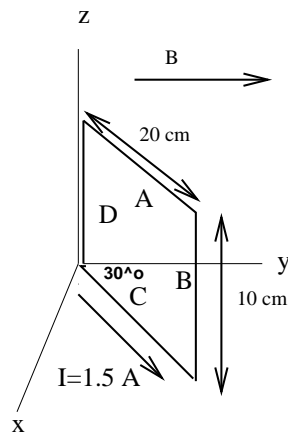


Quantity	Symbol	Value
Coulombs Constant	k_e	$8.98 \times 10^9 \text{ Nm}^2/\text{C}^2$
Electron Mass	m_e	$9.1 \times 10^{-31} \text{ kg}$
Electron Charge	e	$-1.6 \times 10^{-19} \text{ C}$
Electron Volt	eV	$1.6 \times 10^{-19} \text{ J}$
Permittivity	ϵ_o	$8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$
Magnetic Permeability	μ_o	$4\pi \times 10^{-7} \text{ T} \cdot \text{m}/\text{A}$

A rectangular coil of wire (with 100 Turns) carries a current of 1.5 A in a magnetic field of 2 T. The dimensions of the coil are shown below. The coil is hinged around the z axis as shown below. The magnetic field points in the y -direction is as indicated.

1. For each segment A,B,C,D of the wire calculate the magnitude of the force on the wire. Indicate the direction of the force as right/left/up/down/into page/out of page.
2. For each segment of wire indicate the torque that the current produces. Use the formula $\tau = r_{\perp}F$ and indicate the direction as clockwise or counter-clockwise as seen from above.

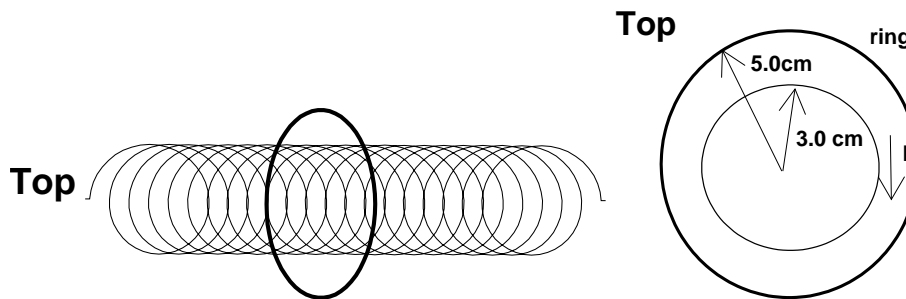


A long solenoid is constructed 100 turns per inch. The current in the solenoid is steady and is 3.0 A. When looked at from above the current flows clockwise as shown below. The radius of the solenoid is 3.0 cm . A solid copper ring is placed around the solenoid and has a radius of 5cm. It has a resistance of 2 m Ω .

1. Determine the magnetic field inside the solenoid.
2. Indicate the direction of the magnetic field in the sideways view shown below.
3. What is the induced current in the ring placed around the solenoid and which way does it flow (clockwise or counter clockwise w.r.t. the top view)?

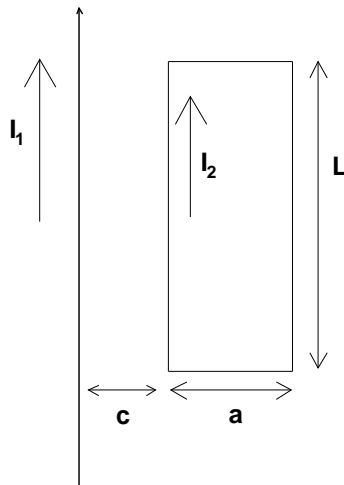
Then the current in the solenoid is turned off , decreasing as a function of time as, $I(t) = 3.0 \text{ A} - (20\text{A/s}) t$.

1. As the current in the solenoid is decreased which way does the induced current flow around the ring (clockwise or counter-clockwise w.r.t. the top view)
2. How big is this current ?
3. What is the force on the ring and which way does it point.



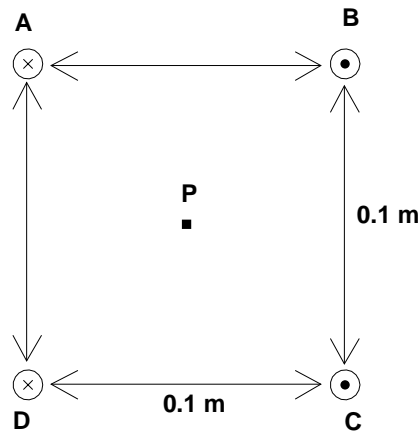
A wire carries a steady current of $I_1 = 5.0A$. Next to it a rectangular coil of wire is stationary and carries a current of $I_2 = 10.0A$. The dimension are $c = 0.1\text{ m}$, $a = 0.15\text{ m}$, $L = 0.45\text{ m}$

1. Determine the magnetic field produced by I_1 at the distance c from the wire using Ampere's Law. (i.e. do not just write down the formula, derive the formula from Ampere's law)
2. What is the magnitude of the force experienced by segment segment of the coil closest to the wire. Indicate the direction of the force below.
3. What is the magnitude of the force experienced by segment of the coil farthest from the wire. Indicate the direction below.
4. Is the the total force between the wire and the loop attractive or repulsive and what is its magnitude.



Four long parallel conductors carry equal currents $I = 5.0 \text{ A}$. An end view of the conductors is shown below. The current direction is into the page at A and D (indicated by the crosses) and out of the page at B and C

1. Determine the magnetic field from A at Point P . Indicate the the direction of the field on the figure with an arrow labeled A
2. Determine the magnetic field B at point P . Indicate the direction of the field on the figure with an arrow labeled B
3. Determine the total magnetic field at point P . Indicate the direction of the total magnetic field with an arrow labeled TOT



A rectangular coil of wire is pulled out of a uniform magnetic field at a constant speed v_o . The magnetic field \mathbf{B} pointing out of the page. The resistance in the wire is R . At time $t = 0$, we start the clock, and the horizontal length of wire in the field is h , while the vertical length is w .

1. When does the wire completely leave the field?
2. Determine the current in the loop.
3. Indicate the direction of the current in the loop.
4. Determine the magnitude of the forces on the three segments A, B, C in the coil. Indicate the direction of these forces in the diagram below.
5. Determine the work done per unit time (the power) done by the person pulling the loop. (Hint in a time Δt the loop moves a distance Δx , and $\Delta W = F\Delta x$.)

