Class -XII
PHYSICS
SQP Marking Scheme
2019-20

Section – A		
1.	a , $\phi = \frac{q}{6\epsilon_0}$ (for one face)	1
2.	b , Conductor	1
3.	a , 1Ω.	1
4.	c ,12.0kJ	1
5.	a , speed	1
6.	d, virtual and inverted	1
7.	a, straight line	1
8.	d, 60^0	1
9.	b, work function	1
10.	b, third orbit	1
11.	45^0 or vertical	1
12.	2 H	1
13.	double	1
14.	1.227 A^o	1
15.	60°	1
16.	Difference in initial mass energy and energy associated with mass of products Or Total Kinetic energy gained in the process	1
17.	Increases	1
18.	$N_o/8$	1
19.	0.79 eV	1
20.	Diodes with band gap energy in the visible spectrum range can function as LED	1

OR

Any one use

Section – B

21. When electric field E is applied on conductor force acting on free electrons

$$\vec{F} = -e\,\vec{E}$$

$$m\vec{a} = -e\vec{E}$$

$\vec{a} = \frac{-e\vec{E}}{m}$

Average thermal velocity of electron in conductor is zero 1

$$(u_t)_{av} = 0$$

Average velocity of electron in conductors in τ (relaxation time) = v_d (drift velocity)

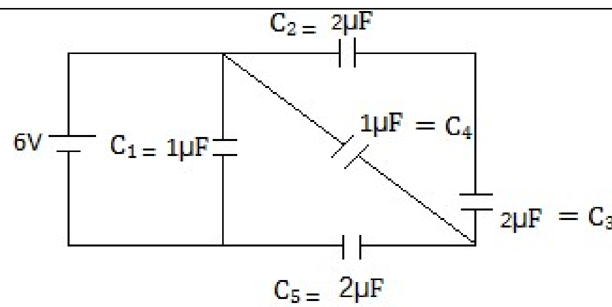
$$v_d = (u_t)_{av} + a\,\tau$$

$$v_d = 0 + \frac{-eE\tau}{m}$$

1

$\overrightarrow{v_d} = \frac{-e\vec{E}\tau}{m}$

22.



