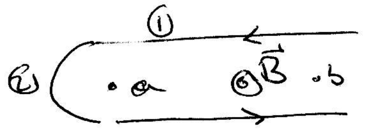
chp 29

1. eqn 29.4 $B = \frac{\mu_0 I}{2\pi R}$, $R = 6.1$

a) $= 3.3 \times 10^{-6}$ T

b) field is horizontal and same mag. as earth's field,
from wire
so it will interfere

5. 

At pt (a) have contribution from ① and ②

① $B_1 = \left(\frac{\mu_0 I}{2\pi R} + \frac{\mu_0 I}{2\pi R} \right) * 0.5$ ← "half-infinite" wire to right only

each of 2 wires

② $B_2 = \frac{\mu_0 I \phi}{4\pi R}$, $\phi = \pi$

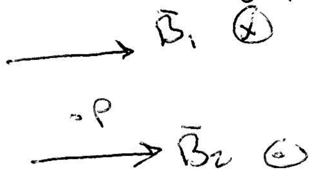
So total is $B_1 + B_2 = 1$ mT

b) At pt (b), only contribution is from ① and

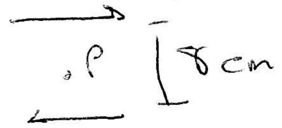
$B = 2 \cdot \frac{\mu_0 I}{2\pi R}$

$= 0.8$ mT

(note that wire now looks infinite in both directions)

9. if same direction : 

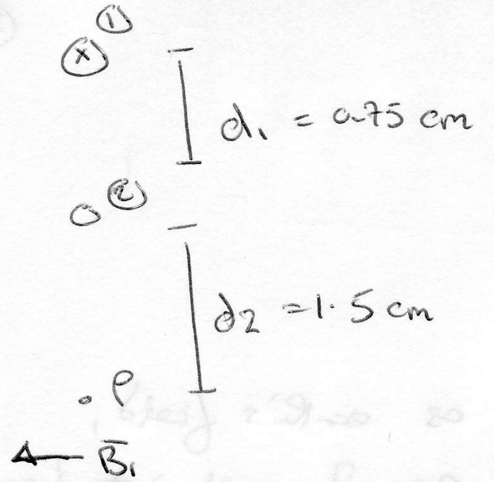
so field would cancel

∴ currents in opposite directions 

$B = 300\ \mu T = 2\left[\frac{\mu_0 I}{2\pi R}\right]$

$I = 30$ A

11.



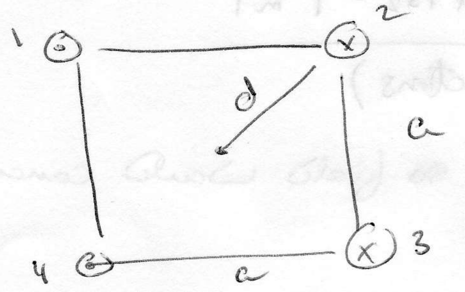
b) so $\bar{B}_2$ must point $\rightarrow$ and wire 2 current is <u>out</u> of page

c) need $|\bar{B}_{Total}| = 0 \Rightarrow |\bar{B}_1| + |\bar{B}_2| = 0$

$$\frac{\mu_0 I_1}{2\pi R_1} = \frac{\mu_0 I_2}{2\pi R_2}, \quad I_1 = 6.5\text{ A}, \quad R_1 = d_1 + d_2, \quad R_2 = d_2$$

$$\underline{\underline{I_2 = 4.3\text{ A}}}$$

29.



$$d = \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \frac{a}{\sqrt{2}}$$

mag of each field is $|\bar{B}| = \frac{\mu_0 I}{2\pi R}$, $R = d$

and
$$\left.\begin{array}{ll} \hat{B}_1 = \frac{\hat{x} + \hat{y}}{\sqrt{2}} & \hat{B}_2 = \frac{-\hat{x} + \hat{y}}{\sqrt{2}} \\ \hat{B}_3 = \frac{\hat{x} + \hat{y}}{\sqrt{2}} & \hat{B}_4 = \frac{-\hat{x} + \hat{y}}{\sqrt{2}} \end{array}\right\} \text{so } x \text{ components cancel}$$

$$\bar{B}_T = 4|\bar{B}| \cdot \frac{\hat{y}}{\sqrt{2}} = 80\,\mu\text{T}\,\hat{y}$$

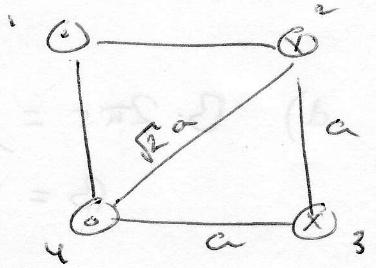
35. $\frac{F_{ba}}{L} = \mu_0 \frac{I_a I_b}{2\pi d}\hat{r}$ $\qquad d = \sqrt{d_1^2 + d_2^2} -$

$\hat{r} = \frac{d_2\hat{x} \mp d_1\hat{y}}{\sqrt{d_1^2+d_2^2}}$

in $\hat{x}$ direction, force is

$\frac{F}{L} = \left(\mu_0 \frac{I_a I_b}{2\pi d^2}\right) d_2\hat{x} = 88 \times 10^{-12}\ N/m$

37.



