P25

$I = 12\,A$

a) $I = |q|\,i$, $i = \frac{I}{|q|} = \frac{I}{e} = \frac{12\,A}{1.6\times10^{-19}\,C}$

$\boxed{i = 7.5\times10^{19}\ \frac{e^-}{s}}$

b) left (opposite I)

c) $\bar{v} = uE = (2.1\times10^{-4})(0.15)$

$\boxed{\bar{v} = 3.15\times10^{-5}\ \frac{m}{s}}$

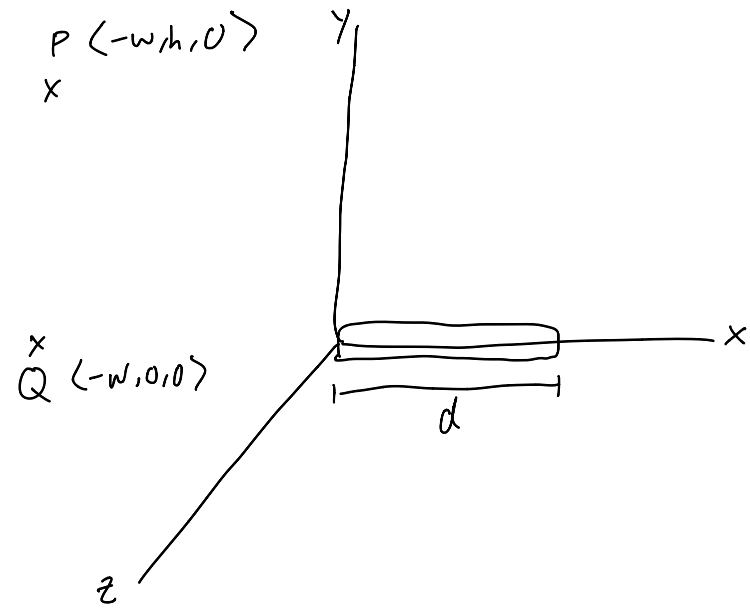
P31

$|\vec{B}| = \frac{\mu_0 I}{2\pi r}$, $I = 0.9A$

$r = 0.035$

$\boxed{|\vec{B}| = 5.14\times10^{-6}\ T}$

P 37



a) $$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{\ell} \times \hat{r}}{r^2}$$

$$d\vec{\ell} = dx\,\hat{x}$$

$$\vec{r} = \vec{r}_{obs} - \vec{r}_{src} = \langle -w,0,0\rangle - \langle x,0,0\rangle = \langle -w-x,0,0\rangle$$

$$|\vec{r}| = w+x$$

$$\hat{r} = \langle -1,0,0\rangle$$

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

$$\hat{x} \times \langle -1,0,0\rangle = -\hat{x} \times \hat{x} = 0$$

$$d\vec{B} = 0 \,,\quad \vec{B} = 0$$

b)

$d\vec{l}$ is the same

$$\vec{r} = \langle -w, h, 0 \rangle - \langle x, 0, 0 \rangle$$

$$\vec{r} = \langle -w-x, h, 0 \rangle$$

$$|\vec{r}| = \sqrt{(w+x)^2 + h^2}$$

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I\, dx\, \hat{x} \times \langle -w-x, h, 0 \rangle}{\left[(w+x)^2 + h^2\right]^{3/2}}$$

$$\hat{x} \times \langle -(w+x), h, 0 \rangle = \hat{x} \times \left[-(w+x)\hat{x} + h\hat{y}\right]$$

$$= \cancel{-(w+x)\hat{x} \times \hat{x}} + h\hat{x} \times \hat{y} = h\hat{z}$$

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

$$\boxed{\vec{B} = \frac{\mu_0 I h}{4\pi} \int_0^d \frac{dx}{\left[(w+x)^2 + h^2\right]^{3/2}} \hat{z}}$$

P42 $\left|\vec{B}_{loop}\right| = \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{(z^2+R^2)^{3/2}}$

at center: $z = 0$

$$\left|\vec{B}\right| = \frac{\mu_0}{4\pi} \frac{N 2\pi R^2 I}{R^3} = N\frac{\mu_0}{4\pi}\frac{2\pi I}{R}$$

