Physics 1215 – Spring 2008
Exam #3
April 11, 2008

Name (Print): Key

My signature below is a statement that all work contained in this exam is my own work. I have not copied work from any other source, or used any material other than one 3 by 5 card and my calculator.

Name (Signature):____________________

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE INSTRUCTED TO DO SO.

STOP WORKING ON THIS EXAM AS SOON AS YOU ARE INSTRUCTED TO DO SO.

You will have approximately 1 hour to do this exam

- The following exam consists of 8 multiple-choice questions and 2 worked problems.
  - Point values are assigned to each problem in the exam.
- It is a good idea to first skim through the entire test and begin with the problems that seem most familiar. If you get stuck on a problem, skip to another.
- For the computational problems, please show all problem solving steps and all your work.
  - All work must be done on the pages provided.
  - Please write neatly and put a BOX around your final answer.
  - Use significant figures in your answers.
- Calculators may be used only to do arithmetic. You cannot use your calculator for solving algebraic equations, for graphing, for vectors, etc.
- One 3 by 5 card with written notes may be used. No books or other notes are allowed.

Problem #	Max Points	Score	Problem #	Max Points	Score
1	5		6	5	
2	5		7	5	
3	5		8	5	
4	5		9	30	
5	5		10	30	
			Total	100	

Constants

$k = 8.99 \times 10^9$ N·m^2/C^2

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

$\mu_0 = 4\pi \times 10^{-7}$ Wb/A·m

1. Two different wires are made of the same material. The first wire is half as long as the second wire with a radius half as large as the second wire. If the first wire is attached to a voltage of V, while the second wire is attached to a voltage of $2V$, how will the current in the first wire (I_1) compare with the current in the second wire (I_2)?

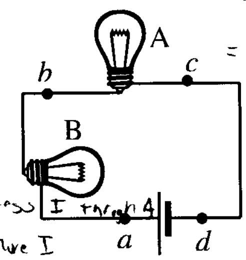
- ☐ $I_1 = 2I_2$
- ☐ $I_1 = 4I_2$
- ☐ $I_1 = I_2$
- ☐ $2I_1 = I_2$
- ☒ $4I_1 = I_2$

$L_1 = L_2/2$, $r_1 = r_2/2$

$I = V/R = \frac{VA}{\rho L} = \frac{V\pi r^2}{\rho L}$

$I_1 = \frac{V\pi r_1^2}{\rho L_1}$ $I_2 = \frac{2V\pi r_2^2}{\rho L_2} = \frac{2V\pi(2r_1)^2}{\rho(2L_1)} = 4I_1$

2. Consider the circuit shown on the left. Which of the following changes will cause bulb A to glow brighter?



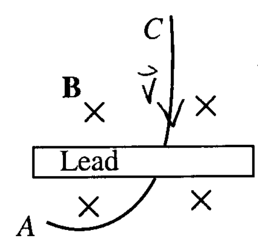
- ☐ Putting another bulb in series with bulb A at point c. ⇒ Less I
- ☐ Putting another bulb in parallel with bulb A between points b and c. ⇒ Less I through A
- ☒ Putting another bulb in parallel with bulb B between points a and b. ⇒ more I through A
- ☐ Putting another bulb between points c and d with a new wire. ⇒ V_1 change
- ☐ More than one of the above changes will cause bulb A to glow brighter.
- ☐ None of the above changes will cause bulb A to glow brighter.

3. You own a 1400 W hair dryer that is manufactured for use in the USA where the rms voltage is 120 V. If you were to plug this hair dryer into a socket in Europe where the rms voltage is 240 V, what would be the power dissipated in the hair dryer? Assume that the resistance of the heating element is the same at both voltages.

$P = \frac{V^2}{R}$ when $V \to 2V$, $P \to 4P$

- ☐ 350 W
- ☐ 1400 W
- ☒ 5600 W
- ☐ 700 W
- ☐ 2800 W
- ☐ 57,600 W

4. A charged particle passes through a region of space that has a uniform magnetic field directed into the paper, **B**, as shown. Halfway through the region of space, the particle passes through a piece of lead and loses momentum. The path of the particle is shown by the curved line. Which of the following is true?



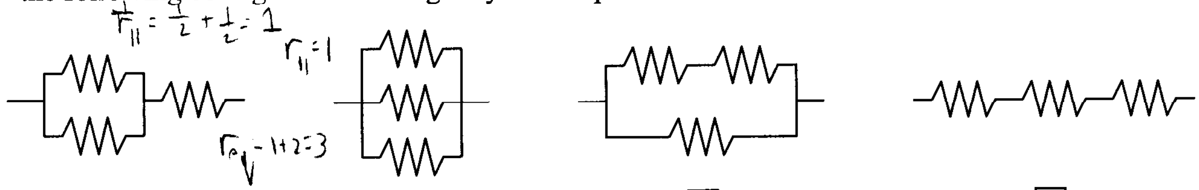
Higher p

lower p

- ☐ The particle starts at point C and ends at point A and has a positive charge.
- ☒ The particle starts at point C and ends at point A and has a negative charge.
- ☐ The particle starts at point A and ends at point C and has a positive charge.
- ☐ The particle starts at point A and ends at point C and has a negative charge.
- ☐ None of the above can be true.

$q < 0$

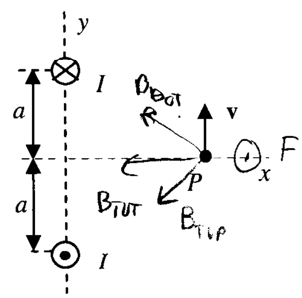
5. You want to use three resistors in a circuit. If each of them has a resistance of 2 Ω, which of the following configurations will give you an equivalent resistance of 3 Ω?



