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Q6) $P\frac{\sin \alpha a}{\alpha a} + \cos\alpha a = \cos ka$

when $P << 1$ and $k \approx 0$

we can assume the first term to be 0 & $\cos ka \approx 1$

$E = \frac{\hbar^2 k^2}{2m}$

so

$\cos \alpha a = 1$

$\alpha a = (2n-1)\frac{\pi}{2}$

$\alpha^2 = \left((2n-1)\frac{\pi}{2a}\right)^2 = \frac{2mE}{\hbar^2}$

now $n = 1$

$\frac{\pi^2}{4a^2} = \frac{2mE}{\hbar^2} \Rightarrow E = \frac{\pi^2 \hbar^2}{8a^2 m}$

Q7) $J_{\cancel{net}} = 0$ Harshit Mewandia

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a) $\cancel{J_{diff} = C \frac{dp}{dx}}$

$$p = n_i e^{\left(\frac{E_i - E_F}{K_B T}\right)} = n_i e^{(a-x)/b}$$

at $x = 0$

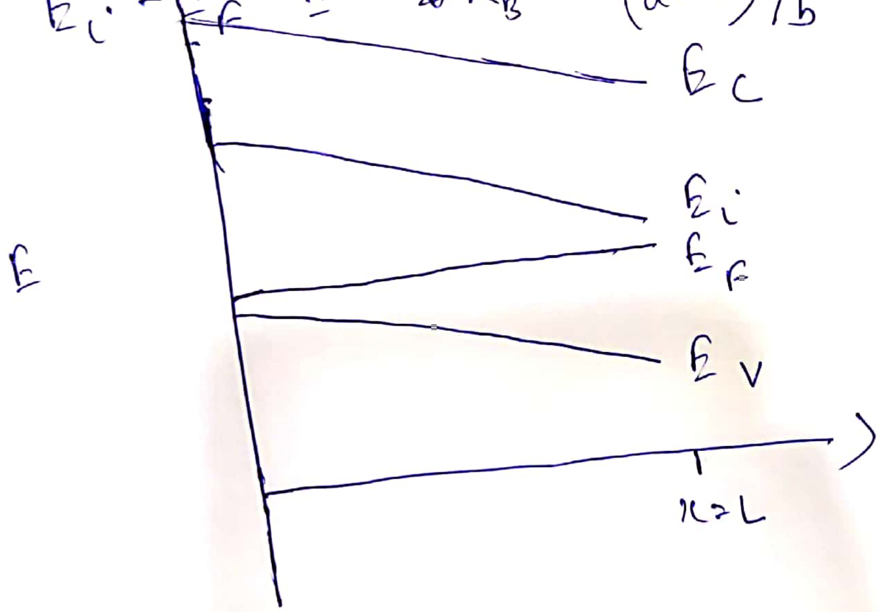
$$\frac{a}{b} = \frac{E_i - E_F}{K_B T}$$

$$\underset{(x=0)}{E_i - E_F} = 18 \times K_B T$$

at $x = L$

$$\underset{(x=L)}{E_i - E_F} = 10 \times K_B T$$

$$E_i - E_F = K_B T \, (a-x)/b$$



since E_F = Const in eq^n condition and E_C, E_V, & E_i are always parallel. therefor ~~ni~~

diagram is correct

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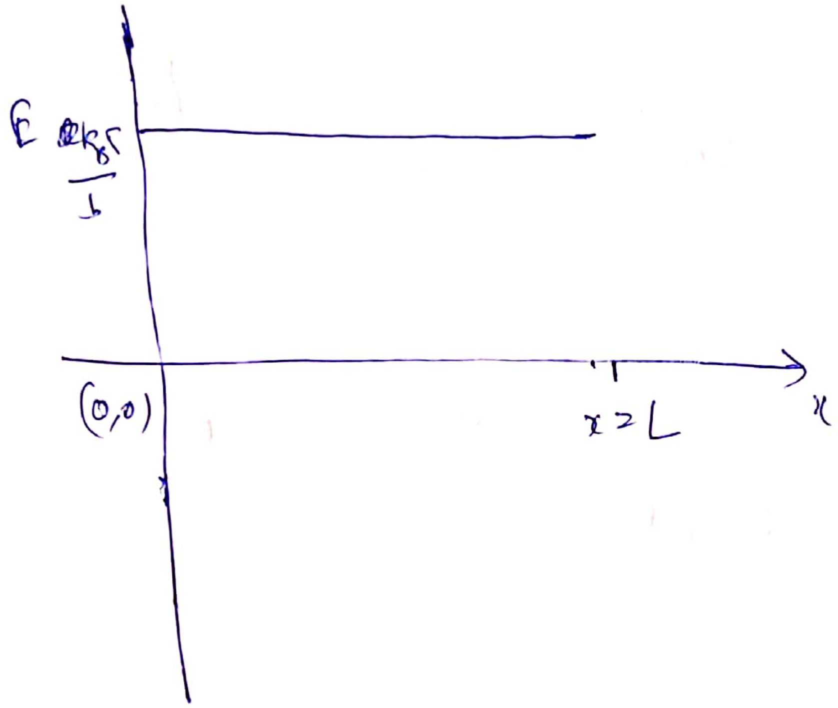
b)

