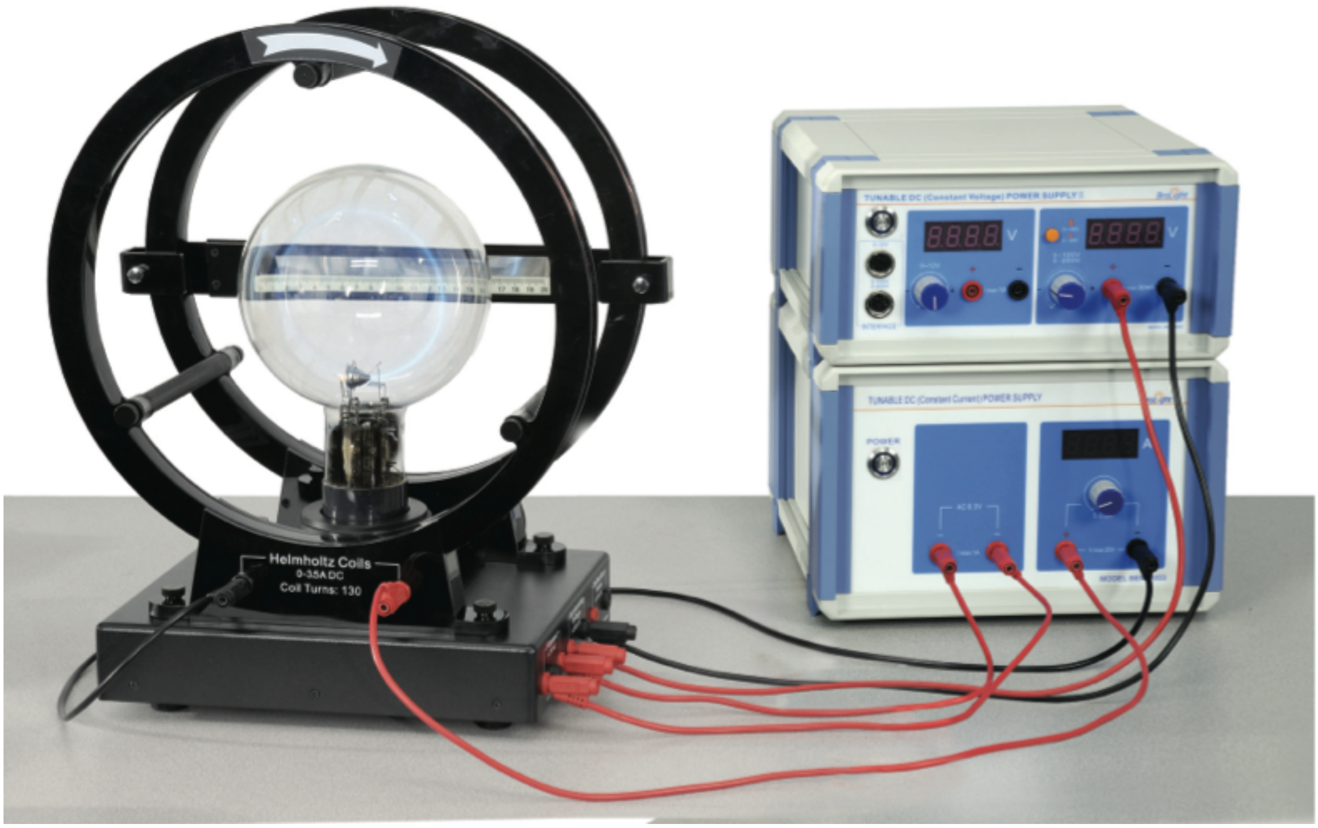
1. A pith ball of mass 0.15 g and charge +2.0 nC is thrown with horizontal velocity 3.0 m/s west through a magnetic field 0.50 T north. (a) Determine the magnetic force. (b) Show mathematically this would have an insignificant effect on its acceleration. (c) What charge on the pith ball would be necessary to decrease its downward acceleration to 9.0 m/s^2?

2. A certain coronal mass ejection (CME) from the Sun sends charged particles out into space at speed 1200 km/s. Determine the acceleration of protons and electrons in the stream of particles encountering the Earth's magnetic field, with strength 0.40 G at a certain elevation above the Earth's north magnetic pole: (a) on an equinox and (b) on a solstice.

