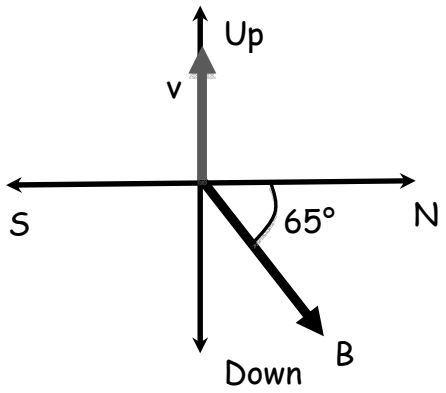
College Physics 104 Exam 2 Spring 2010

Name_____

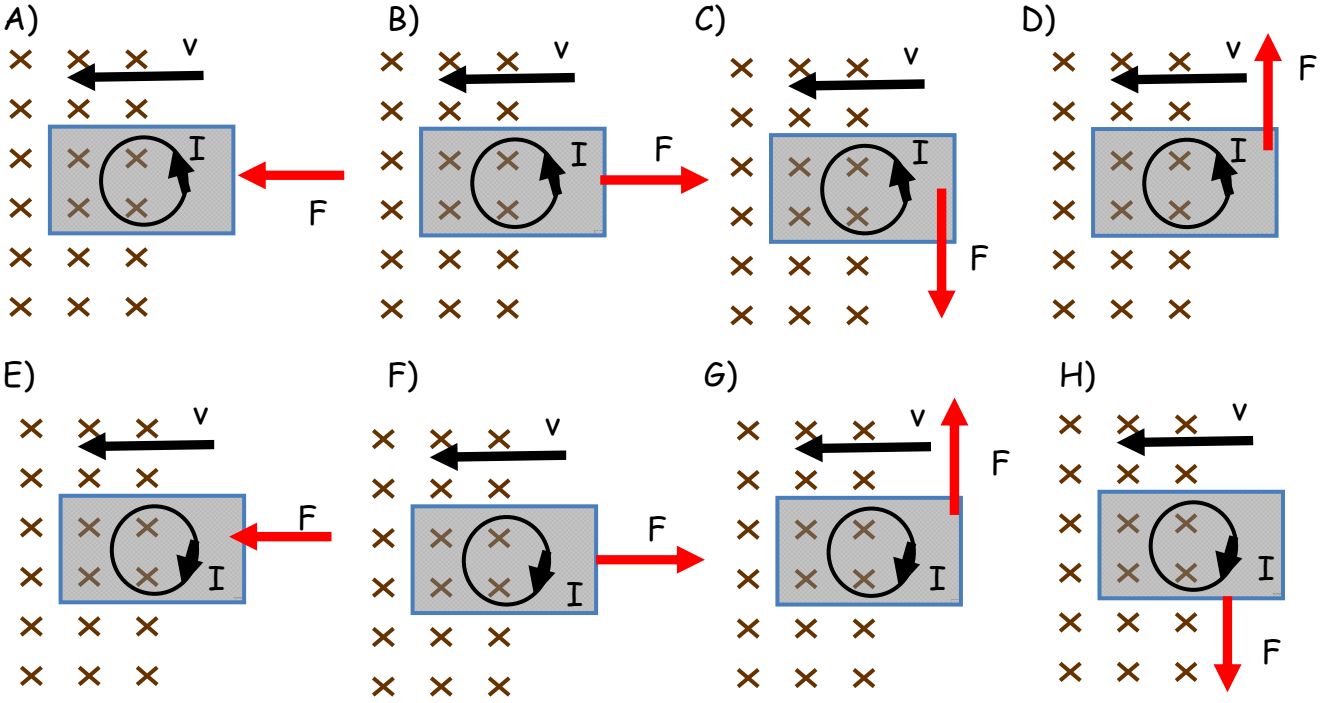
Multiple Choice: (5pts each)

1. A proton is moving UP at a speed of 5.4×10^6 m/s in a magnetic field of 2.2T pointed 65° below North as seen in the sketch. What is the magnitude and direction of the magnetic force?

a) 1.7×10^{-12} N up
b) 1.7×10^{-12} N East
c) 1.7×10^{-12} N West
d) 8.0×10^{-13} N down
e) 8.0×10^{-13} N East
f) 8.0×10^{-13} N West



2. A metal plate is moving to the left into a magnetic field pointing out of the page. Which sketch shows the correct direction of the induced current in the metal and the direction of the force on the metal conductor?



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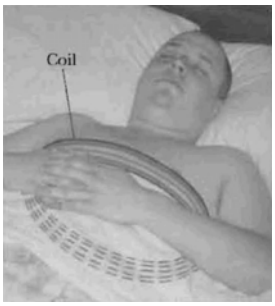
Short Answer: (10 pts each)

1. You decide to build a velocity selector. You have a magnetic field that is equal to 4.3T pointing out of the page.

a) If you want to select for negative charges that have a speed of 570 m/s, what is the magnitude of the electric field you would need?

b) For protons coming in from the left (moving to the right), make a sketch that clearly shows the direction of the magnetic field, the direction of the electric field, the direction of the proton, and the direction a proton would go if it were moving too fast.

