Physics 202, Midterm Exam 2, Spring 2007
Solution
Instructions

1. **Do not wear hats or caps during the exam.**
2. **Please leave your back packs *etc.* near the wall of the hall. You should have ONLY your one 8-1/2 x 11 formula sheet and your calculator.** ***No cell phones!***
3. Use X5 answer sheet (scantron)
4. Use No. 2 pencil
5. Fill in your Last Name, First Name, Middle Initial
6. **(*VERY IMPORTANT*)** ***Fill in your 10 digit UW Student ID*** **NOT Your SOCIAL SECURITY Number**
7. Work out the problems, draw pictures, … on this exam book. There is an extra sheet on the back of your exam that you can use for scratch - **Please clearly indicate your final answers on this exam book and fill in the corresponding mark on the X5 answer sheet.**
8. You must write your name, UW Student ID and circle your lab instructor name on this exam book.
9. **You must turn in this exam book to your lab instructor**
10. Do not spend too much time on any particular problem - you need to answer all questions

Name:____

10 Digit UW Student ID:____

Lab Instructor:

323-330 Adam Dally	**307-322** Tony Barnes	**302-305** Yu Gao	**324-326-327** Brendan Hodis
311-321 Adam Falkowski	**303-329** Jon Eisch	**310-331** Mike Phillips	
304-308 Chris Rivard	**309-325** Miao Zhang		

Constants:

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2

$k = 1/4\pi\varepsilon_0 = 9 \times 10^9$ N-m^2/C^2

$c = 3.0 \times 10^8$ m/s

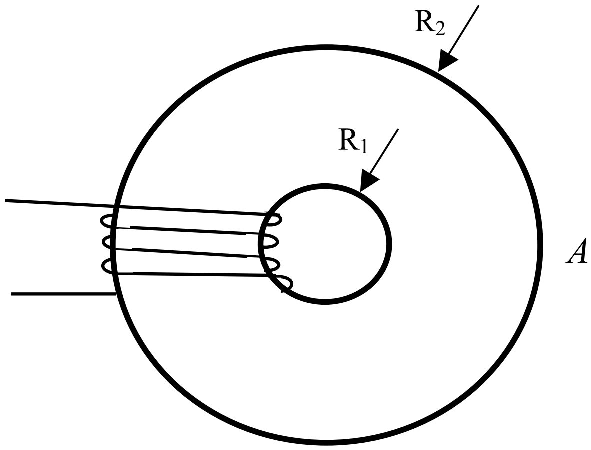
$g = 9.8$ m/s^2

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi\ 10^{-7}$ Tm/A

The following three questions refer to the situation described below:

An iron toroid has a coil of 500 turns of wire around it as shown. The relative permeability of the iron is m = 1500. The inner radius of the toroid is R_1 = 15 cm and the outer radius is R_2 = 30 cm. The resistance of the coil is 50 Ω. A power supply providing a constant 100 V is attached to the coil.



I. (5 pts) What is the magnetic field at a radius $r = (R_1 + R_2)/2$?

a. $B(r) =$ 0.67 T
b. $B(r) =$ 0.21 T
c. $B(r) =$ 0.43 T
d. $B(r) =$ 1.33 T
e. $B(r) =$ 0.33 T

2. (5 pts) If a radial slot were cut through the toroid (thickness *2 mm*) at position *A*, the B-field at $r = (R_1 + R_2)/2$ in the iron would

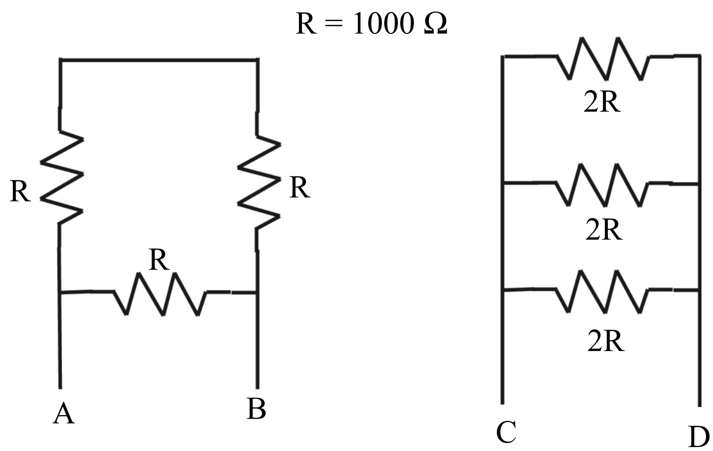
a. decrease
b. increase
c. remain the same

3. (5 pts) If the gap is filled with a *2 mm* slab of gold (a diamagnetic material), the field in the gap would then

a. very slightly increase
b. very slightly decrease
c. remain the same after the gap was cut
d. be zero
e. have the same value as before the gap was cut

The following question is by itself.

