MARKING SCHEME CODE: A

SECTION A

1. (*d*) sixteen times **1**

2. (*a*) k (dielectric constant) **1**

3. (*a*) $\frac{I}{A}$ **1**

4. (*d*) None is damaged **1**

5. (*c*) 0 **1**

6. (*a*) 0.8 **1**

7. (*b*) c **1**

8. (*b*) In **1**

9. (*a*) Forward biasing **1**

10. (*b*) intensity **1**

11. (*d*) $10^{12}h$ **1**

12. (*a*) Mass number **1**

13. (*d*) They saturate as the separation between two nucleon's increases. **1**

14. (*c*) $\frac{\beta}{\mu}$ **1**

15. (*a*) Both A and R are true and R is correct explanation of A. **1**

16. (*d*) A is false and R is also false. **1**

17. (*b*) Both A and R are true and R is not correct explanation of A. **1**

18. (*a*) Both A and R are true and R is correct explanation of A. **1**

SECTION B

19. Displacement current is due to changing electric field.

Conduction current is due to flow of electrons in the circuit. **1**

$$I_D = \epsilon_0 \frac{d\phi_\epsilon}{dt} \qquad I_C = \frac{V}{R}$$ **1**

20. Faraday's 1st law: Whenever there is a change in the magnetic flux linked with the circuit changes an e.m.f is induced in it. It lasts so long as the change in the flux continues. **1**

Faraday's 2nd law: The rate of change of magnetic flux linked with a circuit is directly proportional to emf. induced.

$$e \propto \frac{d\phi}{dt}$$ **1**

21. It is the phenomenon of fusing two or more lighter nuclei into a bigger one. **1**

$${}^{2}H_{1} + {}^{2}H_{1} \longrightarrow {}^{3}Hc_{2} + {}^{1}n_{0} + 3.27 \text{ MeV}$$ **1**

OR

Total Energy, $E = -13.6$ eV

Kinetic Energy $= -E = 13.6$ eV **1**

Potential Energy $= -2$ K.E $= -2 \times 13.6$ **1**

$= -27.2$ eV

22. In forward biasing the forward voltage opposes the potential barrier. As a result of it potential barrier reduced and width of depletion layer decreases. **1**

In reverse biasing the reverse voltage supports the potential barrier. As a result of it potential barrier and width of depletion layer increases. **1**

23. Magnetic dipole moment is the product of strength of either pole (m) and the magnetic length (2*l*) of the magnet.

$$\vec{M} = m(2\vec{l})$$ **1**

It's S.I. unit is joule/tesla or Am^2 **½**

The direction of magnetic dipole moment is from South to North pole of the magnet. **½**

24. $$V_B - V_A = \frac{W_{AB}}{q_0}$$ **½**

If points *A* and *B* lie on equipotential surface then $V_B = V_A$ **½**

$\therefore$ $W_{AB} = 0$

Hence no work is done in moving the test charge from one point of equipotential surface to the other. **1**

OR

$F = 44.1$ N $\quad r = 2 \text{ cm} = 2 \times 10^{-2}$ m

$$F = \frac{1}{4\pi \epsilon_0} \frac{q_1 q_2}{r^2}$$ **½**

$$44.1 = \frac{9 \times 10^9 \times (q \times q)}{(2 \times 10^{-2})^2}$$

$$\Rightarrow \qquad q^2 = \frac{44.1\times(2\times10^{-2})^2}{9\times10^9} \qquad ½$$

$$q = \sqrt{\frac{441\times4\times10^{-4}}{9\times10^{10}}} \qquad ½$$

$$q = 14\times10^{-7}C \qquad ½$$

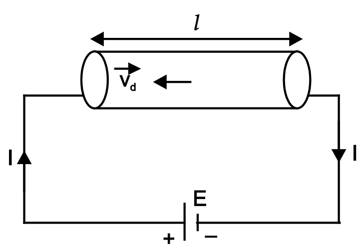
25. The phenomenon of restricting the vibrations of light in a particular direction perpendicular to the direction of wave motion is called **polarization of light**. **1**

Law of Malus: When a beam of completely plane polarised light is incident on an analyser, the resultant intensity of transmitted light is directly proportional to square of the cosine of the angle (θ) between plane of transmission of analyser and polariser. **1**

