PH2200 Practice Exam III *Summer 2003*

INSTRUCTIONS

1. Write your name and student identification number on the answer sheet.

2. Please cover your answer sheet at all times.

3. This is a closed book exam. You may use the PH2200 formula sheet that is included with the exam.

4. Equations may not be stored in calculators, nor may calculators be exchanged.

5. Record your answers in the form A, B, C, etc, on the answer sheet.

6. This exam consists of 10 concept questions worth four points each and five problems having a total of 15 parts. The problem parts are equally weighted: each is worth four points. The total number of points on the exam is 100.

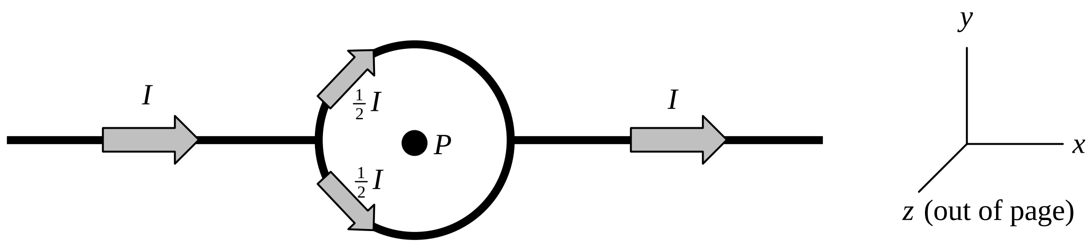
7. If you have any questions during the exam, please raise your hand and wait for assistance.

Concept Questions: Each question has a single correct answer and is worth four points.

1. The American physicist Henry Rowland (1876) placed some charges (in a fixed location) on a non-conducting disk, which he then rotated at high speed about its central axis near a delicate compass. Rowland observed that

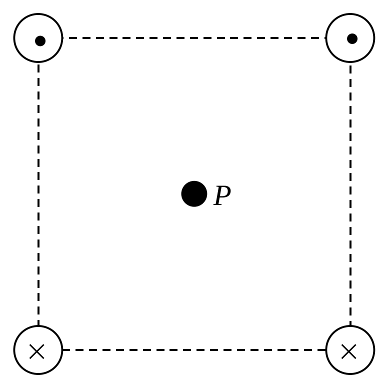
   (A) there was no electric field, so nothing happened to the compass.
   (B) the current created a magnetic field that deflected the compass.
   (C) the charges repelled the compass by Coulomb's Law.
   (D) none of the above.

2. A long wire splits into two identical semicircular segments as shown in the figure below. What is the direction of the magnetic field at point *P*, the center of the circle?



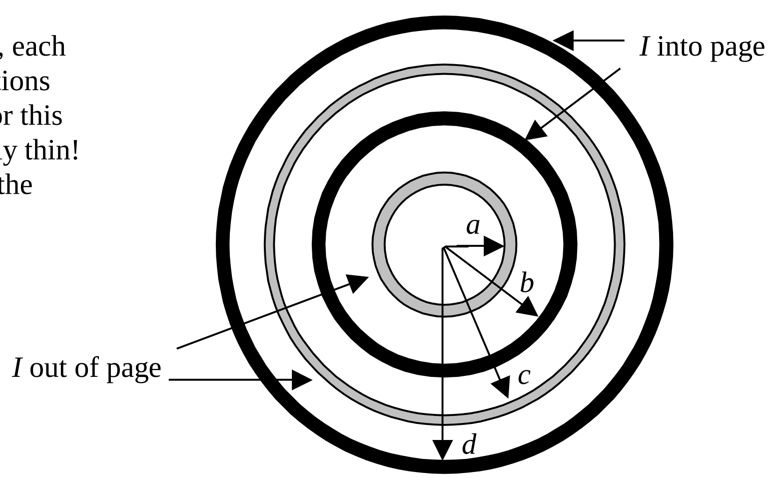
   (A) $+x$ (B) $-x$ (C) $+y$ (D) $-y$ (E) $+z$ (F) $-z$ (G) none of these - there is no field at *P*

3. Four long, straight wires carry the same current. The wires are parallel and pass through the corners of a square. The directions of the currents are shown in the figure. What is the direction of the magnetic field at point *P*, the center of the square?