$$E = \frac{-1}{q}\left(\frac{dE_i}{dx}\right) = \frac{K_B T}{b}$$



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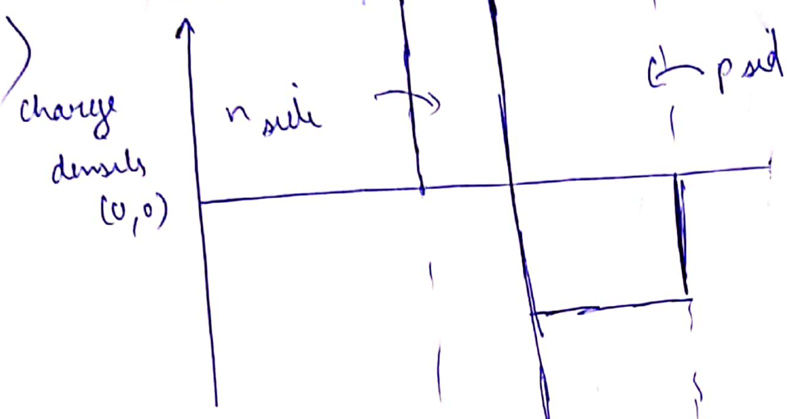
Q7)

$\cancel{P_x = n_i e^{a/b} \cdot e^{-x/b}}$

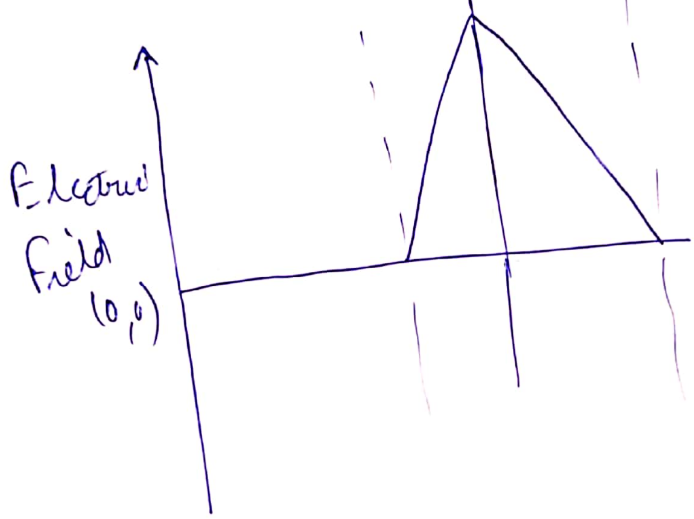
Q10)

a) $\boxed{N_p < N_n}$

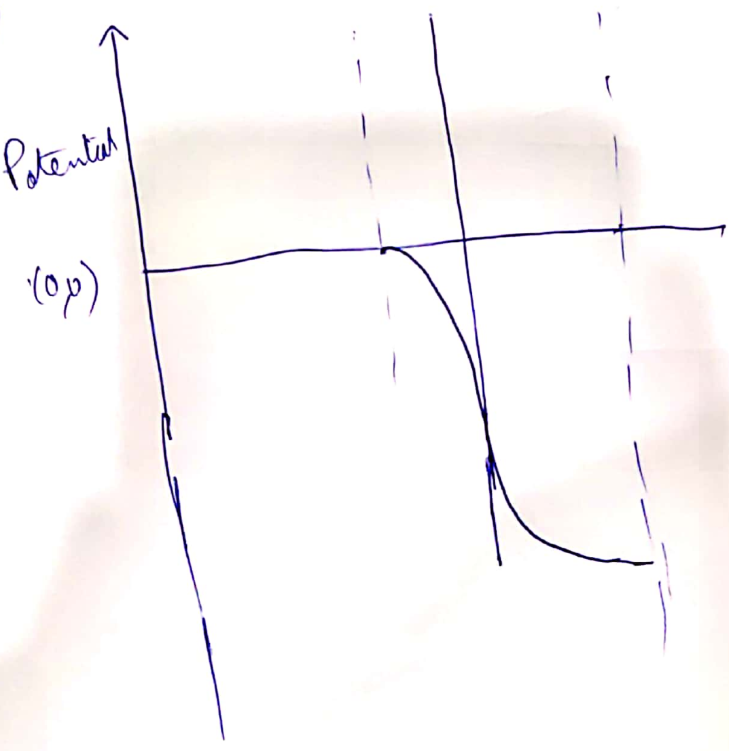
b)



