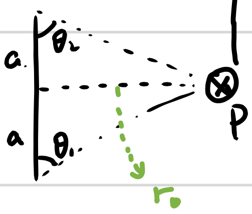
2300012929 尹[illegible]润

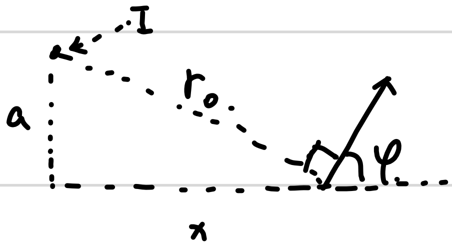
13.

对于一条边：



$$\begin{cases} \vec{B_1} = \dfrac{\mu_0}{4\pi}\dfrac{I}{r_0}\hat{e_\varphi}(\cos\theta_1 - \cos\theta_2) \\ r_0 = \sqrt{a^2+x^2} \\ \cos\theta_1 = -\cos\theta_2 = \dfrac{a}{\sqrt{a^2+r_0^2}} \end{cases}$$

由边叠加，仅留 x 方向分量：



$$\begin{cases} B_x = B_1\cos\varphi \\ \cos\varphi = \dfrac{a}{r_0} \end{cases}$$

$$\vec{B} = 4B_x\cdot\hat{e_x},$$

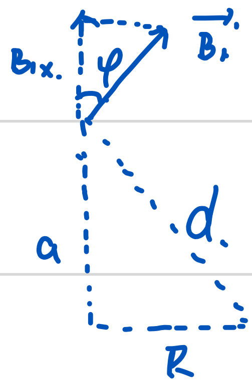
$$\therefore \vec{B} = \frac{2\mu_0 I a^2}{\pi(a^2+x^2)\sqrt{2a^2+x^2}}\hat{e_x}.$$

14. (1). $I = \lambda v = \lambda R\omega$

$$\begin{cases} d\vec{B_0} = \dfrac{\mu_0 I}{4\pi}\dfrac{dl}{R^2}\cdot\hat{e_x} \\ \vec{B_0} = \displaystyle\int_0^{2\pi R} d\vec{B_0} \end{cases}$$

$$\therefore \vec{B_0} = \frac{\mu_0\lambda\omega}{2}\hat{e_x}$$

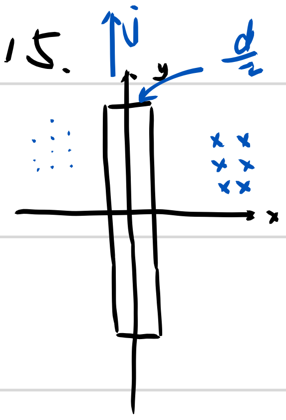
(2) 由对称性，仅 x 分量。



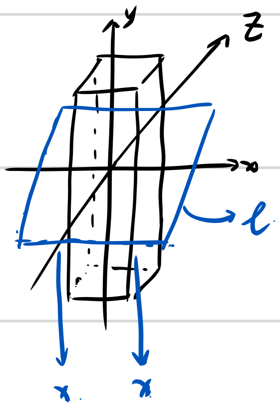
$$\begin{cases} B_{1x} = \dfrac{\mu_0 I}{4\pi}\dfrac{dl}{d^2}\cdot\sin\theta\cdot\cos\varphi \\ \theta = \dfrac{\pi}{2} \\ \cos\varphi = \dfrac{R}{d} \\ \vec{B} = \left(\displaystyle\int_0^{2\pi R} B_{1x}\right)\cdot\hat{e_x} \\ d = \sqrt{a^2+R^2} \end{cases}$$

$$\therefore \vec{B} = \frac{\mu_0\lambda\omega R^3}{2(a^2+R^2)^{\frac{3}{2}}}\hat{e_x}.$$

15.



x 相同处 $\vec{B}$ 相同



取如图环路.