2. A 200 turn coil is laid on a hospital patient's chest to monitor whether or not they are breathing. The earth's magnetic field is 50 μT and it makes an angle of 28° with the plane of the coil. When the person breathes, the area of the loop increases by 3.9×10^{-3} m^2. If it takes 1.8 s to inhale, what voltage is induced in the coil? (From Serway/Faughn/Vuille, College Physics, 7th edition)



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3. Below are two coils. Coil 1 is the source coil and is connected to a battery. Coil 2 is on the right and is connected to a resistor.

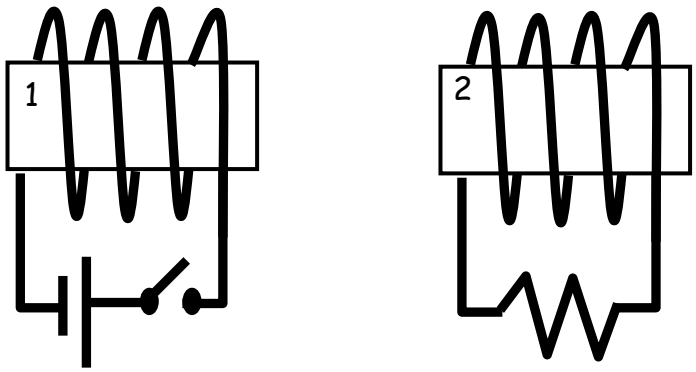
a) When the switch is closed draw the direction of the current in the coil. Show the current on the loops on the coil.

b) Draw arrows on each side of the coil showing the direction of the magnetic field.

c) As the switched is closed, what happens to the magnetic flux?

d) As the switch is closed in coil 1, draw in the direction of the current in coil 2 on the loops and on the resistor.

e) Draw arrows on both sides of coil 2 showing the direction of the magnetic field induced in the coil.



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Problems: (20 pts each) Complete 3 of the following 4 problems. Write "OMIT" on the one you choose to skip.

1. At one instant an electron ($e=-1.6\times10^{-19}C$) is moving at an angle of 30° above south at 6.3×10^{5}m/s in a uniform magnetic field of 5.2T directed due west.

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

b) Sketch a coordinate system that shows the velocity vector and include vectors for the magnetic force and the magnetic field.

c) What would be the magnitude and direction of an electric field that would create an electric force to exactly balance the magnetic force?

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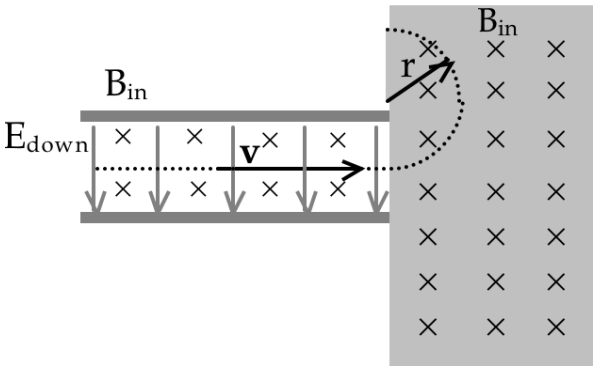
2. A mass spectrometer shown, consists of a velocity selector that allows particles of known charge and a certain velocity to enter into a region of magnetic field where they are deflected differing amounts depending on their charge and mass (all that manage to enter the magnetic field have the same velocity). The velocity selector is a region of crossed electric and magnetic fields that produce opposing forces on the moving charges.



a) For an electron (e^-) or a proton (p^+) moving through fields of $\vec{E} = 100\ {}^{V}/_{m}$ down, and $\vec{B} = 0.50\ T$ into the page, what is the velocity of the particles that do not deflect in the fields (neglect gravity).

b) How far from the slit, and in which direction (up or down) must a detector be placed to detect the electron? ($m_e = 9.11 \times 10^{-31}$kg)

c) How far from the slit, and in which direction (up or down) must a detector be placed to detect the proton? ($m_p = 1.67 \times 10^{-27}$kg)

d) If a proton enters the velocity selector going too fast, what direction will it go? Put this in the sketch with a label.

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3. Two parallel wires each have a length of 2.2 m and are separated by 5.0 mm. Wire one has a current of 7.0A and wire 2 has a current of 3.5 A.

a) If both currents are traveling to the right, what is the magnitude and direction of the magnetic field of wire 1 at the location of wire 2?

b) What is the magnitude and direction of the magnetic force on wire 2 due to wire 1?

c) If both currents are traveling to the right, what is the magnitude and direction of the magnetic field of wire 2 at the location of wire 2?

d) What is the magnitude and direction of the magnetic force on wire 1 due to wire 2?

e) Explain what happens to the directions of the magnetic field due to wire 2 and the magnetic force on wire 1 due to wire 2 if the direction of the current in wire 2 is to the left.

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4. You are curious to find out how much current is flowing through the high voltage power lines. You construct a 1000 turn coil with a radius of 5.0 cm to help you.

You measure a voltage of 80.0 mV when you hold your coil 10 meters below the HV power line. You know that the magnetic field due to the HV power line is changing direction every 1/60 of a second because the current is changing directions at that rate.

a) What is the change in magnetic flux through your coil?
b) Under the power line drawn below, sketch how you would orient the coil to maximize the magnetic flux through the coil.
c) What is the average magnetic field through your coil due to the current in the HV power line.
d) What is the current in the HV power line?