Chapter 22

Problems & Exercises

1.

(a) Left (West)

(b) Into the page

(c) Up (North)

(d) No force

(e) Right (East)

(f) Down (South)

3.

(a) East (right)

(b) Into page

(c) South (down)

5.

(a) Into page

(b) West (left)

(c) Out of page

7.

7.50×10^{-7} N perpendicular to both the magnetic field lines and the velocity

9.

(a) 3.01×10^{-5} T

(b) This is slightly less then the magnetic field strength of 5×10^{-5} T at the surface of the Earth, so it is consistent.

11.

(a) 6.67×10^{-10} C (taking the Earth's field to be 5.00×10^{-5} T)

(b) Less than typical static, therefore difficult

12.

4.27 m

14.

(a) 0.261 T

(b) This strength is definitely obtainable with today's technology. Magnetic field strengths of 0.500 T are obtainable with permanent magnets.

16.

4.36×10^{-4} m

18.

(a) 3.00 kV/m

(b) 30.0 V

20.

0.173 m

22.

7.50×10^{-4} V

24.

(a) 1.18×10^{3} m/s

(b) Once established, the Hall emf pushes charges one direction and the magnetic force acts in the opposite direction resulting in no net force on the charges. Therefore, no current flows in the direction of the Hall emf. This is the same as in a current-carrying conductor—current does not flow in the direction of the Hall emf.

26.

11.3 mV

28.

1.16 V

30.

2.00 T

31.

(a) west (left)

(b) into page

(c) north (up)

(d) no force

(e) east (right)

(f) south (down)

33.

(a) into page

(b) west (left)

(c) out of page

35.

(a) 2.50 N

(b) This is about half a pound of force per 100 m of wire, which is much less than the weight of the wire itself. Therefore, it does not cause any special concerns.

37.

1.80 T

39.

(a) 30º

(b) 4.80 N

41.

(a) decreases by 5.00% if B decreases by 5.00%

(b) 5.26% increase

43.

10.0 A

45.

$A \cdot m^2 \cdot T = A \cdot m^2 \left(\frac{N}{A \cdot m}\right) = N \cdot m.$

47.

$3.48 \times 10^{-26}\ N \cdot m$

49.

(a) 0.666 N $\cdot\, m$ west

(b) This is not a very significant torque, so practical use would be limited. Also, the current would need to be alternated to make the loop rotate (otherwise it would oscillate).

50.

(a) 8.53 N, repulsive

(b) This force is repulsive and therefore there is never a risk that the two wires will touch and short circuit.

52.

400 A in the opposite direction

54.

(a) 1.67×10^{-3} N/m

(b) 3.33×10^{-3} N/m

(c) Repulsive

(d) No, these are very small forces

56.

(a) Top wire: 2.65×10^{-4} N/m s, 10.9 to left of up

(b) Lower left wire: 3.61×10^{-4} N/m, 13.9 down from right

(c) Lower right wire: 3.46×10^{-4} N/m, 30.0 down from left

58.

(a) right-into page, left-out of page

(b) right-out of page, left-into page

(c) right-out of page, left-into page

60.

(a) clockwise

(b) clockwise as seen from the left

(c) clockwise as seen from the right

61.

1.01×10^{13} T

63.

(a) 4.80×10^{-4} T

(b) Zero

(c) If the wires are not paired, the field is about 10 times stronger than Earth's magnetic field and so could severely disrupt the use of a compass.

65.

39.8 A

67.

(a) 3.14×10^{-5} T

(b) 0.314 T

69.

7.55×10^{-5} T, 23.4º

71.

10.0 A

73.

(a) 9.09×10^{-7} N upward

(b) 3.03×10^{-5} $\mathrm{m/s^2}$

75.

60.2 cm

77.

(a) 1.02×10^{3} $\mathrm{N/m^2}$

(b) Not a significant fraction of an atmosphere

79.

$17.0 \times 10^{-4}\%/^{\mathrm{o}}\mathrm{C}$

81.

18.3 MHz

83.

(a) Straight up

(b) 6.00×10^{-4} N/m

(c) 94.1 m

(d)2.47 Ω/m, 49.4 V/m

85.

(a) 571 C

(b) Impossible to have such a large separated charge on such a small object.

(c) The 1.00-N force is much too great to be realistic in the Earth's field.

87.

(a) 2.40×10^{6} m/s

(b) The speed is too high to be practical $\leq 1\%$ speed of light

(c) The assumption that you could reasonably generate such a voltage with a single wire in the Earth's field is unreasonable

89.

(a) 25.0 kA

(b) This current is unreasonably high. It implies a total power delivery in the line of 50.0x10^9 W, which is much too high for standard transmission lines.

(c)100 meters is a long distance to obtain the required field strength. Also coaxial cables are used for transmission lines so that there is virtually no field for DC power lines, because of cancellation from opposing currents. The surveyor's concerns are not a problem for his magnetic field measurements.

92.

(a) $F = qvB\sin\theta$
Since $\sin\theta = 0,\ F = 0$ for the first electron.
For the second and third electrons, $\sin\theta = 1$.
So, $F = (1.60 \times 10^{-19}\text{C})(5.00 \times 10^{7}\text{m/s})(2.00 \times 10^{-7}\text{T}) = 1.60 \times 10^{-18}\text{N}$.

(b) The first electron moves in a straight line. The other two electrons take a circular path.

(c) The first electron will never return to the origin. The other two will return.
$r = \frac{(9.11\times10^{-11})(5.00\times10^{7})}{(1.60\times10^{-19})(2.00\times10^{-7})}\text{m}$
$v = \frac{r}{t}$
$t = \frac{(9.11\times10^{-11})}{(1.60\times10^{-19})(2.00\times10^{-7})}\text{s} = 2.85 \times 10^{15}\text{s}$