Q1)

$$p = d_{ij}T_j \rightarrow \frac{F}{A} \qquad S_j = d_{ij}E_i$$

$$p = \frac{Qa}{V} = \frac{Q}{A} \qquad p = dT = d\frac{F}{A}$$

$$V = \frac{Q}{C} = \frac{Ap}{C} = \frac{Ap}{\frac{\varepsilon_0 \varepsilon_r A}{L}} = \frac{Lp}{\varepsilon_0 \varepsilon_r} = \frac{Ld\frac{F}{A}}{\varepsilon_0 \varepsilon_r}$$

$$= \frac{dLF}{A\varepsilon_0 \varepsilon_r}$$

$$\therefore F = \frac{\varepsilon_0 \varepsilon_r VA}{dL} = \frac{(8.85\times10^{-12}\times1000)\pi(1.5\times10^{-3})^2(3500)}{(250\times10^{-12})(10\times10^{-3})} = 87.6\ N$$

Q2)

$$C_1 = \frac{k_1 A/2\, \varepsilon_0}{d} \qquad C_2 = \frac{k_2 \varepsilon_0 A/2}{d/2} = \frac{k_2 \varepsilon_0 A}{d}$$

$$C_3 = \frac{k_3 A/2\, \varepsilon_0}{d/2} = \frac{k_3 A \varepsilon_0}{d}$$

$$C = C_1 + \left[\frac{1}{C_2} + \frac{1}{C_3}\right]^{-1}$$

$$= \frac{k_1 \varepsilon_0 A/2}{d} + \frac{\varepsilon_0 A}{d}\left(\frac{k_2 k_3}{k_2 + k_3}\right)$$

$$= \frac{\varepsilon_0 A}{d}\left(\frac{k_1}{2} + \frac{k_2 k_3}{k_2 + k_3}\right)$$

Q3) a)

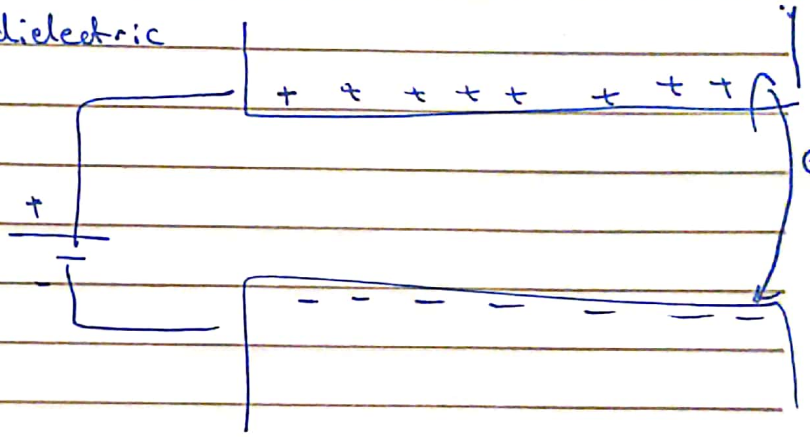
When no dielectric $\longrightarrow$ Gauss Law

$$E_0 = \frac{\sigma}{\varepsilon_0} = \frac{\frac{Q}{A}}{\varepsilon_0} = 1.01 \times 10^7 \text{ and } E = \frac{\frac{Q}{A}}{\varepsilon_0 \varepsilon_r}$$

with no dielectric

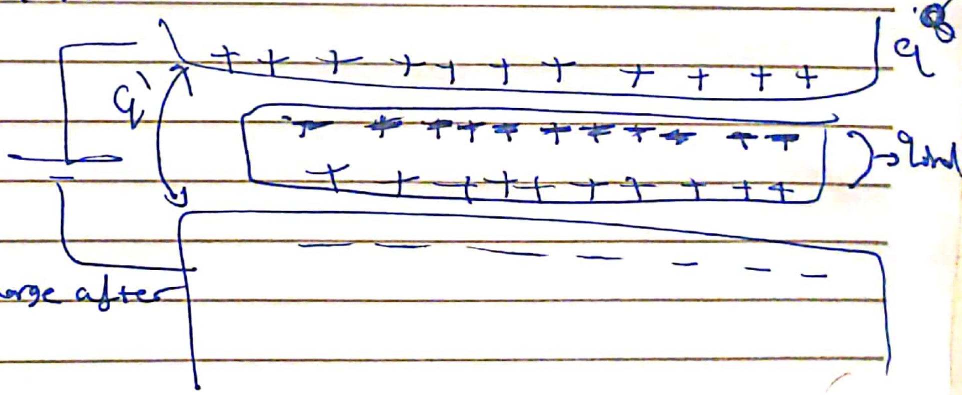
$$\therefore \varepsilon_r = \frac{E_0}{E} = \frac{1.01 \times 10^7}{1.4 \times 10^6} = 7.2$$

b) befor insertion of dielectric



after dielectric insertion

charges on dielectric are induced



$\therefore$ charges before = charge after

$\therefore q_{befo} = q_{after}$ $E =$

$890 = q' + q_{induced}$

$E = \frac{Q}{A\,\varepsilon_0 \varepsilon_r}$ $\therefore Q = 1.4 \times 10^6 \times A \times \varepsilon_0 \varepsilon_r$

$= 124 \text{ nC}$

$\therefore \boxed{q_{induced} = 890 - 124 = 766 \text{ nC}}$

Date: ______ no: ______

Q4) a) increase

b) Charge will not change (no battery)

$\therefore$ E field doesn't change

c) E is const. but Volume increase

$\because U = \frac{1}{2} Q V$

$U = \frac{1}{2} Q E d$ $\therefore$ U increased by same factor

d) E decrease when inserting a dielectric by ε_r

so U decrease also by ε_r