C_2 and C_3 are in series

$\frac{1}{c'} = \frac{1}{2} + \frac{1}{2} = 1$

$c' = 1\mu f$ 1

c' & C_4 are in ∥

$C'' = 1 + 1 = 2\mu f$

C'' & c_5 are in series

$\frac{1}{c'''} = \frac{1}{2} + \frac{1}{2} \Longrightarrow c''' = 1\mu f$

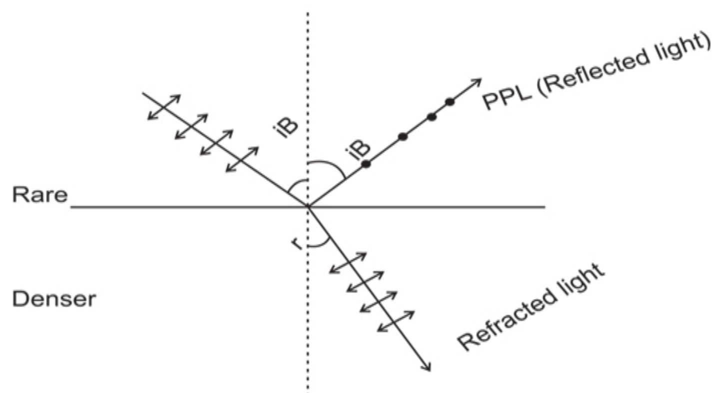
c''' & c_1 are in ∥

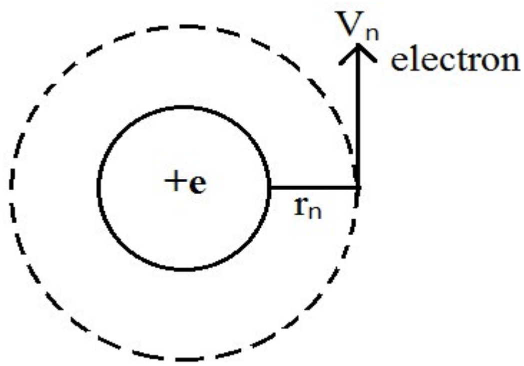
$C_{eq} = 1 + 1 = 2\mu f$ 1

Energy stored

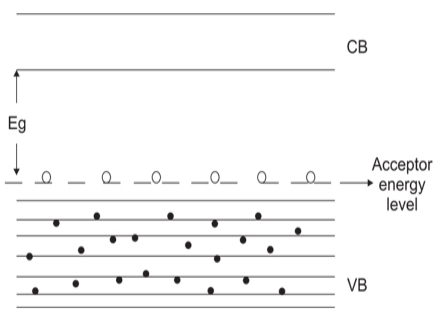
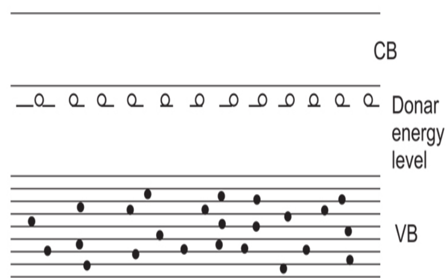
$U = \frac{1}{2}cv^2 = \frac{1}{2}\times 2\times 10^{-6}\times 6^2$

$= 36\times 10^{-6}J$

23.	Gain in KE of particle = Qv $\frac{1}{2}m_p v_p^2 = K_P = q_p V_p$ ----------(i) $V_p = V_\alpha = V$ $\frac{1}{2}m_\alpha v_\alpha^2 = K_\alpha = q_\alpha V_\alpha$ -----------(ii) (ii)/(i) $\frac{m_\alpha v_\alpha^2}{m_p v_p^2} = \frac{q_\alpha}{q_p} = \frac{2}{1}$ $\frac{v_\alpha^2}{v_p^2} = \frac{m_p \times 2}{m_\alpha \times 1} = \frac{2m_p}{4m_p \times 1} = \frac{1}{2}$ $v_\alpha : v_p = 1:\sqrt{2}$	1 1
24.	"The angle of incidence at which the reflected light is completely plane polarized, is called as Brewster's angle (i_B)  At $i = i_B$, reflected beam 1 to refracted beam $\therefore i_B + r = 90 \Longrightarrow r = 90 - i_B$ Using snell's law $\frac{Sin\ i}{Sin\ r} = \mu$ $\frac{Sin\ i_B}{Sin\ (90-i_B)} = \mu \Longrightarrow \frac{Sin\ i_B}{Cos\ i_B} = \mu$ $\mu = \tan i_B$	1 1
25.	wave function $\omega = 2.14eV$ (a) Threshold frequency $\omega = h\nu_0$ $\nu_0 = \frac{\omega}{h} = \frac{2.14 \times 1.6 \times 10^{-19}}{6.62 \times 10^{-34}}$	1

	$= 5.17\times10^{14}$Hz (b) As $k_{max} = eV_0 = 0.6$eV Energy of photon $E = k_{max} + \omega = 0.6$eV + 2.14eV = 2.74eV Wave length of photon $\lambda = \frac{hc}{E} = \frac{6.62\times10^{-34}\times3\times10^{-8}}{2.74\times1.6\times10^{-19}}$ = 4530Å	1
26.	 centripetal force = electrostatic attraction $\frac{mv_n^2}{r_n} = \frac{1}{4\pi\varepsilon0}\frac{e^2}{r_n^2}$ $mv_n^2 = \frac{1}{4\pi\varepsilon0}\frac{e^2}{r_n}$ --------(i) as$mv_n r_n = n\,.\,\frac{h}{2\pi}$ $v_n = \frac{nh}{2\pi m r_n}$ put in (i) $m\,.\frac{n^2h^2}{4\pi^2m^2r_n^2} = \frac{1}{4\pi\varepsilon0}\frac{e^2}{r_n}$ $r_n = \frac{\varepsilon0 n^2h^2}{\pi me^2}$ **<u>OR</u>** Energy of electron in n = 2 is -3.4eV ∴ energy in ground state = -13.6eV kE = -TE = +13.6eV $E_n = \frac{x}{n^2} \Rightarrow -3.4\text{eV} = \frac{x}{2^2} \Rightarrow$ energy in ground state x = - 13.6eV.	1 1 1

