Answers to RPH–DS1/Set-2

1. (c) Mass can exist without charge.

2. (a) Spherical with centre at the centre of the dipole.

3. (d) They are independent of spin.

4. (b) $V_C = \frac{h\nu}{e} - \frac{\phi}{e}$, where ϕ is the work function.

5. (a) Frequency

6. (a) Paramagnetic material

7. (b) Because $\overrightarrow{F_m} = q\,(\vec{v} \times \vec{B})$, lies in plane perpendicular to $\vec{v}$ and $\vec{B}$.

8. (b)

9. (b) Resistance between points A and S is 3 Ω and so on.

10. (c)

11. (a)

12. (b) $E \text{ (in eV)} = \frac{12420}{\lambda(\text{Å})}$ $\therefore\ \lambda = \frac{12420}{2} = 6210$ Å

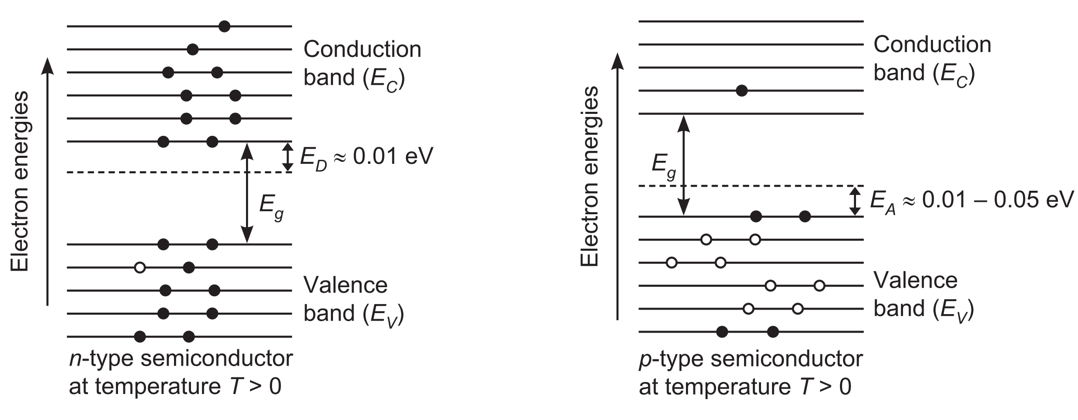
13. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

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

15. (c) If Assertion is true but Reason is false.

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

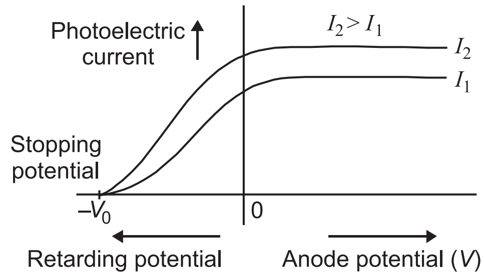
17.



18. (a) (i) **Threshold frequency:** For every metal surface, there is a minimum frequency of incident radiation, below which the photoelectric emission does not take place no matter what the intensity of incident radiation is and for how long the radiations are allowed to fall on the metal. This frequency is called threshold frequency.

(*ii*) **Stopping potential:** It is the minimum retarding potential which should be applied across a photoelectric tube in order to make photoelectric current zero. The photoelectrons of maximum kinetic energy 2 eV can thus, be completely stopped by a potential difference of –2 V (or by a stopping potential of 2 V).

(*b*) Stopping potential remains same. It depends upon the frequency of incident radiation.



Inference: The more is the intensity of photon beam, the greater is the photoelectric current.

19. We know that the number of interference fringes occurring in the broad diffraction peak depends on the ratio $\frac{d}{a}$, i.e. the ratio of distance between the two slits to the width of a slit. This value is independent of wavelength of light. Given that d = 1 mm, and in diffraction pattern, the width of slit, a can be calculated by the width of the central maxima.

$$\therefore \quad \frac{2\lambda D}{a} = n\frac{\lambda D}{d} \quad \text{or} \quad n = 2\frac{d}{a}$$

$$\because \ n = 10 \text{ then we have, } a = \frac{2d}{10} = \frac{d}{5} = \frac{1}{5}\text{mm} = 0.2 \text{ mm}$$

