RH = / 88 CH1 = CH2 = /80

PHYS 251 TEST #4 11/16/18 Dr. Holmes NAME **Key**

DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED NEXT TO THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT. ALL ANSWERS SHOULD BE IN MKS UNITS UNLESS OTHERWISE INDICATED.

Choices for answers to questions (2-c,d,e), (4-d,e), (5-d), (7-h,i,j):

a. decrease by a factor of 1/4
b. decrease by a factor of 1/2
c. decrease by a factor of √½
d. decreased but not by one of the above factors
e. stay the same
f. increase by a factor of √2
g. increase by a factor of 2
h. increase by a factor of 4
i. increases but not by one of the above factors
k. can't tell from information given

1) Name and write down Maxwell's four equations.

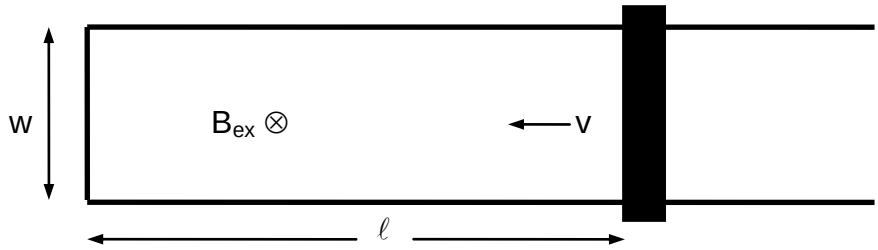
a) [3]

b) [3]

c) [3]

d) [3]

2) Consider the situation depicted in the figure below:



The conducting bar is moving at a speed of 14 m/s (v) to the left across conducting rails that are 22 cm apart (w). The present distance of the bar from the connected end of the rails is 40 cm (ℓ). The strength of the external magnetic field is a constant and uniform .47 T (B_{ex}).

a) What is the voltage induced in the circuit formed by the bar and the rails?

[3] **1.45 volts**.

b) If the circuit has a resistance of 17 Ω, what will the induced current be in the circuit due to this induced voltage?

[3] **.085 A**. c) If the speed of the bar, v, is twice as fast, how will the induced current in the circuit change? (choice a-k above)?

[2] **g (2x)**. d) If the magnetic field, B, is doubled, how will the induced current in the circuit change (choice a-k above)?

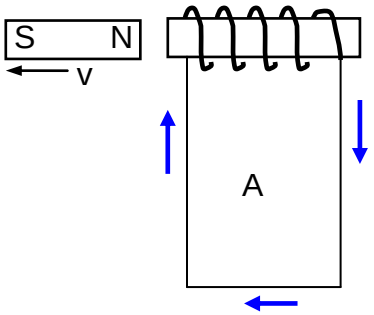
[2] **g (2x)**.

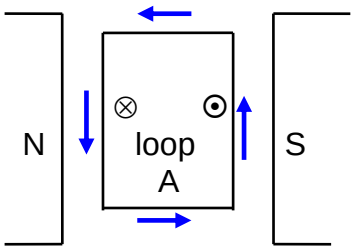
e) If the length of the rails, ℓ, is twice as long, how will the induced current in the circuit change (choice a-k above)?

[2] **e (same)**.

3) Clearly draw in the **direction** of the induced current in circuit A in each of the three diagrams, or write NONE if there is no induced current.