☒ ☐ ☐ ☐

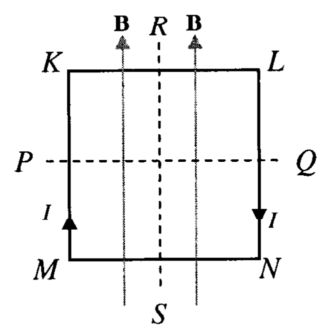
☐ None of the above.

6. Two parallel wires are placed perpendicular to the plane of the paper and carry currents of equal magnitude but opposite direction, as shown in the figure. A proton is moving in the plane of the paper in the direction shown with velocity **v**. What direction is the magnetic force on the proton when it is at point *P*?



☐ to the left (negative *x*)
☐ to the right (positive *x*)
☐ into the paper (negative *z*)
☒ out of the paper (positive *z*)
☐ there is no force on the proton.

7. A square loop of wire lies in the plane of the page and carries a current I as shown. There is a uniform magnetic field **B** parallel to the side *MK* as indicated. The loop tends to rotate:

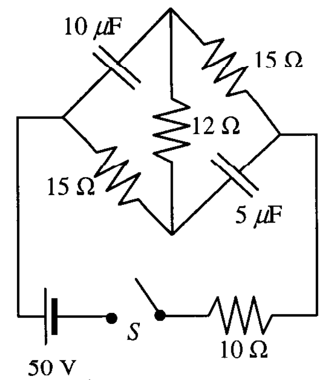


☒ about *PQ* with *KL* coming out of the page
☐ about *PQ* with *KL* going into the page
☐ about *RS* with *MK* coming out of the page
☐ about *RS* with *MK* going into the page
☐ about an axis perpendicular to the page

8. The Ampère-Maxwell law is valid

☐ when there is a high degree of symmetry in the geometry of the situation.
☐ when there is no symmetry.
☐ when the current is constant.
☐ when the magnetic field is constant.
☒ for all of these conditions.

9. The capacitors shown in the circuit to the right are initially uncharged
   a) What is the initial current from the battery when the switch *S* is closed? (Hint: Consider how a capacitor behaves when it is initially being charged?)
   b) What is the current from the battery after the switch has been closed a long time?
   c) What is the final charge on the 5 μF capacitor?



a) initially, capacitors act like wires, so the three resistors are in parallel

$\frac{1}{R_{\parallel}} = \frac{1}{15} + \frac{1}{15} + \frac{1}{12} \Rightarrow R_{\parallel} = 4.62\,\Omega$

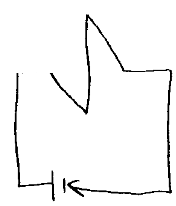
So $R_{eq} = 10\,\Omega + 4.62\,\Omega = 14.62\,\Omega$

$I = V/R_{eq} = 50V/14.62\,\Omega = \boxed{3.4\,A}$

b) Finally, no current flows through capacitor, so

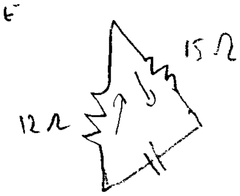
$V - I(15 + 12 + 15 + 10\,\Omega) = 0$

$I = V/52\,\Omega = \frac{50\,V}{52\,\Omega} = \boxed{.96\,A}$



Current path

c) Use Loop rule CWise

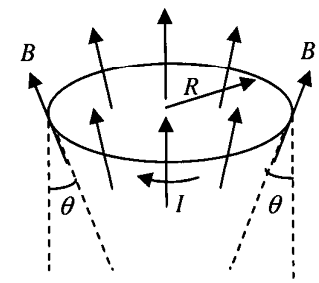


$-I(12\,\Omega) - I(15\,\Omega) + V_c = 0$

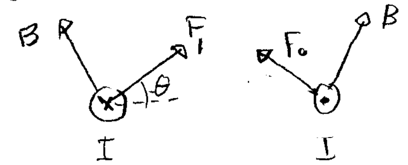
$V_c = I(27\,\Omega) = (.96A)(27\,\Omega) = 25.9\,V$

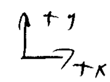
$Q = CV = (5\times10^{-6}F)(25.9\,V) = \boxed{1.3\times10^{-4}\,C}$

10. A circular ring of wire with radius R is placed in a radially symmetric diverging magnetic field that is oriented in a direction generally perpendicular to the plane of the wire, as shown in the figure. The strength of the magnetic field at the ring is everywhere the same magnitude B, and its direction at the ring everywhere makes an angle of θ with the normal to the ring. (If the ring is in the x-y plane, the magnetic field is mostly along the z axis with a small component parallel to the x-y plane.) Find the magnitude and direction of the force the field exerts on the ring when the ring carries a current I. Write your answer in terms of variables given.



(Hint: Use the Biot-Savart law to find the force on a small section of the wire, dL, and integrate over the whole wire. The symmetry of the problem can greatly simplify the amount of work you need to do.)





Look at two sides of ring

$F = I\vec{L}\times\vec{B}$

Note that the x part of F_1 cancels the x part of F_0, so the total force will be only along y. ($F_{1y} = F_1 \sin\theta$)

So $\vec{F} = \int I d\vec{L}\times\vec{B}$ $\quad F_y = \int I dL B \underbrace{\sin 90}_{\text{Angle between I and B}} \sin\theta$

$F_y = IB\sin\theta \int_0^{2\pi R} dL$

$= IB\,2\pi R\sin\theta$

$$\boxed{\vec{F} = 2\pi R I B \sin\theta\ \hat{y}}$$