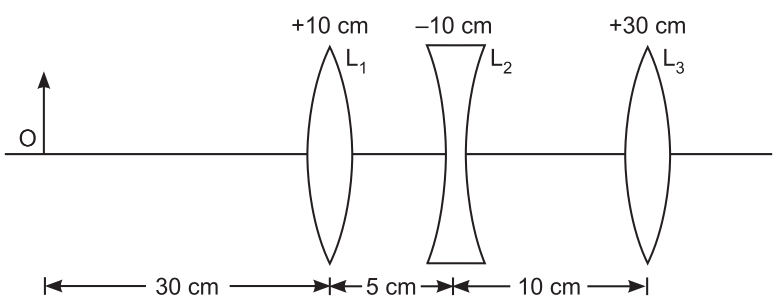
20. Given: $E_1 = 1.5$ V; $E_2 = 2.0$ V, $r_1 = 0.2\ \Omega$; $r_2 = 0.3\ \Omega$

For cells in parallel, the emf of equivalent cell is given by

$$E = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2} = \frac{(1.5 \times 0.3) + (2.0 \times 0.2)}{0.2 + 0.3} = 1.7 \text{ V}$$

and equivalent resistance, $r = \frac{r_1 r_2}{r_1 + r_2} = \frac{0.3 \times 0.2}{0.3 + 0.2} = 0.12\ \Omega$

21.



$u_1 = -30$ cm, $f_1 = +10$ cm

$$\therefore \quad v = \frac{uf}{u+f} = \frac{-30 \times 10}{-30 + 10} = 15 \text{ cm}$$

Image formed from first lens will act as object for second bus with object distance $u_2 = 15 - 5 = 10$ cm

$\because f = -10$ cm

$\therefore \qquad v_2 = \frac{10 \times -10}{10 - 10} = \infty$

For third lens (L_3); $u_3 = \infty, f_3 = +30$ cm

$v_3 = f_3 = +30$ cm

Or

$m = 2, R = -20$ cm

$\because \qquad f = \frac{R}{2} = -10$ cm

Magnification, $m = -2$, let $u = -|u|$

$\because \qquad m = \frac{-v}{-|u|} = -2$

$\therefore \qquad v = -2|u|$

$\therefore \qquad \frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-10} = \frac{1}{-2|u|} + \frac{1}{-|u|}$

$\therefore \qquad \frac{1}{10} = \frac{1+2}{2|u|}$

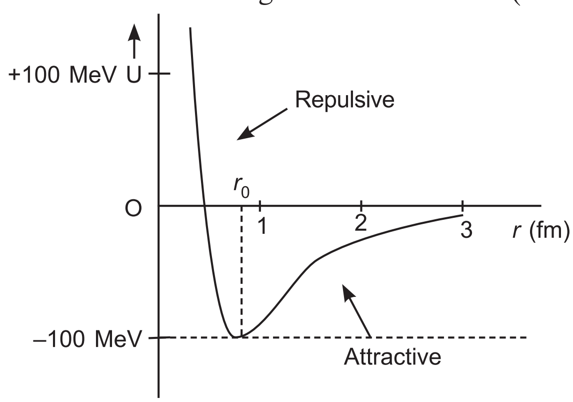
$|u| = 15$ cm

$\therefore \qquad v = -2 \times 15 \text{ cm} = -30$ cm

$\therefore$ Distance of object from the mirror = 15 cm

and distance of image from the mirror (in front of it) = 30 cm.

22. (*a*)



$r_0 = 0.8$ fm

If $r < r_0$, the nuclear force between nucleons is repulsive and if $r > r_0$, up to $r \approx 3$ fm, the nuclear force is attractive. Strong repulsion at shorter distances saves the nucleus from destruction and weak attraction beyond 3 to 4 fm makes the nuclear forces saturated as it remains active near the nucleon only.

(*b*) $^1_0n + {}^{235}_{92}U \longrightarrow {}^{a}_{54}Xe + {}^{94}_{b}Sr + 2{}^1_0n$

We know that for atomic mass

$$1 + 235 = a + 94 + 2$$

$\therefore \quad a = 236 - 96 = 140$

And for atomic number

$$0 + 92 = 54 + b + 0$$

$\therefore \quad b = 92 - 54 = 38$

$\therefore$ The correct equation will be

$${}_0^1n + {}_{92}^{235}U \longrightarrow {}_{54}^{140}Xe + {}_{38}^{94}Sr + 2{}_0n^1$$

23. (*a*) When a d.c. battery is connected with a capacitor, a potential difference between two plates is developed. This generates an electric field, i.e. $E = \frac{V}{d}$, where d is the separation between the plates of the capacitor. The value of E continues to increase till the potential difference between the plates becomes equal to the applied potential of the battery.

