Answers to selected problems from Essential Physics, Chapter 19

1. (a) The magnetic field is perpendicular to the plane of the page.
   (b) The magnetic field is directed into the page.

3. (a) up (b) The field definitely has an upward component, and it may or may not have a component that is directed east or west. It definitely does not have a component directed north or south.

5. (a) Yes – the force is directed out of the page. (b) No, because the magnetic force that acts on a moving charge is always perpendicular to the velocity of the charge.

7. (a) positive (b) negative (c) into the page

9. (a) Yes. Note that there are more field lines entering the region than are leaving it, an indication that there is a net negative charge in the region behind the screen. (b) No. Because magnetic field lines are continuous loops, there are always an equal number of field lines entering a region as there are emerging from a region. That is not the case in this picture.

11. (a) out of the page (b) into the page (c) wire 2

13. (a) 1.75×10^{-4} N, directed in the plane of the page, at an angle of 60° above the positive *x*-direction.

15. (a) 4.0 N (b) 0 (c) 14.5°

17. (a) $m_2 > m_1 > m_3$ (b) $F_1 = F_2 = F_3$

19. Note that this question was incomplete – you can't answer it unless you know the strength of the magnetic field. Let's assume the magnetic field is B = 2.0 T. In that case, (a) 3.5×10^{-3} s (b) 56 m (c) Passing through the negative y-axis at a distance of 56 m from the origin.

21. (a) 1.7×10^{-5} T (b) Yes, at the point 24 cm to the right of wire 2.

23. 6.3×10^{-6} N/m at an angle of 18° below the positive *x*-axis, assuming the positive *x*-axis is directed right.

25. (a) 5.0×10^{-6} T out of the page (a) 1.0×10^{-6} T out of the page
    (c) 5.0×10^{-7} T out of the page (a) 3.5×10^{-6} T into the page

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29. (a) a > c > b. (b) 1.0×10^{-3} T

31. 5.3×10^{7} m/s

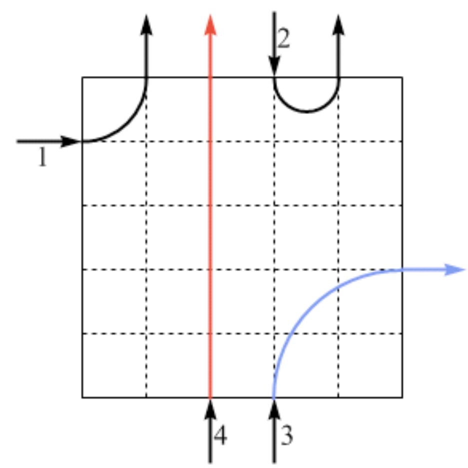
33. (a) The magnets are repelling one another – the field lines at the facing poles curve away from one another, which tells us that the facing poles are like poles. (b) We know like poles are facing one another, but we cannot tell the south poles from the north poles. The iron filings in the picture line up with the field lines, but we can't tell, for instance, whether the right end of the magnet on the right is a north pole, with field lines directed away from it, or a south pole, with field lines directed toward it.

37. (a) The density of field lines passing through the Earth's surface is much higher in the polar regions than it is in other regions of the Earth. Thus, when particles spiral around the field lines, they tend to get carried toward one pole or the other. (b) toward the east.

39. (a) 0 (b) 800 m/s (c) 800 m/s.

41. (a) 3.3×10^{4} m. The axis of the spiral is parallel to the x-axis. (b) 5.2 s
(c) 1.6×10^{5} m

43. (a) into the page (b) The kinetic energy stays the same. The magnetic force is always perpendicular to the velocity. Any force perpendicular to the velocity can only change the direction of the velocity, not its magnitude. Because the speed is constant, the kinetic energy is also constant. (c) positive (d) $v/2$ (e) see the diagram (f) see the diagram (g) particle 3.



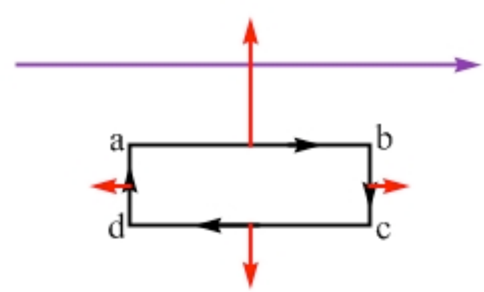
45. (a) into the page. (b) 2.0×10^{-2} T. (c) Faster electrons experience a net force down, so they get deflected down, out of the beam.

47. (a) 4.0×10^{4} m/s (b) 1.7 T.

49. (a) 2 > 3 > 1 (b) wire 1: 4.0×10^{-6} N/m, to the right;
wire 2: 1.6×10^{-5} N/m, to the left; wire 3: 1.2×10^{-5} N/m, to the right

51. (a) Zero force (b) Zero net force

53. (a) The loop is experiencing a non-uniform field from the long straight wire. The magnitude of the field decreases with increasing distance from the wire. (b)



(c) To find the magnetic force on either the left side or the right side, we would have to account for the fact that different points on these sides are different distances from

the long straight wire, and so are experiencing different magnetic fields. To calculate these forces would involve doing calculus. Fortunately, we do not have to do this, because the forces on the left and right sides of the loop cancel one another out.
(d) 3.6×10^{-6} N, directed up. (e) 1.8×10^{-6} N, directed down. (f) 1.8×10^{-6} N, directed up.

55. There are two possible solutions. Either $I_2 = 2I_1$, directed out of the page, or $I_2 = 6I_1$, directed into the page.

57. (a) 2 > 3 > 1 (b) to the right.

59. (a) 4.0×10^{-5} N m (b) 4.0×10^{-5} N m (c) zero

61. The magnitude of the angular acceleration is 107 rad/s^2.