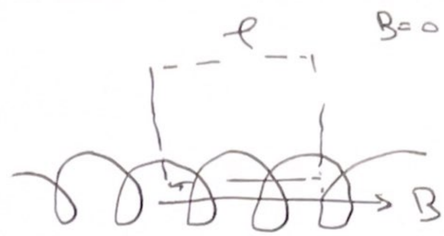
~~4.7~~
S.11



$\mu = \mu_0$

radius $\rightarrow a$

turns/m $\rightarrow n$

Method 1

$$L = \frac{N}{I} \int_s \vec{B} \cdot ds$$

→ The formula 1 in the book dosen't has the N becouse the diagram has only a loop, so $N=1$. This formula is magnetic flux ($N \int \vec{B} \cdot ds$) divided by current and flux $\propto N$

$$\oint \vec{H} \, d\vec{\ell} = I_{encl}$$

$$H \cancel{\ell} + 0 + 0 + 0 = I n \cancel{\ell}$$

$$H = I n \rightarrow B = \mu_0 n I$$

$$L = \frac{N}{I} \mu_0 n I \int_s ds = \frac{N}{\cancel{I}} \mu_0 n \cancel{I} (\pi a^2) \qquad n = \frac{N}{\ell}$$

$$L = \mu_0 n^2 \ell \pi a^2$$

$$\frac{L}{\ell} = \mu_0 n^2 \pi a^2$$

$$\boxed{\frac{L}{\ell} = \mu_0 n^2 A}$$

Method 2

$$du_H = \int_V H \cdot d\vec{B}\, dv \qquad B = \mu_0 H$$

$$= \int_V \mu_0 \vec{H} \cdot d\vec{H}\, dv$$

$$u_H = \frac{\mu_0}{2} \int_V H^2 dv \qquad \leftarrow \text{From metho 1, } \cancel{H_n}\ H = nI$$

$$u_H = \frac{\mu_0}{2} (nI)^2 \int_V dv = \frac{\mu_0}{2} (nI)^2 V \qquad V = \pi a^2 \ell$$

$$u_H = \frac{1}{2} \mu_0 (nI)^2 \pi a^2 \ell \qquad u_H = \frac{1}{2} L I^2$$

$\downarrow$

energy stored in an indctor

$$\cancel{\frac{1}{2}} L \cancel{I^2} = \cancel{\frac{1}{2}} \mu_0 (n\cancel{I})^2 \pi a^2 L$$

$$\boxed{\begin{aligned} \frac{L}{\ell} &= \mu_0 n^2 \pi a^2 \\ \frac{L}{\ell} &= \mu_0 n^2 A \end{aligned}}$$