Answers to RPH–DS1/Set-1

1. (*b*) Principle of superposition

2. (*a*) clockwise

3. (*c*) Using, $\lambda = \frac{h}{p}$

$\therefore \quad \lambda \propto \frac{1}{p}$

4. (*d*) Above A = 55, the value of B.E./Nucleon falls rapidly.

5. (*c*) $F = ilB \sin \theta$

$\therefore \quad \frac{F}{l} = 8 \times 0.15 \times \frac{1}{2} = 0.6$ N/m

6. (*d*) To concentrate the magnetic lines of force.

7. (*a*)

8. (*c*)

9. (*c*) $\frac{3R \times 6R}{9R} = 2\text{R}$

10. (*c*) Charge

11. (*a*) $L = \frac{\mu_0 N^2 A}{l}$; $L' = \frac{\mu_0 (4N^2)(A/4)}{l}$

$\therefore \quad \frac{L}{L'} = 1$

12. (*a*) Bi and Cu

13. (*b*) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

14. (*a*) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

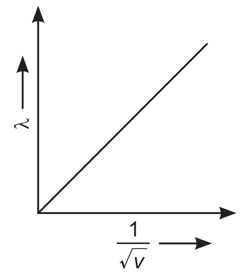
15. (*a*) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

16. (*c*) If Assertion is true but Reason is false.

17. Differences between intrinsic and extrinsic semiconductors are as follows.

Intrinsic semiconductor	**Extrinsic semiconductor**
(*i*) It is semiconductor in pure form.	(*i*) It is doped semiconductor either with trivalent or pentavalent impurity.
(*ii*) Electrical conductivity is low.	(*ii*) Electrical conductivity is high.
(*iii*) Number of electrons = numbers of holes.	(*iii*) Number of electrons >> numbers of holes in n-type semiconductor and numbers of holes >> Number of electrons in *p*-type semiconductor. (*any two*)

18. $\because$ de Broglie wavelength, $\lambda = \dfrac{h}{\sqrt{2\,mqV}}$



For a particle of mass '*m*' accelerated through a P.D. of *V* volt, electric charge

$$q = \left(\frac{h}{\sqrt{2\,m} \times \text{slope of graph}}\right)^2$$

19. (*a*) The phase difference does not remain constant in two independent sources of light.

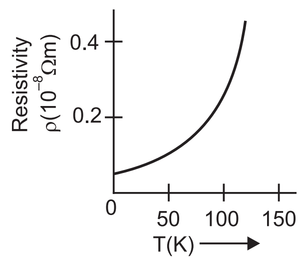
(*b*) A wavefront is the locus of all points vibrating in the same phase.

20. (*a*) Mobility of charge carriers is defined as the ratio of drift velocity, v_d per unit electric field, *E*, i.e. $\mu = \dfrac{|\vec{v}_d|}{E}$. Its S.I. unit is m^2/Vs or $m\ s^{-1}\ N^{-1}C$.

(*b*) Variation of resistivity of copper as a function of temperature is shown in the figure.

In a metal, *n* (no. of electron per unit volume) is not dependent on temperature but τ (relaxation time) decreases with the rise in temperature as a result

$$\rho \propto \frac{1}{\tau} \left(\because \rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau}\right)$$



21. Given: $f = \dfrac{2}{3}R$

Using lens maker's formula for a biconvex lens, $\dfrac{1}{f} = (\mu - 1)\dfrac{2}{R}$, we get

$\therefore \quad \dfrac{3}{2R} = (\mu - 1)\dfrac{2}{R}, \ \mu - 1 = \dfrac{3}{4} \quad \Rightarrow \quad \mu = 1 + \dfrac{3}{4} = \dfrac{7}{4}$

The refractive index of lens material is $\dfrac{7}{4}$.

