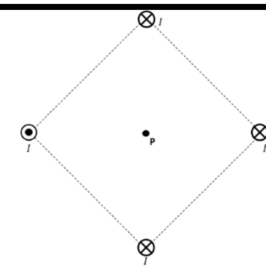
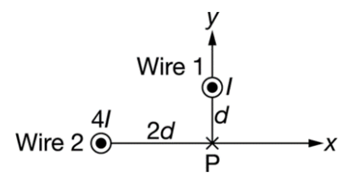
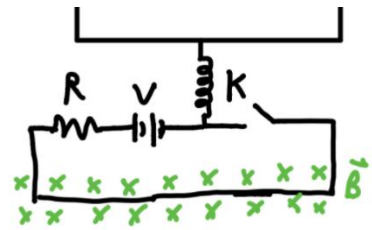


1. The cross sections of four long, straight wires, carrying identical currents, I, form the corners of a square, as shown above. Draw a vector that represents the direction of the net magnetic field at point P, the center of the square.

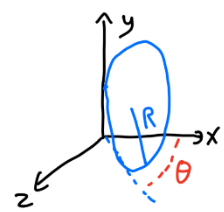
2. Two long, straight current-carrying wires are positioned on the x-axis and y-axis, as shown (with positive z being defined as out of this page). Wire 1 carries current I directed out of the page and wire 2 carries current 4I directed out of the page. Determine the magnitude and direction the net magnitude field at the origin.



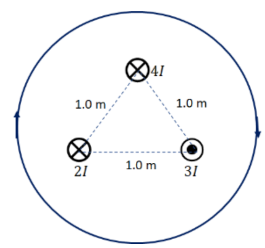
3. Oh no, why would someone do this? An entire circuit with a total mass of 3.0 kg is hung from a spring with a spring constant of K = 50 N/m as shown. The system is allowed to reach equilibrium, with the switch in the circuit initially open. With the system in equilibrium, part of the circuit is placed in a magnetic field of magnitude B = 4.0 T that is directed into this page as shown. The battery voltage that powers the circuit is V = 20 V and the resistor has a resistance of $R = 50\ \Omega$. All other wires has no resistance. The switch is closed. Determine the direction the circuit moves (up or down) and the displacement with which it moves.



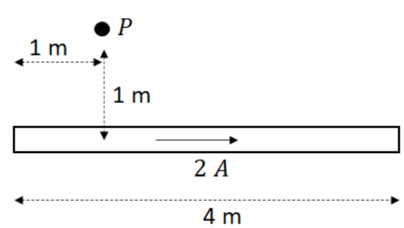
4. The figure shows the orientation of a flat circular loop carrying a current *I*. The magnetic field in the region is directed in the positive *z* direction and has a magnitude of 50 mT. The loop can turn about the *y* axis. If θ = 20°, R = 0.50 m, and the torque on the loop is found to be 0.8 Nm, what is the value of the current I?



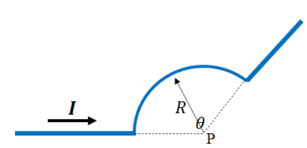
5. The cross-sections of three current-carrying wires are shown in the figure. Calculate the line integral of the magnetic field $\vec{B}$ around the circular path shown, $\oint \vec{B}\cdot d\vec{\ell}$. The path is circular and has a radius of 3 m.



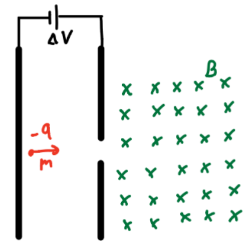
6. Top French scientists create a single wire with a steady state current as shown. The wire is 4 m long and carries a uniform current of 3 A along the x-axis. Point P is 1 m from the center of the in the 7-direction and 1 m from the +left end of the wire. Use the Biot-Savart Law to set-up an integral an integral at point P. Ensure to include bounds with your integral and pull constants out of the integral if possible.



7. Current of magnitude I = 2.0 A runs through a wire as shown. The curved section is circular, with radius R = 0.1 m, and $\theta = 120°$. Determine an expression for the magnitude field at point P.



