Exercises

P. 233

1. A magnetic field of strength 4.34×10^{-3} T makes electrons deflect into a circular path of radius 1.1×10^{-2} m. The accelerating voltage used to get the electrons up to maximum speed was 200.0 V. If the charge on an electron is 1.6×10^{-19} C, what is the mass of an electron?
2. A beam of protons passes through a magnetic field of strength 4.0×10^{-3} T, and is deflected into a curved path of radius 1.14 m. If the accelerating voltage was 1.0×10^{3} V, what is the mass of a proton?
3. If the proton in **Exercise 2** were replaced by deuterium ions that have twice the mass of a proton but carry the same charge, what would the radius of curvature of the magnetically deflected deuterium ions be, in the same circumstances?
4. Protons are accelerated and made to pass through crossed fields where the electric field is perpendicular to the magnetic field, and the protons are moving at such a speed that the magnetic force just equals the electric force, but is in the opposite direction, so that there is no overall deflection of the beam. What speed do the particles have if $B = 0.50$ T and $E = 5.5 \times 10^{4}$ N/C? (Such a device was used by J. J. Thomson when he was measuring the charge-to-mass ratio of electrons. It is called a **velocity selector.**)

Chapter Review Questions

P. 237

1. Name at least three ferromagnetic elements.
2. If you wanted to accelerate a stationary proton, would you use an electric field or a magnetic field? Explain.
3. Draw a diagram showing a conductor with conventional current moving ***into your page.*** Draw a few sample lines of magnetic force around the conductor, including their directions.
4. Describe the magnetic field inside a long solenoid.
5. Draw a solenoid with current moving in a direction of your choice. Label the north end of the solenoid.

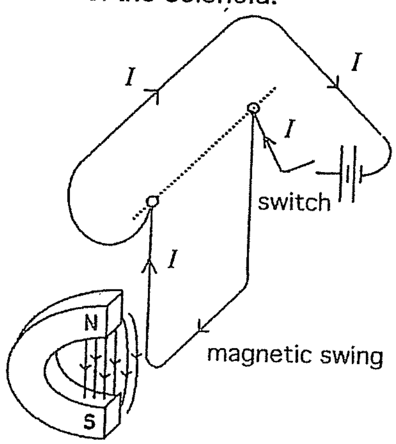


Figure 7.30

6. When the switch is closed on this 'magnetic swing', will it move 'out' from the poles of the magnet or 'in' toward the magnet? Use the Right Hand Motor Rule.
7. An electron moving with a speed of 0.10 c moves through a magnetic field of strength 0.60 T. What force acts on the electron?
   ($c = 3.0 \times 10^{8}$ m/s) ($e = 1.6 \times 10^{-19}$ C)
8. A solenoid is wound with 100 turns per centimetre. What is the magnetic field strength inside the solenoid when it carries a current of 5.0 A? ($\mu_0 = 4\pi \times 10^{-7}$ T· m/A)

9. A magnetic field from a solenoid is used to deflect a beam of electrons 0.80 cm on the screen of a CRT. If the current in the solenoid is doubled, what will the deflection be then?

10. An electron beam in a CRT is deflected 0.64 cm when the accelerating voltage is 500.0 V. By how much will the beam be deflected if the magnetic field is kept constant but the accelerating voltage is increased to 2000.0 V?

11. What is the magnetic force exerted on a segment of wire 12 cm long in a perpendicular magnetic field of strength 36 T, if the wire carries a current of 6.0 A?

12. If the force on a 5.0 cm piece of wire carrying 12 A is 1.0×10^{-3} N, what is the magnetic field strength of the perpendicular field through which the current passes?

13. A conducting wire 1.0 m long carries a current of 7.5 A. It is placed in a magnetic field of strength 5.0×10^{-5} T. If the wire makes an angle of 60° with the magnetic lines of force, what is the force acting on the wire?

14. A 75 mg mass just balances the strip in a current balance when the current in the strip is 2.5 A. If the strip is 2.0 cm long, what is the magnetic field strength inside the solenoid in which the current balance is located?

15. An alpha particle is accelerated by a voltage of 1.53×10^3 V and is then deflected by a magnetic field of strength 0.020 T into a circular path of radius 0.40 m. If the alpha particles have a charge of 3.2×10^{-19} C, what is their mass?

