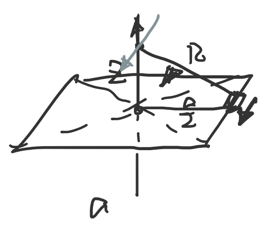
课后题

2022年4月20日 星期三 下午6:03

1. $E_k = 5.0\,MeV = \frac{1}{2}mv^2$, $v = \sqrt{\frac{2E_k}{m}}$

$F = evB = \sqrt{\frac{2\times5\,MeV}{m}} \times e \times 1.5$

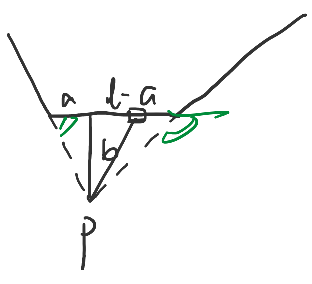
2. 

$d\vec B = \frac{I d\vec l \times \hat R}{R^2} \times \frac{\mu_0}{4\pi}$

$= \frac{I dl}{\frac{a^2}{2}+z^2} \times \frac{\mu_0}{4\pi}$

$dB_z = \frac{\mu_0}{4\pi}\frac{2dl}{\frac{a^2}{2}+z^2} \times \frac{\frac{a}{2}}{\sqrt{\frac{a^2}{2}+z^2}}$

$= \frac{\mu_0}{\pi}\frac{a I dl}{(a^2+4z^2)^{\frac{3}{2}}}$

3. 

l_1, l_2 过P.C., 无B.

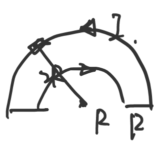
长为 l.

$d\vec B = \frac{\mu_0}{4\pi}\frac{I d\vec l \times \hat r}{r^2} = \frac{\mu_0}{4\pi}\frac{I dl}{\frac{b^2}{\sin^2\theta}}\hat y$

$= \frac{\mu_0 I}{4\pi}\frac{d\theta}{b}\hat y$ $dl = \frac{b}{\sin^2\theta}d\theta$

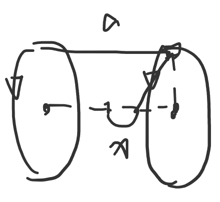
$\vec B = \frac{\mu_0 I}{4\pi b}\int_{\theta_1}^{\theta_2}\sin\theta\, d\theta = \frac{\mu_0 I}{4\pi b}(\cos\theta_1 - \cos\theta_2)$

$= \frac{\mu_0 I}{4\pi b}\left(\frac{l-a}{\sqrt{(l-a)^2+b^2}} + \frac{a}{\sqrt{a^2+b^2}}\right)$

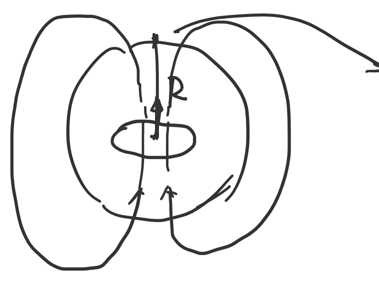
4. 

$\vec B = \frac{\mu_0}{4\pi}\frac{I d\vec l \times \hat r}{r^2} = \frac{\mu_0}{4\pi}\frac{I\times\pi R}{R^2} = \frac{\mu_0 I}{4R}$.

$\vec B = \frac{\mu_0 I}{4}\left(\frac{1}{R} - \frac{1}{\pi R}\right) = \frac{\mu_0 I}{8R}$.

5. 

内部: $-\frac{a}{2} \le x \le \frac{a}{2}$.

6. 

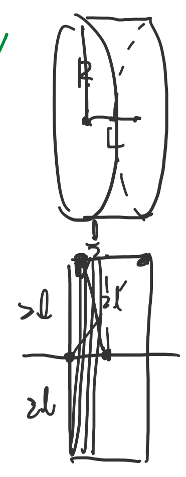
$0.8G = 8\times10^{-5}T$.

