28.6

$$B_{total} = B + B' = \frac{\mu_0}{4\pi}\left(\frac{qv}{d^2} + \frac{q'v'}{d^2}\right)$$

$$\Rightarrow B = \frac{\mu_0}{4\pi}\left[\frac{(8.0\times10^{-16}\,C)(4.5\times10^{6}\,m/s)}{(0.120\,m)^2} + \frac{(3.0\times10^{-6}\,C)(9.0\times10^{6}\,m/s)}{(0.120\,m)^2}\right]$$

$\therefore$ $B = 4.38\times10^{-4}$ T, into the page

28.23

Total B = vector sum of the constant magnetic field and the wire's magnetic field.

So (a) At (0, 0, 1 m), $\vec{B} = \vec{B}_0 - \frac{\mu_0 I}{2\pi r}\hat{i}$

$$= (1.50\times10^{-6}\,T)\hat{i} - \frac{\mu_0}{2\pi}\frac{(8.00\,A)}{(1.00\,m)}\hat{i}$$

$$= -(1.0\times10^{-7}\,T)\hat{i}$$

(b) At (1 m, 0, 0); $\vec{B} = \vec{B}_0 + \frac{\mu_0 I}{2\pi r}\hat{k}$

$$= (1.50\times10^{-6}\,T)\hat{i} + \frac{\mu_0}{2\pi}\frac{(8.00\,A)}{(1.00\,m)}\hat{k}$$

$|\vec{B}| = 2.19\times10^{-6}$ T, at $\theta = 46.8^\circ$ from x to z.

(c) At (0, 0, −0.25 m),

$$\vec{B} = \vec{B}_0 + \frac{\mu_0 I}{2\pi r}\hat{i}$$

$$= (7.9\times10^{-6}\,T)\hat{i}$$

28.31

(a) $F = \dfrac{\mu_0 I_1 I_2 L}{2\pi r} = \dfrac{\mu_0 (5.00\ A)(2.00\ A)(1.20\ m)}{2\pi (0.400\ m)}$

$= 6.00 \times 10^{-6}\ N$

The force is repulsive since the currents are in opposite directions.

(b) Doubling the currents makes the force increase by a factor of <u>four</u> to $F = 2.40 \times 10^{-5}\ N$.

28.42

We will travel around the loops in the counterclockwise direction.

(a) $I_{encl} = 0 \Rightarrow \oint \vec{B} \cdot d\vec{l} = 0$

(b) $I_{encl} = -I_1 = -4.0\ A$

$\Rightarrow \oint \vec{B} \cdot d\vec{l} = -\mu_0 (4.0\ A)$

$= -5.03 \times 10^{-6}\ T \cdot m$

(c) $I_{encl} = -I_1 + I_2 = -4.0\ A + 6.0\ A = 2.0\ A$

$\Rightarrow \oint \vec{B} \cdot d\vec{l} = \mu_0 (2.0\ A) = 2.51 \times 10^{-6}\ T \cdot m$

(d) $I_{encl} = -I_1 + I_2 + I_3 = 4.0\ A$

$\Rightarrow \oint \vec{B} \cdot d\vec{l} = \mu_0 (4.0\ A)$

$= 5.03 \times 10^{-6}\ T \cdot m$

Using Ampere's law in each case, the sign was determined by using the right-hand rule.

28.45

Consider a coaxial cable where the currents run in opposite directions.

(a) For $a < r < b$,

$$I_{encl} = I \Rightarrow \oint \vec{B} \cdot \vec{dl} = \mu_0 I$$

$$\Rightarrow B 2\pi r = \mu_0 I$$

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

(b) For $r > c$, enclosed current is zero, so the magnetic field is also zero.

28.83

(a) Below the sheet, all the magnetic field contributions from different wires add up to produce a magnetic field that points in the positive x-direction. (Components in the z-direction cancel.) From Ampere's law, $\vec{B}$ is anti-symmetrical above & below the current sheet. The legs of the path perpendicular contribute nothing to the integral.

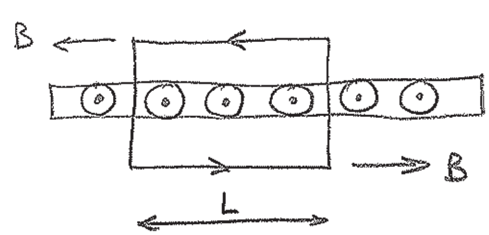
So at a distance "a" beneath the sheet, the magnetic field is

$$I_{encl} = nLI \Rightarrow$$

$$\oint \vec{B} \cdot d\vec{l} = B2L = \mu_0 nLI \Rightarrow$$

$$B = \frac{\mu_0 n I}{2} \text{ in } +\hat{x} \text{ direction.}$$

NB: No dependence on "a".



(b) The field has the same magnitude above the sheet, but points in the negative x-direction.