NAME:
STUDENT ID:

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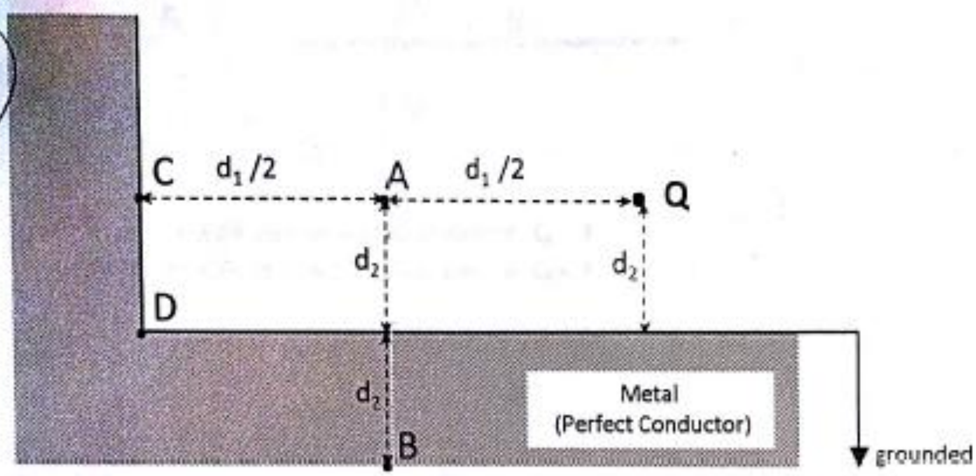
EE 101 QUIZ # 1

1)



i) Find V_A = ? Potential at point A 12 (36)
ii) Find V_B = ? Potential at point B 2 (7)
iii) Find V_C = ? Potential at point C 2 (6)
iv) Find V_D = ? Potential at point D 2 (6)

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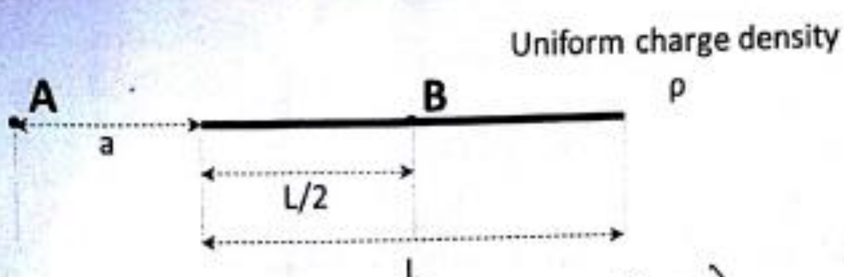
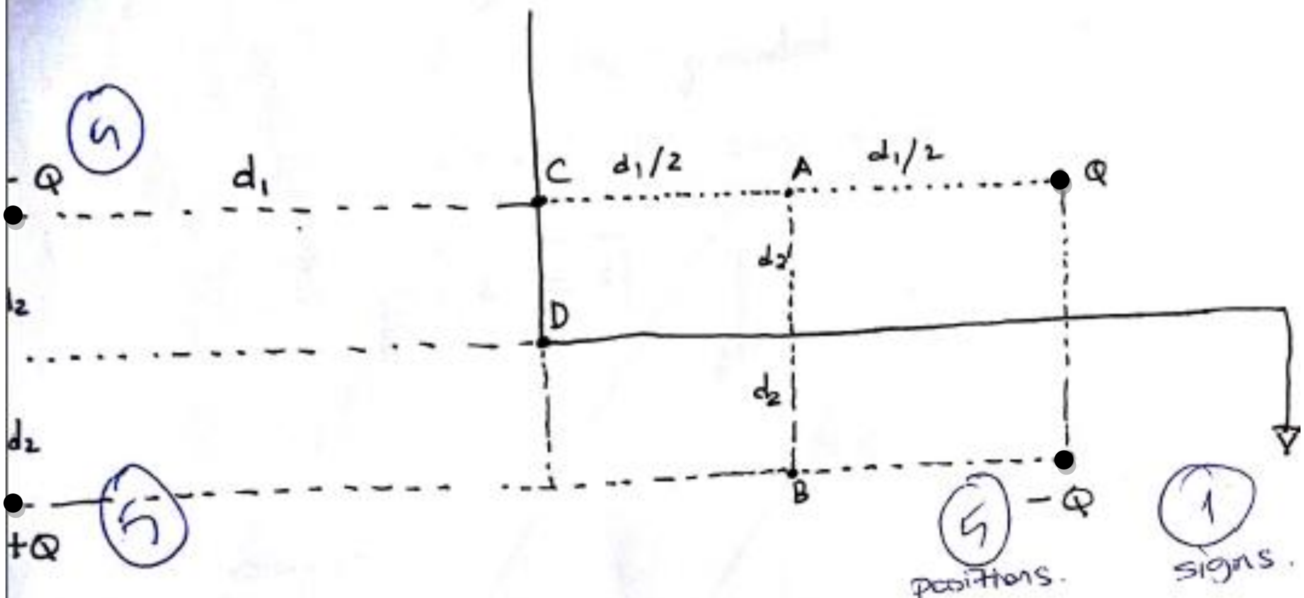
2)



i) Find the electric field ($\bar{E}$) at point A. $\bar{E}_A$ = ? 12 (36)
ii) Find the electric field ($\bar{E}$) at point B. $\bar{E}_B$ = ? 3 (9)