Or

Given: $v = 10$ cm, $m = -19$, $f = ?$

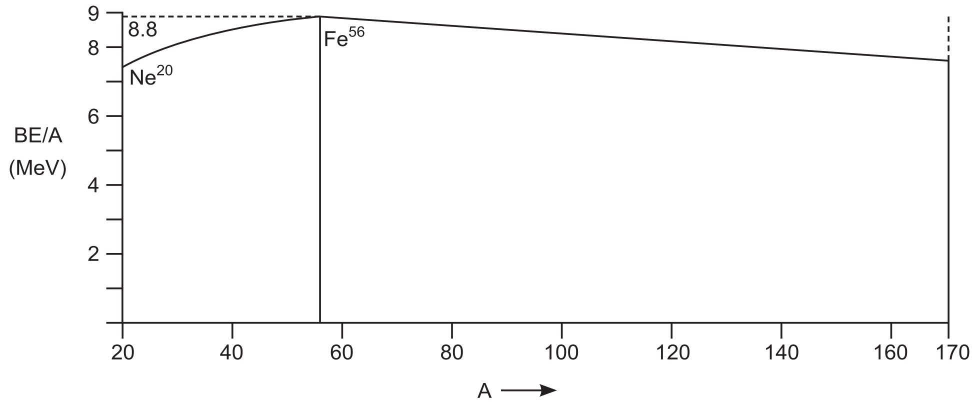
We know that $\qquad m = \dfrac{v}{u} = -19$

$\Rightarrow \qquad v = -19\,u \Rightarrow u = -\dfrac{10}{19}$ cm [By sign convension]

Using the formula, $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{10} + \dfrac{19}{10} = \dfrac{20}{10} = 2 \quad \Rightarrow f = 0.5$ cm

The focal length of the convex lens is 0.5 cm.

22. (*a*)



In the beginning of the graph Ne^{20} is stable nucleus. At A = 40, $_{20}Ca^{40}$ is the last nucleus where N/Z ratio is 1. As the value of A increases, to provide stability against proton-proton repulsion more number of neutrons are accommodated in the nuclei and N/Z ratio goes upto 1.6. After Z = 83 (lead) even the higher number of neutron fail to overcome coulombain repulsion and there after the nuclei turn unstable. Fe^{56}, as shown in the graph is most stable nucleus with BE/A = 8.8 MeV (the highest value). From here to A → 170, the ratio BE/A continue to gradually fall till A becomes equal to 207 for Pb. Beyond this value nuclei becomes unstable.

(*b*) B.E. of nucleus $= \frac{B.E.}{A} \times A = 7.6 \times 240$ MeV

B.E. of each fragments $= 8.5 \times 120$ MeV

∴ Energy released $= 2 \times 8.5 \times 120 - 7.6 \times 240$

$= 240\,[8.5 - 7.6] = 216.0$ MeV

23. Given: $C = 600 \times 10^{-12}$ F, $V = 200$ V

∴ $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 600 \times 10^{-12} \times (200)^2$

$= 3 \times 4 \times 10^{-12+6} = 12 \times 10^{-6}$ J = 12 μJ ...(*i*)

Total charge, $Q = CV = 600 \times 10^{-12} \times 200 = 12 \times 10^{-8}$ C

The charge remains constant when an uncharged capacitor is connected with it.

Total capacity, $C' = 900$ pF $= 900 \times 10^{-12}$ F

[As 600 pF and 300 pF are connected in parallel]

∴ $V' = \frac{Q}{C'} = \frac{12 \times 10^{-8}}{9 \times 10^{-10}} = \frac{4}{3} \times 10^2 = \frac{400}{3}$ volts

∴ $U' = \frac{1}{2}C'V'^2 = \frac{1}{2} \times 9 \times 10^{-10} \times \left(\frac{400}{3}\right)^2$

$U' = \frac{1}{2} \times 16 \times 10^{-6} = 8 \times 10^{-6} = 8$ μJ

∴ Energy loss = 12 – 8 = 4 μJ

Alternative method:

C_1 = 600 pF ; V_1 = 200 V; C_2 = 300 pF = 300×10^{-12} F, V_2 = 0

$$\text{Loss in energy} = \Delta U = \frac{C_1 C_2 (V_1 - V_2)^2}{2(C_1 + C_2)}$$

$$= \frac{600 \times 10^{-12} \times 300 \times 10^{-12} (200 - 0)^2}{2(600 + 300) \times 10^{-12}} = 4 \times 10^{-6} \text{ J}$$

This energy is dissipated in the form of heat, light, crackling etc.