c)



d)



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Q11) $C_{initial} = \frac{\varepsilon_0 A}{d_{initial}}$ $A = \frac{C d_{initial}}{\varepsilon_0}$

$C_{final} = \frac{C_{initial}}{7} = \frac{\varepsilon_0 A}{d_{initial} + d} = \frac{\varepsilon_0 A}{7 d_{initial}}$

$d + d_{initial} = 7 d_{initial}$

$d = 6 d_{initial}$

$d_{initial} = d/6$

Volume of dielectric needed $= (d + d_{initial}) A$

$= \frac{7d}{6} \times \frac{Cd}{6\varepsilon_0} = \boxed{\frac{7}{36} \times \frac{Cd^2}{\varepsilon_0}}$

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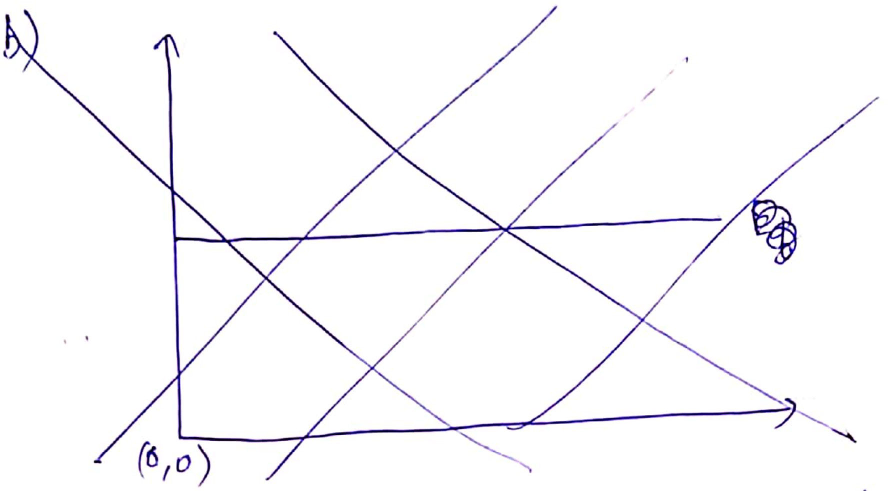
Q12)

a) Yes, sample is in eq^m, because $\frac{dE_F}{dx} = 0$, so net current is zero

b)



b)