	PE = 2TE = -2×13.6eV = -27.2eV	1
27.	(see below)	Any 2x1 =1

P-type semiconductor	n-type semiconductor
1. Density of holes >> density of electron 2. Formed by doping trivalent impurity	1. density of electron>>density of holes 2. formed by doping pentavalent impurity
Energy band diagram for p-type 	Energy band diagram of n-type semiconductor 

OR

Energy of photon $E = \frac{hc}{\lambda} = \frac{6.62\times10^{-34}\times3\times10^{8}}{6000\times10^{-9}\times1.6\times10^{-19}}$eV =2.06eV — 1

As $E<E_g$ (2.8eV), so photodiode cannot detect this photon. — 1

Section – C

28.

Principle of potentiometer, when a constant current flows through a wire of uniform area of cross-section, the potential drop across any length of the wire is directly proportional to the length.

Let resistance of wire AB be R_1 and its length be 'l' then current drawn from driving cell –

$$I = \frac{V}{R+R1} \text{ and hence}$$ 1

P.D. across the wire AB will be

$$V_{AB} = IR_1 = \frac{V}{R+R1} \times \frac{\rho l}{a}$$

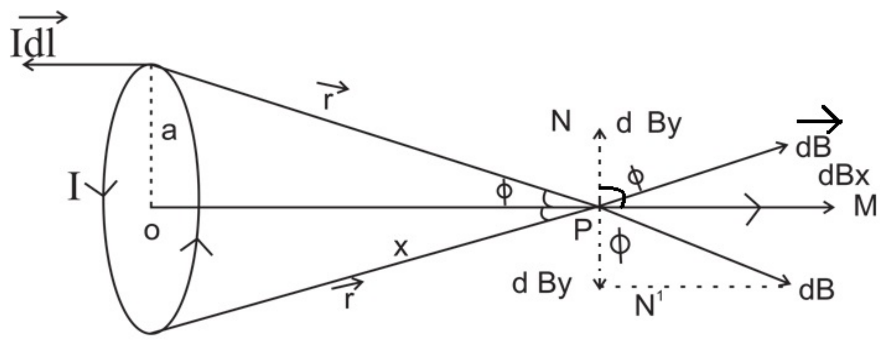
Where 'a' is area of cross-section of wire AB — 1

$$\therefore \frac{VAB}{l} = \frac{V\rho}{(R+R1).a} = \text{constant} = k$$

Where R increases, current and potential difference across wire AB will be — 1

	decreased and hence potential gradient 'k' will also be decreased. Thus the null point or balance point will shift to right (towards, B) side.	

29.



1

According to Biot-Savart's law, magnetic field due to a current element is given by

$$\overrightarrow{dB} = \frac{\mu 0}{4\pi}\frac{\overrightarrow{Idl}\times\hat{r}}{r^2} \quad \text{where } r = \sqrt{x^2 + a^2}$$

$$\therefore dB = \frac{\mu 0}{4\pi}\frac{Idl\ sin90^0}{x^2 + a^2}$$

1/2

And direction of $\overrightarrow{dB}$ is $\perp$ to the plane containing I$\overrightarrow{dl}$and $\vec{r}$.

Resolving $\overrightarrow{dB}$ along the x – axis and y – axis.

$$dB_x = dB \sin\theta$$

$$dB_y = dB \cos\theta$$

taking the contribution of whole current loop we get

$$B_x = \oint dB_x = \oint dB\sin\theta = \int \frac{\mu 0}{4\pi}\frac{Idl}{x^2 + a^2}\frac{a}{\sqrt{x^2 + a^2}}.$$

$$B_x = \frac{\mu 0}{4\pi}\frac{Ia}{(x^2 + a^2)^{3/2}}\oint dl = \frac{\mu 0}{4\pi}\frac{Ia \times 2\pi a}{(x^2 + a^2)^{3/2}}$$