24. Using Bohr's postulates, we know that

$$\frac{mv_n^2}{r_n} = \frac{kZe^2}{r_n^2} \qquad \ldots(i)$$

(centrifugal force on revolving e^- is equal to the coulombian attraction)

$$mv_n = \frac{nh}{2\pi r_n} \qquad \ldots(ii)$$

(angular momentum of revolving e^- is quantised)

Dividing eqn. (*i*) by (*ii*), we get

$$v_n = \frac{kZe^2}{r_n} \times \frac{2\pi r_n}{nh} = \frac{2\pi kZe^2}{nh}$$

or $$v_n = \frac{2\pi ke^2}{nh} \text{ for H-atom} \qquad \ldots(iii)$$

The total energy of the revolving electron in the n^{th} orbit, $E_n = K + U$, where the kinetic energy $K = \frac{1}{2}mv_n^2$ and potential energy, $U = \frac{kZe(-e)}{r_n} = -\frac{kZe^2}{r_n}$

For H-atom $$E_n = \frac{1}{2}mv_n^2 - \frac{ke^2}{r_n}$$

$$= \frac{ke^2}{2r_n} - \frac{ke^2}{r_n} = -\frac{ke^2}{2r_n} \qquad \ldots(iv)$$

As $$r_n = \frac{n^2h^2}{4\pi^2 kme^2}$$ [Using equations (*i*) and (*ii*) $\frac{kme^2}{r_n} = \frac{n^2h^2}{4\pi^2 r_n^2}$, we set this value]

We have $$E_n = -\frac{ke^2}{2} \times \frac{4\pi^2 kme^2}{n^2h^2}$$

or $$E_n = \frac{2\pi^2 k^2 me^4}{n^2h^2} \times \frac{hc}{hc},$$

Putting $$\frac{2\pi^2 k^2 me^4}{h^3 c} = R,$$ (Rydberg's constant = 1.097×10^7 m^{-1})

We have $$E_n = -\frac{Rhc}{n^2} \text{ Joule.}$$

The first line of Balmer series, H_α is produced when electron jumps from orbit $n_2 = 3$ to the second orbit $n_1 = 2$.

Using $$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \text{ we get}$$

$$\frac{1}{\lambda_{H_\alpha}} = R\left(\frac{1}{4} - \frac{1}{9}\right) = R\left(\frac{5}{36}\right)$$

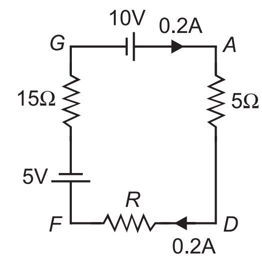
$$\therefore \quad \lambda_{H_\alpha} = \frac{36}{5R} = \frac{36 \times 10^{-7}}{5 \times 1.1} = 6.54 \times 10^{-7} \text{ m.}$$

25. Resistance in the arm BCD of the circuit.

$$R_1 = 5 + 10 = 15\ \Omega$$

Total resistance across arm DB,

$$R_2 = \frac{15 \times 30}{15 + 30} = \frac{15 \times 30}{45} = 10\ \Omega$$



$\therefore$ Total resistance across arm AD, $R' = \dfrac{10 \times 10}{10 + 10} = 5\ \Omega$

Now, circuit reduces to the form shown

From the loop $ADFGA$

$$5 \times 0.2 + R \times 0.2 + 15 \times 0.2 = 5$$

$$0.2R + 4 = 5$$

$$0.2R = 1$$

$$R = \frac{1}{0.2} = 5\ \Omega$$

$$V_{AD} = 5 \times 0.2 = 1 \text{ volt.}$$

26. **Moving Coil Galvanometer.** It is an instrument used for the detection and measurement of current. Its action is based on the torque acting on a current-carrying coil placed in a magnetic field.

