

Prof. Adrian Feiguin

(your name -PRINT)

Problems: (1 pt. each. You can choose 4 out of 5, or lowest score will be dropped if you complete all of them). USE SI UNITS TO EXPRESS YOUR RESULTS

- 1) Two protons (charge 1.6×10^{-19} C) are at positions A and B, at a distance of $d=10^{-6}$ m, as depicted in the figure below. Their velocities are 800 m/s. Calculate:

a) The magnitude of the magnetic field created by proton A at position B.

b) The direction of the magnetic field at point B is (circle one)

A. Into the page

B. Out of the page

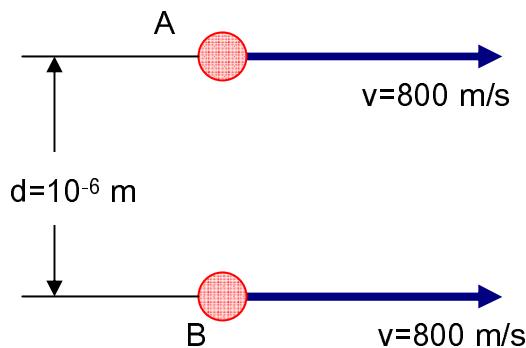
C. None of these.

c) Calculate the magnitude of the magnetic force on proton B.

d) The direction of the force is (circle one)

A. Toward proton A

B. Away from proton A



- 2) A straight wire carries a current of $I=50$ A. An electron (charge -1.6×10^{-19} C) is at a distance of 5 m from the wire, moving with a velocity of 10^6 m/s parallel to the wire, in the same direction as the current.

a) Calculate the magnitude of the magnetic force on the electron.

b) Is the direction of the force: (circle one)

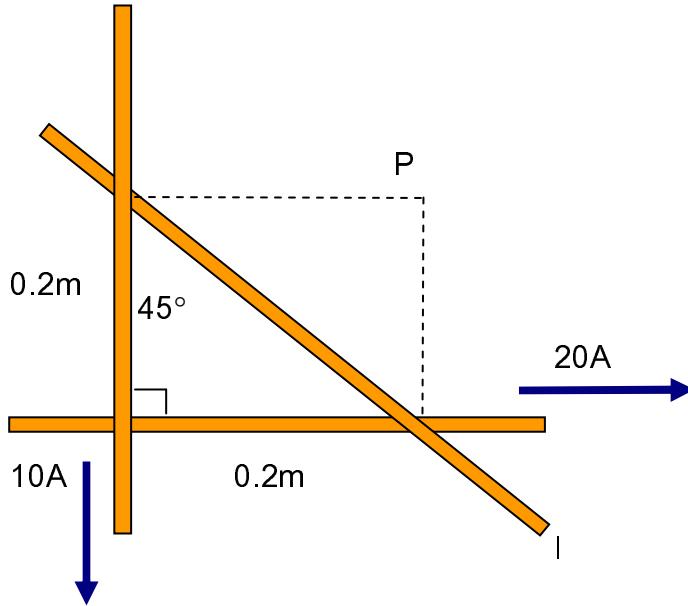
A. Parallel to the wire.

B. Toward the wire.

C. Away from the wire.

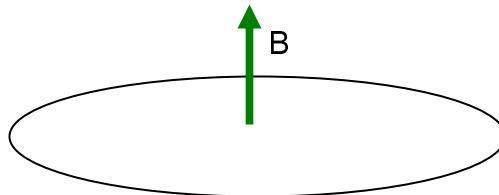
D. None of these.

