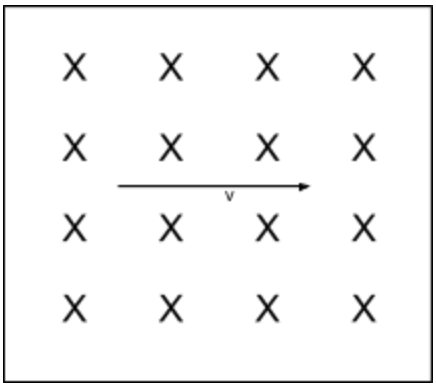
Electromagnetism Calculations

1. The magnitude of the magnetic field around a current-carrying wire is given by the equation $B = \frac{\mu_0 I}{2\pi d}$ where I is the current and d is the distance away from the wire. Calculate the magnetic field 0.50 m and 1.0 m away from a wire with a 0.25 A current.

2. A 1.0×10^{-3} T magnetic field is measured 0.25 meters from a wire. Determine the current in the wire.

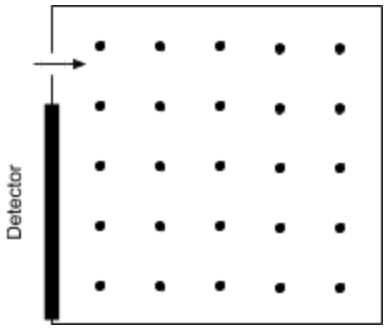
3. A 10.0 V battery is arranged in a simple circuit with a 250 Ω resistor. Calculate the magnetic field 10.0 cm from the wire.

4. A charge moving in a magnetic field experiences a force described by the equation $F = qv \times B$. A positively charged particle (q = +2.0 μC) enters a region with a magnetic field (B=3.0×10^{-3} T) as shown. The particle is traveling 100 m s^{-1}. Calculate and draw the force of the field on the charge.



5. An electron enters a region in which there is a magnetic field directed out of the page at 2.0×10^{-6} T. The electron travels in a circular path with a radius of 10.0 cm.
    a. Draw a diagram of the situation and explain how the electron would travel in a circular path.
    b. Calculate the speed of the electron.

6. In a mass spectrometer, ionized samples of a gas are accelerated into a chamber. A velocity selector ensures all of the samples are traveling the same speed (v_{ion}). A simplified version is shown at right. The chamber contains a magnetic field (B) and a series of detectors along the wall.



   a. What sign of charge would reach the detector?
   b. Explain why the gas sample would follow a circular path.
   c. Derive an equation that relates the mass of the ion to the radius of the path.

7. The force on a current-carrying wire that is in a magnetic field is given by the equation $F = Il \times B$ where *l* is the vector along the wire in the direction of the current. A 2 m wire is carrying a current of 5 A and is oriented perpendicular to the Earth's magnetic field of 5×10^{-5} T. Calculate the force on the wire.

8. Two 0.5 meter wires are placed parallel to one another, 0.25 meters apart. Wire A has a current of 0.5 A, while wire B has a current of 0.1 A.
   a. Calculate the force of wire A on wire B.
   b. Describe an arrangement where the force would be attractive.
   c. Describe an arrangement where the force would be repulsive.