$$= N\frac{\mu_0}{2}\frac{I}{R}$$

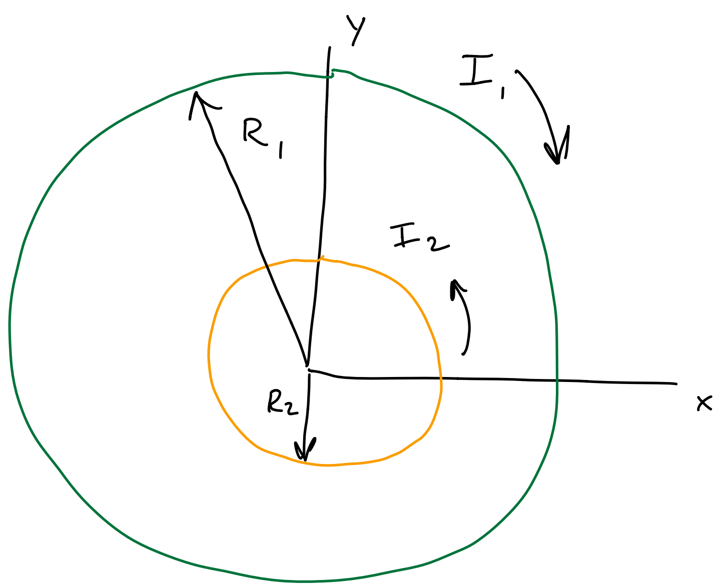
$N = 100$

$I = 4A$

$R = 5\times10^{-2}\,m$

$$\boxed{\vec{B} = 5.03\times10^{-3}\ T \quad \odot \text{ out of page}}$$

P43



$$\vec{B}_{net} = \vec{B}_1 + \vec{B}_2$$

$$\left|\vec{B}_{loop}\right| = \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{(z^2+R^2)^{3/2}}, \quad z = 0$$

$$\left|\vec{B}_1\right| = \frac{\mu_0}{4\pi} \frac{2\pi R_1^2 I_1}{R_1^3} = \frac{\mu_0}{2} \frac{I_1}{R_1}$$

By right hand rule, $\vec{B}_1$ points into page $(-\hat{z})$

$$\vec{B}_1 = -\frac{\mu_0}{2} \frac{I_1}{R_1} \hat{z}$$

$$\vec{B}_2 = \frac{\mu_0}{2} \frac{I_2}{R_2} \hat{z}$$

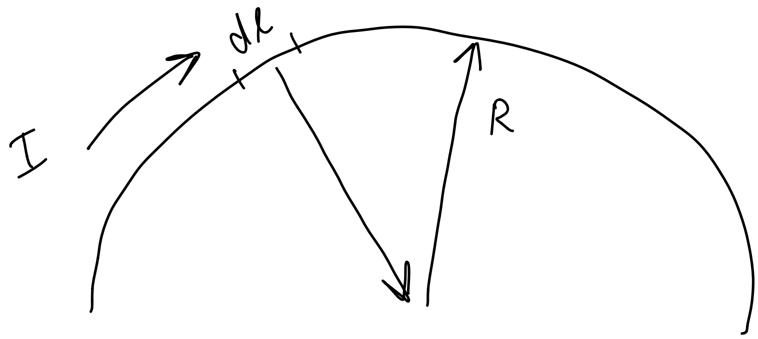
$$\vec{B} = \frac{\mu_0}{2}\left(-\frac{I_1}{R_1} + \frac{I_2}{R_2}\right) \hat{z}$$

$$-\frac{I_1}{R_1} + \frac{I_2}{R_2} = 0$$

$$I_2 = \frac{R_2}{R_1} I_1 = \frac{1}{4} I_1 = 1.5\,A$$

P 45

Superposition of hemispheres



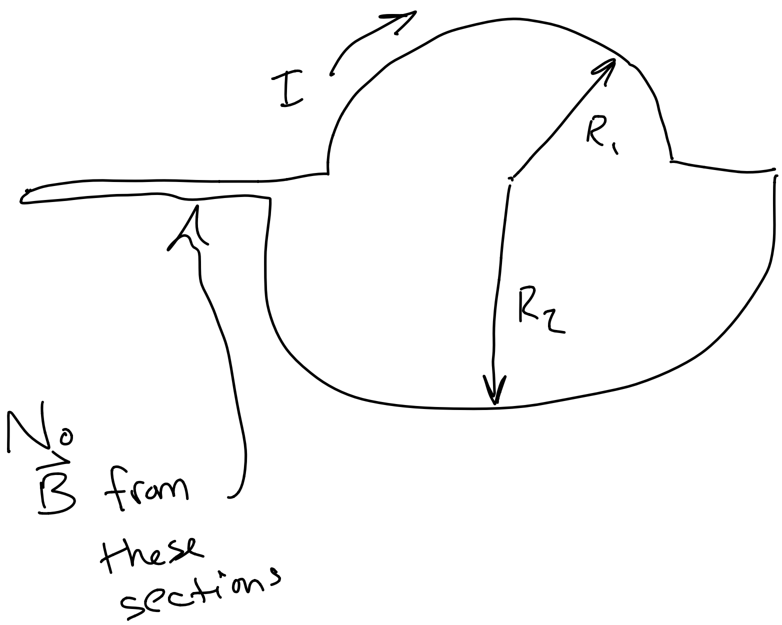
$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \hat{r}}{r^2}$$

$$d\vec{l} \times \hat{r} = dl \text{ into the page } (\otimes)$$

$$|d\vec{l}| = R\, d\phi$$

$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{R\, d\phi}{R^2} = \frac{\mu_0 I}{4\pi R} d\phi$$

$$\vec{B} = \frac{\mu_0 I}{4\pi R} \int_0^{\pi} d\phi = \frac{\mu_0 I}{4R} \otimes$$

