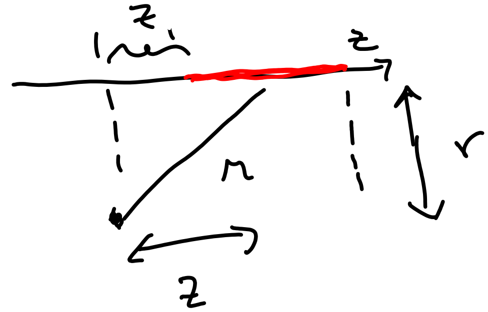
Hmwk soln assign 5



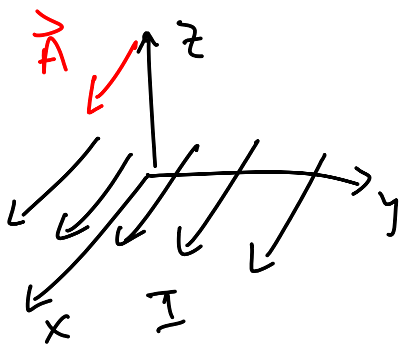
1.) $\vec{A} = \frac{\mu_0}{4\pi}\int \frac{I\,dz}{\mathscr{r}}\,\hat{z} = \frac{\mu_0 \hat{z}}{4\pi}\int_{z_1}^{z_2} \frac{dz}{\sqrt{z^2+r^2}}$

$$= \frac{\mu_0 I}{4\pi} \ln\left[\frac{z_2+\sqrt{z_2^2+r^2}}{z_1+\sqrt{z_1^2+r^2}}\right]\hat{z}$$

2.) $\vec{B} = \vec{\nabla}\times\vec{A} = -\frac{\partial A}{\partial r}\hat{\varphi}$ in cylindrical coords

Put $\frac{\partial A}{\partial r}$ into Mathematica to get $\vec{B}$ for finite wire segment and simplify

3.)



$\vec{K} = K_0\,\hat{x}$ or $= n I_0\,\hat{x}$ ← current thru 1 wire

n ↑ # wires / length

A is in the direction of the current. $\vec{A} = A(z)\,\hat{x}$

We know B from Ampere's law in this case. $\vec{B} = \pm\frac{\mu_0 K}{2}\hat{y}$

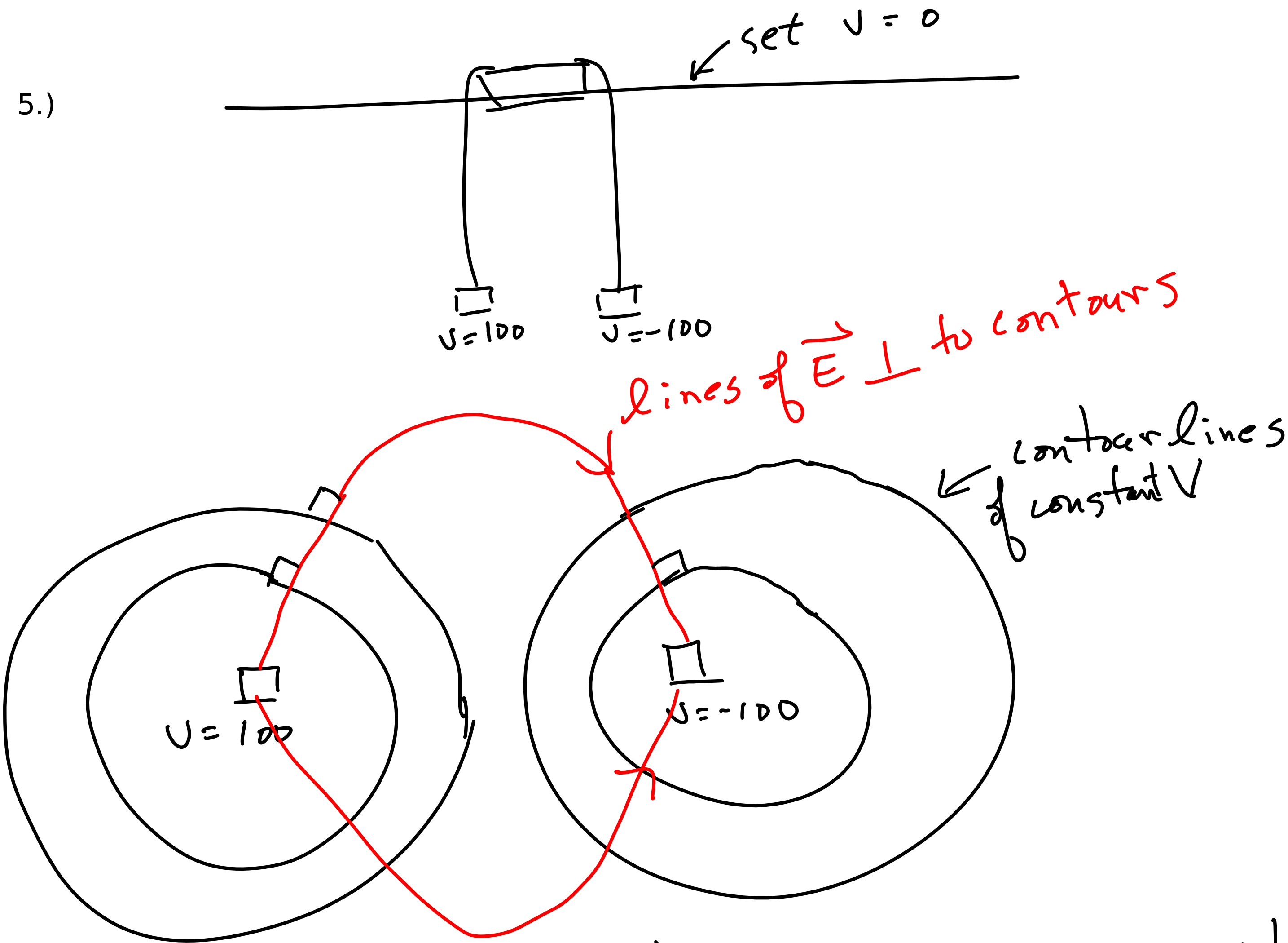
But $\vec{\nabla}\times\vec{A} = \vec{B}$ or

