8.14: Sources of Magnetic Fields (Answers)

Check Your Understanding

12.1. 1.41 meters

12.2. $\frac{\mu_0 I}{2R}$

12.3. 4 amps flowing out of the page

12.4. Both have a force per unit length of $9.23 \times 10^{-12} N/m$

12.5. 0.608 meters

12.6. In these cases the integrals around the Ampèrian loop are very difficult because there is no symmetry, so this method would not be useful.

12.7. a. 1.00382;

b. 1.00015

12.8. a. $1.0 \times 10^{-4} T$;

b. 0.60 T;

c. 6.0×10^{3}

Conceptual Questions

1. Biot-Savart law's advantage is that it works with any magnetic field produced by a current loop. The disadvantage is that it can take a long time.

3. If you were to go to the start of a line segment and calculate the angle θ to be approximately 0°, the wire can be considered infinite. This judgment is based also on the precision you need in the result.

5. You would make sure the currents flow perpendicular to one another.

7. A magnetic field line gives the direction of the magnetic field at any point in space. The density of magnetic field lines indicates the strength of the magnetic field.

9. The spring reduces in length since each coil with have a north pole-produced magnetic field next to a south pole of the next coil.

11. Ampère's law is valid for all closed paths, but it is not useful for calculating fields when the magnetic field produced lacks symmetry that can be exploited by a suitable choice of path.

13. If there is no current inside the loop, there is no magnetic field (see Ampère's law). Outside the pipe, there may be an enclosed current through the copper pipe, so the magnetic field may not be zero outside the pipe.

15. The bar magnet will then become two magnets, each with their own north and south poles. There are no magnetic monopoles or single pole magnets.

Problems

17. $5.66 \times 10^{-5} T$

19. $B = \frac{\mu_o I}{8}(\frac{1}{a} - \frac{1}{b})$ out of the page

21. $a = \frac{2R}{\pi}$; the current in the wire to the right must flow up the page.

23. 20 A

25. Both answers have the magnitude of magnetic field of $4.5 \times 10^{-5} T$.

27. At P1, the net magnetic field is zero. At P2, $B = \frac{3\mu_o I}{8\pi a}$ into the page.

29. The magnetic field is at a minimum at distance **a** from the top wire, or half-way between the wires.

31. a. $F/l = 8 \times 10^{-6}$ N/m away from the other wire;

b. $F/l = 8 \times 10^{-6}$ N/m toward the other wire

33. $B = \frac{\mu_o I a}{2\pi b^2}$ into the page

35. 0.019 m

37. $6.28 \times 10^{-5} T$

39. $B = \frac{\mu_o I R^2}{\left(\left(\frac{d}{2}\right)^2 + R^2\right)^{3/2}}$

41. a. $\mu 0 I$;

b. 0;

c. $\mu 0 I$;

d. 0

43. a. $3\mu_0 I$;

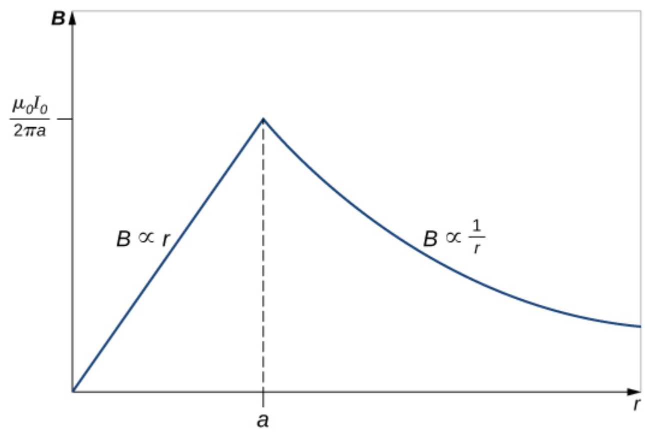
b. 0;

c. $7\mu_0 I$;

d. $-2\mu_0 I$

45. at the radius **R**

47.



49. $B = 1.3 \times 10^{-2} T$

51. roughly eight turns per cm

53. $B = \frac{1}{2}\mu_0 n I$

55. 0.0181 A

57. 0.0008 T

59. 317.31

61. $2.1 \times 10^{-4} A \cdot m^2 \;\; 2.7 A$

63. 0.18 T

Additional Problems

65. $B = 6.93 \times 10^{-5} T$

67. $3.2 \times 10^{-19} N$ in an arc away from the wire

69. a. above and below $B = \mu_0 j$, in the middle $B = 0$;

b. above and below $B = 0$, in the middle $B = \mu_0 j$

71. $\frac{dB}{B} = -\frac{dr}{r}$

73. a. 52778 turns;

b. 0.10 T

75. $B_1(x) = \frac{\mu_0 I R^2}{2(R^2 + z^2)^{3/2}}$

77. $B = \frac{\mu_0 \sigma \omega}{2} R$

79. derivation

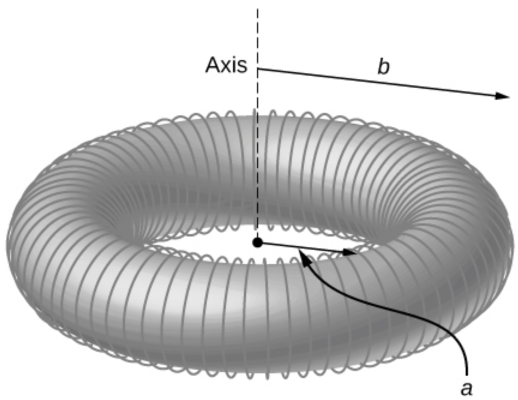
81. derivation

83. As the radial distance goes to infinity, the magnetic fields of each of these formulae go to zero.

85. a. $B = \frac{\mu_0 I}{2\pi r}$;

b. $B = \frac{\mu_0 J_0 r^2}{3R}$

87. $B(r) = \mu_0 NI/2\pi r$



Challenge Problems

89. $B = \frac{\mu_0 I}{2\pi x}$.

91. a. $B = \frac{\mu_0 \sigma \omega}{2} [\frac{2h^2 + R^2}{\sqrt{R^2 + h^0}}]$;

b. $B = 4.09 \times 10^{-5} T$, 82% of Earth's magnetic field