SECTION C

26. Drift velocity is defined as the average velocity with which the free electrons get drifted towards the positive end of the conductor under the influence of an external electric field. **1**

Relation b/w current and drift velocity



If n is the number density of electrons then total number of free electrons in the conductors = A l n

If e is charge on each electron then total charge q = Al ne ...(1) ½

Time taken by es to cross the conductors

$$t = \frac{l}{v_d} \qquad ...(2) \qquad ½$$

As $$I = \frac{q}{t} = \frac{Alne}{l/v_d}$$

$$I = neAv_d \qquad 1$$

27. **Gauss's Theorem:** The surface integral of electric field over a closed path is equal to $\frac{1}{\epsilon_0}$ times the total charge enclosed by surface. **1**

$$\phi = \oint \vec{E}.d\vec{s} = \frac{q}{\in_0}$$

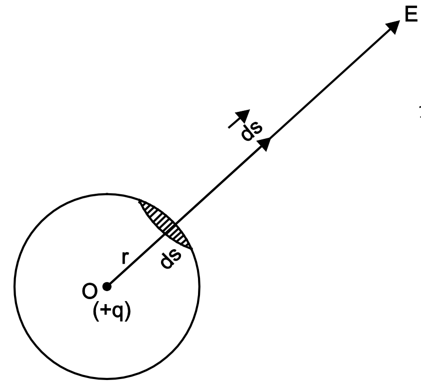
Proof:

Let + q charge is situated at the centre O of the sphere of radius r.

Electric field at point P is $\vec{E} = \frac{q}{4\pi \in_0 r^2}$ **½**

Electric flux over the area element

$$d\phi = \vec{E}.d\vec{s} = \frac{q}{4\pi \in_0 r^2} ds$$ **½**

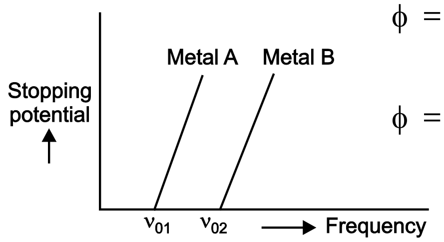


Total flux $$\phi = \int d\phi = \frac{\Sigma}{4\pi \in_0 r^2} \int ds$$

$$\phi = \frac{q}{4\pi \in_0 r^2}(4\pi r^2)$$

$$\phi = \frac{q}{\in_0}$$ **1**

28.



From the graph we note that

(*a*) For a given photosensitive material the stopping potential varies linearly with the frequency of the incident radiation **1**

(*b*) For a given photosensitive material, there is a certain minimum cut off frequency v_0 (called threshold frequency) for which the stopping potential is zero. **1**

29. (*i*) For shortest wavelength

$$\frac{1}{\lambda_s} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$$ **½**

$$\frac{1}{\lambda_s} = \frac{R}{4}$$

For longest wavelength

$$\frac{1}{\lambda_L} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$ **½**

$$\frac{1}{\lambda_L} = \frac{5}{36}(R)$$

On solving

$$\frac{\lambda_L}{\lambda_S} = \frac{9}{5}$$ **1**

or $\lambda_L : \lambda_S = 9 : 5$

(*ii*) Balmer series lies in visible part of spectrum. **1**

OR

Postulates of Bohr's model of atom

1. Every atom consists of a central core called nucleus in which entire mass and positive charge are concentrated. Electrons revolved around the nucleus in circular orbits The necessary centripetal force is provided by the electrostatic force of attraction between the electron and nucleus. **1**

$$\frac{mv^2}{r} = \frac{kze^2}{r^2}$$

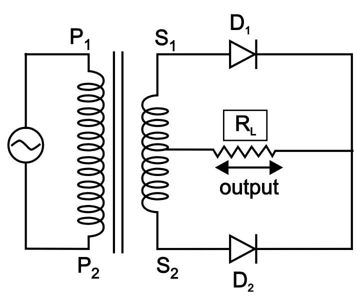
2. Electron can revolve only in certain discrete non-radiating orbits called stationary orbits for which total angular momentum is an integral multiple of $\frac{h}{2\pi}$, where h is planck's constant **1**

