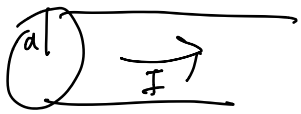
5: 14, 16, 17, 19, 20, 23, 26

5.14)



a) $\oint B \cdot dl = B 2\pi r = \mu_0 I$

inside: $B = 0$

outside: $\frac{\mu_0 I}{2\pi r} \hat{\phi}$ ex. 5.7 too

b) $J \propto s$

$J = ks$

$I = \int_r J\, da = \int_0^a k k\, 2\pi r\, dr$

$= 2\pi k \frac{r^3}{3}$ $\therefore$ $k = \frac{3I}{2\pi a^3}$

$I = \int_0^s ks \cdot 2\pi s\, ds = 2\pi k \frac{s^3}{3}$

$2\pi k s^2$

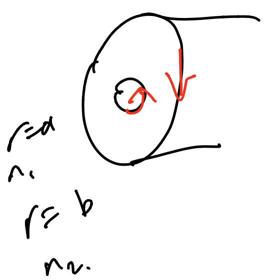
$2\pi \left(\frac{3I}{2\pi a^3}\right) \frac{s^3}{3} = \boxed{I \frac{s^3}{a^3} \hat{\phi} \text{ inside}}$

outside: same as previous

$\frac{\mu I}{2\pi r} \hat{\phi}$

5.16)

$B = \mu_0 n I$



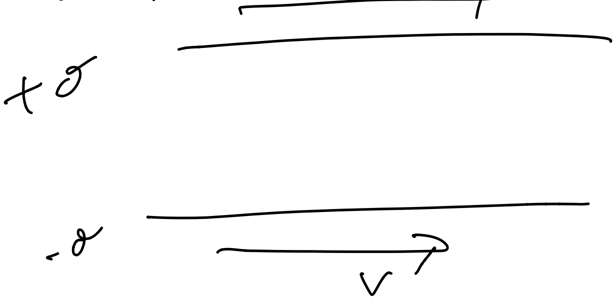
B) outside $= 0$

B: inside little cable

$$\boxed{\mu_0 I n_2 - \mu_0 I n_1}$$

$$a < r < b : \boxed{\mu_0 I n_2}$$

5.17)



a) $B = \mu_0 \sigma v$

outside the plates

$B = 0$

b) F/da $\qquad F = \int \underbrace{K \times B}\, da$

$\vec{K} = \sigma v$

$$B_{\text{bottom}} = \frac{\mu_0 \sigma v}{2} \quad \otimes$$

$$K \times B = (\sigma v)\frac{\mu_0 \sigma v}{2} = \frac{\mu_0 \sigma^2 v^2}{2}(+\hat{z})$$

c) $v = ?$ $f_m = f_e$

$f = \frac{\mu_0}{2\pi} \frac{I_1 I_2}{d}$ 5.40

e field $= \frac{\sigma}{2\epsilon_0}$

$I = \lambda v$ 5.13

$$f_e = \frac{\sigma^2}{2\epsilon_0} = \frac{\mu_0 \sigma^2 v^2}{2} = f_m$$

$$\boxed{\frac{1}{\epsilon_0} = \mu_0 v^2}$$

5.19) $I_{enc} = \int_s J \cdot da$ calc 3.

path is irrelevant because the expression isn't dependent on the specific path

20: $\rho = ?$ $\rho = \frac{Q}{unit^3}$

Cu: $M = 64\,g/mol$
$9\,g/cm^3$

$$\left(1.6\times10^{-19}\,C\right)\left(9\,g/cm^3\right)\left(\frac{1\,mol}{64\,g}\right)\left(\frac{6.0\cdot10^{23}}{1\,mol}\right) = 1.4\times10^4\,\frac{C}{cm^3}$$

b) $d = 1mm$ $I = 1A$

$$J = \frac{I}{\pi s^2} = \rho v \qquad v = \frac{1}{\pi s^2 (1.4\times10^4)} \approx 9.1\times10^{-3}\,\frac{cm}{s}$$

c) $f_m = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} = 2\times10^{-7}$