1/2

And $\quad B_y = \oint dB_y = \oint dB\cos\theta = 0$

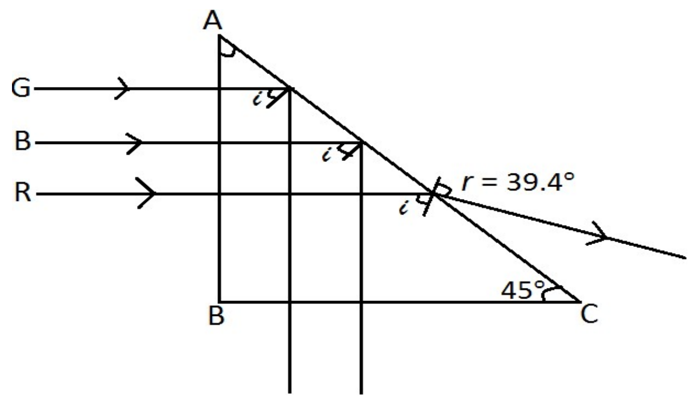
$$\therefore B_P = \sqrt{B_x{}^2 + B_y{}^2} = B_x = \frac{\mu 0}{4\pi}\frac{2IA}{(x^2 + a^2)^{3/2}}$$

$$\therefore \overrightarrow{B_p} = \frac{\mu 0}{4\pi}\frac{2m}{(x^2 + a^2)^{3/2}} \left(\because \overrightarrow{m} = I\vec{A}\right)$$

1

For centre x = 0

$$\therefore \left|\overrightarrow{B_o}\right| = \frac{\mu 0}{4\pi}\frac{2I\pi a^2}{a^3} = \mu_0\left(\frac{I}{2a}\right) \text{ in the direction of } \overrightarrow{m}$$

30.	∵ resonant frequency for LCR circuit is given by $v_0 = \frac{1}{2\pi\sqrt{LC}}$ $= \frac{1}{2\times3.14\sqrt{3\times27\times10^{-6}}}$ $= 17.69\text{Hz}$ Or $\omega_0 = 2\pi v_0$= 111rad/s. ∵ quality factor of resonance $Q = \frac{\omega_0}{2\Delta w} = \frac{\omega_0 L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$ $\therefore Q = \frac{1}{7.4}\sqrt{\frac{3}{27\times10^{-6}}} = 45.0$ To improve sharpness of resonance circuit by a factor 2, without reducing ω_0; reduce R to half of its value i.e. R = 3.7Ω	1 1 1
31.	 Two conditions for T IR – (a) Light must travel from denser to rarer medium (b) $i > i_c$ ∵ $\sin i_c = \frac{1}{\mu}$ $\therefore (i_c)_{Red} = \sin^{-1}\left(\frac{1}{1.39}\right) = 46°$ $(i_c)_{Green} = \sin^{-1}\left(\frac{1}{1.42}\right) = 44.8°$ $(i_c)_{Blue} = \sin^{-1}\left(\frac{1}{1.48}\right) = 43°$ ∵ Angle of incidence at face AC is 45° which is more than the critical angle for Blue and Green colours therefore they will show TIR but Red colour will refract to other medium.	1 1 1
32.	Resolving power (R.P) of an astronomical telescope is its ability to form separate images of two neighboring astronomical objects like stars etc. R.P. $= \frac{1}{d\theta} = \frac{D}{1.22\lambda}$ where D is diameter of objective lens and λ is wave length	1

of light used. 1

$D = 100\text{inch} = 2.54 \times 100\text{cm} = 254\text{cm}$

$= 2.54\text{m}$

$\lambda = 6000\text{Å}$

Limit of resolution $d\theta = \frac{1.22\lambda}{D}$ 1

$= \frac{1.22 \times 6000 \times 10^{-10} m}{254 \times 10^{-2} m}$

$= 2.9 \times 10^{-10}$

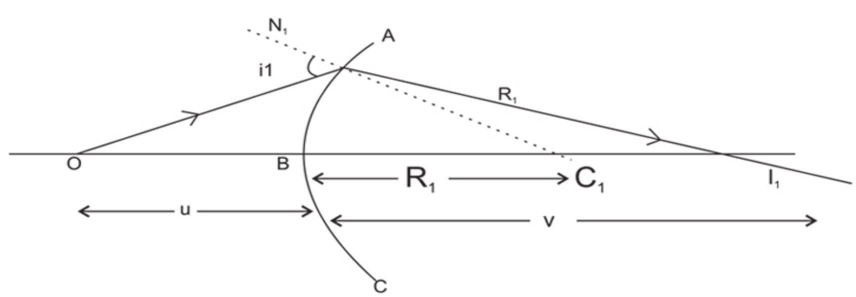
OR

Basic assumptions in derivation of Lens-maker's formula:

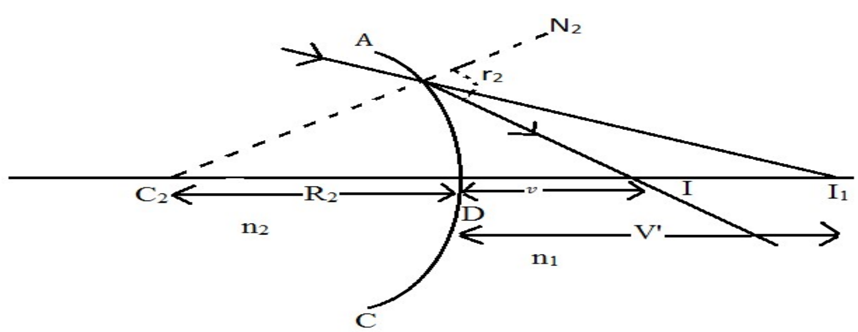
(i) Aperture of lens should be small

(ii) Lenses should be thin 1

(iii) Object should be point sized and placed on principal axis.



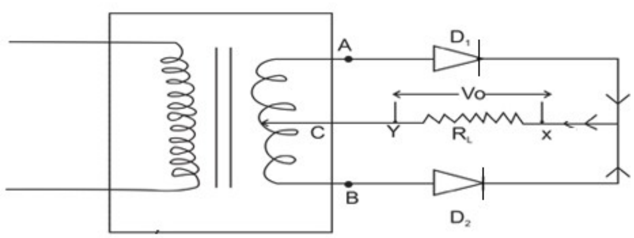
1

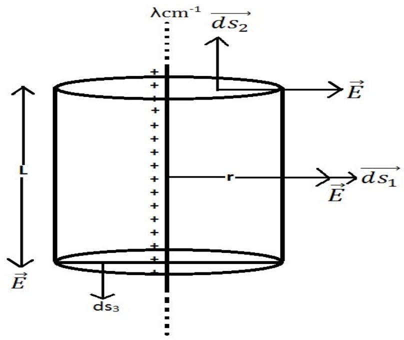


Suppose we have a thin lens of material of refractive index n_2, placed in a medium of refractive index n_1, let o be a point object placed on principle axis then for refraction at surface ABC we get image at I_1 ,

$\therefore \frac{n_2}{V'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$ ---------(1)

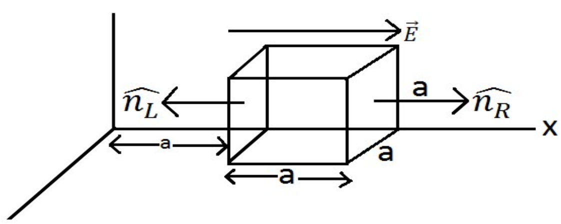
But the refracted ray before goes to meet at I_1 falls on surface ADC and refracts at I_2

	finally; hence I_1 works as a virtual object 2nd refracting surface $\therefore \frac{n_1}{V} - \frac{n_2}{V^1} = \frac{n_1 - n_2}{R_2}$ --------- (2) Equation (1) + (2) $\frac{n_1}{V} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\therefore \frac{1}{V} - \frac{1}{u} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ --------(3) If $u = \infty$, $v = f$ $\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ --------(4) Which is lens maker's formula.	1
33.	${}^{238}_{92}U \rightarrow {}^{237}_{91}Pa + {}^{1}_{1}H + Q$ $\because Q = [M_U - M_{Pa} - M_H]\, c^2$ $= [\,238.05079 - 237.05121 - 1.00783]\, u \times c^2$ $= -\,0.00825u \times 931.5\, \frac{MeV}{u}$ $= -\,7.68 MeV$ $\because Q < 0$; therefore it can't proceed spontaneously. We will have to supply energy of 7.68MeV to ${}^{238}_{92}U$nucleus to make it emit proton.	1 1 1
34.	Circuit Diagram  One possible answer: Change the connection of R from point C to point B. Now No Current flowing through D_2 in the second half. 1 mark for any correct diagram 2 marks for correct explanation	1 2

