

DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED NEXT TO THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT.

(Use the six directions:  $\uparrow$ N,  $\rightarrow$ E,  $\downarrow$ S,  $\leftarrow$ W,  $\odot$ up or out, and  $\otimes$  down or in.)

1) Consider an electron moving  $\downarrow$ South at a speed of  $2.3 \times 10^6$  m/s in a magnetic field of strength 0.056 T directed  $\leftarrow$ West. a) What is the magnitude of the magnetic force on the electron?

[4]  $2.06 \times 10^{-14}$  Nt. b) What is the direction of the magnetic force on the electron?

[4]  $\odot$ up.

c) What is the magnitude of the acceleration of the electron due to this force?

[2]  $2.26 \times 10^{16}$  m/s<sup>2</sup>.

d) Will this force cause the electron to [speed up, slow down, or change direction]?

[2] change direction.

e) Would the magnetic force on a proton moving at the same speed in the same direction through the same field be [greater, the same, or less] in magnitude than on the electron?

[2] same.

f) Would the magnetic force on the proton moving at the same speed in the same direction through the same field be in the [same, opposite, or other] direction than on the electron?

[2] opposite. g) Would the acceleration of the proton be [the same, bigger or smaller] than the acceleration of the electron?

[2] smaller.

2) In a certain mass spectrograph, singly charged ions are injected into the magnetic field with a speed of  $7.0 \times 10^4$  m/s. a) If the ions have a mass of 27 amu ( $1 \text{ amu} = 1.66 \times 10^{-27}$  kg), and the desired DIAMETER of these ions as they orbit in the field is 24 cm, what strength should the magnetic field of the spectrograph be?

[6] 0.163 T. b) Will oxygen atoms of atomic

mass of 16 amu have a [bigger, the same or smaller] orbit than those of part a (assuming they have the same speed in the same field)?

[3] smaller. c) If the speed of the ions is

decreased with the same magnetic field, will the diameter of the ion's orbits be [smaller, the same, or larger]?

[3] smaller.

3) What is the magnetic field strength at the center of a coil of wire that has 700 turns, a radius of 12 cm, and a current of 3.4 amps?

[6] 0.012 T.

b) If the radius of the coil were decreased by a factor of  $\frac{1}{2}$  (to 6 cm) and the number of turns was increased by a factor of 2 (to 1,400) so the amount of wire used was kept the same, what would the field strength at the center become?

[2] 0.050 T.

4) a) DESIGN an electric motor that gives an average torque of 1.33 Nt-m.

To do this, draw a picture [4]

and then specify the values of all the relevant parameters: [6]

b) If this rotates at 60 cycles per second, what is the average power of this motor?

in Watts:

in horsepower:

[3] 501 W;

[1] 0.672 hp.

5) DESIGN an electric generator that will provide 120 volts rms at 60 cycles per second:

To do this, draw a picture [4]

and then specify the values of all the relevant parameters: [6]

6) a) If the rms-voltage of an electrical receptacle is 220 volts at 60 Hz, what is the peak voltage at the outlet?

[4] 311 V.

b) What is the rms-current in a 1,700 Watt electric heater that is connected across the 220 volt-rms outlet?

[4] 7.73 A.

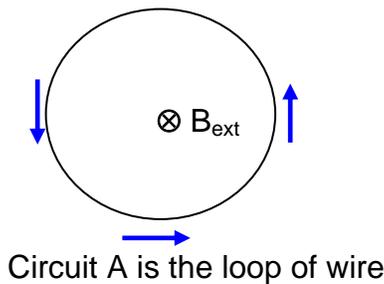
c) Assume that a different 1,700 Watt heater uses a 110 volt rms source instead of the 220 volt rms source.

With this new heater, will the rms-current it draws be [bigger, the same, or smaller] than the original heater that uses a 220 volt rms source?

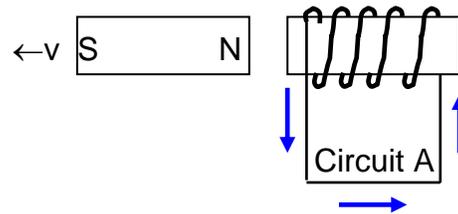
[2] bigger.

7) In each of the four diagrams below, indicate on the A circuit the direction of the induced current in circuit A due to the situation described (if no current, then write the word NONE on circuit A):

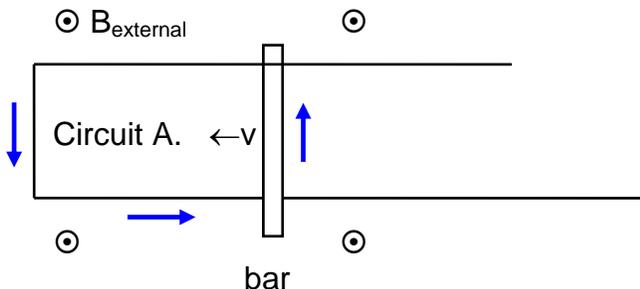
a) the external magnetic field directed DOWN through circuit A is increasing in strength: [4]



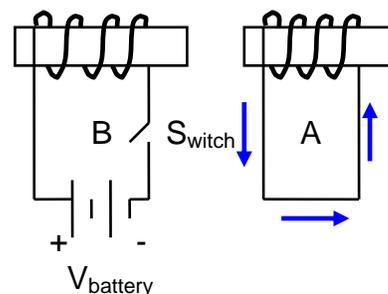
b) the North pole of the bar magnet is pointing toward the solenoid in circuit A and is moving away: [4]



c) The bar is moving to the left: [4]



d) The switch in circuit B is being CLOSED (it was open): [4]



8) Consider a series RLC circuit with an oscillating voltage source of 20 volts (rms) at 600 Hz. The resistance is  $12\ \Omega$ , the capacitance is  $2.2\ \mu\text{F}$ , and the inductance is 39 mH.

a) What is the capacitive reactance ( $X_C$ )?

[3] 120.6  $\Omega$  .

b) What is the inductive reactance ( $X_L$ )?

[3] 147.0  $\Omega$  .

c) What is the impedance ( $Z$ ) of the circuit?

[3] 29.0  $\Omega$  .

d) What is the rms current through this circuit?

[3] 0.689 A .