物理第八次作業 F74094083 資訊系113 林欣誠

CH29

11.

a)

$\varepsilon = -A \cdot \frac{dB}{dt}$

$I = \frac{\varepsilon}{R} = -\frac{A}{R} \cdot \frac{dB}{dt}$

$= -\frac{A}{R}(-\frac{1}{\tau})B_0 e^{-\frac{t}{\tau}}$

when $t=0 \Rightarrow e^0 = 1$

$I_{max} = \frac{\pi \times (0.02)^2 \times 3}{0.6 \times 0.5} = 1.26 \times 10^{-2}$

b)

$I = \frac{AB_0}{R\tau} e^{-\frac{t}{\tau}}$, $t = 1.5$

$= \frac{\pi \times (0.02)^2 \times 3}{0.6 \times 0.5} \times e^{-\frac{1.5}{0.5}}$

$= 6.26 \times 10^{-4}$

36.

$B = \mu_0 n I$

$\varepsilon = \oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$

$\Phi_B = AB = \pi r^2 B$

$\oint \vec{E} \cdot d\vec{l} = E \cdot 2\pi r$

$E \cdot 2\pi r = \pi r^2 \frac{dB}{dt}$

$E = \frac{1}{2} r \frac{dB}{dt} = \frac{1}{2} r \mu_0 n \frac{dI}{dt}$

a)

$E = \frac{1}{2} \times 0.05 \times 4\pi \times 10^{-7} \times 900 \times 36$

$= 1.02 \times 10^{-4}$

b)

$E = \frac{1}{2} \times 0.05 \times 4\pi \times 10^{-7} \times 900 \times 36$

$= 2.04 \times 10^{-4}$

40.

a)

$q(t) = \int i_c dt = 1.8 \times 10^{-3} \times 0.5 \times 10^{-6}$

$= 9 \times 10^{-10}$

$E(t) = \frac{q(t)}{\varepsilon_0 A} = \frac{9 \times 10^{-10}}{8.854 \times 10^{-12} \times 5 \times 10^{-4}}$

$= 2.03 \times 10^5$

$V(t) = E(t) d = 2.03 \times 10^5 \times 2 \times 10^{-3}$

$= 406$

b)

$E = \frac{I}{\varepsilon_0 A} t$

$\Rightarrow \frac{dE}{dt} = \frac{i_c}{\varepsilon_0 A}$ ∵ i_c, ε_0, A are constant

∴ $\frac{dE}{dt}$ doesn't vary with time

$\Rightarrow \frac{dE}{dt} = \frac{1.8 \times 10^{-3}}{8.854 \times 10^{-12} \times 5 \times 10^{-4}}$

$= 4.07 \times 10^{11}$

c)

$J_D = \varepsilon_0 \frac{dE}{dt} = \varepsilon_0 \frac{i_c}{\varepsilon_0 A} = \frac{i_c}{A} = \frac{1.8 \times 10^{-3}}{5 \times 10^{-4}} = 3.6$

$i_D = J_D A = \frac{i_c}{A} A = i_c = 1.8 \times 10^{-3}$

$\Rightarrow$ two current i_D and i_c are equal

44.

a)

$F_{mag} = \frac{l^2 B^2}{R} V$

$a = \frac{\vec{F}_{exp} - \vec{F}_{mag}}{m}$

$= \frac{0.18 - \frac{(4 \times 10^{-2} \times 2.9)^2}{5 \times 10^{-3}} \times 3 \times 10^{-2}}{2.4 \times 10^{-3}}$

$= 4.14$

b)

$F_{mag} = F_{exp}$

$\frac{l^2 B^2}{R} V = 0.18$

$V = 0.18 \times \frac{5 \times 10^{-3}}{(4 \times 10^{-2} \times 2.9)^2}$

$= 6.69 \times 10^{-2}$

$a = 0$ ∵ terminal V

$\Rightarrow \Delta V = 0$

c)

$a = \frac{0.18}{24 \times 10^{-3}} = 7.5$

49.

a)

(i)

$d\Phi_B = B dA$

$B = \frac{\mu_0 I}{2\pi x}$

$\Rightarrow d\Phi_B = \frac{\mu_0 I}{2\pi x} \cdot dA = \frac{\mu_0 I b dx}{2\pi x}$

$\Phi_B = \int d\Phi_B = \frac{\mu_0 I b}{2\pi} \int_r^{r+a} \frac{dx}{x}$

$= \frac{\mu_0 I b}{2\pi} \ln(\frac{r+a}{r})$

$\varepsilon = \frac{d\Phi_B}{dt} = V \frac{d\Phi_B}{dr}$

$= V \frac{d}{dr}(\frac{\mu_0 I b}{2\pi} \ln(\frac{r+a}{r}))$

$= V \cdot \frac{\mu_0 I b}{2\pi}(-\frac{a}{r(r+a)}) = \frac{\mu_0 I b a V}{2\pi r(r+a)}$

(ii)

$\varepsilon = lVB$

$\varepsilon_1 = \frac{\mu_0 I}{2\pi r} vb$

$\varepsilon_3 = \frac{\mu_0 I}{2\pi(r+a)} vb$

$\varepsilon_2 = \varepsilon_4 = 0$

$\varepsilon = \varepsilon_1 - \varepsilon_3$

$= \frac{\mu_0 I}{2\pi} vb(\frac{1}{r} - \frac{1}{r+a})$

$= \frac{\mu_0 I b a V}{2\pi r(r+a)}$

b)

(i)

As the loop moves to right, the magnetic field decreases. According to Lenz's law, a current must flow in the loop such that the induced field opposes the external magnetic field. So, the direction of the induced magnetic field must point into the page. Therefore, the direction of the induced current is clockwise. (according to the right-hand rule)