$$mvr = \frac{nh}{2\pi}$$

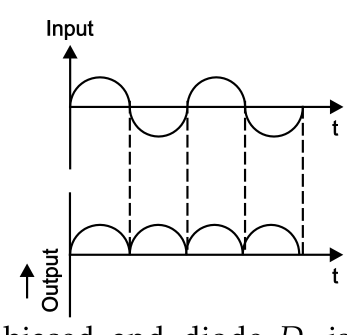
3. The emission/absorption of energy occurs only when an electron jumps from one orbit to another. Energy is absorbed when the electron jumps from an inner to an outer orbit and energy is emitted when electron jumps from outer to inner orbit. **1**

$$E_2 - E_1 = hv$$

30. Full-wave rectifier **1**



1



1

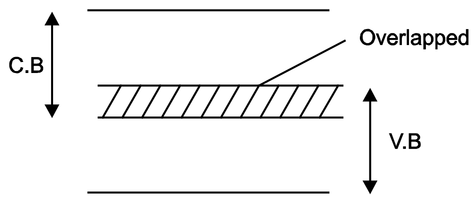
During +ve half cycle diode D_1 is forward biased and diode D_2 is reverse biased. The forward current flows due to D_1. During –ve half cycle, diode D_1 is reverse biased and diode D_2 is forward biased. The forward current flows due to D_2. The output waveforms is shown in figure. **1**

OR

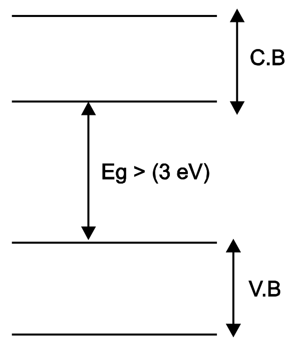
In conductors (metal) the conduction band is partially filled with electrons or the conduction and valence band partly overlap each other. There is no forbidden energy gap. **1**

In insulators, the valence band is completely filled and the conduction band is empty and energy gap is quite large (E.g. > 3eV). **1**

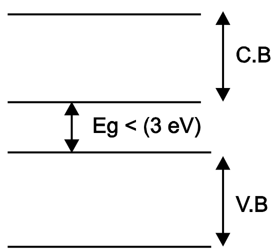
In semiconductors the valence band is totally filled and the conduction band is empty but the energy gap between conduction band and valence band is quite small *e.g.* In Ge = 0.72 eV and in Si = 1.1 eV **1**



Conductors



Insulators



Semiconductors

SECTION D

31. (*i*) (*b*) $[ML^2T^{-3}A^{-2}]$ **1**

(*ii*) (*a*) $R = \dfrac{V}{I} = \dfrac{2}{1 \times 10^{-6}} = 2 \times 10^6\ \Omega$ **1**

(*iii*) (*d*) Specific resistance of a wire only depends on nature of material and is independent of dimensions. **1**

(*iv*) (*a*) a straight line **1**

OR

(*d*) $\rho = \dfrac{RA}{l}$ $\qquad A = \dfrac{\pi D^2}{4}$

$= \dfrac{2\times 4\pi\times 10^{-8}}{1}$ $\qquad$ $= \dfrac{\pi(4\times 10^{-4})^2}{4}$