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Section – D</td></tr>
<tr><td>35.
(a)</td><td>

According the Gauss's law –
$\oint N, d\vec{s} = \frac{1}{\epsilon_0}\{q\}$
$\int \vec{E}\,\overrightarrow{ds_1} + \int \vec{E}\,\overrightarrow{ds_2} + \int \vec{E}\,\overrightarrow{ds_3} = \frac{1}{\epsilon_0}(\lambda L)$
$\int Eds_1 Cos0 + \int Eds_2 Cos90^o + \int Eds_3 Cos90^o = \frac{\lambda L}{\epsilon_0}$
$E\int ds_1 = \frac{\lambda L}{\epsilon_0}$
$E \times 2\pi rL = \frac{\lambda L}{\epsilon_0}$
$E = \frac{\lambda}{2\pi\epsilon_0 r}$
$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}$</td><td>1

1

1</td></tr>
<tr><td>35.
(b)</td><td>

$\because E_x = \propto x = 400x$
$E_y = E_z = 0$
Hence flux will exist only on left and right faces of cube as $E_x \neq 0$
$\because \overline{E_L}\,.\,a^2(n_2) + \overline{E_R}\,.\,a^2\widehat{n_R} = \frac{1}{\epsilon_0}\{qin\} = \phi$
$-E_L\,.\,a^2(\bar{n_2}) + a^2E_R = \phi_{Net}$
$\phi_{Net} = -(400a)a^2 + a^2(400 \times 2a)$
$= -400a^3 + 800a^3$
$= 400a^3$
$= 400 \times (.1)^3$
$\phi_{Net} = 0.4\ Nm^2c^{-1}$</td><td>1</td></tr>
</table>

$\because \phi_{Net} = \frac{1}{\epsilon 0}\{qin\}$

$\therefore$ qin = $\epsilon 0 \phi_{Net}$ 1

$= 8.85 \times 10^{-12} \times 0.4$

$= 3.540 \times 10^{-12}$c

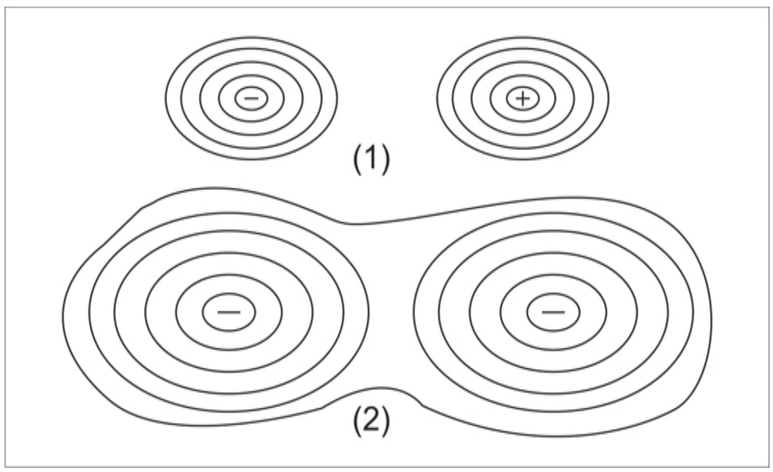
OR

(a) Definition of electrostatic potential – SI unit J/c of Volt. 1

Deduction of expression of electrostatic potential energy of given system of charges – 2

$$U = \frac{1}{4\pi\epsilon 0}\left[\frac{q1\,q2}{r12} + \frac{q1\,q3}{r13} + \frac{q2\,q3}{r23}\right]$$

(b)

