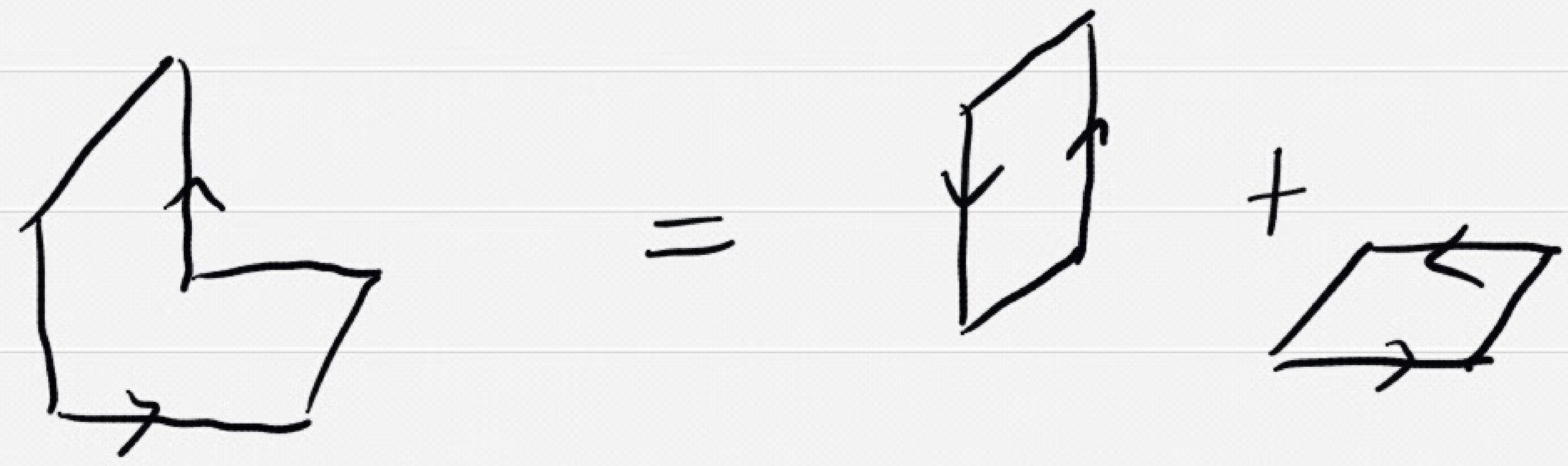
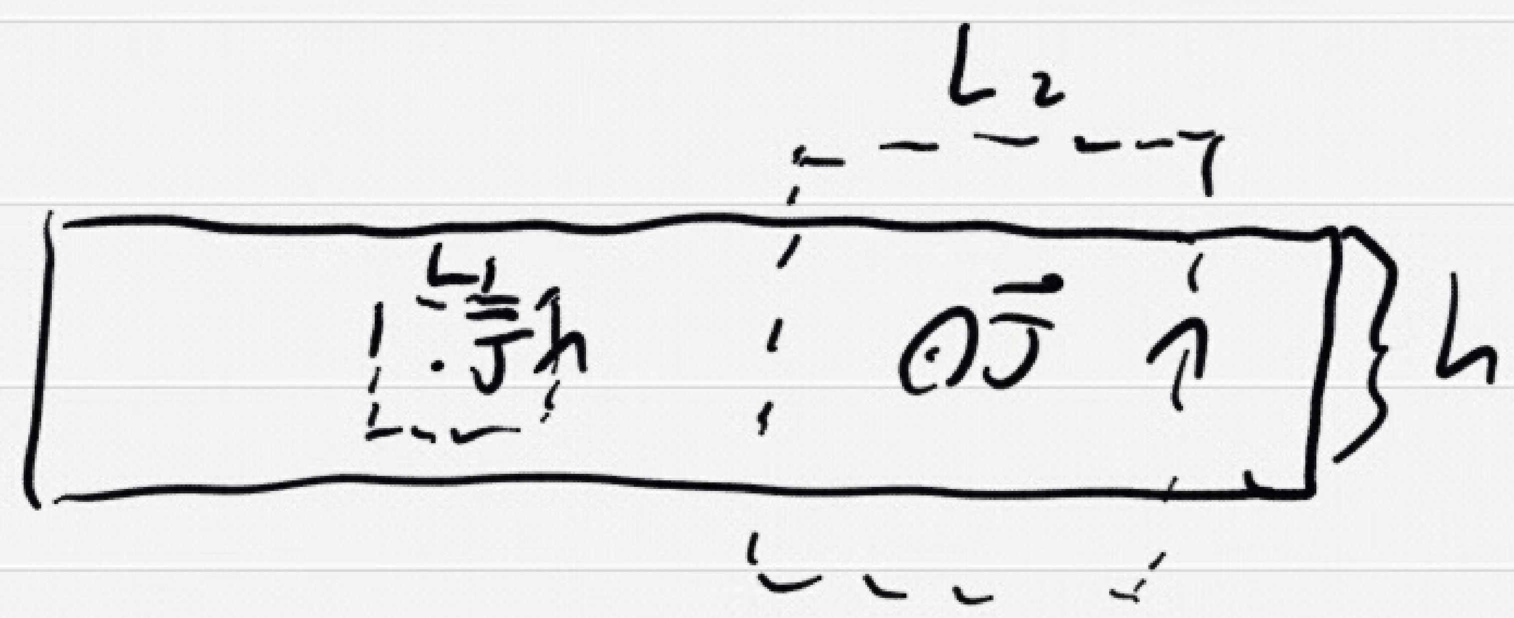
1.



