PHYS 232
Homework #7 Solutions

29.40 $r = \frac{mv}{qB}$ so $m = \frac{rqB}{v} = \frac{(7.94 \times 10^{-3}\ \text{m})(1.60 \times 10^{-19}\ \text{C})(1.80\ \text{T})}{4.60 \times 10^{5}\ \text{m/s}}$

$$m = 4.97 \times 10^{-27}\ \text{kg}\left(\frac{1\ \text{u}}{1.66 \times 10^{-27}\ \text{kg}}\right) = \boxed{2.99\ \text{u}}$$

The particle is singly ionized: either a tritium ion, $\boxed{{}^{3}_{1}\text{H}^{+}}$, or a helium ion, $\boxed{{}^{3}_{2}\text{He}^{+}}$.

29.63 Call the length of the rod L and the tension in each wire alone $T/2$. Then, at equilibrium:

$\Sigma F_x = T\sin\theta - ILB\sin 90.0^0 = 0$ or $T\sin\theta = ILB$

$\Sigma F_y = T\cos\theta - mg = 0$, or $T\cos\theta = mg$

Therefore, $\tan\theta = \frac{ILB}{mg} = \frac{IB}{(m/L)g}$ or $B = \frac{(m/L)g}{I}\tan\theta$

$$B = \frac{(0.0100\ \text{kg/m})(9.80\ \text{m/s}^2)}{5.00\ \text{A}}\tan(45.0^\circ) = \boxed{19.6\ \text{mT}}$$

30.7 We can think of the total magnetic field as the superposition of the field due to the long straight wire (having magnitude $\mu_0 I/2\pi R$ and directed into the page) and the field due to the circular loop (having magnitude $\mu_0 I/2R$ and directed into the page). The resultant magnetic field is:

$$B = \left(1 + \frac{1}{\pi}\right)\frac{\mu_0 I}{2R} = \left(1 + \frac{1}{\pi}\right)\frac{\left(4\pi \times 10^{-7}\ \mathrm{T\cdot m/A}\right)(7.00\ \mathrm{A})}{2(0.100\ \mathrm{m})} = 5.80 \times 10^{-5}\ \mathrm{T}$$

or $\boxed{\mathbf{B} = 58.0\ \mu\mathrm{T}\quad \text{(directed into the page)}}$

30.21 From Ampère's law, the magnetic field at point *a* is given by $B_a = \mu_0 I_a/2\pi r_a$, where I_a is the net current flowing through the area of the circle of radius r_a. In this case, $I_a = 1.00$ A out of the page (the current in the inner conductor), so

$$B_a = \frac{\left(4\pi \times 10^{-7}\ \mathrm{T\cdot m/A}\right)(1.00\ \mathrm{A})}{2\pi(1.00 \times 10^{-3}\ \mathrm{m})} = \boxed{200\ \mu\mathrm{T}\ \text{toward top of page}}$$

Similarly at point *b*: $B_b = \dfrac{\mu_0 I_b}{2\pi r_b}$, where I_b is the net current flowing through the area of the circle having radius r_b.

Taking out of the page as positive, $I_b = 1.00\ \mathrm{A} - 3.00\ \mathrm{A} = -2.00\ \mathrm{A}$, or $I_b = 2.00$ A into the page. Therefore,

$$B_b = \frac{(4\pi \times 10^{-7}\ \mathrm{T\cdot m/A})(2.00\ \mathrm{A})}{2\pi(3.00 \times 10^{-3}\ \mathrm{m})} = \boxed{133\ \mu\mathrm{T}\ \text{toward bottom of page}}$$

30.66 The central wire creates field $\mathbf{B} = \mu_0 I_1/2\pi R$ counterclockwise. The curved portions of the loop feels no force since $\mathbf{l} \times \mathbf{B} = 0$ there. The straight portions both feel $I\mathbf{l} \times \mathbf{B}$ forces to the right, amounting to

$$\mathbf{F}_B = I_2\, 2L\, \frac{\mu_0 I_1}{2\pi R} = \boxed{\frac{\mu_0 I_1 I_2 L}{\pi R}\ \text{to the right}}$$