4. (5pts) Three resistors are connected in each of the circuits shown below. R=1000 Ω. The equivalent resistance between points A and B is R_{AB} and is to be compared to the similar equivalent R_{CD}:



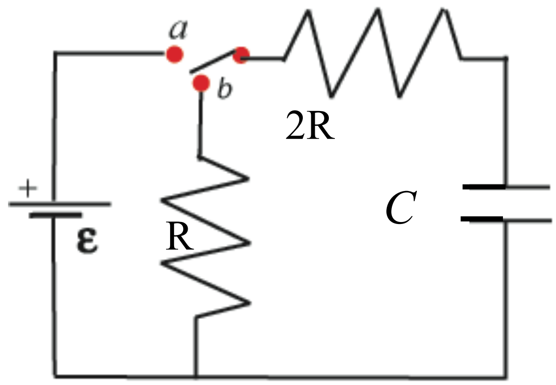
a) $R_{AB} > R_{CD}$
b) $R_{AB} < R_{CD}$
c) $R_{AB} = R_{CD} = 0$
d) $R_{AB} = R_{CD}$
e) cannot be compared

The following question is by itself.

5. (5pts) A string of 5W holiday lights (all bulbs in parallel) is connected to a 15 V power supply that is fused for a maximum of 15 A. The largest number of bulbs that can be in the string without blowing the fuse is

a. 3
b. 9
c. 15
d. 45
e. 225

The following three questions pertain to the situation described below.
A capacitor and two resistors are connected in the circuit as shown. R= 1000 Ω and C = 30 μF. The ideal battery generates 10V. Initially, the capacitor is uncharged and the switch is open.



6. (5pts) Just after the switch (*a*) is closed, what is the current drawn from the battery?

a. I = 3. mA
b. I = 5. mA
c. I = 15. mA
d. I = 12. mA
e. I = 8. mA

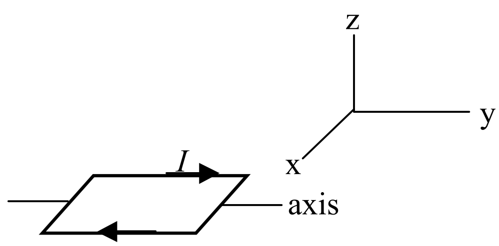
7. (5pts) After a long time, the switch is moved from position *a* to *b*. The time constant for discharge of the capacitor is:

a. $\tau = 0.9$ sec
b. $\tau = 3 \times 10^{-2}$ sec
c. $\tau = 6 \times 10^{-2}$ sec
d. $\tau = 8 \times 10^{-2}$ sec
e. $\tau = 9 \times 10^{-2}$ sec

8. (5pts) After the switch is opened (as in the previous question), the energy dissipated in the resistors during the complete discharge of the capacitor is:

a. E = 0.04 mJ
b. E = 0.38 mJ
c. E = 0.15 mJ
d. E = 1.5 mJ
e. E = 2.0 mJ

The following question is by itself.

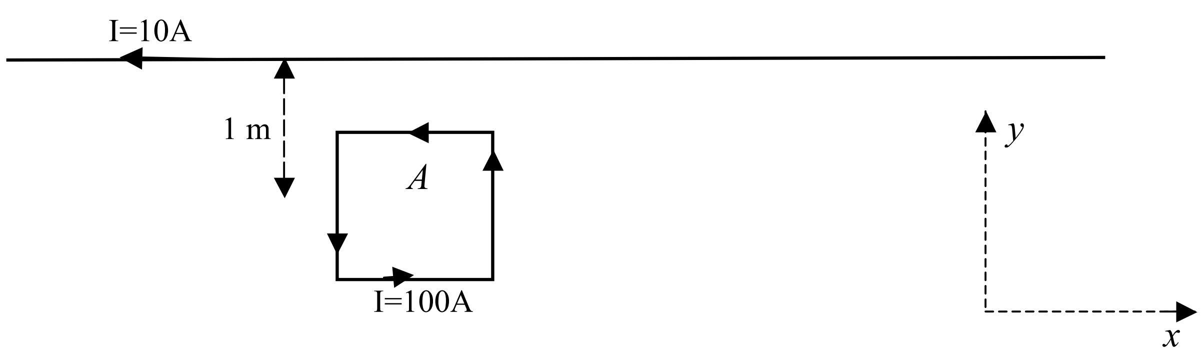


9. (5pts) A square loop of wire 10 cm on a side is mounted free to rotate about an axis in the y direction as shown. There is a current of I=10 A flowing around the loop in the direction shown. The loop is placed in a constant B field of 1 T pointing in the +x direction. The potential energy varies with orientation. The magnitude of the difference between the greatest and smallest value is

a. 0.02 J
b. 0.01 J
c. 0.1 J
d. 0.2 J
e. 1.0 J

The following two questions pertain to the situation described below.