We will use "method of images" to solve Q1 :



i) Potential at point A

Use the following example:

Potential at point P(x,y,z)

$$V(x,y,z) = \frac{Q}{4\pi\epsilon_0}\left(\frac{1}{R_+} - \frac{1}{R_-}\right)$$

where $R_+ = \left[x^2 + (y-d)^2 + z^2\right]^{1/2}$

$R_- = \left[x^2 + (y+d)^2 + z^2\right]^{1/2}$

Then:

$$V_A(x,y,z) = \frac{Q}{4\pi\epsilon_0 \frac{d_1}{2}} + \frac{-Q}{4\pi\epsilon_0 \frac{3d_1}{2}} + \frac{-Q}{4\pi\epsilon_0 \sqrt{\left(\frac{d_1}{2}\right)^2 + (2d_2)^2}} + \frac{Q}{4\pi\epsilon_0 \sqrt{\left(\frac{3d_1}{2}\right)^2 + (2d_2)^2}}$$

For the rest of the Q1:

∴ At all points on the grounded conducting plane, the potential is zero: that is

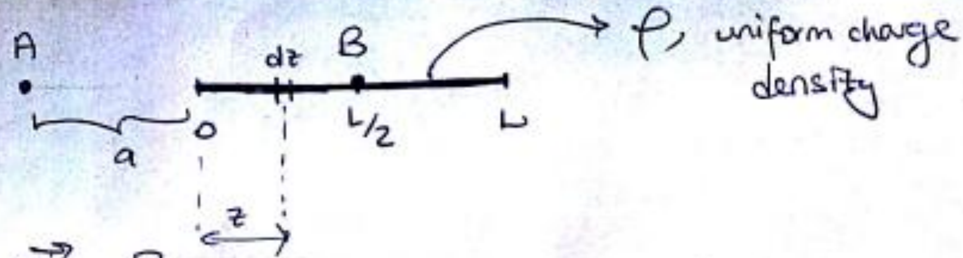
Potentials at points B, C, D is "0".

$V_B = 0$ (7)

$V_C = 0$ (6)

$V_D = 0$ (6)

(2)



ⓐ $\vec{E}_A = ?$

ⓑ $\vec{E}_B = ?$

ⓐ $$d\vec{E}_A = -\hat{z}\,\frac{\rho\,dz}{4\pi\epsilon_0 (a+z)^2}$$

$$\vec{E}_A = -\hat{z}\int_0^L \frac{\rho\,dz}{4\pi\epsilon_0 (a+z)^2} \qquad a+z=x$$

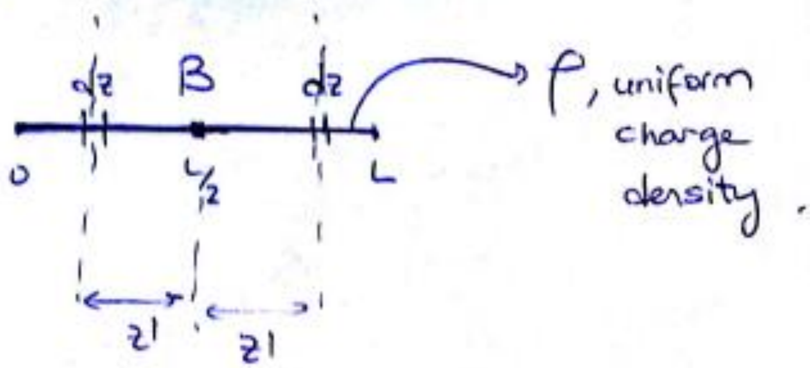
$$= \int_a^{a+L} \frac{\rho\,dx}{4\pi\epsilon_0 x^2} = \frac{\rho}{4\pi\epsilon_0}\left[-\frac{1}{x}\right]\Bigg|_a^{a+L}$$

$$= -\hat{z}\,\frac{\rho}{4\pi\epsilon_0}\left(\frac{-1}{a+L} + \frac{1}{a}\right)$$

$$\boxed{\vec{E}_A = \hat{z}\,\frac{\rho}{4\pi\epsilon_0}\,\frac{L}{a^2+aL}}$$

(b) $$\vec{dE_B} = \frac{-\hat{z}\,\rho dz}{4\pi\epsilon_0 (z')^2} + \hat{z}\frac{\rho dz}{4\pi\epsilon_0 (z')^2} = 0$$

due to a charge pair



So the total $\vec{E}$ at point B, which is the result of the integration from sides to the middle of the line charge is also 0.