49.

b)

(iii)

We have free charges in each one of the loop sides, according to $\vec{F}=q\vec{v}\times\vec{B}$, the positive charges will build up in the two sides that are parallel to the wire, causing a potential difference between the ends of each one of the sides. Since the left side is closer to the wire, it will have a higher induced emf. Thus, the direction of the induced emf will be in the same direction of the current in this wire, which means the current circulates clockwise in the loop.

c)

(i)

when the loop is stationary

$v=0$

$\Rightarrow \mathcal{E}=0$

$\Rightarrow$ reasonabe

(ii)

$a\to 0 \Rightarrow \Phi_B=0$

$\Rightarrow \mathcal{E}=0$

$\Rightarrow$ reasonable

(iii)

far away from the wire

$\Rightarrow B\to 0$

$\Rightarrow \mathcal{E}=0$

$\Rightarrow$ reasonable

52.

$$F_{mag}=\frac{B^2l^2}{R}v$$

$$F-\frac{B^2L^2}{R}v=ma=m\frac{dv}{dt}$$

$$\frac{F}{m}dt=\frac{dv}{1-\frac{vB^2L^2}{FR}}$$

$$\Rightarrow \frac{F}{m}\int_0^t dt=\int_0^v\frac{dv}{1-\frac{vB^2L^2}{FR}}$$

$$\Rightarrow \frac{F}{m}t=-\frac{FR}{B^2L^2}\ln(1-\frac{vB^2L^2}{FR})$$

$$t=-\frac{Rm}{B^2L^2}\ln(1-\frac{vB^2L^2}{FR})$$

$$=\frac{0.12\times 80}{1.5^2\times 0.2^2}\ln(1-\frac{25\times 1.5^2\times 0.2^2}{19\times 80})$$

$$=1.59$$

53.

$$\oint\vec{B}\cdot d\vec{l}=\mu_0 I$$

$$\Rightarrow B(r)=\frac{\mu_0 Ir}{2\pi R^2}$$

$$d\Phi_B=B(r)Wdr=\frac{\mu_0 IW}{2\pi R^2}rdr$$

$$\Phi_B=\int d\Phi_B=\frac{\mu_0 IW}{2\pi R^2}\int_0^R rdr$$

$$=\frac{\mu_0 IW}{4\pi}$$

54.

a)

$$I=I_{bat}-I_{ind}$$

$$I_{bat}=\frac{\mathcal{E}}{R},\ I_{ind}=\frac{\mathcal{E}_{ind}}{R}$$

$$\Rightarrow I=\frac{\mathcal{E}-\mathcal{E}_{ind}}{R}$$

$$=\frac{\mathcal{E}-BLv}{R}$$

$$F=ILB=\frac{(\mathcal{E}-BLv)LB}{R}$$

$$a=\frac{F}{m}=\frac{(\mathcal{E}-BLv)LB}{mR}=\frac{dv}{dt}$$

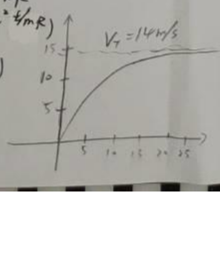
$$\frac{dv}{\mathcal{E}-BLv}=\frac{LB}{mR}dt$$

$$\int_0^v\frac{dv}{\mathcal{E}-BLv}=\int_0^t\frac{LB}{mR}dt$$

$$\ln(\frac{\mathcal{E}}{\mathcal{E}-BLv})=\frac{B^2L^2t}{mR}$$

$$v=\frac{\mathcal{E}}{BL}(1-e^{-B^2L^2t/mR})$$

$$=14(1-e^{-t/6})$$



54.

b)

$$a=\frac{\mathcal{E}LB}{mR}=\frac{12\times 2.4\times 0.36}{0.9\times 5}=2.304$$

c)

$$a=\frac{\mathcal{E}LB}{mR}=\frac{(12-2.4\times 0.36\times 2)\times 2.4\times 0.36}{0.9\times 5}=1.97$$

d)

$V_T=14$

55.

a)

$$B=\frac{\mu_0 I}{2\pi r}$$

$$d\mathcal{E}=\vec{v}\times\vec{B}\cdot d\vec{l}$$

$$=-vBdr=-v\frac{\mu_0 I}{2\pi r}dr$$

$$V_{ba}=\int_a^b d\mathcal{E}=-\int_d^{d+L}\frac{\mu_0 Iv}{2\pi r}dr$$

$$=-\frac{\mu_0 Iv}{2\pi}\int_d^{d+L}\frac{dr}{r}=-\frac{\mu_0 Iv}{2\pi}\ln(1+\frac{L}{d})$$

b)

"$-$" $\Rightarrow V_{ba}$ is negative

$\Rightarrow$ point a is at higher potential

c)

$$\mathcal{E}=-\frac{d\Phi_B}{dt},\quad \Phi_B=BA$$

$$\Rightarrow \frac{d\Phi_B}{dt}=0\Rightarrow \mathcal{E}=0\Rightarrow I=0$$

57.

a)

$$\mathcal{E}=\int_0^L\omega Brdr=\frac{1}{2}\omega BL^2$$

$$=\frac{1}{2}\times 8.8\times 0.65\times 0.24^2=0.165$$

b)

$V=|\mathcal{E}|=0.165$

c)

$$\mathcal{E}=\int_0^{\frac{L}{2}}\omega Brdr=\frac{1}{8}\omega BL^2$$

$$=\frac{1}{8}\times 8.8\times 0.65\times 0.24^2=41.2\times 10^{-3}$$

between the ends of the road: 0

$\because$ the polarities of the $\mathcal{E}$ induced in the two halves of the rod are reversed.

between the center of the rod and one end: 41.2×10^{-3}