   (A) toward the top of the page
   (B) toward the bottom of the page
   (C) toward the left
   (D) toward the right
   (E) out of the plane of the page
   (F) into the plane of the page

4. Consider a series of four long concentric cylinders, each carrying the uniform current I in alternating directions into and out of the page, as shown in the figure. For this problem, each cylinder is considered to be infinitely thin! Let r denote the radial distance from the center of the cylinders. The magnetic field is zero

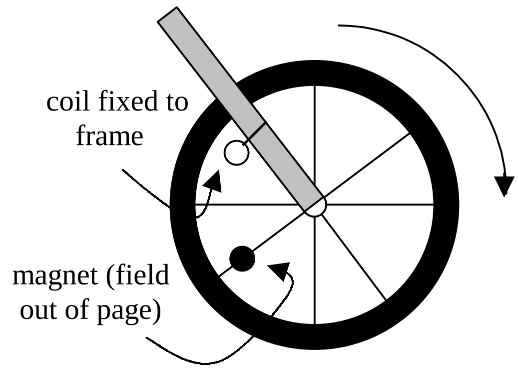


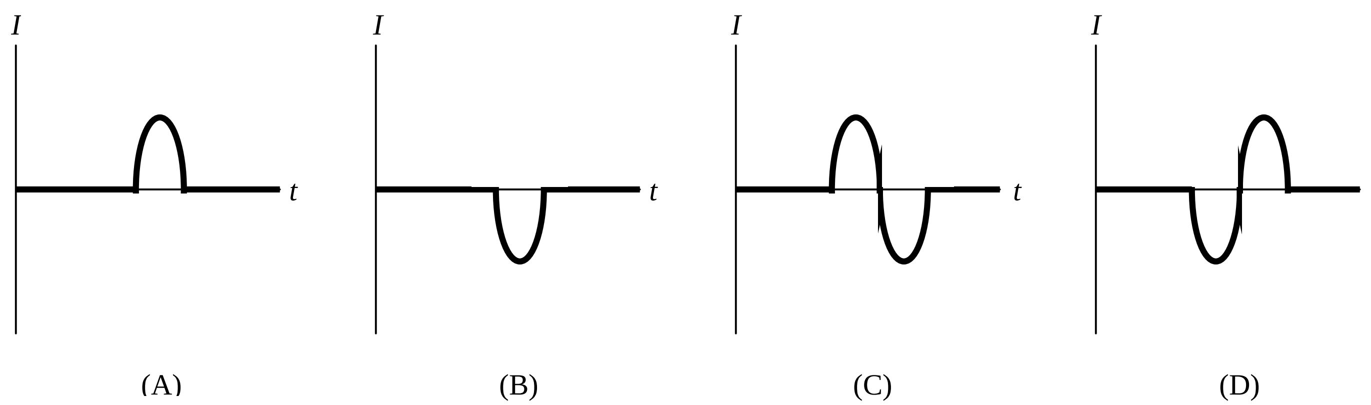
   (A) only for $r < a$.
   (B) only for $r < a$ and $r > d$.
   (C) only for $r < a$ and $b < r < c$ and $r > d$.
   (D) only for $a < r < b$.
   (E) only for $r > d$.

5. In a demonstration conducted during lecture, a magnet was dropped through a metal tube held vertically. Why did the magnet fall much more slowly than a nonmagnetic object passing through the same tube?

   (A) Induced currents were set up flowing around the cylindrical circumference of the tube.
   (B) An induced current was set up flowing along the length of the tube.
   (C) The tube was permanently magnetized.
   (D) The Earth's magnetic field was drawn into the tube and repelled the falling magnet.
   (E) This demonstration was never conducted.