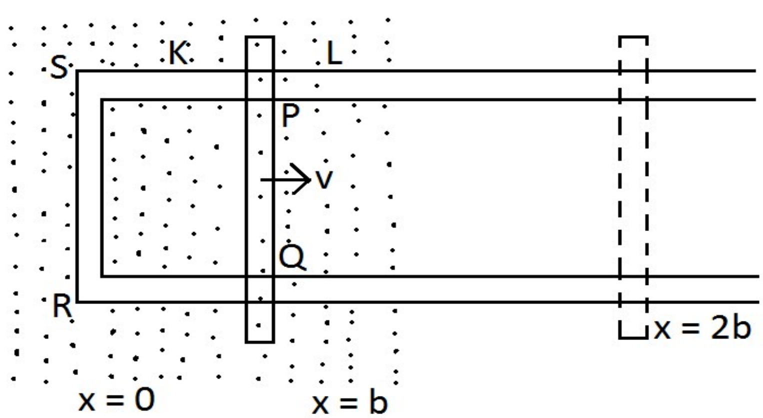


1

1

36. For forward motion from x = 0 to x = 2b.

The flux ϕ_B linked with circuit SPQR is



$\phi_B = Blx$ $\quad 0 \le x < b$ 1

Blb $\quad b \le x < 2b$

The induced emf is,

$$e = \frac{-d\phi_B}{dt}$$

$e = -Blv$ $\quad 0 \le x < b$ 1

$= 0$ $\quad b \le x < 2b$

When induced emf is non-zero, the current İ in the magnitude;

$$I = \frac{e}{r} = \frac{Blv}{r}$$

The force required to keep arm PQ in constant motion is F =IlB. Its direction is to the left. In magnitude