$$\begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ A(z) & 0 & 0 \end{vmatrix} = \pm\frac{\mu_0 K}{2}\hat{y}$$

$$\vec{A} = \left(-\frac{\mu_0 K}{2}|z| + \text{constant}\right)\hat{x}$$

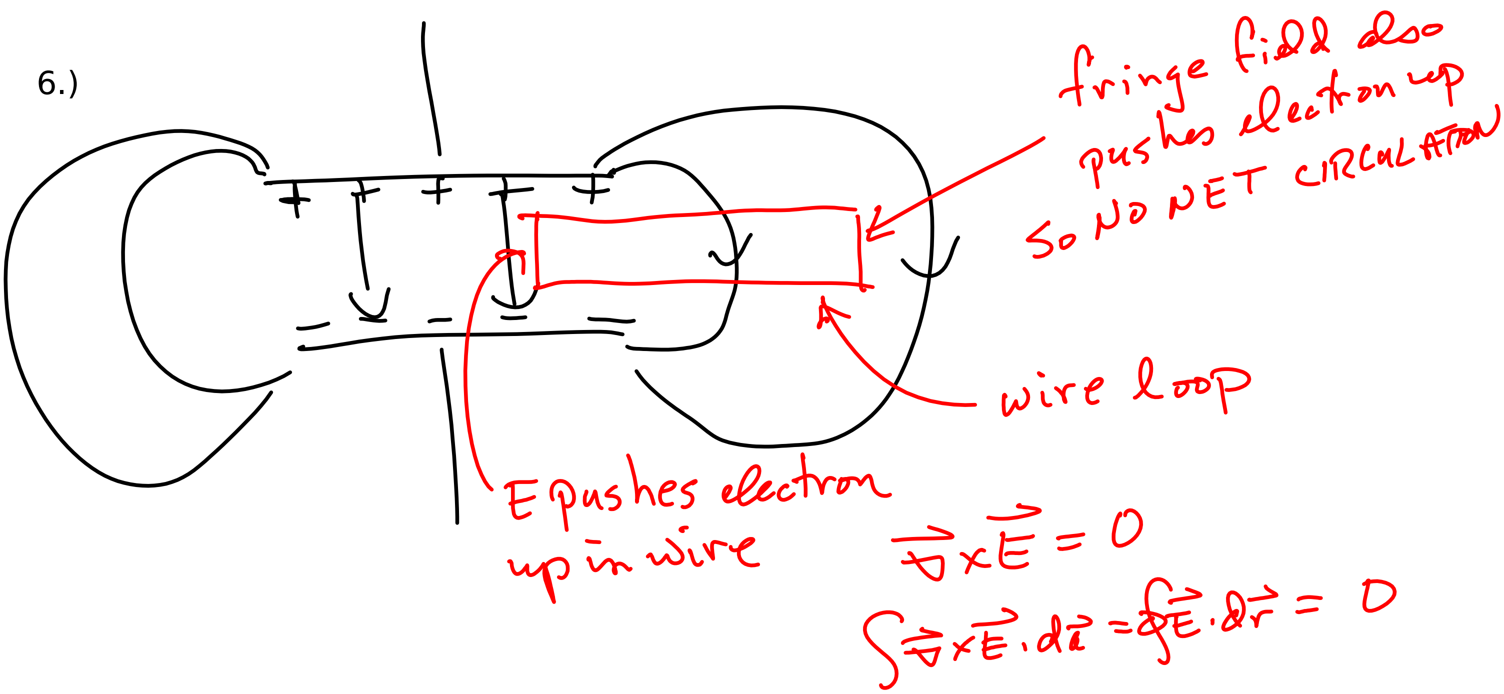
4.) See the last part of the Feb. 19 lecture