(*b*) Given: $C = \frac{\varepsilon_0 A}{d}$ is the capacity of a capacitor.

$\therefore \quad Q = CV = \frac{\varepsilon_0 A}{d} V$

When the separation is doubled and dielectric slab is introduced, then

$$C' = \frac{K\varepsilon_0 A}{2d} = \frac{KC}{2}$$

As the total charge remains constant, i.e.

$$V'C' = VC$$

$\therefore \quad V' = \frac{VC}{C'} = \frac{2VC}{KC} = \frac{2V}{K}$

(*i*) We know that $\quad E = \frac{V}{d} \quad \therefore \; E' = \frac{V'}{2d}$

$$E' = \frac{2V}{K \times 2d} = \frac{E}{K}$$

(*ii*) Energy of capacitor, $\quad U = \frac{1}{2}CV^2$

$$U' = \frac{1}{2}C'V'^2 = \frac{1}{2}\left(\frac{KC}{2}\right)\left(\frac{4V^2}{K^2}\right) = \frac{2}{K}U$$

24. $\Delta E = -13.6$ eV $+ 12.5$ eV $= -1.1$ eV [13.6 eV is the energy supplied to an electron from the ground state to ionise a hydrogen atom]

For $n = 3$, the energy of 2nd excited state ($n = 3$)

using, $\quad E_n = -\frac{13.6}{n^2}$, we have $E_3 = -\frac{13.6}{9} = -1.51$ eV

For $n = 4$, $\quad E_4 = -\frac{13.6}{16} = -0.85$ eV

As ΔE less than energy of 3rd excited state and more than that of 2nd excited state; it will go to the level of 2nd excited state (i.e. $n = 3$).

(*a*) For wavelength of Ist member of Lyman series.

$$\frac{1}{\lambda_{1L}} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$$

$$\therefore \quad \frac{1}{\lambda_{1L}} = \frac{3R}{4} = \frac{3 \times 1.097 \times 10^7}{4}$$

Hence, $$\lambda_{1L} = \frac{4 \times 10^{-7}}{3 \times 1.097} = 1.216 \times 10^{-7} \text{ m} = 1216\text{Å}$$

(*b*) For wavelength of Ist member of Balmer series.

$$\frac{1}{\lambda_{H_\alpha}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5R}{36}$$

$$\therefore \quad \lambda_{H_\alpha} = \frac{36}{5R} = \frac{36}{5 \times 1.097 \times 10^7}$$

$$= 6.563 \times 10^{-7} \text{ m} = 6563\text{Å}$$

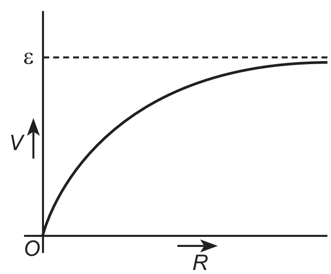
25. (*a*) (*i*) As $$\varepsilon = V + iR$$

and $$i = \frac{\varepsilon - V}{r}$$

$$V = iR = \left(\frac{\varepsilon - V}{r}\right)R$$

or $$V\left(1 + \frac{R}{r}\right) = \frac{\varepsilon R}{r}$$

$$\therefore \quad V = \frac{\varepsilon R}{R\left(1 + \frac{r}{R}\right)} = \frac{\varepsilon}{1 + \frac{r}{R}}$$



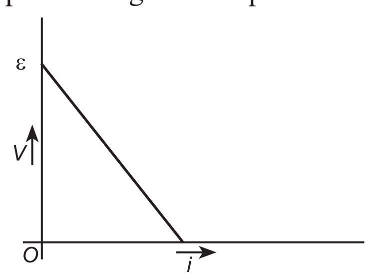
If $R = 0$, $V = 0$

If $R = \infty$, $V = \varepsilon$

(*ii*) $$\varepsilon = V + ir$$

$$\therefore \quad V = -ir + \varepsilon$$

Hence, V versus i graph has negative slope.