$= 2.55 \times 10^{-7}\ \Omega m$ $\qquad$ $= 4\pi \times 10^{-8}\ m^2$ **1**

32. (*i*) (*d*) increases **1**

(*ii*) (*a*) $P = P_1 + P_2 = +1.5 + 1.0$ **1**

$= +2.5$ D

(*iii*) (*b*) $f = \dfrac{1}{P} = \dfrac{1}{5} = +20$ cm **1**

(*iv*) (*a*) $P = P_1 + P_2 = \dfrac{1}{f_1} + \dfrac{1}{f_2}$

$= \dfrac{100}{10} - \dfrac{100}{5}$

$= -10$ D **1**

Or

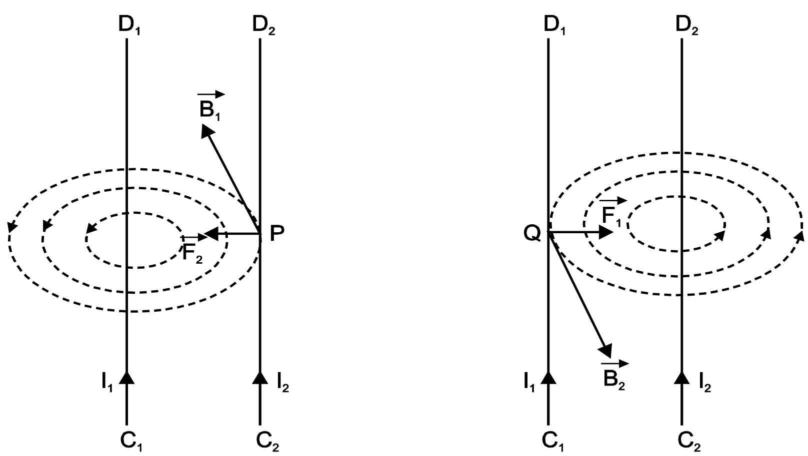
(*b*) diverging in nature **1**

$$P = P_1 + P_2 = \frac{1}{f_1} + \frac{1}{f_2}$$

$$= \frac{100}{25} - \frac{100}{20}$$

$$= -1 \text{ D}$$

SECTION E

33.  **1**

Consider C_1D_1 and C_2D_2 two infinite long straight conductors carrying currents I_1 and I_2 in same direction at a distance r apart held $\|^{el}$ to each other.

Mag. field Induction at pt. P on C_2D_2 due to current I_1 in C_1D_1

$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2I_1}{r}$ $\perp^{ar}$ to plane of paper acting inwards given by Right hand Rule.

$\therefore$ The unit length of C_2D_2 experience a force F_2.

$$F_2 = B_1 I_2 \times 1 = B_1 I_2$$

$$F_2 = \frac{\mu_0}{4\pi} \frac{2 I_1 I_2}{r} \quad ...(1)$$ **1**

According to Fleming's left hand rule force on C_2D_2 acts in the plane of paper $\perp$ to C_2D_2, directed towards C_1D_1.

$\|ly$ C_1D_1 also experience force given by equation (1) which acts in the plane of paper $\perp$ to C_1D_1 directed towards C_2D_2.

Hence C_1D_1 and C_2D_2 attract each other carrying current in same direction. **1**

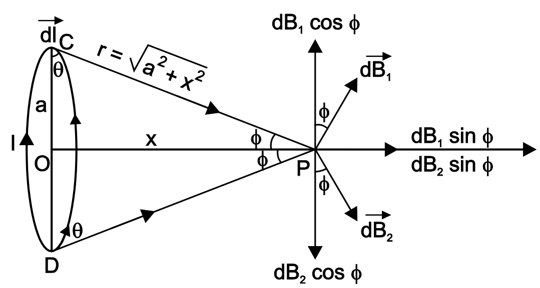
One Amphere: is that much current which when flowing through each of two $\|^{el}$ uniform long linear conductors placed in free space at a distance of 1 m from each other will attract or repel each other with a force of 2×10^{-7} N/m of their length. **1**

OR

Biot– Savart's law is an equation that gives the magnetic field produced due to a current carrying element. **1**

$$dB = \frac{\mu_0}{4\pi} \frac{I\, dl \sin\theta}{r^2}$$

Mag. field at a point on the axis of a circular coil carrying current.



1

Consider a circular coil of radius a.

$$OP = x$$

$$PC = r = \sqrt{a^2 + x^2} \qquad \angle CPO = \phi$$

θ is the angle b/w $\vec{dl}$ and $\vec{r}$

$\overrightarrow{dB_1}$ mag. field at P due to $\overrightarrow{Idl}$ at C

$$\overrightarrow{dB_1} = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2} \qquad \theta = 90° \text{ if a is small}$$

dir^n of $\overrightarrow{dB_1}$ $\perp$ to $\overrightarrow{dl}$ & $\vec{r}$ and acting upwards **1**

$\|ly$ $\overrightarrow{dB_2}$ = mag. field at P due to $I\,\vec{dl}$ at D

$$= \frac{\mu_0}{4\pi}\frac{Idl}{(a^2+x^2)}$$

dir^n of $\overrightarrow{dB_2}$ is $\perp$ to both $\vec{dl}$ & $\vec{r}$ and acting downward.

$$\left|\overrightarrow{dB_1}\right| = \left|\overrightarrow{dB_2}\right|$$ **1**

Resolve $\overrightarrow{dB_1}$ and $\overrightarrow{dB_2}$ into its rectangular components as shown in figure.