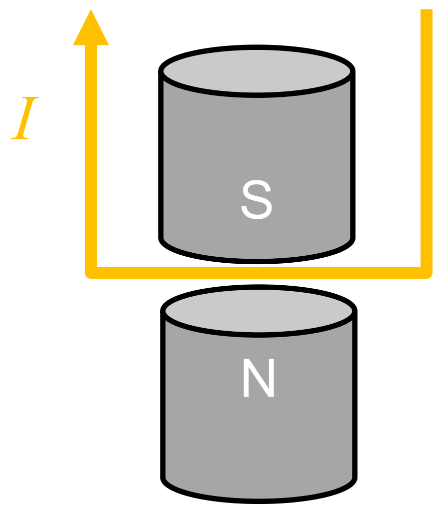
3. An alpha particle moving westward at speed 1.5×10^7 m/s encounters a magnetic field of 8.0 mT upward. (a) Find the radius of curvature in the particle's path. (b) Determine the angular speed. (c) If the distance through the field is 1.0 cm estimate the change in direction of the alpha. (d) Repeat for a beta particle with speed 1.5×10^8 m/s.

4. In the e/m apparatus shown electrons move in a circle of radius 45.0 mm at speed 6.0 Mm/s in the presence of a uniform magnetic field. (a) Determine the magnetic field strength. (b) Determine the accelerating voltage of the electron gun. image credit: Pasco



5. A certain mass spectrometer has a velocity selector with fields $E = 165$ kN/C and $B = 0.600$ T. The same uniform magnetic field extends into the region where particles are detected. Suppose beryllium ions are analyzed. (a) What speed is selected by the velocity selector? (b) Find the radius of path followed by singly ionized beryllium-9.

6. A wire “swing” carrying a current of 3.0 A passes through the intense magnetic field of 0.80 T in the gap between two bar magnets of diameter 2.5 cm. Estimate the force on the swing by assuming the field is negligible outside the gap.

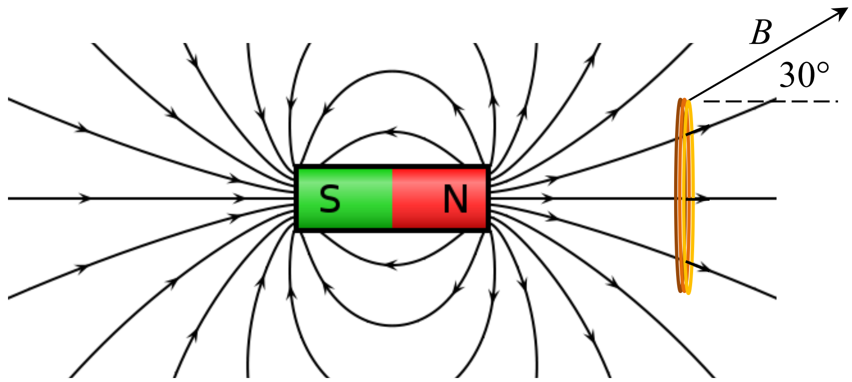


7. In a classroom experiment a rectangular loop of wire with 30 turns and resistance 1.4 ohms is connected to a 6.0 V battery with internal resistance 1.5 ohms. Estimate the maximum force that can result from an interaction with a cow magnet of diameter 1.2 cm and field strength 7.0 mT near the poles.

8. The same rectangular loop (3.9 cm by 9.0 cm) is taken to a location where Earth's field is 0.50 G horizontal and north and placed flat on a table with the long sides running east and west. (a) Determine the current that would cause the force on the north side of the rectangle to be 0.10 N downward. (b) Find the torque on the loop. (c) Repeat if the rectangle is now rotated 30° on the table. (d) Find the force on the other sides of the rectangle in both orientations.

9. Suppose the same rectangular loop is taken to Antarctica at the magnetic pole and placed on a table with current 5.0 A clockwise. Find the force on each side of the rectangle.

10. A circular coil of 45 turns, radius 3.0 cm, and current 2.5 A is repelled by a net force of 25 mN when placed as shown near a magnet. Determine the field strength *B* and the direction of the current.



11. A long vertical wire carries a current of 6.0 A directly downward toward the ground. Determine the magnetic field it creates: (a) 1.0 cm north of its center, and (b) 2.0 cm west of its center. (c) If the Earth's field in this locale has a horizontal component of 22 μT north, at what distance north of the wire would a compass point 30.0° east of north?

12. A long straight wire carries a current I north. A particle of charge q and mass m moves with velocity v south at a distance x on the east side of the wire. (a) Derive an expression for the radius of path at that instant. (b) How does this value change as x changes? (c) Sketch the path followed by the particle.