(*b*) Given: $R_1 = 4\ \Omega$, $I_1 = 1$ A;

$R_2 = 9\ \Omega$, $I_2 = 0.5$ A

We know that $$E = V + ir = iR + ir$$

$$E = i(R + r)$$

For 1st case $\qquad E = 1(4 + r) \qquad$ ...(*i*)

For 2nd case $\qquad E = 0.5(9 + r) \qquad$ ...(*ii*)

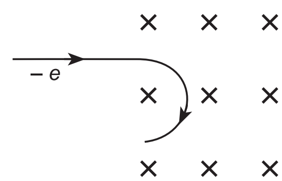
From (*i*) and (*ii*), we get

$4 + r = 0.5 \times 9 + 0.5r \quad \Rightarrow \quad 0.5\, r = 4.5 - 4 = 0.5$

$\therefore\ r = 1\ \Omega$

and $E = 1 \times (4 + 1) = 5$ V. $\qquad$ [From (*i*)]

26. (*a*) An electron is moving from left to right, its direction in (⊗) magnetic field will be as shown in the diagram.



Given that $\qquad v = 4 \times 10^4$ m/s, $\quad B = 10^{-5}$ T.

We know that, $\quad r = \dfrac{mv}{qB} = \dfrac{9.1\times10^{-31}\times4\times10^{4}}{1.6\times10^{-19}\times10^{-5}}$ m

$\therefore \qquad r = 22.75 \times 10^{-3}$ m $= 2.27$ cm

Also $\qquad t = T/2 = \dfrac{\pi r}{v} = \dfrac{3.14\times2.27\times10^{-2}}{4\times10^{4}} = 1.78\times10^{-6}$ s

(*b*) Given that $m = 200$ g $= 0.2$ kg, $l = 1.5$ m, $I = 2$ A.

As the weight of the wire is balanced by magnetic force, we have

$$IlB = mg$$

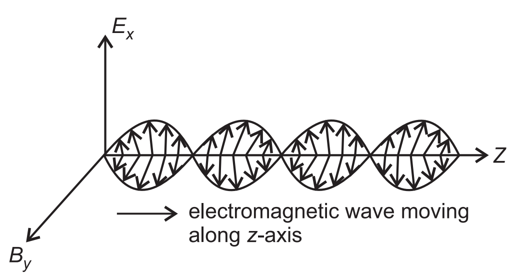
$$2 \times 1.5 \times B = 0.2 \times 9.8$$

$$\therefore \qquad B = \frac{0.2\times9.8}{3} = 0.653\ \text{T}$$

27. (*a*) When a capacitor is charged by a battery, conduction current flows through the connecting wires, due to which capacitor plates acquire electric charges. Therefore, electric flux between the capacitor plates changes and results in displacement current between the plates, which is given by

$$i_D = \varepsilon_0 \frac{d\phi_E}{dt}$$

(*b*)



28. (*a*) Transformer

Power losses in a transformer: Various power losses in a transformer and the ways by which they can be minimised are:

Power Loss	**Minimised by**
(*i*) Joule's heating of the primary and secondary windings	(*i*) Using thick wires of materials having low resistivity, e.g. copper.
(*ii*) Heating of the core due to eddy currents.	(*ii*) Using an insulated laminated core.
(*iii*) Hysteresis loss	(*iii*) Using a material having low hysteresis loss as the core, e.g. soft iron.
(*iv*) Flux leakage or incomplete flux linkage.	(*iv*) Using a closed soft iron core shaped to follow field lines.

(*any three*)

(*b*) AC voltage can be stepped up to high value, which reduces the current in the output, therefore during transmission power loss (I^2R) is reduced considerably, while such increase in voltage is not possible for direct current.

Or

(*a*) The given ac source of alternating voltage $V = V_0 \sin \omega t$ is connected to an inductor.

$$V = L\frac{dI}{dt}$$

$$\Rightarrow \qquad dI = \frac{V}{L}dt$$

$$\therefore \qquad dI = \frac{V_0}{L}\sin \omega t \, dt$$

Integrating,
$$I = \int dI = \frac{V_0}{L}\int \sin \omega t \, dt = -\frac{V_0}{\omega L}\cos \omega t$$

$$\therefore \qquad I = I_0 \sin(\omega t - \pi/2)$$

where
$$I_0 = \frac{V_0}{\omega L}$$

(*b*) **Expression for average power dissipation in an inductor:**

The small work done in sending the electric current through the inductor in small time interval dt given by

$$dw = VI\,dt$$

where $V = V_0 \sin \omega t$, and $I = -I_0 \cos \omega t$

Therefore, the net work done, during one complete cycle ($t = 0$ to $t = T$ s)

$$W = \int dw = -V_0 I_0 \int_0^T \sin\omega t \cos \omega t \, dt = \frac{-V_0 I_0}{2}\int_0^T 2\sin \omega t \cos \omega t \, dt$$

$$W = \frac{-V_0 I_0}{2}\int_0^T \sin 2\omega t \, dt = \frac{-V_0 I_0}{2}\left[\frac{-\cos 2\omega t}{2\omega}\right]_0^T$$

$$W = \frac{+V_0 I_0}{4\omega}\left[\cos 2.\frac{2\pi}{T}.T - \cos 0\right]$$

$$W = 0$$

$\therefore$ $$P_{av} = \frac{W}{T} = 0$$

29. (*i*) (*d*)