The current passed through the galvanometer is directly proportional to the deflection produced. This is working principle of moving coil galvanometer.

A torque is exerted in a current carrying coil if placed in a magnetic field.

Given that $$V = i_g(G + R_1) \quad ...(i)$$

and $$\frac{V}{2} = i_g(G + R_2) \quad ...(ii)$$

Dividing (*i*) by (*ii*), we get

$$2 = \frac{G + R_1}{G + R_2} \quad \text{or} \quad G = R_1 - 2R_2 \quad ...(iii)$$

Suppose R is the resistance in series for range $2V$, then

$$2V = i_g(G + R) \quad ...(iv)$$

Dividing (*iv*) by (*i*) we get

$$2 = \frac{G+R}{G+R_1}$$

or $\quad R = G + 2R_1 \Rightarrow R_1 - 2R_2 + 2R_1 \; [\because G = R_1 - 2R_2]$

$\therefore \quad R = 3R_1 - 2R_2$

27. General expression for the modified Ampere's circuital law is

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 \left[I_C + \varepsilon_o \frac{d\phi_E}{dt} \right]$$

where $\quad I_C$ = conduction current and

$$\varepsilon_o \frac{d\phi_E}{dt} = I_d = \text{displacement current.}$$

(*i*) In connecting wires, we have only conduction current $\left(I_C = I = \frac{dq}{dt} \right)$, and there is no displacement current as $\phi_E = 0$. So $I_d = 0$.

(*ii*) In the region between the plates of capacitor, there is displacement current but no conduction current as ($I_C = 0$).

$$\varepsilon_o \frac{d\phi_E}{dt} = \varepsilon_o \frac{d}{dt}(EA) = \varepsilon_o \frac{d}{dt}\left(\frac{q}{\varepsilon_o}\right) = \frac{dq}{dt} = I \qquad \ldots \left(E = \frac{q}{\varepsilon_0 A} \right)$$

28. Let an alternating current of $I = I_m \sin \omega t$ be passing through a network of L, C and R creating a potential difference of $V = V_m \sin(\omega t \pm \phi)$ where ϕ is the phase difference. Then the power consumed is given by

$$P = VI = V_m I_m \sin(\omega t \pm \phi) \sin \omega t$$

$$\therefore \quad P = V_m I_m (\sin \omega t \cos \phi \pm \cos \omega t \sin \phi) \sin \omega t$$

$$P = V_m I_m \left(\sin^2 \omega t \cos \phi \pm \frac{1}{2} \sin 2\omega t \sin \phi\right)$$

$$P_{av} = \frac{\int_0^T P dt}{\int_0^T dt} \Rightarrow P_{av} = \frac{V_m I_m}{T} \left[\int_0^T \sin^2 \omega t \cos \phi \, dt + \frac{1}{2} \int_0^T \sin \phi \sin 2\omega t \, dt \right]$$

$$P_{av} = \frac{V_m I_m}{T} \left[\frac{T}{2} \cos \phi + 0 \right] \qquad \left[\because \int_0^T \sin^2 \omega t dt = \frac{T}{2} \text{ and } \int_0^T \sin 2\omega t dt = 0 \right]$$

$$P_{av} = \frac{V_m I_m}{2} \cos \phi = V_{\text{rms}} I_{\text{rms}} \cos \phi$$

(*a*) No power is dissipated if (*i*) resistance in the circuit is zero and (*ii*) phase angle between voltage and current is $\pi/2$.

(*b*) Maximum power is dissipated if (*i*) resistance in the circuit is maximum and (*ii*) phase angle between voltage and current is zero.

Or

(*a*) The circuit element *X* is a resistor and *Y* is a capacitor.

