33.61. Model: Electric and magnetic fields exert forces on a moving charge. The fields are uniform throughout the region.

Visualize: Please refer to Figure P33.61.

Solve: **(a)** We will first find the net force on the antiproton, and then find the net acceleration using Newton's second law. The magnitudes of the electric and magnetic forces are

$$F_E = eE = (1.60\times10^{-19}\text{ C})(1000\text{ V/m}) = 1.60\times10^{-16}\text{ N}$$

$$F_B = evB = (1.60\times10^{-19}\text{ C})(500\text{ m/s})(2.5\text{ T}) = 2.00\times10^{-16}\text{ N}$$

The directions of these two forces on the antiproton are opposite. $\vec{F}_E$ points *up* whereas, using the right-hand rule, $\vec{F}_B$ points *down*. Hence,

$$\vec{F}_{net} = (2.0\times10^{-16}\text{ N} - 1.60\times10^{-16}\text{ N, down}) \Rightarrow F_{net} = 0.40\times10^{-16}\text{ N} = ma$$

$$\Rightarrow \vec{a} = \left(\frac{0.40\times10^{-16}\text{ N}}{1.67\times10^{-27}\text{ kg}} = 2.4\times10^{10}\text{ m/s}^2\text{, down}\right)$$

(b) If $\vec{v}$ were reversed, both $\vec{F}_E$ and $\vec{F}_B$ will point *up*. Thus,

$$\vec{F}_{net} = (1.6\times10^{-16}\text{ N} + 2.0\times10^{-16}\text{ N, up}) \Rightarrow \vec{a} = \left(\frac{3.6\times10^{-16}\text{ N}}{1.67\times10^{-27}\text{ kg}} = 2.2\times10^{11}\text{ m/s}^2\text{, up}\right)$$

33.67. Model: A magnetic field exerts a magnetic force on a length of current-carrying wire. We ignore gravitational effects, and focus on the *B* effects.

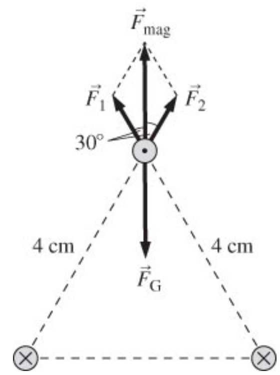
Visualize: Please refer to Figure P33.67. The figure shows a wire in a magnetic field that is directed out of the page. The magnetic force on the wire is therefore to the right and will stretch the springs.

Solve: In static equilibrium, the sum of the forces on the wire is zero:

$$F_{\text{B}} + F_{\text{sp 1}} + F_{\text{sp 2}} = 0\ \text{N} \Rightarrow ILB + (-k\Delta x) + (-k\Delta x) \ \Rightarrow\ I = \frac{2k\Delta x}{LB} = \frac{2(10\ \text{N/m})(0.01\ \text{m})}{(0.20\ \text{m})(0.5\ \text{T})} = 2.0\ \text{A}$$

33.70. Model: The wire will float in the magnetic field if the magnetic force on the wire points upward and has a magnitude *mg*, allowing it to balance the downward gravitational force.

Visualize:



Solve: Each lower wire exerts a repulsive force on the upper wire because the currents are in opposite directions. The currents are of equal magnitude and the distances are equal, so $F_1 = F_2$. Consider segments of the wires of length L. Then the forces are

$$F_1 = F_2 = \frac{\mu_0 L I^2}{2\pi d}$$

The horizontal components of these two forces cancel, so the net magnetic force is upward and of magnitude

$$F_{mag} = 2F_1 \cos 30° = \frac{\mu_0 L I^2 \cos 30°}{\pi d}$$

In equilibrium, this force must exactly balance the downward weight of the wire. The wire's linear mass density is $\mu = 0.050$ kg/m, so the mass of this segment is $m = \mu L$ and its weight is $w = mg = \mu L g$. Equating these gives

$$\frac{\mu_0 L I^2 \cos 30°}{\pi d} = \mu L g \Rightarrow I = \sqrt{\frac{\mu g \pi d}{\mu_0 \cos 30°}} = \sqrt{\frac{(0.050 \text{ kg/m})(9.8 \text{ m/s}^2)\pi(0.040 \text{ m})}{(4\pi \times 10^{-7} \text{ T m/A})\cos 30°}} = 238 \text{ A}$$