(*ii*) (*b*) ${}_{\omega}\mu_g = {}_{\omega}\mu_a \times {}_{a}\mu_g = \frac{3}{4} \times \frac{3}{2} = \frac{9}{8}$

(*iii*) (*a*)

Or

(*iii*) (*a*) ${}_{a}\mu_g = \frac{3}{2} = \frac{c_a}{c_g} = \frac{3 \times 10^8}{c_g}$ $\therefore$ $c_g = 2 \times 10^8$ m s^{-1}

(*iv*) (*a*)

30. (*i*) (*b*)

(*ii*) (*d*)

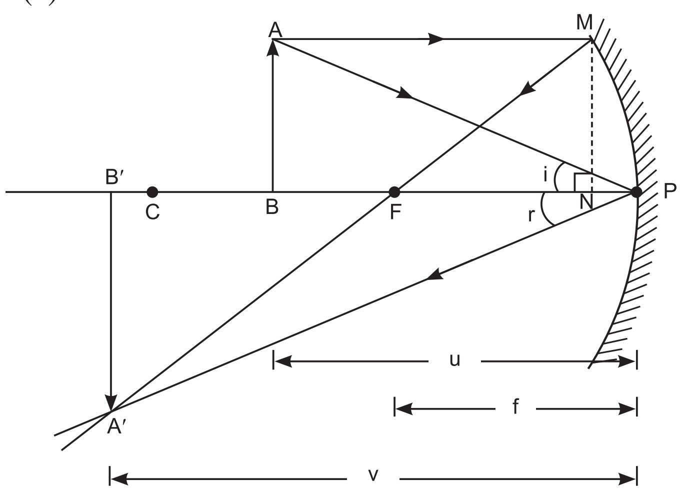
(*iii*) (*d*)

Or

(*iii*) (*c*)

(*iv*) (*a*)

31. (*a*)



(*b*) In the figure

$$\Delta ABP \sim \Delta A'B'P$$ (AA similarity)

$\Rightarrow$ $$\frac{AB}{A'B'} = \frac{PB}{PB'}$$ ...(*i*)

Similarly, $$\Delta MNF \sim \Delta A'B'F$$ (AA similarity)

$\Rightarrow$ $$\frac{MN}{A'B'} = \frac{NF}{B'F}$$ ...(*ii*)

$\because$ $MN = AB$ and NF $\approx PF$, $FB' = PB' - PF$

$\therefore$ Equation (*ii*) becomes

$$\frac{AB}{A'B'} = \frac{PF}{PB' - PF} \qquad ...(iii)$$

From equation (*i*) and (*iii*), we get

$$\frac{PB}{PB'} = \frac{PF}{PB' - PF} \qquad ...(iv)$$

As per sign convention

$PB = -u$, $PB' = -v$, $PF = -f$

$$\therefore \qquad \frac{-u}{-v} = \frac{-f}{-v-(-f)} \Rightarrow \frac{u}{v} = \frac{-f}{-v+f}$$

$$-uv + uf = -vf$$

$$uf + vf = uv$$

Dividing both sides by uvf

$$\Rightarrow \qquad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

This is the mirror formula.

$$\text{Linear magnification} = m = \frac{\text{Size of image}}{\text{Size of object}}$$

$\therefore$ From equation (*i*)

$$\frac{-u}{-v} = \frac{h_o}{-h_t}$$

$AB = h_o$, $A'B' = -h_I$

$$\therefore \qquad m = \frac{h_I}{h_o} = \frac{-v}{u}$$

(*c*) The following are the two advantages of a reflecting type telescope over a refracting type telescope:

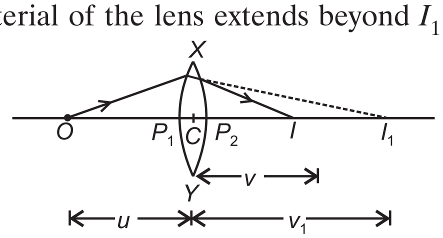
1. As there is no refraction, it is free from the chromatic aberration.
2. The light gathering power of the objective must be higher to get better resolution. It is easier to handle and cheaper to make mirrors of larger diameters.