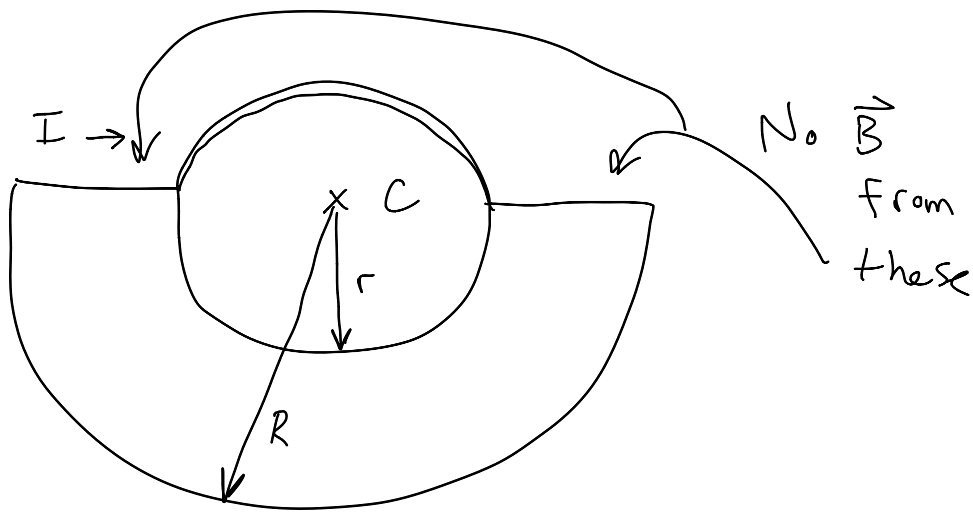


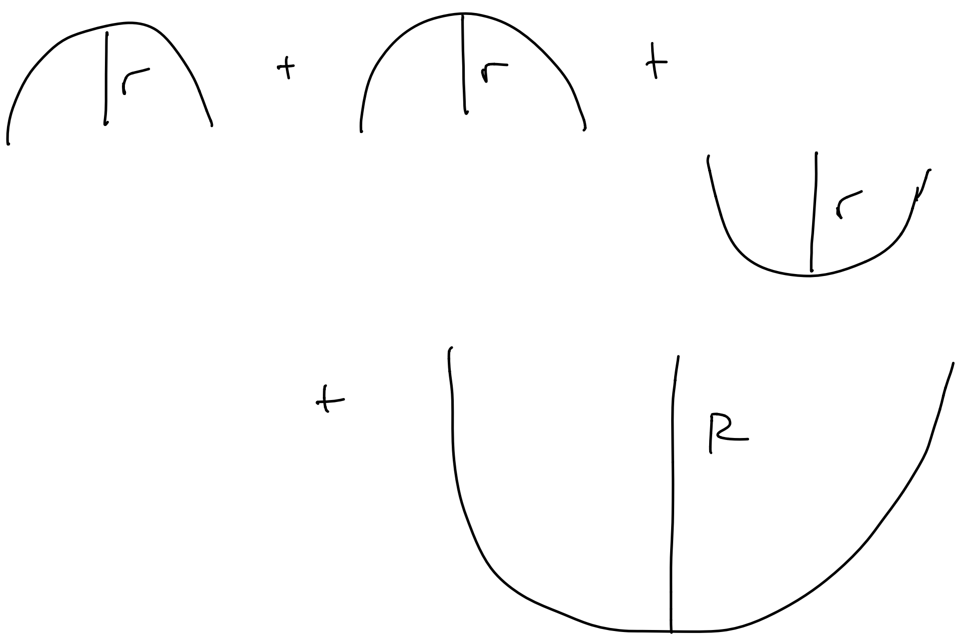
$$\vec{B} = \vec{B}_1 + \vec{B}_2$$

$$= \frac{\mu_0 I}{4R_1} \otimes + \frac{\mu_0 I}{4R_2} \otimes$$

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

P51





$$\vec{B} = \frac{\mu_0 I}{4}\left(\frac{1}{r} + \frac{1}{r} + \frac{1}{r} + \frac{1}{R}\right) \otimes$$

$$\vec{B} = \frac{\mu_0 I}{4}\left(\frac{3}{r} + \frac{1}{R}\right) \otimes$$