$$\vec{m} = I\vec{a} = I(\vec{a}_1 + \vec{a}_2)$$
$$= I L^2 (\hat{y} + \hat{z})$$

2. a.



$|z| < h/2$: $\oint \vec{H} \cdot d\vec{l} = 2 H L_1$
$$= J \cdot 2|z| \cdot L_1$$
$$\Rightarrow H = J|z|$$

$$\vec{H} = -Jz\,\hat{y}$$

$|z| > h/2$: $\oint \vec{H} \cdot d\vec{l} = 2 H L_2$
$$= J \cdot h \cdot L_2$$
$$\Rightarrow H = Jh/2$$

$$\vec{H} = \begin{cases} Jh/2\,\hat{y} & z < h/2 \\ -Jh/2\,\hat{y} & z > h/2 \end{cases}$$

2b. $\vec{M} = \chi_m \vec{H}$ $= \boxed{-\chi_m J z \hat{y}}$ inside
$= \boxed{0}$ outside

$$\vec{B} = \mu_0 (\vec{H} + \vec{M})$$
$$= \mu_0 (1 + \chi_m) \vec{H}$$

$$= -\mu_0 (1+\chi_m) J z \hat{y} \quad \text{inside}$$
$$= -\mu_0 J\, h/2 \quad z > h/2$$
$$\mu_0 J\, h/2 \quad z < -h/2$$

2c. $\vec{K}_b = \vec{M} \times \hat{n}$
$$= -\chi_m J\, h/2\, \hat{y} \times \hat{z}$$
$$= \boxed{-\chi_m J\, h/2\, \hat{x} \quad z = h/2}$$

$$= -\chi_m J \cdot -h/2 \cdot \hat{y} \times -\hat{z}$$
$$= \boxed{-\chi_m J\, h/2\, \hat{x} \quad z = -h/2}$$

$$\vec{J}_b = \nabla \times \vec{M}$$
$$= -\partial M_y / \partial z\, \hat{x}$$
$$= \boxed{\chi_m J \hat{x}}$$

$$\vec{J}_b = \chi_m \vec{J}_f$$

$$\vec{J}_b \cdot h = \chi_m J \cdot h$$
$$= -\vec{K}_{b\_total}$$

Total bound current = 0 as it must!

3. a. $\vec{B} = ks\hat{z}$

$$\nabla \times \vec{B} = \mu_0 \vec{J} = \mu_0 \vec{J}_b \quad (\vec{J}_f = 0)$$

$$= -\partial B_z/\partial s \, \hat{\varphi}$$

$$= -k\hat{\varphi}$$

$$\Rightarrow \boxed{\vec{J}_b = -\frac{k}{\mu_0}\hat{\varphi}}$$

b. Bound current must cancel

$$\int \vec{J}_b \cdot d\vec{a} = -\int \vec{K}_b \cdot d\vec{l}$$

$$-\frac{k}{\mu_0} L \cdot R = -K_b \cdot L$$

$$\Rightarrow \boxed{\vec{K}_b = \frac{kR}{\mu_0}\hat{\varphi}}$$

c. $\Delta \vec{B}_{\parallel} = \mu_0 (\vec{K}_b \times \hat{n})$

$$= \mu_0 \cdot \frac{kR}{\mu_0} \hat{\varphi} \cdot \hat{s}$$

$$= -kR\hat{z}$$

$$\vec{B}_{in}(R) = kR\hat{z}$$

$$\Rightarrow \vec{B}_{out}(R) = 0 \quad \Rightarrow \boxed{\vec{B}_{out} = 0}$$

Also from Amperes law

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc} = 0 \Rightarrow \vec{B}_{out} = 0$$