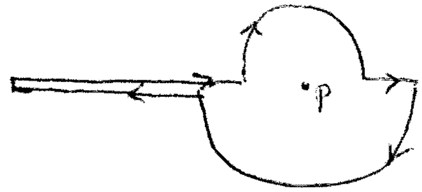
17.P.45



The straight wires do not contribute to the field at P, because the $d\vec{l} \times \hat{r}$ term in Biot-Savart is zero.

The field due to a full circle at its center is $B = \frac{\mu_0 I}{2R}$

For a semicircle, the field is $\frac{1}{2}\frac{\mu_0 I}{2R} = \frac{\mu_0 I}{4R}$

By the right hand rule, both semicircles give fields at P that are into the page.

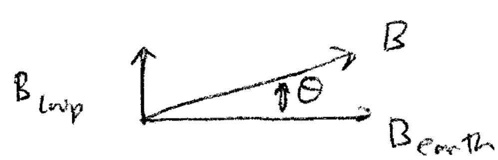
$$B = \frac{\mu_0 I}{4R_1} + \frac{\mu_0 I}{4R_2} = \frac{\mu_0 I}{4}\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \quad \otimes$$

17. P. 49

$$B = N\left(\frac{\mu_0 I}{2R}\right) = (3\text{ turns})\left(\frac{(4\pi \times 10^{-7})(0.25A)}{2(0.15m)}\right)$$

$$= 3.1 \times 10^{-6}\ T \quad \otimes \text{ into page}$$

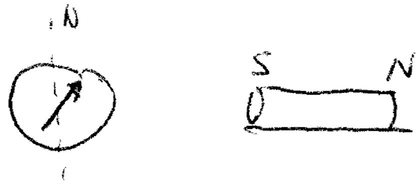
From the top view



$$\tan\theta = \frac{B_{loop}}{B_{earth}} = \frac{3.1 \times 10^{-6} T}{2 \times 10^{-5} T} = 0.157$$

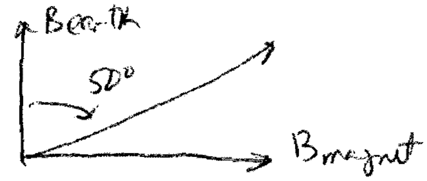
$\theta = 8.9°$ deflection is inward

17.P.50



(a) The N pole of the compass needle is pulled toward the bar magnet, so the nearer pole of the magnet must be a S pole

(b)

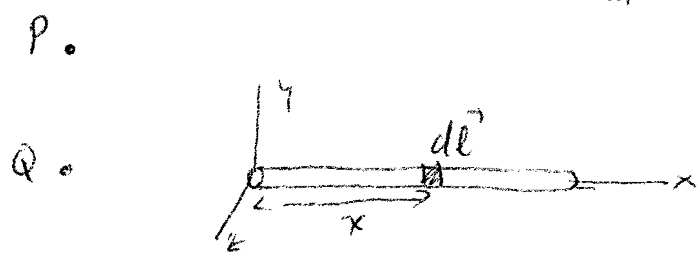


$$\tan 50° = \frac{B_{magnet}}{B_{earth}} \Rightarrow$$

$$B_{magnet} = B_{earth} \tan 50° = 2.4 \times 10^{-5}\ T$$

$$B_{magnet} = \frac{\mu_0}{4\pi}\frac{2\mu}{r^3} \Rightarrow \mu = \frac{B_{magnet}\, r^3}{2\frac{\mu_0}{4\pi}} = \frac{(2.4\times 10^{-5} T)(0.15 m)^3}{2\,(10^{-7})} = 0.49\ A\,m^2$$

17.P.55



$$d\vec{l} = \langle dx, 0, 0\rangle$$

(a) $B_Q = 0$ because $d\vec{l} \times \hat{r} = 0$ in Biot-Savart law.

(b) The vector from $d\vec{l}$ to P is $\vec{r} = \langle -w, h, 0\rangle - \langle x, 0, 0\rangle = \langle -w-x, h, 0\rangle$

$$\hat{r} = \frac{\vec{r}}{|\vec{r}|} = \frac{\langle -w-x, h, 0\rangle}{\sqrt{(w+x)^2+h^2}}$$

$$d\vec{l} \times \hat{r} = \langle dx, 0, 0\rangle \times \frac{\langle -w-x, h, 0\rangle}{\sqrt{(w+x)^2+h^2}} = \frac{\langle 0, 0, h\,dx\rangle}{\sqrt{(w+x)^2+h^2}}$$

$$d\vec{B} = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \hat{r}}{r^2} = \frac{\mu_0 I}{4\pi} \frac{1}{(w+x)^2+h^2} \frac{\langle 0, 0, h\,dx\rangle}{\sqrt{(w+x)^2+h^2}}$$

$\vec{B}$ has only a z component

$$B_z = \frac{\mu_0 I}{4\pi} \int_0^d \frac{h\,dx}{\left[(w+x)^2 + h^2\right]^{3/2}}$$