Answer Type Questions. Answer any 3 questions. Each question carries 5 marks : 3 × 5 = 15

21. Find out the expression for equivalent focal length of two lenses in contact.

Ans.—Expression for focal length when two thin lenses separated : Suppose a combination consists two thin lenses of focal length f_1 and f_2. They are parallel and separated by 'd'.



A ray parallel to the optical axis and at height 'h' travels from infinity and incident at A. The image is formed at I_1 due to first lens and this image acts as object for second lens and image is formed at I_2. CK is the position of the equivalent lens. Let F be the focal length of equivalent lens.

In ΔABC

$$\therefore \quad \delta = \delta_1 + \delta_2$$

$$\because \quad \delta = \frac{\text{height}}{\text{focal length}}$$

$$\frac{h}{F} = \frac{h}{f_1} + \frac{h_1}{f_2}$$

$$h\left(\frac{1}{F} - \frac{1}{f_1}\right) = \frac{h_1}{f_2}$$

$$f_2\left(\frac{1}{F} - \frac{1}{f_1}\right) = \frac{h_1}{h} \qquad \ldots(i)$$

ΔAO_1I_1 and ΔBO_2I_1 are similar

$$\therefore \quad \frac{h_1}{h} = \frac{(f_1 - d)}{f_1} \qquad \ldots(ii)$$

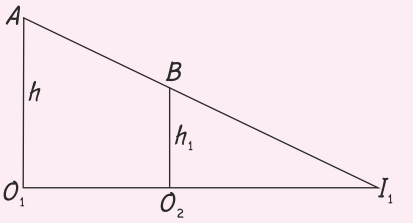
From (i) and (ii)

$$f_2\left(\frac{1}{F} - \frac{1}{f_1}\right) = \frac{f_1 - d}{f_1}$$

$$\frac{1}{F} - \frac{1}{f_1} = \frac{f_1 - d}{f_1 \cdot f_2} = \frac{1}{f_2} - \frac{d}{f_1 \cdot f_2}$$

$$\text{or,} \quad \boxed{\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 \cdot f_2}}$$

If the lenses are in contact,



$d = 0$

$$\boxed{\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}}$$

$$\boxed{P = P_1 + P_2}$$

22. Establish expression for the width of the interference fringe.

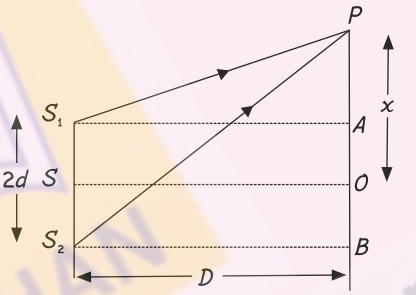
Ans.—Interference—A phenomenon in which redistribution of energy of light during super position is called interference.

Expression for fringe width in young's double slit experiment—Determination of wavelength.

Suppose S_1 and S_2 are two virtual image of source S. S_1 and S_2 are coherent sources.

The waves coming from two coherent sources, occuring from the interference.

The fringes are formed on the screen.



D = distance between the source and screen

$2d$ = distnace between the slits.

Path difference = $S_2P - S_1P$ ...(i)

From figure.

$$(S_1P)^2 = D^2 + (x - d)^2$$

and $\quad (S_2P)^2 = D^2 + (x + d)^2$

Now $\quad (S_2P)^2 - (S_1P)^2 = (x + d)^2 - (x - d)^2$

or, $\quad (S_2P - S_1P)(S_2P + S_1P) = 4xd$

$$(S_2P - S_1P) = \frac{4xd}{(S_2P + S_1P)}$$

So path difference $(\Delta x) = \dfrac{4xd}{D + D} = \dfrac{2xd}{D}$

For constructive interference

path difference = $n\lambda$

$$\therefore \quad n\lambda = \frac{2xd}{D}$$

$$\therefore \quad x = \frac{n \cdot D\lambda}{2d}$$

If distnace of n^{th} and $(x + 1)^{th}$ fringes are x_n and x_{n+1}

then fringes width $(\beta) = x_{n+1} - x_n = \dfrac{(n+1)\lambda D}{2d} - \dfrac{nD\lambda}{2d}$

$$\beta = \frac{D\lambda}{2d}$$

$$\therefore \quad \boxed{\lambda = \frac{2\beta d}{D}}$$

For distructive interference :

$$\text{Path difference} = (2n+1)\frac{\lambda}{2}$$

$$(2n+1)\frac{\lambda}{2} = \frac{2xd}{D}$$

$$x_n = \frac{(2n+1)D\lambda}{4d}$$

$$\therefore \quad x_1 = \frac{3\lambda d}{4d}$$

$$x_2 = \frac{5\lambda D}{4d}$$

$$x_3 = \frac{7\lambda D}{4d} \ldots\ldots$$

$$\beta = x_2 - x_1 = \frac{2\lambda D}{4d}$$

$$\boxed{\beta = \frac{\lambda D}{2d}}$$

23. Explain construction, working and uses of a transformer.

Ans.—A transformer is an electrical device based on mutual induction which is used to get high voltage at low current or low voltage at high current from an *AC* source. It has two coils wound on a laminated isolated core. The coil connected to input *AC* source is called primary (coil) and the coil across which output is obtained is called secondary.