$$\int \vec{B}\cdot d\vec{l} = \mu_0 \cdot I_{内}$$

$$\int \vec{B}\cdot d\vec{l} = |\vec{B_x}|\cdot 2l$$

$$\therefore |\vec{B_x}| = \begin{cases} \mu_0 j x, & x \le \frac{d}{2} \\ \mu_0 j \frac{d}{2}, & x > \frac{d}{2} \end{cases}$$

方向: $\begin{cases} x \geq 0, & 向\ z\ 轴正方向 \\ x < 0 & 向\ z\ 轴负方向 \end{cases}$

16.(1) $r < R_1$:

$$\begin{cases} \oint_{(L)} \vec{H}\cdot d\vec{l} = I\frac{r^2}{R_1^2} \\ \oint_{(L)} \vec{H}\cdot d\vec{l} = |\vec{H}|\, 2\pi r \\ \vec{B} = \vec{H}\cdot \mu_0 \end{cases} \Rightarrow \begin{cases} \vec{H} = \frac{Ir}{R_1^2\cdot 2\pi}\vec{p} \\ \vec{B} = \frac{\mu_0 I r}{R_1^2 2\pi}\vec{p} \end{cases}$$

($\vec{p}$ 是与 $\hat{e}_r$ 垂直的切向单位向量 顺时针方向)

$R_1 < r < R_2$:

$$\begin{cases} \oint_{(L)} \vec{H}\, d\vec{l} = I \\ \oint_{(L)} \vec{H}\cdot d\vec{l} = |\vec{H}|\cdot 2\pi r \\ \vec{B} = \vec{H}\cdot \mu_0\mu_r \end{cases} \Rightarrow \begin{cases} \vec{H} = \frac{I}{2\pi r}\vec{p} \\ \vec{B} = \frac{\mu_0\mu_r I}{2\pi r}\vec{p} \end{cases}$$

$r > R_2$:

$$\begin{cases} \oint_{(L)} \vec{H}\cdot d\vec{l} = I \\ \oint_{(L)} \vec{H}\cdot d\vec{l} = |\vec{H}|\cdot 2\pi r \\ \vec{B} = \vec{H}\mu_0 \end{cases} \Rightarrow \begin{cases} \vec{H} = \frac{I}{2\pi r}\vec{p} \\ \vec{B} = \frac{\mu_0 I}{2\pi r}\vec{p} \end{cases}$$

(2)

$$\begin{cases} i' = \vec{M}\times\vec{n} \\ \vec{M} = \chi_m \vec{H} \end{cases}$$

$\underline{r = R_1, R_2}$

$$\begin{cases} i'\big|_{R_1} = \frac{(\mu_r - 1)I}{2\pi R_1} \\ i'\big|_{R_2} = -\frac{(\mu_r - 1)I}{2\pi R_2} \end{cases}$$

17.(1) $\vec{B_r} = \frac{\mu_0 I}{4\pi}\frac{2}{r} = \frac{\mu_0 i}{2\pi r}\vec{p}$ 单位向量 垂直纸面向里

$\Phi = \oiint_S \vec{B}\, d\vec{s} = \int_a^b |\vec{B_r}| \cdot l\, dr$

$\therefore\ \Phi = \frac{\mu_0 i l}{2\pi}\ln\frac{b}{a}$

$\Phi = \left(\frac{\mu_0 l}{2\pi}\ln\frac{b}{a}\right)\cdot I_0 \sin\omega t$

(2) $\varepsilon = -\frac{d\Phi}{dt}$

$\therefore\ \varepsilon = -\left(\frac{\mu_0 l}{2\pi}\ln\frac{b}{a}\right) I_0\omega\cos\omega t$

18.

$$\begin{cases} \varepsilon = -\frac{d\Phi}{dt} = -kS_{\text{扇}}B_0 \\ S_{\text{扇}} = \frac{\sqrt{3}}{4}R^2 + \frac{\pi}{12}R^2 \end{cases}$$