8. Two plates are set up with a potential difference **V** between them as shown. An electron (mass **m**, charge **e**) is placed at the left-hand plate, which has a negative charge, and is allowed to accelerate across the space between the plates and pass through a small opening. After passing through the small opening, the sphere enters a region in which there is a uniform magnetic field of magnitude **B** directed into the page.



a) Describe the path taken by the electron when it enters the magnetic field. Justify your answer.

b) Derive an expression for the radius of the path taken by the sphere as it moves through the magnetic field. Answer in terms of the bolded quantities in the problem description, as necessary.

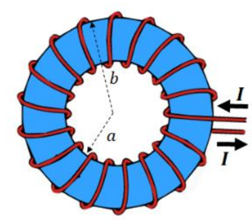
An experiment is performed in which electrons are accelerated across the plates and goes through the opening. The electron then travels in a semicircular path and strike the right-hand plate. The potential difference is varied such that the radius of the circular path is always R = 0.40 m.

Potential difference (V)	30	35	50	60	70
B (mT)	5.2	5.6	6.8	7.0	8.0

c) Briefly describe how linear regression could be used to calculated the value of mass-to-charge ratio of an electron.

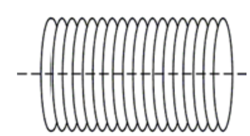
d) Using your answer to b), estimate mass-to-charge ratio of an electron. (*based on the problem here, it won't be simar to an actual electron because the numbers here are made up)

9. In the land of Mordor, in the fires of Mount Doom, the Dark Lord Sauron forged, in secret, a Master Ring to control all others. And into this ring he poured his cruelty, his malice, and a plastic insulating material that he then wrapped in conducting wire to form a toroidal solenoid. The toroid has 18 turns and a current, an inner radius of a = 3 cm and an outer radius of b = 5 cm.



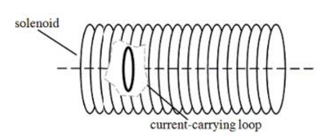
a) Use Ampere's Law to calculate the magnetic field at a radial distance of 4.2 cm from the center of the toroid.

Frodo Baggins destroys the toroid by forming into a solenoid as shown below; assume it has 18 turns still. The radius of the solenoid is 0.03 m and the length is equal to 0.3 m. The current is now fixed at 9.0 A.

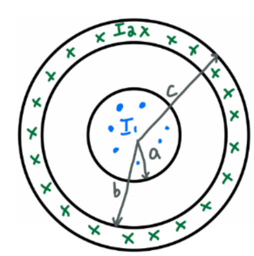


d) Use Ampere's law to find the magnetic field in the solenoid; ensuring to clearly define your Amperian path.

e) A single circular loop of wire with radius 0.02 m is placed at the center of the solenoid. Find the current in the loop that would cause the magnetic field at the center of the loop to be zero.



10. A coaxial cable, a cross-section of which is shown, consists of a solid cylindrical conductor of radius a=0.1 m, surrounded by a hollow coaxial conductor of inner radius b=0.2 m and outer radius c=0.3 m. The conductors each have current in opposite directions, with $I_1 = 2.0\ A$ and $I_2 = 1.0\ A$.

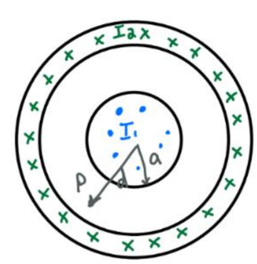


a) Use Ampere's law to determine the magnitude of the magnetic field at a distance r from the axis of the cable in each of the following cases.

i. 0 < r < a

ii. r > c

b) An proton (q=$1.6x10^{-19}\ C$) is placed at point P as shown with a velocity v = 1337 m/s directed out of the plane of this page. Point is a distance of 0.18 m from the center of the coaxial cable.



i. Draw a single vector that represents the direction of the force on the electron. Justify your answer.

ii. Calculate the value of the force on the proton.