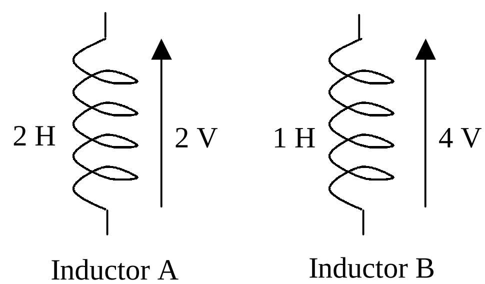
6. In a bicycle speedometer, a bar magnet is attached to the spokes of the wheel and a coil is attached to the frame . As the magnet moves past the coil, a current is induced in the coil. The elapsed time between successive pulses of induced current can be used to compute the bicycle's speed. In the figure to the right, the magnetic field of the rotating magnet is out of the plane of the page when the magnet moves past the coil. If a current in the counterclockwise direction is taken to be positive, which of the graphs best shows the resulting current in the coil as a function of time?



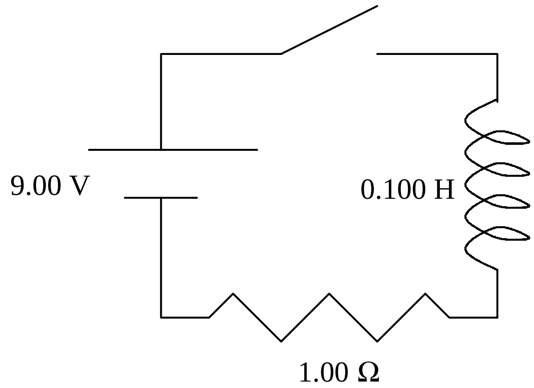


7. Shown to the right are two inductors with both the self-inductance and the induced emf given for each. Which inductor has the greater current flowing through it?

   (A) Inductor A
   (B) Inductor B
   (C) The two currents are equal.
   (D) There is insufficient information.



8. The switch in the circuit to the right is initially open. At time $t = 0$ s the switch is closed. Which of the following statements is false?



   (A) At time $t = 10$ s the energy dissipated by the resistor is negligible.
   (B) At time $t = 10$ s the potential difference across the inductor is negligible.
   (C) At time $t = 0.1$ s the current in the circuit is about 5.69 A.
   (D) At time $t = 0.001$ s the current in the circuit is negligible.
   (E) At time $t = 0.001$ s the potential difference across the inductor is about 9 V.

9. A light-bulb is connected to an electrical outlet that supplies an rms voltage of 115 V at 60 Hz. How many times per second does the current through the light-bulb reverse direction?

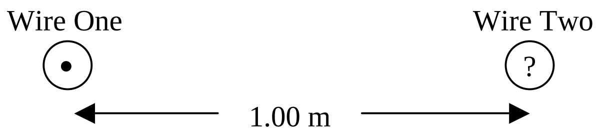
   (A) 30
   (B) 57.5
   (C) 60
   (D) 115
   (E) 120

10. A capacitor is used in a 60 Hz circuit in the USA. When the same capacitor is used in a 50 Hz circuit in Europe, its capacitive reactance will be

   (A) the same as in the USA.
   (B) less than in the USA.
   (C) greater than in the USA.
   (D) any of the previous results, depending on the size of the specific capacitor.
   (E) none of the above.

Problems: Each part of each problem is worth four points.

1. Consider two long, straight parallel wires separated by 1.00 m. In the figure below, the current through wire one is 1.00 A and is directed out of the plane of the page. The direction and magnitude of the current through wire two is unknown. Wire two is observed to be attracted toward wire one with a force per unit length of 2.00×10^{-7} N/m.