$U_{OA} = \varepsilon = -\frac{3\sqrt{3}+\pi}{12}R^2 kB_0.$

19.(1)

$$\begin{cases} U_{R_0}(t) + U_L(t) + U_R(t) = \varepsilon \\ U_L(t) = L\frac{di(t)}{dt} \\ U_{R_0}(t) = i(t)\cdot R_0 \\ U_R(t) = i(t)\cdot R \\ i(0) = 0 \end{cases} \Rightarrow i(t) = \frac{\varepsilon}{R_0+R} - \frac{\varepsilon}{R_0+R}e^{-\frac{R_0+R}{L}t}$$

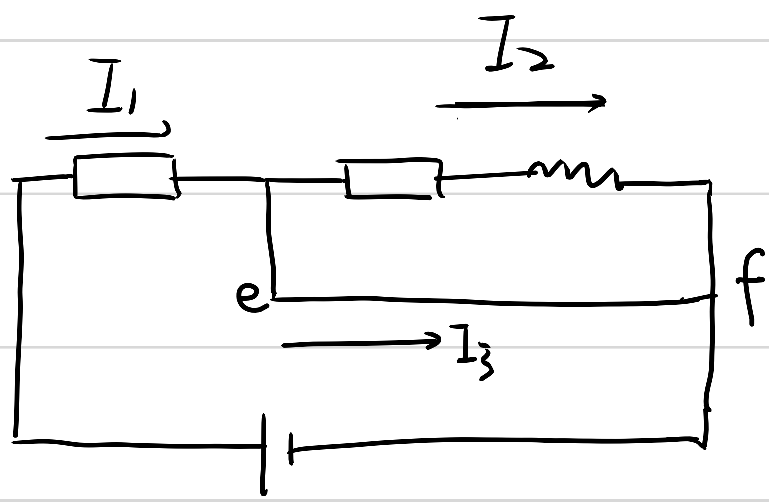
$$U_{BC} = i(t)\cdot R + \frac{di(t)}{dt}\cdot L = \frac{\varepsilon R}{R_0+R}\left(1-e^{-\frac{R_0+R}{L}t}\right) + \varepsilon e^{-\frac{R_0+R}{L}t}$$

$$U_{AB} = i(t)\cdot R_0 = \frac{\varepsilon}{R_0+R}\left(1-e^{-\frac{R_0+R}{L}t}\right)\cdot R_0$$

(2) 代入得. $U_{AB} = 2V$

$U_{BC} = 18V$

(3) 稳时 记时为 0.



$$\begin{cases} U_L(0) = 0 \\ U_{R_0}(0) + U_R(0) = \varepsilon \end{cases} \Rightarrow \begin{cases} i_1(0) = i_2(0) = \frac{\varepsilon}{R+R_0} \\ i_3(0) = 0 \end{cases}$$

$$
\begin{cases}
U_{R_0}(t) + U_L(t) + U_R(t) = \varepsilon \\
U_L(t) = L\dfrac{d i_2(t)}{dt} \\
U_{R_0}(t) = i_2(t)\cdot R_0 \\
U_R(t) = i_1(t)\cdot R \\
i_1(t) = i_2(t) + i_3(t) \\
U_{R_0}(t) = \varepsilon
\end{cases}
\qquad
\begin{cases}
i_2(t) = \dfrac{\varepsilon}{R+R_0} e^{-\frac{R_0}{L}t} \\
i_1(t) = \dfrac{\varepsilon}{R_0}
\end{cases}
$$

$$
i_3(t) = \frac{\varepsilon}{R_0} - \frac{\varepsilon}{R+R_0} e^{-\frac{R_0}{L}t}.
$$

$$
i_3(0.01) = 0.33\,A, \quad e \to f.
$$

20.

$$
\begin{cases}
\oint_{(L)} \vec{B}\cdot d\vec{l} = \mu_0 I \\
\psi = \int_a^b B\, dr \\
L = \dfrac{\psi}{I}
\end{cases}
\qquad
L = \frac{\mu_0}{2\pi}\ln\frac{b}{a}.
$$