

Instructions:

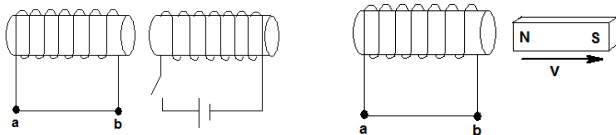
1. Do all of your work on this sheet.
2. **Show all of your steps** in problems for full credit.
3. **Be clear and neat** in your work. Any illegible work, or scribbling in the margins, will not be graded.
4. Place your **answers in a box**.
5. If you need more space, you may use the back of the page and write **On back** in the problem space.

1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

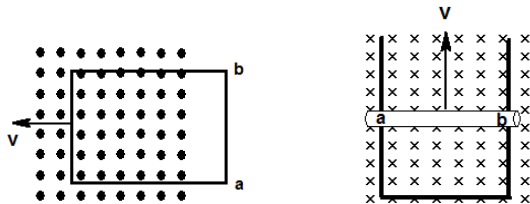
- a. Two straight wires that are parallel to each other are carrying currents in opposite directions. What happens to the wires?
  - a) They stop carrying current because the current directions cancel each other out.
  - b) Nothing happens.
  - c) They repel each other.
  - d) They attract each other.
- b. If the B-field points into your paper and a positive charge moves from right to left in this field, then the force is directed
  - a) towards the bottom;
  - b) out of the paper;
  - c) into the paper;
  - d) to the left;
  - e) none of these.
- c. A motor
  - a) converts electrical energy into heat energy.
  - b) converts heat energy into mechanical energy.
  - c) converts electrical energy into mechanical energy.
  - d) converts mechanical energy into electrical energy.
  - e) converts nuclear energy into heat energy.

2. **Definition/Principle (5 pts)**

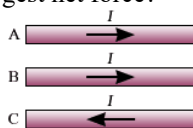
a. In the following closed loops, indicate the direction of the induced current by an arrow between points a and b.



(as switch is closed)



b. Three long, equally spaced, straight wires are carrying currents that have the same magnitude. Which wire experiences the largest net force?



**Constants**  $m_e = 9.11 \times 10^{-31} \text{ kg}$ ,  $m_p = 1.67 \times 10^{-27} \text{ kg}$ ,  
 $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$

3. **Problems (12 pts)**

- a. An electron moves  $5.6 \times 10^7 \text{ m/s}$  East through a 1.4 T magnetic field which points North. What is the force on the electron?
- b. A wire of length 6.28 m is used to make a circular loop. A current of 0.5 A is applied to the loop. What is the magnetic field at the center of the coil?
- c. A magnetic field has a magnitude of 0.078 T and is uniform over a circular surface that has a radius of 0.10 m. The field is oriented at an angle of  $25^\circ$  with respect to the surface normal. What is the magnetic flux?
- d. A 30 cm long conducting rod on a conducting rail moves perpendicular to a 0.25 T magnetic field at 2.0 cm/s. If the resistance in the wire is  $0.05 \Omega$ , then what is the current in the rod?

**Bonus.** A proton beam passes through a velocity selector and the protons are rerouted by a magnetic field.

- i. If  $E = 100.0 \text{ V/m}$  and  $B = 0.50 \text{ T}$ . What is the velocity of the protons that do not get deflected?
- ii. What is the radius of the circular path that the protons follow in the magnetic field?