$\vec m = I\vec S$.

$\vec B = \frac{\mu_0}{4\pi r^3}[3(\vec m\cdot\hat r)\hat r - \vec m]$

$= \frac{\mu_0}{4\pi r^3}\times(3\vec m - \vec m) = \frac{\mu_0}{2\pi r^3}\vec m$.

$m = \frac{2\pi r^3 B}{\mu_0} = \frac{2\pi\times216\times10^{18}\times8\times10^{-5}}{4\pi\times10^{-7}} = 216\times4\times10^{20}$

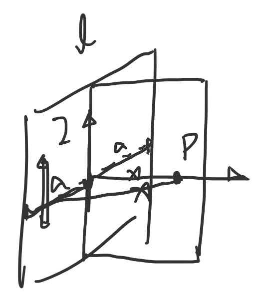
7. 

$R = 2L$. $n = 200$. $I = 0.1A$. $\sqrt{17}$

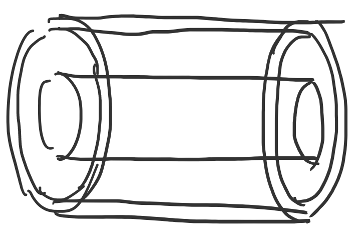
$B = \frac{\mu_0 n I}{2}(\cos\beta_2 - \cos\beta_1)$

$= \frac{1}{2}\mu_0 n I \times 2 \times \frac{1}{\sqrt{17}} =$

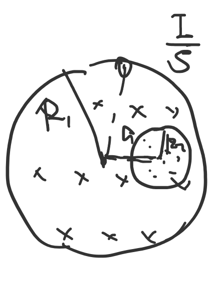
$B = \frac{1}{2}\mu_0 n I \times \left(1 - \frac{1}{\sqrt{5}}\right) =$

8. 

$k = \frac{I}{2a}$.

10. 

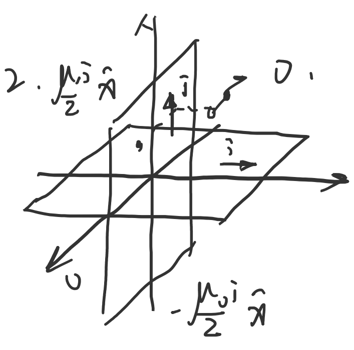
$B = \begin{cases} \frac{\mu_0}{2\pi r}\frac{r^2}{a^2}I & r<a \\ \frac{\mu_0}{2\pi r}I & a<r<b \\ -\frac{\mu_0}{2\pi r}\frac{r^2-b^2}{c^2-b^2}I + \frac{\mu_0}{2\pi r}I & b<r<c \\ 0 & r>c \end{cases}$

11. 

轴线: $B=0$ (对称性).

空腔: $B_1\times2\pi x = \frac{I}{\pi R_1^2}\times\pi x^2$, $B_1 = \frac{Ia}{2\pi R_1^2}$.

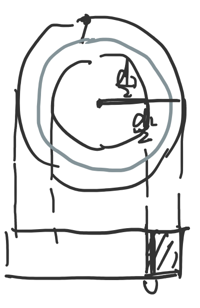
$B_2\times2\pi(a-R_2) = \frac{I}{\pi R_2}$

12. 

看一条电流: 距 xOy a, 距 xOz b.

$B = \int_{-\infty}^{\infty}\frac{\mu_0}{2\pi}\frac{i a}{a^2+x^2}dx = \frac{\mu_0 a I}{4\pi}\int_{-\infty}^{\infty}\frac{1}{a^2}\frac{1}{(\frac{x}{a})^2+1}dx$

$= \frac{\mu_0 j}{4\pi}\arctan\frac{x}{a}\Big|_{-\infty}^{\infty} = \frac{\mu_0 j}{4}$.

13. 

