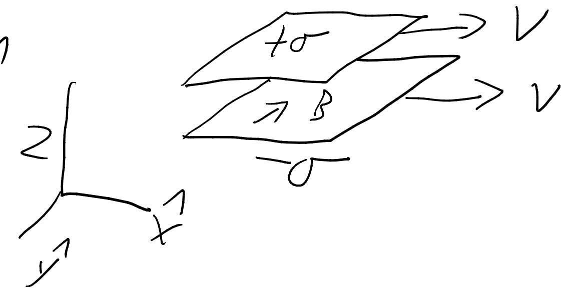
5.17

Tuesday, December 8, 2020 11:46 PM

(a) From previous submission



$\vec{B}_{mid} = -\mu_0 \sigma V \hat{y}$

$\vec{B}_{bot} = \vec{0}$

$\vec{B}_{top} = \vec{0}$

(b) Find F_{mag}/m^2 on upper plate, w/ direction

$F_{mag} = Q(\vec{v} \times \vec{B})$

$= m^2 \sigma (\vec{V} \times (-\mu_0 v \hat{y})) = \sigma(v \hat{x} \times -\mu_0 \sigma v \hat{y}) m^2$

$= -m^2 \mu_0 (\sigma V)^2 \hat{z} = \boxed{\dfrac{-\mu_0 (QV)^2}{m^2} \hat{z} = F_{mag}/m^2}$

(c) At what speed v would electric force balance F_{mag}?

$\vec{E}_{capacitor} = \dfrac{-\sigma}{\epsilon_0} \hat{z}$ Eq 12.88

$= -\dfrac{Q}{m^2 \epsilon_0} \hat{z}$

$\vec{F}_{\vec{E}} = Q \vec{E} = -\dfrac{Q^2}{m^2 \epsilon_0}$

$$E = \omega E = \frac{[illegible]}{m^2 \epsilon_0}$$

5.17 cont.

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$$\vec{F_E} = \vec{F_{mag}}$$

$$\frac{+\mu_0 (QV)^{\cancel{2}}}{\cancel{m\gamma^2}} \hat{z} = \frac{+\cancel{Q^2}}{\cancel{m\gamma^2}\epsilon_0} \hat{z}$$

$$\mu_0 V^2 = \frac{1}{\epsilon_0}$$

$$V^2 = \frac{1}{\mu_0 \epsilon_0}$$

$$\boxed{V = \sqrt{\frac{1}{\mu_0 \epsilon_0}} = C}$$

5.19

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I realize the surface does not matter for the validity of Ampere's Law, but a flatter surface is prefered because it makes calculations easier.

5.20

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(a) Find ρ for copper

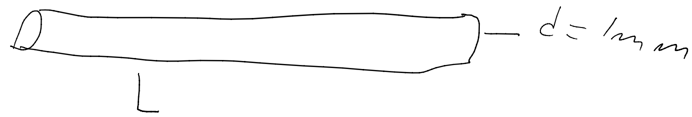
$Cu\ density = 8.92 \frac{g}{cm^3}$ $\quad$ $Cu\ molar mass = 63.546\ g/mol$

$e^-_{mol} = 6.02214 \times 10^{23}\ mol^{-1}$

$$\frac{6.02214 \times 10^{23}\ e^-}{1\ mol} \times \frac{1\ mol}{63.546\ g} \times \frac{8.92\ g}{1\ cm^3} = \boxed{\frac{8.45 \times 10^{22}\ e^-}{cm^3}}$$

(b) what is v for 1mm wire with I=1Amp?

$$1\ Amp = \frac{1\ coloumb}{s} = \frac{6.24 \times 10^{18}\ e^-}{s}$$

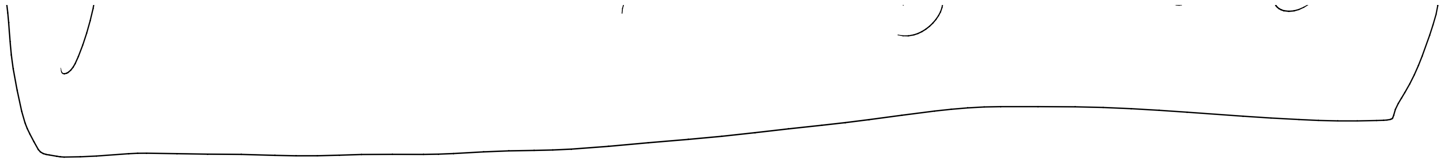


$$\rho \pi r^2 \dot{L} = \frac{e^-}{s}, \quad \dot{L} = v$$

$$8.45 \times 10^{22} \cdot \pi (0.05)^2 v = \frac{6.24 \times 10^{18} e^-}{s}$$

$$v = \frac{6.24 \times 10^{18}}{8.45 \times 10^{22} \pi (0.05)^2} = \boxed{0.01\ cm/s}$$

e^- goes slowly but change in movement, the signal, goes really fast, like c



5.23

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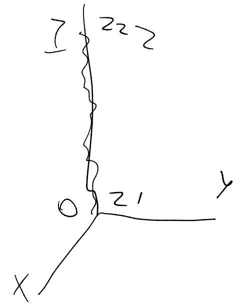
Find magnetic vector potential for straight wire with current I.



$$\vec{A} = \frac{\mu_0 I}{4\pi}\int \frac{1}{r}\, d\vec{l} \qquad r = \sqrt{x^2+z^2}$$

$$\vec{A} = \frac{\mu_0 I}{4\pi}\int_{z_1}^{z_2} \frac{dz}{\sqrt{x^2+z^2}}\,\hat{z} = \frac{\mu_0 I}{4\pi}\ln\left(\sqrt{z^2+x^2}+z\right)\Big|_{z_1}^{z_2}$$

$$= \frac{\mu_0 I}{4\pi}\left[\ln\left(\sqrt{z_2^2+x^2}+z_2\right) - \ln\left(\sqrt{z_1^2+x^2}+z_1\right)\right] = \boxed{\frac{\mu_0 I}{4\pi}\ln\left(\frac{\sqrt{x^2+z_2}+z_2}{\sqrt{x^2+z_1^2}+z_1}\right)}$$