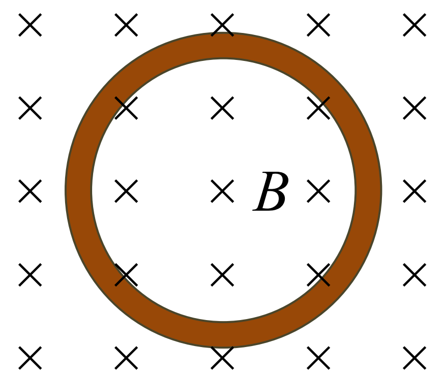
13. Two long straight parallel wires separated by 3.00 cm carry current 12.0 A in opposite directions. (a) Determine the force on a one meter section of one of the wires. (b) Determine magnetic fields at locations that are twice as far from one wire as the other. (c) Repeat with currents in the same direction.

14. There exists a magnetic field line that forms a circle of radius 2.00 cm that passes through the two locations analyzed for opposite the currents in the previous problem. Apply Ampere's Law to this circle to find the average magnetic field strength and compare to the two values found previously.

15. A current of 2.0 A passes through a slinky coil stretched out on a table. The coils are evenly spaced and separated by 5.0 mm. Determine the magnetic field strength inside the solenoid.

16. A solenoid of length L and N turns carries a current I. Derive an expression for the magnetic field strength at one end of the solenoid. Hint: use superposition principle and imagine there is an identical solenoid placed end to end with this one.

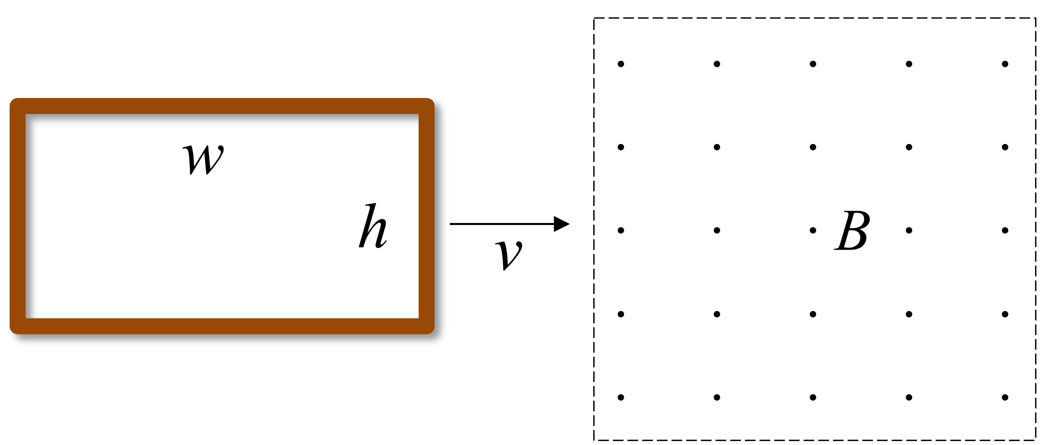
17. A circular coil of wire with 330 turns and radius of 4.5 cm is subject to a magnetic field that increases from zero to 10.0 mT in 0.2 s. Determine the emf and compare to an experimental value using a similar setup.



18. Use a magnetic field sensor to measure a changing field that points straight through a circular coil with 2000 turns and radius 2.9 cm. Use the graph to determine the rate of change in flux and compare to the measured voltage of the coil. Find a point on the graph where a field exists but an emf does not. Explain.

19. The flux through a circular coil of radius 10.5 cm and 200 turns that rotates can be modeled by $\Phi = BA\sin(\omega t)$, where the angle between B and A is given by $\theta = \omega t$. Estimate the maximum emf that can be generated by the coil in the Earth's field if it is rotated at 5.0 Hz. How should the axis of rotation be oriented? At what point in the rotation is the emf maximum? minimum?

20. A rectangular wire loop of height h and width w moves with speed v into a region with uniform magnetic field B as shown. Derive an expression for the emf and describe its sense.



21. Suppose the loop in the previous problem is a coil of 50 turns, dimensions 4.0 cm by 8.0 cm, speed 10.0 m/s, and resistance 3.0 Ω moving into a magnetic field of 0.20 T. (a) Determine the current in the coil. (b) Determine the magnetic force opposing the coils motion. (c) Determine the electrical power and the mechanical power of the agent pushing the coil forward.