$c^2\mu_0 = \frac{1}{\epsilon_0}$

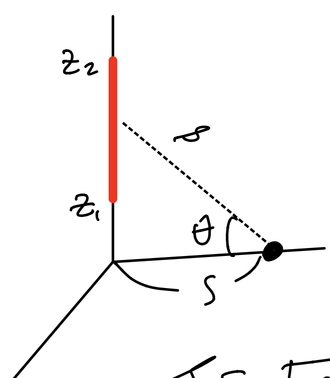
d) $E = \frac{1}{2\pi\epsilon_0}\frac{\lambda}{d}$ $f_e = \frac{c^2}{v^2}\underbrace{\frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}}_{f_m}$

$f_e = \frac{c^2}{v^2}(2\times10^{-7})$

$\left(\frac{3\times10^8}{9.1\times10^{-5}}\right)^2 = 1.1\times10^{25}$

$f_e = 2\cdot10^{20}\ N/m$

23



eq. 5.66

$A = \frac{\mu_0 I}{4\pi}\int\frac{1}{\mathscr{r}}\,dl'$

$= \frac{\mu_0}{4\pi}\int\frac{K}{\mathscr{r}}\,da'$

5.37

$B = \frac{\mu_0 I}{4\pi s}(\sin\theta_2 - \sin\theta_1)$

$\mathscr{r} = \sqrt{s^2+z^2}$ dz

$\int\frac{I\hat{z}}{\mathscr{r}}\,dz$

$A = \frac{\mu_0 I}{4\pi}\hat{z}\int_{z_1}^{z_2}\frac{1}{\sqrt{s^2+z^2}}\,dz$ Wolfram

$$\frac{\mu_0 I}{4\pi}\left[\ln\left(\frac{z_2+\sqrt{s^2+z_2^2}}{z_1+\sqrt{s^2+z_1^2}}\right)\right]\hat{z} \qquad \ln(\sim)-\ln(\sim)$$

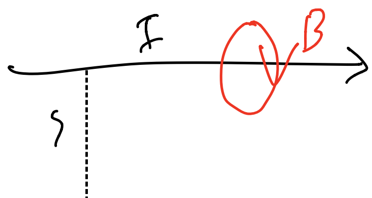
$$B = \nabla \times A = -\frac{\partial A}{\partial s}\hat{\phi}$$

$$= \frac{\mu_0 I}{4\pi}\left[\frac{s}{\sqrt{z_2^2+s^2}}\,\frac{1}{(z_2+\sqrt{z_2^2+s^2})} - \frac{s}{\sqrt{z_1^2+s^2}}\,\frac{1}{(z_1+\sqrt{z_1^2+s^2})}\right]$$

wolfram help $\Rightarrow$ $$= \frac{\mu_0 I}{4\pi}\left[\frac{z_2}{\sqrt{z_2^2+s^2}} - \frac{z_1}{\sqrt{z_1^2+s^2}}\right]\hat{\phi}$$

$$= \frac{\mu_0 I}{4\pi}\left[\sin\theta_2 - \sin\theta_1\right]\hat{\phi} \qquad \sin\theta = \frac{z}{s}$$

2b) $\nabla\cdot A = 0$ $\quad \nabla \times A = B = \frac{-\partial}{\partial s}A\hat{\phi} = \frac{\mu_0 I}{2\pi s}\hat{\phi}$



$$A = -\int \frac{\mu_0 I}{2\pi s}\,dr$$

$$= -\frac{\mu_0 I}{2\pi}\ln(s)\,\hat{z}$$

$$\nabla\cdot A = 0$$

$$\nabla \times A = B$$

b) $r = R$

$$\oint B \cdot dl = B 2\pi s = \mu_0 I = \mu_0 J \pi s^2 = \mu_0 \frac{I s^2}{R^2}$$

$$J = \frac{I}{\pi R^2}$$

$$B 2\pi s = \mu_0 \frac{I s^2}{R^2}$$

$$B = \frac{\mu_0 I s}{2\pi R^2} \hat{\phi}$$

$$\frac{\partial A}{\partial s} = -B$$

$$A = \frac{-\mu_0 I s^2}{4\pi R^2} \hat{z}$$

$$A = \frac{-\mu_0 I}{4\pi R^2} s^2 \hat{z} \quad \text{inside}$$

$$\frac{-\mu_0 I}{2\pi} \ln(s) \quad \text{outside}$$