Or

(*a*) **Lens Maker's Formula:** Consider a thin convex lens made of a material of absolute refractive index n_2 placed in a rarer medium of absolute refractive index n_1. Let n be the refractive index of the material of the lens with respect to the medium surrounding it.

$$\text{So} \qquad n = \frac{n_2}{n_1}$$

Let us first consider refraction of light from the object O at surface XP_1Y of the lens of radius of curvature R_1. Let I_1 be the real image formed due to refraction at surface XP_1Y assuming that the material of the lens extends beyond I_1 then



$$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \quad \ldots(i)$$

Here $v_1 = P_1I_1 = CI_1$

and $u = -OP_1 = -OC$

So $$\frac{n_2}{CI_1} + \frac{n_1}{OC} = \frac{n_2 - n_1}{R_1} \quad \ldots(ii)$$

Let us now consider refraction at surface XP_2Y of the lens of radius of curvature R_2. For this surface I_1 acts as the virtual object. Therefore, the final image (real) of the object O is formed at I as shown in the diagram above.

For refraction at surface, XP_2Y, we have

$$\frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1 - n_2}{R_2} \quad \ldots(iii)$$

Here $v = P_2I = CI$ and $v_1 = P_2I_1 = CI_1$

Therefore, equation (*iii*) can be rewritten as

$$\frac{n_1}{CI} - \frac{n_2}{CI_1} = \frac{n_1 - n_2}{R_2} \quad \ldots(iv)$$

From equations (*ii*) and (*iv*), on adding, we get

$$\frac{n_1}{CI} - \frac{n_2}{CI_1} + \frac{n_2}{CI_1} + \frac{n_1}{OC} = (n_2 - n_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

or $$n_1\left[\frac{1}{CI} + \frac{1}{OC}\right] = (n_2 - n_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

or $$\frac{1}{CI} + \frac{1}{OC} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

As $CI = v$ and $OC = -u$ and $\frac{n_2}{n_1} = n$

$$\therefore \quad \frac{1}{v} - \frac{1}{u} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

(*b*) Given: $u = -100$ cm; $n = 1.5$ (R.I. of glass); $R = 20$ cm

$$\frac{1}{f} = (n-1)\frac{2}{R} = (1.5-1)\frac{2}{20}$$

$$\because \quad f = 20 \text{ cm}$$

Using lens formula,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

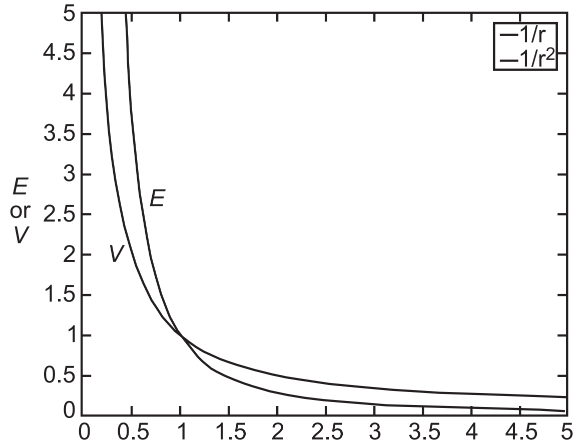
$$\frac{1}{20} = \frac{1}{v} - \frac{1}{(-100)}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{100} = \frac{5-1}{100}$$

$$v = 25 \text{ cm}$$

The image is formed at a distance of 25 cm on the other side of the object.

32. (*a*) $E \propto \frac{1}{r^2}$ and $v \propto \frac{1}{r}$



(*b*) Let V_1 and V_2 be the potential differences that must be applied across the parallel and the series combinations of two capacitors C_1 and C_2 (given that $C_1 : C_2 :: 1 : 2$). Given that the energy stored in two cases are equal.