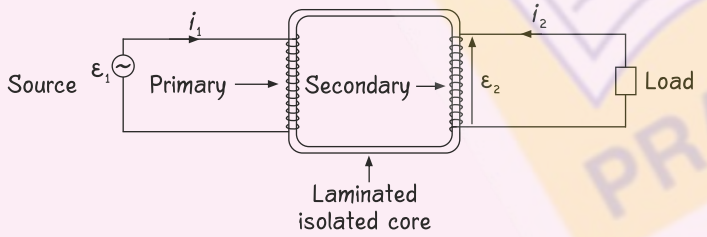


Figure shows an alternating emf ε_1 applied. Each turn of primary is identical to secondary, but number of turns in the primary is N_P and that in the secondary is N_S. If a flux ϕ is linked with each turn, then,

$$\varepsilon_1 - N_P\frac{d\phi}{dt} = 0 \qquad \ldots(i)$$

$$\text{and } \varepsilon_2 = -N_S\frac{d\phi}{dt} \qquad \ldots(ii)$$

$$\text{It is evident that } \frac{\varepsilon_2}{\varepsilon_1} = -\frac{N_S}{N_P} \qquad \ldots(iii)$$

The minus sign shows that ε_1 and ε_2 have a phase difference of 180°.

For step up transformer $N_S > N_P$ and for step down transformer $N_S < N_P$.

The efficiency of transformer is the ratio of output power to input power. It is usually less than 100% (up to 99%) due to losses like flux loss, copper loss, joule heating hysteretic loss, etc.

Uses : (i) Transformer is used for charge the voltage level in the alternating current.

(ii) Transformer is used in the electric electronic devices.

24. Establish expression for heat produced in a conductor due to flow of current. What do you mean by electric power and electric energy?

Ans.—Expression for heat produced in a conductor due to flowing of current : Suppose a conductor having resistance *R* and carrying current *I*. Due to flowing of current (*I*), the heat is produced in the conductor is *H*.

Suppose conductor is connected by a cell of potential difference *V*.

$\therefore$ work done = $V \cdot q$

This work done is converted into the heat according to first law of thermo dynamics

$$H = W = V \cdot q$$

Let *q* be the charge flowing in time '*t*'

Therefore,

$$\text{electric current } (I) = \frac{q}{t}$$

$$\therefore \quad q = It$$

$$H = VIt$$

According to Ohm's law

$$V = IR$$

$$\therefore \quad \boxed{H = I^2Rt}$$

This is the expression for heat produced by the current. This heat is also depends on the resistance of conductor and the time of duration.

Electric Power : The rate of consume the electrical energy in the any electrical circuit is called electric power.

$$\text{Electric power} = \frac{\text{elecetrical energy}}{\text{time}}$$

Its S.I. unit is watt (W)

$$P = \frac{w}{t} = \frac{VIt}{t} = VI$$

Electric Power = Electric current × Potential difference

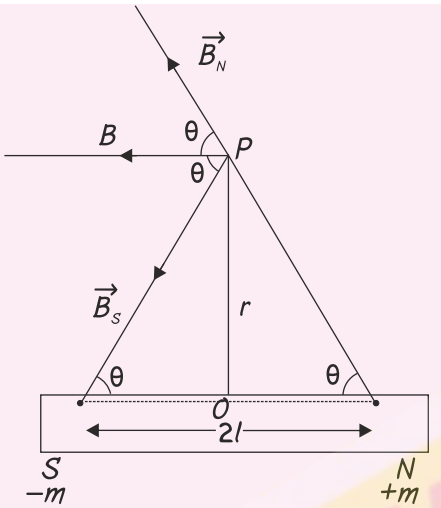
Electric Energy : The amount of energy is consumed in the any electrical circuit due to flowing the electric current is called electric energy. It is always measured in kilowatt hour (kWh). This unit is also called B.T.U.

25. Establish expression for magnetic field at equatorial position of a magnet.

Ans.—Suppose *SN* be the bar magnet having length 2*l* and pole strength $-m$ and $+m$.

$OS = ON = l$

M = Magnetic moment = $(2m)l$



P be the point where magnetic field to be determined. Point P lies in Broad side on position.

$OP = r$

B_N and B_S are the magnitudes of the magnetic field due north pole and south pole.