Lets assume that between L/2 to L

$E_i = a x^{1/2} + c$

$\vec{E} = \frac{dE_i}{dx}$

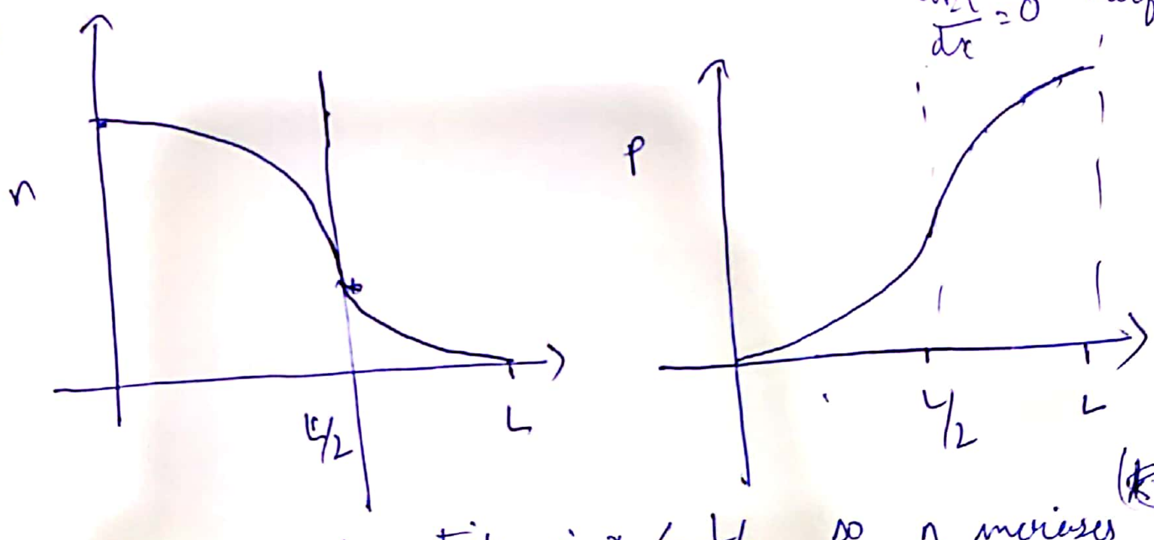
$= b x^{-1/2}$

in 0 to L/2

$E_i = C$

$\frac{dE_i}{dx} = 0$ therefor $\vec{E} = 0$

c)



P decreases exponentially in $x < L/2$ so n increases

similarly in L/2 to L n will decrease and p will increase but behaviour we don't know

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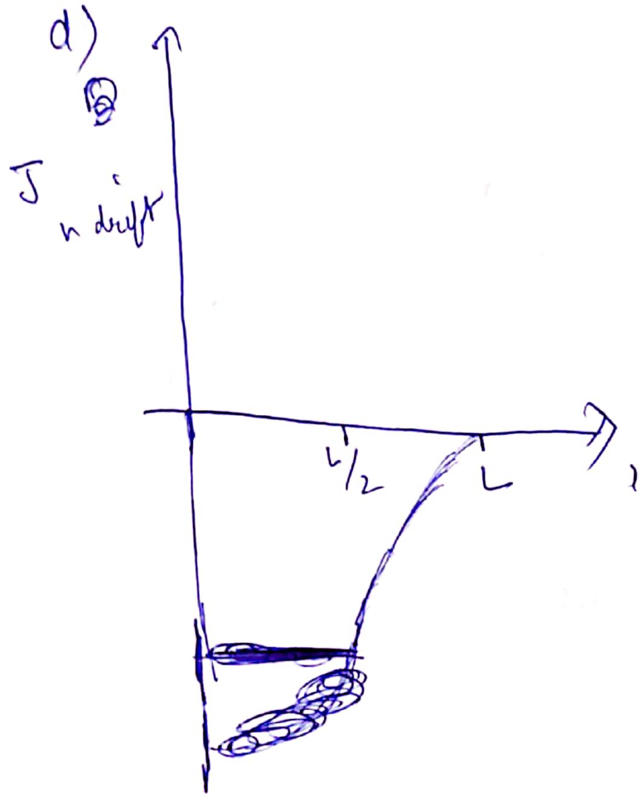
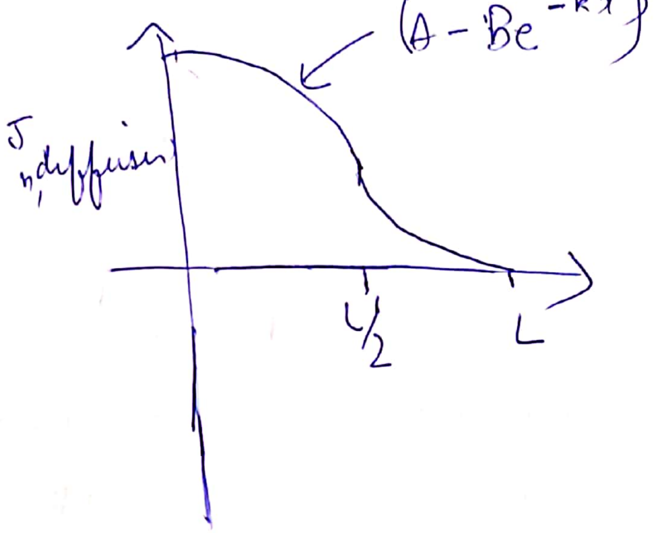
d)



$$\boxed{J_{n,drift} = -\sigma_n E}$$ (~~in depletion~~)