Consider a long wire carrying current I=10A. A center of a square circuit *A* (1 m on a side) carrying current 100 A is located 1 m from the wire as shown. *Note the axes*.



10. (5pts) The net force on circuit A is

a. in -x direction
b. in +y direction
c. in -y direction
d. in +x direction
e. zero

11. (5pts) The torque on circuit A is

a. in -x direction
b. in +y direction
c. in -y direction
d. in +x direction
e. zero

The following question is by itself.

12. (5pts) You are looking at the face of a CRT (beam of electrons coming toward you.) The north pole of a magnet held above the beam will deflect it

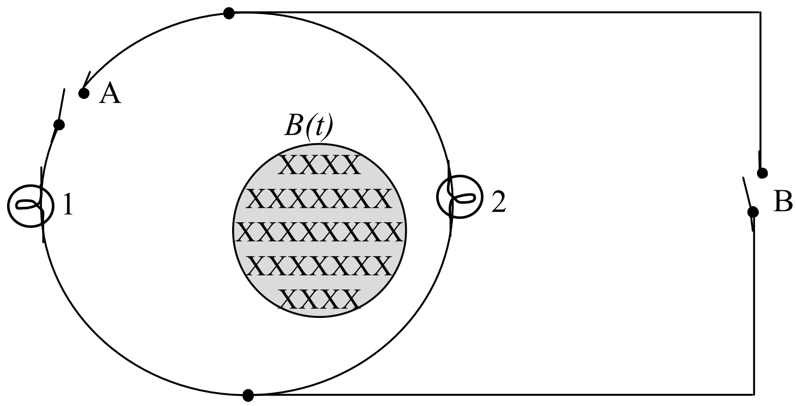
a. right
b. left
c. up
d. down
e. have no effect

The following question is by itself.

13. (5pts) A helium nucleus ($Q = +2e$; $m = 6.6 \times 10^{-27}$ kg) is moving in a uniform magnetic field of $0.5\ T$ in a circular orbit of radius $0.5\ m$. The potential difference required to provide the kinetic energy of the ion (from rest) is

a. insufficient information given
b. $7.5 \times 10^5\ V$
c. $1.5 \times 10^6\ V$
d. $3.0 \times 10^6\ V$
e. $6.1 \times 10^6\ V$

The following two questions pertain to the situation described below.



Two light bulbs are connected to opposite sides of a circular loop of wire as shown. A changing magnetic field is confined to the smaller gray area. All switches are initially open. When switch A is closed both bulbs are lighted.

14. (5pts) Switch A remains closed and then switch B is closed. Then

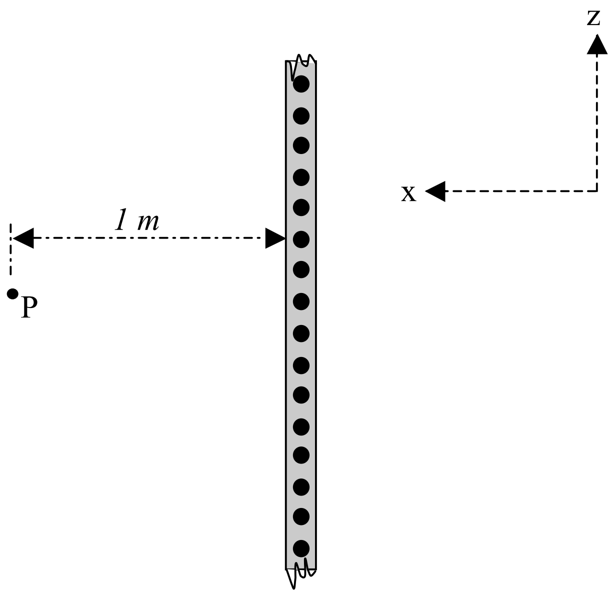
a. both lights remain lit.
b. light 1 is lit and light 2 goes out.
c. light 2 is lit and light 1 goes out.
d. both lights go out.
e. insufficient information is given

15. (5pts) Switch B remains closed and then switch A is opened. Then

a. both lights remain lit.
b. light 1 is lit and light 2 goes out.
c. light 2 is lit and light 1 goes out.
d. both lights go out.
e. insufficient information is given

The following question is by itself.