Total mag. field at $P = \sum dB_1 \sin\phi$

$$B = \int \frac{\mu_0}{4\pi}\frac{Idl\sin\phi}{(a^2+x^2)}$$

$$= \frac{\mu_0}{4\pi}\frac{I}{(a^2+x^2)}\sin\phi \int dl$$

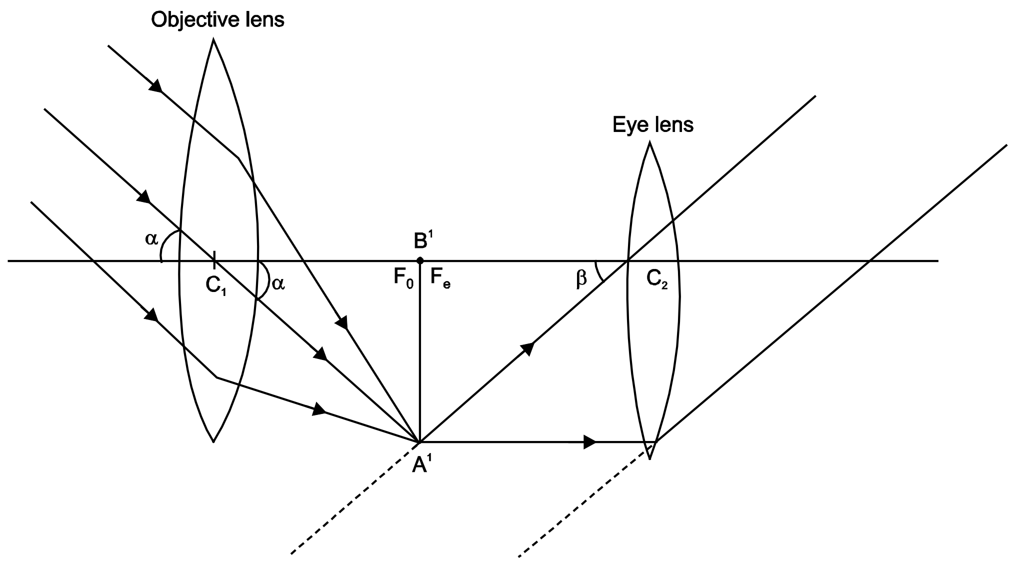
$$= \frac{\mu_0}{4\pi}\frac{I}{(a^2+x^2)}\frac{a}{\sqrt{a^2+x^2}}(2\pi a)$$

$$= \frac{\mu_0}{4\pi}\frac{I(2\pi a^2)}{(a^2+x^2)} \qquad \because \quad A = \pi a^2 = \text{area of loop}$$

$$B = \frac{\mu_0}{4\pi}\frac{2IA}{(a^2+x^2)^{3/2}}$$ **1**

34. **Astronomical Telescope:** It consists of two lenses, objective and eye piece. Objective lens is of large aperture and large focal length. Eye-piece of small aperture and focal length is used. **1**