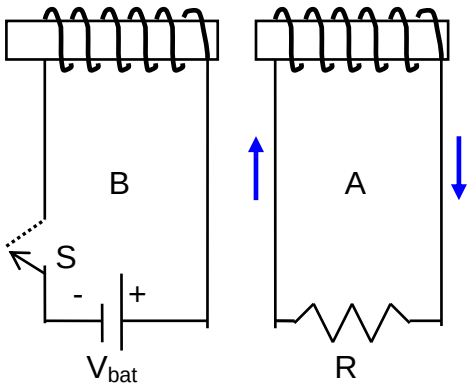
a) the North magnetic pole is moving away from the solenoid of circuit A. [4]





b) the loop is rotating so that the right side is moving out of the paper and the left side is moving into the paper. [4]

c) consider the induced current in the circuit labeled A due to the switch being closed in the circuit labeled B. [4]



4) DESIGN an electric generator that produces 440 volts rms at 60 Hz that uses a coil that rotates in an external magnetic field: a) DRAW A PICTURE: [3]

b) Specify the values for all parameters: [4]

c) What is the amplitude of the sine wave voltage produced?

[4] **622 Volts**.

d) If the number of turns of the coil is doubled, will the rms voltage: (choose one from list at top of page 1)

[2] **g (2x)**. e) If the frequency of rotation is doubled (from 60 Hz to 120 Hz), will the rms voltage: (choose one from list at top of page 1)

[2] **g (2x)**.

5) Consider an inductor of 0.75 H. a) How much current would have to flow through the inductor for it to store 1 Joule of energy?

[3] **1.63 A**. b) If this current was raised from zero to this value at a constant rate over 0.25 seconds, what was the voltage across the inductor during that quarter of a second?

[3] **4.90 Volts**. c) If the current oscillates as a sine function with the above current as its amplitude (AC current) and with a frequency of 60 Hz, what will the amplitude of the voltage across the inductor be?

[3] **461 Volts**. d) If the frequency of the current is doubled (but the amplitude of the current remains unchanged), will the amplitude of the voltage across the inductor: (choose one from list at top of page 1)

[1] **g (2x)**.

6) a) DESIGN a series LRC circuit that has a natural resonance frequency of 300 Hz: [6]

L = _____ R = _____ C = _____ .

b) Give a mechanical analogue of this circuit, that is, give the mechanical analogue of:

Electrical quantity	Mechanical quantity analogue (symbol plus descriptive word)

7) Consider a series LRC circuit with an oscillating voltage source of 14 volts (rms) at 250 Hz. The resistance is 65 Ω, the capacitance is 2 μF, and the inductance is 0.75 H. What is the:

a) capacitive reactance (X_C)? [2] **318 Ω**.

b) inductive reactance (X_L)? [2] **1,178 Ω**.

c) impedance (Z) of the circuit? [2] **862 Ω**.

d) rms current in the circuit? [2] **.016 A**.

e) What is the rms voltage across the inductor ($V_{L\text{-rms}}$)? [2] **19.1 volts**.

f) Does $V_{AC\text{-rms}} = V_{L\text{-rms}} + V_{C\text{-rms}} + V_{R\text{-rms}}$? [1] **No**.

g) Does $V_{AC}(t) = V_L(t) + V_C(t) + V_R(t)$? [1] **Yes**.

h) If the frequency of the voltage source is doubled to 500 Hz, how will the rms current in the circuit change (use one of the choices from the top of page 1): [1] **d (decrease by other)**.

i) If the amplitude of the voltage from the source is doubled, how will the current change (use one of the choices from the top of page 1): [1] **g 2x)**.

j) If the inductance is doubled, how will the current change (use one of the choices from the top of page 1): [1] **d (decrease by other)**.

8. Consider a solenoid with 3,400 turns wrapped around a cylinder of radius 6 cm and length 10 cm. The inductor is part of a DC circuit that contains a 12 volt battery and 62 ohms of resistance. An iron bar is inserted into the cylinder. For each of the following quantities, answer Y if the insertion of the iron changes the quantity, D if it changes the quantity only during the insertion, or answer N if it doesn't affect the quantity at all: (answer Y, N, or D)

a) $L_{inductance}$ [2] **Y** b) $V_{inductor}$ [2] **D** c) $E_{nergy\ stored}$ [2] **Y**

d) H_{inside} [2] **D** e) M_{inside} [2] **Y** f) B_{inside} [2] **Y**