(*b*) Here, $R = X_C = \frac{V_{rms}}{\sqrt{2}}$

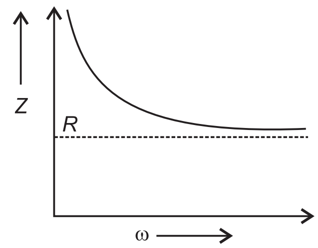
When *X* and *Y* are connected in series, the impedance is given by

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{2R^2} = \sqrt{2}R$$

$$I_{rms} = \frac{V_{rms}}{\sqrt{2}R} = \frac{\sqrt{2}R}{\sqrt{2}R} = 1 \text{ A}$$

(*c*) $$Z = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$$

The *Z*-ω graph will be of the type as shown in the figure.



29. (*i*) (*a*) (*ii*) (*a*) (*iii*) (*c*) ***Or*** (*iii*) (*a*)

(*iv*) (*d*) Aperture of Californian Telescope ≈ 5 m

1 m = 39.37 inches

∴ 5 m = 5 × 39.37 inches

= 196.85 inches

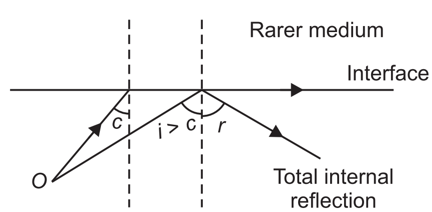
∴ Aperture of Californian telescope ≈ 200 inches.

30. (*i*) (*a*) (*ii*) (*c*) (*iii*) (*a*) ***Or*** (*iii*) (*a*) (*iv*) (*a*)

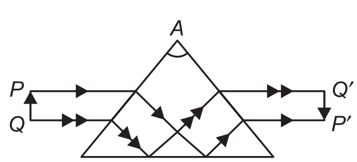
31. (*a*) (*i*) The following are the two essential conditions for phenomenon of total internal reflection to occur:

(1) Light should travel from denser to rarer media.

(2) The angle of incidence in a denser medium should be greater than the critical angle for a pair of media in contact.



(*ii*)



(*iii*) **Optical Fibre:** An optical fibre transmits light introduced at one end to the opposite end, with little loss of the light through the sides of the fibre.

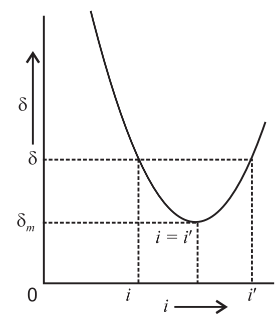
The optical fibre consists of a cylindrical central core of diameter of the order of a few micrometre made up of thousands of long and extremely thin strands of high quality glass or quartz.

(*a*) (*b*)

The core is covered by a material of slightly lower refractive index called cladding.

A light ray entering the fibre will suffer total internal reflection at the interface of core and cladding, if the angle of incidence exceeds the critical angle. Even for a bent or twisted fibre, light guidance can occur through multiple total internal reflections.

(*b*) Variation of angle of deviation as a function of angle of incidence.



Expression for refractive index of the prism:

The ray diagram showing the passage of a ray of light through a prism of refracting angle A.

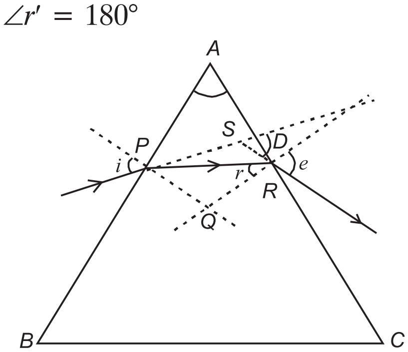
Here $\angle BAC = \angle A$, $\angle SPQ = \angle i$, $\angle SRQ = \angle e$

