10) exploit linearity of E&M

this is B loop + Bwire

for the wire we know that

$B_w = \frac{\mu_0 I}{2\pi a}\hat{z}$ for the loop we use Biot Savart

$dB_\ell = \frac{\mu_0}{4\pi}\frac{I\, d\ell \times \hat{r}}{r^2}$ $d\ell \times \hat{r} = r\, d\theta\, \hat{z}$

$dB_\ell = \frac{\mu_0}{4\pi}\frac{I a\, d\theta}{a^2}\hat{z} \Rightarrow B_\ell = \frac{\mu_0 I}{2a}\hat{z}$ ↗ save this one for later

$B = \frac{\mu_0 I}{2a}\left(1 + \frac{1}{\pi}\right)\hat{z}$

15) the parts leading to and from the semicircle do not contribute as $d\ell \times \hat{r} = 0$ (r is in same direction as $d\ell$)

$B_\ell = \frac{\mu_0 I}{2a}\hat{z}$ or $dB_\ell = \frac{\mu_0 I\, d\theta}{4\pi a}\hat{z}$

its half a loop so...

$B = \frac{\mu_0}{4}\frac{I}{a}(-\hat{z})$

↓ current goes other way

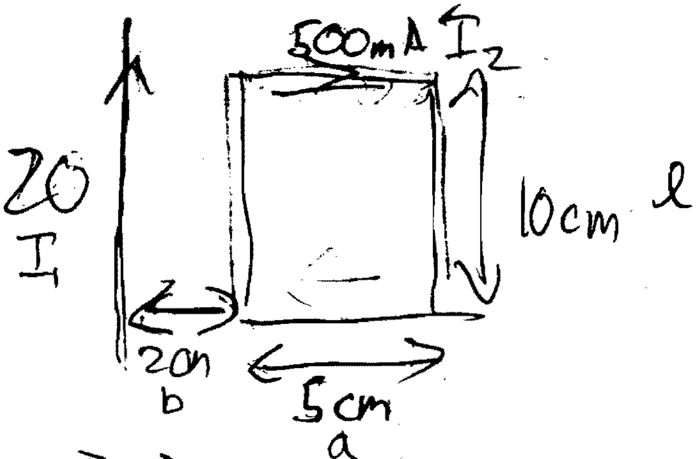
17 the one semicircle

was $-\frac{\mu_0 I}{4a}$ for 

thus we will get

$$\left(\frac{\mu_0 I}{4b} - \frac{\mu_0 I}{4a}\right)\hat{z}$$ for the pair

24)



$$\vec{F} = l\vec{I}\times\vec{B} \qquad B = \frac{\mu_0 I_1}{2\pi x}(-\hat{z})$$

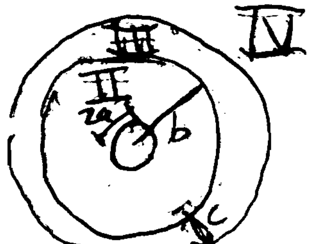
$$F = \left[\frac{\mu_0 l I_2 I_1}{2\pi b} + \frac{\mu_0 l I_1 I_2}{2\pi(a+b)}\right]\hat{x}$$

36 

inside $I_{enc} = 0$ so $B = 0$

outside $I_{enc} = I(\hat{x})$

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

40) 

current inside and outside is ±I we will say + is in and − is out

$J_{in} = \frac{I_{in}}{A} = \frac{I}{\pi a^2}$ $J_{out} = \frac{I}{\pi(b+c)^2 - \pi b^2}$

I $\oint B \cdot dl = \mu_0 I_{enc}$ ($I_{enc} = J A_{enc}$) $2\pi r B = \frac{\mu_0 I \pi r^2}{\pi a^2}$

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

II $\oint B \cdot dl = \mu_0 I_{enc}$ $B = \frac{\mu_0 I}{2\pi r}$ $I_{enc} \to I$

III $\oint B \cdot dl = \mu_0 I_{enc}$ $2\pi r B = \mu_0 [I - J_{out}(\pi r^2 - \pi b^2)]$

I_{enc} is now I in region III plus current inside in regions II and I $B = \frac{\mu_0 I \left(1 - \frac{r^2 - b^2}{(b+c)^2 - b^2}\right)}{2\pi r}$

IV $B = 0$ as $I_{enc} = 0$

45) $l = 10m \quad d = .50\ mm$

d tells you how closely spaced your wire can be

in this case $n = \frac{N}{l} = \frac{1}{.5mm} = 2000\ m^{-1}$

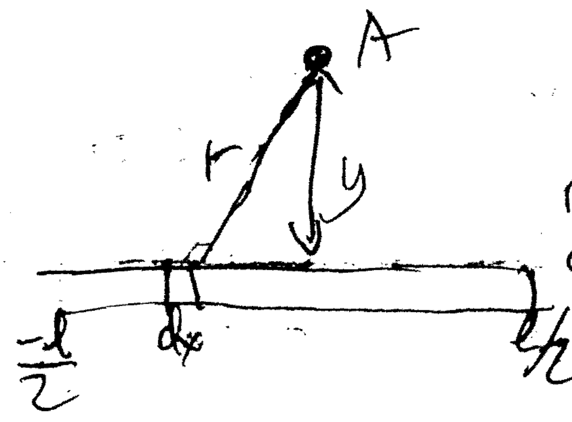
thus $B_{in} = \mu_0 n I = .038T$

b) for a wire of $l = 10m \Rightarrow r = \frac{10}{2\pi}$

recall result from 10) $B = \frac{\mu_0 I}{2r} = \frac{\mu_0 2\pi I}{20}$

$B = 6\times10^{-6}\,T$

57)



$dB = \frac{\mu_0 I}{4\pi}\frac{dl \times \hat{r}}{r^2}$

$r = \sqrt{x^2+y^2} \quad \hat{r} = \frac{x}{r}\hat{x} + \frac{y}{r}\hat{y}$

$dl = dx\,\hat{x} \quad dl \times \hat{r} = \frac{y\,dx}{r}\hat{z}$

$dB = \frac{\mu_0 I\, y\, dx}{4\pi (x^2+y^2)^{3/2}}\hat{z} \quad B = \int_{-l/2}^{l/2} \frac{dB(x)}{dx}\,dx$

$B = \frac{\mu_0 I y}{4\pi}\left(\frac{l}{y^2\sqrt{l^2+4y^2}}\right) = \frac{\mu_0 I l}{2\pi y\sqrt{l^2+4y^2}}\hat{z}$

as $x \to \infty$