In normal adjustment: final image is formed at infinity



1

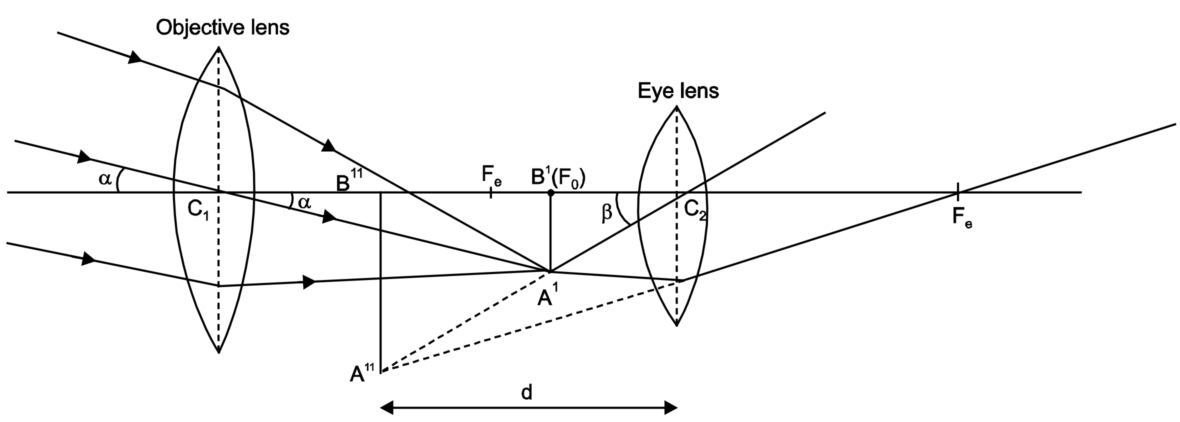
$$m = \frac{\beta}{\alpha} \approx \frac{\tan\beta}{\tan\alpha}$$

$$= \frac{A'B'}{C_2B'} \times \frac{C_1B'}{A'B'} = \frac{C_1B'}{C_2B'} = \frac{f_o}{f_e}$$

$$m = \frac{f_o}{-f_e} \quad ...(1)$$

–ve sign shows that final image is inverted.

Magnifying power of an astronomical telescope at least distance of distinct vision is the ratio of angle subtended by image at least distance of distinct vision to the angle subtended at eye by the object at infinity, when seen directly. **1**



1

$$m = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha} = \frac{C_1B'}{C_2B'} = \frac{f_o}{-u_e} \quad ...(2)$$

By lens formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

$v_e = -d, \quad u = -u_e, \quad f = +f_e$

$$\frac{1}{f_e} = \frac{1}{-d} - \frac{1}{-u_e}$$

$$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{d} = \frac{1}{f_e}\left[\frac{1+f_e}{d}\right]$$

Put in (2)

$$m = \frac{+f_o}{-u_e} = \frac{-f_o}{f_e}\left[1+\frac{f_e}{d}\right]$$ **1**

–ve sign means final image is inverted

OR

Huygen's Principle: Acc. to Huygen's Principle

(*i*) Every point on primary wave front acts as fresh source of disturbance which travel in all direction with velocity of light and called as secondary wavelets. **1**

(*ii*) Surface obtained by joining secondary wavelets tangentially in forward direction called secondary wave front. **1**

Reflection of plane wavefront

AB is plane wave front incident on a plane mirror at $\angle BA\,A' = i$

Acc. to Huygen's principle, every pt on AB is a source of secondary wavelets.

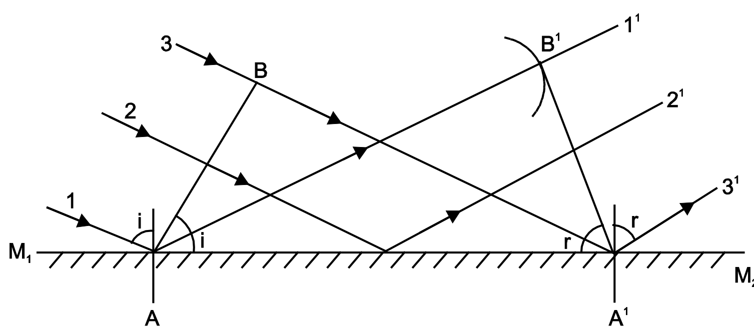
Let the secondary wavelets from B strike $M_1\,M_2$ at A' in t seconds **1**

$\therefore \quad BA' = c \times t$

Draw an arc at B' with A as a centre and $c \times t$ as radius so that $AB^1 = ct$

From A' draw a tangent plane $A'B'$ touching the spherical arc tangentially at B'.

$\therefore \; A'B'$ is the reflected wave front.



