RH = /66 CH1 = CH2 = /40

PHYS 251 TEST #3 10/26/18 Dr. Holmes NAME______**Key**______

DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PART OF EACH PROBLEM IS MARKED IN THE AREA FOR THE ANSWER. SHOW YOUR WORK FOR PARTIAL CREDIT.

IN ALL CASES INVOLVING DIRECTIONS, EXPRESS YOUR ANSWER AS ONE OF THE FOLLOWING: {UP, DOWN, NORTH, EAST, SOUTH, OR WEST}. (DO NOT EXPRESS IT AS INTO THE PAPER OR OUT OF THE PAPER!)

N ↑ ⊙up
W← →E
↓ ⊗down
S

USE MKS UNITS IN YOUR ANSWERS UNLESS OTHERWISE SPECIFIED.

1) An alpha particle ($m=4*m_{proton}$ and $q=+2e$) is moving with an initial speed of 3×10^6 m/s directed North ↑ in a location where the magnetic field strength is 0.47 Teslas directed down ⊗.
a) What will be the magnetic force on the alpha particle?
Magnitude direction?

[5] ______**4.51×10^{-13} Nt**___ [5] _**West ←**__________.

b) Would the force on a proton moving at the same speed in the same direction in the same magnetic field as the alpha particle be: [(a) the same magnitude and direction, (b) the same magnitude but opposite direction, (c) a **smaller magnitude but same direction**, or (d) a larger magnitude but opposite direction, or (e) other - please specify] ? (answer a,b,c,d, or else specify)

[2] ___**c**_____.

2) A certain mass spectrometer has singly ionized atoms with speed 2.0×10^5 m/s entering a magnetic field of strength 0.704 T. If the ions have a diameter of 33 cm in the field, what is the mass of the ions in kilograms? in amu?

[6] __**9.26×10^{-26} kg**_____. [2] ___**56 amu**_____.

c) Will Cu-64 ions have a [bigger, the same, or smaller] radius?

[2] ____**larger**______.

3) A rectangular loop of wire of width (↔) 9 cm and length (↕) 7 cm is placed in a region where the magnetic field is .054 Teslas in strength as shown in the figure below (the North and South poles of the magnet are indicated in the figure by the N and S letters). A current of 2.2 Amps flows clockwise (as viewed from above) through the wire. Use the direction convention indicated on the first page (N↑, E→, S↓, W←, up⊙, down⊗) a) What will be the magnetic force on the West side of the loop? Magnitude: direction:

[2] ___**8.32×10^{-3} Nt**_________, [2] ______**down ⊗**_____.

b) What will be the magnetic force on the North side of the loop?
Magnitude: direction:

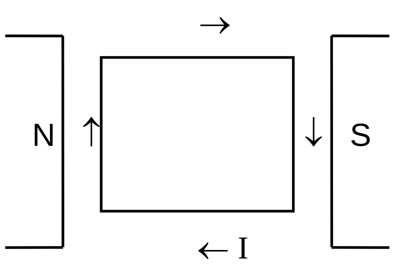
[2] ______**zero**______________, [2] __**none**_______. c) Will the force on the East side be equal and opposite to that on the West side (yes or no)?

[2] __**Yes**__.

d) Which direction will the TOTAL magnetic FORCE on the rectangular current loop be? (specify direction or answer none if force is zero)

[2] __**none**________. e) Which direction will the total magnetic TORQUE on the rectangular current loop be? (specify direction or answer none if torque is zero)

[2] ____**South ↓**__________.



4) DESIGN a D.C. electric motor that provides ⅔ horsepower when it rotates at 600 rpm.

a) Draw a diagram: [4]

b) Specify the values of all the parameters: [6]

c) What is the **average** torque generated by your motor?

[2] ____**7.92 Nt*m**_________.

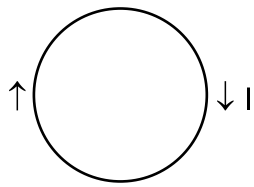
d) What is the **maximum** torque generated?

[2] _______**12.4 Nt*m**________.

5) A circular coil of wire with 700 turns each of radius 12 cm carries a current of 4.2 Amps directed clockwise as viewed from above. a) What is the magnetic field at the center of the loop? Magnitude: direction:

[5] __**.0154 T = 154 G**__________, [5] __**down ⊗**_____. b) If the same current is maintained, but the radius of the circular loop is made larger with the number of turns decreased (so the amount of wire remains the same), will the field at the center of the coil be bigger, remain the same, or be smaller?

[2] ______**smaller**_____.



6) A solenoid has a length of 50 cm, a radius of 4 cm, and 1,200 windings wound around it. A current of 4.2 amps flows through the solenoid. a) What is the magnitude of the magnetic field at the center of the solenoid? **= .0125 T**

[4] _**≈ .0127 T**____________. b) Is this an "exact" or "approximate" calculation?

[2] _________________. c) Is the "approximate" value higher, the same, or lower than the "exact" value?

[2]______**higher**____________. d) In this case, by what percent does the "approximate" value differ from the "exact" value?

[2] ___**1.3 %**_______.

7) A moving electron at a certain instant is located 7 mm North of a long straight wire that carries a current of 4.2 amps due West. a) If the electron is moving South (towards the wire) with a speed of 3×10^5 m/s, what is the magnetic force on the electron at this instant?
Magnitude: direction:
[4] **5.76×10^{-18} Nt**, [4] **West ←** b) What is acceleration the electron will undergo at this instant if this is the only force on the electron?
Magnitude: direction:
[2] **6.33×10^{12} m/s^2**, [2] **West ←**. c) Will this acceleration speed up the electron, slow it down, turn the electron, or not affect the electron's motion since the acceleration is zero?
[2] **turn**. d) If the electron were moving West (parallel to the current) instead of North, would the **magnitude** of the magnetic force on the electron be greater, be the same, or be less?
[2] **same**. e) If the electron were moving East (anti-parallel to the current) instead of West, what would the **direction** of the magnetic force on the electron now be (if zero force, answer N/A).
[2] **South ↓**.

8) Consider the two currents in the figure below. a) Is the net magnetic force between the currents attractive, zero, or repulsive?
[2] **repulsive**. b) What is the magnitude of the **net** magnetic force on the rectangular current?
[6] **1.92×10^{-5} Nt**. c) Is the magnitude of the net magnetic force on the straight current bigger, the same, or smaller than the magnitude of the net magnetic force on the rectangular current?
[2] **same**.

I_{wire} = 12 Amps; $I_{rectangular}$ = 3 Amps, w = 8 cm; near distance to straight wire = 2 cm; distance from far side to straight wire = 6 cm .