$\therefore \quad PN = \sqrt{r^2 + l^2}$

$PS = \sqrt{r^2 + l^2}$

$\therefore \quad B_N = \frac{\mu_0}{4\pi} \cdot \frac{m}{(r^2 + l^2)} \quad \left(\text{along } \overrightarrow{NP}\right)$

$B_S = \frac{\mu_0}{4\pi} \cdot \frac{m}{(r^2 + l^2)} \quad \left(\text{along } \overrightarrow{PS}\right)$

$\therefore$ Magnetic field due to bar magnet.

$$B = \sqrt{B_N^2 + B_S^2 + 2B_N B_S \cos 2\theta}$$

$\therefore \quad B_N = B_S$

$$B = B_N \sqrt{1 + 1 + 2\cos 2\theta}$$

$$B = \frac{\mu_0}{4\pi} \frac{m}{(r^2 + l^2)} \cdot \sqrt{2(1 + \cos 2\theta)}$$

$$B = \frac{\mu_0}{4\pi} \frac{2m}{(r^2 + l^2)} \cos\theta$$

$$B = \frac{\mu_0}{4\pi} \frac{2m}{(r^2 + l^2)} \cdot \frac{l}{\sqrt{r^2 + l^2}}$$

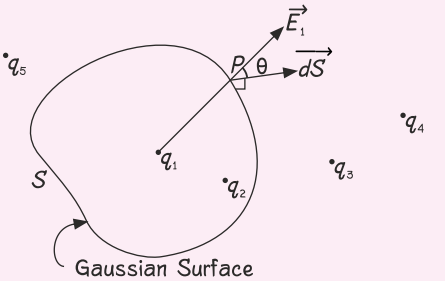
$$\boxed{B = \frac{\mu_0}{4\pi} \frac{M}{(r^2 + l^2)^{\frac{3}{2}}}}$$

26. Write down Gauss's theorem and prove it.

Ans.—Statement of Gauss Theorem—The total electric flux over a closed surface is equal to the net charge q enclosed by the surface divided by, the permittivity of the free space ϵ_0.

$$\oiint \vec{E} \cdot \overrightarrow{dS} = \frac{q}{\epsilon_0}$$

Here L.H.S. is electric flux and q is the net charge enclosed.



Proof : Let us consider a closed surface and let there be charge $q_1, q_2 \ldots q_5$ as in

At a point P of Gaussian surface, the electric field $\vec{E}$ is produced by all the charges q_1, q_2, q_3, q_4. That is,

$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4 + \vec{E}_5$$

Its flux over the closed surface is given by

$$\phi = \oiint \vec{E} \cdot \overrightarrow{dS} = \oiint \left(\vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4 + \vec{E}_5\right) \cdot \overrightarrow{dS}$$

$$= \oiint \vec{E}_1 \cdot \overrightarrow{dS} + \oiint \vec{E}_2 \cdot \overrightarrow{dS} + \oiint \vec{E}_3 \cdot \overrightarrow{dS} + \oiint \vec{E}_4 \cdot \overrightarrow{dS} + \iint \vec{E}_5 \cdot \overrightarrow{dS}$$

Using $\vec{E}_1 = \frac{q_1}{4\pi \epsilon_0 r_1^2} \hat{r}_1$,

$$\oiint \vec{E}_1 \cdot \overrightarrow{dS} = \frac{q_1}{4\pi \epsilon_0} \oiint \frac{dS \cos\theta_1}{r_1^2}$$

Now $\frac{dS \cos\theta_1}{r_1^2}$ is the solid angle subtended by dS at q_1.

Hence its integral is the solid angle made by the closed surface at an inside point, which is 4π.

$$\therefore \quad \oiint \vec{E}_1 \cdot \overrightarrow{dS} = \frac{q_1}{4\pi \epsilon_0} \times 4\pi = \frac{q_1}{\epsilon_0}$$

Similarly, for the inside charges. Thus,

$$\oiint \vec{E}_2 \cdot \overrightarrow{dS} = \frac{q_2}{\epsilon_0}$$

For the outside charge, the solid angle made by the closed surface is zero. Hence,

$$\oiint \vec{E}_3 \cdot \overrightarrow{dS} = \frac{q_3}{4\pi \epsilon_0} \times 0 = 0$$

$$\oiint \vec{E}_4 \cdot \overrightarrow{dS} = \frac{q_4}{4\pi \epsilon_0} \times 0 = 0$$

$$\oiint \vec{E}_5 \cdot \overrightarrow{dS} = \frac{q_5}{4\pi \epsilon_0} \times 0 = 0$$

Thus, $\oiint \vec{E} \cdot \overrightarrow{dS} = \frac{q_1}{\epsilon_0} + \frac{q_2}{\epsilon_0} + 0 + 0 + 0 = \frac{q_1 + q_2}{\epsilon_0}$

But $q_1 + q_2$ is the net charge enclosed by S. Hence the total flux of $\vec{E}$ is equal to the net charge enclosed divided by ϵ_0. Proved.