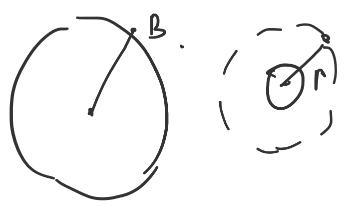
(1) $B\times2\pi r = \mu_0 N I$.

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

(2) $\Phi = BS = B\,dh = \int_{\frac{d_1}{2}}^{\frac{d_2}{2}} B(r)\,dr\,h$

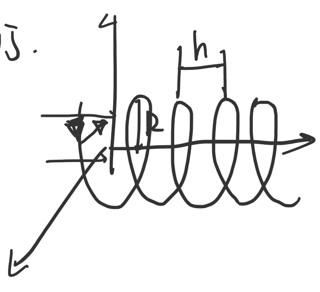
$= \int_{\frac{d_1}{2}}^{\frac{d_2}{2}}\frac{\mu_0 N I}{2\pi r}dr\,h$

$= \frac{\mu_0 N I}{2\pi}\ln\frac{d_2}{d_1}\cdot h = \frac{\mu_0 N I h}{2\pi}\ln\frac{d_2}{d_1}$

14. 

$F_B = qvB = 1.6\times10^{-19}\times2.2\times10^{6}\times10^{8}$

$F_e = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2} = \frac{(1.6\times10^{-19})^2}{4\pi\times8.85\times10^{-12}\times(0.53\times10^{-10})^2}$

15. 

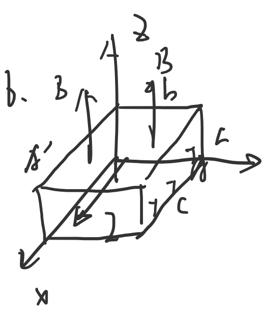
(1) $evB = m\frac{v_\perp^2}{R}$, $v_\perp = \frac{eBR}{m} = \frac{1.6\times10^{-19}\times2\times10^{-3}\times0.002}{9.1\times10^{-31}}$

$T = \frac{2\pi R}{v_\perp} = \frac{2\pi\times0.002}{v_\perp} =$

$v_\parallel T = h$. $v_\parallel = \frac{h}{T} =$

$v = \sqrt{v_\parallel^2 + v_\perp^2} =$

(2) 向y轴正方向

16. 

$\varphi_A > \varphi_{A'}$. 负

$U = Eb$ $F = Ee = evB$, $E = Bv$

$I = nqabv$.

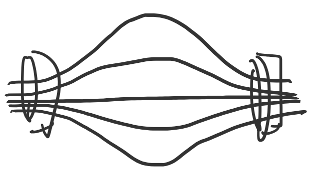
$\therefore U = \frac{BI}{nqab}b = \frac{IB}{naq}$, $n = \frac{IB}{Uaq} = \frac{1\times3050\,G}{6.5\times0.001\times1.6\times10^{-19}}$

$= \frac{3}{6.5\times16}\times10^{27} =$

17. $evB_0 = m\frac{v_0^2}{r_0}$. $r_0 = \frac{mv_0}{eB_0}$. $\frac{v_0^2}{B_0} = \frac{v^2}{B}$, $v = \sqrt{\frac{B}{B_0}}v_0$

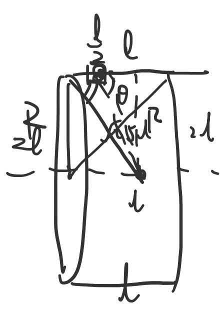
磁矩 $\mu = \frac{mv_\perp^2}{2B}$ 不变.

$evB = \frac{mv^2}{r}$, $r = \frac{mv}{eB} = \frac{m}{eB}\sqrt{\frac{B}{B_0}}v_0$.

18. 

$R_m = 4 =$

$\theta_c = \arcsin\sqrt{\frac{1}{R_m}}$

7. 