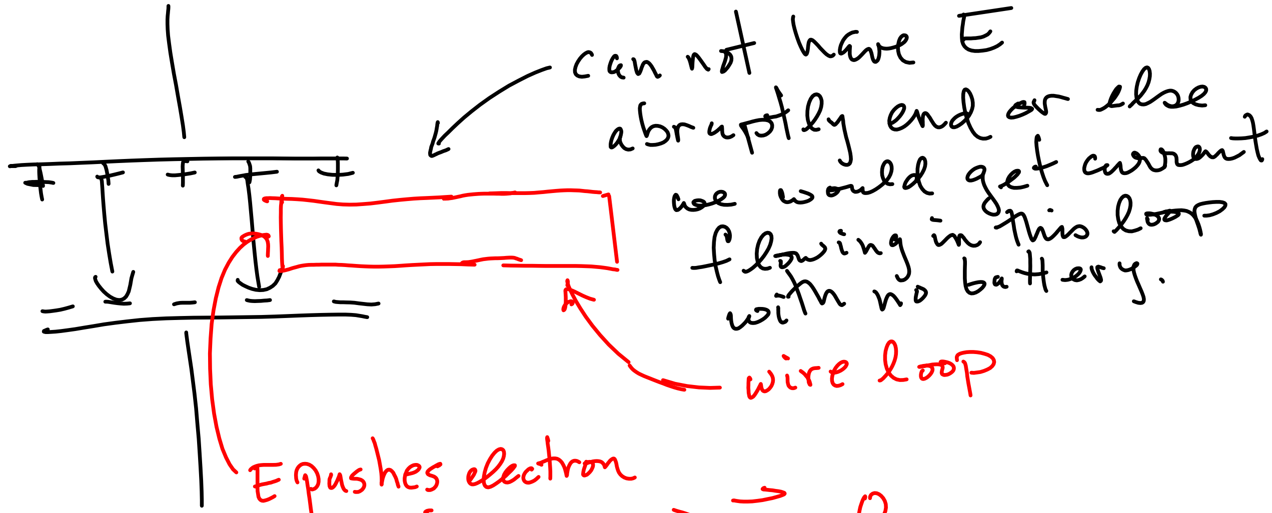
5.)



Ohm's law ⇒ $\vec{J} = \sigma \vec{E}$ so J flows along E!

6.)





$$\vec{\nabla}\times\vec{E} = 0$$

$$\int \vec{\nabla}\times\vec{E}\cdot d\vec{a} = \oint \vec{E}\cdot d\vec{r} = 0$$

7.) $\rho = 8.9 \frac{g}{cm^3}$ $\quad 63 \frac{g}{mole}$

(a) $8.9 \frac{g}{cm^3}\ 10^6 \frac{cm^3}{m^3}\ \frac{1\ mol}{63\ g}\ 6\times10^{23} \frac{atoms}{mol}$

(b) $J = \rho v$ $\quad \rho = (8\times10^{28}\ electrons/m^3)(1.9\times10^{-19} \frac{C}{electron})$

For $J = 100 \frac{A}{m^2} = \rho v \Rightarrow v \simeq 7\times10^{-9}\ m/s$

8.) See the section in Shadowitz on the microscopic model of conduction.

Heat is generated when electrons collide with the lattice atoms.

Resistivity typically increases with temperature see

http://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity#Linear_approximation

Electrons are more easily scattered by lattice vibrations (phonons) and don't move through the crystal as easily.