4-23

問2

(1)

単位長さあたりの巻数は $\frac{N}{l}$ で表わせるので

$$H = \frac{N}{l} I \quad [A/m]$$

(2)

$$\Phi = BS$$

$$= \mu_0 H \pi a^2$$

$$= \mu_0 \frac{N}{l} \pi a^2 I \quad [Wb]$$

$$N\Phi = LI \quad より$$

$$L = \frac{N\Phi}{I} = \mu_0 \frac{N^2}{l} \pi a^2 \quad [H]$$

(3)

$$U_m = \frac{1}{2} L I^2$$

$$= \frac{1}{2l} \mu_0 N^2 \pi a^2 I^2 \quad [J]$$

(4)

$$U_m = \frac{1}{2l} \mu_0 N^2 \pi a^2 I^2 \quad より$$

$$l \to l - \Delta l$$

$$U_m' = \frac{1}{2(l-\Delta l)} \mu_0 N^2 \pi a^2 I^2$$

l が小さい方が U は大きくなるので

$U_m < U_m'$

$$\Delta U_p = U_m' - U_m$$

$$= \frac{\Delta l}{2l(l-\Delta l)} \mu_0 N^2 \pi a^2 I^2$$

$$\fallingdotseq \frac{\Delta l}{2l^2} \mu_0 N^2 \pi a^2 I^2$$

(5)

$$\Delta U_p = \Delta U_m$$

(6)

$$\Delta U_m = F \Delta l$$

$$F = \frac{\Delta U_m}{\Delta l} = \frac{1}{2l^2} \mu_0 N^2 \pi a^2 I^2 .$$