

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 1.7×10^6 m/s in a magnetic field of strength 0.043 T directed \odot up . a) What is the magnitude of the magnetic force on the electron?

[4] 1.17×10^{-14} Nt. b) What is the direction of the magnetic force on the electron?

[4] East.

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

[2] 1.28×10^{16} m/s².

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 7.0×10^4 m/s. a) If the ions have a mass of 16 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] 0.097 T b) Will carbon atoms of atomic

mass of 12 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

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

[3] larger.

3) What is the magnetic field strength at the center of a coil of wire that has 400 turns, a radius of 8 cm, and a current of 5.4 amps?

[6] 0.017 T.

b) If the radius of the coil were decreased by a factor of $\frac{1}{2}$ (to 4 cm) and the number of turns was increased by a factor of 2 (to 800) so the amount of wire used was kept the same, what would the field strength at the center become?

[2] 0.068 T.

4) a) DESIGN an electric motor that gives an average torque of 2.33 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] 878 W;

[1] 1.18 hp.

5) DESIGN an electric generator that will provide 48 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 1,900 Watt electric heater that is connected across the 220 volt-rms outlet?

[4] 8.64 A.

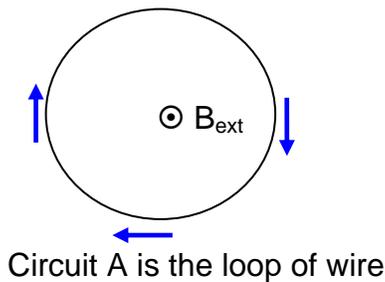
c) Assume that a different 1,900 Watt heater uses a 110 volt rms source instead of the 220 volt rms source.

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?

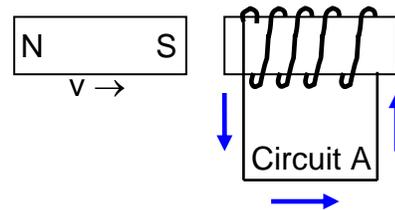
[2] bigger.

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):

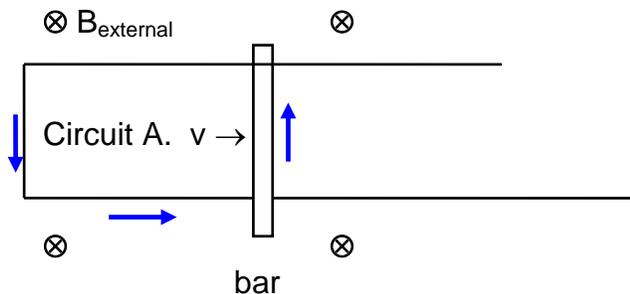
a) the external magnetic field directed UP through circuit A is increasing in strength: [4]



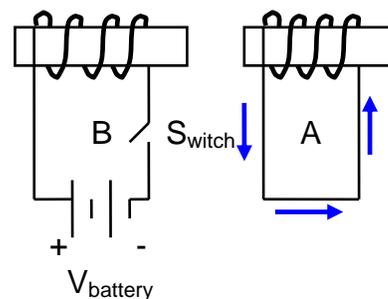
b) the South pole of the bar magnet is pointing toward the solenoid in circuit A and is moving towards it: [4]



c) The bar is moving to the right: [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 700 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] 103.3 Ω .

b) What is the inductive reactance (X_L)?

[3] 171.5 Ω .

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

[3] 69.2 Ω .

d) What is the rms current through this circuit?

[3] 0.289 A .