1

In $\Delta AA'B$ and $\Delta AA'B'$

AA' is common

$BA' = AB' = c \times t$

$\angle B = \angle B' = 90°$

$\therefore$ $\Delta's$ are congruent

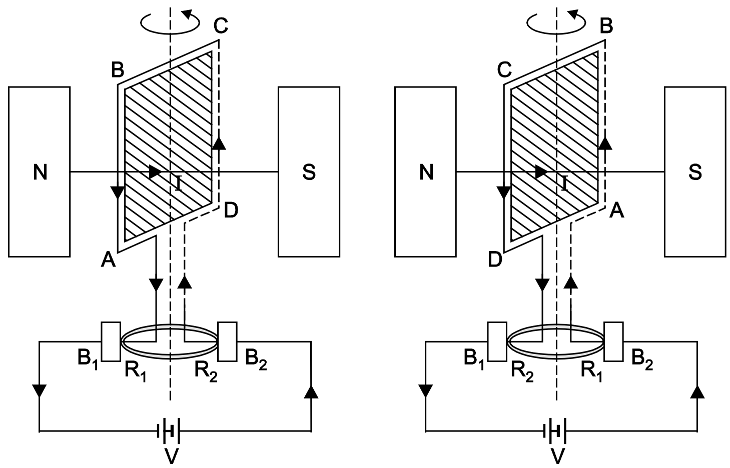
$\therefore$ $\angle BAA' = \angle B'A'A$

i.e., $i = r$

Incident w.f. AB, reflected w.f. $A'B'$ and reflecting surface M_1M_2 all lie $\perp$ to plane of the paper. **1**

35. **A.C. Generator:** It is a device used to convert mechanical energy into electrical energy. **1**

Principle: It is based on principle of electromagnetic induction. Whenever mag. flux linked with a coil change, induced emf. produces in coil. **1**



1

Working: As the armature coil is rotated in the mag. field angle θ b/w field and normal to the coil changes continuously. An emf is induced in the coil. The direction of induced current is shown in figure.

Let N = no. of turns in the coil

A = area of each turn

$\vec{B}$ = strength of mag field

$\phi = N(\vec{B}.\vec{A})$ = NBA cosθ

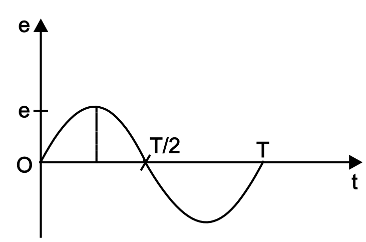
= NBA cos ωt

$$e = \frac{-d\phi}{dt} = \frac{-d}{dt}(\text{NBA} \cos \omega t) = \text{NBA}\omega \sin \omega t$$

e will be max. if sin ωt = 1 **2**

$\therefore$ $e_{max} = e_0$ = NBAω

$\therefore$ $e = e_0$ = sin ωt



OR

(i) **Phasor diagram:** is drawn to show the phasor relationship between voltage and current in an a.c. circuit **1**

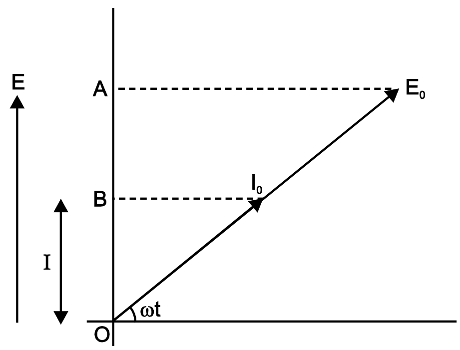
Let $E = E_0 \sin \omega t$ ...(1)

$$I = \frac{E}{R} = \frac{E_0 \sin \omega t}{R}$$

I_{max} if $\sin \omega t = 1$ $\therefore$ $I_0 = \frac{E_0}{R}$

$\therefore$ $I = I_0 \sin \omega t$ ...(2)

From (1) & (2), it is clear that emf current are in same phase **1**



$OA = E = E_0 \sin\omega t$ **1**

$OB = I = I_0 \sin\omega t$

(ii) $L = 25 \text{ mH} = 25 \times 10^{-3}\text{H}$

$E_V = 220 \text{ V}, \ v = 50 \text{ Hz}$

(i)
$$X_L = \omega L = 2\pi v L = 2 \times \frac{22}{7} \times 50 \times 25 \times 10^{-3} = 7.85 \text{ ohm}$$ **1**

(ii)
$$I_v = \frac{E_v}{X_L} = \frac{220}{7.85} = 28\text{A}$$ **1**