Chapter 8

8-1

解:

由电磁感应定律,得:

$$\mathscr{E} = -\frac{d\Phi}{dt} = -\pi a^2 \frac{dB}{dt} = -\pi (3t + 4) \times 10^{-6} \tag{SI}$$

又由欧姆定律,得:

$$I = \frac{\mathscr{E}}{R}$$

• (1) 代入t = 2s, 得:

$$\mathcal{E} = -3.14 \times 10^{-5} \text{ T}$$

 $I = -3.14 \times 10^{-2} \text{ A}$

• (2)

$$Q=|rac{\Delta\Phi}{R}|=4.4 imes10^{-2}~{
m C}$$

8-2

解:

(1)由电磁感应定律,得:

$$egin{align} \mathscr{E} &= \int_L (oldsymbol{v} imes oldsymbol{B}) \cdot doldsymbol{l} = rac{\mu_0 I v}{2\pi} \cot heta \int_d^{d+l \sin heta} rac{dr}{r} \ &= rac{\mu_0 I v}{2\pi} \cot heta \ln rac{d+l \sin heta}{d} \ &= 2.79 imes 10^{-4} ext{ V} \end{aligned}$$

• (2) 由 $\mathscr{E}>0$,得D电势高。

8-4

解:

$$U_{ab} = \mathscr{E} = \int_L (oldsymbol{\omega} imes oldsymbol{r} imes oldsymbol{B}) \cdot doldsymbol{l} = -rac{B \omega l^2}{4}$$

由于 $U_{ab} < 0$,故b点电势高

8-6

解:

• (1) 对棒及电路进行分析,可得:

$$\mathcal{E} = Blv$$

$$I = \frac{\mathcal{E}}{R}$$

$$m\frac{dv}{dt} = -BIl$$

联立得:

$$egin{aligned} rac{dv}{dt} + rac{B^2 l^2}{mR} v &= 0 \ \\ \Rightarrow & v = v_0 e^{-rac{t}{ au}} \end{aligned} \qquad (其中 au = rac{mR}{R^2 l^2}) \end{aligned}$$

• (2)

$$\frac{dv}{dt} + \frac{B^2 l^2}{mR} v = 0$$

$$\Rightarrow v \frac{dv}{dx} + \frac{v}{\tau} = 0$$

$$\Rightarrow \frac{dv}{dx} = -\frac{1}{\tau}$$

$$\Rightarrow x = -\tau (v - v_0)$$

停止运动时, v=0, 得:

$$x_m = rac{mRv_0}{B^2l^2}$$

• (3)

$$Q = \int_0^t I^2 R dt = rac{B^2 l^2}{R} \int_0^t v^2 dt$$

代入 $v=v_0(1-e^{-\frac{t}{\tau}})$, 令 $t\to +\infty$, 得:

$$Q=rac{1}{2}mv_0^2$$

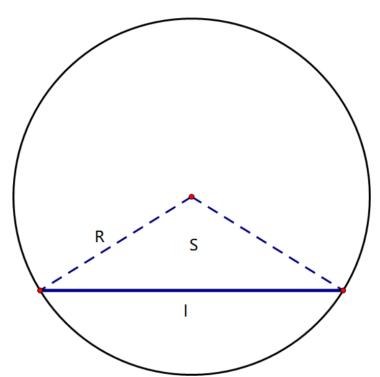
• (4) 由能量守恒,应有:

$$Q = -\Delta E_k$$

上述结果满足此式。

8-9

解:



如图,有圆形磁场区域感生电场垂直于半径,所以两虚线上无感应电动势。故:

$$U_{PQ}=-rac{d\Phi}{dt}=-rac{l}{4}\sqrt{4R^2-l^2}rac{dB}{dt}$$

负号表示Q电势更高。

8-10

解:

• (1)

$$\Phi=\int_a^b-rac{\mu_0}{2\pi}rac{I}{r}ldr=-rac{\mu_0l}{2\pi}\lnrac{b}{a}I_0e^{-ct}$$

由电磁感应定律,得:

$$\mathscr{E} = -rac{d\Phi}{dt} = -rac{\mu_0 lc}{2\pi} \lnrac{b}{a} I_0 e^{-ct}$$

电流为逆时针方向。

• (2)

$$M = \frac{\Phi}{I} = \frac{\mu_0 l}{2\pi} \ln \frac{b}{a}$$

8-11

解:

由8-10的结论,得互感系数:

$$M = \frac{\mu_0 c}{2\pi} \ln \frac{b}{a}$$

故有:

$$\mathscr{E} = -M\frac{di}{dt} = -\frac{\mu_0 c I_0 \omega}{2\pi} \cos \omega t \ln \frac{b}{a}$$

8-14

解:

对于中间部分,即距离某导线距离为r到d-r,长度为l的一部分,磁通量为:

$$\Phi=2\int_{r}^{d-r}rac{\mu_{0}}{2\pi}rac{I}{r}ldr=rac{\mu_{0}Il}{\pi}\lnrac{d-r}{r}$$

故有:

$$L = \frac{\Phi}{I} = \frac{\mu_0 l}{\pi} \ln \frac{d - r}{r}$$

8-15

解:

答案为D.