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Q14)

$$\frac{mv^2}{\cancel{2}} = \frac{3}{\cancel{2}} K_B T$$

$$v = \sqrt{\frac{3K_BT}{m_{eff}}} = \sqrt{\frac{2K_BT}{m_0}}$$

$$= \sqrt{\frac{2 \times 1.38 \times \cancel{10^{-23}}}{9.1 \times \cancel{10^{-31}}} \times \cancel{100}\ 10^{10}} = 5.507 \times 10^{4}$$

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Q5) $E = \frac{hc}{e\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{0.45 \times 10^{-6} \times 1.6 \times 10^{-19}}$

$\lambda E = C$

$= 1.239 \times 10^{-6}$ eV m

$E_{0.45} = \frac{1.239 \times 10^{-6}}{0.45 \times 10^{-6}} = 2.75$ eV

$E_{0.9} = \frac{2.75}{2} = 1.376$ eV

$E_{0.8} = 1.54$ eV

~~3 < 44~~ ~~will~~ GaN will be transparent ~~(so)~~ since $3.44 > 2.75$ (so no visible light)

GaP = non transparent ($1.54 < 2.26 < 2.75$ so visible light)

Si = transparent ($1.12 < 1.376$, so no photon)

GaAs = partially transparent ($1.376 < 1.42 < 1.54$ so in the infrared range boundary)

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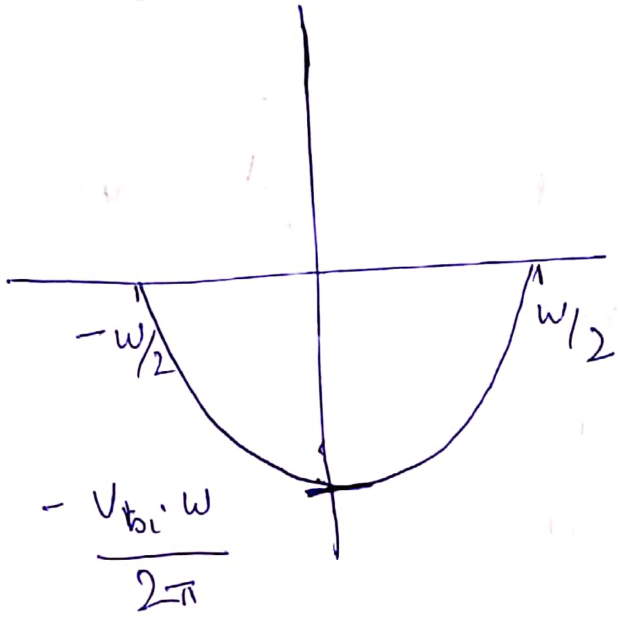
Q17) a) $E = -\frac{dV}{dx}$

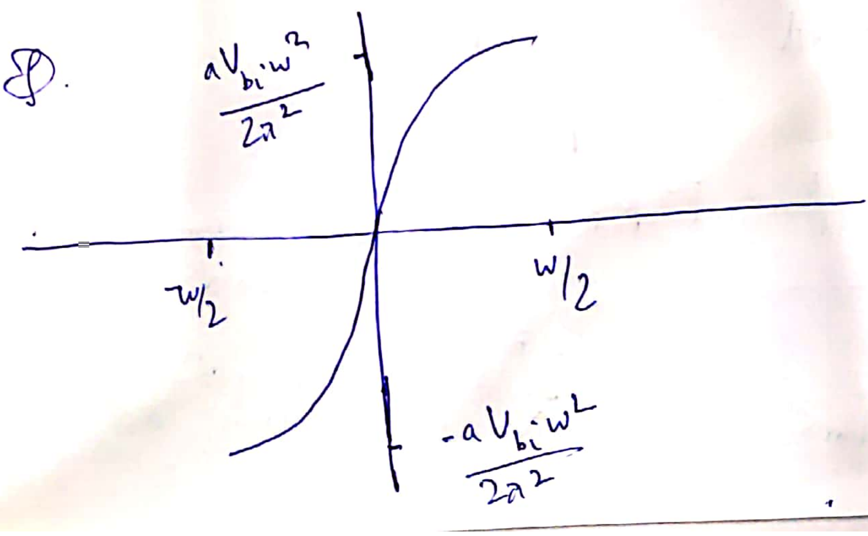
$E = -\frac{V_{bi} W}{2\pi} \cos \frac{\pi x}{W}$



b) $J = a \frac{dE}{dx}$

$= a \frac{d}{dx} \left(-\frac{V_{bi} W}{2\pi} \cos \frac{\pi x}{W} \right)$

$= \frac{a V_{bi} W^2}{2\pi^2} \sin \frac{\pi x}{W}$



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Q20)

a) $n_0 = n_i \cdot e\left(\frac{E_F - E_{FI}}{K_B T}\right)$

$= 10^{10} e\left(\frac{\cancel{0.3 \times 10}}{\cancel{2} \times 8.61 \times 10^{-5} \times \cancel{300}}\right)$

