

49. (a) We use Eq. 29-24. The inner radius is $r = 15.0$ cm, so the field there is

$$B = \frac{\mu_0 i N}{2\pi r} = \frac{(4\pi \times 10^{-7} \text{ T}\cdot\text{m/A})(0.800 \text{ A})(500)}{2\pi(0.150 \text{ m})} = 5.33 \times 10^{-4} \text{ T}.$$

(b) The outer radius is $r = 20.0$ cm. The field there is

$$B = \frac{\mu_0 i N}{2\pi r} = \frac{(4\pi \times 10^{-7} \text{ T}\cdot\text{m/A})(0.800 \text{ A})(500)}{2\pi(0.200 \text{ m})} = 4.00 \times 10^{-4} \text{ T}.$$

51. It is possible (though tedious) to use Eq. 29-26 and evaluate the contributions (with the intent to sum them) of all 200 loops to the field at, say, the center of the solenoid. This would make use of all the information given in the problem statement, but this is not the method that the student is expected to use here. Instead, Eq. 29-23 for the ideal solenoid (which does not make use of the coil diameter) is the preferred method:

$$B = \mu_0 i n = \mu_0 i \left(\frac{N}{\ell} \right)$$

where $i = 0.30$ A, $\ell = 0.25$ m, and $N = 200$. This yields $B = 3.0 \times 10^{-4}$ T.

52. We find N , the number of turns of the solenoid, from the magnetic field $B = \mu_0 i n = \mu_0 i N / \ell : N = B \ell / \mu_0 i$. Thus, the total length of wire used in making the solenoid is

$$2\pi r N = \frac{2\pi r B \ell}{\mu_0 i} = \frac{2\pi(2.60 \times 10^{-2} \text{ m})(23.0 \times 10^{-3} \text{ T})(1.30 \text{ m})}{2(4\pi \times 10^{-7} \text{ T}\cdot\text{m/A})(18.0 \text{ A})} = 108 \text{ m}.$$

53. The orbital radius for the electron is

$$r = \frac{mv}{eB} = \frac{mv}{e\mu_0 n i}$$

which we solve for i :

$$i = \frac{mv}{e\mu_0 n r} = \frac{(9.11 \times 10^{-31} \text{ kg})(0.0460)(3.00 \times 10^8 \text{ m/s})}{(1.60 \times 10^{-19} \text{ C})(4\pi \times 10^{-7} \text{ T}\cdot\text{m/A})(100/0.0100 \text{ m})(2.30 \times 10^{-2} \text{ m})} \\ = 0.272 \text{ A}.$$

59. The magnitude of the magnetic dipole moment is given by $\mu = NiA$, where N is the number of turns, i is the current, and A is the area. We use $A = \pi R^2$, where R is the radius. Thus,

$$\mu = (200)(0.30 \text{ A})\pi(0.050 \text{ m})^2 = 0.47 \text{ A} \cdot \text{m}^2 .$$