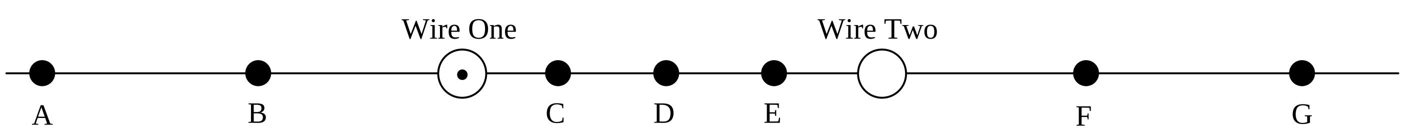
1-1 Is the current through wire two into or out of the plane of the page?

(A) into page
(B) out of page

1-2 What is the current through wire two?

(A) 1.00 A
(B) 1.50 A
(C) 2.00 A
(D) 2.50 A
(E) 3.00 A

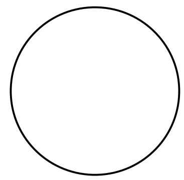
1-3 Suppose a third wire is to be positioned so that the net magnetic force on wire two is zero. If wire three carries a current of 0.500 A directed out of the plane of the page, at which position A through G should wire three be placed?



(A) A
(B) B
(C) C
(D) D
(E) E
(F) F
(G) G

2. A long cylindrical conductor having a radius of 5.00×10^{-2} m carries a current of 10.0 A uniformly distributed over its cross-section and directed out of the page in the figure below.

10.0 A (out of page)



2-1 What is the magnitude of the magnetic field produced by the cylindrical conductor a distance of 0.500 m from its center?

(A) 2.00×10^{-6} T
(B) 4.00×10^{-6} T
(C) 6.00×10^{-6} T
(D) 8.00×10^{-6} T
(E) 1.00×10^{-5} T

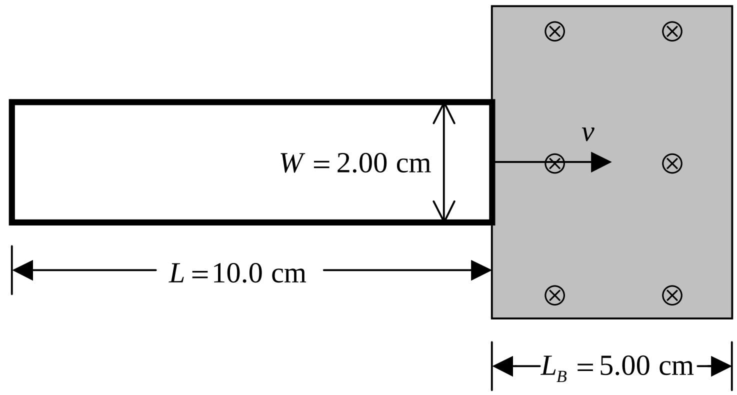
2-2 What is the magnitude of the magnetic field at a point inside the cylindrical conductor, a distance of 2.50×10^{-2} m from its center?

(A) 2.00×10^{-5} T
(B) 4.00×10^{-5} T
(C) 6.00×10^{-5} T
(D) 8.00×10^{-5} T
(E) 1.00×10^{-4} T

2-3 Where is the magnitude of the magnetic field due to the current carrying wire greatest?

(A) at the center of the wire
(B) at points inside the wire but neither at the center nor on the surface of the wire
(C) on the surface of the wire
(D) at points outside the wire but not infinitely far away from the wire
(E) at points infinitely far away from the wire

3. At time $t = 0$, a rectangular single-loop coil of resistance $R = 5.00\ \Omega$ and dimensions $W = 2.00$ cm and $L = 10.0$ cm enters a region of constant magnetic field directed into the page with $B = 2.50$ T. The length of the region containing the magnetic field is $L_B = 5.00$ cm as shown. The coil is observed to move to the right with the constant speed of $v = 2.00$ cm/s



3-1 At time t = 0.500 s, what is the magnitude of the applied force required to maintain this velocity?