$I = 7.5\ A$, $a = 13.5\ cm$

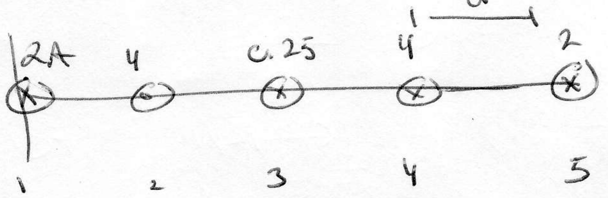
$\frac{\bar{F}}{L}_{1,4} = \mu_0 \frac{I^2}{2\pi a} + \hat{y}$ (attraction)

$\frac{\bar{F}}{L}_{3,4} = \mu_0 \frac{I^2}{2\pi a}(-\hat{x})$ (repulsion)

$\frac{\bar{F}}{L}_{2,4} = \left(\mu_0 \frac{I^2}{2\pi\sqrt{2}a}\right)\left(\frac{-a\hat{x} - a\hat{y}}{\sqrt{2}\,a}\right)$

$\frac{F}{L}_{Total} = -125\,\mu T\ \hat{x} + 41\,\mu T\ \hat{y}$

39.



, $d = 0.5\ m$

$\frac{\bar{F}_{13}}{L} = \mu_0 \frac{I_1 I_3}{2\pi(2d)} - \hat{x}$ $\qquad \frac{\vec{F}_{23}}{L} = \mu_0 \frac{I_2 I_3}{2\pi d}(+\hat{x})$

$\frac{\vec{F}_{43}}{L} = \mu_0 \frac{I_4 I_3}{2\pi d} + \hat{x}$ $\qquad \frac{\vec{F}_{53}}{L} = \mu_0 \frac{I_5 I_3}{2\pi(2d)}(+\hat{x})$

$\frac{\vec{F}_T}{L} = +0.8\,\mu\ N/m\ \hat{x}$

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43. $\int \bar{B} \cdot d\bar{l} = \mu_0 I_{encl}$ I is uniformly distributed over area, so in radius $= r$, have fraction of current:

$I_0 \cdot \frac{\pi r^2}{\pi a^2}$, $I_0 = 170$ A

$\therefore \quad B(2\pi r) = \mu_0 I_0 \frac{\pi r^2}{\pi a^2}$

$$B = \frac{\mu_0 I_0 r}{2\pi a^2}$$

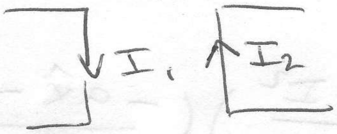
a) $B = 0$ b) $B = 0.85$ mT c) 1.7 mT d) $B \cdot 2\pi r = \mu_0 (170)$

$B = 0.85$ mT

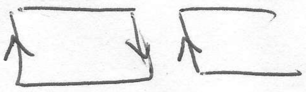
44. $\int \bar{B} \cdot d\bar{l} = \mu_0 I_{encl}$

a) $\int \bar{B} \cdot d\bar{l} = \mu_0(-I_1 + I_2)$

$= -2\mu_0$ T·m



b)



$\int \bar{B} \cdot d\bar{l} = \mu_0(\mp I_1 \mp I_{3,1} \mp I_2)$

$= -13\mu_0$ T·m

45. a) $\int \bar{B}\, d\bar{l} = \mu_0 I_{encl}$

$= \mu_0(-2 - 2 + 2) = -2\mu_0$ Tm

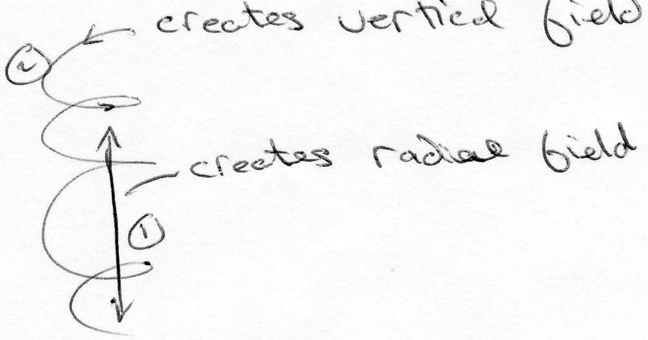
b) $I_{encl} = 0 \rightarrow \int \bar{B} \cdot d\bar{l} = 0$

50. $B = \mu_0 i n$, $n = \frac{N}{L}$

$= (\mu_0)(3.6)\left(\frac{1200}{0.95}\right) = 5.7\,mT$

51. $B = \mu_0 i \frac{N}{L} = 3 \times 10^{-4}\,T$

55.



For 45°, need $|B_1| = |B_2|$

$B_1 \Rightarrow \oint B_1\,dl = \mu_0 I_{1,encl}$

$B_1 \cdot 2\pi r = \mu_0 6$

$|B_1| = \frac{6\mu_0}{2\pi r}$

$B_2 = \mu_0 i_2 n$, $i_2 = 0.02\,A$

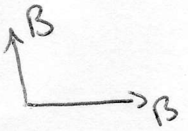
$n = 10$ turns/cm

So have $\mu_0 i_2 n = \frac{6\mu_0}{2\pi r}$

$r = 4.7$ cm

a)

b) Have



i.e. $B\hat{x} + B\hat{y}$ and so mag is

$\sqrt{B^2 + B^2} = \sqrt{2}\,B$

where $B = \mu_0 i_2 n = \frac{6\mu_0}{2\pi r}$