$F = IlB = \frac{B^2 l^2 v}{r}$; $\quad 0 \le x < b$ 1

$= 0$; $\quad b \le x < 2b$

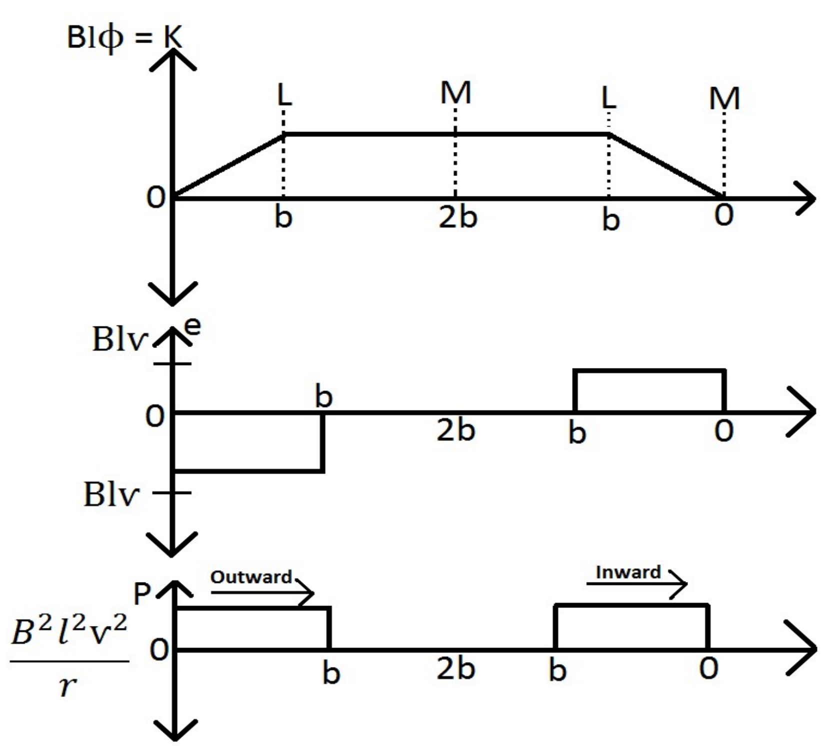
The Joule heating loss is

$P_J = I^2 r$

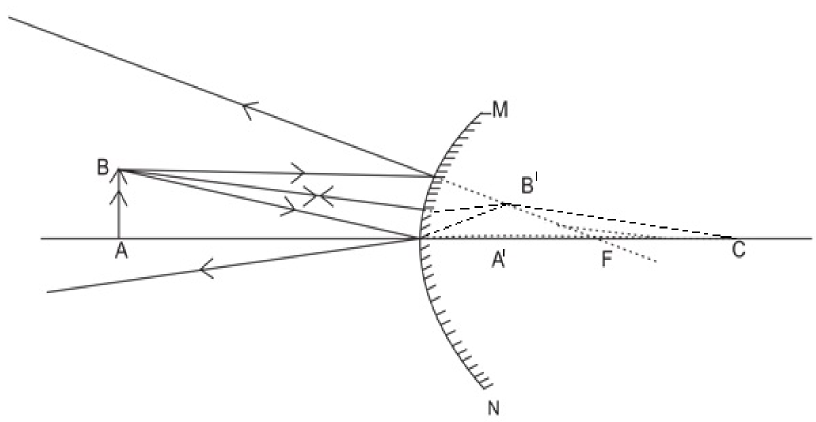
$= \frac{B^2 l^2 v^2}{r}$ $\quad 0 \le x < b$ 1

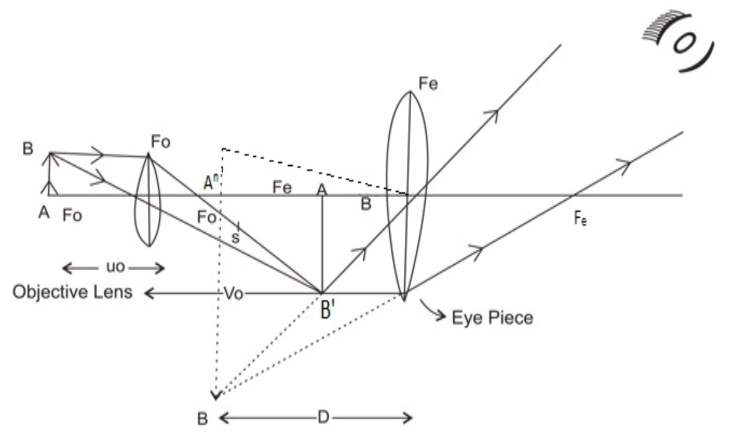
$= 0$ $\quad b \le x < 2b$

One obtains similar expressions for the inward motion from x = 2b to x = 0



1

	OR Working principle of cyclotron Diagram Working of cyclotron with explanation Any two appliations	1 1 2 1
37.	 Deduction of mirror formula $$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$ For a convex mirror f is always +ve. $\therefore$ f > c Object is always placed in front of mirror hence u < 0 (for real object) $$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$ $$\Rightarrow \quad \frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$ As u < 0 u –ve hence $$\frac{1}{v}>0$$ $\Rightarrow$ v> 0 i.e. +ve for all values of u. Image will be formed behind the mirror and it will be virtual for all values of u.	1 2 1 1
37. (a)	**OR** Ray Diagram : (with proper labeling)	1



Magnifying power $m = \frac{V_o}{u_o}\left(1 + \frac{D}{fe}\right)$

$$m = \frac{L}{f_o}\left(1 + \frac{D}{fe}\right)$$

1

37. (b)

$\because m = m_o\, m_e = -30$ (virtual, inverted)

$\because f_o = 1.25\text{cm}$

$f_e = 5.0\text{cm}$

Let us setup a compound microscope such that the final image be formed at D, then

$$m_e = 1 + \frac{D}{fe} = 1 + \frac{25}{5} = 6$$

1

and position of object for this image formation can be calculated –

$$\frac{1}{Ve} - \frac{1}{ue} = \frac{1}{fe}$$

$$\frac{1}{-25} - \frac{1}{ue} = \frac{1}{5}$$

$$-\frac{1}{ue} = \frac{1}{5} + \frac{1}{25} = \frac{6}{25}$$

$$ue = \frac{-25}{6} = -4.17\text{cm}.$$

1

$\because m = m_o \times m_e$

$\therefore m_o = \frac{+Vo}{uo} = \frac{-30}{6} = -5$

$\therefore V = -5u_o$

$$\frac{1}{Vo} - \frac{1}{uo} = \frac{1}{fo}$$

$$\frac{1}{-5uo} - \frac{1}{uo} = \frac{1}{1.25}$$

	$\frac{-6}{5uo} = \frac{1}{1.25}$ uo = -1.5cm $\Longrightarrow v_0$ = 7.5cm Tube length = $V_o + \|u_e\|$ = 7.5cm + 4.17cm L = 11.67cm Object should be placed at 1.5cm distance from the objective lens.	1