$= 10^{10} e^{\cancel{5.8}\ 11.6} \approx \cancel{330 \times 10^{?}}\ 109097 \times 10^{10}\ cm^{-3}$

$n_{p_0} = \frac{n_i^2}{n_0} = \frac{10^{10}}{\cancel{330 \times 10^{10}}\ 109097} = \cancel{3.03}\ 9.1 \times 10^{4}\ cm^{-3}$

b) $n = n_i\, e\left(\frac{E_F - E_i}{2K_B T}\right)$

$= 10^{10} \cdot e\left(\frac{0.318}{2 \times 8.61 \times 10^{-5} \times 300}\right)$

$= 10^{10} \times e^{\cancel{6.148}\ 12.296} = \cancel{467 \times 10^{10}}\ 218818 \times 10^{10}\ , cm^{-3}$

$p = \cancel{330 \times 10^{10}}\ 109097 \times 10^{10}\ cm^{-3}$

c) $j = ne V_d = \sigma E = ne\mu E$

$\sigma = ne\mu$

$\sigma_{total} = ne\mu_n + pe\mu_p = e\left(2.2 \times 10^{15} \times 1100 + 1.1 \times 10^{15} \times 400\right)$

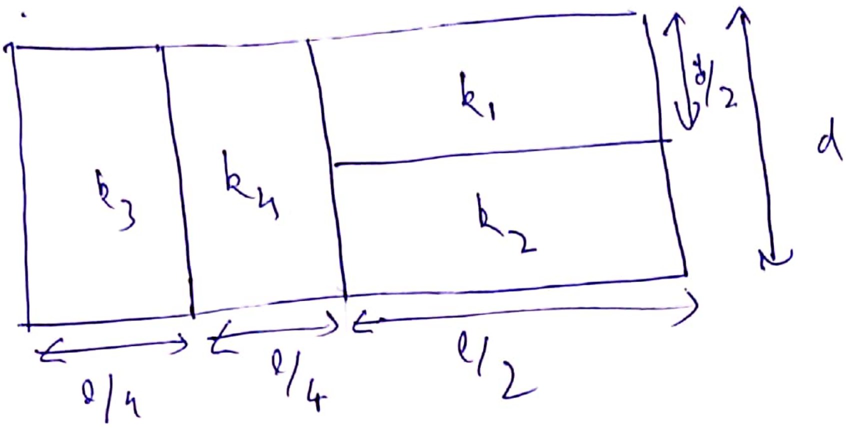
$(24.2 + 4.4) \times 10^{17} e$

$\rho = \frac{1}{28.6 \times 10^{17} \times 1.6 \times 10^{-19}} = \frac{100}{28.6 \times 1.6} = 2.18$

$\Omega\ cm$

Q 26) Harshit Mawandia : 2020CS10348

Ans.



k_1 & k_2 are in series so C will be ~~added~~ in inverse relation and then their combination will be in parallel with k_3 & k_4 so then will be added

$$C_{eq_1} = C_{eq} \text{ of } C_{k_1} \text{ and } C_{k_2} = \frac{\varepsilon_0 A/2}{\left(\frac{d}{2k_1} + \frac{d}{2k_2}\right)}$$

$$= \frac{\cancel{2}\,\varepsilon_0 A k_1 k_2}{\cancel{2} d (k_1 + k_2)}$$

$$C_{net} = C_{k_{eq_1}} + C_{k_3} + C_{k_4}$$

$$= \frac{\varepsilon_0 A k_1 k_2}{d(k_1 + k_2)} + \frac{k_3 \varepsilon_0 A}{4d} + \frac{k_4 \varepsilon_0 A}{4d}$$

$$= \frac{\varepsilon_0 A}{d} \left(\frac{k_3 + k_4}{4} + \frac{k_1 k_2}{k_1 + k_2} \right)$$