16. Why does a DC motor need a split-ring commutator?

17. Two parallel wires carry currents in the *same* direction. Will the wires attract or repel each other? Explain with the help of a diagram.

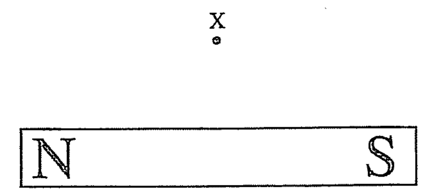
Brain Busters

18. In the velocity selector part of a mass spectrometer, a field of 0.65 T is used for magnetic deflection of a beam of protons travelling at a speed of 1.0×10^6 m/s. What electric field is needed to balance the force due to the magnetic field? If the distance between the plates of the electrical deflection apparatus is 0.50 cm, what voltage must be applied to the plates?

19. What speed must electrons in a beam of electrons going through a velocity selector have, if the beam is undeflected by crossed electric and magnetic fields of strengths 6.0×10^3 V/m and 0.0030 T respectively? If the electric field is shut off, what would the radius of the beam become due to the unbalanced magnetic force?

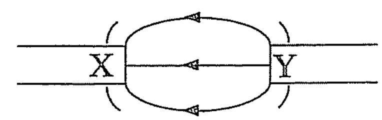
Test Yourself!

Multiple Choice



1. At X, what is the direction of the magnetic field due to the bar magnet?

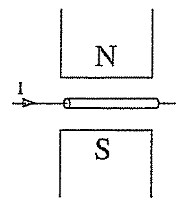
A. into the page
B. ←
C. →
D. ↓
E. out of the page



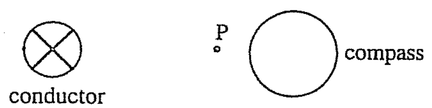
2. Identify the poles of the magnet in the above diagram.

	Pole X	Pole Y
A	south	north
B	south	south
C	north	south
D	north	north

3. A permanent magnet is dipped into a pile of metal scraps. Which type of metal will no picked up by the magnet?
A. iron
B. tin
C. cobalt
D. nickel

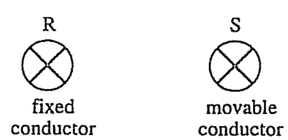


4. What is the direction of the magnetic force on the conductor in the above diagram?
   A. ↑
   B. ↓
   C. into the page
   D. out of the page
   E. →



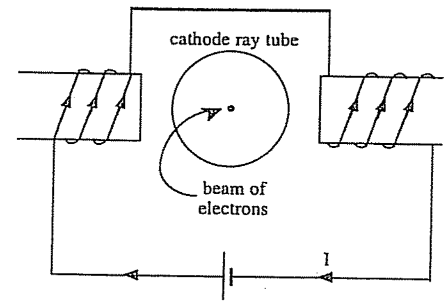
5. The conductor on the left is carrying conventional current into the page. In which direction will a compass needle point if the compass is placed at **P**?

   A. ← B. ↑ C. → D. ↓



6. Two conducting wires, **R** and **S**, run parallel with each other, and both carry current into the page. Conductor **R** is fixed, but conductor **S** can move. In what direction will the magnetic fields due to currents in the wires tend to make conductor **S** move?

   A. ← B. ↑ C. → D. ↓



(7-9) Two solenoids are being used to deflect the same beam of electrons in a cathode ray t

7. In what direction will the electron beam be deflected?

   A. ← B. ↑ C. → D. ↓

8. If the magnetic field strength ***B*** is doubled, the deflection will change from δ to
   A. 2.00 δ.
   B. 0.500 δ.
   C. 0.707 δ.
   D. 1.00 δ.
   E. 1.414 δ.

9. If the accelerating voltage V_a is doubled, the deflection will change from δ to
   A. 2.00 δ.
   B. 0.500 δ.
   C. 0.707 δ.
   D. 1.00 δ.
   E. 1.414 δ.