In trapezium *APQR*,

$$\angle A + \angle PQR = 180° \quad \ldots(i)$$

In ΔPQR,

$$\angle r + \angle PQR + \angle r' = 180° \quad \ldots(ii)$$



In trapezium *PQRS*,

$\angle SPQ + \angle PQR + \angle SRQ + \angle PSR = 360°$

$\angle i + (180° - \angle A) + \angle e + \angle PSR = 360°$

Also $\quad \angle PSR + \angle D_{min} = 180°$

$\therefore \angle i + (180° - \angle A) + \angle e + 180° - \angle D_{min} = 360°$

or $\quad \angle i + \angle e = \angle A + \angle D_{min} \quad \ldots(iii)$

From equations (*i*) and (*ii*), we get

$$\angle r + \angle r' = \angle A$$

When $\quad \angle r = \angle r' , 2\angle r = \angle A$

or $\quad \angle r = \dfrac{\angle A}{2}$ and $\angle i = \angle e$

$\therefore$ Equation (*iii*) becomes $2\angle i = \angle A + \angle D_{min}$

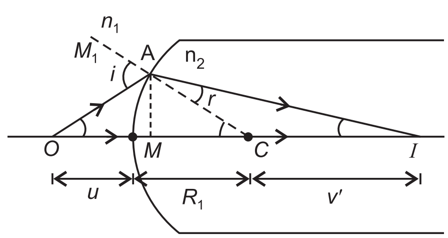
$$\Rightarrow \quad \angle i = \frac{\angle A + \angle D_{min}}{2}$$

$$\therefore \quad \mu = \frac{\sin i}{\sin r}$$

$$\mu = \frac{\sin\left(\dfrac{A + D_{min}}{2}\right)}{\sin \dfrac{A}{2}}$$

Or

(*a*)



For small angles, $\angle AOM \simeq \tan \angle AOM = \dfrac{AM}{MO}$

$$\angle ACM \simeq \tan \angle ACM = \frac{AM}{MC}$$

$$\angle AIM \simeq \tan \angle AIM = \frac{AM}{MI}$$

From ΔAOC, $\quad \angle i = \angle AOM + \angle ACM$

$$\angle i = \frac{AM}{MO} + \frac{AM}{MC} \quad ...(i)$$

From ΔACI, $\quad \angle r = \angle ACM - \angle AIM$

$$\angle r = \frac{AM}{MC} - \frac{AM}{MI} \quad ...(ii)$$

Using Snell's law, we get, $n_1 \sin i = n_2 \sin r$

For small angles, $n_1 i = n_2 r$

Substituting values of $\angle i$ and $\angle r$ from equation (*i*) and (*ii*), we get

$$\frac{n_1}{MO} + \frac{n_1}{MC} = \frac{n_2}{MC} - \frac{n_2}{MI}$$

$$\frac{n_1}{MO} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$$

As $MO = -u$, $MI = +v'$, $MC = +R_1$

$$\frac{n_1}{-u} + \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1}$$

(*b*) Given: $v + u = 90$ cm ...(*i*)

and $m = +\frac{v}{u} = 2$

$\therefore$ $v = 2u$ ...(*ii*)

$\therefore$ From equation (*i*), we get

$$3u = 90 \text{ cm} \Rightarrow u = 30 \text{ cm}$$

Putting these values in formation, i.e. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

Take $u = -30$ cm, $v = +60$ cm [By sign convention]

$$\frac{1}{f} = \frac{1}{60} + \frac{1}{30}$$

$$= \frac{1+2}{60} = \frac{3}{60} \Rightarrow f = 20 \text{ cm}$$

The lens is a convex lens of focal length 20 cm.

32. (*a*) (*i*) The arm *BE* contains a capacitor, hence no current flows through it. Let in mesh *DEFABCD*, the current *I* flows.

The total emf of the mesh = $2V - V = V$

The effective resistance, $R' = 2R + R = 3R$

$\therefore$ $I = \frac{V}{3R}$

Now the potential difference across *BE* can be either

$$V_{BE} = 2V - I \times 2R = 2V - \frac{V}{3R} \times 2R = \frac{4V}{3}$$

or $V_{BE} = V + I \times R = V + \frac{V}{3} = \frac{4V}{3}$

As the cell and capacitor are in series, the potential difference across the capacitor,