If $C_1 = C,\ C_2 = 2C$

In parallel combination, the effective capacity, $C_P = C_1 + C_2$

$$C_P = C + 2C = 3C$$

$$\therefore \quad U_1 = \frac{1}{2} C_p V_1^2 = \frac{1}{2} 3CV_1^2 \qquad ...(i)$$

In series combination, the effective capacity $C_S = \frac{C_1 C_2}{C_1 + C_2}$

$$\therefore \quad C_S = \frac{C \times 2C}{3C} = \frac{2C}{3}$$

$$\therefore \quad U_2 = \frac{1}{2} C_S V_2^2 = \frac{1}{2}\left(\frac{2C}{3}\right) V_2^2 = \frac{1}{3} CV_2^2 \qquad ...(ii)$$

Given: $U_1 = U_2$

$$\therefore \quad \frac{3}{2}CV_1^2 = \frac{1}{3}CV_2^2 \quad \Rightarrow \quad \frac{V_1^2}{V_2^2} = \frac{C}{3} \times \frac{2}{3C} = \frac{2}{9}$$

$$\therefore \quad \frac{V_1}{V_2} = \frac{\sqrt{2}}{3}$$

Hence, the ratio of potential differences is $\sqrt{2} : 3$.

Or

(*a*) We know that E for line charge,

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

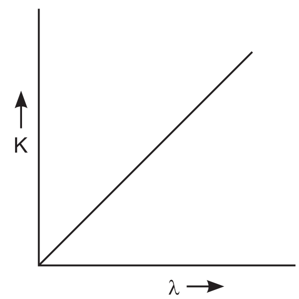
$\therefore$ Centripital force, $\frac{mv^2}{r} = eE$

or $$\frac{mv^2}{r} = \frac{e\lambda}{2\pi\varepsilon_0 r} \Rightarrow mv^2 = \frac{e\lambda}{2\pi\varepsilon_0}$$

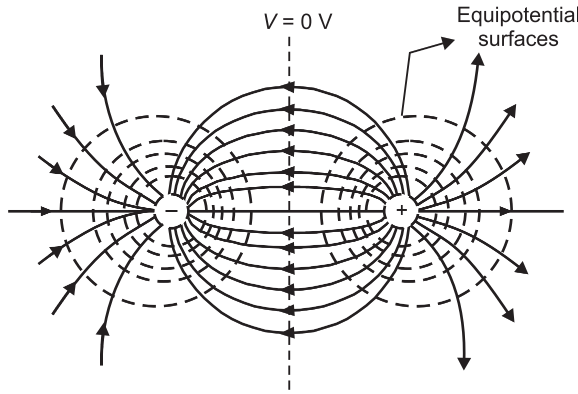
$\therefore$ Kinetic energy, $K = \dfrac{e\lambda}{4\pi\varepsilon_0}$

(*b*) As Kinetic energy, $K \propto \lambda$

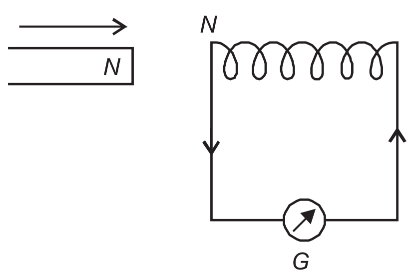
Therefore, K v/s λ graph is given below.



(*c*) The equipotential surfaces of a system of two equal and opposite charges, i.e. a dipole are as shown below.

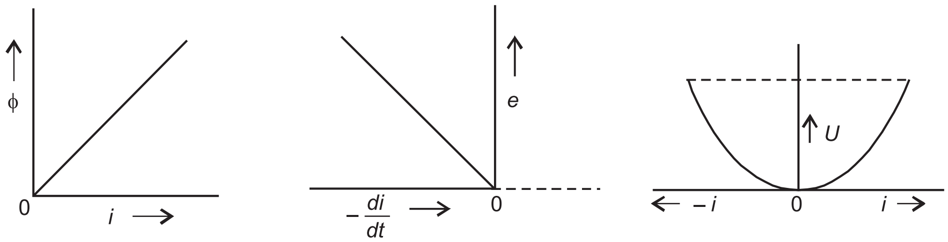


33. (*a*) When the north pole of a magnet is brought close to a copper coil attached with a galvanometer, an anti-clockwise current flows in the galvanometer showing a deflection towards right.