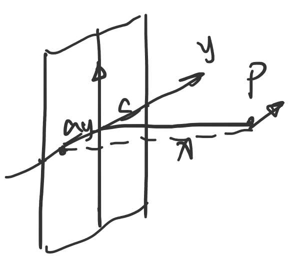
$\int_{\beta_1}^{\beta_2}\frac{\mu_0}{4\pi}\frac{nI\,r\,d\alpha}{r}\sin\alpha = \int_{\alpha_1}^{\alpha_2}\frac{\mu_0}{4\pi}nI\sin\alpha\,d\alpha$.

$B = \frac{\mu_0}{4\pi}\frac{2dl}{r}$

$B = \frac{1}{2}\mu_0 nI(\cos\beta_2 - \cos\beta_1)$

$= \frac{1}{2}\mu_0 nI\left(-\frac{1}{\sqrt{17}} - \frac{1}{\sqrt{17}}\right) = \frac{1}{\sqrt{17}}\mu_0 nI$.

$B = \frac{1}{2}\mu_0 nI\left(-\frac{1}{\sqrt{5}} - 0\right) = \frac{1}{2\sqrt{5}}\mu_0 nI$.

8. 

$\vec k = \frac{I}{2a} = \frac{I}{2a}\hat y$.

$\vec B = \int_{-a}^{a}\frac{\mu_0}{4\pi}\frac{I}{2a}\frac{1}{\sqrt{y^2+x^2}}\times\frac{x}{\sqrt{y^2+x^2}}dy$

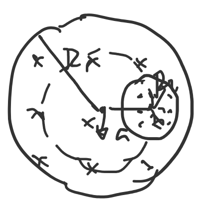
$= \frac{\mu_0 I}{8\pi a}\int_{-a}^{a}\frac{x}{y^2+x^2}dy$.

$= \frac{\mu_0 I}{8\pi a}\int_{-c}^{c}\frac{1}{x(\frac{y}{x})^2+1}dy$ $\frac{dy}{x}$

$= \frac{\mu_0 I}{8\pi a}\int_{-c}^{c}\frac{1}{(\frac{y}{x})^2+1}d\left(\frac{y}{x}\right)$

$= \frac{\mu_0 I}{4\pi a}\left[\arctan\frac{a}{x} - \arctan\left(-\frac{a}{x}\right)\right]$

$= \frac{\mu_0 I}{2\pi a}\arctan\frac{a}{x}$.

11. 

(1) $B_{01} = 0$.

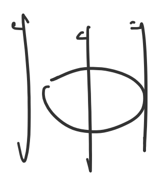
$B_{02}\times2\pi R_2 = \mu_0\frac{I}{\pi(R_1^2-R_2^2)}\times\pi R_2^2$

$B_{02} = \frac{\mu_0 I R_2}{2\pi(R_1^2-R_2^2)}$

I 分布在 $\pi(R_1^2-R_2^2)$

(2) $B_1' = \frac{\mu_0 I}{2\pi a}\frac{\pi a^2}{\pi(R_1^2-R_2^2)} = \frac{\mu_0 I a}{2\pi(R_1^2-R_2^2)}$. $B_2' = 0$

(3) $B = \frac{4\pi\times10^{-7}\times20\times(0.5\times10^{-3})^2}{2\pi\times\cancel{0.5\times10^{-3}}\,((0.5\times10^{-2})^2-(10\times10^{-3})^2)}$.

17. 

$\mu = IS = \frac{mv_\perp^2}{2B}$ 不变.

$\frac{mv_0^2}{2B_0} = \frac{mv^2}{2B}$, $v = \sqrt{\frac{B}{B_0}}v_0$.

$evB = m\frac{v^2}{r}$, $r = \frac{mv}{eB} = \frac{m}{eB}\sqrt{\frac{B}{B_0}}v_0 = \frac{mv_0}{e\sqrt{BB_0}}$.