A very large current sheet is shown. The current is in the -*y* direction and J_S represents the current per unit length measured along the *z* axis, $J_S = 100\ A/m$.



16. (5pts) The magnetic field at point P (*1 m* from the current plane) is

a. $\left|\vec{B}\right| = 252\ \mu T$

b. $\vec{B} = 63\ \mu T\ \hat{z}$

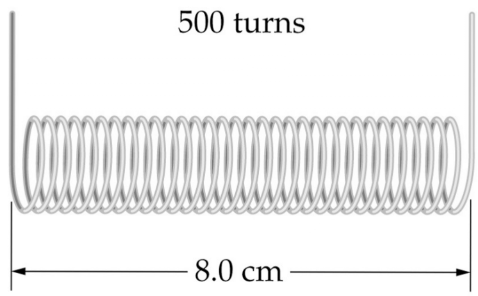
c. $\vec{B} = -63\ \mu T\ \hat{z}$

d. $\vec{B} = 126\ \mu T\ \hat{z}$

e. $\vec{B} = -126\ \mu T\ \hat{z}$

The following two questions pertain to the situation described below.

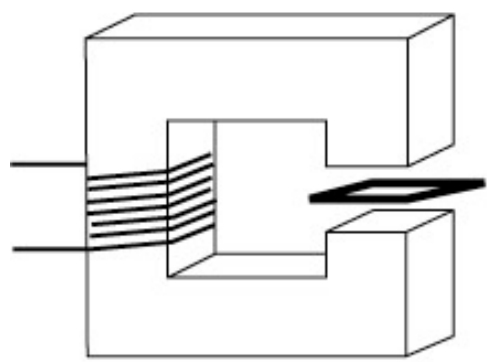
A solenoid of 500 turns has a current flowing of 1.5 A. The coil is 2 cm in diameter and 8 cm in length.



17. (5pts) The magnetic flux Φ within the solenoid is

a) 2.9×10^{-7} T-m^2
b) 3.8×10^{-6} T-m^2
c) 3.0×10^{-7} T-m^2
d) 9.8×10^{-4} T-m^2
e) 1.2×10^{-2} T-m^2

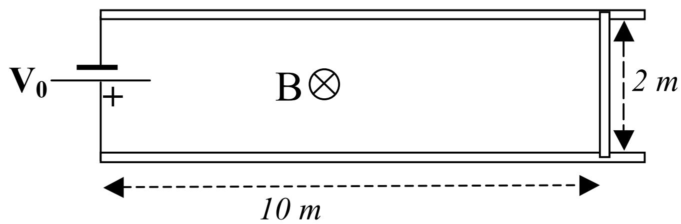
18. (5pts) A magnet has a field of 1.4 T in the gap. A square loop of wire 0.5 m on a side has a resistance of 50 Ω per meter. The force required to extract the loop at a constant velocity of 2 m/s is:
Neglect edge effects.



a) $4.9 \times 10^{-3} N$
b) $6.9 \times 10^{-3} N$
c) $9.8 \times 10^{-3} N$
d) $1.39 \times 10^{-2} N$
e) $1.96 \times 10^{-2} N$

The following two questions pertain to the situation described below.

Two conducting rails are placed *2 m* apart. A *2 m* metal bar is welded in place across the rails and a battery (V_0 = *600 V*) is placed across one end as shown. A constant magnetic field (*B=1.5 T*) exists throughout the area between the rails directed into the page. The resistance of the rails is negligible but the resistance of the bar is *100 Ω per meter*.



19. (5pts) The force on the bar is

a. 4.5 N to the right
b. 4.5 N to the left
c. 9 N to the right
d. 9 N to the left
e. zero

20. (5pts) The battery is replaced by a wire. To apply a force of the same magnitude on the bar directed to the right, the initial field (*B=1.5 T into the page*) must change at the constant rate

a. no change is necessary

b. $\frac{d|\vec{B}|}{dt} = +60\ T/s$

c. $\frac{d|\vec{B}|}{dt} = -60\ T/s$

d. $\frac{d|\vec{B}|}{dt} = +30\ T/s$

e. $\frac{d|\vec{B}|}{dt} = -30\ T/s$