11.11: Magnetic Forces and Fields (Answers)

Check Your Understanding

11.1. a. 0 N;

b. $2.4 \times 10^{-14} \hat{k} N$;

c. $2.4 \times 10^{-14} \hat{j} N$;

d. $(7.2\hat{j} + 2.2\hat{k}) \times 10^{-15} N$

11.2. a. $9.6 \times 10^{-12} N$ toward the south;

b. $\frac{w}{Fm} = 1.7 \times 10^{-15}$

11.3. a. bends upward;

b. bends downward

11.4. a. aligned or anti-aligned;

b. perpendicular

11.5. a. 1.1 T;

b. 1.6 T

11.6. 0.32 m

Conceptual Questions

1. Both are field dependent. Electrical force is dependent on charge, whereas magnetic force is dependent on current or rate of charge flow.

3. The magnitude of the proton and electron magnetic forces are the same since they have the same amount of charge. The direction of these forces however are opposite of each other. The accelerations are opposite in direction and the electron has a larger acceleration than the proton due to its smaller mass.

5. The magnetic field must point parallel or anti-parallel to the velocity.

7. A compass points toward the north pole of an electromagnet.

9. Velocity and magnetic field can be set together in any direction. If there is a force, the velocity is perpendicular to it. The magnetic field is also perpendicular to the force if it exists.

11. A force on a wire is exerted by an external magnetic field created by a wire or another magnet.

13. Poor conductors have a lower charge carrier density, n, which, based on the Hall effect formula, relates to a higher Hall potential. Good conductors have a higher charge carrier density, thereby a lower Hall potential.

Problems

15. a. left;

b. into the page;

c. up the page;

d. no force;

e. right;

f. down

17. a. right;

b. into the page;

c. down

19. a. into the page;

b. left;

c. out of the page

21. a. $2.64 \times 10^{-8} N$;

b. The force is very small, so this implies that the effect of static charges on airplanes is negligible.

23. $10.1^\circ; 169.9^\circ$

25. 4.27 m

27. a. $4.80 \times 10^{-19} C$;

b. 3;

c. This ratio must be an integer because charges must be integer numbers of the basic charge of an electron. There are no free charges with values less than this basic charge, and all charges are integer multiples of this basic charge.

29. a. $4.09 \times 10^3 m/s$;

b. $7.83 \times 10^3 m$;

c. $1.75 \times 10^5 m/s$, then, $1.83 \times 10^2 m$;

d. $4.27 m$

31. a. $1.8 \times 10^7 m/s$;

b. $6.8 \times 10^6 eV$;

c. $3.4 \times 10^6 V$

33. a. left;

b. into the page;

c. up;

d. no force;

e. right;

f. down

35. a. into the page;

b. left;

c. out of the page

37. a. 2.50 N;

b. This means that the light-rail power lines must be attached in order not to be moved by the force caused by Earth's magnetic field.

39. a. $\tau = NIAB$, so τ decreases by 5.00% if **B** decreases by 5.00%;

b. 5.26% increase

41. 10.0 A

43. $A \cdot m^2 \cdot T = A \cdot m^2 . \dfrac{N}{A \cdot m} = N \cdot m$

45. $3.48 \times 10^{-26} N \cdot m$

47. $0.666 N \cdot m$

49. $5.8 \times 10^{-7} V$

51. $4.8\times10^{7} C/kg$

53. a. $4.4\times10^{-8} s$;

b. 0.21 m

55. a. $1.92\times10^{-12} J$;

b. 12 MeV;

c. 12 MV;

d. $5.2\times10^{-8} s$;

e. $1.92\times10^{-12} J$, 12 MeV, 12 V, $10.4\times10^{-8} s$

57. a. $2.50\times10^{-}2m$;

b. Yes, this distance between their paths is clearly big enough to separate the U-235 from the U-238, since it is a distance of 2.5 cm.

Additional Problems

59. $-7.2\times10^{-15} N\hat{j}$

61. $9.8\times10^{-5}\hat{j}T$; the magnetic and gravitational forces must balance to maintain dynamic equilibrium

63. $1.13\times10^{-3} T$

65. $1.6\hat{i}-1.4\hat{j}-1.1\hat{k})\times10^{5} V/m$

67. a. circular motion in a north, down plane;

b. $(1.61\hat{j}-0.58\hat{k})\times10^{-14} N$

69. The proton has more mass than the electron; therefore, its radius and period will be larger.

71. $1.3\times10^{-25} kg$

73. 1:0.707:1

75. 1/4

77. a. $2.3\times10^{-4} m$;

b. $1.37\times10^{-4} T$

79. a. 30.0°;

b. 4.80 N

81. a. 0.283 N;

b. 0.4 N;

c. 0 N;

d. 0 N

83. 0 N and 0.012 Nm

85. a. $0.31 Am^{2}$;

b. 0.16 Nm

87. $0.024 Am^{2}$

89. a. $0.16 Am^{2}$;

b. 0.016 Nm;

c. 0.028 J

91. (Proof)

93. $4.65 \times 10^{-7} V$

95. Since $E = Blv$, where the width is twice the radius, $I = 2r, I = 2r, I = nqAv_d, v_d = \frac{I}{nqA} = \frac{I}{nq\pi r^2}$ so $E = B \times 2r \times \frac{I}{nq\pi r^2} = \frac{2IB}{nq\pi r} \propto \frac{1}{r} \propto \frac{1}{d}$. The Hall voltage is inversely proportional to the diameter of the wire.

97. $6.92 \times 10^7 m/s$; 0.602 m

99. a. $2.4 \times 10^{-19} C$;

b. not an integer multiple of e;

c. need to assume all charges have multiples of e, could be other forces not accounted for

101. a. B = 5 T;

b. very large magnet;

c. applying such a large voltage

Challenge Problems

103. $R = (mvsin\theta)/qB; p = (\frac{2\pi m}{eB})vcos\theta$

105. $IaL^2/2$

107. $m = \frac{qB_0^2}{8V_{acc}}x^2$

109. 0.01 N