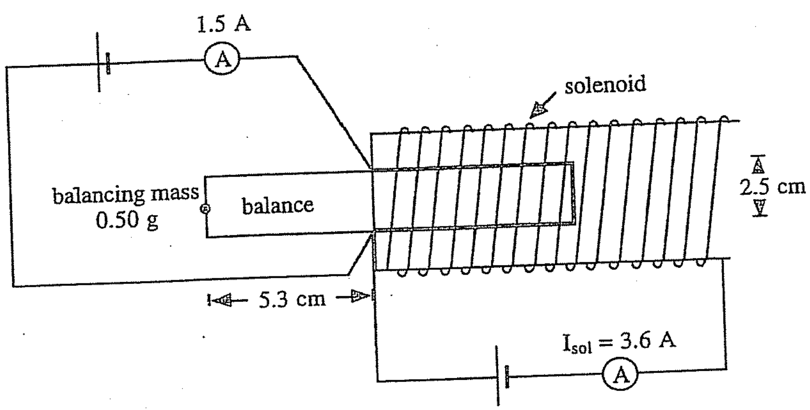
)pen-Ended Questions

0. A particle carrying a charge of 0.50 μC enters a magnetic field of strength 0.045 T, with a velocity of 350 m/s. The velocity is perpendicular to the magnetic field. What is the magne force acting on the charged particle?

1. A segment of conducting wire 5.0 cm long carrying 5.0 A of current is perpendicular to a magnetic field of 12 T. What magnetic force acts on the segment?

12. A solenoid 0.20 m long has 600 turns of wire. What current must be passed through the solenoid to produce a magnetic field of 2.0×10^{-2} T?

13. (a) A particle of mass m and charge q is moving with speed v in a circular path of radius R in a uniform magnetic field B. How would you calculate the radius from the other information?
(b) An alpha particle, of mass 6.7×10^{-27} kg and charge 3.2×10^{-19} C, is accelerated from rest by a voltage of 2.00×10^{3} V. What will be the radius of curvature of its path in a uniform magnetic field of 0.070 T?
(c) What is the momentum of the alpha particle?



14. What is the magnetic field B inside the solenoid of this current balance, if the force of gravity on the 0.50 gram mass just provides enough torque to balance the torque due to the magnetic force on the current balance?

Chapter 7
Magnetic Forces

Exercises

Page 212

1. (a) Lines are circular and clockwise around the conductor with current going into the page, and counterclockwise around the conductor with current coming out of the page.
(b) Repel. Lines of force in the space between the conductors run in the same direction (*down* on the diagram), just as they would with two bar magnets lined up with like poles adjacent to each other.
2. End **B** is north.

Page 218

1. 2.0 cm
2. (a) 0.70 cm (b) 0.35 cm
3. 2.0×10^{3} V

Page 220

1. (a) 8.0×10^{-15} N (b) 8.8×10^{15} m/s^2, perpendicular to the velocity.
2. 1.0×10^{-15} N
3. (a) Up, perpendicular to magnetic field lines.
(b) 1.2×10^{-10} N

Page 221

1. 8.0×10^{-3} T
2. 300 turns
3. [illegible]

Page 227

1. (a) 2.5×10^{-2} T (b) 1.5×10^{-3} N
2. 9.1×10^{-3} T
3. 0.74 A
4. (a) 0 (b) 4.3×10^{2} N (c) 6.1×10^{2} N
5. (a) 3.1 N (b) 125 T

Page 233

1. 9.1×10^{-31} kg
2. 1.7×10^{-27} kg
3. 1.6 m
4. 1.1×10^{5} m/s

Page 235

1. 2R
2. (a) 3.0×10^{5} m/s (b) 8.4 cm

Chapter Review

Page 237

1. iron, cobalt, nickel.
2. Electric field. A constant magnetic field will not affect a stationary charged particle.
3. Lines of force are clockwise and circular.
4. Lines are parallel for the length of the solenoid, going from **S** to **N** *inside* the solenoid.
6. 'Out'.
7. 2.9×10^{-12} N
8. 6.3×10^{-2} T
9. 1.60 cm
10. 0.32 cm
11. 26 N
12. 1.7×10^{-3} T
13. 3.2×10^{-4} N
14. 1.5×10^{-2} T
15. 6.7×10^{-27} kg
17. attract
18. 6.5×10^{5} V/m, 3.3×10^{3} V
19. 2.0×10^{6} m/s, 3.8 mm