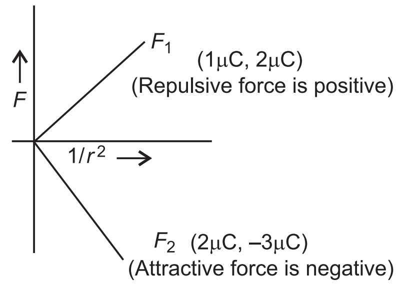
$$V_{BE} = V_C + V$$

or $V_C = \frac{4}{3}V - V = \frac{V}{3}$

(*ii*) Charge on capacitor, i.e. $Q = C \times \frac{V}{3} = \frac{CV}{3}$

(*iii*) Energy stored in the capacitor, $U = \frac{1}{2}CV^2 = \frac{1}{2}C\left(\frac{V}{3}\right)^2 = \frac{CV^2}{18}$

(*b*) The slope of the line is directly proportional to the force acting between the charges for a given separation. The force with 1st pair of charges, i.e. F_1 is repulsive and hence positive (+ve), while the force for 2nd pair of charges, i.e. F_2 is attractive and hence negative (–ve). Here F_2 is greater than F_1, therefore slope of F_2 is greater than F_1.



Or

(*a*) Let C be capacity of the parallel plate capacitor charged to a potential V of the battery. When the battery is disconnected, the charge on the capacitor remains the same.

(*i*) On inserting a dielectric, slab the capacitance of the capacitor becomes K times the original value.

i.e. $C' = KC$

(*ii*) The new potential V' is given by

$$V' = \frac{Q}{C'} = \frac{Q}{KC} = \frac{V}{K} \qquad \left[\because \; V = \frac{Q}{C}\right]$$

i.e. potential is reduced K times.

Now, the new electric field E' is given by

$$E' = \frac{V'}{d} = \frac{V}{Kd} = \frac{E}{K} \qquad \left(\because \; E = \frac{V}{d}\right)$$

i.e. the electric field is reduced K times.

(*iii*) Let U and U' be the energies stored in the capacitor before and after the dielectric is introduced.

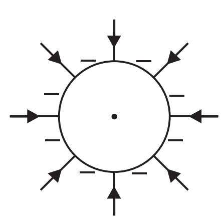
Then $$U = \frac{1}{2}CV^2 \text{ and } U' = \frac{1}{2}C'V'^2 = \frac{1}{2}KC\left(\frac{V}{K}\right)^2 \qquad \left[\because \; V' = \frac{V}{K}\right]$$

$$U' = \frac{1}{2}\frac{CV^2}{K} = \frac{U}{K}$$

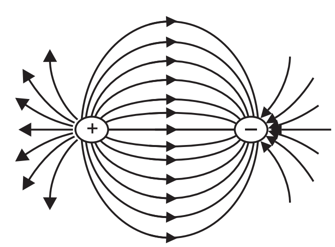
i.e. the energy stored in the capacitor is reduced K times.

(*b*) The pattern of electric lines of force of a conducting sphere having a negative charge.

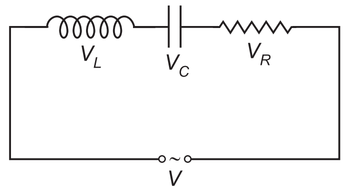
(*i*) There is no electric field lines of force inside the conducting sphere.



(*ii*) The pattern of the electric field lines of force of the electric dipole.

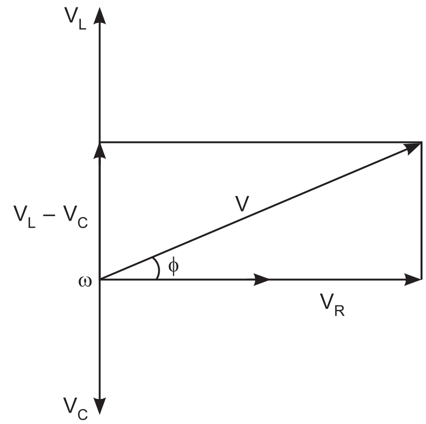


33.



$V = V_m \sin \omega t$ is the alternating emf put across a LCR circuit.