- 3) Three very long wires carrying current intersect forming a triangle, as shown in the figure
- Calculate the magnitude of the current I on the diagonal wire such that the field at point P is zero
 - Is the direction of the current (circle one)
- A. upward (from right to left) B. downward (from left to right)

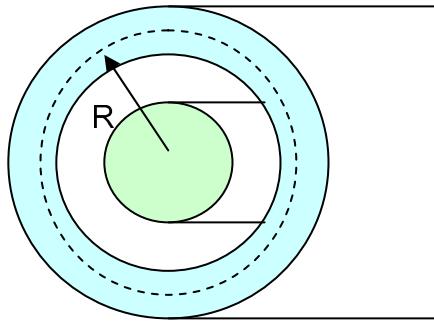


- 4) Consider a circular loop of wire, enclosing an area of 0.01m^2 . A uniform external B -field points in a perpendicular direction upward, through the plane of the coil. The magnitude of the external field increases at a rate of 0.001T per second.
- Use Faraday's law to calculate the magnitude of the EMF induced in the wire.
 - Is the direction of the current in the loop (circle one)

- A. Clockwise B. Counter-clockwise.



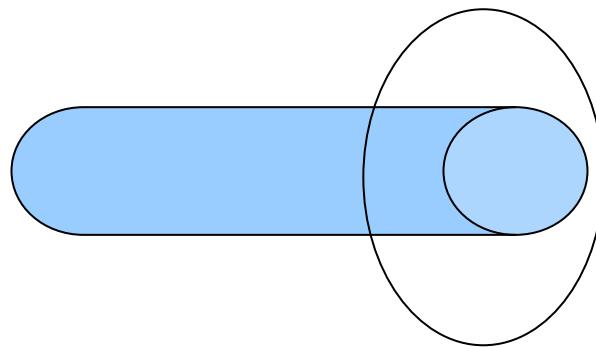
- 5) The coaxial cable shown in the figure below consists of a solid inner conductor, surrounded by a hollow cylinder of inner radius a , and outer radius b . The two carry equal currents of magnitude I but in opposite directions. The current density in the outer conductor is given by $j=C/r$, where $C=I/2\pi(b-a)$ is a constant.
- Calculate the expression for the total current enclosed by a circle of radius R with $a < R < b$. Express the result in terms of a, b, R, I .
 - Use Ampere's Law to calculate the magnetic field at this distance.



BONUS PROBLEM (optional - 1 point)

A cylindrical solenoid 0.025 m in diameter, and 0.30 m long has 300 turns and carries 12A.

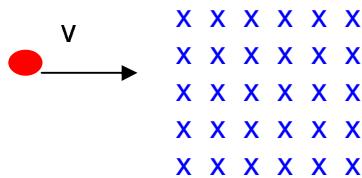
- Calculate the magnetic field flux through a loop of wire enclosing the solenoid, and 0.05m in diameter.
- The current increases linearly at a rate of 1Amp per second. Use Faraday's law to calculate the magnitude of the EMF induced on the loop.
- Using the definition of motional EMF, calculate the magnitude of the induced electric field on the loop.



BONUS QUESTIONS (optional – 0.2 points each)

- 1) What is the initial direction of the deflection of the *positive* charge entering the B-field shown below? (circle one)

A. up B. down C. into the page D. out of the page E. None of these.



- 2) Each of the eight wires shown in the figure carries a current of 2A into or out of the page. What is the result of the integral $\oint \vec{B} \cdot d\vec{l}$ for:

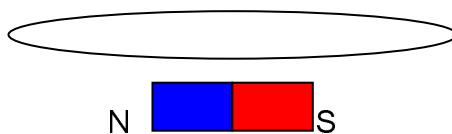
- a) Path 1
b) Path 2



- 3) A circular loop of wire undergoes thermal expansion while it is in a uniform magnetic field. If the field points into the page, what will be the direction of the induced current? (circle one)

- A. clockwise B. counter-clockwise

- 4) A bar magnet is pushed toward a loop of wire as shown the figure below. Is there a current induced in the loop? If so, in which direction?



- 5) There is a counter-clockwise induced current in the conducting loop shown below. Is the magnitude of the magnetic field inside the loop (circle one)

- A. Increasing. B. Decreasing. C. Steady.