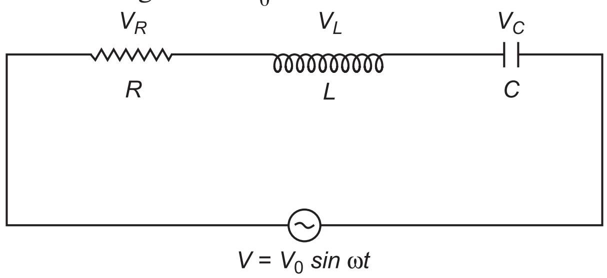
This induced current gives rise to the north pole of the magnet at the left side of the coil. The incoming N-pole of the magnet suffers opposition due to similar polarity of the left end of the coil. External work is being done to overcome this repulsion, which manifests itself as induced emf across the terminals of the coil in accordance with Lenz's law.

(*b*) (*i*) $\phi = Li$ (*ii*) $e = -L\dfrac{di}{dt}$ (*iii*) $U = \dfrac{1}{2}Li^2$

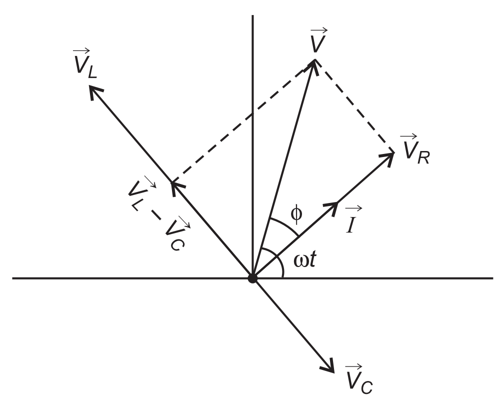


Or

***LCR* circuit:** Suppose a resistance R, on inductance L and capacitance C are connected in series to an a.c source of voltage $V = V_0 \sin \omega t$.



- Across R, phasor $\vec{V_R}$ and $\vec{I}$ are in the same direction.
  So, voltage amplitude is
  $$V_R = I_o R$$
- Across inductor L, voltage leads the current in phase by $\pi/2$ radian.
  So, voltage amplitude is
  $$V_L = I_o X_L \quad \text{where} \quad X_L = \text{inductive reactance.}$$
- Across C, voltage lags behind the current I in phase by $\pi/2$ radian. So voltage amplitude is $V_C = I_o X_C$. Consider $V_L > V_C$.
  So, phasor diagram for LCR circuit is as shown.
  It is assumed that $V_L > V_C$. As $\vec{V_L}$ and $\vec{V_C}$ are in opposite direction, their resultant is $\vec{V_L} - \vec{V_C}$. Using parallelogram law of vector addition



$$\vec{V} = \vec{V_R} + (\vec{V_L} - \vec{V_C})$$

Using pythagorean theorem, we get

$$V_o^2 = V_R^2 + (V_L - V_C)^2$$
$$= I_o^2[R^2 + (X_L - X_C)^2]$$

or $$\frac{V_o}{I_o} = \sqrt{R^2 + (X_L - X_C)^2}$$

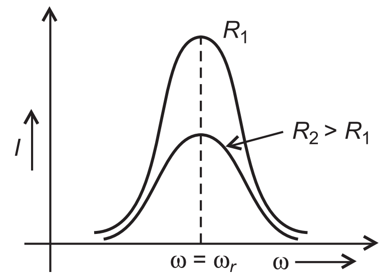
or $$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

where $\dfrac{V_o}{I_o} = Z$ = effective resistance which opposes the flow of current.

Z = Impedance of series LCR circuit.

So, instantaneous current in the circuit is

$$I = I_o \sin(\omega t + \phi)$$



The variation of current I as the function of angular frequency 'ω' of the applied a.c. source for two resistance R_1 and R_2 ($R_2 > R_1$) is shown in the figure.

In a series, LCR circuit, the resonance occurs only when the frequency of the applied a.c. is such that $X_L = X_C$ and the circuit is purely resistive. The current is maximum at $\omega = \omega_r$ such that

$$L\omega_r = \frac{1}{C\omega_r} \quad \text{or} \quad \omega_r^2 = \frac{1}{LC} \quad \text{or} \quad \omega_r = \frac{1}{\sqrt{LC}}$$

At a frequency less than or greater than ω_r, the current falls off. The maximum current is more if the resistance R is less.

A curve with low value of R falls very sharply. Resonance in this case is said to be sharper than the curve with a larger R.

For both LCR circuit, resonant frequency is

$$\omega_r = \frac{1}{\sqrt{L_1C_1}} = \frac{1}{\sqrt{L_2C_2}}$$

$$\Rightarrow \qquad L_1\,C_1 = L_2\,C_2$$