Phasor diagram for overall inductive circuit is given as,



We have, $$V^2 = V_R^2 + (V_L - V_C)^2$$

or $$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

or $$iZ = \sqrt{i^2[R^2 + (X_L - X_C)^2]}$$

(where, Z is the impedance of the circuit)

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

$$\tan \phi = \frac{V_L - V_C}{V_R} = \left(\frac{\omega L - \frac{1}{\omega_C}}{R}\right)$$

and instantaneous current, $i = i_m \sin(\omega t - \phi)$ as current lags behind voltage by phase ϕ.

Condition for resonance: When $X_L = X_C$, Z is minimum and equals to R. Hence the amplitude of current is maximum. This condition is called electrical resonance.

Putting $X_L = X_C$, we get

$$\omega L = \frac{1}{\omega L}, \omega$$

$$= \frac{1}{\sqrt{LC}}$$

or $$\nu = \frac{1}{2\pi\sqrt{LC}} = \nu_0$$

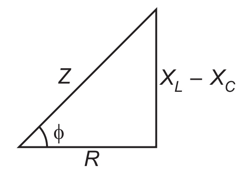
Where ν_0 is the natural frequency of the circuit.

Power factor: It is a factor by which the product of the r.m.s. values of voltage and current must be multiplied to give the power dissipated. For a circuit containing pure resistance, $\phi = 0$. So, that $\cos\phi = 1$, which is the maximum value of power factor. Average power dissipated across pure resistor is maximum.

For a circuit containing resistance, capacitance and inductance, we have

$$\tan\phi = \frac{X_L - X_C}{R} = \frac{\omega L - \frac{1}{\omega C}}{R}$$

Impedance triangle is shown.



$$\therefore \qquad \cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

This is the expression for power factor.

(*i*) If $\phi = 0$, $\cos\phi = 1$ or $Z = R$

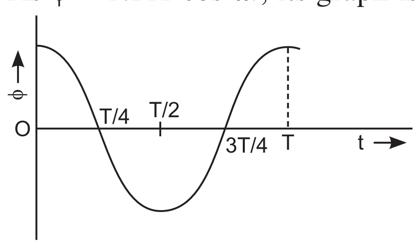
The power factor is maximum under electric resonance.

(*ii*) If $\phi = \frac{\pi}{2}$, $\cos\phi = 0$.

In a pure inductance the current lags behind the voltage by $\frac{\pi}{2}$. The average power absorbed in pure inductance is zero as power factor is zero. In a pure capacitance the current lead voltage by phase angle $\frac{\pi}{2}$. Here also the average power absorbed in pure capacitance is zero as the power factor is zero. The current in such cases is called wattless current.

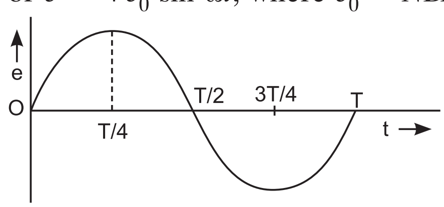
Or

(*a*) (*i*) As $\phi = NBA\cos\omega t$, its graph is as



(*ii*) As $e = -N\frac{d\phi}{dt} = +NBA\,\omega\sin\omega t$

or $e = +e_0\sin\omega t$, where $e_0 = NBA\omega$



(*b*) Given that $V_p = 2.5 \times 10^3$ V, $\frac{n_s}{n_p} = \frac{1}{10}$, $I_p = 20$ A

Using $\frac{V_s}{V_p} = \frac{n_s}{n_p} = \frac{1}{10}$, $V_s = \frac{V_p}{10} = 2.5 \times 10^2$ V

Also $\dfrac{I_s}{I_p} = \dfrac{n_p}{n_s} = 10$

$\therefore$ $I_s = I_p \times 10 = 10 \times 20 = 200$ A

As $P_s = \eta P_p$

$\therefore$ $P_s = \dfrac{90}{100} \times 2.5 \times 10^2 \times 200 = 45 \times 10^3$ W

Hence, (*i*) power output = 45 kW;

(*ii*) output voltage = 0.25 kV and

(*iii*) current in secondary = 200 A.