(A) 0
(B) 1.00×10^{-5} N
(C) 1.25×10^{-5} N
(D) 1.75×10^{-5} N
(E) 2.25×10^{-5} N

3-2 At time t = 3.00 s, what is the magnitude of the applied force required to maintain this velocity?

(A) 0
(B) 1.00×10^{-5} N
(C) 1.25×10^{-5} N
(D) 1.75×10^{-5} N
(E) 2.25×10^{-5} N

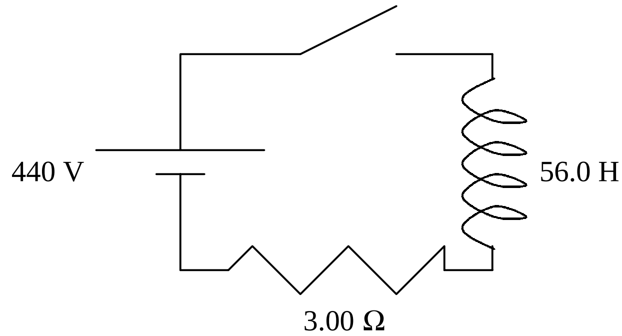
3-3 What is the power dissipation in the coil at time t = 2.00 s?

(A) 1.00×10^{-7} W
(B) 1.50×10^{-7} W
(C) 2.00×10^{-7} W
(D) 2.50×10^{-7} W
(E) 3.00×10^{-7} W

3-4 In which direction will the induced current flow through the loop at time t = 2.00 s?

(A) clockwise
(B) counterclockwise
(C) There is no induced current at time t = 2.00 s.

4. A large electromagnet used for lifting scrap metal has a self-inductance of 56.0 H. It is connected through a switch to a constant 440 V source of emf. The total resistance of the circuit is 3.00 Ω.



4-1 What is the time constant for this circuit?

(A) 1.19 s
(B) 6.03 s
(C) 12.1 s
(D) 18.7 s
(E) 23.4 s

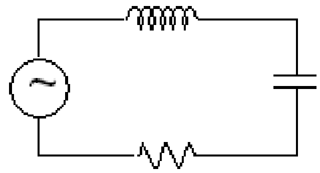
4-2 When the switch is closed, how much time does it take the current through the inductor to reach 75.0% of its final value?

(A) 12.9 s
(B) 15.0 s
(C) 18.7 s
(D) 22.3 s
(E) 25.9 s

4-3 What energy is stored in the inductor a long time after the switch is closed?

(A) 2.92×10^{5} J
(B) 3.60×10^{5} J
(C) 4.43×10^{5} J
(D) 5.65×10^{5} J
(E) 6.02×10^{5} J

5. Consider the series RLC circuit shown below with the following components: $R = 225\ \Omega$, $L = 20.0\times10^{-3}$ H, $C = 1.00\times10^{-7}$ F, and $\Delta V_{rms} = 115$ V.



5-1 Find the (angular) frequency of the ac generator for which resonance occurs.

(A) 1.17×10^{4} rad/s
(B) 2.24×10^{4} rad/s
(C) 3.01×10^{4} rad/s
(D) 3.89×10^{4} rad/s
(E) 4.28×10^{4} rad/s

5-2 Determine the average power delivered to the circuit by the ac generator when operating at the resonance frequency.

(A) 23.0 W
(B) 39.2 W
(C) 58.8 W
(D) 74.1 W
(E) 85.0 W

PH2200 Practice Exam III *Summer 2003*

Name: ________________________ ID# ________________________

Concept Questions	***Problems***	
1. B	1-1 B	4-1 D
2. G	1-2 A	4-2 E
3. D	1-3 F	4-3 E
4. C	2-1 B	5-1 B
5. A	2-2 A	5-2 C
6. D	2-3 C	
7. D	3-1 B	
8. A	3-2 A	
9. E	3-3 C	
10. C	3-4 B	
Subtotal 1 10	Subtotal 2 10	Subtotal 3 5

Exam Score 25