

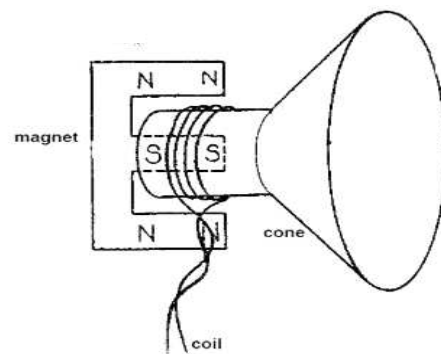
W13.01

Force on a Moving Charge

1. An electron in a television tube travels at 3×10^7 m/s and is acted on both by gravity and by the earth's magnetic field. Which exerts the greater force on the electron? ($q_e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg, $B_E = 4.5 \times 10^{-5}$ T – on average; Earth's field varies from about 30-60 μ T depending on location.)
2. What is the radius of the path of an electron whose speed is 1.0×10^7 m/s in a magnetic field of magnitude 0.020 T when the electron's path is perpendicular to the field? (Ignore gravity.)
3. A charge of 1×10^{-6} C is moving at 500 m/s along a path parallel to and above a long straight wire. The wire carries a current in the same direction as that of the charge.
 - a. What is the direction of the force on the charge?
 - b. If the current is 2.0 A and a distance from the wire of 0.1 m, what is the magnitude of the force on the charge? (The field due to a wire is $B = \mu_0 I / 2\pi r$.)

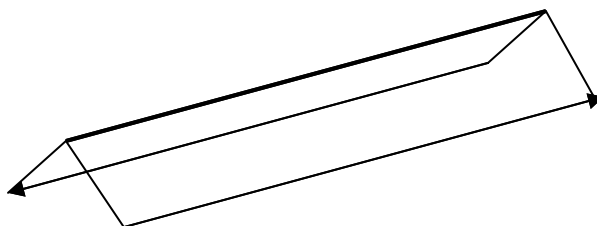
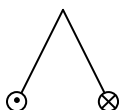
Force on a Current

4. A wire 1.0 m long carries a 1-A current horizontally from right to left. A magnetic field of 0.10 T is directed into the page.
 - a. What is the magnitude and direction of the force on the wire?
 - b. If the wire is moved so that it now carries a current into the page, what is the magnitude and direction of the force on the wire?
5. A vertical wire 2.0 m long is in a 1.0×10^{-2} T magnitude field whose direction is northeast. What is the magnitude and direction of the force on the wire when a 5.0-A current flows upward in it?
6. In a typical loudspeaker a permanent magnet creates a radial magnetic field in which a wire coil attached to the apex of a paper cone can move perpendicularly to the field. An alternating current in the coil causes the cone to oscillate and thereby produce sound waves. If the 40-turn coil of a certain loudspeaker is 8.0 mm in radius and is located in a 0.40-T magnetic field, what is the force on the coil when the current in it is 0.050 A. (Hint, consider the total length of wire in the field.)



Force between Two Currents

7. The parallel wires in a lamp cord are 0.0020-m apart. What is the force per meter between them when the cord is used to supply power to a 120-V, 200-W light bulb? (Hint: Get B from the equation above for a current-carrying wire.)
8. (Honors) Two parallel wires 0.10-m long, each of mass 20 g are suspended by 0.10-m long strings from an overhead rod. When current I is passed through the wires in opposite directions, the wires swing so that they hang 0.02 m apart. Find I .



Solutions:

1. $F_W = 9.11 \times 10^{-30} \text{ kg}$, $F_B = 2.16 \times 10^{-16} \text{ N}$
2. 0.00285 m
3. a) down; b) $2 \times 10^{-9} \text{ N}$
4. a) 0.1N, down; b) No F
5. 0.1 N NW
6. 0.0402 N
7. $2.8 \times 10^{-5} \text{ N/m}$
8. 1411 A